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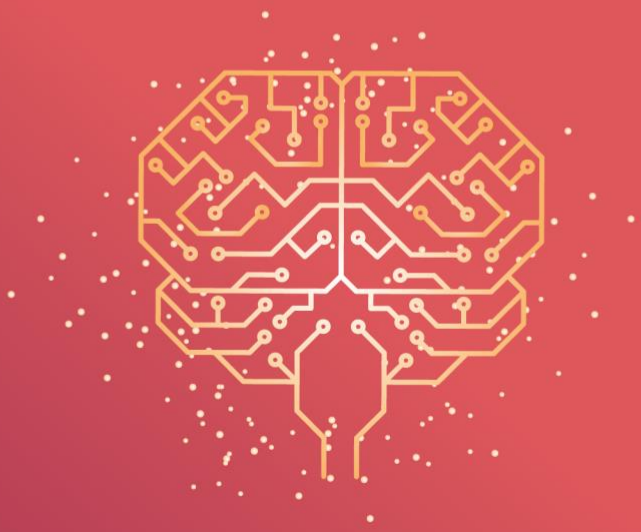

Opportunities and Challenges of **Artificial Intelligence** Technologies for the **Cultural and Creative Sectors**

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ABSTRACT (EN)

This study aims to

- identify opportunities in artificial intelligence (AI) for the Cultural and Creative Sectors (CCS), taking into consideration also the current challenges they pose, and
- suggest actions for CCS stakeholders as well as national/international policymakers in applying AI and promoting a culturally diverse offer of European works.

Ten cultural and creative sectors were analysed including architecture, book publishing, fashion, film, museums, music, news media, performing arts, visual art and video games. Chapter 4 discusses the opportunities in AI, in particular for the smaller, independent players that are characteristic of Europe's CCS. It summarises use cases that can help cultural and creative sectors (1) save costs and increase efficiency, (2) make decisions, (3) discover and engage the audience and (4) inspire human creation. As AI is expected to bring a competitive edge to those who successfully develop or adopt it, these use cases aim to inspire stakeholders in the CCS and help them seize opportunities. Chapter 5 presents potential risks and Chapter 6 identifies the key challenges to overcome. Chapter 7 provides recommendations for creative entrepreneurs as well as national/international policy makers in five areas, notably access to data, access to skills, transparency, collaborative ecosystems and access to finance. Chapters 8 to 17 presents more detailed use cases and recommendations per creative sector, for those who want to zoom in on one sector only.

All information and views set out in this publication are those of the authors and do not necessarily reflect the official opinion of the European Commission.

ABSTRACT (FR)

Cette étude vise à

- identifier les opportunités de l'intelligence artificielle (IA) pour les secteurs culturels et créatifs (SSC), en tenant compte également des défis actuels qu'elles posent, et
- proposer des actions pour les parties prenantes du secteur culturel et créatif ainsi que pour les décideurs politiques nationaux et internationaux dans l'application de l'IA et la promotion d'une offre culturellement diversifiée d'œuvres européennes.

Dix secteurs culturels et créatifs ont été analysés, notamment l'architecture, l'édition de livres, la mode, le cinéma, les musées, la musique, les médias d'information, les arts du spectacle, les arts visuels et les jeux vidéo. Le chapitre 2 examine les possibilités offertes par l'IA, en particulier pour les acteurs indépendants de petite taille qui sont la caractéristique du SSC européen. Il résume les cas d'utilisation qui peuvent aider les secteurs culturels et créatifs à (1) économiser des coûts et augmenter l'efficacité, (2) prendre des décisions, (3) découvrir et engager le public et (4) inspirer la création humaine. Comme l'IA devrait apporter un avantage concurrentiel à ceux qui réussissent à la développer ou à l'adopter, ces cas d'utilisation visent à inspirer les acteurs du SSC et à les aider à saisir les opportunités. Le chapitre 5 présente les risques potentiels et le chapitre 6 identifie les principaux défis à relever. Le chapitre 7 fournit des recommandations aux entrepreneurs créatifs ainsi qu'aux décideurs politiques nationaux/internationaux dans cinq domaines, notamment l'accès aux données, l'accès aux compétences, la transparence, les écosystèmes collaboratifs et l'accès au financement. Les chapitres 8 à 17 présentent des cas d'utilisation et des recommandations plus détaillées par secteur créatif, pour ceux qui souhaitent se concentrer sur un seul secteur.

Toutes les informations et opinions présentées dans cette publication sont celles des auteurs et ne reflètent pas nécessairement l'opinion officielle de la Commission européenne.

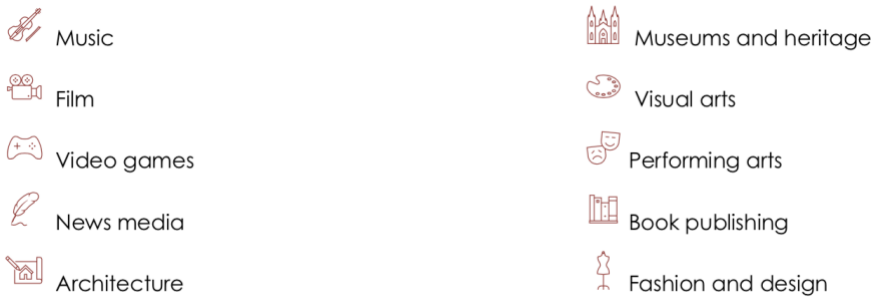
1 Executive summary

1.1 Objectives of the study and methodology

This study is the result of research carried out about the '*Opportunities and Challenges of Artificial Intelligence Technologies for the Cultural and Creative Sectors' (CCS)*. The project has been commissioned by the European Commission (DG CNECT and DG EAC) and prepared by a consortium made up Technopolis Group, the Danish Institute of Technology, the Research Institute of Sweden, and BOP Consulting.

The objectives of the study are to identify opportunities in artificial intelligence (AI) for the CCS, taking into consideration also the current challenges they pose, and suggest actions for CCS stakeholders as well as national/international policymakers in applying AI and promoting a culturally diverse offer of European works.

The following ten sectors have been analysed:



AI has been defined as a "set of technologies able to identify complex structures from massive datasets and to use these structures to make predictions and/or take actions and decisions on previously unseen data"[1]. The European Commission's proposal for a regulation on AI[2] (2021) considers artificial intelligence as "*a fast-evolving family of technologies that can contribute to a wide array of economic and societal benefits across the entire spectrum of industries and social activities. By improving prediction, optimising operations and resource allocation, and personalising digital solutions available for individuals and organisations*".

The study is based on desk research, literature review, 66 interviews and three focus groups (including technology developers, industry stakeholders, artists, producers, publishers, researchers, and other experts), as well as on an analysis of startup data. It also draws upon the results of the discussions and brainstorming exercises conducted at a stakeholder event which took place on 30 September 2021.

The study is structured around the discussion of 1) opportunities in AI in particular for the smaller, independent players of the CCS 2) risks of AI that require caution and 3) challenges to overcome in order to unfold the potential of AI. The first part of the report provides an overview of all CCS, while the sectoral chapters discuss AI use cases particular for each individual sector.

In doing so, the study aims to provide inspiration as well as recommendations, both to creative sectors and to policymakers (national and European), to reduce challenges and to seize the opportunities AI could bring.

[1] Baptiste Caramiaux, Fabien Lotte, Joost Geurts, Giuseppe Amato, Malte Behrmann, et al.. AI in the media and creative industries. [Research Report] New European Media (NEM). 2019, pp.1-35.
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0206

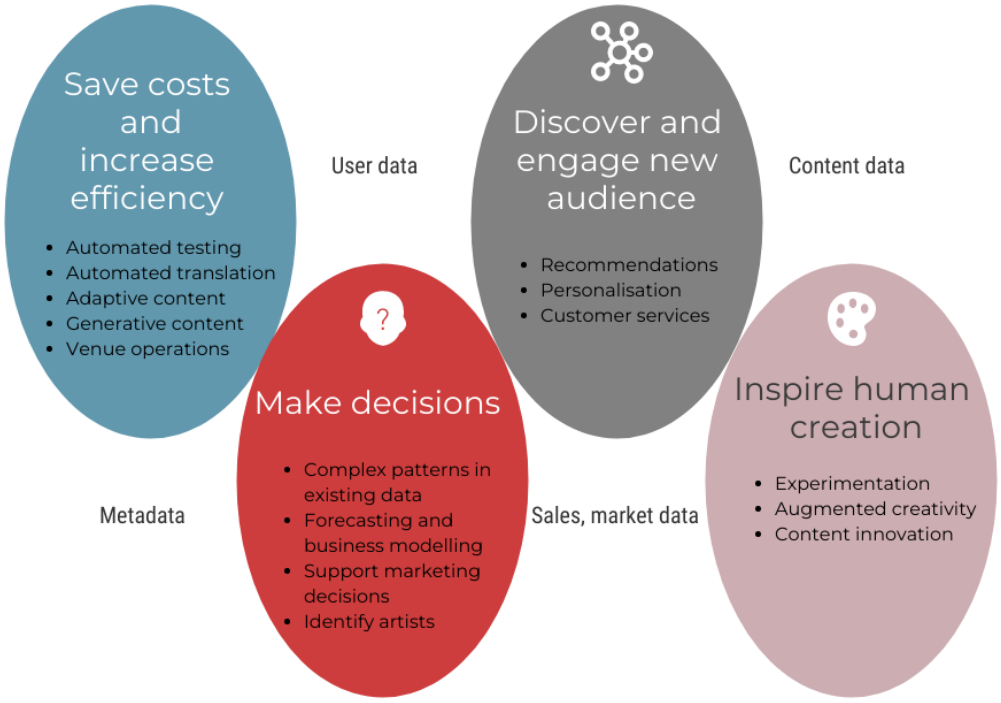
1.2 AI opportunities to grow the cultural and creative sectors

Cultural and creative sectors (CCS) are crucial for the European economy, not just from the perspective of the 7.2 million people employed across Europe (Eurostat, 2020)[3], but also with a view to their spillover effects to a wide range of other industrial ecosystems. The Covid-19 pandemic has had a severe impact on these sectors all around Europe and is still affecting them heavily (OECD, 2020). The lockdowns accelerated ongoing trends of digitalisation. In this context, cultural and creative businesses and institutions are confronted with the challenge to reach out to digital-minded and increasingly digital-native audiences and find new ways to monetise their content.

Artificial intelligence (AI) technologies have been witnessing a recent surge in usage across the CCS. The ever-growing amount of digital cultural and creative content has created new opportunities for AI applications fuelling the digital transformation of these sectors. AI can provide a value added for each stage along the CCS sectoral value chains such as the creation, production and distribution of creative and cultural content. There is an untapped potential for smaller players, independent content creators and artists to boost their efficiency, decision-making and output thanks to AI tools (Figure 1). There are a set of viable applications available to CCS, such as using machine learning for data analytics, deep learning for predictions, and AI recognition tools to support image search. AI technologies such as machine learning help the development of new subscription models by relying on predictive insights.

AI technologies are expected to augment CCS potential and save valuable resources that they can direct towards other more interesting activities. Use cases can be grouped into four (often overlapping) categories that help CCS 1) save costs and increase efficiency 2) make decisions 3) discover and engage the audience 4) inspire. AI is expected to bring a competitive edge to those who successfully develop or adopt it and the use cases presented in the sectoral chapters highlight numerous opportunities to seize. The following pages summarise some of the use cases by bringing examples from various sectors.

Figure 1: Overview of common promises and AI applications across the cultural and creative sectors



Source: authors
Note: Various data sources can be relevant for any opportunity group

[3] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Culture_statistics_-_cultural_employment#Cultural_employment_.E2.80.94_overall_developments (Please note that the European Commission Annual Single Market report published in 2021 indicates another estimate notably 8.02 million people employed in the cultural and creative industries)

*Table 1: Examples of AI use cases that help **save costs and increase efficiency***

Sector	Use Case	Value proposition
Architecture	**Parametric architecture**	AI can help create several design options to be tested and suggested to the users without requiring extra resources.
Book publishing	**Automated translation**	Automated translation drives cost reduction by speeding up the content creation and, for simple content only, lowering costs of translations for book publishers.
Film	**AI-powered film editing**	AI can save a significant amount of time in the pre-editing phase and thus free up budget and time for the creative process.
Music	**AI audio mastering**	AI can be applied in supporting audio-mixing and post-production. A range of AI-based compositional tools make it more affordable to create high-quality content.
News media	**Automated content curation**	Efficiency gains and improved workflow can be reached with the use of AI-powered automation behind the scenes of the journalistic and editorial process.

*Table 2: Examples of AI use cases that help **take better decisions***

Sector	Use Case	Value proposition
Architecture	**Cloud-based AI software for buildings**	AI-based decision-making can shorten the planning time of buildings and the design process. Architecture firms can leverage the power of AI tools to propose different options to a client.
Fashion&Design	**Predictive trend forecasting**	AI-driven trend forecasting addresses the need of fashion designers to adapt ever faster to trends and optimise supply chains to the maximum in order to stay competitive.
Film	**'Green lighting' of films (approving film's production and finance)**	AI-driven data analytics can help directors decide which films should get funding (get the green light) and go into production. AI can also support the marketing, distribution and release dates.
Music	**AI-based data analytics**	AI-based data analytics help track performances, identify local opportunities and pinpoint industry trends to enhance their business strategies. A&R managers can scout for talent more easily.
Visual art	**Authentication of art works**	AI can support collectors authenticate genuine art works and identify fakes.

Source: authors

*Table 3: Examples of AI use cases that help better **understand and reach out to new audiences***

Sector	Use Case	Value proposition
Book publishing	**Immersive reading enhanced by AI**	Technology-based startups offer new ways to engage the reader beyond the book by offering an immersive reading experience. The future digital reader can become part of the story.
News media	**Personalisation of content**	Using AI and machine learning on visitor data can be used to build a general understanding about audience composition and allow for product design that takes different subgroups into account in order to make the product more engaging and more accessible.
Music	**Personalisation of music experience**	AI technologies that will help changing the type of playlist or music that the listeners is suggested depending for instance on his/her mood, the weather, the position (for instance commuting, studying).
Video games	**Adaptive games**	The development of AI and machine learning techniques is allowing games developers and researchers to create game products that adapt and personalise to the individual players.
Visual art	**AI-augmented art for people with disabilities**	AI enables an audience with disabilities to experience art. Technology adapts and helps transform the art works into content accessible to visually impaired people for instance a voice-over.

Source: authors

*Table 4: Examples of AI use cases that help **inspire human creation***

Sector	Use Case	Value proposition
Book publishing	**AI suggested new content**	AI can help publishers identify relevant content. Publishers can get new inspiration to identify the right author and the right content by analysing reading patterns.
Films	**Automatic story generation**	Despite its name, automatic story generation is considered to be limited on its own, however, it can support to script writer to get inspiration for an unexpected turn in the storyline.
Music	**AI-inspired music generation**	AI tools can help musicians to test new sounds, get inspiration and compose music relying on algorithmic input. These applications can generate instrumental algorithmic music under musical rules.
News media	**Open Data Mining**	Insights are subjected to an automatic verification process built on journalistic practice and for journalists to independently verify and eventually publish.
Performing arts	**AI-augmented choreography**	In performing arts, current AI applications inform and enhance the creative process alongside a human creator such as the choreographer.

Source: authors

1.3 Potential risks of AI

The real-world application of artificial intelligence technologies in the cultural and creative sectors is not without challenges and it comes with a range of risks and ethical questions. Moreover, a reflection is needed about both the impact of AI on jobs and the positioning of the EU on the global AI landscape. It is not AI technology that causes problems per se but how systems, relationships and processes are built around them as highlighted by some of the interviews conducted for this study. The actual impact of AI in assisting creative content creation, production and business processes depends very much on how people make use of it. Some of the key risks identified in the study include the following:

Risk of low-quality content, monocultures and bias: The impact of AI depends very much on the type of algorithm it relies on, and the data used to train the system. Many of the AI algorithms currently influencing us when interacting with digital creative content can reinforce cultural preferences and push towards a personal monoculture limiting users to a specific world view and cultural sphere. A danger highlighted is the production of mass content with lower quality.

Language diversity: The diversity of European languages comes into play when disseminating/introducing AI-based tools because the use of artificial intelligence in CCS is largely language-based (natural language processing, natural language understanding, speech technologies, language-centric AI). Several of the common opportunities in AI have to do with language including data analytics in the form of text, AI-enhanced cataloguing, and analysing of user trends.

AI can amplify misinformation: Algorithms focused on engagement may prioritise divisive content and spread misinformation, an issue that has recently been raised for instance regarding Facebook[4]. As yet, AI cannot always distinguish whether the input it receives is accurate or inaccurate. This can lead to issues around authenticity – if AI receives questionable input, the corresponding output may be false. In addition, it becomes harder to ensure that a feed or a set of recommendations is balanced and includes articles with different viewpoints.

Risks of manipulation: Monopolies over data lead naturally to monopolies over the understanding of user behaviours and influencing consumption. AI algorithms are used today to finetune recommendation engines most often embedded in online platforms. They significantly influence the pool of content that consumers can discover.

Excessive reliance on AI: Concerns have been expressed in the interviews conducted for this study that if AI is more widely adopted to support recommendation engines and decision-making, overreliance on its predictions and suggestions can create inertia and narrow-mindedness. This can result in wrong decisions that do not take into account other broader factors such as local context.

Structural changes in the content of jobs: A consequence of introducing artificial intelligence in the creative process and decision-making is that AI is expected to replace some jobs that have been human-only until now. The nature of jobs such as technicians, journalists, reporters, and market research specialists will change and face competition from the 'intelligent computer'.

Competing with the US and the rise of China: AI development is currently led by the USA boasting a much higher share of global patent applications in AI and investing more in AI startups. At the same time, China has become a major player in many aspects and is posing new challenges to the use of AI in the cultural and creative sectors.

1.4 Challenges and recommendations

While keeping in mind the need to mitigate the risks, there are a range of key challenges that currently make it harder for CCS to make more investment in AI applications including access to data, skills and training, collaboration, transparency and access to funding. Yet, these challenges can be overcome by focusing on the 'low-hanging fruits' first and going step-by-step. The study makes a number of recommendations to address these challenges both for actions by players in the cultural and creative sectors and by policy makers at national or EU level as appropriate.

1.4.1 Data access

Access to appropriate data is a common problem across all cultural and creative sectors. In most cases data are considered to be commercially sensitive and are held by individual companies, organisations or online platforms. While there are common data access challenges, the landscape does vary a lot across the CCS and these differences should be taken into account.

[4] https://www.washingtonpost.com/technology/2021/09/03/facebook-misinformation-nyu-study/

Recommendations

To the sectors:

- Seize the momentum and start cooperation within your sector around data sharing by building collaboration with other organisations (potentially including your competitors) to build negotiation power towards aggregators.
- Identify 'safe areas' and non-controversial datasets to test how collaboration can work. Common goals around the type of dataset to share can generate trust and become an incentive for others to join.
- Focus data sharing on a clear application field. Collaborate on a specific type of news item, on sound annotation, film shoot composition, or a subset of customer analytics etc.
- Share your data models and collaborate on metadata standards, as interoperability across your sector may ultimately create benefits for all those who participate. Interoperability is the cornerstone of improving data management and is linked to the standardisation of processes and to the will and ability of CCS organisations to adhere to agreed practice in terms of creating and sharing metadata.
- Start by reviewing your current metadata frameworks and address the gaps. A simple agreement on categories and taxonomies can facilitate translations, result in coherent datasets, and increase negotiation power.
- Build services around data sharing initiatives. Eventually, joint analytical services, tools and solutions should facilitate concrete use of the big datasets.
- Datasets need to be tailored which is usually an expensive process. There is often a big gap between data availability and data usability. Tech startups need to make large investments to be able to clean the data and make it 'AI and also purpose ready'.
- Pay attention to cybersecurity which is a key aspect of any future data space. Network security systems can provide protection at various levels and ensure that data exchange remains secure across the entire data supply chain.

To policy makers:

- Foster the emergence of pioneer stakeholders that want to move ahead with sharing data, for instance in a sector-wide collaboration around metadata.
- Improve the business environment for European AI tech startups that can develop data sharing initiatives for the CCS.
- Consider incentives to federated data management systems. The existence of appropriate data sharing smart contracts securing the fair management of the system will be critical to establish trust.
- Foster the development of a blockchain- and smart contract-based framework that allows CCS stakeholders to store data locally and share it without losing control and ownership of it.
- Foster the emergence of a research data space in Europe for specific CCS (similar to Google Magenta) and pool data across Europe, to develop culturally diverse AI applications. The European Open Science Cloud could cater for all types of research domains including CCS.
- Foster the development of an interoperability assessment tool that can serve as a basis for the CCS to monitor standards and compliance (similar to healthcare data initiatives), possibly as part of the cultural heritage data space or media data space[5].
- Support the development of infrastructure, computational power and cloud solutions that enable the handling of AI algorithms and run them on large-scale datasets. Data infrastructure is the basis for building large data pools and for testing and running AI applications. Finding appropriate cloud solutions has been a recognised issue hindering innovation in the CCS.

[5] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6428

- Explore the potential set up of an independent 'Data Agency' for the CCS that pools together data from various sources and builds upon public-private collaboration of pioneering CCS companies, institutions and AI technology firms.

1.4.2 Skills, AI and many other competences

One of the major business challenges for all sectors is about finding the right combination of skills in terms of technical talent and innovative CCS professionals who can make use of AI technologies and manage change. In CCS, professionals do not necessarily need to understand codes and be computer programmers, but they need to understand what AI technology can do for them. At the same time AI tech developers need also more understanding how CCS work.

Recommendations

To the sectors:

- Put in place dedicated AI training programmes for CCS for various job positions such as managers/directors, employees, artists, creators etc.
- Implement programmes that can help small CCS stakeholders leverage the power of artificial intelligence. Innovation capacities and know-how to differentiate have become even more important in the upcoming era of AI-powered tools. Next to AI skills, CCS have to be competent how to use it for innovative applications.
- Foster training on AI assessment and interpretation of results, on data management skills. CCS stakeholders (museums, book publishers, media houses, independent labels) hold precious data but externalise the treatment and valorisation of content to tech companies. Skills are necessary to know what to do with data and how to valorise it in the new digital era.
- Foster programmes that help manage change within the organisation and adapt organisational models to AI. The adoption of AI is about managing change. AI technology brings the promise of saving costs and increasing efficiency, but AI tools and their results should be integrated into the complete organisational workflow of creative companies and cultural institutions in order to harness the full potential in AI.

To policy makers:

- Foster the inclusion of AI training (not only coding but also a preparation for an AI-powered future world) in the curricula of CCS academies at bachelor and master levels.
- More broadly, AI education needs to start in schools and through informal after school programmes, as well as in secondary school and universities.
- Develop a CCS-AI training/internship scheme and foster its implementation among IT/computer science students.
- Create an AI virtual or physical competence centre for CCS building upon the results of the AI4Media project.
- Continue to foster the development of AI talent for CCS in the EU and create more incentives for AI talent to stay. The shortage of AI talent in Europe causes an increase of salary expectations from data scientists. Access to skills is hampered by limitations in how startups can motivate their employees and what remuneration packages they can offer in terms of salaries and other benefits.
- Increase the number of AI PhDs with a focus on a CCS topic.
- Complement education programmes with information on how to use common data standards.

1.4.3 Collaborative ecosystems between tech and CCS

There is a lack of in-house capacity of traditional CCS companies and institutions to develop their own AI solutions. This makes them dependent on a relatively small group of AI specialist tech companies to take up AI.

Recommendations

To the sectors:

- Nurture the emergence of a strong European AI tech startup scene and ecosystem specialised in solutions for the cultural and creative sectors in partnership with CCS.
- Exchange and co-design AI applications with tech startups. Improve mutual understanding between creative professionals and technology developers.
- Initiate testing and participate in demonstration projects that can showcase the viability (and profitability) of using AI in CCS.
- Explore existing European programmes that help finance collaborative projects in AI.
- Incentivise independent artists and creators to exchange know-how with technology developers.

To policy makers:

- Continue to support collaborative projects between CCS and AI tech across the EU including smaller-scale actions such as voucher schemes or projects for experimentation.
- Consider ways to support exchanges where CCS professionals are made residents in tech companies for a limited amount of time, and vice versa such as 'Artist in residence' and 'technologist in residence' schemes, taking into account opportunities under existing relevant programmes.
- Put in place an AI tech public-private partnership that can incentivise collaboration between larger European-based platforms, tech companies and CCS stakeholders.
- Incentivise the participation of CCS in the European Digital Innovation Hubs Network.
- Foster the development of tech-CCS cluster initiatives and ecosystem development.
- Integrate the CCS into the new European Innovation Council Marketplace which is currently under development.

1.4.4 Balancing transparency and innovation

When taking up AI solutions, CCS firms face issues around transparency related to the recommendation and decision-making systems powered by AI. Unless such issues are resolved, many CCS firms will continue to hesitate to adopt AI in their operations. Providers of AI solutions for the CCS need to undertake several steps in order to make transparent how they work.

Recommendations

To the sectors:

- Foster the development of AI standards and labels in voluntary codes of conduct for the transparent use of AI in specific CCS applications.
- Consider the development (with possible facilitation by governments) of a toolkit for 'Cultural Diversity Checklists' that can be used by any company or organisation in the sectors concerned when putting in place an AI based recommendation system. The check shall ensure that the system is transparent and relies on diverse and fair data.
- Foster a dialogue about ethical behaviour among AI tech startups and CCS.
- Introduce JUST data annotation: creators of datasets should annotate their data aiming to be Judicious, Unbiased, Safe and Transparent.

To policy makers:

- Make AI solutions accountable and adopt clear rules on liability of decisions taken that were informed by AI input. Since AI technologies are used in decision-making, a need has emerged for algorithmic accountability, which must rely on an appropriate governance framework.
- Develop rules for online platforms to publish a user guide about their recommendation systems.

- Continue to foster initiatives that help reduce bias in AI applications by making for instance functional language technology services available to AI developers and similar structures that help access to broader datasets.
- Pursue further research and knowledge sharing to assess the need for further action at a larger scale to promote and preserve cultural diversity.

1.4.5 Funding AI demonstration and new business models

Developing AI-based tools for the creative and cultural sectors is expensive and needs an upfront investment. Access to finance has been a well-known barrier to innovation in general and especially for CCS because culture and art is a public good and the sector is less driven by pure business considerations.

The issue is not only access to finance but often also poor financial capacity among small players, or a lack of willingness to invest among larger ones. Nevertheless, the most relevant issue that has been identified is the lack of a clear business case that would motivate CCS to invest.

Although there are a range of public initiatives to help creative and cultural tech startups grow, the lack of suitable, unbureaucratic funding sources has been highlighted as an issue since there are no dedicated 'creative AI' funding mechanisms in Europe. In existing programmes, there is also a lack of (public) financing dedicated to the 'low-hanging fruit' applications of AI and fund demonstrators.

European AI tech startups lack venture capital investment and are often lured to other global AI hotspots. The danger of a lack of appropriate finance and misplaced investments is that if AI technology-based tools are developed by actors in other parts of the world, Europe might lose its technological independence in this area.

Recommendations

To the sectors

- Foster awareness-raising and change in the mindset of creative professionals to understand business models around AI.
- Become more active in seizing existing opportunities in Creative Europe, the Digital Europe programme or the European Institute of Innovation and Technology Culture and Creative Industries Knowledge and Innovation Community that can fund AI projects.
- Initiate projects similar to Mediafutures under Horizon Europe and publish sub-calls with the opportunity for CCS to test new AI applications[6]
- Launch demonstration and test projects for CCS to develop new business models around AI applications.

To policy makers:

- Raise awareness of the available EU programmes that can finance AI innovation projects in the cultural and creative sectors.
- Consider the development of funding schemes that allow for an easy access to testing AI in CCS and can demonstrate the viability of the application. Simple schemes that can help create links among CCS and AI tech startups should be explored.
- Launch thematic investment initiatives dedicated to AI CCS tech startups and scaleups or a process to raise awareness of CCS opportunities among investors (including training, matchmaking, showcasing that can create trust, personal contact among VC).
- Facilitate access to finance for AI CCS tech startups and scaleups through equity and debt instruments under InvestEU.

[6] https://mediafutures.eu/

2 Résumé analytique

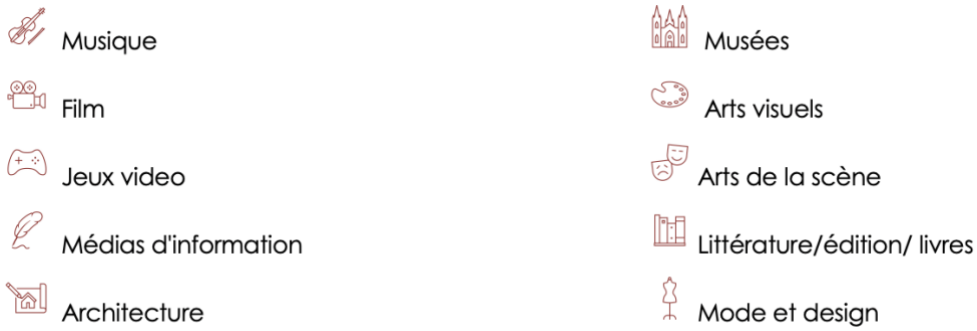
2.1 Objectifs de l'étude et méthodologie

Cette étude est le résultat d'une recherche menée sur les " *Opportunités et défis des technologies d'intelligence artificielle pour les secteurs culturels et créatifs* " *(SCC)*.

Le projet a été commandé par la Commission européenne (DG CNECT et DG EAC) et préparé par un consortium composé de Technopolis Group, l'Institut danois de technologie, l'Institut de recherche de Suède et BOP Consulting.

Les objectifs de l'étude sont d'identifier les opportunités de l'intelligence artificielle (IA) pour les SCC, en prenant également en considération les défis actuels qu'elles posent, et de suggérer des actions pour les parties prenantes des SCC ainsi que pour les décideurs politiques nationaux/internationaux dans l'application de l'IA et la promotion d'une offre culturellement diversifiée d'œuvres européennes.

Les dix secteurs suivants ont été analysés :



L'IA a été définie comme un "ensemble de technologies capables d'identifier des structures complexes à partir d'ensembles de données massifs et d'utiliser ces structures pour faire des prédictions et/ou entreprendre des actions et prendre des décisions sur des données inédites"[7]. La proposition de règlement de la Commission européenne sur l'IA[8] (2021) considère l'intelligence artificielle comme "*une famille de technologies en évolution rapide qui peut contribuer à un large éventail d'avantages économiques et sociétaux dans tout le spectre des industries et des activités sociales. En améliorant la prédiction, en optimisant les opérations et l'allocation des ressources, et en personnalisant les solutions numériques disponibles pour les individus et les organisations*".

L'étude se fonde sur une recherche documentaire, une analyse de la littérature existante, 66 entretiens et trois groupes de discussion (comprenant des développeurs de technologies, des acteurs du secteur, des artistes, des producteurs, des éditeurs, des chercheurs et d'autres experts), ainsi que sur une analyse des données de démarrage. Elle s'appuie également sur les résultats des discussions et des exercices de brainstorming menés lors d'un événement destiné aux parties prenantes qui a eu lieu le 30 septembre 2021.

L'étude est structurée autour de l'examen 1) des opportunités de l'IA, en particulier pour les petits acteurs indépendants des SCC, 2) des risques liés à l'IA qui nécessitent de la prudence, et 3) des défis à surmonter pour déployer le potentiel de l'IA. La première partie du rapport donne une vue d'ensemble de tous les SCC, tandis que les chapitres sectoriels traitent des cas d'utilisation de l'IA propres à chaque secteur.

Ce faisant, l'étude vise à fournir une inspiration ainsi que des recommandations, tant aux secteurs créatifs qu'aux décideurs politiques (nationaux et européens), pour réduire les défis et saisir les opportunités que l'IA pourrait apporter.

[7] Baptiste Caramiaux, Fabien Lotte, Joost Geurts, Giuseppe Amato, Malte Behrmann, et al.. AI in the media and creative industries. [Rapport de recherche] New European Media (NEM). 2019, pp.1-35.
[8] https://eur-lex.europa.eu/legal-content/FR/TXT/?uri=CELEX%3A52021PC0206

2.2 Opportunités d'IA pour développer les secteurs culturels et créatifs

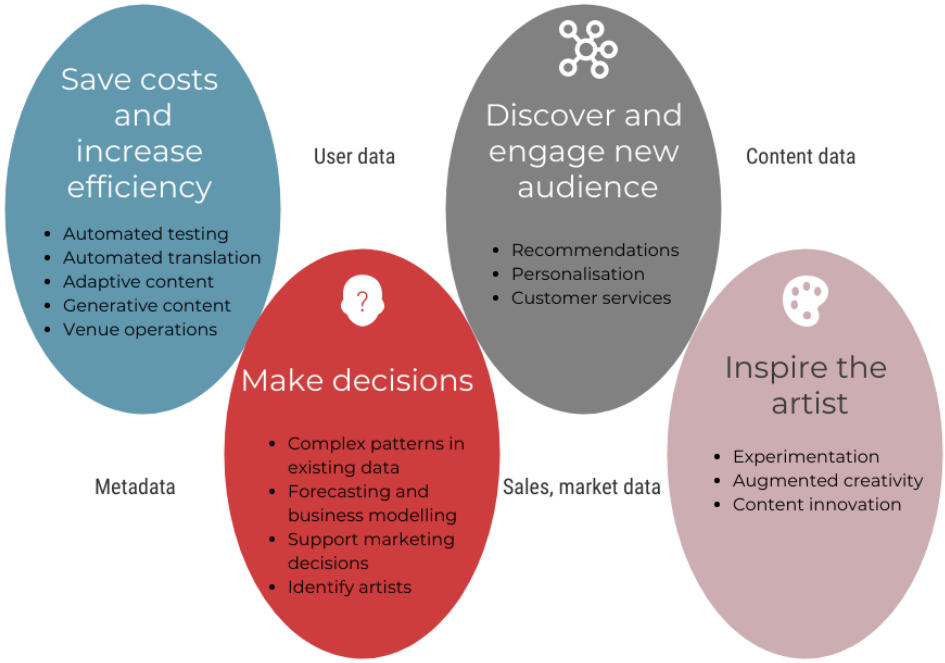
Les secteurs culturels et créatifs (SCC) sont cruciaux pour l'économie européenne, non seulement du point de vue des 7,4 millions de personnes employées dans ces secteurs en Europe (2019), mais aussi du point de vue de leurs retombées sur un large éventail d'autres écosystèmes industriels. La pandémie de Covid-19 a eu de graves répercussions sur le secteur dans toute l'Europe et continue de l'affecter fortement. Les confinements ont accéléré les tendances actuelles de la numérisation. Dans ce contexte, les entreprises et institutions culturelles et créatives sont confrontées au défi d'atteindre des publics adeptes du numérique et de plus en plus natifs du numérique, et de trouver de nouveaux moyens de monétiser leurs contenus.

Les technologies de l'intelligence artificielle (IA) ont récemment connu une forte augmentation de leur utilisation dans le secteur culturel et créatif. La quantité toujours croissante de contenu culturel et créatif numérique a créé de nouvelles opportunités pour les applications d'IA, alimentant ainsi la transformation numérique de ces secteurs.

L'IA peut apporter une valeur ajoutée à chaque étape des chaînes de valeur sectorielles des SCC, comme la création, la production et la distribution de contenu créatif et culturel. Il existe un potentiel inexploité pour les petits acteurs, les créateurs de contenu indépendants et les artistes, potentiel qui peut stimuler leur efficacité, leurs prises de décision et leur production grâce aux outils de l'IA (figure 1). Il existe un ensemble d'applications viables à la disposition des SCC, comme l'utilisation de l'apprentissage automatique pour l'analyse des données, l'apprentissage profond pour les prévisions et les outils de reconnaissance de l'IA pour soutenir la recherche d'images. Les technologies de l'IA telles que l'apprentissage automatique aident au développement de nouveaux modèles d'abonnement en s'appuyant sur des informations prévisionnelles.

Les technologies d'IA devraient permettre d'accroître le potentiel des SCC et d'économiser des ressources précieuses qu'ils pourront alors orienter vers d'autres activités plus intéressantes. Les cas d'utilisation peuvent être regroupés en quatre catégories (qui se chevauchent souvent) qui aident les SCC à 1) réduire les coûts et à accroître leur efficacité 2) prendre des décisions 3) découvrir de nouveaux publics et les fidéliser 4) inspirer. L'IA devrait apporter un avantage concurrentiel à ceux qui réussissent à la développer ou à l'adopter, et les cas d'utilisation présentés dans les chapitres sectoriels mettent en évidence de nombreuses opportunités à saisir. Les pages suivantes résument certains des cas d'utilisation en apportant des exemples issus de divers secteurs.

Figure 2: Aperçu des applications de l'IA dans SCC



Source: les auteurs

Table 5: Exemples de cas d'utilisation de l'IA qui permettent de réduire les coûts et d'accroître l'efficacité

Secteur	Cas d'utilisation	Proposition de valeur
Architecture	**Architecture paramétrique**	L'IA peut aider à créer plusieurs options de conception à tester et à suggérer aux utilisateurs sans nécessiter de ressources supplémentaires.
L'édition de livres	**Traduction automatisée**	La traduction automatisée permet de réduire les coûts en accélérant la création du contenu et, pour les contenus simples uniquement, en diminuant les coûts de traduction pour les éditeurs de livres.
Film	**Montage cinématographique assisté par l'IA**	L'IA peut faire gagner beaucoup de temps dans la phase de pré-édition et ainsi libérer du budget et du temps pour le processus créatif.
La musique	**AI audio mastering**	L'IA peut être appliquée à la prise en charge du mixage audio et de la post-production. Une gamme d'outils de composition basés sur l'IA rend plus abordable la création de contenu de haute qualité.
Les médias d'information	**Curation de contenu automatisée**	Des gains d'efficacité et une amélioration du flux de travail peuvent être obtenus grâce à l'utilisation d'une automatisation alimentée par l'IA dans les coulisses du processus journalistique et éditorial.

Table 6: Exemples de cas d'utilisation de l'IA qui aident à prendre de meilleures décisions

Secteur	Cas d'utilisation	Proposition de valeur
Architecture	**Logiciel d'IA en nuage pour les bâtiments**	La prise de décision basée sur l'IA peut raccourcir le temps de planification des bâtiments et le processus de conception. Les cabinets d'architecture peuvent tirer parti de la puissance des outils d'IA pour proposer différentes options à un client.
Mode & Design	**Prévision prédictive des tendances**	La prévision des tendances par l'IA répond au besoin des créateurs de mode de s'adapter toujours plus vite aux tendances et d'optimiser au maximum les chaînes d'approvisionnement pour rester compétitifs.
Film	**Approbation de la production et du financement du film**	L'analyse de données pilotée par l'IA peut aider les réalisateurs à décider quels films devraient obtenir un financement et entrer en production. L'IA peut également prendre en charge le marketing, les dates de sortie.
La musique	**Analyse des données basée sur l'IA**	Les analyses de données basées sur l'IA permettent de suivre les performances, d'identifier les opportunités locales et de repérer les tendances du secteur pour améliorer leurs stratégies commerciales. Les responsables A&R peuvent rechercher des talents plus facilement.
Les arts visuels	**Authentification d'œuvres d'art**	L'IA peut aider les collectionneurs à authentifier les œuvres d'art authentiques et à identifier les contrefaçons.

Source: les auteurs

Table 7: Exemples de cas d'utilisation de l'IA qui permettent de mieux comprendre et d'atteindre de nouveaux publics

Secteur	Cas d'utilisation	Proposition de valeur
L'édition de livres	**Une lecture immersive améliorée par l'IA**	Les startups technologiques proposent de nouvelles façons d'engager le lecteur au-delà du livre en offrant une expérience de lecture immersive. Le futur lecteur numérique peut devenir partie intégrante de l'histoire.
Les médias d'information	**Personnalisation du contenu**	L'apprentissage automatique sur les données des visiteurs peut être utilisée pour construire une compréhension générale de la composition du public et permettre la conception de produits qui rendent le produit plus engageant et plus accessible.
La musique	**Personnalisation de l'expérience musicale**	Les technologies d'IA peuvent aider à changer le type de liste de lecture ou de musique suggéré à l'auditeur en fonction de son humeur, de la météo, de sa position, etc.
Les jeux vidéo	**Jeux adaptatifs**	Le développement de l'IA et des techniques d'apprentissage automatique permet aux développeurs de jeux de créer des produits de jeu qui s'adaptent et se personnalisent à chaque joueur.
Les arts visuels	**L'art augmenté par l'IA**	L'IA permet à un public handicapé de découvrir l'art. La technologie s'adapte et aide à transformer les œuvres d'art en un contenu accessible aux personnes malvoyantes, par exemple une voix off.

Table 8: Exemples de cas d'utilisation de l'IA qui contribuent à inspirer la création humaine

Secteur	Cas d'utilisation	Proposition de valeur
L'édition de livres	**Nouveau contenu suggéré par l'IA**	L'IA peut aider les éditeurs à identifier le contenu pertinent. Les éditeurs peuvent trouver une nouvelle inspiration pour identifier le bon auteur et le bon contenu en analysant les habitudes de lecture.
Film	**Génération automatique d'histoires**	Malgré son nom, la génération automatique d'histoires est considérée comme limitée en soi, mais elle peut aider le scénariste à trouver l'inspiration pour une tournure inattendue de l'intrigue.
La musique	**Musique inspirée par l'IA**	Les outils d'IA peuvent aider les musiciens à tester de nouveaux sons, à trouver l'inspiration et à composer de la musique. Ces applications peuvent générer de la musique algorithmique instrumentale selon des règles musicales.
Les médias d'information	**Open Data Mining**	Ces "aperçus" sont soumis à un processus de vérification automatique fondé sur la pratique journalistique et destiné aux journalistes qui les vérifient de manière indépendante et les publient éventuellement.
Les arts de la scène	**IA-augmentée chorégraphie**	Dans les arts du spectacle, les applications actuelles de l'IA informent et améliorent le processus de création aux côtés d'un créateur humain tel que le chorégraphe.

Source: les auteurs

2.3 Risques potentiels de l'IA

L'application concrète des technologies d'intelligence artificielle dans les secteurs culturels et créatifs n'est pas sans défis et elle s'accompagne d'une série de risques et de questions éthiques. En outre, une réflexion s'impose sur l'impact de l'IA sur l'emploi et le positionnement de l'UE dans le paysage mondial de l'IA. Ce n'est pas la technologie de l'IA qui pose problème en soi, mais la manière dont les systèmes, les relations et les processus sont construits autour d'elle. L'impact réel de l'IA sur la création de contenus créatifs, la production et les processus commerciaux dépend en grande partie de la façon dont les gens l'utilisent. Voici quelques-uns des principaux risques identifiés dans l'étude :

Risque de contenu de faible qualité, de monocultures et de partialité : L'impact de l'IA dépend beaucoup du type d'algorithme sur lequel elle s'appuie, et des données utilisées pour entraîner le

système. De nombreux algorithmes d'IA qui nous influencent actuellement lorsque nous interagissons avec du contenu créatif numérique peuvent renforcer les préférences culturelles et pousser vers une monoculture personnelle limitant les utilisateurs à une vision du monde et à une sphère culturelle spécifiques. L'un des dangers mis en avant concerne la production de contenus de masse de moindre qualité.

Diversité linguistique : La diversité des langues européennes entre en jeu lors de la diffusion/introduction d'outils basés sur l'IA car l'utilisation de l'intelligence artificielle dans les SCC est largement basée sur le langage (traitement du langage naturel, compréhension du langage naturel, technologies vocales, IA centrée sur le langage). Plusieurs des possibilités courantes de l'IA sont liées au langage, notamment l'analyse de données sous forme de texte, le catalogage amélioré par l'IA et l'analyse des tendances des utilisateurs.

L'IA peut amplifier la désinformation : Les algorithmes axés sur l'engagement peuvent donner la priorité aux contenus qui divisent et diffuser des informations erronées, une question qui a récemment été soulevée, par exemple, à propos de Facebook[9]. À ce jour, l'IA ne peut pas toujours distinguer si les données qu'elle reçoit sont exactes ou inexactes. Cela peut entraîner des problèmes d'authenticité : si l'IA reçoit des données douteuses, les résultats correspondants peuvent être faux. En outre, il devient plus difficile de s'assurer qu'un flux ou un ensemble de recommandations est équilibré et inclut des articles présentant des points de vue différents.

Risques de manipulation : Les monopoles sur les données conduisent naturellement à des monopoles sur la compréhension des comportements des utilisateurs et l'influence sur la consommation. Les algorithmes d'IA sont aujourd'hui utilisés pour affiner les moteurs de recommandation le plus souvent intégrés dans les plateformes en ligne. Ils influencent de manière significative le pool de contenus que les consommateurs peuvent découvrir.

Dépendance excessive à l'égard de l'IA : Les entretiens menés dans le cadre de cette étude ont fait apparaître des préoccupations quant au fait que si l'IA est plus largement adoptée pour soutenir les moteurs de recommandation et la prise de décision, une dépendance excessive à l'égard de ses prédictions et suggestions peut créer de l'inertie et de l'étroitesse d'esprit. Il peut en résulter des décisions erronées qui ne tiennent pas compte d'autres facteurs plus larges tels que le contexte local.

Changements structurels dans le contenu des emplois : L'une des conséquences de l'introduction de l'intelligence artificielle dans le processus de création et de prise de décision réside dans le fait que l'IA devrait remplacer certains emplois jusqu'à présent réservés aux humains. La nature des emplois de techniciens, de journalistes, de reporters et de spécialistes des études de marché, par exemple, va changer et subir la concurrence de l'"ordinateur intelligent".

Concurrence avec les États-Unis et montée en puissance de la Chine : Le développement de l'IA est actuellement mené par les États-Unis, qui se targuent de concentrer une part beaucoup plus importante des demandes de brevets mondiaux en matière d'IA et investissent davantage dans les start-ups d'IA. Dans le même temps, la Chine est devenue un acteur majeur dans de nombreux domaines et pose de nouveaux défis à l'utilisation de l'IA dans les secteurs culturel et créatif.

2.4 Défis et recommandations

Tout en gardant à l'esprit la nécessité d'atténuer les risques, il existe une série de défis clés qui rendent actuellement plus difficile pour les SCC d'investir davantage dans les applications de l'IA, notamment l'accès aux données, les compétences et la formation, la collaboration, la transparence et l'accès au financement. Pourtant, ces défis peuvent être surmontés en se concentrant d'abord sur les "fruits mûrs" et en procédant étape par étape. L'étude formule un certain nombre de recommandations pour relever ces défis, tant en ce qui concerne les actions à entreprendre pour les acteurs des secteurs culturels et créatifs que pour les décideurs politiques au niveau national ou européen, le cas échéant.

2.4.1 Accès aux données

L'accès aux données appropriées est un problème commun à tous les secteurs culturels et créatifs. Dans la plupart des cas, les données sont considérées comme commercialement sensibles et sont détenues par des entreprises individuelles, des organisations ou des plateformes en ligne. Bien qu'il existe des défis communs en matière d'accès aux données, le paysage varie beaucoup à travers les SCC et ces différences doivent être prises en compte.

[9] https://www.washingtonpost.com/technology/2021/09/03/facebook-misinformation-nyu-study/

Recommandations

Aux secteurs :

- Profiter de la dynamique et lancer la coopération au sein de votre secteur autour du partage des données en établissant une collaboration avec d'autres organisations (y compris potentiellement vos concurrents) afin de renforcer le pouvoir de négociation vis-à-vis des agrégateurs.
- Identifier des "zones sûres" et des ensembles de données non controversés pour tester le fonctionnement de la collaboration. Des objectifs communs autour du type d'ensemble de données à partager peuvent générer de la confiance et inciter les autres acteurs à se joindre à vous.
- Concentrer le partage des données sur un champ d'application précis. Collaborer sur un type spécifique d'article d'actualité, sur l'annotation sonore, la composition d'un tournage, ou un sous-ensemble d'analyses de clients, etc.
- Partager vos modèles de données et collaborer à l'élaboration de normes en matière de métadonnées, car l'interopérabilité dans votre secteur peut, à terme, apporter des avantages à tous ceux qui y participent. L'interopérabilité est la pierre angulaire de l'amélioration de la gestion des données et est liée à la normalisation des processus ainsi qu'à la volonté et à la capacité des organisations des SCC d'adhérer à des pratiques convenues en termes de création et de partage de métadonnées.
- Commencer par passer en revue vos cadres de métadonnées actuels et combler les lacunes. Un simple accord sur les catégories et les taxonomies peut faciliter les traductions, aboutir à des ensembles de données cohérents et accroître le pouvoir de négociation.
- Créer des services autour des initiatives de partage des données. À terme, des services, outils et solutions analytiques communs devraient faciliter l'utilisation concrète des grands ensembles de données.
- Les ensembles de données doivent être adaptés, ce qui représente généralement un processus coûteux. Il existe souvent un écart important entre la disponibilité des données et leur facilité d'utilisation. Les start-ups technologiques doivent réaliser de gros investissements pour pouvoir nettoyer les données et les rendre "prêtes pour l'IA et pour d'autres usages".
- Prêter attention à la cybersécurité, qui constitue un aspect essentiel de tout futur espace de données. Les systèmes de sécurité des réseaux peuvent fournir une protection à différents niveaux et garantir que l'échange de données reste sécurisé tout au long de la chaîne d'approvisionnement des données.

Aux décideurs politiques :

- Favoriser l'émergence de parties prenantes pionnières qui veulent aller de l'avant avec le partage des données, par exemple dans le cadre d'une collaboration sectorielle autour des métadonnées.
- Améliorer l'environnement commercial pour les startups européennes spécialisées dans les technologies d'intelligence artificielle qui peuvent développer des initiatives de partage de données pour les SCC.
- Envisager des mesures incitatives pour les systèmes fédérés de gestion des données. L'existence de contrats intelligents de partage de données appropriés garantissant la gestion équitable du système sera essentielle pour établir la confiance.
- Favoriser le développement d'un cadre basé sur la blockchain et les contrats intelligents qui permet aux parties prenantes des SCC de stocker des données localement et de les partager sans en perdre le contrôle ni la propriété.
- Favoriser l'émergence d'un espace de données de recherche en Europe pour des SCC spécifiques (similaire à Google Magenta) et mettre en commun les données dans toute l'Europe afin de développer des applications d'IA culturellement diversifiées. L'European Open Science Cloud pourrait prendre en charge tous les types de domaines de recherche, y compris les SCC.

- Favoriser le développement d'un outil d'évaluation de l'interopérabilité qui puisse servir de base aux SCC pour contrôler les normes et la conformité (à l'instar des initiatives relatives aux données sur les soins de santé), éventuellement dans le cadre de l'espace de données sur le patrimoine culturel ou sur les médias[10].
- Soutenir le développement de l'infrastructure, de la puissance de calcul et des solutions en nuage qui permettent de gérer les algorithmes d'IA et de les exécuter sur des ensembles de données à grande échelle. L'infrastructure de données est la base nécessaire à la constitution de grands pools de données ainsi qu'aux tests et à l'exécution d'applications d'IA. Parvenir à trouver des solutions d'informatique dématérialisée appropriées constitue un problème reconnu qui entrave l'innovation dans les SCC.
- Étudier la possibilité de créer une "agence de données" indépendante pour les SCC, qui rassemblerait des données provenant de diverses sources et s'appuierait sur une collaboration public-privé entre les entreprises et institutions pionnières des SCC et les entreprises spécialisées dans les technologies d'IA.

2.4.2 Compétences

L'un des principaux défis commerciaux pour tous les secteurs consiste à trouver la bonne combinaison de compétences en termes de talents techniques et de professionnels innovants des SCC capables d'utiliser les technologies de l'IA et de gérer le changement. Dans le domaine des SCC, les professionnels ne doivent pas nécessairement comprendre les codes et être des programmeurs informatiques, mais ils doivent comprendre ce que la technologie de l'IA peut leur apporter. Dans le même temps, les développeurs de technologies d'IA doivent également mieux comprendre le fonctionnement des SCC.

Recommandations

Aux secteurs :

- Mettre en place des programmes de formation dédiés à l'IA pour les SCC à différents postes tels que les gestionnaires/directeurs, les employés, les artistes, les créateurs, etc.
- Mettre en œuvre des programmes qui peuvent aider les petits acteurs des SCC à tirer parti de la puissance de l'intelligence artificielle. Les capacités d'innovation et le savoir-faire qui permettent de se différencier sont devenus encore plus importants dans l'ère à venir des outils alimentés par l'IA. Outre les compétences en matière d'IA, les SCC doivent savoir comment l'utiliser pour des applications innovantes.
- Favoriser la formation sur l'évaluation de l'IA et l'interprétation des résultats, sur les compétences en matière de gestion des données. Les acteurs des SCC (musées, éditeurs de livres, entreprises de médias, labels indépendants) détiennent des données précieuses mais externalisent le traitement et la valorisation du contenu à des entreprises technologiques. Des compétences sont nécessaires pour savoir quoi faire des données et comment les valoriser dans la nouvelle ère numérique.
- Favoriser les programmes qui aident à gérer le changement au sein de l'organisation et à adapter les modèles organisationnels à l'IA. L'adoption de l'IA consiste à gérer le changement. La technologie de l'IA apporte la promesse de réduire les coûts et d'augmenter l'efficacité, mais les outils d'IA et leurs résultats doivent être intégrés dans le flux organisationnel complet des entreprises créatives et des institutions culturelles afin d'exploiter tout le potentiel de l'IA.

Aux décideurs politiques :

- Favoriser l'inclusion d'une formation à l'IA (non seulement le codage, mais aussi une préparation à un monde futur alimenté par l'IA) dans les programmes des établissements de formation des SCC aux niveaux licence et master.
- Plus largement, l'éducation à l'IA doit commencer dans les écoles et par le biais de programmes extrascolaires informels, ainsi que dans les écoles secondaires et les universités.

[10] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6428

- Développer un programme de formation/stage SCC-IA et encourager sa mise en œuvre parmi les étudiants en informatique.
- Créer un centre de compétences virtuel ou physique en IA pour les SCC en s'appuyant sur les résultats du projet AI4Media.
- Continuer à encourager le développement de talents en IA pour les SCC dans l'UE et créer davantage d'incitations pour que les talents en IA restent sur place. La pénurie de talents en IA en Europe entraîne une augmentation des attentes salariales des experts en mégadonnées. L'accès aux compétences est entravé par les limitations imposées aux motivations que les startups peuvent proposer à leurs employés ainsi qu'aux formules de rémunération qu'elles peuvent offrir en termes de salaires et autres avantages.
- Augmenter le nombre de doctorats en IA axés sur un sujet lié aux SCC.
- Compléter les programmes d'éducation par des informations sur la manière d'utiliser les normes communes en matière de données.

2.4.3 *Écosystèmes de collaboration entre la technologie et les SCC*

Les entreprises et institutions traditionnelles des SCC manquent de capacités internes pour développer leurs propres solutions d'IA. Elles sont donc dépendantes d'un groupe relativement restreint d'entreprises technologiques spécialisées dans l'IA.

Recommandations

Aux secteurs :

- Favoriser l'émergence d'une scène et d'un écosystème de startups européennes spécialisées dans les solutions pour les secteurs culturels et créatifs, en partenariat avec les SCC.
- Échanger et coconcevoir des applications d'IA avec des startups technologiques. Améliorer la compréhension mutuelle entre les professionnels de la création et les développeurs de technologies.
- Lancer des tests et participer à des projets de démonstration qui peuvent démontrer la viabilité (et la rentabilité) de l'utilisation de l'IA dans les SCC.
- Explorer les programmes européens existants qui aident à financer des projets de collaboration dans le domaine de l'IA.
- Inciter les artistes et créateurs indépendants à échanger leur savoir-faire avec les développeurs de technologies.

Aux décideurs politiques :

- Continuer à soutenir les projets de collaboration entre les SCC et les technologies d'IA dans toute l'UE, y compris les actions à plus petite échelle telles que les systèmes de bons ou les projets d'expérimentation.
- Étudier les moyens de soutenir les échanges dans le cadre desquels des professionnels des SCC résident dans des entreprises technologiques pour une durée limitée, et vice-versa, à l'instar des programmes d'"artiste en résidence" et de "technologue en résidence", en tenant compte des possibilités offertes par les programmes pertinents existants.
- Mettre en place un partenariat public-privé dans le domaine de la technologie de l'IA qui puisse encourager la collaboration entre les grandes plateformes européennes, les entreprises technologiques et les parties prenantes des SCC.
- Encourager la participation des SCC au réseau européen des pôles d'innovation numérique.
- Favoriser le développement d'initiatives de grappes d'entreprises technologiques liées aux SCC et le développement de l'écosystème des SCC.
- Intégrer les SCC dans le nouveau marché du Conseil européen de l'innovation, actuellement en cours de développement.

2.4.4 *Établir un équilibre entre transparence et innovation*

Lorsqu'elles adoptent des solutions d'IA, les entreprises des SCC sont confrontées à des problèmes de transparence liés aux systèmes de recommandation et de prise de décision alimentés par l'IA. Si ces problèmes ne sont pas résolus, de nombreuses entreprises des SCC continueront d'hésiter à adopter l'IA dans leurs activités. Les fournisseurs de solutions d'IA pour les SCC doivent entreprendre plusieurs démarches afin de rendre leur fonctionnement transparent.

Recommandations

Aux secteurs :

- Encourager le développement de normes et de labels d'IA dans des codes de conduite volontaires pour l'utilisation transparente de l'IA dans les applications spécifiques aux SCC.
- Envisager le développement (avec l'aide éventuelle des gouvernements) d'une boîte à outils pour des "listes de contrôle de la diversité culturelle" pouvant être utilisées par toute entreprise ou organisation des secteurs concernés lors de la mise en place d'un système de recommandation basé sur l'IA. Ce contrôle doit permettre de s'assurer que le système est transparent et s'appuie sur des données variées et équitables.
- Favoriser un dialogue sur le comportement éthique entre les startups de la technologie de l'IA et les SCC.
- Introduire l'annotation des données selon le principe JUST : les créateurs d'ensembles de données devraient annoter leurs données dans le but d'assurer leur caractère judicieux, impartial, sûr et transparent.

Aux décideurs politiques :

- Rendre les solutions d'IA responsables et adopter des règles claires sur la responsabilité des décisions prises qui ont été informées par les données de l'IA. Les technologies d'IA étant utilisées dans la prise de décision, un besoin de responsabilisation algorithmique s'est fait jour, qui doit s'appuyer sur un cadre de gouvernance approprié.
- Élaborer des règles pour que les plateformes en ligne publient un guide de l'utilisateur sur leurs systèmes de recommandation.
- Continuer à encourager les initiatives qui contribuent à réduire les préjugés dans les applications de l'IA en mettant, par exemple, des services de technologie du langage fonctionnel à la disposition des développeurs d'IA et des structures similaires qui facilitent l'accès à des ensembles de données plus larges.
- Poursuivre les recherches et le partage des connaissances afin d'évaluer la nécessité de prendre de nouvelles mesures à plus grande échelle pour promouvoir et préserver la diversité culturelle.

2.4.5 *Financer la démonstration de l'IA et les nouveaux modèles commerciaux*

Le développement d'outils basés sur l'IA pour les secteurs créatifs et culturels est coûteux et nécessite un investissement initial. L'accès au financement est un obstacle bien connu à l'innovation en général, et en particulier pour les SCC, car la culture et l'art sont un bien public et le secteur est moins guidé par des considérations purement commerciales.

Le problème n'est pas seulement l'accès au financement, mais souvent aussi la faible capacité financière des petits acteurs ou le manque de volonté d'investir des grands acteurs. Néanmoins, le problème le plus pertinent qui a été identifié concerne l'absence d'un argumentaire commercial clair qui motiverait les investissements dans le domaine des SCC.

Bien qu'il existe une série d'initiatives publiques pour aider les startups créatives et culturelles à se développer, le manque de sources de financement adéquates et non bureaucratiques constitue un problème important puisqu'il n'existe pas de mécanismes de financement dédiés à l'IA créative en Europe. Dans les programmes existants, il y a également un manque de financement (public) consacré aux applications "à portée de main" de l'IA et au financement de démonstrateurs.

Les start-ups européennes de l'IA manquent d'investissements en capital-risque et sont souvent attirées par d'autres centres mondiaux de l'IA. Le danger lié à un manque de financement approprié et à des investissements mal placés réside dans le fait que si les outils basés sur la technologie de l'IA sont

développés par des acteurs d'autres parties du monde, l'Europe pourrait perdre son indépendance technologique dans ce domaine.

Recommandations

Aux secteurs:

- Favoriser la sensibilisation et le changement d'état d'esprit des professionnels de la création en vue d'une meilleure compréhension des modèles économiques autour de l'IA.
- Saisir plus activement les opportunités existantes dans le cadre de l'Europe créative, du programme Digital Europe ou de la Communauté de la connaissance et de l'innovation des industries culturelles et créatives de l'Institut européen d'innovation et de technologie, qui peuvent financer des projets d'IA.
- Lancer des projets similaires à Mediafutures dans le cadre d'Horizon Europe et publier des sous-appels permettant aux SCC de tester de nouvelles applications d'IA.[11]
- Lancer des projets de démonstration et de test pour que les SCC puissent développer de nouveaux modèles économiques autour des applications de l'IA.

Aux décideurs politiques :

- Faire connaître les programmes européens disponibles qui peuvent financer des projets d'innovation en IA dans les secteurs culturels et créatifs.
- Envisager le développement de programmes de financement qui permettent un accès facile aux tests de l'IA dans les SCC et qui peuvent démontrer la viabilité de l'application. Il convient d'étudier des programmes simples qui peuvent aider à créer des liens entre les SCC et les start-ups technologiques de l'IA.
- Lancer des initiatives d'investissement thématiques dédiées aux start-ups et aux entreprises de croissance du secteur de l'IA dans le domaine des SCC ou un processus visant à sensibiliser les investisseurs aux possibilités offertes par les SCC (formation, mise en relation, présentation de produits susceptibles de créer la confiance, contacts personnels entre investisseurs de capital-risque).
- Faciliter l'accès au financement pour les startups et les entreprises de croissance du secteur de l'IA dans le domaine des SCC par le biais d'instruments de capitaux propres et de titres de créance dans le cadre d'InvestEU.

[11] https://mediafutures.eu/

3 Introduction and methodology

3.1 Objectives

This study is the result of research carried out about the 'Opportunities and Challenges of Artificial Intelligence Technologies for the Cultural and Creative Sectors'. The project has been commissioned by the European Commission (DG CNECT and DG EAC) and prepared by a consortium made up of Technopolis Group, the Danish Institute of Technology, the Research Institute of Sweden, and BOP Consulting.

The objectives of the study were the following:

- to identify artificial intelligence (AI) use cases and application areas that offer a clear positive business opportunity which are currently being used and/or will/can be deployed in the next five years for the cultural and creative sectors;
- to examine the challenges that AI technologies raise for the promotion of, and access to, a culturally diverse offer of European works;
- to recommend support measures that can unlock the potential in AI in particular fields (access to data, skills and training, ecosystems, ethics, and transparency), and can be funded by upcoming policy programmes or through industry actions.

The ten cultural and creative sectors (from now on abbreviated as CCS) covered in this report are:


Music


Museums and heritage


Film


Visual arts


Video games


Performing arts


News media


Book publishing


Architecture


Fashion and design

The study does not cover copyright related use cases and analysis of AI on copyright since this subject has been elaborated in a parallel study of the European Commission (please see the study on 'Copyright and new technologies: copyright data management and artificial intelligence' by Technopolis Group, Philippe Rixhon Associates, UCLouvain, Crowell&Moring & IMC University Krems, 2022).

3.2 Definitions

Defining AI is not trivial, and goes well beyond the scope of this study to agree a single definition for AI. However, for the purposes of this work, we provide the following broad definitions: AI is considered as a "set of technologies able to identify complex structures from massive datasets and to use these structures to make predictions and/or take actions and decisions on previously unseen data" (Caramieux et al, 2019). AI technology is understood as performing human-like cognitive functions such as learning, understanding, reasoning or interacting. What makes AI particularly useful today, is that it is capable of recognising patterns in large sets of data. It comprises different forms of cognition and meaning, understanding and human interaction (e.g. signal sensing, smart control, simulators). This definition refers to narrow AI systems, as opposed to a general AI system, which would be truly autonomous and able to self-improve independently from humans – a milestone that has not yet been reached. Beyond the above description, AI could also understood as the notion of "*imitating intelligent behaviour*" (Kriebitz and Lutge, 2020). This definition includes all solutions that can support humans in tasks we have believed require human intelligence, or in situations where humans act towards the AI as they would towards a human, or expect it to react much like a human. This covers both sophisticated neural networks at one end of spectrum and less complex algorithms at the other. Many less-complex solutions are used in use cases where, most likely, a more sophisticated AI algorithm would work as well. AI technologies can encompass

a wide range of techniques such as machine learning, computational creativity, algorithmic composition, generative art or neural networks, just to mention a few.

The European Commission launched a proposal for a regulation laying down harmonised rules on AI[12] in April 2021. This proposal defines artificial intelligence from an application perspective notably as "*a fast-evolving family of technologies that can contribute to a wide array of economic and societal benefits across the entire spectrum of industries and social activities. By improving prediction, optimising operations and resource allocation, and personalising digital solutions available for individuals and organisations, the use of artificial intelligence can provide key competitive advantages to companies and support socially and environmentally beneficial outcomes*".

Cultural and creative sectors are comprised of all sectors whose activities are based on cultural values, or other artistic individual or collective creative expressions[13] (European Commission, 2021).

3.2.1 Selection criteria for sectoral use cases

The use cases presented in the sectoral chapters have been selected because they are already making a difference in the sectors and could be realistically adopted more broadly within the next five years. The use cases come from various parts of the sectoral value chains (creation – production – marketing) but most importantly address an existing business need in the stage of *production and business processes* (making it more efficient) and *distribution* (supporting outreach to the appropriate audience and monetisation). The use cases illustrate how AI can be used to create new business opportunities and practical, near-term solutions to current sectoral challenges. In sum, the criteria applied include the following:

- Cases should be valuable (either in terms of employment or growth prospects)
- Cases should be scalable/generalisable (not just a one-time use)
- Evidence of benefits to the sector
- Types of technologies and data should be identifiable

3.3 Methodology

The study is based on desk research and literature review, 66 interviews and three focus groups with technology developers, industry stakeholders (artists, producers, publishers etc), researchers and other experts, as well as on an analysis of startup data and tech mining. It also draws upon the results of the discussions and brainstorming exercises conducted at a stakeholder event which took place on 30 September 2021 with the involvement of 102 attendees, including sectoral representatives and experts from the ten sectors. Given the broad scope and diverse topics, the findings provide inspiration and ideas but cannot be regarded as a full assessment of all sectoral challenges and the feasibility of future suggested actions.

This report is structured as follows:

Chapters 4-7 present a synthesis of the opportunities, risks and challenges of AI technologies in the ten cultural and creative sectors including a detailed list of recommendations to policy and industry (Chapter 5). Recommendations have been focused on the challenges of 1) access to data, 2) skills and training, 3) collaboration between tech and CCS, 4) transparency and ethics, and 5) new forms of funding.

Chapters 8-17 present the sectoral analysis per CCS. The sectoral chapters present the opportunities including more detailed use cases, the challenges and a list of sector-specific recommendations.

[12] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0206
[13] https://ec.europa.eu/culture/sectors/cultural-and-creative-sectors

4 Opportunities to grow the cultural and creative sectors using AI

4.1 COVID-19 has accelerated the digitalisation of the cultural and creative sectors

Cultural and creative sectors are crucial for the European economy, employing 7.2 million people (Eurostat, 2020)[14], which represented 3.7% of all employment, or equivalent to 3.8% of total employment in the EU27 (KEA, 2020). The estimated value of the EU creative economy was over €477 billion as estimated by the European Commission in the Annual Single Market report issued in 2021 (EC, 2021). At the time of writing this report, cultural and creative sectors are about to revive again as most of the live activities are starting up, but they have to face a new environment with changed user preferences, a more digital audience, greater emphasis on safety, and continuing fear of further lockdowns.

CCS in general are confronted with the challenge of how to find new ways to monetise their content and reach out to digital-minded and increasingly digital-native audiences in innovative ways. They also have an important intrinsic value, beyond their role in the broader economy. CCS have a societal value which could be reinforced by seeking new collaborative partnerships with, among others, the education, healthcare and service sectors[15].

The COVID-19 pandemic has had a severe impact on the CCS around Europe. Venue-based sectors such as museums, performing arts, live music, festivals, and cinemas, have had to close down their operations, and have been the hardest hit by social distancing measures (OECD, 2020).

Trends that were already underway before the pandemic have accelerated. Before the pandemic, the entry of new information and communication technology players had disrupted the market structure, not only for cultural production and distribution but also for all kinds of organisations included in their value chains (KEA, 2017). This has had a significant impact not only on the production and diffusion of cultural goods, but also on financial flows and copyrights. The digitisation of creative works has lowered the costs, and consequently the barriers, to production for artists and creators. This has led to an increase in artistic output leading to more creative works being produced, distributed and published than prior to the digitisation trend.

Lockdowns reinforced these digital transformation trends in the CCS and shifted attention to online cultural and creative activities. Certain online platforms have even profited from the increased demand for cultural content streaming (OECD, 2020). The lockdown and shift to internet-based communication also proved that digital platforms can become a lifebelt for communities to stay in contact and keep on pursuing at least some cultural and creative activities in this particular situation.

In this new context, resources such as data and skills in digital technologies including AI have become highly valued. The ever-growing amount of digital content produced across the cultural and creative sectors and the progress of AI technologies have created new and transformative opportunities in various fields. Most importantly, AI has become a powerful enabler for CCS, helping these sectors handle and use large amounts of data accumulated as a result of the digitisation process.

Artificial intelligence can provide a value added for each stage along the CCS sectoral value chains such as the creation, production and distribution of creative and cultural content. Although AI has been used mostly by large tech companies, tech startups and digital distributors, there is potential for smaller players, independent content creators and artists to boost their efficiency, decision-making and output thanks to AI tools (Figure 3). There are a set of viable applications available to CCS, such as using machine learning for data analytics, deep learning for predictions, and AI recognition tools to support image search.

AI technologies are expected to augment CCS and save valuable resources that they can direct towards other more interesting activities. In this report, the use cases have been grouped into four (often

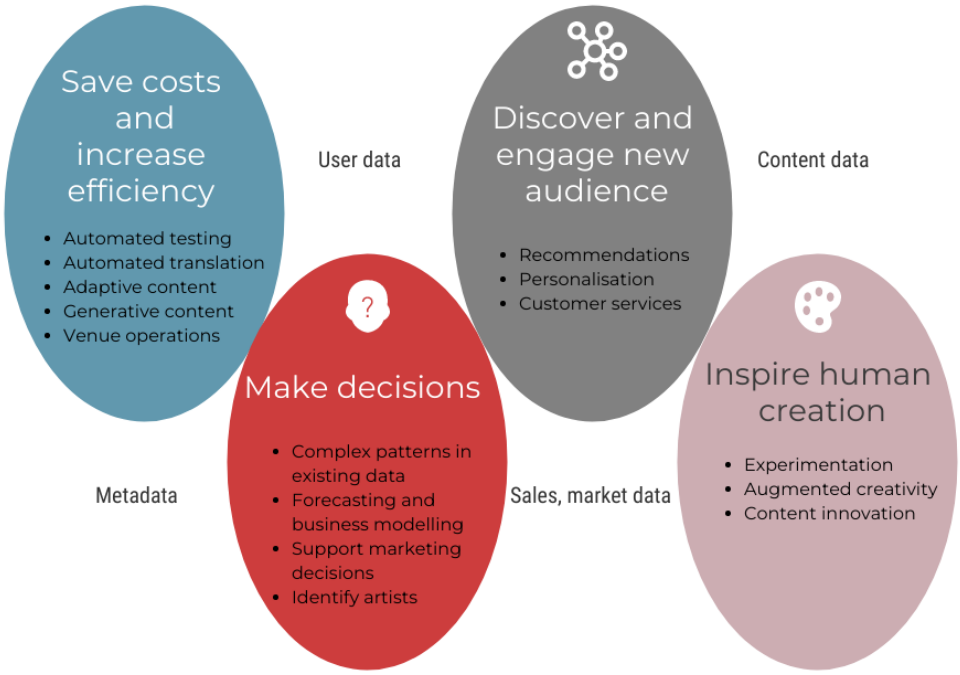
[14] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Culture_statistics_-_cultural_employment#:~:text=%3A%20Eurostat%20(cult_emp_sex)-,In%202020%2C%20there%20were%207.2%20million%20people%20in%20cultural%20employment,2020%20(see%20Table%201). (Please note that the European Commission Annual Single Market report published in 2021 indicates another estimate notably 8.02 million people employed in the cultural and creative industries)

[15] See an analysis of cross-industry collaboration more in detail: https://keanet.eu/wp-content/uploads/Impulse-paper-on-the-role-of-CCIs-in-innovating-European-industry_integrated.pdf

overlapping) categories that help CCS 1) save costs and increase efficiency 2) make decisions 3) discover and engage the audience 4) get inspiration from. In each group AI is powered by a particular type of data including content, user, market and metadata.

Nonetheless, it is important to set realistic targets, gauge the value added of AI solutions against their cost, and cut through the hype. AI is expected to bring a competitive edge to those who successfully develop or adopt it and the use cases presented in the sectoral chapters highlight numerous opportunities to seize. It is, however, important to keep in mind that use cases have their limitations too and will not bring any immediate miracle.

Figure 3: Overview of common promises and AI applications across the cultural and creative sectors



Source: authors

Note: Various data sources can be relevant for any opportunity group

The sectoral chapters (Chapters 8-17) in this study present detailed opportunities in AI and provide an assessment of their value and potential growth prospects. Opportunities in AI have to be dealt with in a sector-specific context since the adoption path, feasibility but also associated challenges and risks depend very much on the nature of the specific cultural or creative activity and on the group of stakeholders shaping their ecosystem. Nevertheless, there are some commonalities that can be highlighted which are valid more or less across all sectors. The following sections present this synthesis with references to the sectoral use cases grouped around key value propositions. They have to be regarded as highlights only (details are reserved for the sectoral chapters).

4.2 Save costs and increase efficiency

Some AI applications promise to make business processes more efficient and potentially less costly. The use of AI denotes potential for major efficiency gains in content production, development and access/distribution including the possibility of creating generative content. In all covered sectors, AI tools are used to automate various simple, often repetitive tasks at the production and post-production stages. Some of the common use cases that can be highlighted are described in the following.

Table 9: Examples of AI use cases that help save costs and increase efficiency

Sector	Use Case	Value proposition
Architecture	**Parametric architecture**	AI can help create several design options to be tested and suggested to the users without requiring extra resources.
Book publishing	**Automated translation**	Automated translation drives cost reduction by speeding up the content creation and, for simple content only, lowering costs of translations for book publishers.
Fashion & design	**Customisation of items**	AI can be used to tailor fashion products to customers' specifications, i.e by defining exactly the right quantity of fabric to be used for the customer.
Film	**AI-powered film editing**	AI can save a significant amount of time in the pre-editing phase and thus free up budget and time for the creative process.
Museums & heritage	**Computer vision for cataloguing artefacts**	While it is still experimental, this will help Museums and Heritage organisations to research and categorise their digital collections more effectively and helps speed up this otherwise manual process.
Music	**AI audio mastering**	AI can be applied in supporting audio-mixing and post-production. A range of AI-based compositional tools make it more affordable to create high-quality content.
News media	**Automated content curation**	Efficiency gains and improved workflow can be reached with the use of AI-powered automation behind the scenes of the journalistic and editorial process.
Performing arts	**Support sales**	By linking data and information, service providers can provide insights that inform marketing decisions and help producers forecast attendance and ticket sales for a show.
Video games	**Game testing**	Artificial Intelligence and machine learning promises to automate the process of game testing, accelerating the process of bringing a game to market and lowering the cost of production.
Visual arts	**Speed art production**	Many free software packages empower creators to work on their digital content fast and effectively, focusing on the creative output rather than the manual editing tasks.

Source: authors

The value of these AI use cases lies in time saving on existing tasks and fastest production, expansion of the scope of activities (e.g. new business models), cost reduction and improved products. It has the added value of limiting the least rewarding aspects of the professionals' activities, leaving them more time to pursue the more creative aspects of their work.

AI is used by organisations to provide a faster and more affordable approach to essential tasks. This in turn frees up time for experts to focus on more complex parts of their activities (e.g. a journalist focusing on a complex investigation, a curator spending more time researching). Outside highly specialised tools, AI can ease work for professionals by simplifying tasks such as data security, data treatment and processing but also make user-friendly navigation.

- In the news media sector, AI is used to clean large amounts of data and to perform editorial tasks. AI is also used to filter questionable content in comment sections, instead of human moderators. It supports the automated writing of stories based on data like sports results and allows organisations to cover more stories. Automated translation can help reduce costs and make production of content faster.
- The use cases in the film industry can help producers cut costs significantly. The film sector is especially interested in AI applications helping to automate solutions including the framing of cameras, editing raw footage, video production aids to produce trailers, and in generating environmental design. Other examples are text tagging for metadata and even in predicting a film's potential success.
- Image recognition can be used to explore, categorise and map extensive museum collections and content more efficiently. In the music sector, tasks such as mixing and mastering can be

greatly accelerated with the use of AI-powered tools. This is also true for film production where visual effects, film editing, and planning shooting schedules can be automated.

- The architecture sector involves heavy and complex technical checks and regulations compliance; and AI can perform many of these tedious tasks faster and more accurately than human employees. The accuracy of AI is a recurrent argument in favour of its adoption for these repetitive tasks.
- In the creative process, artists can leverage AI tools to finalise their artwork (e.g. colourisation) in order to speed up their production. AI methods can fix lost parts of images or videos.

4.3 Support decision-making

AI is very powerful in analysing large-scale data, recognising trends and revealing valuable insights. With the introduction of digitally consumed cultural and creative productions, tech firms, online platforms and CCS can collect previously unknown information about the use of their content. Examples of AI applications for data analytics to support decision-making include predicting revenues, planning marketing campaigns, or improving the quality of the work delivered. In several sectors, data analytics can help identify emerging artists and match their work to consumer interests. Some of the common use cases that can be highlighted are outlined in the following table.

Table 10: Examples of AI use cases that help take better decisions

Sector	Use Case	Value proposition
Architecture	**Cloud-based AI software for buildings**	AI-based decision-making can shorten the planning time of buildings and the design process. Architecture firms can leverage the power of AI tools to propose different options to a client.
Book publishing	**Identify relevant content**	Publishers get inspiration to identify the right author and the right content by analysing reading patterns and 'connecting the manuscripts with the target group'. Very relevant in academic publishing.
Fashion & design	**Predictive trend forecasting**	AI-driven trend forecasting addresses the need of fashion designers to adapt ever faster to trends and optimise supply chains to the maximum in order to stay competitive.
Film	**Green lighting' of films (approving film's production and finance)**	AI-driven data analytics can help directors decide which films should get funding (get the green light) and go into production. AI can also support the marketing, distribution and release dates.
Museums & heritage	**AI for curating exhibitions**	AI can personalise and generate playful visitor specific experiences that reimagine and reinterpret a collection - increasing engagement with the collection. For example compare a user selfie to artwork.
Music	**AI-based data analytics**	AI-based data analytics help track performances, identify local opportunities and pinpoint industry trends to enhance their business strategies. A&R managers can scout for talent more easily.
News media	**Curate content based on user interaction**	AI driven alert in the CMS about audience interaction with a story: The AI sees a familiar pattern in the audience behaviour and alerts the journalist to something that might be a story with building interest
Performing arts	**Programming decisions**	It enables producers to understand the types of shows that audiences are likely to positively respond to, providing producers with a powerful tool to inform creative and programmatic decisions for the future.
Video games	**AI for player modelling**	Player modelling enables designers to design and adapt games and NPCs based on the behaviours and experiences of a player.
Visual arts	**Authentication of art works**	AI can support collectors authenticate genuine art works and identify fakes.

Source: authors

Access to data motivates sectors to explore new business models such as providing data analytics services from specialised providers (e.g. providing customers' data analytics and market analysis) and traditional actors exploring new target groups or ways to engage with their customers (e.g. providing style

advice in the fashion and design industry). Moreover, a higher degree of automation of the supply and value chain through data analytics can lead to an important reduction in production and supply costs.

- Fashion and design players can increase profit by tailoring their next collections to the preferences of their customers, adapting rapidly to trends and minimising waste following AI-based data analytics. The expected result is to optimise processes and increase productivity.
- This also applies to the architecture sector, where improved construction materials and management can make an important difference both in construction times but also in sourcing recyclable materials to make construction more sustainable, thus contributing to the circular economy, and to make housing more affordable.
- In the film industry one can estimate the potential audience of a film and when/where to release it while the design industry can use AI tools to forecast demand and adapt the value chain.
- Museums can use data analytics to catalogue their collections more effectively.

This potential might not have the same scale in all sectors. Professionals in certain sectors such as book publishing or film tend to rely largely on their experience and perception of public expectation in deciding which books to publish or which films to produce.

Some of the AI-powered data insight applications (depending on the CCS) are still in an early stage of development, and some CCS organisations express concerns over how to turn the AI results into real added value. Return on investment is still limited, but future developments, trials and errors are expected to make these AI tools more sophisticated.

4.4 Discover and engage audiences and the new class of content creators

A new audience and market for creative and cultural content has been 'growing up' as digital natives are now reaching adulthood. Information technology is natural to them, they are more familiar with the virtual world, absorbing information and new digital trends much faster. The new 'Generation Z'[16] considers technology in an immersive way. This represents market opportunities for (sometimes niche) products or services that cater to audiences interested in novel ways to experience culture such as immersive art exhibitions, AR/VR gaming or personalised music playlists.

Culture is increasingly accessed through search engines, online platforms and social media. Customers now have access to more diverse products and can purchase parts of bundled products, which should in turn improve cultural access.

The old 'audience' category has been taken over by new 'content creators' and 'cultural producers' who are enhanced by the development of digital technologies and tools. The new digital audience is not a passive receiver of information anymore. In this new digital era, AI should be more and more considered as a facilitator for cultural production online. Engagement in culture and creative content should take into account these changes and should empower the users of content in a more active way. The future of CCS is influenced by a creator class of users that generates new content with the help of a range of novel AI-based applications. For example, Rosebud.AI[17] is a synthetic media platform enabling people to create photos and videos of virtual models for brand advertising and entertainment. In the music industry, Aiva[18] enables anyone to create compelling themes for projects by leveraging the power of AI-generated music.

AI technologies promise to deliver hyper-personalised content which can also be co-created with users who are invited to participate in the artistic process. Companies in the fashion industry have explored AI-based personalisation of products to the size of customers (preferred fits) to limit returns and simplify processes between companies and customers. AI is also used to analyse the reactions and emotions of an audience, for example when watching a film based on recognition technologies (facial expressions, emotion, gait, and other mannerisms).

Artificial Intelligence and machine learning has the potential to support societal transformations. It can for example improve accessibility for people with disabilities. Although these technologies could help to improve some of the challenges for the nearly 90 million Europeans living with a disability[19], continued

[16] Defined as "the generation of people born in the late 1990s and early 2000s" by Merriam-webster.
[17] https://rosebud.ai/
[18] https://www.aiva.ai/
[19] https://www.disability-europe.net/downloads/1046-ede-task-2-1-statistical-indicators-tables-eu-silc-2018

initiatives to create a barrier-free society would still be needed. Previous initiatives to enable technology to work for everyone include the Union of Equality: Strategy for the Rights of Persons with Disabilities 2021-2030, Audiovisual Media Services Directive and the Web Accessibility Directive.

There are also new channels and industrial pathways to reach new types of users often in a cross-sectoral setting. AI has proven to deliver value both in terms of recommendations and more personalisation. Some of the common use cases that can be highlighted are explained in the following table.

Table 11: Examples of AI use cases that help better understand and reach out to new audiences

Sector	Use Case	Value proposition
Architecture	**User-centred, real-time design**	AI can provide information to architexts about building are used and how they shape users behaviour and alter the future design of buildings
Book publishing	**Immersive reading enhanced by AI**	Technology-based startups offer new ways to engage the reader beyond the book by offering an immersive reading experience. The future digital reader can become part of the story.
Fashion & design	**AI-driven shopping assistants**	Platforms offer a combination of human stylist and machine learning algorithms, where customers receive personalised information from human stylists and suggestions from an algorithm that understands the customer's preferences over time
Film	**Recommendations systems**	Major VOD platforms use recommendation algorithms. AI technologies can analyse the metadata and user behaviour to guide choices but also analyse the video content itself to find other similar content.
Museums & heritage	**Audience engagement activities**	Organisations can better manage their venues using AI applications, while tracking visitor numbers, forecasting attendance, and analysing feedback from visitors (sentiment analysis).
Music	**Personalisation of music experience**	AI technologies that will help changing the type of playlist or music that the listeners is suggested depending for instance on his/her mood, the weather, the position (for instance commuting, studying).
News media	**Personalisation of content**	Using AI and machine learning on visitor data can be used to build a general understanding about audience composition and allow for product design that takes different subgroups into account in order to make the product more engaging and more accessible.
Performing arts	**Make live content available**	Novel ways to make live content availablefor example by using augmented reality headsets to enable deaf and hard-of-hearing audiences to access subtitles and captions in real time.
Video games	**Adaptive games**	The development of AI and machine learning techniques is allowing games developers and researchers to create game products that adapt and personalise to the individual players.
Visual arts	**AI-augmented art for people with disabilities**	AI enables an audience with disabilities to experience art. Technology adapts and helps transform the art works into content accessible to visually impaired people for instance a voice-over.

Source: authors

Use cases related to content recommendations and curation cover a range of applications, especially in content discovery and promotion. Because culture consumption is taste-dependent, recommendation systems are particularly useful for the cultural and creative sectors to find their target audience. Recommendation systems are built on user interaction with the content, user profiles, and similar content/user-related characteristics. They are developed with technologies such as collaborative filtering, natural language processing and audio analysis that can extract and assess information from large datasets.

Curating content using recommendation systems helps sectors capture the attention of a user for a longer time span and increase consumer satisfaction with the platform. For ad-based streaming models, the longer a user stays on the platform, the higher the profit. With the explosion of streaming models these systems have become more refined, not only building on user interaction with content and their preferences but also, depending on the sector, on the time of the day, user location, size, mood or current

activities (e.g. studying/working out). Similar content curation efforts are developed in film, book publishing and fashion but also by social media platforms to propose news that may interest the reader or to filter unwanted content.

- In the music industry, streaming platforms (e.g. Spotify, YouTube) use recommendation systems to capture user preferences and adapt the suggested content, but also to promote ready-made and automated playlists. The platform business model relies primarily on advertising.
- It is notable that recommendations across content types have emerged on retail platforms such as Amazon which collect data on users regardless of the content they engaged with. For example, film and book consumption can be linked to building better user profiling and refining the content curation. In the book publishing industry, where profit has a typically long tail, recommendations lead consumers to discover and buy books related to any field of interest, which increases profit.
- Recommendation systems are usually proprietary to large platforms and retailers, disrupting the balance of power with creators. In the book publishing industry, little information is shared with book publishers who are unable to leverage extensive data to adapt to readers' preferences.

AI allows personalisation for disabled audiences. Improvements in text-to-speech technology is one example of progress in machine learning now being applied to the film industry, making a film accessible to people with certain disabilities or to foreign language audiences. The automation of the transcription work and translation including automated captions is already available to producers.

4.5 Inspire and complement the content creator

AI is often discussed in the context of its role in creating art and content, however, the development of 'AI as an artist' is not (yet) a realistic scenario for the short-term transformation of CCS. The music industry is one the most advanced in terms of its AI use for content creation. Compositional tools can create new sounds, helping artists push musical boundaries. In cases such as news media, where AI is playing an increasing role in robot journalism, AI is expected to complement journalistic work.

From the perspective of the CCS, there is an unlocked potential in AI to inspire and enhance the content creation process and foster creativity. Machines can become great inspiration aids to artists, in any sector, adapting to their own style and even 'surprising' them with unexpected propositions. This can improve cultural outputs and attract a larger audience thanks to fresh ideas. For painters developing a series of works, for example, an AI can become a precious aid to save time in the creation process.

In the book publishing sector, AI applications have been developed to support the creative process of the user, for example helping a writer have a consistent style. Similarly, in journalism, AI can support journalists' writing by recommending topics based on earlier output and headlines based on story sentiment. In visual art, artists can train an AI to study their own style and suggest paintings.

Some of the common use cases that can be highlighted are explained in the following table.

Table 12: Examples of AI use cases that help inspire human creation

Sector	Use Case	Value proposition
Architecture	**AI-powered building design**	Using data-driven design, a cloud-based SaaS platform enables users to design a building and to download a 3D editable BIM file, in a matter of hours,boosting design productivity
Book publishing	**AI suggested new content**	AI can help publishers identify relevant content. Publishers can get new inspiration to identify the right author and the right content by analysing reading patterns.
Fashion & design	**Smart textiles**	A combination of sensor technology and textile science makes it possible to collect data on the external and internal environment of the wearer. The field is particularly explored at the intersection of sportswear and technology.
Film	**Automatic story generation**	Despite its name, automatic story generation is considered to be limited on its own, however, it can support to scriptwriter to get inspiration for an unexpected turn in the storyline.
Museums & heritage	**AI painting restoration**	AI can be used to restore missing edges of a painting by training AI to colour in a similar style used in the painting, including brush strokes.
Music	**AI-inspired music generation**	AI tools can help musicians to test new sounds, get inspiration and compose music relying on algorithmic input. These applications can generate instrumental algorithmic music under musical rules.
News media	**Open Data Mining**	These "insights" are then subjected to an automatic verification process built on journalistic practice and for journalists to independently verify and eventually publish.
Performing arts	**AI-augmented choreography**	In performing arts, current AI applications inform and enhance the creative process alongside a human creator such as the choreographer.
Video games	**Software to improve non-player characters**	Some ML engines are free for small businesses or individuals to enable developers to train NPC with ML techniques. Others help create personalities for NPC that evolve during the game.
Visual arts	**AI assisting post-production workflows**	AI is used to enhance and develop design outputs. A number of widely used software packages already include in their offer, AI-enabled processes for contrast enhancement, colourisation, resolution, etc.

Source: authors

4.6 AI opportunities across sectors and beyond

AI opens up new avenues both for cross-sectoral cooperation within the cultural and creative sectors and beyond with other industries. Although each cultural and creative sector has its own ecosystem with stakeholders that are not necessarily or always communicating with the other sectors as such, there are various ways for cross-overs to emerge.

- Audio 'generativity' and performer-computer co-creativity can enable music generation in real time for AR/VR personalised environments and new performances. AI offers a new way to connect music to theatre performances and art.
- In video games, museum collections and images can be potentially used to generate objects and landscapes in virtual environments.
- News media can tap into the potential of visual arts and use photography and AI for photojournalism, video and audio content to enhance news features.
- Virtually designed environments and architectures are an important ingredient in video games. AI-powered tools can better connect the two worlds by using architectural plans as input. Visualisation techniques from video games can also help architects to better present their plans in an immersive setting.

- Cloud-based AI solutions used in architecture can be potentially used in the performing arts sector when it comes to designing a stage for a play or performance.

As show in the positive examples above, many cultural and creative actors are closely connected. An opportunity for one sector can represent a threat or lead to a loss in another actor. These relationships can complicate how a specific technology use is perceived (and therefore invested in) as AI-generated content can affect positively one or several sectors while diminishing revenues in another. For example, AI-generated music may reduce revenues of music artist, but it can be more efficiently used in the film industry or in video games. Similarly, AI-enhanced images cost less in terms of royalties and can be an advantage for the news media sector.

In the post-COVID world, there are further opportunities to be seized by cultural and creative sectors in collaborating with other industries. AI can help CCS provide new added value to education, healthcare or engineering, for instance through the creation of dynamic animated learning environments for children, testing environments for engineers or mental support platforms for disadvantaged people.

5 Potential risks of AI for culture and creativity

The real-world application of artificial intelligence technologies in the cultural and creative sectors is not without challenges and it comes with a range of risks and ethical questions. This section summarises the main risks and potential negative impacts that have been identified as part of the sectoral assessments. It has to be noted:

- It is not AI technology that causes problems per se but how systems, relationships and processes are built around them as highlighted by several interviewees. The actual impact of AI in assisting creative content creation, production and business processes depends very much on how people make use of it.
- It is important to separate long-term concerns from more pressing challenges. A full assessment of how AI may change the landscape of culture and creativity is beyond the scope of this study. This report focuses on a number of immediate challenges such as data access, skills, collaboration and access to funding to be analysed in the next chapters. At the same time some impacts are foreseeable and also considered in this report, in particular in relation to the promotion of and access to a diverse cultural offer. However, to grasp fully the implications of AI on cultural diversity in the long-term, further in-depth examination of the multi-faceted dimensions of cultural diversity is needed. This was underlined by the feedback from stakeholders gathered during this study.

Several of the existing AI tools used by the largest CCS players, such as larger publishing houses, record labels, and online platforms, can create inequalities. Smaller, independent stakeholders and individual artists face major obstacles that hinder access to data and/or their ability to adopt AI technology, thus limiting its potential benefit. Furthermore, organisations using AI-powered predictions to understand future trends and probable successes/outcomes may gain an 'information advantage' over independent creators they would sign on or freelancers they may wish to hire. In addition, AI can have a negative influence on cultural diversity of content, potentially reinforce bias and open the way for malicious developments. Centralised ownership and biased recommendations can also lead to homogenisation. The impact of increased digital use, including AI technologies, on the environment should also be considered (e.g., the switch to digital business models increases the use of electricity and the carbon footprint of data storage is significant). These potential risks are explained in more detail below.

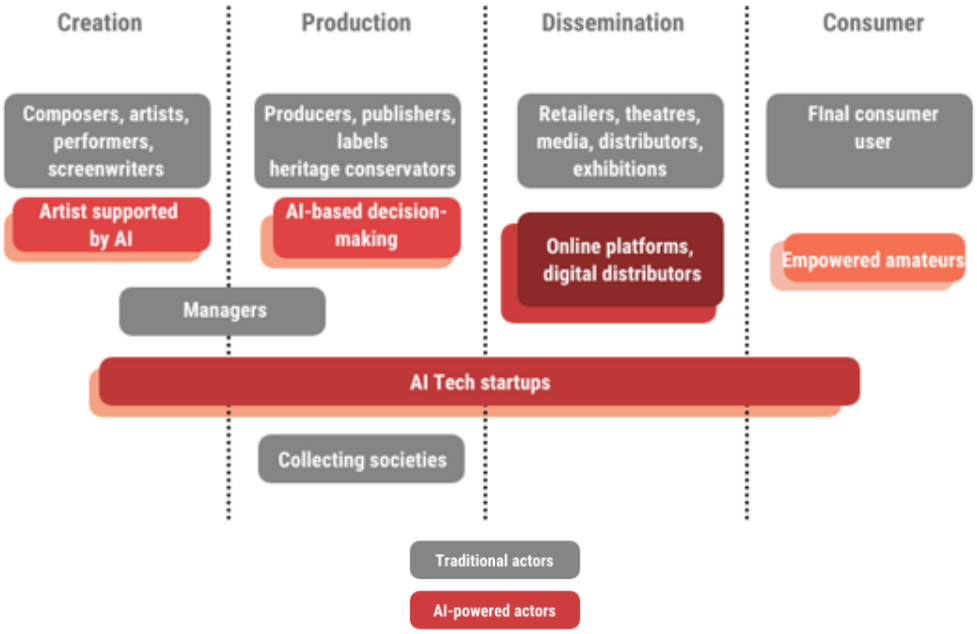
At the same time, AI can create opportunities to engage in new types of activities within the cultural and creative sectors and help develop new forms of cultural content. If Europe wants to gain global leadership in this area, it needs to foster a positive business environment for AI creative technology, establishing a clear set of rules to address the above-mentioned challenges and risks without imposing unnecessary barriers to growth in the sectors.

5.1 AI challenging the status quo along the cultural and creative value chains

As all radical or disruptive innovation tends to do, AI redefines the rules of the game and shakes up the status quo. New technologies-based innovations create new opportunities for some players while putting existing operational models to the test. Most importantly, it can make some models more powerful while rendering others obsolete. Challenges emerge that need to be addressed to ensure that, while transformations happen, the game stays fair. New AI-based applications are disrupting the traditional creative value chain in various ways, as they cause shifts among players in the wider creative landscape. As a result of the disruptive nature of AI, new forms of revenue generation appear and new ways to create content become possible. There is an inherent risk that with the spread of AI, the technology will threaten those creative content firms that are slower to adapt. Moreover, while innovative models are generally positive for consumers' experience and engagement with creative and cultural content, the concentration of power can create worrying asymmetries between the stakeholders with potential effects on the diversity and quality of the cultural experience available to consumers.

Innovation and change are natural and can help create new value, but it can become a problem when it leads to unfair results for consumers, and the concentration of too much power and asymmetries enables unfair practices which affect other actors in the CCS value chain.

Figure 4: AI impacting various stakeholders along the cultural and creative sectoral value chain



Source: Technopolis Group

AI has created new business opportunities in an asymmetric way along the value chain.

- AI startups specialised in cultural and creative sectors can anticipate where novel technology is expected to disrupt the status quo. A new breed of tech startups specialised in specific cultural and creative sectors has emerged that combine technology and creative content. In a similar way as the internet has eliminated certain sources of revenues while creating new ones, the spread of AI-based tools challenges traditional cultural and creative sectors who may need to rely more and more on the advancements of these new tech firms in order to stay competitive.
- Digital service providers (DSPs)/digital distributors such as Spotify, YouTube, Netflix, Steam or the social media platforms have accumulated a vast amount of data about their users and are now heavily involved in deploying their own AI laboratories and services. Existing platforms can benefit from winner-takes-all effects to successfully develop and market AI-based tools and services.
- While online platforms have become powerful, they have also changed the way in which users consume creative content. Besides their power in influencing consumption patterns with the help of machine learning tools, we should not forget that they also offer a new opportunity for independent artists to get closer to their fans so they can bypass the traditional production companies. In this sense, the context of some traditional intermediaries is changing such as large record labels or managers who are tasked with marketing or promoting an artist. However, in the field of music, while some artists managed to increase their revenues, many saw them decrease, although the analysis of NBER (2015) showed that interactive streaming appeared to be revenue-neutral for the recorded music industry. It has been also noted that streaming revenues are extremely low for artists.
- The largest players in the cultural and creative sectors such as the biggest newsrooms, large record labels, powerful publishing houses have the capacity to build their own AI in-house, but smaller publishers lack resources (both financial and technical) to build their own technological systems. This creates a market for licensing proprietary content and ready-made tools.
- Digital technologies can be used to put a professional finish on artists' work. AI makes creative content production easier with less professional and technical training needed. These trends might weaken the position of studios, but interviewees expect continued demand for professional production engineers.
- AI is expected to further blur the lines between the amateur consumer and the producer of creative content (creating a new class of so-called 'prosumers' (Lang et al, 2021)). For instance, with the help of online music composition platforms, the non-musician user can

generate a new range of high-quality creative works that redefine the genre. Some of these production-support platforms are readily accessible to a growing 'prosumer' market.

- The links between the cultural and creative sectors and other industries have changed as creative content is now used in a variety of new ways. AI-assisted curation and content creation can be used in retail, hospitality, marketing and advertising, etc. For instance, music is more and more a feature of social media output.
- There is a blind spot in the cultural and creative sectors not realising that while many hold data relevant for AI, they are incapable or unwilling to make use of the data or to collaborate with similar stakeholders in building/compiling strategic assets. Instead, they outsource the valorisation of content to tech companies and create a less favourable position for themselves in certain cases.

The quality of AI startups and a good European technology base will be crucial for the future of the cultural and creative sectors if Europe wants to avoid depending on US- or Chinese-based tools and data. The question of CCS specialised AI tech startups creates a 'chicken and egg problem': only strong AI startups will be able to offer quality solutions for the real benefit of CCS solutions, but those startups need a business environment where trustworthy data pools are available and can be shared.

The trends and transitions described above are reorganising the operational model of the cultural and creative sectors. For many in these sectors, AI's emergence represents an unfair reconfiguration of power. Their desire is to see AI open up opportunities but not in an unbalanced way favouring a smaller number of players (i.e. large tech companies and other players with financial resources) and early adopters who control data and technological advancements. The monopolisation of power in distribution is already in evidence, placing these industries (especially SMEs) at further risk of falling behind.

AI can create a monopolised market for AI in the cultural and the creative sectors and exacerbate the 'winner-takes-all' phenomena. AI can reinforce platform market tendencies and dominance, and will likely increase the influence of those players who can harness power more rapidly. For instance, in the news media AI is expected to give an edge to large media houses, with smaller outlets losing market share. An example of risk of dominance, vertical integration and AI is Spotify creating their own content (i.e. podcasts), but also being in charge of the recommendation engines. In the short term, this increases the risk of creators losing out and, in the longer term, Spotify is in a position to shape tastes in line with the content they are producing or plan to produce. More transparency is needed in this relationship and process.

At the same time, we should not forget the important role of innovative companies in enhancing technological development and building up innovation ecosystems around them. For instance, Spotify is also considered a cooperative partner in the music sector in the interviews conducted for this study. Interviewees further stressed the importance of discoverability of new content and access to users.

Some online services have directly contributed to the emergence of a new startup scene around data analytics. Again, Spotify is offered as an example of giving part of the data away, which in turn creates new opportunities, new jobs and more innovation. Another example is the Google Magenta[20] open source research project which is exploring the role of machine learning as a tool in the creative process. While this AI lab for music is concentrating data and power, it is sharing a lot of useful documentation, and is seen by some startups as a good source of ideas and collaboration, even between Europe and the US. Despite these positive sounding stories, some suggest that the strategy of digital players may be to share data with the objective of increasing the value of their own platforms to further strengthen their position. As the report of CERRE (2020) highlighted: "*Data that can be accessed and the terms on which access is offered are determined by the platform itself and can vary over time as the platform's strategy evolves and/or it internalises some applications into its own business (often through the acquisition of other service developers*)."

5.2 The risk of low-quality content, bias and monocultures

The impact of AI depends very much on the type of algorithm it relies on, and the data used to train the system[21]. Many of the AI algorithms currently influencing us when interacting with digital creative content can reinforce cultural preferences and push towards a personal monoculture limiting users to

[20] https://magenta.tensorflow.org/
[21] See also: https://fra.europa.eu/sites/default/files/fra_uploads/fra-2019-data-quality-and-ai_en.pdf

a specific world view and cultural sphere. Another danger highlighted in multiple interviews is the production of mass content with lower quality.

AI is raising concerns around the standardisation of taste as pointed out in several sectoral use cases including news media, book publishing, film and visual art. AI can create so-called 'filter bubbles' (Parisier, 2011) in the sense that smart algorithms may feed users only material they prefer to see, leading to less understanding of other viewpoints and a lack of common ground with other members of the community. As a result of personalised searches, the user will be recommended new content based on past clicks and search history and can be locked into a certain type of content. Filter bubbles risk creating a narrowed information flow around the users, making them "*believe that this narrow self-interest is all that exists*" (ibid). Personalised recommendation can thus lead to a homogenised view of the world. More dangerously in the field of news media, it can lead to a fragmentation of society where users can no longer make decisions based on shared and broadly comparable information (Sunstein, 2001). Besides filter bubbles, artistic expression can become limited by the products monopolising the market thanks to inappropriate use of AI. In the case of the architecture case studies, it has been pointed out that the clean aesthetic and overly edited images obtained thanks to what interviewees explained as "*the same sky replacement tool, the same skin smoothing, the same fake fog, and the same dodge and burn tools*" might end up limiting the diversity of works in that space. Similarly, there is a perceived risk that the increased use of AI and automation could result in more generic architecture (see Section 6).

Some of the interviewees also pointed out the potential consequence of proliferating low-quality content (e.g. 'low-value' journalism, low-quality functional music) as a result of using AI curation or generation techniques. Wrongly tuned recommendation systems can lead to instances where users are confronted with a range of promoted content that is of no use to them (mass products without artistic quality, without authenticity or without respect for the environment) instead of a better choice that was offered to them under the promise of 'personalised content'. Promoting the consumption of low-grade games, films, sounds or news items can have a bad influence on our culture and quality of life. For instance, in the film sector there is a fear that AI technology will lead to a standardisation of future films.

Furthermore, artists cogenerating art with technology may grow dependent on specific technology or algorithms that they base their skillset on, and which is controlled by companies who can remove or change functionality at will. There are artistic dangers in AI. As it is pointed out in the sectoral analysis on films, "*If filmmaking is standardised, like in Hollywood, then AI may be useful, since AI is thriving on existing data. Hollywood tries to replicate the business success of film and to achieve again what they achieved in the past*".

While being conscious about the above risks, some earlier studies have also shown that the uptake of new technologies does not necessarily lead to a cultural decline and creative professionals often respond in a non-linear and complex way that nurtures the emergence of new creative islands of activities (Solis 2017, Hodgson, 2021).

What remains important is to be able to assess the severity of the risks related to the adoption of AI and weigh the risks against the benefits. AI algorithms should be monitored over time and their model tested and reviewed. This test should be run continuously and not just implemented once.

5.2.1 Understanding the risk inherent in bias and the ability to catch it

There is a common concern among both professionals and consumers that algorithms and data used to train systems are likely to include human-generated or algorithmic bias, which in turn is augmented by the AI system. Without necessarily any bad intentions, AI can create bias depending on the initial data or the point of departure of the AI engineer who has set up the algorithm. The AI system will take forward any initial bias and even reinforce them[22]. If embedded in algorithms and not managed properly, this could lead to limited diversity in curatorial and research outputs. In the case of music for instance, algorithmic-automated playlists have been linked by some scholars to a loss of musical diversity and amplification of systemic biases (Jannach et al, 2016). Recommendation algorithms can also increase the gender gap since much of the data is based on male artists and their creative works. Bias regarding race or gender can be particularly worrying and critical to avoid in order to safeguard equality and fairness. It should be acknowledged that humans are also biased and, when trained well, AI may actually be less biased than people. Detecting and removing bias from AI is important for AI engineers thus toolkits have emerged such as the AI Fairness 360[23] from IBM or the Google's What-If Tool[24].

[22] See also https://fra.europa.eu/sites/default/files/fra_uploads/fra-2019-data-quality-and-ai_en.pdf
[23] https://aif360.mybluemix.net/
[24] https://pair-code.github.io/what-if-tool/

Non-transparent preferences based on user interaction can lead to unwanted personalised experiences (e.g. users being shown mainly sports articles after researching football for a project) which are impossible to change. In the field of architecture, AI algorithms sometimes rely on biased input (e.g. overly focused on Western designs). In the field of news media, biases can also be introduced (e.g. MSN.com rolled out a story with automated image retrieval that resulted in an incorrect depiction of race in a rock band accompanying a piece on racism[25]). Examples like this lead to criticism that AI algorithms are subject to various bias.

Representatives of the cultural and creative sectors interviewed called for more discussion around 'algorithm neutrality' in order to determine whether or not algorithms may be used to push certain types of creative content. The diversity of cultural production could certainly benefit, provided that AI is built on large datasets with rich cultural heritage. For instance, curated playlists have been shown to improve diversity (Impala, 2021). In architecture, feeding the algorithm with diverse data on the built-up environment and housing stock in Europe can result in a broader view on potential designs.

Importantly, bias is not always easy to catch as it can sometimes be hidden and not easily detectable. There are also relevant sectoral differences: bias about political views can be very problematic and dangerous for news media; bias in architecture can put the safety of people at risk as well as the approach to sustainable buildings and affordable housing. Bias in book taste or music genre may lead to cultural homogenisation and negatively affect creators' career and income opportunities.

5.3 Opportunities and risks to language diversity

The diversity of European languages comes into play when disseminating/introducing AI-based tools because the use of artificial intelligence in CCS is largely language-based (natural language processing, natural language understanding, speech technologies, language-centric AI). Several of the common opportunities in AI have to do with language including data analytics in the form of text, AI-enhanced cataloguing, and analysing of user trends. Language Technologies referring to the broad class of computational techniques for incorporating speech and text are an extremely crucial piece of the puzzle. There is an identified need for language technologies "made in Europe, for Europe".

A number of initiatives already exist such as the European Language Grid (ELG) and the European Language Equality (ELE) project. The ELG project is a Horizon 2020-supported three-year initiative for developing a primary language technology platform for Europe. It is expected to host thousands of datasets and hundreds of functional language technology services. "As the European Language Technology landscape is highly fragmented, ELG wants to provide a joint umbrella platform for all stakeholders that belong to this community, providing reach and visibility".

The ELE project is developing a strategic research, innovation and implementation agenda as well as a roadmap for achieving full digital language equality in Europe by 2030. The whole project is designed in such a way that individual work streams create input for the strategic agenda, for example, in terms of empirical evidence, desk research, and technology deep dives.

Related to the fragmentation of languages, an issue is the development of curation technologies. Although data curation is one of the fundamental aspects of machine learning, Europe's competitiveness suffers from significant fragmentation of stakeholders and providers of curation technologies. This issue is recognised, and the EU launched the European AI on Demand Platform[26] to support innovation, offering a critical mass of resources.

5.4 AI can amplify but also address the spread of misinformation

5.4.1 Misinformation

Algorithms focused on engagement may prioritise divisive content and spread misinformation, an issue that has recently been raised for instance regarding Facebook[27]. As yet, AI cannot distinguish whether the input it receives is accurate or inaccurate. This can lead to issues around authenticity – if AI receives questionable input, the corresponding output may be false. In addition, it becomes harder to ensure that a feed or a set of recommendations is balanced and includes content with different viewpoints.

[25] See https://www.standard.co.uk/tech/microsoft-robot-ai-editors-jade-thirwall-little-mix-a4463706.html
[26] https://www.ai4eu.eu/ai4eu-platform
[27] https://www.washingtonpost.com/technology/2021/09/03/facebook-misinformation-nyu-study/

Powerful artificial intelligence systems have the potential to amplify misinformation in various ways (CSET, Buchanan et al, 2021):

- Generating short messages that advance a particular false theme.
- Developing a story that fits within a desired worldview
- Rewriting news articles from a new perspective, shifting the tone, worldview, and conclusion
- Targeting certain groups with messages designed to prompt actions or to amplify division.

The Horizon Europe Work Programme 2021-2022 includes a specific call related to the topic of AI to fight disinformation[28] with a focus on advanced AI solutions against advanced disinformation techniques for media professionals. The objective is to equip scientific researchers and media practitioners with tools based on AI capable of detecting different forms of deep-fakes and tampered content and to understand how and where such type of content spreads online.

5.4.2 Deep fakes

Although conceptually different but with real dangers in the future, deepfakes, notably the malicious use of AI-generated synthetic media, may cause serious problems for the news media, but also the film, music and visual art sectors. Media houses are impacted by external AI technologies because deep fakes and automatic content generation make the verification of source material more time-consuming and expensive.

- In films, misuse of open-source machine learning software for face-swapping actors with celebrities allowing the creation of deep fakes, for example, political messages and fake news. Deeptrace[29] found almost 15,000 deep fake videos on the internet in 2017 (Henry Ajder, 2019[30]). The technology can also be used commercially or in films as demonstrated by Disney (Jacek, 2020) to replace faces. In music, sound engineers using AI-generated deep fakes can replace the voice of an artist. All these cases open up important legal and ethical questions that should be tackled. To this end, content verification enhanced by AI and machine learning will become even more critical.
- While the use of deep fakes for the purposes of misinformation should be strictly banned, there are other use cases where deep fake technology can help save costs and gain efficiencies. Tech startups working for the CCS and interviewed for this study stressed the importance of striking the right balance. For instance, generating content in another language with the purpose of serving an additional, less accessible (and typically less commercially viable) target group involves a lot of work. With the help of AI, video content can be turned into a new language with a deep fake persona, thus reducing the production time and effort substantially. Ethically, a careful balance is needed on the use of AI for the purposes of facial recognition to prevent harms to fundamental rights, while enabling the beneficial uses of the technology subject to strict safeguards.

5.4.3 Misuse of personal information such as political opinions or health status

Data trails include information about users that browse an online platform such as a music streaming service, digital media, or internet film. Data trails are also applied in gaming industries, where the behaviour of each player is analysed so the company can better understand their style of play and decide when best to approach them with 'offers' they cannot refuse.

With the help of these data trails, users are basically giving away their behavioural data to platforms, service providers but also to advertisers. Theoretically, this could be beneficial since AI is used to analyse user preferences and behavioural patterns and, based on this, predicts what the user would need in the future. In practice, there are some fundamental problems with this routine. This can involve gathering and analysing personal data and can reveal sensitive personal information about individuals such as political opinions and health status. Moreover, it can be used to influence behavioural patterns not necessarily beneficial for the user.

As pointed out in a recent report of Vladimir Šucha and Jean-Philippe Gammel, users are not well informed about the types of data they provide to others about themselves while on the internet and there is no transparency on how these data are collected and stored (Šucha & Gammel, 2021). This is

[28] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl4-2021-human-01-27
[29] Deeptrace is an Amsterdam-based cybersecurity company
[30] https://sciencemediahub.eu/2019/12/04/a-scientists-opinion-interview-with-henry-ajder-about-deepfakes/

an issue despite the General Data Protection Regulation (GDPR) in place, because GDPR is not always effectively enforced. Although internet platforms have been obliged to inform their users about their cookie policy, users are often tricked into sharing data in order to access particular content as highlighted by some interviewees. Collecting user data can also serve to construct UX dark patterns that trick users in signing up or buying products they did not mean to. Moreover, privacy notices are often not clear about how data are used, despite stipulations outlined in the GDPR.

5.5 Risks of manipulation

Monopolies over data lead naturally to monopolies over the understanding of user behaviours and influencing consumption. AI algorithms are used today to finetune recommendation engines most often embedded in online platforms. They significantly influence the pool of content that consumers can discover. AI-driven recommendation models are however expensive, need time to develop and need infrastructure, hence it is no coincidence that some of the early movers notably the large digital distributors have gained strengths and currently hold the upper hand. Smaller platforms also have opportunities, but they are much more constrained and rather focused on certain niches.

Besides the useful features of recommendation engines (such as access to information and personalised content), they can incentivise harmful behaviour, for instance when data are used to influence people and urge them to consume more of a specific type of content, which might lead to addiction or even mental health problems in certain cases (Riehm KE, 2019; Hökby, 2016). While manipulation-oriented technologies can be also useful (e.g. using them to treat mental disorders or enhance language learning), there are various malevolent uses of AI technologies that have mental effects. AI built into social media platforms recommending content can stimulate addictive behaviour by messing with the brain's dopamine level. It has been, however, stressed that the issue is not with AI per se but with the context in which it is used.

Manipulation is particularly acute in video games, but also in other sectors such as news media and film. Stakeholders in the music industry (Impala, 2021) have also voiced the need for more caution and action against the use of AI in streaming manipulation. Video games are already known to cause addictive behaviour in some players (WHO, 2020). As highlighted by the analysis on video games (Chapter 15) player modelling and personalisation through AI can increase the risk for manipulation and addictive behaviour. The behaviour can have negative consequences in many aspects such as personal, family, social and occupational.

5.6 Excessive reliance on AI can negatively influence creative decisions

Concerns have been expressed in the interviews conducted for this study that if AI is more widely adopted to support recommendation engines and decision-making, overreliance on its predictions and suggestions can create inertia and narrow-mindedness. This can result in wrong decisions that do not take into account other broader factors such as local context. In this sense, they expressed scepticism about the algorithms' rationale.

Both users and developers of AI-based data analytics are challenged to translate the results into concrete actions. AI will provide indicators and numbers, but more 'intelligence' is needed to be able to look behind and understand patterns or trends. To avoid excessive reliance on AI, more emphasis is needed on making sure the AI algorithm is trustworthy and fit for purpose (i.e. able to answer the question, 'What does this mean for me or my sector? What's next?'). AI provides additional knowledge and value only if it is interpreted well.

5.7 Structural changes in the content of jobs

A consequence of introducing artificial intelligence in the creative process and decision-making is that AI is expected to replace some jobs that were human-only until now. The nature of jobs such as technicians, journalists, reporters, and market research specialists will change and face competition from the 'intelligent computer'. In this case, concerns around labour displacements are certainly legitimate (e.g. threat on certain activities such as grammar check or translation), and it is up to company executives to decide how reliant they will be on AI tools over their human colleagues (Chow, 2020).

Despite the endeavours of AI developers to create algorithms that can turn structured data into text, music or a new image, the concern that artificial intelligence will replace creativity altogether is misplaced. Although AI is a hot topic and there are fears in terms of its impact on jobs, there is no need for "technological alarmism" (McGuinness et al., 2019). AI is still working on specific tasks and behind

AI there are thousands of humans to make this happen. There is still a big gap between researchers' AI vision and daily reality, as pointed out during the interviews and the workshops.

An analysis by Cedefop (2020) concluded that there has been little evidence of substantial negative effects on occupations deemed to be fully automatable. The application of human-machine systems creates new opportunities rather than replacing jobs entirely[31]. It should be noted that automation generally does not affect job positions but specific tasks. Current AI applications are much more pragmatic and need a range of human decision-making and controls to draw the right conclusions. Some examples of how tasks within jobs can change as a result of AI are presented below.

Table 13: Examples of tasks that will be impacted by AI in CCS

Jobs	**New Tasks**	**Tasks disappearing**
Technicians, Recording Engineers	Handling of AI tools, Developing AI algorithms	Technical tasks
Editors	Calibrating machine learning-powered editing	Editing
Translators	Upgrading AI translated work	Translation
Producers, Architects, Designers	Handling AI tools	Traditional design tasks

Source: authors

The eventual impact of predictive models is only minimal since the actual creative decisions are either made before or after the involvement of AI. Their platforms simply serve as an informational aid, which means humans are still ultimately in charge of the final decisions. Moreover, AI models as they stand today are still a long way from achieving 'true intelligence' that matches or even surpasses the human ability to create (Chow, 2020).

Most importantly, AI is not about replacing artists or creative professionals, but more focused on opening up new horizons, creating a new AI-enhanced cultural and creative offer. No doubt, this 'offer' will compete with existing creative works and fields, but it will also change the possibilities of certain stakeholders to create, distribute and advertise certain creative content more than others.

Changes that are expected on the labour market can be addressed by education policies but also short and long-terms employment measures. Policymakers will need to manage change and adjust to the potential short-term structural unemployment.

5.8 Competing with the US and the rise of China

The global AI tech landscape is currently dominated by tech firms in the USA that have led the first phase of the AI revolution so far. China has become a major player in many aspects and is posing new challenges to the use of AI in general but also in the cultural and creative sectors. As a recent analysis of international technological trends highlighted (ATI, 2021), patent application numbers indicate that the US is leading in the area of big data (close to 40% of worldwide transnational patent applications vs. about 15% for the EU) as well as in AI[32].

Based on patent data sourced from PatSnap and an analysis of the science literature database of Scopus, this study identified 99,875 simple patent families and 7,660 scientific publications globally related to artificial intelligence in the ten cultural and creative sectors (applied for in the period from 2009-2019).

The table below highlights two of the indicators of the tech mining analysis to show the relative technology innovation and science strengths of the ten sectors in the European Union and in United States. The relative strength in these two regions is compared to the world average. The Table below

[31] https://ati.ec.europa.eu/reports/policy-briefs/collaborative-robots-human-ai-systems-and-role-policy
[32] https://ati.ec.europa.eu/reports/international-reports/advanced-technology-landscape-and-related-policies-united-states

shows which economic region boasted more scientific publications and more patent applications in which sector. The cells marked in green is the region which has gained the strongest position.

Table 14: Relative science and technology strength in EU27 and the United States compared to the world

Sector	EU27	United States	EU27	United States
Museums	7.8	2.1	3.8	13.2
News media	6.3	5.4	0.3	3
Performing arts	5.6	3.8	1.7	10.3
Music	5.5	3.4	0.6	6.7
Video games	5.1	4.5	0.9	12.1
Architecture	4.9	4.9	1.4	16.1
Publishing	4.3	3	0.7	12.1
Visual arts	4.1	4	1	6.9
Fashion	3.9	2.5	1.4	7.8
Film	3.2	3.9	1.2	11.7

Note: The relative strength is calculated within each of the ten sectors and is not comparable across sectors. The cells marked the green is the region which has gained the strongest position between EU27 and the United States.

Source: PatSnap and Scopus.

The results in the table indicate overall that EU27 has a stronger position in science than technology innovation compared to the United States. The EU27's science level compared to the USA is stronger in nine of the 10 sectors examined, where the USA is stronger in all sectors within technology innovation.

To illustrate the interpretation of the results of the table. In the museum sector, the EU27 has published 7.8 times as many research articles about artificial intelligence than in the world average, and the United States publishing only 2.1 times as many. This may indicate that the EU27 has a stronger position in research compared to the United States. According to the level of technological innovation, the EU27 has applied for 3.8 times more patents than the world average, while the United States has applied for 13.2 times more than the world average. This indicates that the United States has a stronger position in technological innovation in artificial intelligence in the museum sector than the EU27.

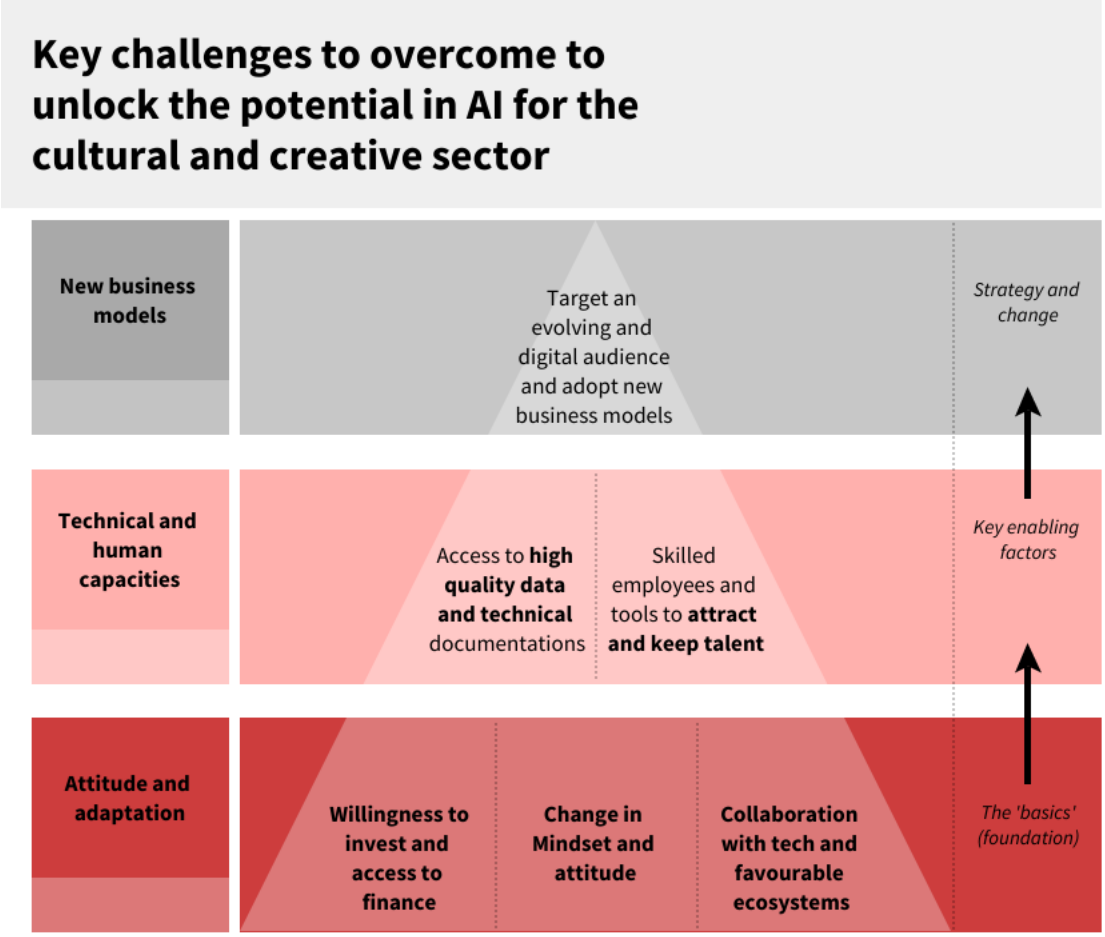
Besides technology development, there is also a talent drain as European startups and AI researchers are lured to the US, especially to big companies with a more competitive salary and AI opportunities as highlighted by several interviewees but also discussed at the stakeholder workshop. The issue of AI brain drain has been identified as a problem in the outline of the German AI Strategy (Harhoff et al, 2018) and by a report of Elsevier[33]. Even though Europe comes close to the US in terms of the number of specialised master's programmes (Stanford University, 2021), there are huge incentives that endanger the opportunities of the EU to keep this AI talent within their territories. To this end, programmes that link education to entrepreneurial programmes and startup activity should create a better bridge. In addition, US companies' European subsidiaries are recruiting talent (or buying companies) that stay within the territories but whose skills and patents benefit their US parent companies.

[33] https://www.timeshighereducation.com/news/warning-over-brain-drain-european-ai-talent-industry

6 Key challenges to overcome

Innovative entrepreneurs and early adopters of AI technology face a number of obstacles as they explore and take up AI. They need an environment where cultural and creative sectors can evolve positively while using technology as a new source of inspiration and business intelligence. If Europe wants to ensure its cultural and creative sectors can thrive, it needs to give more leeway to artists, startups and creative and cultural organisations to explore new horizons, while mitigating the risks and avoiding critical pitfalls. The protection of data, personal information, fair play and human values are among the most crucial factors for a human-centred approach to AI in the CCS. Figure 5 provides an overview of some of the key challenges identified that are discussed in the next sections. Challenges start at the level of awareness and understanding of the opportunities and include key technical and human assets such as data and skills. Nevertheless, successful transformation can only happen if the underlying business models and organisational strategies are adjusted.

Figure 5: Some of the key challenges discussed in this study



Source: Technopolis Group

6.1 Access to data

AI algorithms can only learn patterns and make new predictions when trained on large amounts of high-quality data. Hence, data ownership gives a competitive edge to companies that have access to it. Access to appropriate data is a common problem across all cultural and creative sectors. In most cases data are considered to be commercially sensitive and are held by individual companies or organisations.

Data access varies across the CCS and among use cases. For instance, in the publishing industry, book publishers own and manage the content of their books and have a large dataset at their disposal that is ideal to train AI. In music and film, large amount of data, in particular user data is concentrated in the hands of tech companies and digital service providers. News media can gather data from their own sites but are unable to gather contextual data without the agreement of others. That means that

it may be difficult to understand how the user decides to click on an article found by search or social media.

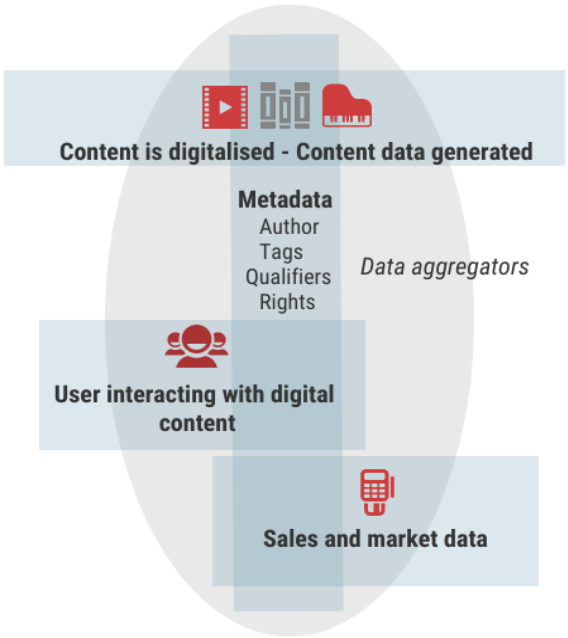
News organisations usually rely on their own reader data to analyse user behaviour. Audience composition plays a big role, and it is not obvious that user data from a large financial news site would be relevant for a small local newspaper. There are a number of different types of relevant/useful data: unique visitors, sessions, time engaged, completed interactions, click-throughs and other interactions, etc. In the music industry, record labels and composers/authors need to pay attention to correctly tag their data and ensure discoverability and identifiability for royalty collection. Private data aggregators play an important role in the ecosystem to pool a large amount of music content, meta- and user data, and allow for AI-powered data analytics. In architecture, meanwhile, valuable data is mostly owned by large firms, at the expense of smaller players, and data is generally messy (unstructured) and not in the same format.

6.1.1 What type of data can be possibly shared?

Data that AI algorithms rely on originate from the digitisation of content, the use of content in various digital ways and the interaction of users with content online. Figure 6 provides an overview of the type of data generated in the cultural and creative sectors and the table below indicates potential data sources.

Metadata is 'data about data' that helps the collection, cataloguing, tracking and analysis of any creative content being produced. Metadata can facilitate the discoverability, visibility and identifiability of creative and cultural content, and help make sure that the rights holders are remunerated. It is, however, an issue that the structure of metadata created by some organisations may not match those used by others. That can make it harder to communicate data, making it less 'findable, accessible, interoperable and reusable' (FAIR)[34]. Moreover, metadata usually evolves over time which makes data standards and governance more complex. In AI-driven new business models, different data types are usually integrated in order to offer a 'data product' and new services based on them.

Figure 6: CCS data overview



Source: authors

Table 15: Type of data and data sources in the CCS

Data category	Types of data	Data sources
Content element data	Sounds, annotations, audio loops, categorised cinematic shots, truncated files	European research projects – open source Public databases Tech startup collections
Content data	Audio files: audio recording, lyrics, films, trailers, images, ebooks, news items, architectural designs, etc.	Public research initiatives Private initiatives Databases of CCS representatives
Related content data	Financial data, geodata, socio-demographic data, performance data, etc.	Private databases (e.g. Google books digitalising more than 25 million books) Public records
Metadata	Titles, authors, producer names, the publisher(s), country code, basic content properties, tags, camera output, bitrate, timestamps, etc.	International Standard Recording Code National content release databases Private initiatives, tech startups Online platforms
User data	Readership data, user behaviour data, downloads, views, preferences, shopping history, etc.	Online platforms Private initiatives

[34] https://www.rd-alliance.org/metadata-standard-improving-interoperability-through-research-data-alliance

Data category	Types of data	Data sources
		CCS representatives with own digital platform (e.g. digital newspaper, online game portal, online bookshop etc.)
Market and sales data	Market players, volume of sales, country coverage, types of sales, etc.	Large private market data providers Retailers, online platforms (e.g. Amazon)
Data aggregators	Private initiatives of startups/companies pooling available data and offering a new service Publicly supported data aggregation initiatives in cultural heritage	E.g. Soundcharts (France), BMAT (Spain) for music National or thematic aggregators for Europeana: https://pro.europeana.eu/page/aggregators

Source: authors

Data in the cultural and creative sectors are usually scattered. There are many barriers that impede the success of data-sharing initiatives. Many actors do not see an incentive to share their data and collaborate at this stage, with the exception of metadata to promote their content. There are also actors that take a gatekeeper position and restrict dataflows in the ecosystem. Past experience in various sectors shows that vested interests and asymmetrical power in data ownership can easily undermine the objective of creating a common data platform.

Without doubt, certain actors such as online platforms have become repositories of valuable data, especially user data. Spotify, Netflix, YouTube, Getty Images, Apple, Google News have the advantage of being able to track the behaviour of a large number of users online and monitor user preferences.

At the same time, tech startups have been active in pooling data and developing new, data-driven services, often capitalising on the data from social media platforms. An example is companies providing book publishers with readers 'review of books and market analysis. Private firms and startups across all cultural and creative sectors have worked on tools to create, store and maintain data in order to offer tools based on proprietary algorithms. These tech firms compete globally, with particularly stiff competition from US-based and Chinese startups with AI solutions.

Beyond tech, creative content data are generated by production companies and key players of the CCS such as record labels, film companies, news media houses, publishers, museums, and theatres. There are some organisations in each sector that attempt to create standards and references for metadata.

In news media, Europeana Newspapers (that has been integrated into the Europeana platform) analysed large amounts of historical data and aggregated historical newspaper pages.[35] While the source material is newspapers and the project highlights the specific challenges involved in dealing with this format, the main use of the platform is for cultural heritage and research, not for the news media industry per se. This matters because in cultural heritage, it makes more sense to have open-ended use cases as it is impossible to know what questions individual researchers or users will have with regards to the data, or which data will turn out to be relevant for those research questions.

While cultural heritage institutions have spent a lot of money digitising their collections, there is a large amount of metadata which is technically accessible but cannot be used legally. This can include data in the hands of cultural organisations, museums, film production companies and in the music sector. Beyond proprietary data, there are also important sets of public data which are currently underutilised or protected from use. In the field of music, royalty organisations such as GEMA or public cultural institutions possess data currently not exploited. For cultural/public institutions, the path to digitisation is complex because many still operate according to old-school business models. The interviews highlighted this as a clear issue even if attitudes towards digitisation are changing in the aftermath of the pandemic and the new realities have led museums to reconsider digitisation. Similarly, European film institutes also store vast amounts of film material that could be valuable to the AI film industry, but the data are kept under strict legal agreements, making it difficult to use for commercial purposes but also non-profit and research projects.

[35] https://pro.europeana.eu/tags/newspapers

6.1.2 *What is the quality of data?*

Data quality is the pre-condition to run AI algorithms properly. As a recent report of the European Union Agency for Fundamental Rights (2019) stated, "an algorithm in its application can only be as good as the data it uses". There are various aspects to take into account, such as data standards, time-series compatibility, data-source evolution, managing multiple analytical results, serialising data, and optimising performance (Seligman et al, 2014). Paying attention to data quality is not only important to make AI work but it can help mitigate potential problems such as discrimination and cultural homogenisation.

Data standards are considered as indicators of probable success. Interoperability is the cornerstone of improving data management across CCS players and is linked to the standardisation of processes and to the will and ability of organisations to adhere to agreed practice in terms of creating and sharing data. For example, Schema.org[36] is a collaborative, community tool and structured data process that helps create, maintain, and promote schemas for structured data on the Internet, which can be a movie, an image or any other creative content on a website.

Complying with standards is particularly important in the case of metadata. There are, however, important sectoral differences that need to be taken into account, which are presented in more detail in the sectoral chapters:

- Sharing metadata, creating interoperability and working together on common data models is a topic in news media and book publishing. Discussions between publishers are increasing, creating a momentum to also explore interoperability.
- The music industry has worked to develop a centralised database and set standards for metadata, but progress is patchy; some stakeholders have adopted workable practices and several tech startups have created applications to help sectoral players sort out and track metadata.
- In the film industry and cinemas, along with their partners from distribution, sectoral stakeholders rely on data analytics and there are important standards such as identification numbers (i.e. ISAN and EIRD) that can help align metadata.
- In architecture, building a common data standard is a clearly identified need.
- In some CCS such as performing arts metadata is not a current problem.

Data are fragmented across EU countries and often coded in different languages. To address this issue, there are ongoing European initiatives such as the previously mentioned European Language Grid[37]. The ELG is expected to offer a large collection of datasets and language resources. Users will be able to search for and download datasets, corpora, language models and source code in the next years. Operating systems, programming languages, frameworks and library dependencies can all be included. Such tools can be used by any AI development project in the future to ensure language diversity.

Datasets need to be tailored which is usually an expensive process. There is often a big gap between data availability and data usability. Public data are often of not enough quality to be used immediately for AI applications and tech startups need to make large investments to be able to clean the data and make it 'AI and also purpose ready'. Data are not always in the appropriate format or structure for a specific research question or application for a particular client in the CCS. Much of the data on the internet and in digitised archives is not well structured or tagged and can include both errors and misfiled information.

When looking at access to data, it is important to distinguish between different types of organisations in the CCS. Business-to-consumer (B2C) organisations generally have a lot of user-generated data that they can use to train algorithms. In contrast, business-to-business (B2B) organisations further up in the supply chain have access to less data, and due to their scale larger firms typically have access to bigger datasets than smaller firms.

6.1.3 *Access to algorithms and infrastructure*

The scope of AI applications is shaped not only by the underlying data but by the rise of open-source software tools and datasets as well as low-cost computational platforms. Nonetheless, access to

[36] https://schema.org/docs/about.html
[37] https://www.european-language-grid.eu/grid/

codes, documentation and computational power are currently lacking and are one of the key barriers to increased deployment of AI.

AI algorithms and their training models need special attention. Current AI algorithms that developers rely on are often non-European, which can result in negative bias (for instance by taking into account a different type of population, language, data) and less transparency (given the different cultural standards in particular in China), and raises questions in terms of their usability. Although it varies across sectors, key algorithms are often closely guarded, which is a huge challenge to expanding the use of AI. The data used is proprietary and this is considered by some to be creating unequal opportunities. In architecture, there are many open-source libraries of AI algorithms, but here the problem is rather one of data access. In fashion, AI applications are often offered as software-as-a-service (SaaS) products.

There are few initiatives (e.g. Google Magenta, DALL·E by OpenAI[38], OpenCV[39]) that offer access to their AI technology and publish the entire documentation about how to run a specific AI. Developing a code and putting it on GitHub[40] (one of the largest coding community in the world), for example, is not enough because more information is needed on the actual operating system and details of the documentation in order to be able to make further use of the code.

Several service providers underline the difficulty of developing an AI-driven application, not only from a technical point of view but also the familiarity with data science. This is not always straightforward even for AI engineers but less so for professionals working in CCS. The cultural and creative sectors will need to rely on technicians to do the data cleaning for them. Data needs a certain structure and transformation in order to be ready for AI, and hence good technical expertise of the process of creating an AI-readable dataset.

There are already initiatives addressing technological challenges in the field of data curation. QURATOR[41], a German project funded by the Federal Ministry of Education and Research (BMBF), aims to help improve the quality of curation activities and the generation of digital content in various industry contexts. The projects aim to make the data more efficient and cost-effective through automation and by supporting knowledge workers and editors in curating digital content.

Very much linked to the technical challenges is the need to access infrastructure, computational power and cloud solutions that enable the handling of AI algorithms and run them on large-scale datasets. Data infrastructure is the basis for building large data pools and for testing and running AI applications. At European level, there is a need for more openness, transparency and the ability to connect to other European countries. To this end, pan-European initiatives that tackle strategic technological challenges have been reinforced in 2020. The European Open Science Cloud (EOSC)[42] has been set up with the objective of creating a trusted environment for sharing and analysing data from all publicly funded research. Among the objectives is to foster a marketplace where research and industry can interact and add research data of commercial relevance. The pan-European cloud initiative called GAIA-X (originally launched by France and Germany) aims to establish a unified ecosystem of cloud and data services, and an interoperable data exchange through which businesses can share data protected by European laws. The system would see various suppliers of cloud services linked up via interoperable data exchange acting as a vessel across industries. It will also act as a repository that businesses can search when looking for specific data services – such as AI, IoT, analytics and big data.

The challenge is to make large datasets available to stakeholders, which would require appropriate data infrastructure. Current solutions, such as the European Open Science Cloud[43] (EOSC) or GAIA-X, are not yet suitable for packaging data for AI, as pointed out by several interviewees. These services do not address the particular needs of the CCS. They are mostly associated with governance issues land thus not fitting the specific purpose of CCS. There are also persistent issues regarding algorithmic efficiency and insufficient available computational power for researchers and small businesses. These issues need to be addressed as large corporations have the available resources to pay for adequate infrastructure, but often smaller businesses do not. In some sub-sectors, such as in fashion, access to data seems to be less of an issue for smaller players compared to other CCS, as software companies

[38] https://openai.com/blog/dall-e/
[39] https://opencv.org/
[40] GitHub is an increasingly popular programming resource used for code sharing. It's a social networking site for programmers that many companies and organizations use to facilitate project management and collaboration.
[41] https://qurator.ai/projekt/
[42] https://eosc-portal.eu/
[43] https://eosc-portal.eu/

offer solutions that can work with the user data they generate. Nevertheless, access to data is still a challenge especially for small and emerging designers.

Cybersecurity is another key aspect of any future data space. Network security systems can provide protection at various levels and ensure that data exchange remains secure across the entire data supply chain.

6.1.4 EU-level policies

The EU has devised several EU policy initiatives as well as legal proposals that aim to maximise the potential of AI while protecting stakeholders and users from the inherent risks associated with this technology. Among these policies, a number address the questions of copyright, data access and user data management. Thus, the context of pan-European data spaces for the cultural and creative sectors has been framed by various EU initiatives and discussions. The establishment of common data lakes was called for by the European Commission in 2017 as an instrument helping SMEs integrate themselves into digital value chains[44].

In February 2020, the European Commission published its Communication on 'A European strategy for data'[45]. This strategy aims at creating a single market for data and reinforcing Europe's global competitiveness and data sovereignty. Common European data spaces are expected to make more data available for use in the economy and society, while keeping companies and individuals who generate the data in control. The Communication put forward a proposal for a forthcoming Data Act[46], which is a legislative initiative to facilitate fair data access and use, and should also address the rules on the legal protection of databases (see further below). The Commission has also proposed a regulation on European data governance or the so-called Data Governance Act (DGA) as part of its data strategy. This new regulation will play a vital role in the future position of the EU in the global data economy. The regulation is expected to initiate the creation of common European data spaces in strategic sectors, such as health, the environment, energy, agriculture, mobility, finance, manufacturing, and public administration. The Data Governance Act is also expected to create new EU rules on the neutrality of data marketplaces and facilitate the reuse of certain data held by the public. A provisional agreement on the DGA was reached by the European Parliament and Council in November 2021as a new law to promote data availability. The Act will thus create a mechanism to enable the safe reuse of certain categories of public-sector data that are subject to the rights of others including trade secrets, personal data and data protected by intellectual property rights[47].

The Commission's Work Programme 2021 and the Intellectual Property Action Plan announced a revision of the Database Directive and a clarification of the protection of undisclosed know-how and business information against their unlawful acquisition, use and disclosure, which will create the framework condition for solid data governance.

Two further legislative initiatives proposed by the European Commission notably the Digital Services Act (DSA) and the Digital Markets Act (DMA) offer a single set of new rules applicable across the whole EU to create a safer and more open digital space. This set of regulations is key for digital actors, focusing on how to address the negative impacts on users and society. They notably clarify the rules of operations of platforms, promote increased competition (DMA) and transparency and consumer protection for all intermediaries (DSA). The DMA is a proposal for a regulation on contestable and fair markets in the digital sector, laying down harmonised rules for digital platforms acting as gatekeepers between business users and their customers in the EU. The DMA legislation tries to prevent the misuse of personal data, for example prohibiting combining personal data from different sources. The objective is to limit the level of granularity platforms have on users which gives them a competitive advantage compared to newcomers. The DSA legislation aims to provide rules for the removal of illegal content from online platforms and about their transparency regimes (e.g. advertising targeting). The DSA legislation aims to provide rules for the removal of illegal content from online platforms and about their transparency regimes (e.g. advertising targeting, transparency of their recommender systems).

The recent EU regulation on platform-to-business relations (P2B Regulation) aims to create better framework conditions in the field of fair access to data for the cultural and creative sectors. The regulation created a set of rules for a fair, transparent and predictable business environment for

[44] https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Big%20Data%20v1_0.pdf
[45] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy
[46] https://www.europarl.europa.eu/legislative-train/theme-a-europe-fit-for-the-digital-age/file-data-act
[47] https://www.consilium.europa.eu/en/press/press-releases/2021/11/30/promoting-data-sharing-presidency-reaches-deal-with-parliament-on-data-governance-act/

smaller businesses and traders on online platforms. According to the P2B Regulation, providers are obliged to disclose to their commercial users the extent to which they have access to the data processed within the scope of the use of the services. Antitrust claims to access data (e.g. from competitors) could be facilitated by the transparency obligations of the P2B Regulation. Nevertheless, small players would benefit more from actual data access than from merely knowing what kind of data platforms control.

The modalities of data spaces will be guided also by the 2021 Coordinated Plan on Artificial Intelligence[48] (AI) which aims to create EU global leadership in trustworthy AI. As foreseen in this plan, the EU will launch a European Alliance for industrial data, edge and cloud in order to foster innovative data-sharing environments based on open, interoperable, secure and resource-efficient cloud and edge solutions.

More specifically for the cultural and creative sectors, there are three concrete calls for action:

- In the field of news media, the Media Action Plan of the European Commission published in 2020 highlighted that data technology is at the centre of the transformation of the media sector. The Commission has proposed to bring this about by fostering the creation of a European "media data space". Data spaces can host relevant media data such as content, audience data and metadata as well as other types of data on users' behaviours that might be useful to create content better tailored to consumer needs and distribute it more efficiently. The media data space initiative, financed through the Horizon Europe and Digital Europe Programmes (DEP), will support press, publishers, broadcasters, other media companies and technology providers in the creation of a data space dedicated to media applications. DEP will help the deployment of the data infrastructure and define a interoperability strategy, all in line with the European Data Strategy and the new horizontal data governance.
- In the field of cultural heritage:
    - Commission Recommendation on a common European data space for cultural heritage and support under DEP, issued in November 2021. This recommendation aims for Member States to pursue the digitisation of cultural heritage elements and their reuse for educational, touristic, or creative purposes. The preservation of the European cultural heritage will be facilitated by a data space developed and funded by the EC.
    - In 2021, the Commission launched a project for the design and set-up of a European competence centre aiming to preserve and conserve European cultural heritage. The project, which will work for a period of three years, has been granted up to €3 million from Horizon 2020. It will set up a collaborative digital space for cultural heritage conservation and give access to repositories of data, metadata, standards, and guidelines.
- In the music sector, the Creative Europe Programme[49] calls for actions to support data-gathering and analysis building on and continuing to support the experiences and expertise gained within the 'Music moves Europe' initiative.

With regard to interoperability, the European Interoperability Framework (EIF) is part of the Communication (COM(2017)134) from the Commission adopted on 23 March 2017. The framework gives specific guidance on how to set up interoperable digital public services.

Moreover, the Copyright Directive in the Digital Single Market (2019/790) was published in 2019 and entered into force in June 2021 across the EU. The purpose of this Directive is to protect creativity in the digital age, among others to the benefit of the creative sector, the media and press sector, research, education and cultural heritage institutions in the EU. For example, Article 14 ensures that material resulting from reproductions of public domain works of visual art can be freely re-used in all EU Member States unless this material is an original creation ; as a result, museums can no longer claim copyright over these digital reproductions of public domain works in their collections, which should enhance public access to cultural heritage, including digital reproductions of public domain works in the collections of cultural heritage institutions. This Directive also provides for two exceptions for Text and Data Mining (TDM). TDM has been defined as "*any automated analytical technique aimed at analysing text and data in digital form in order to generate information which includes but is not limited to patterns, trends and correlations.*" *In practice, this means that TDM can be used to add value to*

[48] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review
[49] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0818&from=EN

and make sense of big data sets (EC, 2019). The two exceptions would among other things allow cultural heritage institutions to carry out data and text mining techniques on publicly available works, under certain conditions, respectively for a scientific research purpose and/or other purposes. These provisions mean that cultural institutions will be able to harness the potential of cultural works to an unprecedented extent[50]. The relevance of the TDM exceptions for the use of AI solutions in the cultural sector has been analysed in detail in the study of the European Commission on 'Copyright and new technologies: copyright data management and artificial intelligence' (Technopolis Group et al, 2022).

6.1.5 Policy or private initiatives to build upon

Publicly funded data pools that developers could draw from would be necessary to address the data gap for smaller players, as pointed out by several experts consulted for this study. There are several existing initiatives to pool data that should be built upon and are presented in the table below.

Table 16: Examples of initiatives for data pooling

Sector	Data initiative	Type of data	Funded by
News media	EcoDaLo	Customer data (to build joint advertising models)	Imec, national, Belgium
News media	INMA's Smart Data Initiative	Metadata, user data etc.	INMA international news media association
News media	A European Perspective European Broadcasting Union (EBU)	Content data from several MS news broadcasters offered via a recommendation box (participating broadcasters will contribute news content to a digital hub where it will be automatically translated and can be reused by others in the hub)	EU, as part of a project entitled 'Towards a European Public Sphere: Multilingual Programmes from across Europe'
Cultural heritage	Europeana DSI & the EU data space for cultural heritage (to be launched in 2022)	Content data and metadata	EU CEF (Europeana DSI) & Digital Europe Programme (data space)
Music	Future Pulse	Metadata, customer data etc	Horizon 2020
Music	Audio Commons https://www.audiocommons.org/	Audio features data	Creative Europe Programme
Film	Cinema Belgica: Database for Belgian Film History	Content data, film data	Public, University of Ghent, the University of Antwerp, and the University of Amsterdam
Book publishing	ARDITO	Metadata	Horizon 2020
News media, music, film	Bloomen	Designed for the media industry, the main goal of Bloomen is to extend the use of the blockchain technology to different types of online user transactions, and to provide an innovative way for content creation, sharing, personalised consumption, monetisation and copyrighting	Horizon 2020

[50] For a recent thorough analysis on AI and the copyright framework, see the Study on copyright and new technologies, EC 2022.

Sector	Data initiative	Type of data	Funded by
Horizontal	European Language Grid	Language models, corpora, source code	Horizon 2020
Horizontal	SmartDataLake	The overall goal of SmartDataLake is to design, develop and evaluate novel approaches and techniques for extreme-scale analytics over big data lakes, facilitating the journey from raw data to actionable insights	Horizon 2020

Source: authors

6.2 It is not just AI skills but many other missing competences

One of the major business challenges for all sectors is about finding the right combination of skills in terms of technical talent and innovative CCS professionals who can make use of AI technologies and manage change. In CCS, professionals do not necessarily need to understand codes and be computer programmers, but they need to understand what AI technology can do for them.

Small firms and public institutions such as museums or theatres rarely have the in-house capacity to develop and operate AI systems internally and need to rely on external service providers. The interviews also highlighted that often creative professionals do not want to become involved in data crunching.

Ready-made AI algorithms can be used by artists and technicians with interest but limited programming skills. For instance, architects often play a central role in the planning and building process.

Digital literacy is a challenge in architecture as tools such as 3D modelling are not widely used yet (even if computer assisted design - CAD is widely used). These are prerequisites, however, for making use of more advanced technological tools such as AI. In the fashion industry, while the sector relies increasingly on AI and big data analytics, notably for the supply chain, the corresponding skills are not yet prevalent among designers. While large corporations can invest in AI skills among staff members, smaller design companies risk falling behind. Indeed, many smaller players already face precarious conditions and do not have the means to pursue such AI (re)skilling. This means they will need to rely on external service providers more often and collaborative projects between AI tech firms/startups and CCS become more relevant (as further detailed in the next Section 4.3).

The skills challenge should be tackled both from the perspective of CCS professionals and AI tech firms specialising in CCS. While creative professionals first engage with the technology in order to integrate it to their practice, AI engineers and computer scientists need more training on skills such as domain-specific knowledge, creative skills, ethics and philosophy, to enable a human-centred design approach to AI. Combining tech and creative aspects within firms yields positive outcomes. Indeed, companies that combine creative/design skills with tech skills often experience increased growth (see also Sapsed et al, 2013).

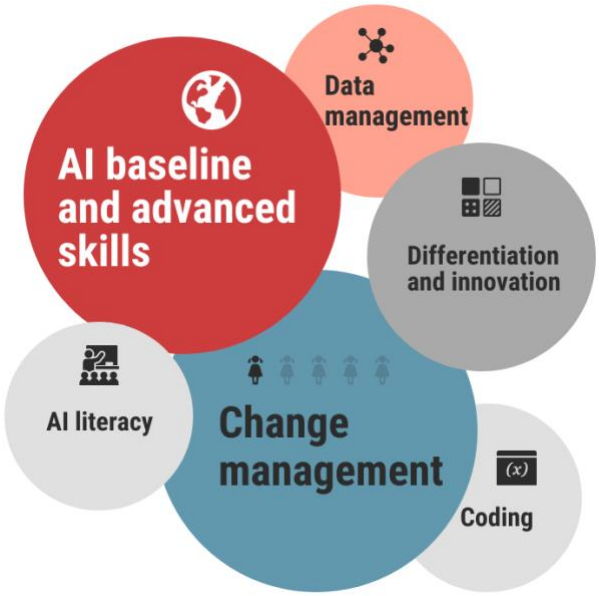
6.2.1 Skills challenges of CCS

The skills challenge starts with the lack of awareness of what AI can and cannot do for CCS. While this is not true for all CCS (the video games industry makes an extensive use of AI) most sectors demonstrate marginal understanding and use of the technology. There is a general lack of attention to AI by artists and creatives in many CCS and therefore few applications of AI in real creative settings. While individuals such as artists can inspire the use of technology, empowering an entire sector requires long-term ground measures. Identifying a need is key for each sub-sector, as the adoption of AI first and foremost depends on the existence of a problem it can help solve. It is the role of cultural and creative leaders to identify such needs/problems and determine if and how AI can be part of the solution. Once the potential of adopting AI is established, business skills such as identifying how to monetise new aspects of the creative production or its by-products are increasingly useful.

Besides baseline and more advanced AI knowledge, competences to handle AI tools and general AI literacy, there are various other skill sets that need to be considered. As highlighted by some interviews, it is not always easy to train creative professionals in the application of AI in their profession since many are reluctant to adopt a digital or computerised approach to their work. The emphasis should be on how AI can make the creative process less laborious and more inspirational instead of number crunching and coding. This requires a different approach in AI training schemes developed for the CCS.

Change management skills: The adoption of AI is about managing change. Most of the CCS companies and institutions interviewed highlighted that even if some of the staff becomes familiar with AI or AI tools, the whole organisation has to change if it wants to tap the full potential. AI technology brings the promise of saving costs and increasing efficiency, but AI tools and their results should be integrated into the complete organisational workflow.

Figure 7: Skills needs of CCS related to AI



Source: authors

Differentiation skills: The skills challenge is very much linked to the innovation capacities and know-how to differentiate in the upcoming era of AI-powered tools. As the OECD report on the 'Future of Education and Skills 2030' concluded, the AI challenge is not just about educating more AI experts, but also about building skills that are unique, and that computers cannot perform (Financial Times, 2017).

Data management skills: CCS stakeholders have to realise that often players (museums, book publishers, media houses, independent labels) hold precious data but externalise the treatment and valorisation of content to tech companies[51]. This is a risk; either not owning the digitised data or missing out on other opportunities by limiting use to one provider. Building the digital literacy of middle and senior management is especially important in this regard.

Involvement of the general public in the creative processes: As the New European Bauhaus initiative has shown, it is important to include citizens and users in the creative process and not just regard them as separate categories to inform or educate. This is the only way we will be able to train AI data inclusively and reduce biases.

Table 17 provides an overview of the AI and related skills needs by type of jobs typically found in CCS.

Table 17: Skills needs in AI

Type of job	Role of AI in the task	Skills needs
Directors, head of strategy	Developing new digital business models	Digital strategy, AI strategy, Data strategy, understanding the potential of AI, AI ethics
Managers, chief editors	Finding talent, forecast success AI enhanced editing, proof-reading how to interpret decisions recommended by AI, understanding and estimating the risk and magnitude of bias undermining the validity of AI-informed decisions	Basic AI knowledge, ability to operate AI-based tools such as editing, AI-based software
Journalists, technicians, creative studios	Augmenting, accelerating content production	AI knowledge to operate AI-based tools, collaboration with AI tech firms

[51] E.g. publicly available newspapers in a national library are digitised by a firm and the digital version becomes the ownership of the private company

Type of job	Role of AI in the task	Skills needs
Marketing professionals	AI supported marketing campaign, predict sales	Data science, data management, machine learning, interpretation of data, Data science is a necessary skill in order to be able to gather and interpret data.
Software/AI engineer	Developing own data warehouse, developing AI algorithms that can analyse data	Computer science, data management, Hadoop, search engine optimisation, programming skills (Python etc) AI ethics Business skills and sector-specific skills in order to understand the creation process and the sectoral challenges. Communication and data visualisation skills
Individual artists/creatives	Inspiration, content creation support, how to interpret decisions recommended by AI, understanding and estimating the risk and magnitude of bias undermining the validity of AI-informed decisions	Programming skills for AI algorithms in order to experiment and be inspired, using AI as a new 'instrument'
General public	Use of AI	AI literacy (users will need to be better skilled in terms of AI in order to be able to judge the relevance and quality of the content/recommendation they are confronted with).

Source: authors

The level where AI education is introduced has to be reconsidered. Past efforts of integrating AI to industries have focused on acquiring high-level AI experts, typically holders of a PhD. However, AI skills can be gained after entering the labour market and considering the fast pace of technology it is even preferable. While formal academic education is useful for developing an AI strategy and general approach, empowering existing talent in CCS can boost the take-up of AI tools. In a context of scarce AI talent pool, retraining the existing workforce with the necessary skills would increase the supply of AI employees in the CCS.

It is not straightforward for creative individuals to upgrade their competences as they often do not have access to training due to the specificities of their employment contract(s) (self-employment, freelance…). This issue has been particularly highlighted during the COVID-19 crisis and underlines the need for specific skills upgrading pathways for CCS professionals. This is proposed at the sectoral level by the creative skills Europe platform for audio-visual professionals.

Moreover, in many sectors, for the institutions that are aware of the potential of AI and wish to adopt it in their practices, management teams are often unsure whether to invest in team members with appropriate skills or whether to collaborate with external companies on an ad-hoc basis. Nevertheless, several interviewees pointed out the lack of tech employees interested in the creative and cultural sectors.

6.2.2 Skills challenges of tech firms

The shortage of AI talent in Europe causes an increase of salary expectations from data scientists. Access to skills is hampered by limitations in how startups can motivate their employees and what remuneration packages they can offer in terms of salaries and other benefits. Cultural and creative sectors can rarely match the high salaries offered to AI experts in other sectors. For instance, in the case of museums, salaries and the need for specialised skills are not matched and AI engineers can earn considerably more outside of these public institutions. The option to give incentives are limited by the existing regulations which make it difficult to hire engineers. Employment regulations and tax regimes around compensation and to what extent employees can become shareholders in a company, for instance, are often strict and do not give much leeway to startups. Competition for talent also exists within Europe, with qualified AI talent from Eastern Europe tending to leave their countries to work in Western Europe where they have access to higher salaries (LinkedIn, 2019).

This shortage is particularly acute in the EU, since the US and China produce more AI talent. Notably, many AI PhD-holders educated in the EU tend to leave for the US, and there are less academic publications on AI in the EU compared to the US (which makes up almost half of publications) and China (jfgagne.ai, 2020). Moreover, a 2019 LinkedIn study of users' profiles showed that the US had just over three times more individuals with AI skills than the EU average. Those AI-skilled professionals work

mainly (two-thirds) in the ICT sector or academia, showcasing the difficulties of distributing these skills across European economic sectors (LinkedIn, 2019). While these data need to be interpreted with caution, they do point in the same direction, indicating that Europe risks falling behind when it comes to the skills necessary for the successful uptake of AI across the economy.

Access to talent can be problematic for tech firms active in CCS, but so is the access to profiles that boost their innovation levels. It is an issue that tech employees going into the field of CCS have lower skills in some cases which tends to result in a suboptimal use of technology.

Possibly because there are many different AI education pathways in Europe, the education level of AI talent varies. Some tech employees do not have a sufficiently high degree of skills, while tech companies working in CCS need AI graduates with the right know-how. This suggests there is a case for university-industry collaboration that could support the students' school-to-work transition but also create incubation programmes and develop innovation capacities.

6.2.3 *EU level policies*

The EU has recognised the need to support training and skills development in CCS for the use of digital technologies including AI. The European Commission launched several initiatives aimed at fostering digital skills in the workforce and society at large including support for AI projects through the Digital Europe Programme and the Digital Skills and Jobs Platform (an initiative under the Connecting Europe Facility Programme). The Creative Europe Programme 2021-2027 (Regulation (EU) 2021/818) includes a focus on nurturing skills and supporting the digital transition of the cultural and creative sectors, especially for the audio-visual sector (including mentoring programmes, ad hoc boot-camps providing hands-on schemes for young talents across Europe funded under a call for proposal), skills development for creatives and artists.

The Pact for Skills as part of the European Skills Agenda is the first flagship measure related to sectoral skills. One of the EU Pact for Skills has been set up for CCS and supports large-scale skills partnerships. The pact represents a new engagement and governance model for skills that will mobilise all relevant stakeholders, industry, public and private employers, social partners, chambers of commerce, education and training providers and employment agencies. Pact stakeholders will identify clear statements of commitments to finding practical and operational solutions to the identified skills problems, defining the most appropriate structure of the partnership, its governance, scope and responsibilities.

The pact builds on the initiative called 'Blueprint for sectoral cooperation on skills' which addresses skills shortages and challenges at sectoral level. As part of the blueprint and through a selective process, so-called "alliances for sectoral cooperation on skills" have been set up that are composed of different relevant sector stakeholders such as businesses, trade unions, research institutions, education and training institutions, and public authorities. One of the blueprints is related to audio-visual and live performance[52].

The Digital Education Action Plan (DEAP) targets several AI-related questions/fields in the area of education. Moreover, it includes specific actions relevant for CCS: the development of a European Digital Education Content Framework that will build on European pedagogical, cultural and creative diversity and a feasibility study on a possible European exchange platform to share certified online resources and connect with existing education platforms. Importantly, the DEAP also encompasses activities targeting the early age education, which will contribute to a more fundamental understanding of the basic functioning, applicability and potential of tools, such as artificial intelligence. This early understanding is an important basis for offering value-adding modules at tertiary education levels. Considering that the use of AI and data in educational settings will only grow stronger and expand, within the framework of Digital Education Action Plan, ethical guidelines on the use of AI and data in teaching and learning for educators are also being developed and are informed through a dedicated Commission Expert Group. The Guidelines will be published by September 2022. Finally, the Commission is also exploring ways in which AI and data can be used to inform reoccurring tasks and policies and, in turn, supports the development of AI pilot tools/apps for educational purposes. These tools should be able to identify skills essential to specific job sectors/vacancies and match labour market needs to existing academic programmes, in an effort to bridge the gap among academic curricula, skills and real job market needs.

[52] https://ec.europa.eu/social/main.jsp?catId=1415&intPageId=5062

6.2.4 *Existing policy and industry initiatives to build upon*

Currently, AI-related skills programmes are scarce across all cultural and creative sectors, although some sectors, such as news media and music, are better endowed or already well served by private initiatives such as video games. Skills development in some sectors has been addressed by projects such as those listed in the table below.

Table 18: Examples of AI skills initiatives in CCS

Sector	***Title***	***Description***
News media	AI4Media[53]	Funded under the European Union's Horizon 2020, the project aspires to become a centre of excellence engaging a wide network of researchers across Europe and beyond, focusing on delivering the next generation of core AI advances and training to serve the media sector, while ensuring that the European values of ethical and trustworthy AI are embedded in future AI deployments.
News media	Stars4Media	The project has been an innovation exchange programme for media professionals to accelerate media innovation including AI and cross-border cooperation in Europe and hence also provides a framework for developing skills and digital competences.
News media	INMA Smart Data Initiative[54]	The International News Media Organisation initiated the INMA smart data initiative with the objective of helping publishers analyse and act on data in new and creative ways. In the framework of this initiative, a masterclass is being organised that helps answer questions such as: • What data is the most valuable? And how much data do you really need? • What does it mean for a media organisation to be data-driven and how to get your organisation there? • How to use data and Artificial Intelligence algorithms responsibly in a privacy-centric world? • What does a Chief Data Officer actually do? And do you need one?
Music	AI and Music S+T+ARTS Festival	It is supported by the S+T+ARTS programme of the European Commission, dedicated to linking technology and artistic practice. It fosters knowledge development and exploration of AI for music.
Museums	Museums and Artificial Intelligence Network	Although not a training programme as such, it fosters greater understanding of AI through senior museum professionals and prominent academics developing the conversation around AI, ethics and museums.
Architecture	CONNECTARCH	The project aims to reinforce the sector's capacity and help the profession to face adaptation to digital technologies, acquisition of new skills and competences among others.
Fashion and design	DeFINE	A collaborative project, co-funded by COSME, aiming at supporting the fusion of cutting-edge technologies and innovation within the European fashion and design industries.
Fashion and design	Fashion Tech Alliance	Project, funded by ERASMUS+ aimed to facilitate the exchange and the flow of knowledge within the fashion-tech sector to boost students' employability and innovation potential.

Source: authors

[53] https://www.ai4media.eu/
[54] https://www.inma.org/Initiatives/Smart-Data/

In January 2019, the AI4EU consortium (funded by Horizon 2020) was established to build the first European Artificial intelligence On-Demand Platform and Ecosystem under the Horizon 2020 programme. AI4EU targets research activities in five key interconnected AI scientific areas (explainable AI, physical AI, verifiable AI, collaborative AI, integrative AI), which arise from the application of AI in real-world scenarios.

6.3 Collaboration between tech and CCS

There is often a lack of in-house capacity of traditional CCS companies and institutions to develop their own AI solutions. This makes them dependent on a relatively small group of AI specialist tech companies to take up AI. Public intervention may be warranted in order to support partnerships between CCS and AI specialist firms, and in doing so to nurture the emergence of a strong European AI tech startup scene and ecosystem specialised in solutions for the cultural and creative sectors.

Cultural and creative sectors tend to be highly concentrated in the space (Lazzeretti et al. 2008) and clusters of technology oriented creative and cultural firms, individuals and other organisations are key to fostering the right environment for innovation.

6.3.1 Collaboration between CCS and tech industry

Presently, collaboration between tech and CCS is challenged by a range of factors.

From the perspective of the digital transformation, many cultural and creative organisations have been relatively late adopters of digital technologies (Massi et al, 2021). Despite their innovation potential, cultural and creative sectors might have less of a business incentive to venture into technology, given their focus on art and culture (compared to other sectors such as finance or manufacturing). CCS firms often shy away from investing in in-house AI capabilities, e.g. by hiring expensive data scientists. This means that many CCS in Europe are not yet taking up AI. Smaller players tend to adapt already existing solutions, developed by external stakeholders or tech companies.

One factor that hinders technology adoption as highlighted during the interviews concerns a general lack of understanding of how to use AI and how to interpret its results. CCS professionals interested in AI expect it to assist them by predicting trends, or helping with personalisation of content, among other things, but they are less aware of the limitations. On the other hand, AI developers do not always have the opportunity to better tailor the AI tools under development. To make sure that AI solutions are fit for purpose and address real needs, CCS professionals need to be involved in every stage of the development and implementation of AI-driven technologies from the origination of ideas and proposals for development through to design, modelling, data-gathering and analysis, testing, implementation, operation and evaluation (see also Yeung, 2019).

To improve mutual understanding, creative professionals and technology developers should be brought closer together. Exchange and co-design of solutions are important. This requires a knowledge exchange in both directions. CCS professionals need to understand how AI can help them overcome challenges in their sectors, and where its limitations lie. Conversely, AI technology specialists need to understand what evolving needs the cultural and creative sectors have when it comes to technology, and how AI can help them. A transfer of knowledge, and input from creative-sector workers to developers of AI algorithms and solutions could benefit the latter by ensuring that human-centred design is adopted.

While some collaboration is already taking place from the ground up, a key problem lies in the fact that the CCS is not the most lucrative target market for AI developers, who would rather focus on applications in fintech, healthcare, manufacturing, retail/ecommerce, and others. Except for video games, cultural and creative sectors do not pay well and are less attractive for AI engineers or entrepreneurs, which is another barrier for technology development. AI startups need to be incentivised in order to develop solutions for CCS. Demonstration and test projects showing the viability (and profitability) of using AI in CCS also for AI developers could help overcome such reservations.

It was pointed out by stakeholders consulted for this study that CCS firms and innovators are often spread across multiple countries and individuals might work cross-border or cross-continents. Hence, uptake of AI in CCS should not be an exclusively European endeavour but rather build on a knowledge exchange between pioneers globally. At the same time, CCS firms should avoid dependency on individual AI solution providers. Some AI applications are developed in collaboration by several EU-based companies such as automated translation services or data analytics for the entertainment sectors. These initiatives are especially relevant for applications that require European-specific algorithms.

At the level of CCS companies, even where financial resources or the basic intention to adopt AI are there, AI needs to be embedded in the organisational structure and work processes, even the operational logic of the publisher, producer, architect, or filmmaker, as pointed out by experts interviewed for this study. That requires substantial change and often faces stiff resistance from stakeholders in each sector. For instance, the application of AI in collections management is very difficult for many heritage organisations that are short on staff and lack the expertise needed to implement these services in their day-to-day processes. As Karim Lakhani from the Harvard Business School highlighted in his recent work, "AI is challenging the very concept of the firm where AI-centric organisations exhibit a new operating architecture, redefining how they create, capture, share, and deliver value."[55]

Players in the cultural and creative sectors should keep in mind that their audience is evolving and becoming more (multi-user) participatory. Cultural sectors need to capture the attention of young people differently, giving them access to play with art, interact with content and immerse themselves in the experience. In this respect, AI can help cultural institutions to think about new ways of reaching out to their target groups. Another challenge linked to lack of new business models is the capability to scale up current use cases that are promising but need further impetus to fully roll out. There is a need for more scalable pilots and de-risking opportunities.

Collaboration is one way to lighten the burden, and it can take place between CCS professionals and organisations and AI developers in the tech industry, but also between individual CCS sub-sectors. For instance, sectors such as film or performing arts could learn how AI is used extensively in video games. Programmes such as internships or 'artist in residence' schemes could support the temporary talent flow between different CCS subsectors. In doing so, it is once again important to identify the key challenges that each sub-sectors currently faces, and to identify where AI can make a meaningful difference.

6.3.2 *EU level policies*

Several existing EU initiatives could be built upon to stimulate such knowledge exchange and facilitate co-design and co-creation of AI solutions for CCS and beyond.

Besides the EU Pact for Skills mentioned in section 6.2.3 that will mobilise industry and other stakeholder to develop partnerships to fill skills gaps, some of the CCS-specific collaborative projects include:

S+T+ARTS[56] is an initiative and eco-system linking technology and artistic practice financed by Horizon 2020. It supports collaboration between artists, scientists, engineers and researchers to develop more creative, inclusive and sustainable technologies. The project was launched in 2015, following up on previous activities funded by the Commission, namely ICT&Art 2012, FET-ART, ICT ART CONNECT 2013 and ICT ART CONNECT, whose results demonstrated the worldwide emergence of communities of hybrid collaborations among science, technology and arts, and their relevance.

Through the Creative Innovation Lab (CIL) action[57], Creative Europe fosters innovative approaches to content creation, access, distribution, and promotion across CCS as well as with other sectors. Such approaches take digital transition into account and cover both market and non-market dimensions. CIL incentivises firms and individuals working in different cultural and creative sectors to design and test innovative digital solutions with long-term positive impact, and to ease creation of innovative, close-to-market tools, models and methods for the audio-visual sector and at least another creative or cultural sector.

More broadly, a rather horizontal initiative that could help companies in CCS across Europe to speed up their digital transformation, including through the use of AI, is the European Digital Innovation Hubs (EDIH) initiative which helps build a network through mentoring and coaching services of hubs, including on AI applications in design and media. This initiative is enhanced in the DIGITAL Europe Programme[58], helping research projects develop, test and deploy AI use cases in CCS, and to adapt and develop new AI algorithms and applications for the CC sectors. The EC launched a first call for EDIHs in November 2021.

[55] https://hbr.org/webinar/2020/01/competing-in-the-age-of-ai
[56] https://www.starts.eu/about-2/
[57] https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/crea/wp-call/2021/call-fiche_crea-cross-2021-innovlab_en.pdf
[58] https://digital-strategy.ec.europa.eu/en/activities/artificial-intelligence-digital-programme

The European Institute of Innovation and Technology (EIT) is in the process of launching a Culture and Creative Industries KIC[59]. This community will include projects working at the intersection of technology and CCS. The KIC will encompass partner organisations from business, higher education and research in a pan-European ecosystems. Together, the partners will work on entrepreneurial innovation projects and business-creation modules to Strengthen Europe's CCS. The KIC will be located all across Europe and is planned to be operational in 2024. It will focus on several challenges: (1) the need to innovate for producers, distributors, broadcasters, cinemas and theatres, (2) the shortage of entrepreneurship and cross-cutting skills in light of a profound digital transformation, (3) limited cooperation between research and industry, (4) insufficient level of integration of creative clusters and innovation hubs[60].

6.3.3 *Existing policy and industry initiatives to build upon*

There are numerous initiatives co-financed under Horizon Europe, Creative Europe, or the COSME programme aimed at connecting tech companies and CSS firms. Some of these examples are presented in the table below.

Table 19: Examples of collaborative initiatives in CCS

Sector	***Title***	***Description***
News media	MediaMotorEurope[61]	The project aims to build a strong European ecosystem fostering media and the creative industries. The objective is to drive getting innovative technology solutions for media and creative industries to the market and potential clients, with a large focus on deep-tech solutions, such as AI and machine learning.
News media	Stadiem[62]	The project is working on a piloting and acceleration programme to bring together startups, scale-ups, investors and media organisations, and foster the development of next-generation media solutions.
Music	AI and Music S+T+ARTS Festival	It is supported by the S+T+ARTS programme of the European Commission, dedicated to linking technology and artistic practice. It fosters knowledge development and exploration of AI for music.
Fashion and design	Worth Partnership[63]	The project is funded by the EU's COSME programme and aims at creating transnational collaborations between fashion designers, creative people, manufacturing enterprises (SMEs) and technology firms looking to develop design-driven and innovative products.

Source: authors

6.4 Transparency requirements

Artificial intelligence is, in essence, a collection of mathematical rules, but how it is applied in practice can raise a range of questions around transparency. There are various reasons why the cultural and creative sectors need to realise the importance of transparency and sector-wide principles.

AI can seem like a 'black box' due to the difficulty to explain how it operates or lack of sharing of that information to users AI creates a knowledge asymmetry: on the one hand, we find the owners of the algorithms and data who have an overview of how their AI algorithm works, on the other hand there are the artists, producers, and other creative professionals but also the users who have a poor understanding how and why a particular decision has been reached. Hence, organisations adopting

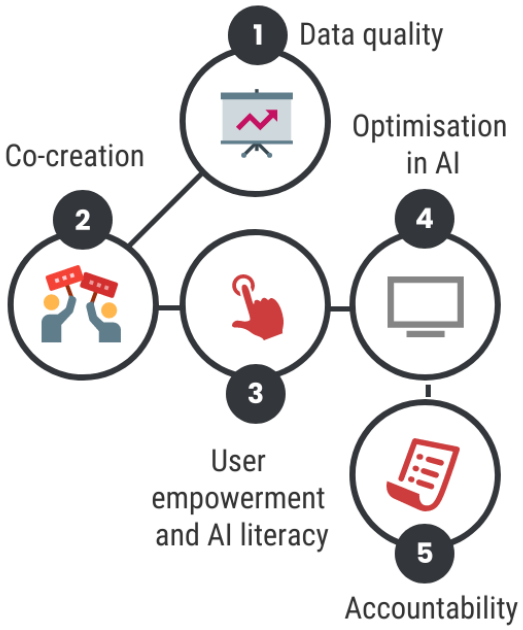
[59] Knowledge and Innovation Community which are based on the principle of the knowledge triangle (business, education, research)
[60]https://eit.europa.eu/sites/default/files/factsheet_on_the_knowledge_and_innovation_community_cultural_and_creative_industries_.pdf
[61] https://mediamotoreurope.eu/overview/
[62] https://www.stadiem.eu/
[63] https://worthproject.eu/worth-project/

AI need to make more effort to understand the programming process, the intent, values, and assumptions behind AI tools and their algorithms.

The subject of trustworthy AI is vast and has been addressed in detail by the High-Level Expert Group on Artificial Intelligence (AI HLEG)[64], an independent group mandated by the European Commission with the drafting of an AI Ethics Guidelines. The need for transparency has emerged in terms of two aspects during the interviews in this study:

- Many CCS stakeholders calling for more AI transparency in the current practices applied by online platforms affecting their sector,
- More collaboration between CCS and AI tech startups to develop a transparent AI system from the very start.

Figure 8: Some of the cornerstones of AI transparency



Source: authors

Since AI technologies are used in decision-making, a need has emerged for algorithmic accountability, which must rely on an appropriate governance framework. As part of the interviews conducted for this study, accountability issues have been raised regarding online platforms and larger tech companies, where the operation of AI is often opaque. Online platforms play a powerful role in AI across all CCS. They act as gatekeepers of information but also cultural experience as a whole and have access to data in an unequal manner. The interviews conducted for this study raised issues around their impact on cultural diversity, data access, and the transparency of recommender systems. Although online platforms are an important piece of the tech creative ecosystem and collaboration rather than regulation should be promoted, liability and accountability should be clear from a legal point of view. Ethical behavior has been also an aspect stressed regarding AI tech startups. AI engineers are not necessarily aware of all the possibilities how to make their data more representative and tailored, however, there are several possible steps to make the AI development process more transparent.

Providers of AI solutions for the CCS need to undertake several steps in order to make transparent how they work:

Inform about the quality of the data the AI relies upon: The input data has a high relevance since it is the basis for the AI to make its predictions. Data should be checked against a range of criteria and bias have to be minimised. Augmented data that is being produced as a result of the interaction between the initial dataset and testing for human beliefs can also help address the problem.

Explain how AI algorithms define and identify an 'optimal outcome': Reaching an optimal solution out of all possible outcomes, taking into account the right variables to solve the particular problem in question. Companies and institutions using AI solutions will have to be transparent about what goals they are pursuing in doing so. For instance, it should be clear whether they use AI merely to increase revenue or to cut costs, or whether they also use it to improve quality of content and outputs. An example given during the stakeholder event was that of architecture firms using AI to build cost-efficient but generic designs. A human-centred approach would ensure that AI-empowered designs are fit for purpose and do not only benefit investors.

Empowering the users: To mitigate the risks of recommendation systems, transparency is needed so that the audience can understand how the recommendations are made. The user should also have the right to choose among recommendation systems or even to select and deselect individual parameters used in a recommendation system, or even have the right not to use/be subjected to a recommendation system at all. In order to understand how data translates into a particular story, designing AI to be accountable to consumers will need to be thoughtfully considered. One way to achieve this – especially with data-heavy content where AI has a natural advantage – might be by allowing consumers to adjust the parameters of an algorithm to see how the results change. When

[64] https://digital-strategy.ec.europa.eu/en/policies/expert-group-ai

applied to news, it is worth considering whether new transparency obligations need to be imposed so that people know whether a story or other content was authored by a machine or human.

6.4.1 EU-level policies

The proposed Digital Services Act (DSA) and Digital Markets Act (DMA) aim to introduce some rules regarding AI transparency that can be built upon for the purpose of increasing transparency of AI solutions for the CCS. The DSA proposal provides for obligatory transparency reporting for intermediary and hosting services and online platforms on algorithmic processes and introduces transparency audits with regard to how information is prioritized and targeted, how recommendation systems work and are linked to advertising. The proposed Act also includes rules on how to handle complaints by users related to alleged misuse of algorithms not in line with the terms and conditions of companies using them. The DMA would oblige platform providers to make transparent how they profile users by collecting data on them. To the extent that CCS firms make use of social media platforms or other online gatekeepers such as search engine providers to engage with their customers, the DMA can help CCS firms by making transparent how they connect such firms to their customers via algorithms and profiling of users.

In 2019, the High-Level Expert Group on AI presented its Ethical Guidelines for Trustworthy Artificial Intelligence. This followed the publication of the guidelines' first draft in December 2018 on which more than 500 comments were received through an open consultation. According to the Guidelines, trustworthy AI should be: (1) lawful – respecting all applicable laws and regulations, (2) ethical – respecting ethical principles and values, (3) robust – from a technical perspective while taking into account its social environment.

The European Commission published a White Paper on AI[65] in 2020 which proposed different policy options for a human-centred approach. Building on this preparatory work, the Commission's proposal for an AI Regulation lays down uniform rules for AI directly applicable in the same way in all 27 EU Member States. The proposal aims to fill gaps in existing legislation and puts forward horizontal rules applicable to the whole AI lifecycle. Its main objective is to ensure that AI systems are human-centric and trustworthy, so that people can trust that the AI technology is used in a safe and legally compliant way, including the respect of fundamental rights. The proposal for an AI Act follows a risk-based approach. First, it bans certain AI practices that are posing a clear threat to the safety, livelihoods and rights of people. This includes AI systems that exploit vulnerabilities of specific groups of persons or manipulate human behaviour to circumvent users' free will in a harmful way. Use of 'real time' remote biometric identification systems for law enforcement purposes in publicly accessible spaces is also prohibited unless limited exceptions apply. Second, it identifies certain high risk AI systems falling in the broad categories of biometric recognition, critical infrastructure, employment, education, access to essential public and private services, law enforcement, migration, judiciary and democratic processes. High-risk AI systems will be subject to strict requirements and conformity checks before they can be put on the EU market as well as ex post controls and monitoring. These requirements cover risk management, data quality and data governance procedures, documentation and traceability, transparency and provision of information to users, human oversight, accuracy, robustness and cybersecurity. While no system in the creative and cultural sector is identified at present as high-risk, the proposal also encourages the drawing up of codes of conduct to foster the voluntary application of the requirements to all AI systems. Finally, specific transparency obligations are imposed for certain AI systems, such as chatbots, whereby people should be made fully aware that they are interacting with a machine so they can take an informed decision to continue or step back.

6.5 Access to funding

Developing AI-based tools for the creative and cultural sectors is expensive and needs an upfront investment. This obstacle has been highlighted by the majority of interviews across all sectors. The challenge of access to funding is two-fold:

- on the one hand CCS need financial resources (and willingness) to invest in AI,
- on the other hand, AI tech startups that specialise in any of the cultural and creative sectors need financial capital in order to be able to develop globally competitive AI applications.

[65] https://ec.europa.eu/info/sites/default/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

6.5.1 Access to finance for CCS

Access to finance has been a well-known barrier to innovation in CCS because culture and art is a public good and the sector is less driven by pure business considerations. Given the large financial resources required, for instance, to develop a text-tagging system, a recommendation engine, a personalised feature, or an AI creative assistant, smaller players (and even larger ones) need to see the clear benefits and concrete returns in order to embark on this journey. Producers and publishers of content face an immense risk and additional costs of technology development without a guaranteed return, and this constellation is not very attractive to these players. Otherwise, they can well use the money to develop a new product or type of content, responding to current needs and not risking AI. Thus, it is difficult to fully evaluate the usefulness of AI in real-world contexts.

The issue is not only access to finance but a lack of a clear business case that would motivate CCS to invest. For instance, in the field of music, the major players (including the larger labels and studios) are reluctant to invest in AI because their current business model and revenue resources work well. New entrants such as Google with its Digital News Innovation Funds (DNI) have, however, made significant contributions to funding projects that explore the possibilities of the new technologies. In the film industry, one of the challenges is that the European audio-visual sector is highly subsidised, and therefore European film producers have more focus on the 'art' than on the financial outcome of the films they make. In the US, films are financed by private investors, and large corporations, who expect a return on investment and this increases US companies' interest in Cinelytic, and other technologies that can reduce risk and improve profit.

Inducing change in the mindset of creative professionals will be key to allow for a positive attitude towards investments into AI. According to the feedback gathered through interviews and consultations for this study, the adoption of AI-enhanced applications in the European cultural and creative sectors is often hampered by a lack of clear strategy and appropriate finance. It requires CCS stakeholders (companies and cultural institutions) to recognise the added value of data but also to accept new technologies in general. There is still a range of actors who are sceptical and focused on different problems other than investing in AI. This is not surprising in many ways because it is difficult to convince conservative elements of the creative sector to integrate an AI-based solution. Profit margins are already rather slim, and any profit-sharing needs to be justified by a clear business case. Interviewees pointed out that public discussion about AI in Germany, for example, is controversial and AI is sometimes rejected by the population due to ethical concerns. Some countries are more open to embracing AI technologies than others. For instance, Sweden has a thriving ecosystem for music tech professionals often flowing over from the country's connections to Spotify (Swedish entrepreneurs started it), which helps to attract key AI talent and professionals.

Although there are a range of public initiatives to help creative and cultural tech startups grow (including EU programmes presented in Section 4.6 and various national and regional funds such as the Creative Industries Fund[66] in the Netherlands), the lack of suitable, unbureaucratic funding sources has been highlighted as an issue and there are no dedicated 'creative AI' funding mechanisms in Europe. There is also a lack of (public) financing dedicated to low-hanging fruit such as investment in using AI to support the business processes of cultural and creative companies and institutions. Although, there are existing funding programmes such as the Creative Europe Programme or the Guarantee Facility (presented in the section below), they do not necessarily address the need to finance experimentation on a smaller-scale between CCS stakeholders and AI tech startups within one sector. Applying for funding is too costly for small CCS players and current funding systems do not fully fit, often threatening their very existence by negatively affecting their cashflows. The biggest gap is in the lack of funding for seed ideas at low technology readiness levels, as highlighted by the experts interviewed for this study.

On the other hand, there is also a lack of awareness and capacity to make better use of the existing instruments and it is the responsibility of the sectoral stakeholders to harness the available opportunities and put forward joint projects.

6.5.2 Tech startup funding challenge

AI tech startups face another investment challenge. Venture capital (VC) investment in AI is not only an issue in the field of creative sectors but is a general problem in the EU. As a recent analysis of the OECD (2021) concluded VC investors from the US represented 41% of total investments in 2020. The US

[66] https://stimuleringsfonds.nl/ - Creative Industries Fund NL is the Dutch cultural fund for architecture, design and digital culture, as well as crossover.

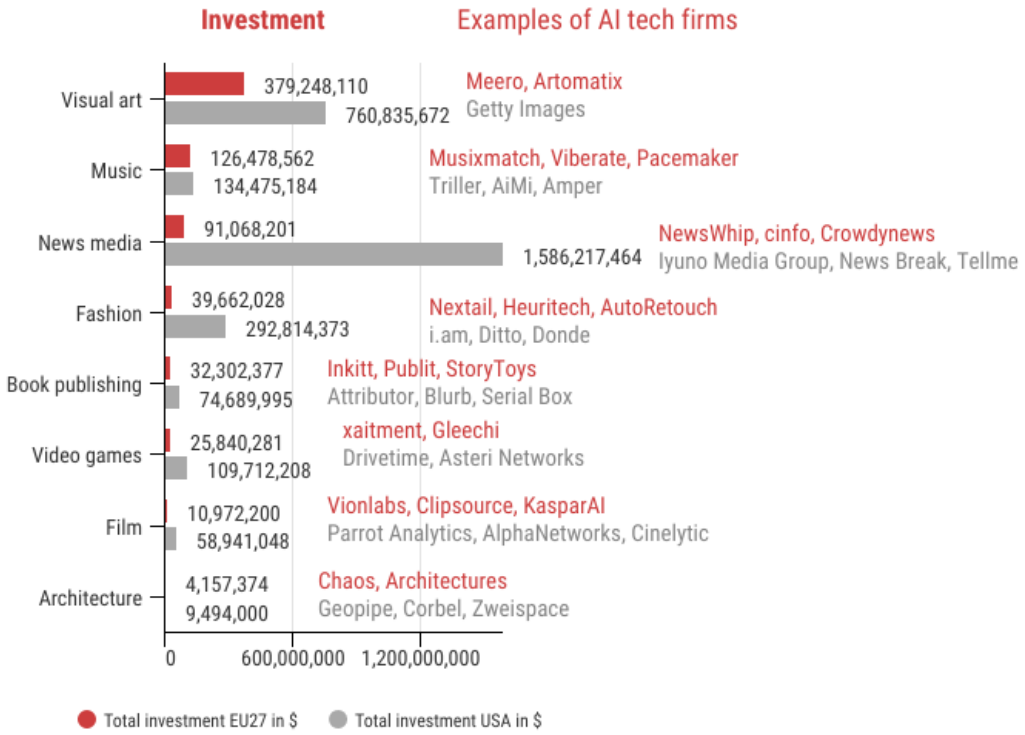
has a historical advantage since their VC industry is the most mature, globally. Based on investment data found, the EU is clearly behind both the US and China in terms of VC investment in AI startups[67].

Creative industry AI ventures are disadvantaged compared to other AI fields since the products and services they target often does not have a proven market. Creative and cultural industries often have little or no tangible products which VCs can easily assess, so they depend very much on artistic skill, which is an intangible quality. Cultural production is considered to be risky due to supply and demand uncertainty (see Lee, 2021; Cohen, 2017; Hesmondhalgh, 2019). The funding challenge is further complicated by the different strategies of digital tech funds investing potentially in the creative sectors on the one hand, and specialised creative industry VC funds investing potentially in digital projects on the other hand.

Despite some success, VC investors in the field of digital technology tend to invest in AI applications through other sectors, according to Crunchbase[68], a tech startup database. Crunchbase information includes investments and funding information, founding members, mergers and acquisitions, news, and industry trends. Originally built to track startups, the Crunchbase website contains information on public and private companies on a global scale. Crunchbase sources its data in four ways: through a venture programme, machine learning, an in-house data team, and the Crunchbase community.

Table 20 summarises the total private equity and venture capital investment spent on AI tech companies working in the field of CCS between 2010-2021 based on the analysis of Crunchbase. For the interpretation of the figures as below, the definitions taken for each CCS have to be kept in mind. The overviews shows that US startups received more funding across all creative and cultural sectors. The EU comes closest to the USA in the case of the music industry, where a buoyant startup scene can be observed. The largest VC investment went into Musixmatch (developing algorithms and tools for music discovery) and Viberate (a data analytics startup). In the USA AiMi, a tech firm developing AI to turn electronic music into a flow of adaptive music, received the highest ($20 m in a B series) funding round in November 2021. In visual arts, VC funds have invested in AI startups developing image editing and photography related applications. The high value is attributed for instance to Meero a French AI company supporting photographers with market research, invoicing, post-production, and delivery services. Interestingly, film is a field where there are very few AI startups

Table 20: Estimated venture capital and private equity investment in AI tech specialised in CCS (2010-2021)



[67] https://ati.ec.europa.eu/reports/eu-reports/report-technology-trends-technology-uptake-investment-and-skills-advanced
[68] https://www.crunchbase.com

Sector	Total investment EU27 in $	Total investment USA in $
Architecture	4.157.374	9.494.000
Book publishing	32.302.377	74.689.995
Fashion	39.662.028	292.814.373
Film	10.972.200	58.941.048
Music	126.478.562	134.475.184
News media	91.068.201	1.586.217.464
Video games	25.840.281	109.712.208
Visual art	379.248.110	760.835.672
Museums/Performing arts	N/A	

Source: Technopolis Group based on Crunchbase

Besides the available limited funding, in certain cases the VC landscape in CCS is characterised by a further problem notably foreign investors taking a high stake in EU AI startups. Foreign venture capital investment is not an issue as such and can be instrumental for startups to scale up. However, foreign acquisitions that might determine the future development path of the CCS should be more closely monitored. In the field of music for instance, automated music generation related startups got later stage investments from the USA and China. Aiva technologies, a music startup using AI to develop soundtracks is funded by the Chinese NetEase. Endel that offers music for personalised, sound-based, adaptive environments are funded by US investors. Viberate or Soundcharts are further AI music data analytics companies backed up by US VC. In the field of image AI technology, we can observe a similar US dominance especially in late-stage investments.

The danger of a lack of appropriate finance and misplaced investments is that if AI technology-based tools are developed by players in other parts of the world, Europe might lose its technological independence in this area. If musicians rely on the tools of Google Magenta, they will become the key source of revenue generation and new business value will be created less in Europe.

Despite the relative disadvantages of the EU in the field of AI investment in an international context, there are a long list of creative industry-related VC funds in Europe that bridge the financing gap for startups. For instance, in Finland, IPR.VC, a venture capital fund for creative industries was founded in 2015 and had raised a total of €65 m by 2021. The fund has invested mostly in Finnish digital content companies that produce TV programmes, movies, games, animations, Internet and mobile content, music or other licensable media content. Investors in the fund include pension institutions, family-owned investment companies, industrial investors, but also the Finnish government-owned Tekes Pääomasijoitus Oy and the fund managers. In France, the Cultural and Creative Industries (CCI) funds, as part of the BPI France portfolio, are designed for equity and quasi-equity investment operations aimed at all stages of company development[69]. Regional funds such as the audiovisual investment fund Wallimage Enterprises[70] in Wallonia in Belgium foster the development of filming and post-production facilities but also of audiovisual content. It has invested directly in a portfolio of companies including the startup Musimap offering annotated music databases (recently acquired by Utopia Music).

6.5.3 EU-level policies

There are various EU programmes that provide a funding source for AI development in the cultural and creative sectors.

The Creative Europe programme consists of the Creative Europe CULTURE and Creative Europe MEDIA (audio-visual) as well as the Cross-sectoral strand. It supports cross-border cooperation and networking activities for all cultural and creative sectors and co-finances platforms and networks. For the period 2021-2027, the programme's budget is an estimated €2.44 billion (compared to €1.47 billion for 2014-2020)[71].

[69] https://www.bpifrance.com/private-equity/direct-investment/venture-capital/cultural-and-creative-industries
[70] https://www.wallimage.be/en
[71] https://ec.europa.eu/culture/news/creative-europe-2021-2027-programme-launch

A good example of a project funded under this programme is the European ARTificial Intelligence Lab[72] (2018 - 2021). The Lab has brought together AI related scientific and technological topics and fostered artists to develop new business models and professional networks in technology.

The Horizon Europe research and innovation programme has a dedicated envelope for culture, notably 'Cluster 2 'Culture, Creativity and Inclusive Societies', which focuses on challenges related to democratic governance, cultural heritage and the creative economy, as well as social and economic transformations through culture. Cluster 2 actions support green and digital European cultural heritage and foster innovation and creativity in the sector of arts, the cultural and creative industries and the new European Bauhaus initiative. Research and innovation projects that aim at developing artificial intelligence technologies for the CCS are also eligible. The previous Horizon 2020 programme for instance funded projects such as the MediaFutures.

MediaFutures has been a three-year European innovation project, which aimed at contributing to innovative media activities. MediaFutures has established a funding mechanism for artists and startups for pilots, artworks and experiences that use data to encourage citizens to engage more meaningfully with high-quality journalism, science education and digital citizenship. It supported more than 50 startups and SMEs through a three open calls with an amount of €2.5 m.

The Cultural and Creative Sectors Guarantee Facility[73] is **a loan programme developed by the European Investment Fund in 2016**. It is the first EU financial instrument specifically targeting CCS by facilitating their access to bank loans, which naturally have to be paid back The European Commission has committed to partially cover financial intermediaries' potential losses when they engage with CCS projects. Loans are available for cultural project development such as funding for independent game developers, publishers of books or sound recordings, loans to exhibitors for the digitisation of cinema theatres, working capital loans to cover distribution costs (print, marketing, advertising, dubbing and subtitling), and so on. The instrument can help to accelerate investment in digitisation and in mature technological solutions, but it is not certain whether it applies to the research and innovation needed for AI development.

The VC gap in AI has been addressed by the European Investment Fund through its recent instruments, notably the EFSI Equity Instrument and InnovFin Equity. The objective is to stimulate the EU's stake in AI (and other digital technologies such as blockchain) by investing in risk capital funds whose strategies target these tech activities. In 2020, the European Commission and the EIF made available additional resources through initiatives under the above-mentioned instruments to further support innovations in the fields of AI and blockchain but also space technology, impact investing and the blue economy. The resulting Artificial Intelligence and Blockchain Technologies initiative is dedicated to financial intermediaries specialising in financing for Distributed Ledger Technology and blockchain[74]. These instruments will be key to accelerate VC funding in AI, but it will be up to the VC funds to decide whether to invest in applications in the creative and cultural sectors as well. Those financial instruments will be further developed under the InvestEU programme.

[72] https://www.creativeeuropeireland.eu/culture/projects/case-studies/european-artificial-intelligence-lab
[73] https://digital-strategy.ec.europa.eu/en/policies/finance-cultural-creative-sectors
[74] https://www.eif.org/what_we_do/equity/efsi/index.htm

7 Recommendations

7.1 Data-sharing comes next to trust-building and identifying common sectoral goals

As the analysis above and the sectoral chapters further below highlight, some cultural and creative sectors have more experience to build upon in terms of generating data for AI than others. There are also differences in terms of the activity of private tech firms and startups working on solutions for tracking the use of creative content or offering tools to assist the production and business processes, to mention two examples. The willingness and motivation of stakeholders to cooperate and share data also varies. All these factors affect the scope and complexity of action at the industry or policy level. There is not a one-size fits all CCS solution with regard to a European data space. Table 21 provides an overview of recommendations which are then expanded on in subsequent pages.

Table 21: Recommendations for data spaces in the cultural and creative sectors

Nr	***Recommendation***	***Level of intervention***	***Link to policy/funding***
1	Seize the momentum and start cooperation around data, explore the opportunities in data sharing by building collaboration with other organisations Build upon existing horizontal and sector-specific initiatives to pool data such as Horizon 2020 or CEF Digital Service Infrastructure (DSI) projects (Europeana DSI Smartdatalake etc.)	Sectors	Horizon Europe
2	Identify 'safe areas' and non-controversial datasets to test how collaboration can work. Common goals around the type of dataset to share can become an incentive. A list of projects should be set up for specific application areas with the specific parties who are interested to get engaged.	Sectors	Na
3	Focus data sharing on a clear application field, collaborate on a specific type of news item, on sound annotation, film shoot composition, or a subset of customer analytics etc.	Sectors	Horizon Europe
4	Review your current metadata frameworks by addressing the gaps and share your data models and collaborate on metadata.	Sectors	Na
5	Build services around data sharing initiatives. It is not enough to pool data, but analytical services, tools and solutions should facilitate concrete use.	Sectors	
6	Foster the emergence of pioneer stakeholders that want to move ahead with sharing data instead of focusing on the creation of one large sectoral data space.	Policy	Horizon Europe (supporting further projects similar to Smartdatalake etc)
7	Improve the business environment for European AI tech startups that can develop data sharing initiatives for the CCS	Policy	DIGITAL

Nr	Recommendation	Level of intervention	Link to policy/funding
8	Review of publicly held data that could be made better use of e.g.: data of collective rights management societies, public cultural organisations, public film archives, public building administration on construction plans, etc.	Sectors/Public-Private cooperation	no
9	Foster the emergence of a research data space similar to Google Magenta etc and pool data across Europe in view of the objective of developing culturally diverse AI applications, potentially as part of the European Research Infrastructures. EOSC could also cater for all types of research domains including the CCS.	Policy	Horizon Europe, European Research Infrastructures, EOSC
10	Foster the development of an interoperability assessment tool that can serve as a basis for the CCS to monitor standards and compliance (similar to healthcare data initiatives) This initiative could be, for instance, connected to the Industry Commons[75] which is leading standardisation of cross-domain interoperability.	Policy/Sectors	Horizon Europe Industry Commons
11	Foster the development of blockchain- and smart contract-based framework that allows CCS stakeholders to store data locally and share without losing control and ownership of it.	Policy	
12	Consider incentives to federated data management systems. The existence of appropriate data sharing smart contracts securing the fair management of the system will be critical to establish trust. Explore the potential set up of an independent 'Data Agency' for the CCS that pools together data from various sources and gathers a range of members.	Policy	

Source: author

The first challenge to overcome is to find an appropriate incentive mechanism and framework to share and pool specific types of data most relevant for each sector. The objective should not be necessarily to create one large sectoral data space but to foster the emergence of pioneer stakeholders that want to move ahead and build a new joint business model or create a common initiative for unbiased, culturally diverse AI applications. The scope of data sharing can be limited to a set of private/public players and a specific AI use case. Such an approach is already part of the recently published recommendation on a common European data space for cultural heritage[76]. The aim is to accelerate the digitisation of cultural heritage assets, where data holders are in control of who can get access to what data, as a key feature of the planned data space. Each cultural and creative sector has momentum to start cooperation around data sharing. Building trust and clarifying the rules of data sharing is critical. The rules of data sharing, and ownership of data should be clear for the whole ecosystem. Some players are afraid to share data because of the possible negative consequences to their reputation or fear of legal risks when sharing sensitive information or misusing information. Groups of companies could entrust the metadata around their content to researchers if they know it will be used to build solutions in their interest.

To start data sharing one has to identify 'safe areas' and non-controversial datasets to test how collaboration could work. Common goals around the type of dataset to share can become an incentive for collaboration in certain cases. In the US, students from the University of Stanford and media newsrooms collected, processed, and released a dozen datasets as part of the Big Local News programme[77]. The

[75] https://industrycommons.net/
[76] https://digital-strategy.ec.europa.eu/en/news/commission-proposes-common-european-data-space-cultural-heritage
[77] https://biglocalnews.org/#/login

objective was to share data related to the COVID pandemic such as hospital beds, nursing homes, daily updates of COVID-cases, tweets from governors, health departments, etc. Another incentive is often the value that one can get out of a larger pool of data (i.e. to join forces against tech giants). Individual newsrooms, independent record labels, film production companies might not have a large enough dataset to gain more specific insight. Their data are restricted to a specific country without the understanding of customers from a broader set of cultures. If they were willing to share data, they would be able to generate more robust analytics, get more value and have a better overall position on the market.

Data sharing should be focused on a clear application field, as interviewees highlighted across all sectors. Aiming at creating a large data pool with various unrelated and unstructured data can be counterproductive. Focused actions to pool certain types of data for a specific use are considered to be more promising. Such datasets can include, for instance, collaboration on a specific type of news item and news data, on sound annotation, film shoot composition, or a subset of customer experience analytics. The data space shall provide not only data in raw format, but services built on top of this that provide value. It is not enough to pool data, but analytical services, tools and solutions should facilitate concrete use of the big datasets. Common catalogues are another way to make European content more visible. In this respect, there is a need for a layer of intermediaries that have the necessary expertise to sort the data and make it available/suitable for different uses.

Any future data initiative addressing CCS should prioritise a list of promising data pooling projects with concrete objectives building upon existing initiatives (e.g. projects financed under the Horizon 2020 projects but stopped after three years with pilots not being able to scale up). It would be useful to better explore what data exists within culture-related public institutions, and see how this information can be made available for startups.

Sharing data models is an easier step than sharing content or user data, as pointed out by the interviewees. Before data can be used extensively by AI, it needs to be labelled and 'trained', often in first instance by diverse teams of humans to avoid biases. Data models describe how data and metadata are structured so that it can be prepared in the same way (consistently), which is a first step for cooperation among a larger number of CCS stakeholders. These training models should be transparent and quality assured so they can be used in different contexts without inherent biases creeping in.

Data interoperability is vital to effective data sharing between organisations. A key challenge for each sector is to review the current metadata frameworks and address the gaps. Metadata is key for each sector, not just to be able to analyse datasets but to be able to track the usage of content and ensure fair remuneration. For example, the Europeana Data Model (pro.europeana.eu/page/edm-documentation) allows a standardised representation of the data delivered to Europeana by cultural heritage institutions from different domains using different formats; the Europeana Licensing Framework provides a set of 14 standardised rights statements (pro.europeana.eu/page/available-rights-statements) that can be used by cultural heritage institutions to communicate the copyright or re-use status of digital objects to the public; the Europeana Publishing Framework (pro.europeana.eu/post/publishing-framework) defines layers of content and metadata quality ('tiers') to manage the quality of data delivered by data partners to Europeana.

A public data space for CCS may not be needed in all situations. In certain cases, tech startups are better placed to develop data solutions and the market should be left to operate on its own. Nevertheless, the EU should have an interest in making sure that tech startups have the right framework conditions to grow in Europe (i.e. not moving to the US or elsewhere). AI startups often lack talent and struggle to finance their growth. EU venture capital initiatives should pay specific attention to the potential in the cultural and creative sector, and should become aware of the opportunities.

Trusted data governance models have to be set up for each sector by establishing project leadership and clear description of data partners committed to sharing and using data to develop their business and the sector. Data governance must start with the creation of a trusted ecosystem where members share common interests and trust that collaboration will bring value for all. Data governance can build upon various models such as:

- Peer exchange – sharing data on a bilateral basis
- Multilateral data sharing – agreement in a closed private group

- Sharing data via a third-party platform
- Open public data sharing
- Creating a specialised data crawler – creative sectors could consider building their own crawler in a safe space that is not accessible to big tech platforms

Interviewees considered a federated data management system as a realistic option. As an example, the architecture of the German Industrial Data Space[78] does not require central data storage capabilities and pursues the idea of decentralisation of data storage, which means that data physically remains with the respective data owner until it is transferred to a trusted party. The existence of appropriate data sharing smart contracts securing the fair management of the system will be critical to establish trust.

There are public institutions (i.e. film archives) that pool data and might help create trust based on their experience/success. They could be used to pool data for a central European film and visual archive. This could act as a secure central data source that production companies can confidently entrust their data to, thus help startups to grow further. Neutral, trusted organisations are well placed to take the initiative, which can also include associations, universities, libraries etc. Shared and federated data spaces need a trusted coordinator and solid governance structures.

A solution for data governance is a blockchain- and smart contract-based framework that allows users to store data locally and share without losing control and ownership of it. Blockchain enables the creation of an automatic verification system of the conditions for data access.

Data pooling initiatives should be accompanied by wider education programmes available across the industry in order to inform and train all actors how to use common data standards.

The interviews conducted for this study highlighted that an important barrier to sharing data is related to the infrastructure that is necessary to manage the technical implementation of data pools. Finding appropriate cloud solutions has been a recognised an issue hindering the effective organisation of common data warehouses.

7.2 Foster AI tech skills and related competences both in CCS and tech

Skills and training form a key pillar in the strategy to foster the adoption of AI in the broader CCS. Although there are numerous initiatives ongoing both at national and European level that support training in AI, there is still a lot to do in order to reach a critical mass. Table 22 provides an overview of the recommendations that are detailed below.

Table 22: Recommendations for skills in the cultural and creative sectors

Nr	***Recommendation***	***Level of intervention***	***Policy/funding***
1	Foster the inclusion of AI training (not only coding but also a preparation for an AI-powered future world) in the curricula of CCS academies at bachelor and master levels. More broadly, AI education needs to start in schools and through informal after school programmes, as well as in secondary school and universities.	National/regional education policy	National/ ERDF
2	Develop and foster AI training programmes for CCS for various job positions such as managers/directors, employees, artists, creators etc. The training programme should be composed of several modules:	Sectors	National/Creative Europe/Digital Europe

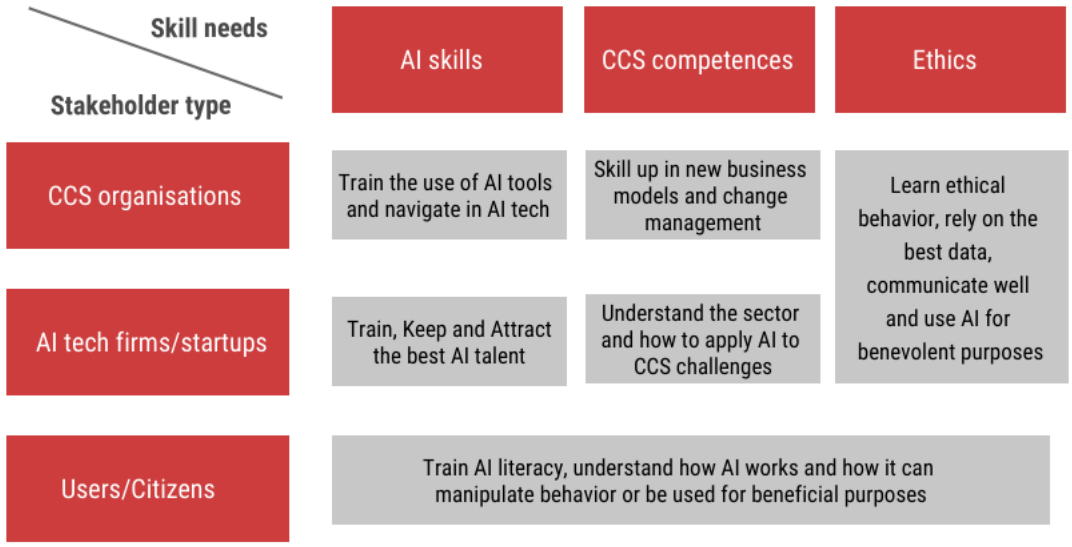
[78] https://www.fraunhofer.de/content/dam/zv/en/fields-of-research/industrial-data-space/whitepaper-industrial-data-space-eng.pdf

Nr	Recommendation	Level of intervention	Policy/funding
	- overall use of AI, how to use AI tools (asking for presentations from AI tech companies specialised in CCS), - how to assess the usefulness of AI, how to interpret the results - how to manage data, what to do with data - how to manage change within the organisation, how to adapt organisational models Such programme can build upon initiatives such as the 'AI Academy for Small Newsrooms of the London School of Economics that is running a 6-week programme to help small newsrooms leverage the power of artificial intelligence.		
3	Develop a CCS-AI training/internship scheme and foster its implementation among IT/computer science students	National/EU policy/ CCS	National/Digital Europe
4	Create an AI virtual or physical competence centre for CCS building upon the results of the AI4Media project	Sectors/EU Policy	Part of the upcoming skills partnership for the Cultural and Creative Industries Sectors
5	Support the development of AI talent for CCS in the EU This type of support can take place for instance in the framework of the call for European Cooperation projects (COOP) under the Creative Europe Programme, where there are annual sector-specific priorities and where the use of AI technologies has been identified as a common objective.	EU Policy	Digital Europe Creative Europe Programme
6	Increase the number of AI PhDs with a focus on a CCS topic	National Policy	EU/National

Source: authors

To develop skills and competences, training is needed at various levels and for various stakeholders. Besides training in AI, new creative skills, CCS knowledge, competences to apply AI to real-world applications, AI ethics and literacy are also needed. Training programmes should include modules related to business model thinking and change management. As AI is challenging the very concept of the firm, managers need to be trained on how to reorganise the operating architecture of their companies or organisations. Value has to be captured differently, which requires new ways of thinking. CCS professionals should also be aware of the ethical implications of using AI, and should receive guidance on how to use AI in a transparent manner. Figure 9 provides an overview of the types of skills necessary for the main groups of actors.

Figure 9: Skills development



Source: authors

More investment should be channelled into training programmes that empower creative professionals such as artists or journalists to experiment with AI. Such training programmes should be smart and low-key, targeting professionals working in smaller organisations in the cultural sectors that may lack the in-house resources for such investments. Artists and smaller actors in the cultural and creative sectors do not have time and they need high-impact but low-intensity courses. For CCS employees, digital literacy and basic knowledge can be sufficient for using off-the-shelf AI solutions. One approach is to build on existing competences (e.g. librarians are experienced database managers). However, at the moment, AI training is still failing to integrate the CCS experts and remains with tech specialists.

Curricula across the CCS (such as of music academies, film high schools, school of journalism etc) have to reflect the new needs according to the redefinition of the CCS professionals' role in the future. Experts agreed that training is better done at the master's level. In the case of the film industry, it is necessary to expose filmmakers more to AI-based technology such as that already in the curriculum of film schools. On the other hand, AI expertise is a young profession and most practicing experts have only a few years of experience (LinkedIn, 2019). This indicates there is likely a lack of mid-career employees holding such positions. Yet, managers are important as they understand the sector and its long-term evolution. They can typically better assess how AI comes into play: opportunities and risks.

Skills development is necessary particularly in the field of data management as well. In order to address the lack of understanding of the importance of data and metadata across CCS, there is a need for education programmes organised in collaboration with industry, policymakers and education institutions in the field of data management.

There is a need to tackle the current over-emphasis on coding and math. This implies de-emphasising coding skills and, at the same time, increasing emphasis on business knowledge, improving communication skills, and including data storytelling as part of the training curricula. In this respect, the approach of STEAM Education[79] could be put to better use of. STEAM is an acronym and approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics and fosters dialogue and critical thinking.

Interviewees expressed the need for a dedicated AI competence centre(s) for the cultural and creative sectors. Such a centre (virtual or with a main office and contact points) could align training in all the main subjects mentioned above. The centre should aim at enhancing collaboration and innovation within artificial intelligence across sectors, and development stages. Some of the interviewees' inspiration originates from the European Organisation for Nuclear Research (CERN), the world's premier particle accelerator and centre for fundamental research on particle physics. It attracts top researchers from

[79] https://artsintegration.com/what-is-steam-education-in-k-12-schools/

around the world (and is the birthplace of the world-wide web). CERN already nurtures collaboration with arts and creative-sector stakeholders, and a creative AI competence centre could be powerful.

Related to skills development and training, there is a need to rethink immigration policies. In the US, the majority of the AI PhD graduates are from abroad and they stay in the US: "The percentage of international students among new AI PhDs in North America continued to rise in 2019, to 64.3% – a 4.3% increase from 2018. Among foreign graduates, 81.8% stayed in the United States and 8.6% have taken jobs outside the United States." (Stanford University, 2021). The EU is much less active internationally and lacks a strategy to keep and attract AI talent.

7.3 Go a step beyond: from collaboration between tech and CCS to creative tech ecosystems

As presented above, there are a number of ongoing projects aimed at bringing digital technology companies (including AI) closer to the cultural and creative sectors. The interviews highlighted, however, that while these projects are important first steps, their reach in the entire sector (and thus their transformational capacity) is still limited. Moreover, large projects (such as those funded by Horizon 2020 / Horizon Europe) often take time to be implemented and are not agile/nimble enough for the fast-paced changes taking place in the field of AI.

In the following, we present our recommendations on additional steps that could be undertaken at EU, national, and regional levels to further promote collaboration between tech companies and the CCS in order to foster the update of relevant AI solutions.

Table 23: Recommendations for collaboration in the cultural and creative sectors

No.	***Recommendation***	***Level of intervention***	***Policy/funding***
1	Continue to support collaborative projects between CCS and AI tech in the EU including smaller-scale actions such as voucher schemes or projects for experimentation.	EU/National	National /Creative Europe
2	Consider ways to support exchanges where CCS professionals are made residents in tech companies for a limited amount of time, and vice versa such as 'Artist in residence' and 'technologist in residence' schemes, taking into account opportunities based on relevant programmes.	National, regional	National/Creative Europe/S+T+ARTS /Erasmus+ Projects of this kind could for instance possibly be supported under the Erasmus for young entrepreneurs programme.
3	Put in place an AI tech public-private partnership that can incentivise collaboration between larger European-based platforms, tech companies and CCS stakeholders.	EU and sectors	InvestEU and private co-financing; AI Data Robotics Partnership as a framework
4	Make sure that the emerging European Digital Innovation Hubs Network is open to participants from the CCS and AI and fosters cooperation on CCS and AI matters.	EU	Digital Europe, possibly with co-funding from Creative Europe
5	Foster the development of tech-CCS cluster initiatives.	National/Regional	National

No.	Recommendation	Level of intervention	Policy/funding
6	Foster AI pilots in collaboration of CCS and tech startups focused on clear problem statements related to key challenges individual CCS sub-sectors are facing right now.	EU	EIT CCSI KIC
7	Integrate the CCS into the new European Innovation Council Marketplace which is currently under development. A new EIC marketplace will help EIC companies and projects reach their full potential by facilitating relations and connections with other projects, but also by exploring additional exploitation areas, and exchanging innovative ideas.	EU	European Innovation Council Marketplace

Source: authors

There is a need to create a business/creative and cultural environment across Europe, where AI tech companies and CCS can have more encounters and collaboration opportunities. This can take the form of collaborative projects as already expected to be funded under the Creative Europe Programme, but also under other programmes as appropriate and more cluster initiatives, public-private initiatives (e. g. in the music sector with the involvement of large EU-headquartered streaming platforms, start-ups and research centres) and networking.

Providing opportunities for CCS to work together with AI tech companies should be hands-on and easy to implement without too much administrative burden and formal requirements. Such low-hurdle collaborative schemes could include the following:

- *Technology voucher s5chemes for CCS*: Vouchers issued for the CCS could enable CCS firms, cultural institutions, artists and creators to test an AI tool and tailor it to their purposes or co-develop a new AI-powered solution for their business/activity with the support of European tech companies.
- *Resident schemes*: CCS professionals could be made residents in a tech company for a limited amount of time, and vice versa, developers in a CCS firm. Equally, video gaming professionals could become residents in a music company, or other cross-sectoral collaboration incentives be funded by the Commission. In this, there is potential for spill-over effects. The European exchange programme for entrepreneurs for instance is a cross-border exchange programme which gives new or aspiring entrepreneurs the chance to learn from experienced entrepreneurs running small businesses.[80]
- *Experimentation projects*: Small-scale projects can be a good way to showcase how AI solutions can be applied to a specific CCS challenge. Such projects need to tackle real-life problems of high relevance.
- *Experimental labs*: the lab concept is currently under development by the New European Bauhaus initiative, which places culture and creativity at the centre of societal transformation towards the Green Deal.

The EU should be able to offer the right framework conditions for innovation to flourish across its cultural and creative sectors by adopting an ecosystem approach and fostering cluster initiatives and networking.

- *Cluster initiatives*: There are more than 162 cluster organisations targeting cultural and creative sectors in the EU, according to the European Cluster Collaboration Platform[81]. Cluster initiatives play an important role in creating an innovation milieu where CCS stakeholders can thrive and

[80] https://www.erasmus-entrepreneurs.eu/index.php?lan=en
[81] Clustercollaboration.eu

further grow. Digital transformation is an aspect where cluster organisations can be of support in terms of access to know-how and provision of networking opportunities between tech and CCS.

- *European Digital Innovation Hubs (DIH)*: DIHs[82] are one-stop shops that help companies become more competitive with regard to their business/production processes, products or services using digital technologies. They offer technical expertise and experimentation (a 'test before invest'), and support such as financing advice, training, and skills development, which are all important for CCS stakeholders wanting to venture into AI technologies. The European Digital Innovation Hubs to be set up across Europe should thus proactively involve participants from the CCS in a sustaining network and foster cooperation on AI.
- *EIT Culture and Creative Sector and Industries KIC*: This new European Knowledge and Innovation Community is expected to unite cultural and creative organisations from business, higher education, and research in a pan-European innovation ecosystem. It will aim at stimulating innovation and entrepreneurship, as well as delivering innovative solutions. This new community will be a critical step towards creating an innovative CCS ecosystem. The EIT CCSI KIC could consider the following:
    - *Pay sufficient attention to sectoral differences and sub-ecosystems such as technology networks around news media, music or film.*
    - *Create sectoral partnerships between large tech firms and tech startups and CCS as part of the innovative actions.* Cooperation with some of the online platforms such as Spotify, Deezer, Google AI research group in Europe, Zalando etc. can be explored and not just considered as a threat.
    - *Create novel cross-domain creative applications for AI by collaborating with other EIT KICs.*
    - *Innovation and entrepreneurship should be promoted in a global context.* Although European values and sectoral development should be the priority, international networks on AI research and innovation in CCS should be exploited smartly.

In terms of implementation, there are clear sectoral differences when it comes to building a tech ecosystem around cultural and creative sectors. At one end of the spectrum, there is no intervention needed (video games), at the other end, there is a lot to do (keeping in mind limitations such as in the performing arts). For instance, in video gaming actors collaborate sufficiently and do not need support (here economic conditions and benefits are clear). In fashion there are incentives to collaborate, but some nudging is needed. Performing arts and architecture may need more incentives and support. For instance, as part of the MTF Labs (Music Tech Fest) one of the biggest AI experimentation platforms is Dance AI[83]. Architecture is fast progressing to AI-assisted material lifecycle management, as analysed further in the sectoral chapters. The potential for collaboration also varies in terms of the type of actors such as B2B/B2C and small/large companies and institutions.

Funding programmes should try to fund initiatives that are building or cataloguing modules (certain AI functions) which can be plugged in and borrowed depending on the specific demand (building on AI4Media approach).

7.4 Foster innovation, while ensuring transparency and ethics

As covered in the previous chapter, depending on how the current systems operating around different applications have been set up, AI systems can easily become opaque for users. Given that the proposed AI regulation does not subject AI systems in CCS to mandatory requirements for transparency, data quality, risk management, documentation etc., these can be addressed by voluntary codes of conduct to ensure AI algorithms are fair and used appropriately in CCS decision-making. Ethics is related to trust that can be reached by paying attention to the quality of the dataset, to the optimisation of AI, user information and accountability. Any support measures aimed at boosting AI usage in CCS also need to

[82] https://digital-strategy.ec.europa.eu/en/activities/edihs
[83] https://mtflabs.net/mtforebro/

be coherent with the policy objective of preserving and promoting trustworthy AI and Europe's cultural diversity. Table 24 provides an overview of the recommendations that are then detailed below.

Table 24: Recommendations for more transparency in the cultural and creative sectors

Nr	***Recommendation***	***Level of intervention***	***Policy/funding***
1	Adopt legal frameworks conducive to innovation: examples show that the borderline between a positive and negative application can be thin, and while rules and regulations should be in place, innovative startups should not be stifled.	EU	Regulation
2	Foster the development of specific AI standards and labels in voluntary codes of conduct for the transparent use of AI in specific CCS applications: • Develop rules for online platforms to publish a user guide about their recommendation systems • Develop rules on the use of architecture data	Sectors/EU	Regulation/Voluntary Codes of Conduct
3	Develop toolkits for a 'Cultural Diversity Check' that can be used by any company or organisation in the sectors concerned when putting in place an AI based recommendation system. The check can ensure that the system is transparent and relies on diverse and fair data.	Sectors with possible government facilitation with further research and follow-up action at EU level	
4	Promote more transparency towards users, e.g. to inform people what happens with their user data while listening to or using online streaming platforms (or any online platform) – this can help create fair conditions across the CCS	EU regulation P2B GDPR Sectors	
5	Make AI solutions accountable and adopt clear rules on liability of decisions taken that were informed by AI input	Sectors/EU	
6	Introduce JUST data annotation: creators of datasets should annotate their data aiming to be Judicious, Unbiased, Safe and Transparent. (This concept was proposed to EOSC as part of its expansion to wider stakeholder groups and has been well received by both the research and creative communities.)	Sectors	

Source: authors

The balance between safety, ethics and innovation must be ensured, which is a difficult balancing act. This was echoed throughout the interviews. On the one hand, malevolent use of AI should be strictly avoided, on the other hand innovation to create new ways to support human well-being should be not drowned. European AI tech startups face many challenges and even more so in the cultural and creative sectors. If they want to stay competitive, the business environment should support innovation and protect important public interests such as safety and fundamental rights of people.

For instance, in relation to regulating face recognition, rules should distinguish between face recognition used for malevolent purposes and on a limited set of film material. Developing an AI application to follow natural persons in films should be made possible without a process of asking for permission for each

character analysed in the film. The latter is covered as part of the GDPR. A solution is, however, not to identify the people nor make the data biometric, and in this case there is no need for consent.

A distinction should be made between 'good' and 'bad' artificial intelligence with a specific hindsight for artistic projects without imposing a heavy regulatory burden on tech startups using artificial intelligence. EU regulation should be clear when identifying some AI systems, such as face recognition, as 'high risk AI'. For instance, in the case of the film industry, face recognition can be used inside a limited set of film material in order to improve the film production process. There should be more clarity in the regulation with regard to these artistic use cases and if this would be considered a remote biometric identification system.

Transparency of AI can be addressed by careful management of the AI development and implementation process and its various components. AI engineers have to be accompanied by end-users and end-application stakeholders in order to keep better control and increase the quality and usability of the final AI-enhanced product. Addressing the data bias and be open and clear about the use of data sources to train AI will help to increase transparency. A solution pointed out is the introduction of AI standards to be respected when setting up a system and providing information and interpretative tools to inform users on how the AI reached a particular decision.

As discussed in chapter 3, the impact of cultural diversity remains a concern and UNESCO (United Nations Educational, Scientific and Cultural Organisation), in its recommendation on the Ethics of Artificial Intelligence adopted in November 2021[84], has encouraged its Member States to work on promoting an inclusive access to AI systems with locally relevant content and services and with respect for multilingualism and cultural diversity. This includes among other things, examining and addressing the cultural impact of AI systems and engaging technology companies and other stakeholders to promote a diverse supply of and plural access to cultural expressions, and in particular to ensure that algorithmic recommendation enhances the visibility and discoverability of local content. In this context, as part of efforts to develop 'value-aware' AI applications in the cultural and creative sectors with the involvement of sectors' practitioners, the elaboration of checklists related to cultural diversity can be one way to help AI tech companies and AI engineers become aware of the potential impact of AI tools. They can be used for the purpose of reflecting about cultural diversity principles and identifying the next steps. The check should ensure that the system is transparent and relies on diverse and fair data. Such an initiative should ideally come from the sectors and be a voluntary process; however, in line with the UNESCO recommendation, EU Member States are encouraged to support this process, while, at the EU level, further research and knowledge sharing should be pursued to assess the need for further action on a larger scale.

7.5 Adjust funding mechanisms to foster AI demonstration and new business models

Decisions on what to fund should be left for the market and the individual sectors to decide. CCS stakeholders will need to assess on their own in which AI technologies it is worth investing in. Policymakers can help take decisions by unlocking opportunities to test AI tools, but also foster better access to finance for technology startups venturing both in AI and in the cultural and creative sectors.

Access to finance is a key pillar to enable AI development in CCS, however, the challenge is not about funding only but more about understanding potential business models around AI.

Currently, there are several barriers to investment:

- There are CCS companies that want to invest in technological solutions including AI-based applications, but they do not make enough profit to carry out the upfront investments. Here, bridging funds could be a solution, or loans and co-investment funds that can be repaid later when the investment returns have materialised.
- There are CCS firms that do not want to invest in technology because they doubt the return on investment. For sectors that are not profit driven and without a clear business case for AI, funding alone will not solve the problem. This is why it is important to focus on demonstration projects

[84] https://unesdoc.unesco.org/ark:/48223/pf0000380399

exploring new business models and not just AI technologies. Awareness-raising campaigns and the sharing of experience could also help.

To this end, the Creative Innovation Lab financed under the Creative Europe Programme is expected to foster experimental projects that are cross-border and cross-sectoral. It incentivises players from different cultural and creative sectors to design and test innovative digital solutions with a potential positive long-term impact on multiple cultural and creative sectors. The Lab is intended to facilitate the creation of innovative solutions (e.g. data tools, models and methodologies) that can apply to the audiovisual sector and at least one other creative and/or cultural sector. Such initiatives are welcome, even if they do not fully address the need for sectoral start-ups and creative organisations to work together and test innovative applications.

Table 25: Recommendations for improving access to funding

Nr	***Recommendation***	***Level of intervention***	***Policy/funding***
1	Access to funding to test AI tools and demonstrate the viability of the application (similar to the testing and experimentation facilities under Digital Europe that are currently not addressing the CCS).	EU/sectors	Creative Europe/DIGITAL Europe
2	Launch demonstration projects for CCS to develop new business models around AI applications.	Sectors	Creative Europe
3	Launch thematic investment initiatives dedicated to AI CCS tech startups and scaleups or a process to raise awareness of CCS opportunities among investors (including training, matchmaking, showcasing that can create trust and facilitate personal contacts among VCs).	EU	InvestEU/EIF
4	Initiate projects similar to Mediafutures under Horizon 2020 and publish sub-calls with the opportunity for CCS to test new AI applications (https://mediafutures.eu/).	Sectors/EU	Horizon Europe
5	Funding cross-sectoral innovation projects.	EU	Creative Europe

Source: authors

7.5.1 Access to funding for CCS to test existing AI tools

AI tools developed to support content creation and the artistic process are often too expensive for smaller CCS players to afford. They are expensive because development has a high upfront cost, and the market needs to mature before prices can come down. This creates a 'chicken and egg' problem for the demand and supply side of AI technology: while prices remain high, smaller players do not have the opportunity to test these tools, but since they cannot test the tools, AI developers cannot roll out their technology to a sufficient extent. To address this issue, funding schemes should be put in place that offer demonstration and proof-of-concept opportunities for AI developers and CCS actors who want to test these tools.

The DIGITAL Europe Programme provides co-financing for world class reference facilities for testing and experimentation in real setting focusing on the applications of AI in essential sectors such as health, transport or mobility. These facilities are connected to the network of European Digital Innovation Hubs and are equipped with large computing and data handling facilities, as well as latest AI technologies, including emerging areas such as neuromorphic computing, deep learning and robotics. Similarly, to

other sectoral testing facilities, it can be considered what support can be offered for AI tech startups working for the cultural and creative sectors.

7.5.2 Funding AI CCS tech startups and scaleups

As detailed in the previous chapter, AI tech startups specialised in the cultural and creative sectors face difficulties in obtaining funding and are often undervalued by venture capital funds (compared to other more lucrative AI application fields such as finance or healthcare).

The European Investment Fund (EIF) invests in European VC funds, provides venture debt directly to startups and connects investors with startups. Most recently, the EIF and the European Commission have launched ESCALAR[85] in 2020, a new investment approach that supports venture capital and growth financing for promising companies, enabling them to scale up in Europe and help reinforce Europe's economy and technological strategic autonomy. Through this initiative up to €300 m will be made available with the objective to increasing the investment capacity of venture capital and private equity funds, triggering investments of up to €1.2 billion, four times the original investment and supporting promising companies.

EIF initiated financial instruments could be more explicitly used to support the digital transformation of the cultural and creative sectors. A dedicated thematic investment initiative could be launched that meet the needs of AI and CCS and help mobilise private capital for creative tech. This could be also part of the InvestEU Programme helping tech startups to venture in the field of CCS and also help them scale up when they reach a larger size. Trainings for SMEs and investors are foreseen as part of the 'capacity building' under InvestEU (building on previous experience with the CCSGF that aimed to stimulate loans to creative SMEs).

As another food for thought, the policy experiment in South Korea using venture capital for public cultural investment has been recently analysed by Lee (2021)[86]. In around 2000, the South Korean cultural ministry and the film council began partnering with venture capital companies to raise public-private funds dedicated to the cultural and film industries. The government created a policy that reduced the risk borne by private investors by intervening in the VC market in support of cultural startups. As Lee (2021) described, the state used venture capital companies strategically to stimulate cultural industries. This process has been part of the South Korean public project to create an institutional environment and organisational arrangements for the benefit of the 'cultural industries' formulated as a policy objective. As it was found, this policy experiment has significantly increased capital in CCS and a VC market for cultural industries has been successfully created and nurtured.

7.5.3 Funding cross-sectoral innovation projects

AI has seen different levels of adoption across the cultural and creative sectors, as pointed out above. There is enormous potential to foster cross-sectoral collaboration within CCS but also with other sectors such as education or engineering. There is also a need to incentivise talent flows across sectors (e.g. from video games to performing arts in the context of an internship programme for professionals).

It is, however, a clear issue that cross-sectoral projects are hard to secure funding from the current programmes, because they do not qualify under either category (AI or cultural/creative). An ecosystem approach is needed with funding adapted the programme design, to make it conducive to new forms of partnerships. Although the Creative Europe Programme[87] and Horizon 2020 / Horizon Europe are funding some cross-sectoral projects, their scope is still limited in the field of AI-related cross-sectoral innovation. The budget for the different programmes and their scale of intervention should be considered and potential synergies mobilised.

For example, video gaming professionals could become residents for a temporary period of time in a music company to share their knowledge of the use of AI for better content, business processes, or audience engagement. There is great potential for spill-over effects and cross-fertilisation stemming from such collaboration.

[85] https://www.eif.org/what_we_do/equity/escalar/index.htm
[86] https://www.tandfonline.com/doi/citedby/10.1080/09548963.2021.1926931?scroll=top&needAccess=true
[87] https://ec.europa.eu/culture/funding-creative-europe/cross-sectoral-strand

8 Sector in focus : Architecture

8.1 Short description of the sector and current overall challenges

Architecture is the process of planning, designing and constructing buildings or structures. In this study, which focuses on the creative sector, the planning and designing phase will be emphasised, without completely omitting the construction phase from the analysis.

The European architectural sector is highly competitive, with many European architecture firms designing buildings all around the world, including in rapidly growing markets such as China. The total number of architects in Europe has grown by 24% between 2008 and 2018[88] and more steadily at 1%-2% between 2018 and 2020[89]. While the market shrank quite significantly after the financial crisis in 2008, its growth stabilised between 2010 and 2018. Between 2018 and 2020, the architectural sector grew more strongly at 12% according to the Architects' Council of Europe Observatory.[90] At the same time, as pointed out by one of the experts interviewed for this study, the sector has low profit margins due to the intense competition among firms and due to the limits to scaling up business operations given the local nature of all construction. Internationally, Japan is considered a leader when it comes to digitising architecture.

As is the case in many sectors, the COVID-19 pandemic has left its mark on architecture. Along with the more general economic uncertainty, architectural firms have seen a significant plunge of orders and a halting of construction projects in many places. At the same time, many experts predict that the pandemic will have a catalytic effect on some of the current and future trends foreseen in this sector over the next few years.

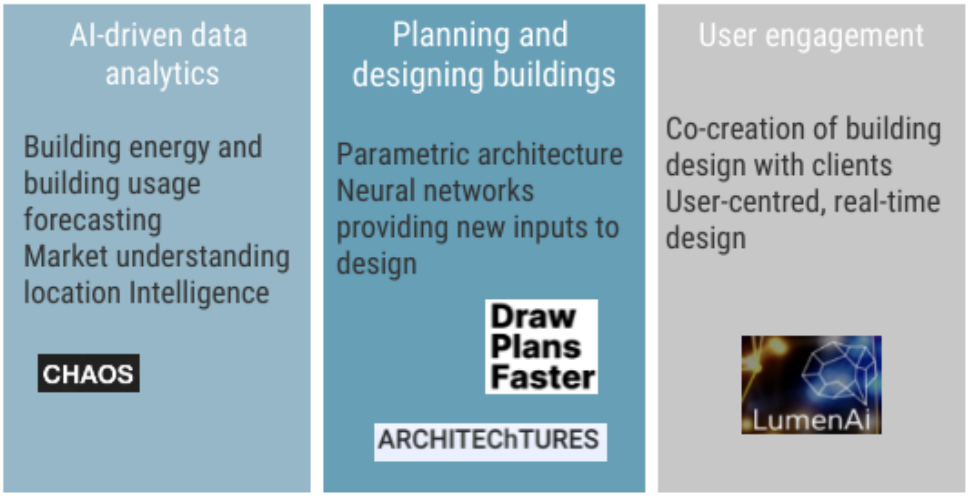
- First, these trends include the recognition that the building sector is a main contributor to carbon emissions, which has increased pressure to find climate-friendly alternatives. Thus, there is a growing emphasis on sustainability in buildings which includes carbon neutral designs.
- Secondly, a defining and important social question is the need, especially in urban centres, to provide affordable housing for all parts of the society. This shifts the architectural sector`s focus more towards renovating repurposing and redesigning of existing spaces, which is also connected to the sustainability aspect in that detached houses are considered to be less energy efficient than apartment buildings. Here, the European Commission has published a strategy in 2020 to boost renovation, called "A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives"[91].
- Thirdly, the COVID-19 pandemic has recently changed working and living patterns of millions of people around the world. Architecture will need to adjust to those changes, some of which may be lasting post-pandemic changes with less frequented but safer office building designs from a health point of view, and an increasing demand for home-office friendly residential spaces.
- Fourthly, and linked to the previous point, mobility patterns of entire cities are changing, which is also facilitated and spurred by smart city approaches in urban planning. With more connectivity in the management of cities and changed daily movement patterns due to home-office and more available public transport links, biking or car sharing options, this will be a trend influencing architecture in the long run.
- Finally, new technologies and digitalisation have changed the sector significantly and will continue to do so in the upcoming years. Design and modelling are increasingly moving to the digital space, aided by technologies such as virtual reality (VR) and 3D-printing. Moreover, big data and artificial intelligence are only at the beginning of making an impact in the sector but hold great potential to transform architectural design and construction. Already, there are some hotspots of firms working on AI use cases in architecture in European cities, including in London and Berlin.[92]

[88] https://www.ace-cae.eu/activities/publications/
[89] https://aceobservatory.com/A_Architects.aspx?Y=2020&c=Europe&l=EN
[90] https://aceobservatory.com/M_Market.aspx?Y=2020&c=Europe&l=EN
[91] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662
[92] Based on analysis of Crunchbase and Pitchbook data done for this study

8.2 Key business opportunities of AI in the architecture sector

AI is used throughout the entire value chain in the architecture sector. Partly, this is because architecture has a defined process of planning, designing and constructing along which firms are starting to discover artificial intelligence as a tool. Moreover, technology is increasingly used in the management and evaluation of building use and performance. Along the value chain, it needs to be understood not as a replacement of human thinking or decision making, but rather as a way to improve these processes by making them more data- and evidence based. This especially holds true for those parts of the process in which computers are superior to humans, such as analysing vast amounts of data and performing repetitive and mundane tasks, but the use of AI is not limited to automation of routine tasks. It can thus help us to make more intelligent decisions in the future about the way we want to live, work and interact.

Figure 10: Key types of use cases of AI in Architecture with examples of European startups developing AI solutions



Source: authors

8.2.1 Use of AI in planning and designing buildings

Artificial intelligence, in combination with other emerging technologies such as basic data analytics, has the potential to vastly change the way buildings are designed and planned.

In the planning phase and design phase, artificial intelligence, in conjunction with big data, will be a powerful tool for architects. It will allow architects to easily access large amounts of data regarding the environment, cost estimates, building materials or model calculations. This can be used to significantly shorten the planning time, which currently sometimes takes years and help decision making based on past datapoints. AI assists architects in decision-making processes by automating compliance checks with building codes and by providing inputs to designs, especially in case of (but not limited to) relatively generic buildings designs such as factory halls. In building performance assessment, AI can help take into account (through simulation) structural behaviour at the design stage, including factors such as building physics, daylight, wind conditions and energy consumption. This can reduce the time needed for architects to obtain feedback on whether their design is working as intended, compared to the current model of collaboration, where architects resort to consultants for such tasks.

An example of AI usage in content creation is the increasingly applied parametric architecture. This refers to the possibility of simultaneously manipulating certain constraints and key parameters of a virtually designed building to create different types of outputs, forms and structures. Thus, several options, which all fulfill the given constraints, can be designed, tested and suggested to the client without requiring extra resources. Although artificial intelligence can provide valuable inputs to the planning and design process, humans will take the ultimate decision or at least verify design plans for the foreseeable future. In terms of greening construction, AI can also help forecast future energy use and demand of buildings and help architects design more energy efficient and sustainable constructions.

AI-powered building design

ARCHITEChTURES is a cloud-based building design platform to boost design productivity and cutting execution times. It aims to dramatically empower building design professionals to address the big challenge of rapid urbanisation for a sustainable global development. Using data-driven design, a cloud-based SaaS platform enables users to design a building and to download a 3D editable BIM file, in a matter of hours, rather than months as the traditional process takes, reducing dramatically production time and cost and boosting design productivity.

Source : https://architechtures.com/?lang=en

Artificial intelligence will allow for a new form of collaboration with clients in the design process. Already from an early stage, co-creation of design will be possible, facilitated through sophisticated forms of experiencing future buildings such as virtual reality. Moreover, the usual course of action is that architects pass on responsibility for the building over to the owner after completion of construction. In the future, (post-)occupancy evaluation could play an increasing role with the help of artificial intelligence. It would allow the architects to collect data on how buildings are used and how they shape behaviour. This information would be highly relevant to factor into decision-making processes (via algorithms) for future buildings. AI can bring in the user experience by analysing data from past usage of buildings and help architects incorporate lessons learnt from this into future designs.

Europe has a high diversity of buildings and architectural designs, which have been built for thousands of years by different peoples and cultures on the continent. This kind of richness and diversity of cultural heritage puts Europe into a unique position worldwide. Generative AI can tap into those cultural resources and leverage the historical background of architecture in different contexts. This starts with the inspection and the conservation of buildings, where artificial intelligence can help to preserve built heritage more effectively and more efficiently. In conjunction with other technologies (such as the use of advanced drones), structures can be monitored autonomously by capturing detailed images and automatically assessing them to generate accurate information of a buildings condition. Even more, AI-technology will make it possible to accurately predict erosion and abrasion of built heritage by analysing data related to climatic conditions, environmental risks, and behaviour of visitors. Thus, artificial intelligence systems can aid in preserving architectural sites for future generations by providing decision-makers with the necessary data and policy options to choose from. It can also, besides the preservation of heritage, learn from different architectural styles and applications to have a more diverse understanding and creativity, which can be a basis for new, but connected, styles of architecture.

Use case: Cloud-based AI software for the planning, designing and analysis of buildings

Overview

For an efficient planning process and feasibility assessment of building projects, a cloud-based AI solution can be used. The software is applying artificial intelligence to allow planners to change parameters of the buildings in the early planning stages and simultaneously receive a high number of design and layout options. This supports the work of the architects which can focus on the design and increases flexibility of the planning should changes become necessary. The software is a platform bringing together different stakeholders early on in the process which allows to integrate their demands in the early planning phase.

Over the next few decades, urbanisation will intensify in cities around the globe, making it necessary to build buildings taller, denser and faster than ever before. At the same time, new buildings should increasingly reflect quality of life concerns and the need for sustainability of construction and building usage, as recognised by the 11th UN Sustainability Goal (Sustainable Cities and Communities). With the advancing integration of technologies in construction and urban planning, cities are becoming complex, 'smart' systems comprising interacting stakeholders and connected structures. Faced with these increasing demands, planning processes are becoming more complex to manage and buildings have a myriad of economic, social and environmental criteria to fulfil.

In the architectural planning process, the cost of changes to the design of buildings increases exponentially in the later stages of the project. Thus, it is preferable to test and analyse the performativity of various different complex designs early on in the process when costs are still at a minimum. This is where this use case comes into play, as the AI application allows architects to manage increasing complexity.

As a platform, the technology discussed in this use case brings together different stakeholders to allow them to contribute to the building's conceptualisation and design phase. Depending on the context of each project, these stakeholders could be architects, municipalities, consultants, property developers and other interest groups, representing civil society, environmental advocacy groups, or investors. Two leading providers offering the described technology are the companies Spacemaker (headquartered in Norway and serving markets in Sweden, France, Finland, Denmark, Germany, the Netherlands and Poland) and Archistar (based in Australia).

Value proposition

The value proposition of these companies is to deliver projects with lower risk, at higher speed and at lower cost, and with a better end result in terms of improved design and building safety compared to what was previously possible. With the help of the software, the planning stakeholders can assess up to 100 criteria and efficiently perform feasibility studies while keeping an eye on key parameters such as cost and time. Especially in the early-stage planning process and when it comes to content creation, this can increase the flexibility and accuracy of the planning and allow architects to better address the needs of their clients and of those who are to occupy the buildings they design (user-centred design). Another explicit value proposition of the solution is to have the application run web-based, which implies that no installation of a software is required. Instead, the business model of companies like Spacemaker is based on subscriptions.

The value proposition for the architects is that they can dedicate more time to the design of the building and need to concern themselves less with the feasibility and performativity of the building.

Technology

The specific AI technology featured in this use case is referred to as *parametric architecture*. It allows for the definition and manipulation of a large number of parameters regarding the performance of the buildings. Artificial intelligence is rapidly grasping the different possibilities and can suggest a large number of alternative layouts to the designer. Additionally, it is important to note the cloud-based nature of the solution which does not require configuration and updating of software on devices but is easily accessible via the browser. The underlying data comes from multiple sources, but the algorithms are trained by feeding them a high number of floor plans from different buildings. The algorithms start to pick up certain patterns from these plans, which have different parameters attached to them (size or price) and can evaluate the best layout suggestions for the architects using the software. It can then also further learn from the choices made in selecting a certain floor plan to work with.

Challenges

Some challenges around this use case could be identified. Firstly, from the perspective of the technology providers, although the potential risk of different stakeholders to buy into the solution is mitigated by offering it as a cloud-based browser version, there is still a challenge to sufficiently mobilise and educate stakeholders who might be more hesitant to join the process. Moreover, the computer simulation needs to factor in all the circumstances which are highly local such as soil conditions, earthquake risks or other similar conditions. Should the simulation omit an important parameter, the simulation could result in an inaccurate reflection of realities on the ground. Moreover, there might be unresolved questions on who ultimately owns the design when all stakeholders have provided their inputs to the software and who is bearing the legal risk for the completeness, accuracy and correctness of the parameters. Secondly, from the perspective of the technology users (the architects), a challenge could be that if there are several similar but competing software options available, there might be a fatigue to adopt yet another one, especially given the relative complexity of programmes.

The use case will not make any architects unemployed, but if it is widely adopted, it could threaten the competitiveness of those architectural firms that are slower to adopt it. There is also a risk, according to one expert interviewed for this study, that the increased use of AI and automation in building design could result in more generic architecture, but at the same time, AI also offers exciting opportunities for genuinely new and innovative designs. Hence, the actual impact of AI usage in content creation in the architectural sectors depends very much on how humans make use of it. The diversity of cultural production could certainly benefit, provided that AI can make use of large datasets on the rich cultural heritage of the built-up environment and housing stock in Europe. At this point in time, such datasets or pools are still lacking.

No risks on copyright or IP can be foreseen in the context of this use case.

8.2.2 *Use of AI for audience engagement and accessibility of content*

The buildings and structures in which we work and live shape interaction patterns of people. By analysing vast amounts of user data, artificial intelligence can simulate what design of building will be most suitable for our natural interaction patterns. In this way, architects are using AI to shape buildings according to human behaviour (instead of the other way around), meaning that machine learning can enable human-centred design. The same mechanism can be applied on a larger scale to inform the design of cities, by analysing movement data of people and pairing it with smart technology to result in smart cities with increased quality of life. Furthermore, virtual and (on constructions sites) augmented reality settings in which AI algorithms allow for real-time adjustments of designs, can be used in design presentations by architects in the future when interacting with prospective clients.

Use case: Learning about human behaviour through AI

Overview

In the development of modern living environments AI solutions can help to encourage interaction, healthy and sustainable behaviour, as well as community building of residents within built spaces. AI technology presents the opportunity to make use of data which is generated by fully integrated sensorics in the architectural design. This data can be analysed to learn about particular behaviour and needs of humans around and within their built environment. Such learnings can help to enhance the experience of existing buildings and provide grounds for improving the next generation of built environments and infrastructure.

Increasingly, technologies such as integrated sensorics are intertwined with the built landscape and can collect data of people's behaviour surrounding buildings. Indeed, already today, companies such as 3XN Architects conduct so-called "Post Occupancy Evaluations" of buildings meant to find out how architecture shapes the behavioural patterns of people. Used responsibly and based on the digital sovereignty of residents, the combination of sensorics and AI can quantify and automate this difficult process and thereby amplify the qualitative analysis of the usage in built spaces.

Through such an analysis, architects can respond to the need to make built environments healthier, more sustainable, and more social by nudging occupants to amend their behaviour. Two methods are instructive in achieving this goal. Firstly, architects can alter existing structures or even plan, from the very start, to design an ever-changing building that can respond to the needs of its residents by making use of the analysed data. Secondly, this analysis can also be used as learnings to improve the future generations of buildings based on empirical evidence. Thus, this technology can allow architects to help communities confront the difficulty to live more sustainable and healthy lives while maintaining or even lowering the necessary level of financial expenses.

Furthermore, residents can also profit personally from the data gathered with the help of sensors and AI. As an example, the UNStudio's 100 Houses project provides a case study for the development of a new model of exchanging data and services that is based on the self-determination and sovereignty of users over their data. While a data infrastructure and a decentralised AI collects and analyses the data they continuously create through their behaviour within the built infrastructure of the project, the participants of the 100 Houses project will be at liberty to exchange their information with service providers (such as the municipality) and thus create a concrete positive impact on their household income.

Value proposition

The value proposition of the pilot is twofold. Firstly, the development of a post-occupancy AI-based analysis of the use of buildings can help to generate evidence-based learnings on how to nudge people towards more healthy, sustainable, and efficient lives. Hence, the value proposition for architectural businesses is that they can improve existing buildings based on the concrete needs of occupants and also let themselves be informed by those learnings to design more useful spaces.

Secondly, by giving residents the tools to choose what data to share with whom, the Urban Data Platform allows people to gain responsibility, self-determination, and financial opportunities from trading their data generated from the behaviour of citizens within the built environment. Thus, the value proposition for the individual resident is that they can profit personally from their data exchange. Furthermore, AI technology

makes it possible for data-driven services to meet even the latent needs of residents and, thereby, potentially saving the community time, energy, and financial resources.

Technology

What specific AI technology is implemented in the different projects of this use-case depends on the concrete goal for the use of data referring to behaviour in built infrastructures. For example, for the purpose of a post-occupancy evaluation of buildings, using opensource pattern recognition databases can make the analysis of such data more efficient and reliable. At the same time, for example, the architectural company 3XN aims to establish their own dataset which can subsequently be used in their future planning of buildings. However, where unaggregated personal data is affected, a decentralised AI solution might be more appropriate. Indeed, for the 100 Homes project, UNStudio is planning to have each service provider use their own AI to analyse the data that is made available to them.

Challenges for the institution or firm

Some challenges regarding the implementation of this use case for the institutions or firms were recognised. Firstly, a challenge is the technical implementation of the sensors, which concerns their positioning and accuracy of measurement. Architects and planners will need to make sense of the data and understand whether the data gathered with the help of the sensors is giving them an accurate picture of what is happening in the structure. Secondly, a challenge comes regarding the non-personalisation of the data. It is crucial to guarantee that this technology will be non-intrusive, especially when extended to non-public spaces. For this, the use case a data platform based on user consent. In the further life of this use case, it will be necessary that the autonomy of residents is guaranteed, and that the technology be fully transparent as to what data is collected, how long this is stored and for everything to be non-personal movement patterns. Thirdly, as argued in the subsector analysis, the role of architects changes from a more technical profession to a social one. They need to make sense of human behaviour and understand how it is facilitated or prevented by the structure around them. Thus, a challenge will be for the firms to build up competencies in the field of social sciences.

Perceived risks

Concerns regarding the security of the residents' data and privacy need to be addressed when using technology to closely analyse users' behaviour. In UNStudios' 100 Homes project, the overarching organisation has set up an Ethics Council consisting of scientists and independent experts from the public and private sector that will serve as an advisory board for the handling and regulation of data.

8.2.3 Use of AI in business processes

Until today, computers and underlying algorithms are not good at open-ended creative solutions which are essential in the design process, but rather at repetitive tasks. Currently, architects spend a considerable amount of time to check the designed buildings regarding statics requirements (will the building stand upright) or on safety regulations of buildings (fire exits, earthquake resilience) – to comply with regulations. Artificial intelligence can perform these rather repetitive and mundane tasks with higher speed and accuracy than humans. Instead of checking the compliance of the designed buildings with rules and regulations the machine can do so throughout the design process. This will allow architects to invest additional time in the design and aesthetics of their buildings, instead of doing the recurring calculations and paperwork.

AI can also gather data on space usage and feed results back into the conception phase of construction. This enables a modular building approach that allows for more flexibility, e.g., by making it possible to reshuffle internal elements of a building on a regular basis in response to changing needs of the users. In a next step, AI could even help predict future usage of a building and adapt the design accordingly. An example of a company exploring this is UN Studio, based in the Netherlands.

In building maintenance, AI can be valuable in optimising energy usage during the lifecycle of buildings.

The advantages of applying artificial intelligence in the planning and design process give rise to the impression that AI presents an opportunity to make European architecture better, cheaper, and quicker than is currently the case.

8.3 Challenges

8.3.1 Industry dynamics and structure

The architecture industry is highly competitive due to the contract nature of the industry, as was pointed out in an expert interview carried out for this study. Firms and individual architects have little incentive to cooperate on projects. Moreover, the profit margins in the industry are extremely thin and a good reputation is crucial. Taken together these dynamics of the industry make it hard for firms to invest in and experiment with new methods. Moreover, the architecture industry is highly place-bound and deeply local. The underlying reasons for this are manyfold, for instance the expectations and requirements towards buildings depend on geographic and climatic conditions. Also, rules and regulations are different in different legislations and the cultures and traditions when it comes to designs and functionality of buildings as well. This makes scalability challenging in the industry. In fact, a survey from 2020 revealed that only 3% of architectural firms' turnover is generated from international work and only 7% of practices engage in international projects[93]. The described nature of the industry represents a challenge regarding the uptake of digitalisation and artificial intelligence. Important framework conditions for the adoption of new practices, tools and methods (innovation) are not given, such as cooperation and the possibility to scale.

On an individual level, the use of AI raises the issue of agency and authorship of designs, especially if architects evolve to become trainers of algorithms more than designers. There is also reason to be cautious about some AI applications. For example, in the construction industry, image recognition and automated labelling are already used to survey building sites and to assess constructions workers' productivity. This is problematic when one worker taking a break is labelled as unproductive, exemplifying the problem of blackbox algorithms when their decisions are followed blindly and not critically reflected. EC funding may be useful in training architects on how to interpret and contextualise AI recommendations.

8.3.2 Data availability and quality

The entire architecture industry is lagging behind other sectors in digitalisation. Partly reason, partly consequence is the low availability and quality of data. To start with, not much data currently exists about buildings or other structures and if it does, it is often owned by firms who have, as described above, little incentive to share the data. Publicly available data is often not of high or sufficient quality, and unlike in music there is no uniform file format, rather architects are confronted with messy data. It is difficult to encode everything that makes up architecture. While the following use cases describe efforts to generate and utilise data, the industry is only at the very beginning. For the implementation and adoption of artificial intelligence, which heavily relies in its learning capacity on vast amounts of data, this is still a challenge. The situation is exacerbated by the fact that most usable data is owned by large architectural firms, who have no incentive to share these with smaller players.

As a consequence of this, AI is currently particularly valuable in the early stages of the design process, for which more date in terms of images are available. For later-stage design processes, more sophisticated is required, which is currently not readily available to train algorithms and neural networks.

8.3.3 Digital literacy and skills

The sector study "The Architectural Profession in Europe in 2020" by the Architects' Council of Europe showed that the digital literacy in the field is a challenge. No more than 35% of architects have received formal training on digital tools. This translates into a moderate use of digital tools, with little more than 60% using 3D modelling on a regular basis. Rendering (process of creating two-dimensional or three-dimensional images of proposed architectural design) and Building Information Modelling (BIM) are only employed by 40% and 30% of architects respectively, on a regular basis.

While digital skills are an important part of the skill set of future architects, the curriculum in general needs to be considered in light of the redefinition of the architects' role in the future. Induced by technology, architects will be expected to take a more coordinating and central role in the planning and building process. The education should reflect this development in the skills and training that the architects bring

[93] The Architectural Profession in Europe 2020, A Sector Study; Architects' Council of Europe (Chapter 3.6, Page 43)

along: communication, leadership, management and digital skills. Moreover, it could be argued that given the increasing importance of algorithms, an architecture curriculum should include more computer-science modules such as programming. If architects` roles in the future are to shift towards creating human-centred building designs, degrees should encompass education on anthropology and sociology. The threat of AI to human creativity should not be overstated though: AI, in view of experts consulted for this study, will likely not create exceptional architecture on its own, as only humans understand the beauty that lies in 'suboptimal' outcomes that are not exclusively driven by efficiency. AI will mainly shorten design steps by working alongside humans, but it will be important to ensure that AI does not only cut costs and improves efficiency but also contributes to better designs. This will be a regulatory question.

Beyond human-centric design approaches, the digital transformation that AI is a part of also has the potential to bring about a life-centric approach where urban and architectural designs draw on nature and are compatible with natural systems. At present, the need to overly different models (design, ecological, other) hampers the use of AI in the design stage.

8.4 Sector-specific recommendations

Table 26: Sector-specific recommendations: Architecture

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Invest in a database of metadata on architectural styles and functionalities, including a catalogue of European architectural heritage. Support efforts to label messy data to make it usable for algorithms and to build datasets that are made publicly available (with at least 1 500 datapoints). Datasets should by dynamic and allow for citizen inputs and climate change data to be integrated.	Policy & creative sectors Could also be useful for urban planners, property developers, construction companies and civil society organisations	Creative Europe cross-sectoral strand could be used as a funding channel Creative Europe Desks network could be used to bring onboard stakeholders across EU member states Digital Europe digital innovation hubs could be regional/national starting points for collecting relevant data that can then be fed into a Europe-wide database
Replicate the SMartDataLake initiative funded under Horizon 2020 for the architecture sector, using Horizon Europe funding		Horizon Europe
Develop rules on how to protect building resident data for adaptable building design	Policy and creative sectors together with independent experts	Rules can build on existing AI guidelines developed at the European level, as expressed in the White Paper on AI, the European Data Strategy, and Ethics Guidelines for Trustworthy AI.
Train and develop skills in the sector on how to use digital tools such as Building Information Modelling (BIM) and AI tools such as parametric architecture and cloud-based planning and design	Policy and creative sectors	Trainings provided under Creative Europe could be extended to architecture The Digital Europe digital innovation hubs can provide mentorship programmes for interested architecture firms The AI4Media project could be replicated for other CCS, including architecture and provide related training on ethical and trustworthy AI use Experts could devise relevant recommendations on how to

Recommendation	Level of implementation (policy, industry, other)	Suitable policy framework
		leverage AI for the safeguarding of Europe's architectural heritage More widely, the European Skills Agenda could include specific interventions targeted at CCS professionals in the area of digital literacy
Support pilot and demonstration projects on how to combine parametric architecture and human-centred design	Creative sectors and technology companies	The European Bauhaus initiative provides a platform for experimentation and connection and a bridge between technology and culture, and could be used to fund such projects Particularly risky demonstration projects with commercial potential could be funded by the Culture and Creative Sector Guarantee Facility or under initiatives such as the Intelligent Cities Challenge of the European Commission DG GROW Horizon Europe can also be used for research projects on AI, as could the EIT KIC for the culture and creative sector
Try out new business models in architecture in the context of urban planning and smart cities. Support interdisciplinary collaboration between AI developers and architects, e.g. on 2d-3d style transfers and how to optimise chains of delivery with AI.	Creative sectors, urban planners	European Bauhaus initiative
Support the use of digital technologies in urban planning departments. This would ensure that public tenders for buildings reflect latest technological developments, incentivising the use of AI by architectural firms. Public funding should also be made contingent on making some of the results (e.g. building datasets) publicly available to improve the data situation. Public building administration could also make their construction-related data publicly available.	Public sector	EU Data Strategy

Source: authors

9 Sector in focus: Book publishing

9.1 Short description of the sector and current overall challenges

The book publishing sector is one of the main cultural and creative sectors in Europe in terms of turnover. In 2017, the book publishing sector generated a turnover of € 22-24 billion per year in the European Union and European Economic Area alone, for a total market value of € 36-40 billion[94], making it an important cultural and creative sector. In this report, book publishing is defined as the creation, printing and distribution of books including e-books.

The sector has, however, suffered with a continuous market loss in the past decade. A reason behind this decrease is the emergence of the Internet which increased direct distribution and saw a reduction of middlemen in the supply chain (Magadan and Rivas, 2018). Another trend has been the digitisation of book production with the transition from analogue to digital formats. Digitisation also covers the online selling and marketing of printed books. The industry faces a set of challenges. Most are linked to the evolving industry among which some are reinforced by the COVID-19 crisis.

The COVID-19 crisis saw books releases delayed and libraries and book shops closing in many European countries. Sales in bookstores dropped between 75% and 95% in most countries where a lockdown was in place (Federation of European Publishers, 2020). Overall, the Global Web Index Coronavirus Research of April 2020 revealed that 35% of people worldwide read more books / listened to more audiobooks while at home during the crisis, and 14% spend significantly more time reading/listening to audiobooks95. The closure of many bookstores has meant a massive shift from physical bookstores to online bookstores and platform.

As a result, there is a need for book publishers to make content widely available online, especially on retail platforms. This stresses the increasing dependency on such platforms, which retain the information and data about consumers while the industry would benefit from better knowing readers' preferences and providing personalised recommendations. Key problems that publishers face in the digital age include the following:

Overall, the situation highlights the pressing need for the publishers to:

- Know and leverage their catalogues in order to put forward related publications when a consumer purchases a specific title
- Develop the metadata that are essential to retrieve books based on the keyword search typical of search engines (such as Google books or Amazon)
- Accelerate the adaptation of books to new channels of consumption (tablets, smartphones)

[94] Federation of European Publishers, The book sector in Europe: facts and figures 2017
[95] Global Web Index, Coronavirus Research | March 2020 Release 3: Multi-market research,

A significant downside of the lockdown and the online shift was a sharp increase in digital piracy. The FEP reported a tripling of the level of digital book piracy in Spain in April 2020 which might be linked to the lack of willingness to pay for digital content (Federation of European Publishers, 2020).

Digital content in the form of e-book has seen a steep increase in many European countries already prior to the COVID-19 crisis. The e-book market was estimated to represent 6-7% of the total book market in Europe in 2017, however with significant differences between countries. This share of the market, while small, shows an impressive growth (Federation of European Publishers, 2017). With the advancement of digital tools, self-publishing has become easier and cheaper. In response, publishing houses have adapted, and new players have entered the market[96].

The policy context and regulatory evolution have had an impact on the industry as well. Book publishers have to adapt their libraries to make their digital content accessible to persons with print disabilities[97] by June 2025 as directed by the European Union (Directive 2019/882, 2019). Moreover, the automated translation technology could also disrupt an industry heavily reliant on place and language-based distribution rights which might have an important impact on copyright and thus revenue streams (WIPO, 2008).

9.2 Key business opportunities of AI for the book publishing sector

The sector has a perceived need for artificial Intelligence-based products. However, while publishers believe that AI will have a massive impact on both their industry in general and their company specifically – the majority does not appear to invest accordingly (GouldFinch, 2019). An industry survey showed that a small minority of publishers had significantly invested in AI technology while over 60% had no plans to invest in AI. Of the latter 50% planned to do no investments and future planned investments were relatively low for another third of surveyed companies (ibid). Only 25% of survey participants worked with AI within their companies. Nonetheless, various technologies, with various degrees of maturity, are being tested, used or explored in the publishing sector.

The current and upcoming uses of AI in content acquisition is on the one hand the authors' side and on the other the publisher's side. AI technologies are expected to improve the efficiency of publishing processes but also to provide a better access to publishing content for the customer for instance through book recommendations (NEM, 2019).

The most widespread and promising application of AI in publishing lies primarily in marketing and distribution as both the use cases in the following sections and the related literature highlight. In marketing, applications are many: AI tools are used to analyse the potential of a manuscript and assess its potential readership. In the distribution phase, companies support publishers in putting forward their catalogues, especially on online platforms. This is done through content classification (automated metadata, audience analysis). Other general uses include automated pricing, dynamic advertising and chatbots. Making use of these powerful tools, often off-the-shelf solutions, leads to higher productivity, as well as more efficient marketing methods for reaching readers.

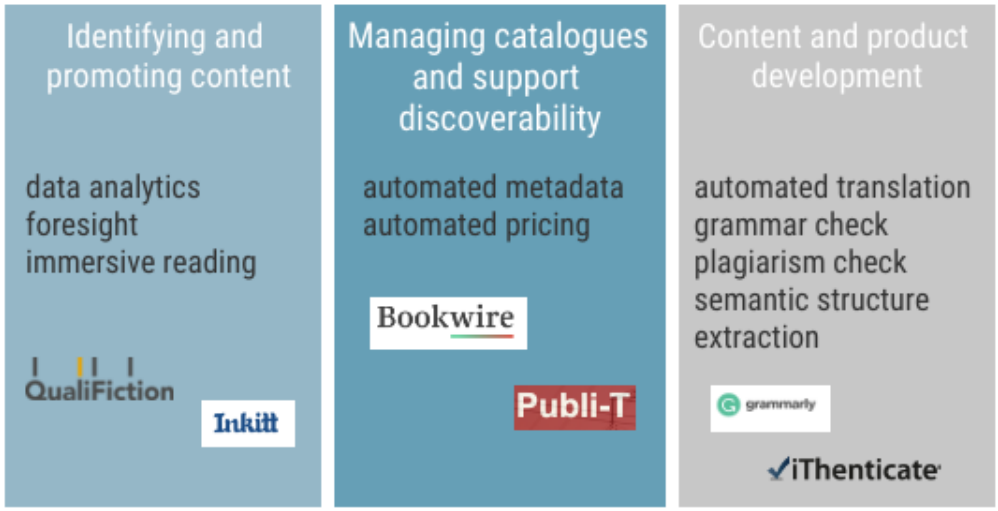
The increase of the consumption of e-books and with it the multiplication of channels of consumption (including audiobooks) strengthens the case for AI adoption by publishing houses because content can be updated, layout modified, new business models applied while minimising time and cost of production. Moreover, e-books production costs are virtually null while they are often priced at only a limited discount compared to the print edition (Wischenbart, 2019). This versality also pushes for innovation in AI, opening further possibilities for the market.

In content creation, the use cases that have the highest potential include AI-based tools that can support the writing process (spell checking, support consistent writing style with tools trained on an author specific's style). In academic publishing, AI is used for researchers to digest important amount of data or streamlining the style of a multi-author paper. Other opportunities lie with production tools like automated translation. In the production phase, tools can help book publishers to speed up production. Already implemented solutions include those linked to the accessibility of books (text-to-speech) and workflow aids such as bibliography entry analysis, image labelling and automated translation.

[96] In Spain, Bubok is a pioneering platform of online self-publishing that allows publishing and selling books on demand, both in paper and digital formats96.
[97] People with visual impairments, with dyslexia, or with motor disabilities which can seriously affect their ability to read.

While large language models are more and more refined, AI as a sole, high-quality content creator is not a reality for the industry. While content creation is the most interesting application of the technology, there is still a long way to go before machines write good-quality fiction novels. Moreover, this application raises concerns among authors and publishers who tend to share the view that originality and creativity are human traits but also threatens copyright models in the industry.

Figure 11: Key business opportunities of AI in the book publishing sector



Source: Technopolis Group, 2021

9.2.1 *The business of modern storytelling: use of AI in identifying and promoting content*

AI has a clear purpose in the field of marketing in the book publishing industry. While book production has become cheaper, the main hurdle for publishing houses is to ensure that their books, especially long-tail ones, are reaching their audience. With the change in reading habits, publishers need to think how to offer a new experience to their readers with short attention spans.

1. **AI can help publishers identify relevant content.** With the help of AI algorithms, publishers can get new inspiration to identify the right author and the right content by analysing reading patterns and 'connecting the manuscripts with the target group'. The technology is also interesting for the general public, and it becomes especially valuable for researchers as the platform analyses data on their past research but also on basis of the research of similar profiles.
2. **AI has the potential to upgrade the user experience.** AI is used to support the accessibility of books through the digitisation of content to reach wider audiences, in particular younger digital native audiences as well as low or non- reader and disadvantaged groups.
3. **AI can inform marketing strategies and support stock management and shelving.** Machine learning is used to forecast demand through the analysis of past selling data. AI is an excellent tool for discovering business prospects of existing content by identifying on the one hand niche markets that could be profitable and on the other hand corresponding existing content in a catalogue.

Decisions that AI can potentially inform include the following: would a certain book be worth republishing the next year; would a new novel of an independent author be worth publishing; would a book be turned into an audio-book or not etc.?

The combination of print-on-demand and infinite shelves in online stores means that smaller, more niche book publishers could increase their benefits because consumers can search through countless options and the marginal cost of producing and distributing products is minimal.

Most of the AI tech startups that have specialised in the book publishing industry and have been captured in this study offer data analytics and help identify, quantify and predict reader behaviour. The US is the most advanced market in this field with companies such as Booxby, StoryFit, Kadaxis just to mention a

few. Simon & Schuster is one of the largest publishers in the United States. It has included a "Stephen King Library" within Google Home and Amazon's Alexa that recommends King's titles based on user preferences established through a series of questions and answers. This is an interesting use of voice assistants to reach out to potential readers, by gamifying the recommendation process.

Optimising marketing by empowering the reader in content selection

Based on data collected on readers, it is possible for a book publisher to optimise communication and marketing using AI (*by assessing the potential effect of a work's title on sales in certain target markets*, for example). It is also possible to identify content that can resonate with current events and find their audience thus helping an optimal timing for publishing a title.

In Europe, Germany is one of the countries nurturing a handful of promising startups. The Hamburg-based company **QualiFiction[98] uses AI-powered text analysis**. This type of software proposes a first classification of the manuscript for example by genre, which allows to develop the best marketing strategy to promote a title to the publishing house's readership.

QualiFiction has launched **BooxMatch.de** a book recommendation platform, which aims to offer an alternative to Amazon by means of a fair and diverse book-sharing concept. On the platform, readers can set their preferences for a book and thus actively help shape the book selection process in publishing. The idea is that on BooxMatch.de, all books should be viewed on an equal footing and content-oriented, instead of filtering according to awareness or ratings. For example, if a user is looking for an easy-to-read, innovatively written novel, all books in the database are evaluated according to these parameters and suitable novels are suggested. The AI analyses the book texts objectively and in a scalable manner and takes into account also books from smaller publishers.

AI can help assessing the potential of a book to become a best seller, used by publishing houses that need to assess the narrative impact of a novel. For example, the software programme LiSA, developed by QualiFiction, analyses a manuscript and reports on aspects such as the level of suspense or the complexity of the sentence structure but also provides sentiment analysis establishing the expected readers' feelings when reading the book.

Machine learning can be leveraged to search through published online content to spot clusters of key words (topic areas). They are also useful to identify conceptual relationships or main authors on a specific topic and identify market trends. This helps publishing houses select content they should add to their library. However, this analysis requires access to large amounts of readers' data. Some is available (from libraries, bookstores) but the data held by online retailers is not completely available to publishers and authors.

With new technology-powered business models, publishers have the choice to let readers themselves decide what books they want to see published instead of book editors. The expectation is that AI models would be better in capturing bestsellers such as Harry Potter that had been originally overlooked by the industry.

In addition, technology-based startups are also experimenting with new ways to engage the reader beyond the book by offering an immersive reading experience. The future digital reader might not want only to read a simple book. They want to be part of the story. Applying AI on e-books has the potential to allow the readers to listen to voices while reading, to view the places in a film like setting and to interact with the story in a multitude of ways. This technology can support children to learn how to read but it also aids persons with a print disability to read and therefore improves their reading experience (for example, the audio can ease the burden of going through the same paragraph several times).

Immersive reading

Inkitt[99] is a Berlin-based software company that offers a crowdsourced publishing platform and uses computer algorithms to predict book success based on reader behaviour. Their idea is simple: authors can post their manuscripts, readers can read them for free for a limited amount of time, Inkitt AI-powered

[98] https://www.qualifiction.info/
[99] https://www.inkitt.com/

tools *analyse these user data and based on this direct reader feedback, the best-performing books will be further promoted* (and their authors receive a publishing deal).

Beyond data-driven demand forecast, Inkitt launched its **smartphone fiction app called Galatea** in January 2019 offering a new immersive experience for their readers. On Galatea readers can read short ten-minutes episodes free but also purchase more beyond the daily limit. The stories that are being sold are a combination of text, sound and visual effects with the use of augmented and virtual reality and audio-drama. The stories can be easily read on the smartphone or on an e-book tool.

Source: https://www.inkitt.com/

While investing in new business models as shown by the example of Inkitt might not be an option for every publishing house, they can certainly benefit from thinking of new ways to sell their books and cooperate with tech startups that offer evidence-based data analytics.

9.2.2 *AI managing book catalogues and supporting discoverability*

Text mining techniques are relatively common and are used for different purposes but often by researchers. They allow to recognise key words or strings of words to identify relevant content. They automate repetitious tasks and reduce the time spent by authors going through websites or journals and freeing time for strategic writing and ideation.

Other less mature examples include text summarisation and content creation technologies such as large language model which can author text or mimic the style of an author.

The most common application of AI in publishing is content classification and tagging**.** It is used primarily to increase the discoverability of content through automatic tagging and production of complete metadata. This is also useful to ensure the metadata for a book includes all the relevant keywords, including phrasing such as those used for a voice command search thanks to speech recognition technology. Metadata has seen progress in associating a subject code per term and all its translations. It ensures language is consistent and avoids 'faux-friends' in metadata use.

Classification and tagging can also be leveraged to identify several relevant texts in the library of a book publisher and be used to repackage content accordingly, offering content for new business models such as the fragmented content, the payment for consumption or content on demand, the subscription model, or membership.

Use case: Leveraging metadata potential with automated tagging

Overview

The publishing value chain is characterised by an important reliance on metadata. Metadata refers to key details about a book or eBook which allow distributors and retailers to easily identify what the publication is all about. While "core metadata" list the author, page number, ISBN and other basic information about the publication, "enhanced metadata" are book description, excerpts but also keywords. Those keywords are important to make the book visible on retail platforms such as Amazon, therefore in the last few years there has been a renewed interest in text tagging in the book publishing industry.

Text tagging is the task of classifying text and setting a corresponding label (or tag) to it. Books and blurbs must be tagged accordingly otherwise, customers cannot find them. Tagging is typically done manually but an increasing number of publishers are automating this tedious and labour-intensive process[100] using NLP and machine learning techniques[101]. AI-driven text analysis allows a machine to scan and automatically generate tags. Machine learning can be trained on basis of the tags, learning the rules behind the tagging. Those rules are then used to classify and label the unknown data[102].

[100] Tagging is generally integrated into the editorial workflow and the content management software.
[101] https://datalanguage.com/tagmatic-for-publishers
[102] Huang, Alice. (2019). The Era of Artificial intelligence and Big Data Provides Knowledge Services for the Publishing Industry in China. Publishing Research Quarterly. 35. 10.1007/s12109-018-9616-x.

Studies on the industry[103] have established the link between enhanced metadata (and more specifically keywords) and increased sales. Heightened sales were the result of edging out competition through search engine optimisation and reducing the consumer search cost[104].

Business needs and value proposition

The use of metadata by large online retailers such as Amazon and the general uptake of online sales, especially during the COVID-19 crisis, have underlined the potential of metadata and the importance for publishers to make use of them.

Publishers need to tag or classify their content for a number of reasons:

4. *to improve search and discovery*
5. *to assist internal processes and workflows*
6. *to provide richer content and user analytics*
7. *to drive advertising*
8. *to unlock value in long-tail content*

In an increasingly competitive market, crowded by new leisure activities, book publishers have to produce content that reaches a maximum number of readers, while ensuring those who are most prone to buying the book do so. Thus, content visibility and discoverability are essential and complementary aspects of book publishing.

Content visibility relates to the use of keywords to ensure the right books/academic articles are easily found and therefore increase sales. The content visibility importantly relies on defining the right keywords that will improve the referencing of the book. Through improved machine learning and semantic analysis, AI is able to tag text quickly and according to a publisher's specific taxonomy and logic while avoiding problems of disambiguation. Those tags can be manually approved or adjusted[105].

Discoverability aspect relates to ensuring the readers that would be potentially interested by a book or article are exposed to it. This matching of consumer and product, in this case reader and content, has been done for over ten years[106] with machine learning and data mining techniques, in many industries.

The costs of publishing have gone down dramatically in the recent past, and the main costs of publishing now sits with the promotion and marketing of the books.

The most common use of AI in publishing is content classification[107]. The main example is tagging metadata automatically in order to improve the discoverability of the content through search engines and browsers. It increases consistency of tagging and decreases the risk of missing on key tags for discoverability as well as reducing the risk of errors of a task that can relatively easily be automated. Text tagging by machines is also done more rapidly, potentially accelerating the delivery of publications. An important added value of automated text tagging is it frees up employees' time to focus on core business activities such as editing and creating higher quality content[108].

While the classification and tagging of content is done at the production stage of the value chain, the added value is realised at the distribution stage. With improved discoverability goes improved sales. Internally, the publisher also has a better knowledge of its portfolio and its content. In some cases, such as for academic or training publishers, new business models can emerge with the opportunity to sell specific chapters or paragraph. It can even offer an opportunity to restructure information into a new product out of existing publications.

[103] IBPA, The Link Between Metadata and Sales, April 2012, URL: https://articles.ibpa-online.org/article/the-link-between-metadata-and-sales/; eContentPro, Metadata in Publishing: An Overview, June 2019, URL: https://www.econtentpro.com/blog/metadata-in-publishing/84
[104] Search cost is the time, energy and money expended by a consumer who is researching a product or service for purchase.
[105] What is Powertagging, Digirati.com, https://digirati.com/work/academic-research-publishing/products/powertagging/
[106] Ghazanfar, Mustansar and Prugel-Bennett, Adam (2010) Building Switching Hybrid Recommender System Using Machine Learning Classifiers and Collaborative Filtering. *IAENG International Journal of Computer Science*, 37 (3).
[107] Frontier Economics People Plus maChines: The role of Artificial intelligence in Publishing, 2020
[108] What's new in publishing, Auto-tagging: AI for publishing beyond the hype curve, 2020, URL: https://whatsnewinpublishing.com/auto-tagging-ai-for-publishing-beyond-the-hype-curve/

Text tagging appears to be a well-functioning technology; however it still has a margin for improvement, especially in the more advanced applications that are running sentiment analysis. Greater tagging accuracy is expected with improved machine learning technology[109].

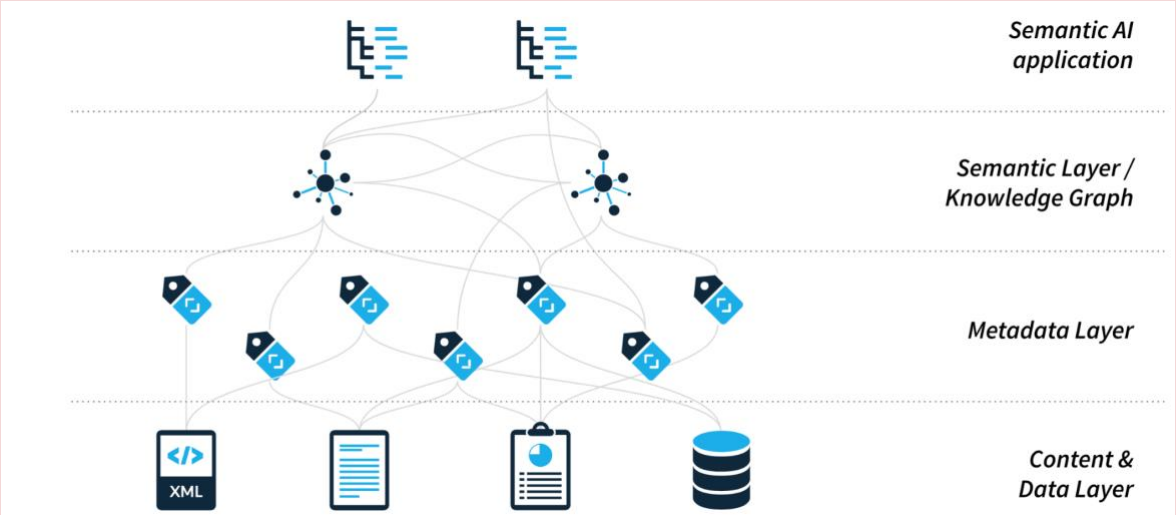
Technology

Text tagging can be done manually; it is a tedious and time-consuming task which may lead to errors when done by humans. There are now computer programs that can perform auto-tagging. Some programs simply use rules and word lists to tag content appropriately. More complex programs use machine learning and/or natural language processing. In this case, the program is trained on previous examples of the taxonomy used by the book publisher. On this basis, the program is eventually able to expand and refine the list of tags but also to understand that language has evolved, for example that two terms can mean one thing (e.g., UK withdrawal and Brexit). These AI-powered programmes perform analysis on the data over time thus providing a high level of accuracy for large data sets. The efficiency of automated tagging also saves time to employee of publishing houses[110].

For the automatic tagging of content to bring value to a publishing house there are three basic steps:

9. The publishing house creates or uses a taxonomy that represents its knowledge domain
10. The texts get analysed and automatically matched (for example against a knowledge graph)
11. The metadata gets automatically attached to the content entities. This can manually be refined to ensure increasing information quality

Metadata management using AI technology



Source: Poolparty inc.

Despite the efficiency of such technology, it still requires a human as human judgement is key to on the one hand define the taxonomy as data can be described in an infinite number of ways but also to check the output as machines are only as good as their training data.

Related to the text tagging, there is a classifier technology[111] that can also classify other information automatically (the topics, sentiment, gender of authors) which is useful at the marketing and consumer engagement stages, to assess the success of a book among a specific category of readers.

Both these technologies are developed by service providers that work essentially for publishing houses.

The technology is by and large developed and proposed by service providers. These service providers have teams dedicated to AI/IT elements as well as specialists of the book publishing industry. Some of them offer a data restructuring service, applied to the sector of publishing (e.g. Data Language)

[109] https://hackernoon.com/8-ways-artificial-intelligence-takes-publishing-to-the-next-level-rvnk3z3m
[110] https://www.poolparty.biz/text-mining-entity-extraction
[111] E.g. uClassify is a text classifier powered by machine learning. Another example is Text AI Services (UK)

Most of them were developing website/data management services and then added AI therefore they understand well the sector's needs. At the moment experts interviewed did not see developers outside the industry pushing AI with other business models.

There are a few in-house solutions that are developed by large publishing houses, but these are costly and building its own AI is not necessarily brand differentiating for a publisher.

Semantic tagging:

AI-powered tagging technology is also used in the production phase of the book publishing value chain. This tagging system is different from the one feeding into metadata and is typically called 'semantic tagging'. It consists in the tagging of the structure of a text where each paragraph is classified as what kind of thing it is — a title, body text, a heading, an extract, a line of verse — according to a set of classification tags or styles that are used consistently for every book[112].

This text tagging technology is used for automated workflow processes. In that case, the text tagging allows to automatically produce layout for the text, make changes in the text – which is especially relevant for educational books. With this system not only can text be developed with a multichannel distribution in mind, but book publishers can also update all their library easily to fit new standards of accessibility for example.

System integrators that provide a bundle of services including workflow process system have become more and more common. They allow for cross-team collaboration on the content management system or digital asset management system while accommodating an AI to tag the content. As a result, the system integrator supports to produce books quicker, notably allowing to produce the text for a variety of channels requiring different layouts[113].

Active companies in this sector include Hederis[114] *(US), Bookalope*[115] *(AU)*

Interviewees are not aware of a service provider having developed or commercialised an AI that provides both services. An explanation is that for technical reasons it is too difficult to train an AI both on metadata tagging and semantic analysis. These two activities also have different objectives. The first aims at increasing sales while the second is a tool to assist a smoother production.

Market potential

94% of publishers are aware of the importance of metadata for improving catalogue promotion but 77% lack the knowledge to improve their practice (Lebrun & Audet, 2020). Because publishing houses do not always have the internal knowledge to maximise their metadata use, they may contract out metadata management firms. Most of these firms offer a bundle of services to publishing houses such as extracting keywords from the content of the manuscript, classify text by topic or tag the concept in a text but also deliver content to website, adapt to site search etc. These firms typically evolved from developing website/data management services for publishing houses and now propose AI-powered services designed to respond to the sector's needs. The AI-system can apply to current manuscripts or to generate relevant metadata for existing books that are being digitised (e.g. books from the 20th century). It is notable that these systems are based on NLP and are therefore language dependent. At the moment, there is no larger dominant actor in this space.

[112] McKesson, Automated Publishing Workflows, Explained, February 2021, URL: https://medium.com/hederis-app/automated-publishing-workflows-explained-58c5da5fb3fe
[113] Digital Asset Management (DAM) helps companies to store, index, search, repurpose and share their digital content. It works cohesively with other business systems through integrations.
[114] https://www.hederis.com/
[115] https://bookalope.net/

Example of companies active in this field are: Edia[116] (NL), Teklia[117] (FR), uClassify[118] (SE), Data Language[119] (UK), StoryFit[120] (US), Supadu[121] (UK), Yewno[122] (UK), Beijing Formax[123] (China), PoolParty[124] (US), FeniXX[125] (FR - for existing books).

Challenges

The main obstacle to AI-powered text tagging is the decision to adopt it. It requires book publishers to recognise the added value of metadata but also accept new technologies in general.

Several service providers[126] underline the difficulty of developing an AI-driven tagging platform, not only from a technical and skills point of view but also the familiarity with data science. Beyond the complexity of driving a digital project, owned solutions that are developed specifically for a publishing house do not add a strong value. This is because a tagging system is only a tool to increase sales. Thus, the large investment of developing a bespoke text-tagging system could be rather invested in developing new products or content[127].

Data access is not a problem, however, as book publishers own and manage the content of their books. Their large datasets are also ideal to train AI.

The shift to AI-adoption requires a new and fundamentally different skillset from the staff traditionally employed in publishing houses. There are several studies (e.g. GouldFinch and Frankfurter Buchmesse, 2019; Magadan et Jesús, 2018) and articles discussing the skills gap among publishing staff, as well as a certain reluctance of the sector to invest in R&D projects for technological solutions. Because publishers have borne the risks and costs of publishing, the additional cost of technology development without a guaranteed return is not attractive to these players. As a result, publishers tend to adapt already existing solutions, developed by external actors and giving rise to a form of technological and technical dependence. While specialised service companies provide publishers with the relevant technologies to accelerate and maximise metadata management, editors know the content of the manuscripts the best therefore there is a crucial need to train editorial staff on metadata through training sessions and guidelines including learning to adapt based on sale channels analytics.

9.2.3 *AI in content and product development*

AI can serve as an idea generation tool, supporting the writing process of authors. The software programme Granthika[128] allows to organise the writing process, the writer can keep track of complex plotlines, for example pointing out contradictions in character development.

Machine learning is increasingly used to develop automatic layout options through semantic analysis. By analysing automatically which part of a text is a title, body text or annotation, the AI can help produce the relevant layout quickly. The steep digital take-up to accompany the shift to remote learning opened interesting perspectives for specialised service providers in the subsector of educational publishing.

Machine learning can be used by publishers to identify papers with similar sounding paragraphs and sentences to identify plagiarised content and to carry out copyright infringement checks.

A common use of AI is to run language checks based on machine learning technology. It checks spelling and grammar of the text rapidly and eases the editorial tasks.

AI can also be used to translate content, though the technology is not yet fully mature, and speeds up remarkably the process of putting books and papers on the market.

[116] https://www.edia.nl/
[117] https://teklia.com/
[118] https://www.uclassify.com/ uClassify is a free web service to create and use classifiers.
[119] https://datalanguage.com/
[120] https://www.storyfit.com/
[121] https://www.supadu.com/
[122] https://www.yewno.com/publishing
[123] http://www.formax-bpo.com.cn/
[124] https://www.poolparty.biz/
[125] https://www.fenixx.fr/
[126] https://datalanguage.com/tagmatic-for-publishers
[127] What's new in publishing, Auto-tagging: AI for publishing beyond the hype curve, 2020,
[128] https://granthika.co/

Use case: Automated translation

Overview

Books are written in an original language, and later (in some cases) translated and published in other languages.

Powered by neural networks, translation software has become widely spread for all kind of activities in the book publishing sector, first and foremost for non-fiction content. Automated translation has however still a long way to go in non-fiction. This translation work is traditionally done by translators who respect the tone and style of the original writing.

Automated translation drives cost reduction by speeding up the content creation and lowering costs of translations for book publishers. It can also enable the rollout of "basic language" books (i.e. children books) in less common languages, for which there would not have been a dedicated translated version, expanding the market but also supporting the language diversity of cultural content.

Automated translation has a few pitfalls to underline. It can threaten the volume of work of translators, result in lower quality translations but also threaten smaller local actors by allowing big players to enter small markets with large catalogues. Finally, it has an impact on intellectual property rights of publishing houses.

Automated translation is typically an outsourced service to specialised companies such as DeepL[129] (DE), Reverso[130] (FR) or Lilt[131] (US). This is because developing an RNN model is expensive while subscribing to their services is not.

Business needs and value proposition

Publishers have not failed to notice the potential of AI for translation. In October 2018, Quantmetry[132], a company expert in AI, together with DeepL, translated into French the 800 pages of the book 'Deep Learning' and published the new version[133]. Similarly, at the 2018 Beijing Book Fair, the Youdao AI Translator translated a 100,000-word non-fiction book from English to Mandarin in 30 seconds. It then took a human narrator a week to clean up the translation and it was ready for publishing. The comparison was six months for human translation alone[134].

In 2018, Forbes expected that "within one to three years, neural machine technology (NMT) translators will carry out more than 50% of the work handled by the $40 billion market"[135]. While this has not happened yet, many actors make use of the power of automated translation. However, in an industry generally reluctant to use machine-powered content production and editing, publishing houses who do, may not advertise it.

The use of automated translation answers the need to speed up production of books, reduce costs of production but also can allow publishers and especially smaller actors and retailers to enter new (niche) markets. It is notable that a translated book might also be found more easily through search engines and recommendation systems.

Machine translation lowers production costs and therefore helps small publishers have their books translated and therefore invest more in the production. It helps entering markets where the margin per unit is not very high (e.g. children books). To make the business model successful, publishers need to produce and sell more, and automated translation is a useful tool to reach this objective. This automated translation shortcut however functions best for non-fiction and books using simple language. One actor estimated that the publishing house saved 4 weeks in the production flow of a book by automatically translating text.

[129] https://www.deepl.com/translator
[130] https://www.reverso.net/
[131] https://lilt.com/
[132] https://www.quantmetry.com/
[133] https://massot.com/collections/lapprentissage-profond/
[134] https://thenewpublishingstandard.com/chinese-bot-translates-300-page-book-from-english-to-chinese-in-30-seconds-with-95-accuracy/
[135] Forbes; 2018; Will Machine Learning AI Make Human Translators An Endangered Species?, URL: https://www.forbes.com/sites/bernardmarr/2018/08/24/will-machine-learning-ai-make-human-translators-an-endangered-species/#750724993902

Machine translation also simplifies some contractual hurdles. When contracting a translator, book publishers need to send the file, make a contract, respect regulations that require translators to receive royalties. As a result, the paperwork is so time consuming and expensive that it is not always worth it for a book publisher.

Related to automated translation is the new text to speech (NTTS) technology which is especially an interesting technology for audiobooks. For example, for children's books and reading exercises where a child can see the text while it is being read out loud through the same system. It is also relevant for transcription, speeding the production of books made out of conferences/talks. For now, the NTTS is developed in one language but there are projects looking to see how to train the service in one language so it can adapt in several languages (e.g. lowering the voice at the end of a sentence). This would allow the technology to be used in local dialects and less common languages.

Because the activity is outsourced and then checked, there is no real issue on employees' skills with the major exception of the threat for translators. The use of automated translation is a direct risk to the volume and nature of their activities. Translators are more editors and quality reviewers in this model. It is notable that translation training is adapting by changing the education completely to curating databases of dictionaries, quality control.

Technology

The state-of-the-art technology for translation is based on neural networks. The technology has been developing remarkably since the mid 2010s thanks to the integration of deep learning. As a result, machine translation systems such as Google Translate[136], Amazon Translate[137], DeepL or Reverso but also companies like Lilt have improved considerably.

With statistical machine translation, the source language was first converted to English, before being translated into the target language. This method led to a loss in quality from the original text to the English translation and additional room for error in the translation from English to the target language.

Neural machine translation (NMT) uses an artificially produced neural network. This deep learning technique, when translating, looks at full sentences, not only just individual words. Neural networks require a fraction of the memory needed by more traditional statistical methods and therefore work much faster. The latest NMT approaches use what is called a recurrent neural network, or RNN and a convolutional neural network, or CNNs. These networks can grasp context of sentences and provide more natural-sounding translations[138]. Google Translate, Microsoft Translator and Lilt use RNN while Facebook Translator uses CNN.

Some models are based on a pre-translation model that is then checked for accuracy and edited/polished by a human translator. Others are suggestions tools, adapting as the translator goes through the text. These engines use machine learning to analyse existing translation data and make predictive translation suggestions. These suggestions allow to increase the translators' efficiency by enabling them to spend their time on challenging translation work while the system handles predictable and repetitive parts automatically. In complex language forms like fiction, even the best machine translation engines do not sound natural.

Market potential

Machine translation is primarily used to translate manuscripts of authors (published or self-published) but also can serve for transversal tasks such as marketing and communication. Publishers make use of off-the-shelf software such as Deepl and Google Translate. Automated translation increases productivity and reduces costs, freeing up resources for other tasks. The recent years have seen a leap in technology, especially Neural Machine Translation which addresses longstanding shortcomings, including the poor readability of automated translations and its incompatibility with certain languages, such as Korean. Moreover, the success of NMT has attracted many researchers who have developed various methods to improve its efficiency and quality (Wang, et al., 2021). This promises an even greater uptake of the

[136] https://translate.google.com/
[137] https://aws.amazon.com/fr/translate/
[138] readwrite.com, Machine Learning for Translation: What's the State of the Language Art? 2019, URL: https://readwrite.com/2019/11/02/machine-learning-for-translation-whats-the-state-of-the-language-art/

technology by publishing houses, but also by self-published authors who will benefit from more affordable translation works. Thus, they can expand the markets in which their works are available.

Besides, the nature of the work is evolving as translators do more and more computer-assisted translation (CAT). CAT combines the time gained using a machine with the ensured quality from a professional translator. It ensures better value for money on translation because translators charge only for the time spent on translation, which is reduced by the computer aid. Companies that propose CAT include market leader SDL Trados Studio[139] and MemoQ[140] both of which have features such as use of translation memory and terminology databases.

Challenges

Besides the potential issues with quality and acceptability, especially in translating fiction books, a major challenge associated with automated translation is related to intellectual property rights.

Authors license content to foreign markets but using AI translation may change this dynamic threatening language-based distribution rights which might have an important impact on copyright and thus revenue streams[141].

This is illustrated by the audiobook sector where there is a different set of rights if there is a voice recording of the book. With the current technology, a streaming service (e.g Spotify) can apply a neural voice engine on its platform so publishers do not need to create audio files, but simply upload the book with the semantic marking and the engine would read the book aloud. This raises questions on licensing as the platform would disrupt a market where there are typically two actors (one is on the print side and issues rights to the other working on the audio). With this engine on the platform the exclusive license sold to an audio publisher is not respected.

The traditional territorial rights of publishers to translate a book, adapt, print and distribute it in a given geography are also in question if an author is able to automatically translate a book and self-publish. These legal issues most likely participate to the difficulties in the adoption of AI in the book publishing sector.

Another set of challenges relates to the limited language processing abilities for smaller languages in Europe. Most AI is based on NLP and the algorithm is connected to the language itself. However, for book publishers, developing a bespoke AI is expensive. At the moment, there are no available open-source algorithm for NLP of good quality in Italy, and this might be true in many other EU MS. With the added difficulty that the European landscape of language technologies is fragmented (over 2,500 players), improving NLP for European languages is necessary. There are a set of existing EU initiatives working on this particular challenge such as the European Language Grid[142] and the European Language equality[143].

The automated translation in less common language is understandably of lower quality due to a lower volume of training data, therefore automated translation of fiction books is not expected in the next years. If, and when, this technology matures it is important European publishers and specifically smaller actors have access to it in order to safeguard the promotion of manuscripts in less common languages - for example by expanding European initiatives such as the European Language Grid.

Traditional publishers may be reluctant to adopt AI-powered translation mainly on basis of a potential lack of quality compared to translation done by a professional. While automated translation quickly, and cheaply, provides rough drafts, the creativity of a professional translator is not matched by a software. Therefore, in the case of fiction, the system is better used as a translation assistant than a complete solution. Another potential explanation to their reluctance is that many translators happen to be authors. Publishers may not want to frustrate them by using machine translation which threatens translators' livelihood. AI replaces human translators, especially for more basic content translation, because of the reduced costs associated with automated translation as well as the ease of avoiding contracting and scheduling work with a translator.

[139] https://www.trados.com/
[140] https://www.memoq.com/
[141] WIPO, Managing Intellectual Property in the Book Publishing Industry A business-oriented information booklet Creative industries – Booklet No. 1, 2008
[142] https://www.european-language-grid.eu
[143] https://european-language-equality.eu/

9.2.4 *Use of AI in business processes: warehousing and stock management*

AI is used in business processes in the book publishing sector similarly to other sectors. Currently it is not a common use of AI, but might become more relevant in the future and is worth exploring:

- AI can be of service to predict demand and improve stock management. However, while stock management is currently a cost for the industry, with the increased share of e-books and print on demand, some expect this cost to decrease which would make the investment in AI for stock management have a limited return on investment.
- There is currently very little evidence of publishers using AI for warehouse management, partly because the technology is not yet fully developed. Examples exist of AI assisting with product sorting.
- AI is applied in finance, contract and customers service departments. The use of automatic invoicing, chatbots is however still nascent in the industry.

9.3 Key challenges of AI for the book publishing sector

9.3.1 *Impact on the sectoral landscape*

There is little research on the use of AI in publishing, however the available evidence suggests that the adoption of AI by the publishing sector will prove to be more advantageous for some actors while more challenging for others.

AI is expected to have a direct impact on the level of employment in publishing houses. Examples are the automated translation technology directly threatening the volume and nature of the work of translators but also proof-readers being assisted and to some extent replaced by grammar and spelling checks software. Despite these risks, AI tools also facilitate the work of editorial teams and free time for them to focus on more difficult and rewarding tasks. The outcome of how much AI tools will impact those actors will depend on the strategy of the publishing houses. However, in a sector where margins are thin a contraction of the number of employees is likely. It is quite typical for more senior employees to have started lower in the hierarchy and then progressed. Thus, an added issue if entry-level positions disappear is that the typical career path might change.

Publishers are less directly negatively impacted by AI however there are indirect risks for their activity. An illustration is how the uptake of automated translation could negatively affect the territorial rights as publishers typically acquire language rights to sell a book in a specific language. With automated translation, either the author publishes their work in many languages without a publishing house or one house can distribute easily in different markets, cutting off other publishing houses from the deal. The ability to translate a book is not sufficient to ensure its success. To understand what to market, how and when, publishers need to understand the audience. Building this understanding through data analytics requires the combination of recommendations systems data and demographics data which is a nascent approach. The objective is to support the decision making and reduce the risks associated with translating and publishing a book for a foreign audience.

There is a risk of dependency on external solutions and expertise. Publishers depend more and more on online sales, and therefore need to better understand purchasing habits. As publishing houses seek to adapt to new modes of consumptions and with limited in-house skills, publishers turn to service providers. Tech firms have adapted or expanded their activities to include AI-powered services, for example in production workflow and business analytics.

Online retailers and especially big actors (e.g. Amazon) are benefiting from the move to online purchasing. Moreover, they attract readers by proposing even the least researched title thanks to virtually infinite shelves and fast deliveries. Infinite shelving also means that big platforms can offer almost any title from any publisher. This represents an unmatched sale opportunity for publishers, especially to offer older or less popular titles. On the other hand, the recommendations systems of these platforms also entice readers to purchase more. The more titles are sold through the platform, the more retailers gather data on clients which feed the recommendations systems but also inform marketing strategies. These data are not fully available to publishing houses meaning they cannot develop a detailed marketing strategy. What's more some of the smaller publishing houses appear to make relatively little out of the data they have access to. This is due to a lack of resources in the teams (both financial and skills), as well as a reluctance towards digital tools. As a result, big retailers may see their influence on the sector increase

further, as they gather customers' data (including cross-media) and can adapt to trends, leaving publishers blind to latest developments in taste, consumption patterns etc. AI can support publishers in identifying the middle sales titles that have become an important income flow generator, as the industry moves away from its dependency on best-sellers. However, this strategy requires to understand niche markets, which is better done by treating large volume of data – an advantage of big platforms. Overall, online platforms are both the best ally and a potential competitor of publishing houses.

9.3.2 *Impact on cultural diversity*

Recommendation systems have raised concerns of standardisation of readers' tastes. By essence, AI uses past data to predict the future, based on probability and is therefore a conservative tool. It bears the risk of reinforcing already dominant or conforming elements by predicting they will fare better than new or unexpected writing styles for example. Recommendation systems can support larger actors and especially retailers to flood smaller markets putting cultural uniqueness at risk. One aspect of this is if automated translated content causes content inflation and less visibility for local actors. Access to readers' data allowing to understand local trends (national, regional) is necessary in order to ensure discoverability of content generated by smaller actors rather than larger platforms.

The diversity of European languages complicates the equal dissemination of language-based AI tools. Data curation is fragmented in Europe, while it is a key element of machine learning and thus impacts the competitiveness of Europe in this space. The adoption of the technology is also questioned on basis of algorithm bias, quality of output but also the threat on the activity of some actors such as translators. Natural language technology is developed on the basis of a language, meaning there is a risk that AI tools are developed for most common languages and do not include less spoken languages, damaging European cultural diversity. Moreover, AI is developed by humans and carry bias and there are risks that AI tools favour some manuscripts or authors over others.

On the positive side, AI can support cultural diversity by offering an always-on creativity support to human authors. Moreover, the development of associated translation of metadata terms increases the chances of referencing books correctly and supports the discoverability of lesser-known content.

9.3.3 *Access to data*

Publishing houses own data and are free to exploit this asset. There are also a few specialised private data providers that offer services for the book industry either in collecting market data or analysing readership/user behaviour data. Nevertheless, the publishing industry lacks large market data aggregators in particular in Europe. The e-book industry is dominated by Amazon that is in the position to collect most user data. The Table below summarises the main types of data available in book publishing and lists examples of data sources.

Table 27: Type of data and data sources in the book publishing industry

Data Type	**Data source**	**Conditions to access**
Book digitised content, e-books and audiobooks	ISBNdb Tekstum	Fee-based
Metadata tagged by author, publisher, genre, mood etc.	Individual book publishers Kadaxis (US) offering keyword optimisation	Own data
Readership data (user behaviour)	Jellybook (UK) Open Book Publishers (UK) Bookmetrix/Springer (Germany) E-readers such as Amazon Kindle, Kobo Self-publishing platforms	Partly free to access Fee-based premium data
Market and sales data	Nielsen Bookscan (NPD in the US) Bookstat (US) Individual book publishers	Subscription service Hold privately

Data Type	Data source	Conditions to access
User feedback data	Book publishers	Surveys

Source: authors

The competition among publishers makes it difficult for actors to exchange data. Moreover, reading statistics are impossible to gather because every country has its own classification.

Metadata in publishing is well structured but it is not always sufficiently complete to help identify trends in readership. There are also metadata features missing such as for instance the identification of mood tags that is relevant for searchability. Data analytics can also help publishers to identify profitable niche markets they have been unaware of. Data about the genre of a book is generally already included but more detailed data can be included such as plot points or characters personalities.

With increased metadata, reading trends would be more easily identified and therefore some manuscripts and catalogues sold better. This would also be useful at the production and acquisition stages of the value chain in order to offer readers content they want. Updating metadata is however a laborious task and AI can be very well equipped to support.

Large retailers have access to valuable data such as cross-media consumption and a detailed profile of consumers that are not made available to publishing houses. Other types of data are owned by different actors with which publishers do not necessarily exchange such as public institutions or libraries. The latter may express concerns on the way the data will be used for the creation of new content.

In 2020, within the framework of the UK's Book Industry Communication programme a directory of metadata has been launched open to all its members[144]. Members can share and receive their metadata uses, compare them to other actors in the sector and improve their metadata management. This initiative is useful and relevant for EU actors as well and could be expanded.

Market data are being collected at a large scale by very few companies. Nielsen Holdings is an American, information, data and market measurement company that developed BookScan offering sales data on book sales. Nielsen sold BookScan to NPD (another US company) in 2017, and the service was renamed NPD BookScan. Nielsen is still active in the United Kingdom and in the EU notably in Ireland, Italy, Spain, and Poland. NPD BookScan/Nielsen Bookscan provides information on book sales covering approximately 85% of print trade books, with over 500 000 different ISBNs tracked in a week. This transactional data is collected via the point-of-sale systems of major book retailers, mass merchandisers and independent book stores[145].

Readership data are collected by various startups for instance how often a book has been viewed or downloaded or about the location of the readers. Bookmetrix is a platform that Springer developed in Germany in partnership with Altmetric (currently the platform is being rebuilt) with the objective to offer a comprehensive overview of the reach, usage and readership of each book or chapter. It allows the user to learn how a particular book has been referenced across mainstream media, policy sources, Wikipedia, blogs or social media[146].

Data are also collected through e-readers owned by Amazon or Barnes & Noble. And they can share — or sell — that information if they like. One official at Barnes & Noble has said sharing that data with publishers might "help authors create even better books." The data is also, of course, a brilliant marketing tool. Best-selling author Scott Turow says e-readers can collect a lot of information about their owners. "You can tell everything about how somebody reads a book," says Turow, "whether they are the kind that skips to the end, how fast they read, what they skip ... So [data from e-readers] can give the author specific feedback. You know, '35 percent of the people who bought this book quit after the first two chapters.' "

ISBNdb gathers data from libraries, publishers, merchants and other sources around the globe to compile a collection of book data searchable by ISBN, title, author, or publisher.

[144] https://publishingperspectives.com/2021/07/the-uks-bic-program-opens-its-new-metadata-capabilities-directory/
[145] https://www.npd.com/industry-expertise/books/
[146] https://www.altmetric.com/blog/bookmetrix-from-concept-to-launch/

9.3.4 *Access to skills*

The industry faces an important skills challenge. Several interviewees pointed at the lack of tech employees in the industry, and in some cases at the low degree of skills of tech employees which tend to result in a troubled use of technologies by publishing houses. In 2020, only 0.36% of professionals in the publishing industry had AI skills while these are increasingly looked for in creative sectors (European Commission, 2021). AI skills are needed at several levels and for several job profiles (see Table below).

Table 28: AI related skills needs in the book publishing industry

Jobs in the publishing industry impacted by AI	**Role of AI in supporting various tasks**	**Skills needs**
Book editors	Finding talent, forecast success, AI enhanced editing, proof-reading	Basic AI knowledge, ability to operate AI-based tools such as editing and proofreading software
Literary agents	Finding talent, predict sales	
Translators	Supporting and accelerating translation	AI tools
Publicists/Marketers	AI supported marketing campaign, predict sales	Data science, data management, machine learning, interpretation of data
Directors	Developing new digital business models	Digital strategy, AI strategy
Software/AI engineer	Developing the publishing house's own data warehouse, developing AI algorithms that can analyse data	Data management, search engine optimisation, programming skills (Python etc),

Source: authors

Roles in the publishing sector require more and more expertise that mix creative and technological skills. A 2019 study showed that the average proportion of skills mixing creativity and technology in all skills mentioned in adverts from 2011-2018 for authors, writers and translators was 5.2% (Bakhshi, et al., 2019). The necessity to adapt sales, marketing to trends and the digital landscape requires to hire new types of employees or to outsource some of these tasks (Carey, et al., 2019). However, outsourcing may prove detrimental in the long run since automation will likely keep progressing and impact more and more the skills needed by employees. Therefore, the industry needs to identify the skills that will become essential to run business activities. Individuals that are trained in data, digital but also in creative or design aspects will likely become indispensable.

At the moment, some actors are not able or willing to invest in digital aspects and technology, many publishers for example do not have a social media team. This is bound to be an obstacle to their success considering increasingly digital consumption patterns. Besides the need to hire highly trained young professionals with an understanding of new technologies, it is mandatory for the industry to support the development of current employees, supporting lifelong learning, and alleviating skills gap. Training is key, not only for employees to learn how to use those technologies but also for senior managers and leaders who need to initiate digital change which involves taking difficult decisions about risk and opportunity. According to interviewees, the teaching curricula in publishing do not yet address sufficiently the data skills needed by young professionals. Moreover, there are few computer engineers in publishing houses and most likely, internal team training does not take place.

9.4 Recommendations

There are actions that can be taken up in order to ensure that the industry as a whole, and particularly the smaller actors, benefit from digital tools. For smaller actors, investing in the right AI projects is key in order to prevent losing time, energy and resources on AI tools that do not deliver on expectations, or worse weakens these actors.

9.4.1 *Access to data*

Considering the economic (and cultural) potential of exploiting the catalogues of publishers, investing in improving metadata management and optimising marketing is expected to pay off as suggested by the related use case. Moreover, taking up AI tools for time-consuming tasks such as translation, or tedious ones such as grammar check could present an interesting benefit, considering the relatively low costs of these solutions compared to developing a bespoke system. Moreover, these tools save time for employees - who would retain the role of quality assurance and - focus their expertise on more challenging tasks.

Establishing a common directory of data and metadata – this could be a solution to ensure a common use of metadata and spread good practices across actors (publishers, editors, writers...). A better use of metadata by notably smaller actors can improve the discoverability of the content they propose, but also reduce the number of wrong purchase and therefore returns. If publishers leverage their metadata by pooling them together it could lead to synergies with important economic returns on investment but take full advantage of current AI technology. AI can process information about publishers' catalogues which could be shared with other stakeholders.

Arranging an agreement on readership data would be advantageous for all players (bookstores, publishers, authors and readers). First, to protect cultural diversity and second to protect the fabric of the sector, the different possibilities for data collection and storage should focus on smaller players. Associating institutions but also libraries and associations would ensure the distribution of new skills and sharing of the results of analyses based on the pooled data. For such pooling to be beneficial to many actors, the collection and the use of the data would have to be regulated by agreements between the actors, and a fair use be ensured by common and shared tools (e.g. software) (Lebrun & Audet, 2020). To support this process, public bodies could set the legal framework, instruments and eventually funding to properly collect, share, store and manage the data coming from various parts of the publishing value chain. The development of tools using AI requires a lot of data and processing power. Training an AI is a long and costly process however once it has been done, the system is reproducible. Thus, there is a clear argument for actors in the book industry to share the costs, which could also be entirely or partially financed by public institutions in order to benefit smaller actors (Lebrun & Audet, 2020). Public support is needed considering the competition between actors, which has been a long-standing obstacle to data sharing.

9.4.2 *Access to skills*

The European Commission has put forward 12 actions under the European Skills Agenda[147], highlighting the need to invest in the existing workforce. This supposes on the one hand to ensure that the hired individuals are correctly trained for their position and on the other hand to implement a framework supporting lifelong learning. In the case of cultural and creative employees and AI technologies, the European initiatives should be leveraged to support individual learning and simplifying access to short courses to ensure professionals have updated knowledge or to upskill when required. There is also an opportunity to take advantage of major EU investments aiming to up and re-skill the workforce in the next 5 years, notably through updated national skills strategies and mobilising federated action within the cultural and creative industrial ecosystem. Under the Pact for Skills, a skills partnership for the CCS ecosystem is in the works with a series of meetings taking place starting in 2021 (European Commission, 2021).

Skills in the CCS are instrumental to ensure the resilience of the sectors, as exemplified by the Creative FLIP[148] (Finance, Learning, Innovation and Patenting/IP) Preparatory Action. In the skills-related part of the project activities are organised with a view to bridging technological education and CCS in Learning Labs across Europe and an online peer-to-peer platform. These Creative Partnerships focus on cross-sectoral cooperation between Creative Hubs and Educational Institutions. The Creative FLIP Learning Labs Program piloted actions to test the inclusion of transversal & creative skills in curricula based on the process of making, creating or practice-led research.

Regardless of developing in-house solutions or not, actors in the publishing sector should consider hiring digital profiles as well as train their employees to be able to understand and leverage AI technologies.

[147] See: https://ec.europa.eu/social/main.jsp?catId=1223&langId=en
[148] https://creativeflip.creativehubs.net/

These employees can also support identifying the AI solutions that do not fit the business model, or present ethical or legal risks, as it is key to remain cautious and consider the impact of these tools in the longer term and on the core, especially creative, activities.

Invest in AI related training of staff in positions such as book editors, literary agents and production editors. Publishing houses tend to outsource AI-related services, but they are more and more facing the necessity to have internal employees with digital skills. In this context, the training of existing employees is crucial. The publishing sector is quite traditional, this cultural factor has to be taken into account because the change and adoption of new skills very much depends on senior managers investing in new and existing talents. In most European countries, education in cultural studies and data science are decoupled, moreover data scientists can generally get better salaries in other industries which limits the attractiveness of cultural and creative sectors.

Invest in hiring AI engineers. Publishing houses that want to develop their own data warehouse and AI analytical tools will need to hire AI specialists and software engineers that can develop their AI programming skills.

9.4.3 *Collaboration*

Success will likely depend on the ability for actors to cooperate around data collection and storage as well as on the support of public bodies on data governance but also skills training and funding efforts.

Strengthen relations with platform providers. One possibility is to strengthen relations with other platform providers, in order to ensure visibility of the books as original content. Wattpad has built global audiences and content across media (and geographies). The model is based on a strong user-base that follows their favorite stories across platforms (books to audiobooks, digital comics, TV series or films). It is notable that specific actors exist, which for example specialise in book to screen adaptation (e.g. Story Ink in India) or provide technology services for audiobooks and ebooks (e.g. Beat Technlogy in Norway). While publishers have the best knowledge of their catalogue and are best placed to analyse and exploit the data derived from it, they are almost cut off from the readers. Retailers and bookstores but also libraries collect data. The latter being public actors, data analysis from libraries should be made available to all relevant actors through an agreement for example.

Table 29: Sector-specific recommendations for book publishing

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Invest in improving metadata management and optimise marketing	Industry, Public sector	To ensure industry stakeholders share their data and cooperate the public sector can act as a facilitator, providing tools, a platform or financial support.
Arranging an agreement on readership data	Industry, Public sector	To ensure industry stakeholders share their data and cooperate the public sector can act as a facilitator, providing tools, a platform or financial support.
Invest in AI related training of staff in positions such as book editors, literary agents and production editors.	Industry	
Invest in hiring AI engineers	Industry	
Strengthen relations with platform providers.	Industry/Policy	

Source: authors

10 Sector in focus: Fashion and design

10.1 Short description of the sector and current overall challenges

For the purpose of this study, the fashion and design sector is defined as encompassing any organisation and individual designing material objects, including but not limited to textiles and clothing, ranging from individual and boutique designers to large and global fashion companies. The reason for adopting such a broad definition is that despite the differences characterising the players in this sector, they are all exposed to, affected by and engaged in new technological developments, including in the field of AI. Importantly, fashion and design are about society and lifestyle because they capture the broader societal Zeitgeist. This section will focus on the creative aspects of the design and fashion sectors but also on the business processes and methods of audience engagement that have the potential to be disrupted by AI. Where applicable, a distinction will be made between small, boutique design outlets and large design firms and brands.

Before turning to the application of AI in the sector, this first section will consider some overall trends and challenges facing the fashion and design sector. Some of the trends currently shaping the field are:

- Fashion and design are trending towards more personalisation of products. This manifests itself in different ways in the industry. For instance, there is the trend of providing more personalised recommendations and advice for consumers, especially in the online sphere. To provide consumers with a memorable customer experience, online merchants help customers navigate through the countless variations and options available. Another example, at an earlier stage of the value chain, is referring to the personalised production of clothes. The combination of available data and advanced production technology are making it possible to produce individually designed products in great quantities.
- Entangled with the theme of personalisation, another key trend is the use of data and analytics in the fashion and design industry. This can be used to forecast trends and help track demand across geographies, categories, channels and value segments. For the last decades, foresight has played a crucial role in the prediction and planning of supply chains and collections. Whereas, it has sometimes been subject to instinct or gut feeling, data and analytics make it more quantifiable. Moreover, designers are using data and computer tools to create new collections and designs of objects. For instance, technology allows designers to track behaviour or movement of consumers which can inform medical or health-based designs.
- Importantly, design and fashion are increasingly concerned with sustainability and responsibility regarding for instance supply chains, materials used and recyclability of products. Especially the fast-fashion paradigm is problematised by society and policy makers due to its social and environmental negative externalities. The implications are relevant for designers and large fashion companies alike – material sourcing will become more local and more conscious of reducing waste.
- The recent COVID-19 pandemic hit the fashion and design industry hard as demand was reduced. It is anticipated that this will accelerate the above-listed trends, especially the digitalisation of the industry. In this regard, digital fashion is playing an increasing role with virtual sneakers being offered for sale. In combination with augmented reality tools and filters in mobile applications, these virtual accessories have seen rising popularity[149].

10.2 Key opportunities for AI in fashion and design

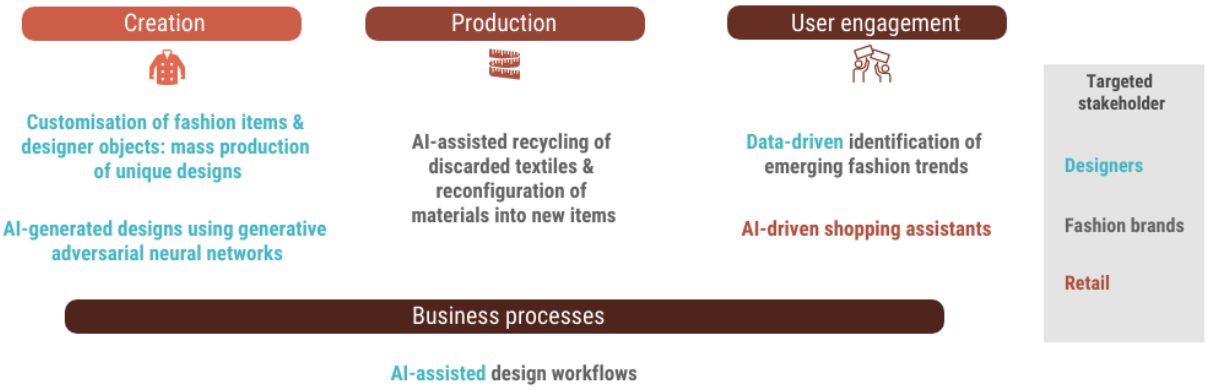
AI is used throughout the entire value chain in the fashion and design sector. While historically, there has been a disconnect between the design and the technology spheres, actors have increasingly come to acknowledge the important role the technology can play in the fashion and design sector over the next five years. In content creation, which is sometimes referred to as "generative AI", the technology still seems to be in the earlier stages in the fashion and design sector. Here, actors are starting to experiment with the integration of AI in the more creative work stages. When it comes to audience engagement and business processes, AI is already more widespread. The varying degrees of adoption will be highlighted in

[149] https://www.dezeen.com/2021/03/19/virtual-25-gucci-wanna-digital-sneaker/

the use cases. Increasingly, designers or fashion companies are relying on heavy data analytics skills and the trend is certainly going towards a higher degree of automation of the supply and value chain. A crucial implication, not necessarily specific to fashion, is that widespread AI adoption necessitates respective skills among designers and other professionals in the industry, which are currently lacking.

The figure below presents the use cases identified that can be deployed over the next five years (or are already being deployed) in the value chain. The customisation of fashion items and objectives is already a widespread feature offered by fashion retailers, whereas AI-generated designs are still at the prototype stage mostly. AI-assisted recycling will be playing an increasing role as the fashion industry has entered the spotlight with regards to its ecological footprint. Data-driven identification of fashion trends has already been piloted and could be rolled out more widely quickly given that it can be outsourced to specialised service providers. AI-driven shopping assistants can also be deployed even in smaller fashion retail and design firms.

Figure 12: Examples of key use cases of AI along the value chain of Fashion/design



Source: authors

10.2.1 Use of AI in content creation and production

Fashion and design are starting to explore ways to employ AI in the process of content creation. Although spurred by the recent pandemic, exploration is only at the beginning, but promises valuable opportunities for the entire sector.

With the help of AI, it becomes easier for designers to involve customers already early in the design process. For instance, AI can be used to tailor fashion products to customers' specifications, for example by defining exactly the right quantity of fabric to be used for the customer. In this way, an efficient and sustainable use of material is guaranteed, and the customer can co-create the design.

An industry expert consulted for this study predicts that in the future, cheap fashion may be designed by AI entirely, with human designers focusing on high-end fashion. AI can also be leveraged to create 'smart' design and fashion items that use algorithms to improve functionality in time and based on user-generated data.

AI can also be used at a later stage in the life cycle in the fashion industry to support content creation. AI can contribute to circular economy approaches by helping find usage for discarded textiles. There are approaches to use AI in recycling of old materials by analysing the fabric and combining them into entirely new pieces. These can then be sold as second-hand products, or at times even as entirely new products.

Another area where AI can transform fashion is 'smart textiles', i.e. garments that can track their wearer's health and fitness and adapt their own properties to regulate body temperature, for example (see use case below on smart clothes in health and fitness).

In design and art, a mobile application platform named Prisma-AI intends to transform photos into artworks using the styles of famous artists. The company's platform uses augmented reality, neural networks, deep learning, and computer vision to enable users to process images easily and create beautiful artwork.

Experts consulted for this study pointed out that there is potential for EU-based designers to carve out a niche in global markets for themselves by reconciling AI with human-centred design approaches, and by respecting EU standards on inclusiveness and data protection.

Use case: AI for predictive trend forecasting

Overview

Since its early days, the fashion industry has been driven by trends. Although fashion shows still play an important role in the industry's identification and presentation of trends (and can benefit themselves from AI-assistance), social media also plays an increasingly important role in creating and spreading trends. In the last decade, the lifetime of fashion trends has become ever shorter, from an entire summer/winter season to just a few weeks. Therefore, a responsive and agile supply chain has become the distinguishing competitive feature in the industry. Supply chains need to be designed in such a way that they allow fashion producers to respond quickly to trends whilst also delivering large quantities of clothing to a global network of stores. In fashion, a supply chain's performance is indicated by the level of so-called dead inventory, which refers to items that have not been sold while they could have been considered fashionable. In this context, the importance of highly accurate trend prediction is indispensable for companies.

This use case describes a novel, technology-driven way to track the formation of microtrends on social media by analysing activity on platforms such as Instagram, Twitter, Pinterest etc. Using AI, high quantities of data such as visual such as photos or videos but also textual elements can be gathered and analysed. In this way, trends which could not be observed by humans alone in such a systematic way can be spotted, analysed and even predicted thanks to technology.

AI-driven trend forecasting and identification addresses the need of businesses and fashion designers to adapt ever faster to trends in order to stay competitive. With supply chains optimised to the maximum, trend prediction seems like a sensible approach to gain a competitive advantage.

The business model of the companies offering AI-driven forecasting solutions to fashion brands and producers is based on the provision of data, intelligence and consulting services to their clients.

One set of important actors are the merchants and fashion brands which are retailing clothing in physical and online shops. For them, the adoption of this technology presents a promising path towards a more economic and sustainable reorganisation of their business and workflows.

One of the actors active in the space of AI-driven trend prediction is Nextatlas. As its core business, the company is analysing a wide range of publicly accessible sources to spot weak signals and make trend prediction. It has also hosted a pop-up store in a shop in London, basing the stock of the store for an entire day on what was trending on social media. This could be successfully and reliably done due to the company's capacity for real-time analysis of platforms and the activities of influencers.

Another company which is offering predictive analytics regarding trends and emerging patterns is the Paris-based Heuritech. Similar to Nextatlas, its solution is capable of analysing vast quantities of data from social media, including pictures, video and text and can pick up on emerging trends. Apart from the real-time monitoring of current trends, its AI-based algorithm is geared towards detecting future patterns based on trending combinations of colours, shapes, sizes and products.

Value proposition

First and foremost, the use case's value proposition is regarding the reduction of inventory levels by accurately forecasting demands and thus making the produced materials more relevant to the customer. The highly undesirable 'dead stock' will be eliminated or at least significantly reduced thanks to this technology, which makes the entire operations more cost efficient by redirecting the production in response to certain trends. Secondly, the reduction of waste also has a strong environmental value proposition by producing what will (most probably) be bought by the customers. This will significantly cut the number of items which cannot be sold and have to be disposed otherwise. Thirdly, a promising value proposition in this use case is the transferability of the technology to other subsectors of the cultural and creative sectors. While trends might not change as rapidly and constantly as in the fashion sector, trend prediction does still play an important role in fields such as design, architecture or music. This can be seen in the design of products, but also in how they are marketed. An example provided by an interview

partner concerns an emerging trend to seek comfort amidst the uncertainties of the COVID-19 pandemic. This led to the trending of comfortable materials in the design of furniture.

Technology

The fashion industry is rich in data and in the past, many companies leveraged big data solutions to improve their operations. Today, trend prediction is still based on data, but increasingly other complementary technologies such as computer vision and natural language processing are used to gather more sophisticated data. AI can make this process more efficient and accurate, by collecting and analysing data in different stages. Firstly, tens of thousands of publicly available fashion websites, social media posts or news articles are periodically crawled to detect any upcoming trends. Trends that are not genuine, but rather concern commercially driven, sponsored posts or publications, are labelled as 'weak signals'. These signals are assigned to users which are producing or reproducing the weak signal. After filtering for activity and reach, it is thus possible to exclude commercial, mainstream or inactive profiles of users on the social media platforms and hence to sort out advertisements. Network density analysis allows to identify linkages between different designers and fashion experts. Secondly, the collected and cleaned data is then fed to an AI for more advanced visual and text-based (neuro-linguistic programming) analysis and forecasting, combining it with historical data to detect any under-the-radar whispers across social media. These are then either passed directly to the company using the raw data or aggregated, analysed and feed into a consulting service. As a result, anomalies such as a rising combination of colours/patterns/styles can be identified. Similar procedures can, according to a technology developer in the industry, also be applied potentially to interior design (an example provided was that of the emerging trend of more comfortable furniture in home office times).

Challenges

For the companies offering AI-based trend prediction, one challenge is the data-literacy in the industry, which is only starting to emerge in the last few years. While there are increasingly many data-savvy decision-makers, it is often left to companies such as Nextatlas and Heuritech to draw the conclusions based on the data. However, they are missing the brand-specific perspective on the strategy and future direction of the firm. In order to engage more employees in the analysis and decision-making on data, new skills need to be learned and new routines are at times hard to establish in rigid organisational structures. Companies and designers also need to revise their workflows in order to plug in AI solutions, which can be challenging at first, even if it can yield great benefits once successfully done – for instance, by allowing designers to focus on the creative aspects of their work while leaving business process-related tasks to algorithms. Without programmes aimed at improving AI literacy of designers, however, there is a risk of those not able to develop such skills on their own account falling behind, widening the gap between large brands and design firms and small-scale/individual designers. Adidas was mentioned as a good practice example of a company that has already adopted a heavily metrics-focused management style, allowing it to take advantage of new technologies more easily than some of its competitors.

One vision for the future of the integration of AI in the fashion industry is to automate the translation from trendspotting to manufacturing of clothes. This means that when a trend is spotted on social media, clothing items taking up this trend are automatically ordered and produced without any human interference in the process. Despite this depicting a seamlessly efficient scenario, there is a risk of de-humanising the production and design of fashion. Ultimately, it could lead to a world where hand-made and human-designed clothes are reserved for the high-price segment and other clothes being automatically mass-produced.

Market potential

At present, the use of algorithms to predict trends or to disseminate content to consumers are already commonly used by brands and designers; e.g. they can easily check on their Facebook or Instagram accounts what would be the best time to post content on their profiles.

Beyond that, the maturity of more sophisticated technology was showcased in a pop-up store in London in 2020, which sold only fashion items trending highly on social media as identified by machine learning and was considered a success by a representative from the company developing the technology interviewed for this study. Having said that, the technology is still at an early stage and not yet widely adopted by companies. Nor do there seem to be many providers of such forecasting technology at scale.

While there are many companies specialising in online surveys and trend analysis, companies specialising in the combination of AI and trend forecasting in the fashion industry seem to be rare. The growth potential could be considered high, given the benefits outlined above.

An expert interviewed for this study stated that the deployment of AI need not have a negative impact on job prospects of designers in the industry. As mentioned above, provided they develop technical skills, designers may experience a shift in the kinds of tasks they focus on, without reducing the need for human designers.

10.2.2 Use of AI for audience engagement and accessibility of content

Regarding the audience engagement and accessibility of content, AI plays a considerable role already in the sector. Designers are starting to use AI more and more regarding audience engagement. Indeed, with the underlying data, designers can use AI to help analyse engagement of audience with the designed object. Furthermore, large companies of the fashion industry are already integrating AI in the shopping experience of consumers. With the help of digital AI-based assistants giving style and shopping advice, engagement with the consumers starts in the virtual space. Prospective customers can change the appearance of an avatar wearing clothing items for sale so that it matches their own ethnicity. Based on the advice from the virtual assistants, consumers can make better choices which result in a higher customer satisfaction and a higher customer retention rate.

Another example concerns a 3D model platform intended for application in a wide range of furniture, shoes, clothing and other consumer goods. The company's platform uses computer vision and deep learning to produce photorealistic quality content which can bring products to life and increase conversion, enabling clients to access their platform to reduce cost and time needed to present products in 3D and XR.

Use case: AI-enabled personalisation of online-fashion retail

Overview

Personalisation is playing an increasingly important role for customers who want unique products reflecting their personal values. Furthermore, spurred by the recent pandemic, the fashion industry is shifting towards online shopping, covering the entire customer journey and not only the actual process of ordering a fashion item. Since sizes and fit of brands and items vary, it has become common practice for customers to order several of the same items in different sizes and return the ones that do not fit. For the fashion producers and online shops/marketplaces, the customers and for the environment, this modus operandi is highly inefficient as it substantially increases the number of parcels sent and results in many items that were returned being destroyed. By integrating tools already in the early stages of the customer journey, allowing customers to determine the right size of an item for themselves, the number of returns can be reduced drastically. These tools are based on artificial intelligence and combine historic returns data, body measurements of the customers and the sizing tables by the fashion brands of the clothing items in question. In fact, some of the companies offering such plug-in algorithms and the option for customers to pre-emptively check their sizes state that returns have decreased by over 50% as a result.

Several actors are involved in this particular type of use case. The merchants need to integrate the tool into their online shops and customers need to opt to use the tool. However, this use case mainly concentrates on those companies which are supplying the software underlying the different tools. The photo-based solutions are offered by companies such as Fit Analytics or 3D Look. Video-based tools are

offered by the German startupPresize, which has received substantial venture capital funding and is aiming to be integrated in some of the major online merchants and who have managed to lower the mean error to 1.2 centimetres.

The current trend of ordering on aggregate twice as many items as one intends to keep is not efficient and has a significant negative impact on the environment. Interestingly, 75% of returns in the fashion industry are due to wrong sizes or a misfit of the items ordered. The underlying problem is that sizes differ across brands and consumers rarely know their exact measurements correctly (which could be accessed in sizing tables). In brick-and-mortar stores, the problem is easily solved by allowing customers to try on several sizes and pick the best-fitting one. Currently, online shops are offering the same solution to the problem, but the return is much more inconvenient for customers. This serves none of the parties involved. Consumers need to invest extra time to organise the returns. Companies need to keep larger inventories and build up a reverse supply-chain which often adds to the operational complexity. Also, the environment is suffering from the increased number of deliveries, sometimes by air. Lastly, even customers not involved in the interactions are harmed, as the (often costly) returns are priced into all the products. Thus, there is a clear need for solutions to this problem that is inherent to online shopping.

As will be shown, specialised companies offer AI-based tools to provide customers with an easy way to find their right size. The business model of the companies consists of a software which is integrated into the online shops of merchants and appears as a tool for the costumer to use optionally. The online merchants pay for the integration of the tool and additionally share some of the savings incurred because of the tool with the software-provider.

The value proposition for the customer is the increased likelihood of finding the best size and to avoid the inconvenience of organising the returns. For the merchants, the primary objective of the technology is to decrease the need for returns. On average, a return shipment creates costs of approximately 20 Euro for the merchant. In order to operate profitably, this needs to be priced into every other item sold on the platform. Moreover, the solution can also significantly increase the customer friendliness of online shops, for instance by only displaying those items with the right sizes which are available. This can save the frustration of finding an item only to discover it is not in stock and contributes to the personalisation of the online shop. The value proposition also contains an ecological perspective. Every return shipment creates nearly 900 grams of CO2 emissions. By reducing the volume of returns, a significant contribution is made to making the fashion industry as a whole more operate more sustainably.

Technology

The software companies that deploy the AI use case described here use slightly different technologies. Mostly, they integrate different data about the customer on the one hand and the piece of clothing on the other. For analysing the customer data, a 3-D model of the customer is produced by asking them to take a few-seconds-video of themselves and supply some basic data such as age and height. The software then scrapes size tables and analyses data to identify any items that are highly likely to be returned since they will not fit the customer. All of this information is then aggregated into a recommendation on what size and fit would be best. Moreover, there are also tools which can simulate the piece of clothing or accessories on the uploaded picture or video of a customer. Artificial intelligence is used to increasingly optimise these suggestions by also analysing historical return data.

Market potential

The technology is mature and already being adopted by major retailers and fashion brands such as s. Oliver, Keller Sports, Northface, Puma, Calvin Klein, Hugo Boss, and many more. It should be possible for the technology also to be adopted by smaller online retailers.

At least three different companies were identified that provide this solution, suggesting that there is sufficient competition and no risk of this technology becoming monopolised any time soon. Hence, it should stay affordable even for smaller brands and retailers. As the take-up and demand for such solutions increases, there could be bottlenecks as the providers are relatively young companies, that may not be able to respond to a rapid increase in demand quickly.

There is demand among many well-known fashion brands but also SMEs with a turnover in the double-digit million Euro range.

By making online shopping more efficient, the technology has the potential to improve customer choice, competitiveness and viability of small and large-scale online shops, platforms, and fashion brands with their own, direct sales channels, and to reduce cost for customers as retail prices no longer need to reflect

expensive returns supply chains. This should have a positive impact on growth in the industry, albeit not necessarily on employment, given that jobs in logistics could be less in demand due to lower returns.

Challenges

For the software providers concerned, it is first of all challenging to convince larger online merchants of the merits of integrating a solution as described. In the fashion industry, profit margins are already rather slim, and any profit sharing needs to be justified by a clear business case. Moreover, privacy issues and data protection are crucial to convince consumers to use such a service. For instance, it is telling that the solutions described here may ask customers to specify their height, but not their weight, which some customers may wish not to disclose. Instead, the right measurements are derived from the photos or videos that the customers shoot of themselves. The personalised data thus collected should not be stored for too long by the online shops, or used in other contexts. The picture of the customer is saved in the cookies but eventually deleted from the platform. At the same time, online shops need datasets of a certain size in order to reap the full benefits of algorithms proposing the right size for customers. They thus need to have been in place for a certain period of time before it makes sense for them to try out such solutions.

Other than that, low awareness or technology scepticism could be obstacles for smaller-scale merchants. The software tools themselves are not particularly costly to install and, given the revenue model of the merchant passing on a share of net gains to the software developer, means that the cost of adoption should not pose a major hurdle for most online shops. The managers of online shops need no particular skills either, since such a software solution can be installed as a service, meaning continued customer support is borne by the AI companies. The issue of a lack of awareness should become less salient as larger online shops adopt such solutions.

Bearing any major data leaks, which could undermine trust in the technology and hence result in customers not opting to make use of this option when shopping online, no major risks can be identified at this stage. If anything, the technology has the potential to make online shopping a much more efficient and user-friendly experience. This could potentially have adverse consequences for brick-and-mortar shops, as more and more customers shift to online shopping. However, that trend has accelerated during the pandemic anyhow, and at the same time, many brick and mortar shops have set up their own online shops and are now increasingly also attracting customers this way. Insofar as these new, small-scale online shops need to become and remain competitive with major online platforms such as Zalando, AI tools can help them offer a similar level of service and thus contribute to a level playing field among retailers. Where small shops lack the necessary datasets, companies such as Presize.ai claim that they can get their algorithms to work with even rudimentary data at the outset, improving the precision of recommendations continuously as customer feedback comes in.

By reducing returns, the technology can make the industry more sustainable and thus contribute to a better image in the wake of increased media attention on the environmental cost of 'fast fashion'.

Use case: AI-assisted shopping assistants

Overview

Another application in audience engagement concerns platforms offering a combination of human stylist and machine learning algorithms, where customers receive personalised information from human stylists and suggestions from an algorithm that understands the customer's preferences over time, enabling men to dress well without having to go shopping. One example of a company adopting this approach is Outfittery, which began to complement it personal stylist consulting for male customers with algorithms in 2020. This allows customers to receive real-time recommendations while they shop online linked to items they already placed in their virtual shopping basket. The CEO's aim is to turn Outfittery into 'the Spotify of fashion'. The company also plans to create an app that would automatically generate outfit recommendations based on certain dates in the personal calendar of customers. The algorithm is trained with a dataset of 200 data points for 1 million customers across nine European countries. AI allows the company to scale up more rapidly and reach profitability sooner. Algorithms can also incorporate sustainable fashion aspects in their recommendations.

Business needs

This use case addresses the preference of businesses for high-margin, repeat customers to generate stable revenue streams. It addresses the need in the market for personalised, time-efficient shopping experiences. By constantly improving shopping proposals to customers, the use case also contributes to reducing returns and hence to making the fashion industry more efficient and sustainable.

The more data customers generate when using shopping assistants such as Outfittery, the more tailored the recommendations they receive can be, and the more fitting the fashion curation outputs are. Such improved customer service in turn increases the number of satisfied and recurring customers, which in turn leads to more data being generated, in a virtuous, self-reinforcing and -accelerating circle.

Outfittery, founded in Germany in 2012 and now active in 9 European countries, with 500,000 customers and a turnover of more than € 80m, is considered to be the market leader in curated shopping in Europe. The technology used by the company to inform its shopping assistant is developed and applied in-house.

The use case promises customisation of outfits according to style (eg formal, casual), size and price preference of customers, allowing for personalised outfits and fashion in a way that was previously only available for wealthy people through personal shopping assistants. Each return of items by unsatisfied customers generates valuable data, refining algorithms, and creating further opportunities for improving the product (as do non-returned items).

Challenges

The use case is highly dependent on access to a sufficient size of user data to inform the algorithms that churn out shopping recommendations. This once again underlines the key role that data and knowing how to make efficient use of it play in fashion industry companies (both brands, online shops and designers) competitiveness.

According to Outfittery, AI works in tandem with human stylists, and poses no threat of replacing them. Rather, it helps the company with scaling up its offering as its customer base grows rapidly and increases the efficiency of stylists' work. 'Art meets science' is the slogan with which the CEO of Outfittery describes the combination of AI and human design. For instance, while a stylist curates outfits, AI can recommend bestselling items for the specific customer type to the stylist.

The dynamic of the respective 'value' of human stylists and AI also shifts over time with repeat customers. Since each purchase/return adds another data point, long-term customers can be assisted better by AI, whereas new customers generally will rely on human stylists for their first outfit recommendations. Asa results, Outfittery has recently introduced a new feature called 'My Shop', that allows customers to directly assemble outfits without the help of human stylists but with the help of real-time algorithms. This feature is still at an experimental stage.

Market potential

The AI functionality has been deployed by Outfittery since 2017 at least. However, the more advanced, real-time solution is still at an earlier stage of development, but already features on the website.

As an example of the appeal of AI-designs, the company carried out an experiment in 2017 when it compared the number of sales of a pair of socks designed by humans versus one designed by an AI based on algorithms of the 500,000 plus Outfittery customers. The human-designed socks faired slightly better, with a sales ratio of 54-46.

Other companies using algorithms to inform outfits recommendations include Stitch Fix, a US-based company that analyses user behaviour on social media of women to recommend styles in a subscription service, and Thread.com in the UK. Furthermore, Amazon is using Israeli machine learning algorithms to understand which outfits are considered stylish by customers, and how fashion trends evolve (Amazon Find).

The sizeable and growing customer base of Outfittery demonstrates the demand for AI-informed shopping assistants in Europe. The fact that large companies such as Amazon are taking up similar features suggests that AI will become ever increasingly embedded in online shops and fashion-related services.

Use case: Smart clothes in health and fitness

Overview

Smart textiles integrate fashion with intelligent technology to result in wearable high-tech products. A combination of sensor technology and textile science makes it possible to collect data on the external and internal environment of the wearer of such fashion items, and to respond to changes in the context in real time. This intersection between clothes and technology has been explored for the last decade. In 2016, IBM and Marchesa designed a smart dress capable of reflecting the reactions of the audience at a fashion show[150]. In recent years, one branch of smart clothes has increasingly focused on applications in health, medicine (including rehabilitation and helping people with disabilities) and fitness, using AI to monitor and analyse body movements. 'Smart' garments can also regulate body temperature. This development needs to be viewed in the context of a larger societal trend to generate and analyse data by using wearables such as smart watches or fitness trackers. Smart clothes promise the opportunity to generate more data and, by using AI, to analyse data in more sophisticated ways. While some startups are actively working on the design and commercialisation of smart clothing, larger players have also begun to dedicate resources to the topic.

The field of smart clothing is explored by some startups which are working at the intersection of sportswear and technology. Their focus areas vary in terms of the types of clothing items which they focus on (e.g. running pants, bra, shirts) and regarding the data they are collecting (heart rate, sweat, movement). Besides the startups active in the field of smart clothing, larger fashion companies are also aware of the opportunities and ready to explore them in the form of partnerships with technology providers. An example of such a company is Puma which already in 2017 partnered up with a startup named Lumo (now FeelPeak) to design an AI-based coaching device which is fed from smart clothing data[151].

Business needs

Regarding the business needs, it is useful to distinguish between the fields of health and fitness. In the area of fitness, there has increasingly been an adoption of devices (and particularly wearables) to track fitness. The data thus obtained can be used to optimise training schedules, can be shared on social media or inform alimentation plans. Already, some insurance companies are incentivising customers to track their fitness in exchange for an improved insurance plan (using a gamification approach). Smart clothing fits into this business need by offering an integrated way to track fitness, making other wearable devices redundant. Closely connected to this is the field of health, where smart clothing has the potential to play an increasingly important role. It allows to give insights into body posture, preventing back problems or other health-related long-term consequences. Additionally, it has the potential to provide the medical sector with information about the healing process of injuries or, as an interesting example shows, the right fit of protheses. Another superordinate application area is that gathered data on health, movement and fitness can be aggregated in data lakes. Non-personalised data would be stored in large databases, giving insights into macro-societal patterns regarding health or mobility.

The value proposition of smart clothing is manifold. It offers a much higher accuracy of tracking different health and fitness parameters (30% better than alternative tracking devices such as smart watches). Not only is the accuracy of measurement higher, but the number of parameters that can be measured by one clothing item also vastly increases. Moreover, it is more practical to integrate the measurement of data into a single product as opposed to using several different external devices.

Technology

The technology that finds application in smart clothing is based on microelectronics (chips and sensors embedded in the textiles) and information communication technology. It also requires the application of conductive material, flexible sensors, power supply and a connection to a cloud (via Bluetooth) to transmit data for analysis. The data can then be analysed by AI algorithms which learn about the user behaviour and can suggest, for example, specific training schedules, alimentation plans, or running routes. The data can also, in non-personalised form, be analysed in aggregate in data lakes to inform about and infer from it more global trends.

[150] https://www.ibm.com/blogs/internet-of-things/cognitive-marchesa-dress/
[151] https://www.wareable.com/fitness-trackers/lumo-puma-fitness-ai-coaching-device-partnership-5594

As an example, one company (Exisom) combines AI and top-grade fabric to develop Bluetooth and sensors embedded activewear including leggings, tops and other related products that sends data like heartbeats, steps counts and breath numbers in real-time on any smartphone devices for both men and women, enabling users to have latest technological products at an affordable cost.

Challenges

The widespread adoption of smart clothing by fashion brands and, eventually, by customers still faces a set of challenges. Firstly, a challenge is still the seamless integration of technology with the clothes. While its functionality has been proven, especially regarding the accuracy of the data in comparison to alternative forms of tracking, actors are now working to increase the comfort of the clothes and aspects of safety with technology close to the human skin. Secondly, many aspects need to be duly tested in production and over the lifecycle of the product. Some ideas might not be achievable because of fabric characteristics or constraints such as exposure of the technology to water. Thirdly, smart clothing items are still expensive compared to ordinary clothes, which is a significant restricting factor in the dissemination of smart clothing and at a time when fast and cheap fashion still dominates the market. Lastly, strict measures for data security and privacy need to be ensured by designers and producers of smart clothing, especially when feeding data back into data clouds/lakes.

One perceived risk could be that movements are constantly tracked, and insurance policies or other health plans make the use of tracking obligatory, leading to a substantial violation of privacy and data protection rights. Although this is a rather distant risk, tracking of movement and health can be considered a slippery slope and the acceptable frame needs to be clearly defined. Another risk is that AI embedded in smart garments incorporates bias arising from the data it has been trained on, with repercussions for the wearers of such items that are hard to predict. It is thus important that designers are involved not only when it comes to integrating technology into clothing, but already at an earlier state in the design process of such technologies and co-determining with software developers what data respective algorithms are trained on.

Market potential

The technology is still at an early stage and has not yet entered the mass markets of fashion. Nevertheless, fully functioning prototypes exist.

A few software companies could be identified for this use case that are working on such technologies. Among some of the more well-known brands experimenting with smart clothing are Under Armour, Levi's, Tommy Hilfiger, Samsung, Ralph Lauren, and Google. Smaller companies making a dent in the niche market include Sensora, Loomia, Komodo Technologies, and Hexoskin.[152]

As regards marketing/retail, customers of fashion products are not yet aware of the potential of smart clothing. The market is still very niche and concerns mainly early adopters of technology gadgets, sports and fitness enthusiasts, and medical applications. Unless prices go down, smart clothing will not become a massive market. At the same time, by helping people with disabilities or otherwise physically impaired, smart clothes have the potential to contribute to a more inclusive society in the long run.

10.2.3 Use of AI in business processes

AI is already significantly impacting business processes and is predicted to play an increasingly important role in the fashion and, to a lesser extent, the design sectors. Overall, according to a survey, AI could help fashion retailers to save 340$ billion annually by 2022.

As highlighted, a key trend is the use of data to better understand customer preferences and predict emerging trends. AI is an important tool for the fashion companies which can for example analyse large amounts of images on social media to learn about what microtrends are probable to develop into society-wide trends. Already today, AI can help to lower the forecasting error by 50%. In close connection to the better understanding of trends is the demand in the current fashion industry for a highly efficient, flexible and responsive supply chain. With the help of AI tools, companies can radically reduce their inventory (by 20%-50%). This is not only due to better forecasting of trends, but also some parts of the value chain become automated and can exploit past information at a superior level compared to what humans could manually achieve. Not only from a cost-perspective does this make sense for industry

[152] https://wtvox.com/fashion/smart-clothing/

players, but also it allows to avoid waste, which is making companies more sustainable. AI can also be used to reduce cost for fashion shows and shootings.

A consideration when it comes to the adoption of AI in the design and fashion sector is the skillset of (fashion) designers. Increasingly, designers or fashion companies are relying on heavy data analytics skills and the trend is certainly going towards a higher degree of automation of the supply and value chain.

10.3 Key challenges of AI for the sector

10.3.1 Impact on the sectoral landscape

The fashion and design sector is undergoing a significant change. It faces pressure to become more sustainable and reduce its ecological footprint, faces increased demand from customers wishing to set themselves apart with unique and tailored designs, and has already been disrupted by the online retail revolution more so than many other CCS. On the one hand, this means that businesses and professionals in the sector already have experienced considerable disruption to their work in the past 10 years, on other hand, more change can be expected in the next 5-10 years.

AI is already having an impact on the sector, with technology and design becoming more entangled and AI not only taking over business processes but also becoming involved in the design process. This will inevitably affect designers and other professionals, but likely more in terms of changing the nature of their work rather than making human work redundant.

In fashion, there are large brands and retailers but also small designer outfits and shops. This bears the risk of a lopsided uptake of AI in theory, although there are indications in the use cases presented in this section suggesting that it will be feasible for small players to make use of AI as well. The larger fashion companies have the resources to operate entire departments dedicated to data analysis whereas the smaller players are mostly lacking the inhouse capacity to employ sophisticated data gathering and analysing tools.

Moreover, a distinction needs to be made between the players which have a business-to-business focus and those which are, more downstream, engaging directly with the end user as business-to-customer companies. While the latter have exposure to customer data which can be gathered and analysed, the latter are lacking the direct access to data sources. Yet, especially in the upstream value- and supply chain important data-driven decisions need to be taken in order to meet customer needs and expectations. The missing incentives to share data are a challenge for the industry.

10.3.2 Impact on cultural diversity

A world in which AI takes over the design of fashion and other objects entirely may risk reducing cultural diversity, especially if the underlying algorithms are trained on limited data representing a faction of present-day culture around the globe. Fortunately, from a diversity point of view, such a scenario is not considered likely by industry experts consulted for this study. Rather, a two-tier market may emerge in which some ordinary fashion may be AI-designed whilst human designers focus on more niche and up-market fashion. Another possibility is that AI will actually enrich diversity at an individual level, by allowing customers to demand unique designs tailored to their individual tastes. Which scenario plays out cannot yet be stated with any degree of certainty.

10.3.3 Access to technology and data

There is a hesitancy (or lack of awareness) among some online fashion retailers of the potential of AI technologies to help their businesses grow, which means that uptake is lower than it could be given the rather mature state of some AI technologies described in the use cases below. The fact that profit margins are rather slim in the fashion industry means that any investment in technology, even with the promise of increased profits in the longer run, needs to be well justified.

Privacy concerns and data protection (e.g., in case of data on customers' body measurements) can potentially pose a hurdle to some customers making use of new features related to personalised fashion. Similar, concerns about the storage and usage of health and fitness data may slow down the uptake of smart textiles. More in general, smart textiles are still at a relatively early stage from a technological development point of view.

10.3.4 Access to skills

Human fashion designers and outfit stylists will have to learn how to interact and make use of machine learning algorithms in order to remain competitive as these technologies are increasingly being taken up. Fashion retailers and service providers will also need to hire more computer and data scientists and statisticians in order to successfully embed such AI technologies in their systems or rely on external technology providers to do so. Either way, the demand for such skills in the fashion industry will increase, which means that competitive wages will have to be paid given that such skills are in high demand across most other industries as well. This could potentially pose a challenge in the longer term, given the already low profit margins in the fashion industry mean there may be less leeway in paying high wages than in other industries.

Conversely, several experts consulted for this study maintained that knowledge should flow not only from technologists to designers, but also vice versa, in that designers should help develop AI algorithms to make sure these take a human-centred approach and to avoid biases due to a lack of diversity in the software developer community being ingrained in AI solutions.

Thus, a central aspect regarding skills is related to secondary and tertiary education. While fashion schools (tertiary) need to integrate technology and AI-related modules in the curricula, the understanding of and desire to learn these skills needs to be addressed already in secondary education. Here, the Digital Education Action Plan by the European Commission is a policy in place to promote the acquisition of the necessary skills in secondary education.

10.4 Recommendations

The cost of integrating AI technologies related to personalised fashion or trend forecasting is relatively low. The cost of producing smart textiles is relatively high, but these prices may be passed on to customers, even if this means that the market may remain relatively limited for a while.

Table 30: Sector-specific recommendations: Fashion

Recommendation	Level of implementation (policy, industry, other)	Suitable policy framework (e.g. Creative Europe, other)
Devise rules on the ethical use of personal data such as on body size and health and fitness data in smart textiles	Policy, creative sectors	Rules can build on existing AI guidelines developed at the European level, as expressed in the White Paper on AI, the European Data Strategy, and Ethics Guidelines for Trustworthy AI.
Train professionals in the sector, promote the integration of AI courses in the education of professionals in the fashion industry and the use of human-centred design in AI and technology courses. Initiate a knowledge exchange and networking between fashion, design and technology professionals.	Policy, creative sectors, technology companies	Creative Europe Desks could help bring the different stakeholders together in a network Relevant trainings for professionals in the fashion and design industry could be channelled through the Digital Europe digital innovation hubs The FP7 project ConCreTe which studied conceptual creativity in humans and machines could be built upon under Horizon Europe The White Paper on AI provides an outline of a human-centred approach to AI More widely, the European Skills Agenda could include specific interventions targeted at CCS professionals in the area of digital literacy The Digital Education Action Plan (DEAP) can be used to promote the integration of AI-related questions in education, including through the European Digital Education Content Framework that aims to build on European cultural and creative diversity and will launch a feasibility study on a possible European exchange platform to share certified online resources and connect with existing education platforms.

Source: authors

11 Sector in focus: Film

11.1 Short description of the sector and current overall challenges

The film industry comprises creative, commercial, and technological institutions of filmmaking that range from the creation of a script to film production companies and studios to editing and distribution of films to festivals, TV, online viewing, and cinemas. The industry employs a wide range of competences and talents such as writers, directors, actors, film crew, producers, and marketers in the box office of local cinemas.

Technology is transforming the film industry, and streaming is a fast-growing channel for films. Global SVOD (subscription video on demand) subscriptions is expected by Research & Markets increase by 491 million between 2021 and 2026 to reach 1.64 billion subscribers (Research and Markets, October 2021) that also forecasts that by 2026 three companies, Disney+, Netflix and Amazon will control more than half of the world's SVOD subscriptions.

The European Audiovisual Observatory (2021) reports the same trends in Europe: "*The paid VOD market (SVOD and TVOD) exploded in the past 10 years, with revenues increasing from €388.8 million in 2010 to €11.6 billion in 2020, mainly driven by an astonishing growth in SVOD revenues, from €12 million in 2010 to €9.7 billion in 2020*". The Observatory also reported that SVOD grew from 300 000 subscribers in Europe in 2011 to more than 140 million in 2020, which means a massive shift towards online streaming.

During COVID-19, this process has accelerated, and the Audiovisual Observatory notes that gross box office dropped 70.4% in 2020 compared to 2019. It is still an open question whether the shift from theatrical to non-theatrical audiences is permanent or if the theatrical market will recover after COVID-19. Also, film production in the EU and USA was affected by COVID-19 and dropped by 30%. Due to delays in major Hollywood productions, the market share of European produced films in the EU28 went up from 26.3% in 2019 to 39.7% in 2020 (European Audiovisual Observatory, 2021).

The effect of changed consumer behaviour towards streaming has also spawned a change in the financing of films. An analysis in the Financial Times expected Netflix to outspend all major rivals in entertainment content with a budget of $13.6 billion in 2020. ViacomCBS (Nickelodeon and Paramount studios) expected to spend $13.5 billion on commissioning or licensing content, Disney around $11 billion and NBCUniversal close to $9.5 billion. The streaming services have their own channels, so broadcasters such as Mediaset, ProSiebenSat. 1, RTL and ITV were expected to earn the same or less in 2020. Streaming is also a part of European national markets, and national broadcasters have considerably less buying power than streaming services. The Financial Times indicates a budget for content for BBC at around $2.1 billion and for ARD/ZDF at $4.2 billion (Barker, 2020).

The European film industry and market are rather different from the USA or China with their own challenges such as industry being dominated by small and mid-sized enterprises (SMEs) and market fragmentation due to multiple languages, limited cooperation among the EU Member States within the EU, a lack of distribution of European films outside national markets, and a large box office share of Hollywood films. The European film industry receives state aid where cultural motives prevail over economic motives (Richeri, 2016).

11.2 Key business opportunities of AI for the film sector

According to interviewees artificial intelligence and machine learning are in very early stages in the film industry.

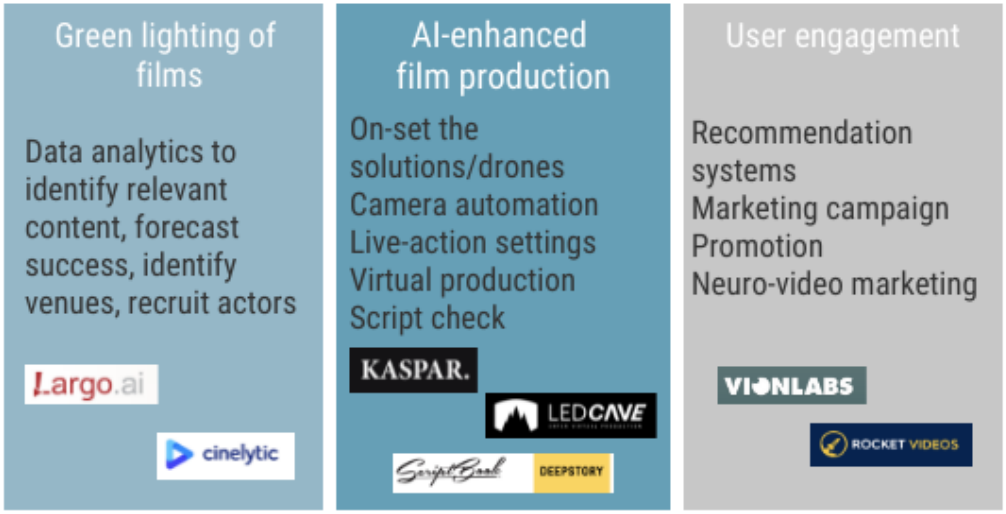
The section includes examples of relatively mature AI technologies that are already applied across the film industry value chain, but most companies identified in this study are small or startups. Exceptions are DJI (a Chinese giant for Unmanned Arial Vehicles (UAVs)), Adobe, and projects with major production studios such as large streaming services, big tech players such as IBM or Google or the large VOD-platforms such as Netflix. Many of the AI services that we have identified are in the early stages, and they may be regarded as examples of what is to come as the technologies mature, computing power increases, and algorithms are refined.

Currently, AI technologies mostly serve the needs of larger film production companies and the VOD market. However, smaller actors in the industry can also find relevant opportunities, such as in the area of special visual effects and better user engagement.

According to the assessment of this study and the review of startups active in AI in the film industry, the following main business opportunities can be listed:

- AI has been effectively used in film production and supports tasks such as film editing, camera automation, and creating special visual effects. The use of AI is often hidden in the film production tool or software and might not be immediately visible to the film producer. Nonetheless, the advancements that the startups developing these AI-based tools can offer is significant to keep the film industry innovative.
- AI can support decision-making and can be applied in the greenlighting of films. Data analytics is a promising field, although the technology is still challenged to make effective predictions. The quality of decision-supporting AI tools depends on the data and the ability to clean and manage databases effectively.
- AI assists audience engagement and marketing, for instance, it can analyse the audience base, the hype surrounding the film, and which actors are the most popular.

Figure 13: Key opportunities of AI in the film industry



Source: authors

The next sub-sections present the application fields of AI in the film industry starting with the cases that represent the highest business potential not just for larger players with more resources but also for smaller film producers.

11.2.1 AI used for film production

The AI-based tools in film production are highly specialised and are often built into known technology or software, especially in video cameras and in editing systems, but there is also workflow assistance to find. One example is the Norwegian startup Visualyst that develops an AI-based tool that transforms the way compliance checks are performed in the film industry. The video is processed by algorithms to identify the most common elements of compliance and it can be tailored to each broadcasters' specific needs. The tool flags questionable snippets from the content and produces a checklist that a human moderator can easily go through and confirm scenes that need to be cut or edited[153].

Regarding the use of artificial intelligence on set, the solutions and tools for these processes range from utilising autonomous unmanned aerial vehicles to exploring potential camera automation techniques in virtual cinematography as precursors for the development of similar techniques in live-action settings (Frohlick, 2020).

[153] https://www.visualyst.co/solution

AI is used, for instance, to create special visual effects and supports the virtual production environment. Virtual reality often relies on the ability to process vast amounts of data at high speeds and needs to be combined with artificial intelligence technologies in order to make new applications a reality. AI models such as deep neural networks can be effectively used to build immersive virtual experiences. They can detect verticals, estimate depth, and segment images and 3D positions.

Production technology: Seervision, UAVs from CineMPC

CineMPC is an AI-based computational tool that can be used for autonomously controlling a drone's onboard video cameras. It has been developed by the University of Zaragoza in collaboration with Stanford University (Fadelli, 2021). Using autonomous drones on film sets have the advantage of being much cheaper and easier to take footage than taking aerial photos from a helicopter.

Seervision[154] is a Swiss robotics startup that is meshing machine learning, computer vision, and cinematography to help broadcasters and production companies automate the process of moving and framing cameras.

Wonder Video[155] is an American startup that develops applications (mobile, desktop and SaaS) to create TV-quality videos, merging artificial intelligence (AI) and human creativity. The company's software offers a professional video production process, a simple user interface, and a digital storyboard, which helps people and businesses to create premium content, enabling them to publish their creations easily and get viral through television, digital signage, web, and social media network.

One example is Carnegie Mellon University in the USA who are developing a system for aerial cinematography. They use insight from human visual preferences to enable drones to make aesthetic filmmaking choices while autonomously filming scenes (Nichols, 2019). A similar example is the CineMPC. World-leading drone-maker DJI with about 70 percent of the consumer markets offers drones that withstand inclement weather, heat, cold, and crashes — with off-the-shelf parts available for reasonable prices (Rezvina, 2018). Examples are the DJI Mavic Pro, DJI Inspire, DJI Phantom, 3DR Solo, Walkera Vitus.[156]

Moreover, machine learning mechanisms can identify the main characters by using facial recognition technology which helps the human film editor to identify such scenes (Allerin, 2020).

Virtual actors: Digital Humans, Headshot, and Synthesia

Digital humans are AI-powered customer experience ambassadors that recreate human interaction used by companies. https://digitalhumans.com/

Headshot from Reallusion offers AI-powered character generation of 3D real-time digital humans from one photo. Headshot is designed for production-level hi-res texture processing and ultimate face shape refinement. The auto mode makes lower-res virtual heads with additional 3D hair in a fully automatic process. https://www.reallusion.com/character-creator/headshot/

Synthesia lets companies create business videos from a text in 40 languages in minutes. Actors, film crews, and expensive equipment is not necessary. AI is used to remove the need for cameras and filming. https://www.synthesia.io/

AI-based tools for virtual filmmaking are found in the US, Europe, and China, in the form of virtual production, virtual stages, and virtual actors.

[154] seervision.com
[155] wonder.video
[156] https://www.mydronelab.com/best-pick/best-drone-for-filming.html

Virtual stages: Unreal Engine, Virtual Stage, MICology, Magnopus GUM Studios and LEDcave

US-based companies have been active in developing virtual stages. To a lesser extent, virtual stages are also available in Europe, for example in Babelsberg with LEDcave[157] (a virtual production and XR studio) or the Dutch FaberAV[158], an audio-visual rental company offering virtual production facilities for film and TV.

In the US, Unreal Engine[159] is a real-time development tool that gives creators across industries the freedom and control to deliver entertainment, compelling visualisations, and immersive virtual worlds.

Virtual Stage (part of Microsoft) is a background matting experiment to create high-quality videos from anywhere, improving current virtual green screening techniques with Azure Kinect depth camera. https://www.microsoft.com/en-gb/ai/ai-lab-virtual-stage. The tool has not been applied to major films yet.

The New York-headquartered **Gum Studios[160]** offers virtual production facilities and provides directors with the possibility to try a film set under various circumstances such as sunset, night, daylight, etc. The technology can, for example, rotate the virtual sun in the level editor and project it onto the environment via a LED.

Virtual production in China and Hong Kong

In China, some producers expect that smart technologies such as virtual production will finally replace current technologies because the virtual and AI technology adoption can help producers cut costs by 50% to 70%.

China has two unique advantages in virtual production: sufficient box office revenue to support new technologies and innovations and world-leading AI development (Shenshen, 2021). Chang Hongsong, founder and owner of Beijing Phenom Films Technology Co for forecasting, says that ***"Smart technologies such as virtual production will finally replace current technologies and the entry threshold in film and special effects production will be lower for more artists".***

The use of virtual production was discussed at the Shanghai International Film Festival, Beijing. Phenom Films Technology Co (http://en.phenom-films.com/company.aspx?t=20) claims to have offered AI and film production services for 400 films, including popular titles such as "Mojin: The Lost Legend" and "Painted Skin: The Resurrection." (Shenshen, 2021).

MICology in Hong Kong opens to virtual production in gaming and filming by creating 3D simulated interactive environments with position and motion tracking systems. Backgrounds can be changed instantly by a command. It's suitable for photography, filmmaking, live streaming, and stage performance. https://micology.ai/.

Artificial intelligence tools are used in editing films by creating trailers for films and assist in editing feature-length films (Allerin, 2020). The technology can learn to understand areas of high action or high emotions and highlight them for the human editor who creates the trailer (Philip Hodgetts, 2016). Tools such as Adobe Colour Match is beginning to take advantage of AI film editing technologies (Frohlick, 2020).

Finetuning video edits: Adobe Sensei and Google

Adobe Sensei is the name of the artificial intelligence engine in the widely used video editing software Premiere Pro. Film editors use a colour match to adjust and match the colours of various video clips with a few mouse clicks and ensure that colour grading meets broadcast standards. The user does not have to understand the mechanics of AI to use the tool.

AI Sensei provides colour matching, auto reframe (reframes the subject of a video shot in widescreen, when you want to export it to social platforms (in square or vertical) and Audio ducking (Automatically

[157] https://www.ledcave.de/locations/berlin
[158] https://faber-av.com/
[159] https://www.unrealengine.com/
[160] https://www.gumstudios.nyc/virtualproduction

adjusts music levels during dialogue, and creates key frames for fine adjustment). More about Adobe Sensei here: https://youtu.be/tL46xeIV5mc .

The Google Cloud platform offers pre-trained AI models that detect over 20,000 entities and actions in your videos. It can also detect explicit content and shots, transcribe speech, recognise text, and more. See **Cloud Video Intelligence**[161] or **AutoML Video Object Tracking**, which allows you to train a custom model using the API to detect and track objects in your videos with bounding boxes and labels. Deploy it to the cloud, then view prediction results in the Cloud Console – or **AutoML Video Classification**, that allows users to train a custom model to classify shots and segments in videos, no machine learning experience required.

Use case: Kaspar A.I.

Overview

Danish-based tech startup Kaspar A.I.[162] develops human validated AI-powered film editing assistance software. The software functionality and usability are tested with a production company[163].

The software helps in identifying characters, objects, places, and action, and shots in the video and tags the footage for further editing in the film and TV industry. It is a new technology application based on the idea that humans will do the creative work, whereas the tedious routine work is done by the AI. The AI analyses and tags the footage, removes shaken or blurred frames, frames with no subject, or in other ways bad video clips. The tags and classifications are made by object detection, actions, place classification or cinematic qualities or landscapes. After the analysis results are loaded into a clip database that the film editor can easily import standard film editing tools such as Premiere Pro.

The vision of Kaspar A.I., in the long run, is to let Kaspar A.I. produce a first version of the film based on narratives or moods in the film[164].

The founders have a background in documentary production, marketing, and AI programming and software development. The service from Kaspar A.I. is based on SaHaas (Software and Human as a service) with a €1 500 subscription price a month and €0.45 per second analysis. The expected revenue for an average production is €2 500 for Kaspar A.I.

The software is implemented and tested by the film and TV company BLUE (Denmark), but if successful, Kaspar A.I. expects collaboration with 10 further film production companies in Denmark, Netherlands, and France. Kaspar A.I. targets primarily mid-sized to major European film or TV companies that have the most demand for editing. The data model of Kaspar A.I. is not yet ready as stand-alone off-the-shelf services that could serve the interest of smaller film production companies. Kaspar AI.I. is targeting documentarists who generate a large amount of footage during the process and consequently need pre-editing procedures.

Value proposition

The value proposition of Kaspar A.I. is to save a significant amount of time in the pre-editing phase and thus free up budget and time for the creative process. It has the potential of reducing weeks of pre-editing to an overnight data crunch by Kaspar A.I. which means that the creative editing process can start sooner, and the budget for creating a film will be lower.

Challenges

[161] https://console.cloud.google.com/video-intelligence/dashboard?_ga=2.162702204.1149268452.1623934402-1379543933.1623934402&pli=1&project=berlin-guide-kort&folder=&organisationId=
[162] https://www.kasparai.com/
[163] A short presentation video is found at t.ly/tO9u (URL shortened)
[164] A model for auto-generation of a film based on user preferences has been presented by Kaspar A.I. at IDFA – International documentary festival Amsterdam (2019) in cooperation with design studio RNDR (NL). The project demonstrated the ability to let AI combine film clips based on user preferences on characters, action, lightning, objects to autogenerate the film based on user preferences.

Kaspar A.I. is still in an advanced development stage. The technical challenge, in the long run, is to get a working, off-the-shelf product that can be easily used by editing assistants. The challenge the first year is to get a first version of the product, called a minimum viable product (MVP) on the market.

Film data is considered to be limited, as most films and TV have strict copyright agreements, meaning this data cannot be released publicly. Therefore, much of the training data is obtained through cooperation with production companies. European film institutes also store vast amounts of film material that could be very valuable to the AI film industry, but which are under strict legal agreements, making it difficult to use this data for commercial purposes. Data for the analysis is the raw footage generated for the project.

In the first versions of the software, staff at Kaspar A.I. will need to be involved and this requires specialist assistance. The innovation plan says that in 2024 an online version could be available that requires a minimum set of skills from the editors and instructors. At that time, Kaspar A.I. expects that instructors or film editors can simply upload their footage, have it analysed by the AI and then receive back a cleaned and tagged database of their footage that easily integrates with Premiere Pro or other industry-standard editing software. "If you know how to google, you'll know how to use the product". [165]

Kaspar A.I. describes their software as a cobot to editors, that reduces the amount of tedious work of preparing the footage before getting it ready for editing the film. The human touch and creativity are still needed to create the final film.

The risk to the first users is failed promises from the software, which is mitigated by the Danish Innovation Foundation that support the tech development. For later users, the risk is a wasted investment if Kaspar A.I. does not deliver its promises, but the risk seems to be negligible in comparison to the time saved in the film editing process.

Market potential

The technology is still at the demonstration level. In terms of Technological Readiness Level (TRL), it can be classified as a TRL 7, which refers to a system prototype demonstration in an operational environment. TRL 9, the actual system is proven in an operational environment, is expected by Autumn 2021 according to the innovation plan in Kaspar A.I.

Kaspar A.I. is a specialised technology provider and will in the long run have the potential to reduce the need for pre-editing assistants.

The technology has yet to be tested against the market. A high volume of production means pressure on editing capacity. Kaspar A.I. is projected to cut 60% of the pre-editing phase in video production, and for the average production, according to Kaspar A.I., this is saving 2 weeks of work and is worth €5 000 to production.

A documentarist can easily have 300 hours of raw footage and may spend 3-4 months reviewing and editing before the final product. The Kaspar A.I. may significantly reduce the time for tedious review and editing and thus leave more time for creativity in the editing process.

The software will, if it delivers as promised, increase productivity and profitability of film creation, especially in situations with a large amount of footage. The savings in time and money from pre-editing may be invested in creative time, lower the financial barriers for creating a film or increase the profitability of filmmaking. Employment in the film industry may shift from pre-editing assistants to instructors or creative editing.

11.2.2 AI used to support decision-making

Machine learning technology also has a rising role in greenlighting films. The decision-making process of moving forward with the film or not is closely connected to the potential revenue of the film. The introduction of AI tools has already begun to transform the ways in which films are developed and researched prior to the essential 'greenlight' decision (Frohlick, 2020).

Artificial intelligence is used in financial forecasting tools that predict the revenue of a film with 85% accuracy, such as Largo.ai (Largo.ai, 2021), Cinelytic (Cinelytic, 2021) or Vault (Raevskiy, 2020). Raevskiy distinguishes situations where the needs of the viewer depend "on many parameters: religion, gender,

[165] Interview with CEO Esbern Torgard Kapsersen, 4. June 2021

age, geography, cultural characteristics, etc. The life of such a viewer is generally algorithmic, predictable, therefore, AI predicts a film's success with high accuracy. Raevsky points out that algorithms will favour safe and profitable films and dismiss unsuccessful scenarios. This could lead to a reduction in diversity and potentially crowd out newcomers (Raevskiy, 2020).

AI support business processes in both creation, production, and the distribution phase. In the creation of films, tools like Largo.ai, Cinelytic, and ScriptBook support decision-making in the early stages and while experimenting with the script, cast, and budget to optimise ROI. AI tools forecast the return on investments depending on the script, type of film, cast, expected markets, and so on. For filmmakers, sound financial analysis is important before investing and AI tools are available to everyone for a fee and are relatively simple to use.

Data from the distribution phase and users' behaviour used to create user recommendations may increase the profitability of some films while making it more difficult to make films that are new and innovative in their concept[166]. According to producers who engage with recommendation systems, the results are still experimental, but the engagement is there, and since there might be a first-mover advantage, the systems will eventually be effective decision support instruments.

Use case: Greenlighting film productions

Overview

The use case is about artificial intelligence systems supporting decision-making in the early stage of film production. The use case is defined as artificial intelligence tools and algorithms which aim to assist film content creators to make faster and better-informed decisions through predictive analytics in the greenlighting stage. Greenlighting is the process by which a film studio formally approves a film's production based on decisions about the feasibility and earning potential of the film project. Two AI platforms,

Cinelytic and Largo.ai are discussed here as a use case. "*Artificial intelligence and machine learning are in very early stages now both in the film industry, as well as in other industries*", says Dev Sen, Cinelytic and Sami Arpa[167,168] .

The target groups for artificial intelligence systems which help decision-making in the greenlighting stage are film studios and investors. Up until now, they have based their decisions on human intelligence. The promise of AI technology is to support better decision-making and help to reduce financial risk, improve profitability, stabilise capital flow, and improve efficiency in the production of filmed content.

Largo.ai has, in 2020, initiated a project with 22 European producers to expand the knowledge and value of using artificial intelligence in the film industry (The Usage of AI in European Movies (online seminar), 2021). The producers have used the artificial intelligence tools developed by Largo.ai for 6 months on their film projects that were in development. More than 60 films at different stages have been analysed by AI tools during the programme. The two producers who participated in this programme with their films discussed their experience with the usage of AI tools while producing a film at the workshop[169] (The Usage of AI in European Movies (online seminar), 2021). The overall feedback from the producers was positive, but usage is still on an experimental level.

Business needs and value proposition

The technologies are still in the early stages of development, and the spread of technology is limited, but the potential for forecasting turnover may make the film industry more economically sustainable and democratised. The value of the analytical tool from Cinelytic is thus linked to the economic considerations

[166] Note that The European Commission has adopted the Media and Audiovisual Action Plan to support the recovery and transformation of the media and audiovisual sector and that MediaInvest is dedicated to equity investment to foster European audiovisual productions and distribution strategies. https://digital-strategy.ec.europa.eu/en/policies/maap-implementation

[167] Sami Arpa is co-founder and CEO of Largo Films.

[168] Interview with Sami Arpa from Largo.ai. TEAMS based interview 25.2.2021

[169] Danish Technological Institute participated in the workshop, 4.3.2021, 15:00-16:00.

in film production and how the production becomes more efficient in terms of planning and economic optimisation.

One interviewee mentioned about largo.ai, that "*It is very intuitive to use, and you get a small introduction, and through practice you get to understand. However, you still need to make your own conclusions. I use it mostly for a quick opinion. It takes maybe 15 minutes to start an analysis, and another 30 minutes to understand and compare. It helps me profiling the film and to confirm, what I already do intuitively. It confirms or proves that I am not completely of the track. But it is based on track records and cannot foresee the impact of disruptions such as COVID-19*".

Artificial intelligence does not replace creativity but assists the film industry to be creative. The platform simply does the number-crunching and modelling based on the user's input to provide detailed information that the user would use to support their decision-making process (Chow, 2020). Time is one of these resources that holds a lot of value in the film industry and thus the main value proposition of these companies is that their products will save producers and executives valuable time that can be better spent on more complex and creative tasks (Chow, 2020).

Besides forecasting the financial revenue, artificial intelligence tools promise to contribute to the decision-making regarding the casting process. A value of the tool is that it can suggest a list of possible actors for the role based on the actor's previous roles. AI cannot choose the best candidate but can come up with suggestions. AI may democratise the process because it gives all the actors in their database the same opportunity to be proposed as a possible candidate for the role as soon as they have matching attributes with the character in the project. However, the use of such technology is a disadvantage for the completely new actors without any previous experience, as they are not registered in Largo's databases, but in the future, it will probably be possible to create a DNA of new actors from their demo reels. According to Largo, AI technology can handle new types of films that are not similar to the rest in their databases since they categorise a film on many parameters and break it down into many sessions, which makes it possible to compose films in many ways. Therefore, their AI technology can handle brand new creative film ideas well.

Market potential

The companies studied here are still in the startup/SME segment. If the value proposition of the companies is fulfilled, they could attract more clients, money, and competitors. The tools are expensive for small producers to use, and one producer joined as a test company only with government support for an 80 percent price-reduction: "That is only for big players. Small producers cannot pay that amount of money. Every month for that money you can run three new analyses. The quota does not really work for me. It is nice to have, not need to have."

One interviewee, a producer who tested the AI from Largo.ai comments: "*My motivation for the involvement with Largo.ai is mostly out of curiosity and to be part of the development, by giving feedback from a producer's POV to further develop the tools according to our needs. And of course, to know how things work – in order to be able to get the most out of it commercially for my projects, once we're a bit further.*"

Challenges

Largo.ai, expresses that there is a lack of knowledge about artificial intelligence in Europe. Cinelytic and Largo.ai can be found online, but the technology is still not widespread among filmmakers. Interviewees observe, "that it is not the impression that AI is on the top of filmmakers' mind. Largo.ai has been doing presentations for a while now, which stir some interest. At the moment, it seems that the immediate commercial benefit for development and production is still building up, while the sales predictions are looked at with great interest. In this development state of the AI tools, they don't see any monetary difference for its use".

Using artificial intelligence tools in the greenlighting stage of film production is not without challenges. They include the attitude towards using technologies in the creative film industry, the fear that AI technologies might standardise future films, the EU lagging behind competing markets such as the US or even China, and the methodological challenges of using artificial intelligence.

The forecasting tools are not a technological marvel to the film industry which ensures only profitable films to be produced. Forecasting models based on past evidence have inevitable limitations, i.e., artificial

intelligence cannot forecast unexpected situations such as a global pandemic that influences the entire film industry. The forecasting tools need human interpretations and contextual understanding.

The data sources in the predictive analysis are a combination of public and private data. The interviewees from Cinelytic and Largo.ai could not be specific in which data they are using due to competitive reasons. The used data in their artificial intelligence systems is concealed from the public and competitors since the data is the base and most essential part of their forecasting tools.

According to Cinelytic the interest in AI systems is higher in the USA than in the European market because US films are financed by private investors and large corporations, who expect a return on investment. This increases US companies' interest in Cinelytic and other technologies that can reduce risk and improve profitability.

One obvious critique is that the introduction of AI into the decision-making process at the greenlighting stage will spell the end of the creative, novel, and 'risky' projects being produced, and this would be detrimental to the diversity of the film ecosystem at various levels (Raevskiy, 2020)(Chow, 2020). Dev Sen does not think that creativity in the film industry is challenged by AI since AI cannot model cause-effect but can only find correlations between variables. Therefore, at least in the near future, AI will not take over human creativity.

A key concern of using AI in the film industry is that of bias and perpetuated stereotypes (Farish, 2020). This line of argument results in a concern that film culture will become homogenised. At the workshop "The Usage of AI in European Movies", one producer feared that the artificial intelligence technologies will lead to standardisation of film and that the tools were only available to those who could afford it (The Usage of AI in European Movies (online seminar), 2021). The producers were impressed by the script analysis, financial forecasting, and casting tools but also said that they were not afraid that the technologies will replace the creativity, "*if you know the system, you can still be original*".

Largo.ai has experienced, and still finds, that the film industry has misconceptions about what AI is and what it can do. Largo has experienced that there is resistance to using AI in the film industry but typically only until they find out how much value it has. However, they have experienced that the industry can change rapidly and is generally experiencing great interest in using artificial intelligence.

According to interviewees, AI technologies in the greenlighting stage may change decision making in the film industry in the future. The decision-making power of the film industry is concentrated on very few people. By using AI, this decision-making process can be more democratised, faster, and better-informed based: "In the next 5 years, we think that the global film industry, including studios, streaming companies, and independents, will more fully embrace the use of AI in assisting decision-making across the entire value chain".

A consequence of introducing artificial intelligence in the decision-making process is that it will replace some jobs that were human-only until now. Such job positions within market research, industry analyses, audience surveys, financial forecasts will be in competition with the intelligence of the computers. In this case, their fears are certainly legitimate, and it is up to company executives to decide how reliant they will be on the AI tools over their human colleagues (Chow, 2020).

The response to that negative impact of using artificial intelligence is that the tools to aid decision-making will provide a more accurate prediction about the performance of the film that would really only be utilised as an aid by its human users (Chow, 2020). The tool would be used as a time-saving tool for decision-making.

The eventual impact of their predictive models is only minimal since the actual creative decisions are either made before or after the involvement of AI (Cinelytic, 2021). Their platforms simply serve as an informational aid and that the human is still ultimately in charge of the final decisions, while also reminding critics of the fact that AI models as they stand today are still a long way off from achieving true intelligence that matches or even surpasses the human ability to create (Chow, 2020).

One interviewee sees a challenge from the point of view of the producer: "If the investors use these tools, it might endanger the innovative capacity of the creators. If financing decisions is based on the past and they just trust the tool. It will be a threat since content should fit markets and not necessarily an artistic vision. A solution is to make tools accessible to producers. If we know it - we also have the information

and the power better balanced". The interviewee also underlines that the price tag means "that it may only be for bigger players, and only granting access for small players will level the playing field".

In addition to generating new scripts, machine learning algorithms can be used to analyse the scripts for things like gender representation. Examples of companies offering this are ScriptBook and Largo.ai (Allerin, 2020), (ScriptBook, 2021) (Largo.ai, 2021). This technology can help film producers to improve the quality since computers analyse faster and more systematically than humans.

Analysing scripts: ScriptBook and DeepStory

Belgium based **ScriptBook** offers an AI-based platform to analyse film scripts. The value proposition from ScriptBook "lies in the improvement of the human greenlighting process, eliminating false positives and bias while maximising a film's potential for critical and commercial success". https://www.scriptbook.io/#!/

DeepStory is an AI-powered script and story generator developed by ScriptBook. ScriptBook claims that DeepStory is a way of democratising storytelling with the use of AI. This next-generation writing tool uses neural networks to help creators co-write original stories with the help of AI. It is a beta version – and it is free to try.: https://www.deepstory.ai/#!/

Another part of this stage is the tasks in the pre-production phase which include scouting a location, casting actors, and planning shooting scheduling (Allerin, 2020). Artificial intelligence can be utilised to plan schedules and to identify real-world locations to shoot the scenes. Besides being valuable in being time-efficient, AI algorithms can be used in the casting process. AI algorithms can assist the producers to choose the right actors:Based on the history of the actors the machine learning algoritm can contribute to targeting the marketing campaigns where the actors are most popular.

Pre-production: Locationfinder, Yamdu and casting.ai

Locationfinder.ai is a visual search engine powered by artificial intelligence. It is fast, and the service delivers access to thousands of film-friendly locations all in one place making location searches quick and easy for scouts and managers. Locationfinder showcases location agencies' and film commissions' locations to a huge worldwide audience of professional managers and scouts. https://locationfinder.ai/

Yamdu.ai Yamdu is a **creative management system** for every type of visual production. Our tools help you schedule your project, plan and manage your tasks, share information, communicate, collaborate, and create everything you need during every stage of production. Take control with Yamdu. https://yamdu.com/

Casting.ai AI agents can measure the size and engagement of an actor's online audiences, which is quickly becoming the most important factor in casting. Also, the AI agents eliminate the need for days or weeks of phone tag to book a single actor. With automated systems, actors can be booked directly from your phone with just a couple of clicks, as fast and easy as ordering an UBER. https://www.f6s.com/casting.ai

11.2.3 AI used for audience engagement and accessibility of content

The success rate of a film often depends on marketing and promotion, where artificial intelligence can assist in analysing the audience base, the hype surrounding the film and where the actors are most popular (Allerin, 2020). Based on such screenings the film production is enabled to targeting marketing campaign more directly to their target group.

Another way to target the marketing campaigns by using artificial intelligence is to use individuals' likings (Allerin, 2020). It means using public data from social media and grouping individuals to create personalised advertisements. Another example will be automated trailer generation by AI as demonstrated by IBM Watson in the Morgan Film Trailer (Smith, 2016) or by Netflix or Amazon to recommendation of content on their streaming platform (Subramanian, 2019).

Speech-to-Text: Sonix A.I and CaptionHUB

Sonix A.I translates speech into text in more than 30 languages. It is a cloud-based tool that works from any connected device. The text can be exported, or the video can be edited using the text. It might not be for major films yet, but for promotional videos it may be enough. https://sonix.ai/

CaptionHub is an online captioning platform used by some of the world's largest brands, reaching millions of users. Built with a sophisticated combination of artificial intelligence, human workflow management, speech recognition and machine translation, CaptionHub's mission is to offer the best solution to streamline and improve captioning using cloud technology.

AI-based speech-to-text engines automates the transcription work and may even be done in different languages. Examples are Sonix, AI that translates into 30 languages, HappyScribe[170], AI Dubbing[171], or Simonsays[172], with an online service. Automatic speech-to-text software increase the accessibility of the video or film for people with certain disabilities or a foreign language audience and make sub-titling possible where it is otherwise too expensive to do. It may reduce the demand for professional translators and subtitlers. The market for captioning and subtitling solutions is estimated to have a Compound Annual Growth Rate (CAGR) of 7.7% during the forecast period 2021-2027 (Valuates reports, 2021).

Use case: Recommendation systems on VOD

Overview

Major Video on Demand (VOD) platforms like Netflix and Amazon uses recommendation algorithms to allow users to discover new films and guide their choices. On video platforms such as TikTok or YouTube, this is even more central to the user experience and here AI technologies can not only analyse the metadata and user behaviour to guide choices but also analyse the video content itself to find other similar content.

AI-based recommendation software for VOD platforms is not exclusive to the major VOD platforms.

AI-based analytics to understand user behaviour based on user data from an online platform is used widely on websites in other sectors. The service is also offered in the cloud. One example is **Recommender** from Coveo[173] that is used to create recommendations on online platforms of almost any product, including film. Another, similar product, is from Klevu[174], which is marketed as a general powerful and extensible e-commerce search solution that delivers search results based on the shopper's intentions and behaviour, in real-time. It can be integrated with open-source CMS systems such as Magento.

Finally, there are open-source alternatives open for small VOD providers such as LensKit, Crab, Surprise, Rexy, TenderRec, LightFM, Case recommender, Spotlight[175], or MoView Engine (Vallari Manavi. Anjali Diwate, 2020). But clearly, big players such as Disney+, Netflix and Amazon has a stronge advantage in possessing own data.

[170] https://www.happyscribe.com/
[171] https://videotranslator.ai/news/text-to-speech-ai-dubbing-and-what-you-can-do-with-it/
[172] https://www.simonsays.ai/da/home
[173] https://www.coveo.com/en/products/platform/recommender
[174] https://www.klevu.com/
[175] https://analyticsindiamag.com/top-open-source-recommender-systems-in-python-for-your-ml-project/

Value proposition

The value of the recommendations systems for users is that it offers personalised and relevant content for that user. For the platforms using the recommendations systems, the focus on presenting offers most relevant to the user/customer/viewer may increase sales and have them stay longer on the platform.

Challenges

In dissemination, the most interesting field for AI may be with recommendation systems, but it is also found that it is very complex and is proprietary to the large streaming platforms. AI systems are trained on existing data and patterns of data. A good side of recommendation is that audiences get help to get an overview of the thousands of films. But for the moment, the recommendation systems used by the major VODs are echo chambers that recommend films that people are already seeing, and the data is not transparent outside the platform. There is also a risk of perpetuating a self-reinforcing uniformity if the platforms keep recommending content that is very similar to already popular content.

There is general risk in the lack of transparency and exclusivity of data in recommendation systems by the major VOD platforms: "To put it in a nutshell, thanks to the data they collect, they [VOD platforms] prescribe what the public expect, and they produce films according to the taste of the majority of their public. At the same time, the rightsholders, do not have access to the data of the consumption of their films. There is a lack of transparency and hardly any consumption/profile of the public reports are being communicated to them." (Eurocinema, 2020) As the interviews stressed the producers/broadcasters who 'embed' their programmes on the platforms need to know their public. Otherwise, they rely on a third party for the consumption of the works in which they have invested. They are blind and this cannot be accepted. On the contrary, YouTube and the social networks promoting these programmes such as Facebook or Snapchat have a very precise view on who is interested in what. They can monetise this information to other clients that wish to launch targeted advertising or even use them for their own VOD platforms.

Market potential

Recommendation systems are mature software in the sense that the technology have progressed from research to products on the market. The major VoD providers do not share information or technology, but similar systems can be bought by other VOD platforms or other forms of online film distribution.

The interest from major VODs indicates that efficient recommendations systems are a competitive feature in demand with VODs. The most interesting field for AI may be with recommendations systems according to some interviews.

Since the recommendation systems used by major VODs are black boxes in terms of data input, algorithms, and results, it is impossible to estimate the effect. There might be room for variety in that the VOD platforms use different systems.

11.2.4 AI supporting the exhibition of film

Downstream AI tools are used in the distribution of films, but the AI and the associated data sources are proprietary to the companies and are used especially by VOD companies. One example is the market leader Netflix (Netflix, 2021), which explains how AI is used in a multitude of ways – such as in optimising own productions, understanding user preferences for personalisation of film recommendations, scouting locations, and improving streaming quality. Also, Netflix uses AI in the pre-production phase, i.e., Netflix ordered the first two seasons of "House of Cards", a 100 million dollars investment, based on data on user preferences (Petraetis, 2017).

AI tools are also finding their way here, for instance, AI techniques for user-friendly navigation and personal data security (SoftAtHome[176]), HomeOS[177], an AI-based cloud-native home operating system (OS) that also offers enhanced cybersecurity monitoring capabilities and parental control, or LiveScrypt which is a cloud and AI-based speech-to-text transcription service that enables audiences to engage with live events as they happen.

[176] https://www.softathome.com/tag/ai/
[177] https://www.microsoft.com/en-us/research/project/homeos-enabling-smarter-homes-for-everyone/

AI in trailers: Vidnami

Vidnami is a tool for making trailers. It is a point-and-click video maker for everyone. Vidnami create videos in minutes. Vidnami automatically transcribes clips and creates captions. Vidnami uses artificial intelligence to 'read' text and automatically selects video clips from their library of 790,000+ clips. Vidnami automatically combines text, clips, voice tracks, and music. No video editing experience is needed: https://www.vidnami.com/

11.3 Key challenges of AI for the film sector

11.3.1 Main challenges of artificial intelligence in the film industry

- The film industry is transformed with the rising importance of digital distribution of films through streaming on online platforms. Digital platforms, such as Netflix, already have a competitive advantage in the combination of access to own data and the use of artificial intelligence. The direct-to-the-consumer services combined with own productions sets US filmmakers and media groups in a favourable position to be main players in the European film market, as seen in the forecast that three SVOD may dominate more than half of the worlds SVOD subsribers by 2026.
- Low awareness of AI opportunities within the film industry. The opportunities of artificial intelligence throughout the value chain in the film industry is not obvious to the industry. The low awareness may result in missed business opportunities for both tech startups and for the film industry. Raising awareness may accelerate the demand for AI based solutions.
- Artificial Intelligence is still a young technology and many of the tech companies are startups and some of the tools are not mature products. It is a two-way street: It takes mature technologies to convince buyers in the film industry and on the other hand it takes demand to support technology development. Supporting innovation, tests and access to data may accelerate the supply of AI based solutions.
- Access to data may or may not be a challenge depending on the purpose and analytics done by the artificial intelligences. Artificial Intelligence are statistical models that are trained on large datasets. For some uses there is an abundance of data, while some interviewees believe that access to data is a problem. Datasets could be anything from for example tagged data in films, pixel information, user ratings, script databases or information on actors. The need for data is as diverse as the application of AI.
- Access to finance is a challenge for AI startups for developing AI based solutions for the film industry and for small companies in the film industry to access these tools. Funding is needed to remove a barrier for first movers.
- Access to skills is important for the tech side, and there is a risk of losing ground in commercial use of AI to both US and Chinese actors. The skills needed in the film industry is the understanding of AI and the capacity, and incentive, to use the tools.
- New business models and the use of AI throughout the value chain in the film industry may in the longer run disrupt job functions in the film industry when, craft-based skills such as set decoration displaced by virtual sets or editors of raw material are displaced by efficient algorithms in postproduction of the film.
- A threat to creativity? Human creativity is an important fuel in the film industry, and some interviewees raise the flag when it comes to the use of AI to greenlighting and casting film, since AI cannot foresee the success of patterns that differs from the leaning dataset which is always in the past. Outlier or innovative success films such as Parasite would have been very difficult to predict using predictive AI systems. AI is a statistical tool, and it can also be an inspiration in projecting film if it not used in a rigid way.

11.3.2 Access to data

In the film industry, there are datasets on audience behaviour and preferences, datasets on scripts, datasets with economic information, datasets on actors, or technical data to be used in the editing of a film. Some of the data sets are proprietary, like data on user behaviour on VOD platforms, and other

actors are not transparent about their data sources since it might reduce their competitive advantage[178]. The data they use may be their own generated data, public sources, or data traded with other companies. Proprietary and exclusive data may be a competitive advantage, but as shown in the data table below there are open source and commercial datasets available.

Tech startups can also find innovative ways to make use of data. For instance, JustWatch is an online guide that collates films, TV series, and other types of TV streaming, enabling users to skim through content libraries to find what is available, where it can be found, in what quality resolution, and at what cost, etc.[179] The company is powered by building an app for movie fans and uses their data to run highly (re)targeted campaigns for movie studios[180]. Justwatch.com has found a way to use the TMDb API for their cross-platform information services. That is an example of using open-source data to provide new services to viewers in competition with or sometimes supplementing the service provided by each platform.

Table 31: Examples of data and data sources in the film industry

Data Type	Data source	Conditions to access	Web
Digital scripts	Sentiment dataset at Stanford	Open-source	https://ai.stanford.edu/~amaas/data/sentiment/
	OMDb API	Open Source	http://www.omdbapi.com/
	Internet Movie Script Database	Fair use	https://imsdb.com/
Films	FilmGrab	Fee-based	film-grab.com
	MovieStillsDB	For editorial use only	https://www.moviestillsdb.com/
	Film AI	Commercial	https://flim.ai/
	OMDb API	Open Source	http://www.omdbapi.com/
	TMDb	Commercial / Free for non-commercial use	https://www.themoviedb.org/about
Film metadata	IMDB datasets	Free for non-commercial use	Imdb.com
	The Numbers	Free for non-commercial use	the-numbers.com
	Movie Data Set	Research, Free for non-commercial use (Ends 1999)	https://archive.ics.uci.edu/ml/datasets/Movie
	Cinemetrics – mark up tool and data	Community database	http://www.cinemetrics.lv/
	Telus Videodata	Commercial	https://www.telusinternational.com/solutions/ai-data-solutions/data-types/video-data

[178] In the EU, personal data is regulated by the GDPR-regulation while anonymous data is unregulated by GDPR.
[179] https://www.techradar.com/news/what-is-justwatch-the-tv-streaming-service-guide-explained
[180] https://www.justwatch.com/blog/post/justwatch-audience-as-a-service/

Data Type	Data source	Conditions to access	Web
Categorised cinematic shots	CineScale	Accessible for research only	https://cinescale.github.io/
Viewer data (user behaviour)	Streaming platforms, Cinemas	Hold privately	
	Movio	Commercially available	https://movio.co/
Film reviews	MovieLens 20M Dataset	Free, Research	https://grouplens.org/datasets /movielens/20m/
	Cornell Film Review Data	Free, Research	https://www.cs.cornell.edu/people /pabo/movie-review-data/
	IMDB reviews	Commercial	Imdb.com
Market and sales data	Streaming platforms, Cinemas	Hold privately or commercially available, subscriptions	
	Internet Movie Database	Commercially available, subscriptions	Imdb.com
	The Numbers	Commercially available, subscriptions	https://www.the-numbers.com/
	Box Office Mojo	Commercially available, subscriptions	https://www.boxofficemojo.com/
	Vista	Commercially available, subscriptions	https://www.vista.co/vista-products/vista-products/experience/
	Lumiere	Open source	https://lumiere.obs.coe.int

Source: authors

Available data is often fragmented, not uniformly standardised, or un-structured and may be insufficient for the purpose. Low-quality data leads to low quality in the predictions. Well-defined standards could raise the quality of existing data and perhaps also the profitability of applying AI to predictions. And since not all data is publicly available and must be bought, workshop participants suggested that the EU could have a financial scheme to help startups for kick-starting their business.

Some open-source options such as the sentiment dataset at Stanford exist. This is a dataset for binary sentiment classification containing substantially more data than previous benchmark datasets. They provide a set of 25 000 highly polar film reviews for training and testing. There is additional unlabelled data for use as well. Raw text and already processed word formats are provided[181]. And as mentioned above, there are open-source alternatives to be used in, for example, recommendation systems for small VOD providers such as LensKit, Crab, Surprise, Rexy, TenderRec, LightFM, Case recommender, Spotlight[182], or MoView Engine (Vallari Manavi. Anjali Diwate, 2020).

Also, IMDB, the Internet Movie Database, and a service like https://www.the-numbers.com/ that sells film business data should be mentioned in this regard. One site provides a list of 23 data sources for the film

[181] https://ai.stanford.edu/~amaas/data/sentiment/
[182] https://analyticsindiamag.com/top-open-source-recommender-systems-in-python-for-your-ml-project/

industry and concludes that the majority is commercially available, while a few are open-source (REALTÀ, u.d.).

Data for greenlighting films include data on the success of films by the same directors, production firms, casts, same genre films, similar kinds of storylines, or of promotional channels adopted, as well as demographic data and data from social media platforms.

Cinemas may be at a disadvantage compared to VODs in their access to data on audience behaviour and startups may not have, or lack the finances to, access exciting, commercial data. The cinemas may be able to access data but may lack the skills to exploit the data to gain a reasonable return on their investment, while tech startups may have the skills, but not the means to access data for development, training, and experimenting with their AI models. Thus, some form of support for publicly available data from the film industry would be an advantage to smaller players. If it can be made in cooperation with the film industry it could improve the quality and diversity of data.

For cinemas, relevant data range from film ticket prices, the types of films being provided, the number of varying films being provided, the remake or sequel ratio, the competency of marketing strategies, the ratio of international blockbusters to domestic, the age appropriateness for films to the size, location, and technology used in the theatres (Rangaiah, 2021). Cinemas may be at a disadvantage in access to data compared to VODs, which have international reach and an abundance of proprietary data on user behaviour and preferences.

For other applications, such as the examples seen with video editing, the data needed for analysis is readily at hand since it is the footage itself that provides the data.

The massive degree of data available at the behest of the film industry players, the power of data analytics in the sector will only rise, owing to which the future of the film industry will observe a more systematic approach towards the industry's operations with the employment of data analytics at every step (Rangaiah, 2021). However, since most data about films is often not freely available, data access may be a barrier to startups, as explained by interviewees.

Access to data can be improved with data standardisation, that shapes disparate data sets into a common data format and therefore expand analytical opportunities and value. There are already European initiatives on standardising film data to help preserve digital film[183] in parallel with initiatives from CEN[184] and from Germany. Also, for example TMDb[185], IMDB[186], OMDb and MovieLens[187] have tagged their data.

11.3.3 Low awareness

There are numerous examples of AI tools in development or already on the market. Interviewees report that the awareness of AI opportunities and threats seems to be rather low outside expert tech circles. It is technology picked up by front runners rather than mainstream businesses. AI technology is not known for being used by the film industry yet and film producers are not concerned with AI in general. AI does not really exist in the mind of the producers and there is not much interest in the subject. At a workshop, the subject of AI may trigger a lively debate but overall, there is no major awareness as highlighted by some interviewees.

Especially since China and the US seem to be more engaged in using AI, the lack of awareness of AI for films may be a competitive disadvantage for the European film industry. In the US, it seems that the big studios (WarnerMedia, Disney), VOD platforms (Netflix), and tech companies such as Google, Adobe, or IBM are engaged in creating AI-based solutions. But many of the examples of AI solutions mentioned above are created by startups and relatively small companies.

There are also some artistic or creative dangers in using AI: "*If filmmaking is standardised, like in Hollywood, then AI may be useful since AI is thriving on existing data. Hollywood tries to replicate the business success*

[183] https://joinup.ec.europa.eu/collection/rolling-plan-ict-standardisation/preservation-digital-cinema
[184] CEN/TC 457 'Digital preservation of cinematographic works'
[185] https://www.themoviedb.org/documentation/api/wrappers-libraries
[186] https://www.imdb.com/interfaces/
[187] 20 million ratings and 465,000 tag applications applied to 27,000 movies by 138,000 users. Includes tag genome data with 12 million relevance scores across 1,100 tags.

of a film and to achieve again what they achieved in the past, take for instance the film "Fast and furious", now in its ninth incarnation".

11.3.4 Access to skills

Skills can be related to AI programming skills and development of services and skills can be related to users of AI services such as decision-making producers, writers, directors, photographers, editors, and people in distribution of the films and, finally, the audience itself. Film production companies of the future will need their team to be equipped with AI competences at various levels:

- Film producers oversee the entire filmmaking process. They will need AI skills to use tools that assist decision making about scripts, user trends, and film production. Feedback from recommendation engines and streaming companies on user data will be essential to support them.
- Applying AI in the technical process of film production (such as creating visual effects, editing films, improving on-set solutions, e.g., for lighting or camera setup) needs the responsible crew to be trained in AI. As complex technical tasks will become easier to perform with the help of AI tools, the job content of current employees such as colourists, editors or camera men will also change. AI can replace some of the laborious work, but it will also need the new film production team to have competences in managing AI tools, understanding both the potential and limitations and being able to develop or finetune AI algorithms themselves.
- Casting directors and locations managers will need skills to understand how to make better decisions with the help of AI algorithms about possible actors or filming locations. As the market of AI startups is growing, those who offer such AI tools, understanding the operational model, and the algorithm/data behind them will be essential to become better at the job.
- Besides a general upskilling in AI, some of the more entrepreneurial film production companies will need to hire AI engineers that can develop more complex AI algorithms for their specific use.

AI programming skills are in high demand, and at the moment both the USA and China seem to be far ahead of Europe in terms of applications of AI. Big players in the industry are often related to Hollywood, for example, Netflix. Most startups with AI services are based on people with a strong set of AI skills, perhaps in combination with people with film industry insight – as is the case with, for example, Cinelytics and Kasparai.

In the film industry, the leading companies seem to have their own AI capacity. There does not seem to be a demand for AI programming skills among small film production companies or cinemas. The interviews are inconclusive, as one points to "CERN" as an inspiration for cooperation across countries on new technologies and another believes that the amount of red tape for creating a common AI tech centre for the film industry renders the idea useless. The combination of Hollywood and Silicon Valley does pose a competitive advantage for the US film industry and if a creative and efficient common research and innovations centre can be established it would be a way to have a European answer.

On the user's side, many AI services can be accessed online and most will be presented as easy to use. Others are integrated into existing tools such as film-editing tools that are already in use. As is demonstrated in the case of greenlighting films, the skills needed are not AI programming skills but skills in understanding what AI does and what can be concluded from the results. With a good understanding of the tools. results from AI, e.g., greenlighting films can be used as a guide or for inspiration instead of just accepting output as the final truth. Providers of AI services may have a self-interest in guiding and instructing their users, but public information will help this process.

And finally, the audience outside the film industry may need the skills to understand that an AI is recommending a selection and what that means for their options.

11.3.5 Access to funding

AI technology may be developed outside the EU, but it will also be used in the EU if the business model is compelling. One interviewee said: "The challenge in the EU is to apply for funding (for AI development in the film industry). You are expected to have the full roadmap already from the beginning, it is almost impossible to participate in Horizon Europe since the overhead is very large. Also, you need to hire someone that does nothing other than administrating the Horizon Europe programme, and you need partners from many countries. The creative part of inventing and developing new technology is just a

smaller part. In contrast to public investors, a private investor is only concerned with the return of the investment. There are not as many rules. Public funded innovation means accounting for every penny. That is complicated. Too complicated. It is a dilemma since the EU market is too fragmented a market to keep content relevant to different parts of Europe. It is necessary to produce relevant content for Europeans, but it clashes with the need to scale-up".

The situation might be mitigated by the following:

- Access to innovation financing: "Shortening the rule book in the EU innovation and other support programmes to be more relevant to tech-developers"
- Raise awareness among filmmakers: "It is necessary to expose filmmakers to more AI-based technology. i.e., the curriculum in film school. They do not need to understand codes and be programmers, but they need to understand what AI technology can do for you. It helps to understand the world better."
- Avoid complicated funding structures: "A public financed testbed, like in Babelsberg, is not a great idea. Financing could come from the EU, state, regions, and with too many strings attached. It would take too much time to be relevant".

AI technology may make more sense for the film industry in the future, for instance, 10 years from now. But there will always be a need for someone to create content and someone to connect to the audience. Automated film making or film generation may come in use for specific audiences or creating films that adapt to the circumstances of its audience, that might be someone with a small screen in a train or someone in a cinema.

11.4 Suggestions for actions in support of smaller players in the sector

The use of AI in the film industry is, for most applications, at very early stages and in many cases, further tech development is still needed to reach mature and effective tools. Most services are developed by very small companies with less than five employees and as the interviews show, the actors in the film industry are, to a great extent, unaware of the potential of AI when it comes to everyday business. Small players can be both AI service providers to the film industry and small players in the film industry.

The promotion of the AI tech community in the film industry is crucial in order to unlock the potential in AI for the sector. This can be done by supporting awareness, and willingness to experiment with AI tools in the film industry and, finally, fostering increased cooperation between the AI tech community and the film industry. Such initiatives could help unleash innovation and create a stronger position for AI in the film industry. It would also help small players in the film industry since many of the AI-based tools presented above have the potential of reducing production time and costs and increase the outreach of films.

11.4.1 Access to data

A first European initiative could be to develop data standards as suggested by some interviewees. Standardising data will improve data quality, interoperability of datasets, as well as improve the quality of the training datasets that AI is building upon.

Another suggestion is to develop a common data platform for film archives within in the EU. It was suggested that a data pool for the EU could be based on exchanging of data between members of the European Broadcasting Union for internal purposes. Such a pool of data would help smaller companies to a more rapid start, and a database with exclusive access for European companies could be a competitive advantage compared to startups in USA and China.

11.4.2 Access to skills

On the tech side, general support and promotion of AI training will improve the base of skilled AI programmers that startups and more established companies can draw from. European supported cooperation between AI experts and the film industry can, if made practical, spawn both innovation and new companies.

The skills needed for smaller players in the film industry is not programming, but a better general understanding of AI and how to apply it. The services are often user friendly but an improved, general understanding of how AI works will help them to avoid the pitfalls such as "the echo chamber" effect.

Interviewees pointed out that a better understanding of the value of using data strategically in the film industry would be necessary throughout the value chain from producers, sales agents, distributers, and cinemas.

A European supported communication initiative to promote the general understanding of AI in the film industry or broader in the cultural and creative sectors may lead to greater interest and awareness in the business of the creative potential in AI-based tools. An increase in market demand will attract investments in the AI tech industry.

11.4.3 Access to funding and new collaborations

Access to funding is relevant for tech startups or for removing the barrier for filmmakers to be the first movers and experiment with AI-based tools. It was emphasised that tech companies need a better understanding on how the value chain in film operates to build better AI solutions.

This could further important interaction and collaboration between the AI tech community and filmmakers to accelerate innovation and the creation of relevant services. One possible collaboration scheme is to great data pool of film material which have gone into the public domain. This would provide AI tech companies with better AI training material and hence a stronger foundation for development of relevant AI solutions.

A funding scheme or innovation programme at the EU Level would increase incentives to work across borders and strengthen the EU market position. One area for funding[188] could be to help tech startups and small businesses to access or buy film data for training AI models. Startups and small companies are not on an equal playing field with large companies that can afford to buy data.

Also, funding for filmmakers and producers to experiment with AI tools, is a way to accelerate the uptake of AI technology and including filmmakers and producers in the development process with feedback and testing is also a way for tech companies to develop better tools AI-based tools.

Most AI service providers offer new business models that may potentially disrupt the way films are decided upon, produced, edited, or distributed. This disruption may just as well come from small players as large players. European supported cooperation between AI experts and the film industry on innovative uses of AI may spawn new business models and more European based initiatives.

Table 32: Sector-specific recommendations for the film sector

Recommendation	**Level of implementation**	**Suitable policy framework**
Promote the AI tech community in the film industry, supporting awareness, and willingness to experiment with AI tools in the film industry. Put in place pilot AI projects in the film industry.	Industry/EU policy	Already eligible under Creative Innovation Lab & MEDIA tools, and being showcased at EU events such as the European Film Forums.
Promote data standards. Standardising data will improve data quality, interoperability of datasets, as well as improve the quality of the training datasets that AI is building upon. European sales agents/distributors should use standardised Electronic Press Kits (EPKs).	Industry	
Develop a common data platform for film archives within in the EU.	EU policy / Film archives	Creative Europe / Horizon Europe / Digital Europe Film archives could prepare for the upcoming call for proposals for a media data space under Digital Europe in Q3 2022

[188] Suggested in break-out session organised at the workshop 30 September on 'Opportunities of AI technologies for the CCS'

Recommendation	Level of implementation	Suitable policy framework
Develop and implement a training scheme about the general understanding of AI and use of AI tools in the film industry.	Industry	Creative Europe Programme, part of the Pact for Skills on CCI initiative Funding is already possible under MEDIA training, but the industry needs to apply for it
Develop a training module about the use of data and its opportunities in the film sector.	Industry	

Source: authors

12 Sector in focus: Museums and cultural heritage

12.1 Short description of the sector and current overall challenges

The International Council of Museums (ICOM) defines a museum as a "….*non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment*"[189] - and for the purposes of this work we will use the term heritage as a catch-all term for tangible and intangible cultural heritage.[190]

This sector is one of the few creative sectors that remains predominantly end-to-end analogue. The other being the performing arts. By end-to-end analogue we mean, that the heritage and artefacts acquired and exhibited by museums are traditionally and remain predominantly experienced by visitors in a physical building or location. Consequently, AI has had less of an impact on the museums sector compared to many of the other creative sectors that have gone through a process of digitisation over the past 20 years. Not all museums have digitised their collections, and it is understood that they remain predominantly experienced by people in a physical or analogue capacity.

The analogue and location-based nature of the sector means that this sector is one of the most impacted by the recent and ongoing COVID pandemic. ICOM and UNESCO reported that in May 2020 "almost all museums (95%) around the world were closed because of the COVID-19 pandemic".[191] These closures are reported to have resulted in job losses and permanent closures. The full impact of the pandemic is not yet fully estimated. However, in response to the crisis, the same report suggests that "many museums enhanced their digital activities" during this time – with digital activity increasing for at least 15% of all museums. While "digital activity" and audience engagement through digital will never replace physical and in-person experiences, increasing digital activity is part of an overall trend in the sector to further adopt and supplement location-based activities to conserve and exhibit artefacts and culture.

Sometimes museums and networks of museums make their exhibitions, collections and research available digitally and online for the public. Europeana[192] is a prominent European initiative supporting this transition. There is also a trend towards online-only collections and exhibitions – popular examples of this include the Google Arts and Culture project.[193]

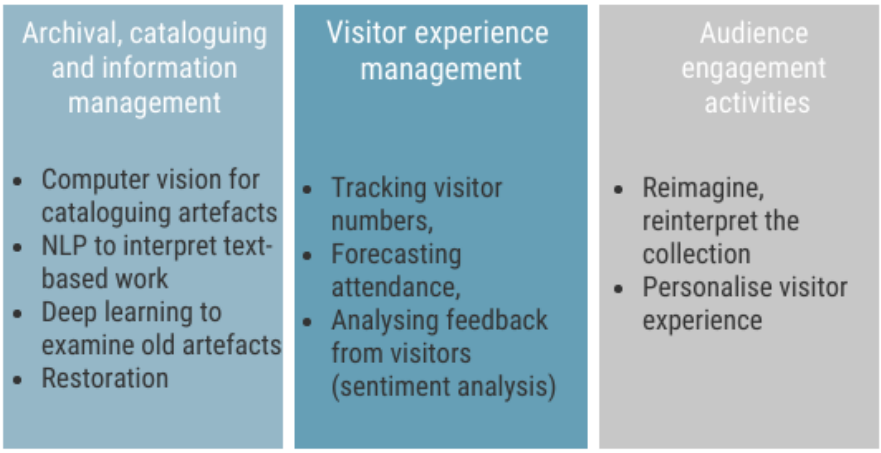
12.2 Key business opportunities of AI for the museum sector

As museums and collections further digitise there are opportunities to make use of AI for the benefit of the sector. Opportunities can be summaries in three groups:

- Archival, cataloguing and information management applications enhanced by AI. This will help Museums and Heritage organisations (as well as archives and libraries) to research and categorise their digital collections more effectively;
- Audience engagement activities. Organisations can use AI to better communicate and engage their audiences, making interactive exhibitions more engaging;
- Visitor experience management. Organisations can better manage their venues using AI applications, while tracking visitor numbers, forecasting attendance, and analysing feedback from visitors (sentiment analysis).

[189] https://icom.museum/en/resources/standards-guidelines/museum-definition/
[190] http://www.unesco.org/new/en/culture/themes/illicit-trafficking-of-cultural-property/unesco-database-of-national-cultural-heritage-laws/frequently-asked-questions/definition-of-the-cultural-heritage/
[191] https://icom.museum/en/COVID-19/surveys-and-data/survey-museums-and-museum-professionals/
[192] https://www.europeana.eu/en
[193] https://about.artsandculture.google.com/

Figure 14: Key opportunities to use AI in museums



Source: authors

12.2.1 Use of AI in content creation

The role of the museums and heritage sector is to "acquire, conserve, research, communicate and exhibit" society's cultural heritage. The process of acquisition and conservation at a museum has in recent times become a digital process, with physical and born-digital artefacts captured, catalogued and if necessary digitised as part of the process of collection management at a museum.

The process of collection management requires conservators and those involved in the collection management process, to capture as much information as possible relating to an artefact so as to adequately conserve that artefact. This process can include generating and storing associated meta-data, processing and archiving documentation and other ancillary information, the conservation and restoration of an object, and/or high-resolution images and 3D models.

Collection management is a labour intensive and traditionally a manual operation that requires a high level of expertise and subject specific knowledge. There is a role for AI in assisting conservators and museums throughout the collection management process, reducing the overheads and complexities involved in all aspects of collection management.

- Tagging and classifying objects: Computer vision, as an AI technology, is being employed experimentally to support institutions in identifying and tagging objects in a collection. This technology enables museums to semi-automate the process of cataloguing objects for a collection and helps speed up this otherwise manual process. The technology and the application are still experimental but have the potential to lower the costs of cataloguing and digitisation. For instance, they can be used in archival research by recognising patterns, ancient handwritings such as making a difference between Latin or Greek, helping to classify objects.
- Text processing: Computer vision combined language and text processing enable museums and archives to also process, analyse and interpret text-based works. This enables researchers to carry out a semantic analysis on text-based archives and ancillary research material. In turn this means museums can provide better access to collections online.

Machine learning and AI are also applied to the restoration and conservation of ancient art works. For this task AI has already been successfully applied using image analysis to "in-game" areas that are damaged. This enables conservators to fill-in missing areas as part of a complex restoration to a high level of accuracy.

Computer vision in museums

When the Science Museum in the UK moved over 300,000 objects to a new storage facility, they photographed, catalogued and published these objects online. The museum is using Amazon's 'Rekognition' service to add keyword tags as part of the cataloguing process. The results of the automated tagging process are available on an experiment website called 'What the Machine Saw'

AI painting restoration in museums

Rijksmuseum's in Amsterdam used AI to restore missing edges from a painting called The Night Watch from Rembrandt. The museum used a neural network and trained it to colour in a style that Rembrandt used in the painting, including colours and his brush strokes. The missing strips were fabricated using the AI created strips that were affixed to the painting.

Use case: Unlocking the value of digitised collections through AI

Overview

A number of Museum and Heritage institutions in Europe and beyond are using AI to organise, analyse and generate new data and, ultimately, knowledge from their digitised collections. In the case of institutions and organisations with a large amount of digitised records, images are often not supported by enough metadata and keywords, making them difficult to organise and search. AI can be used to assist the categorisation or tagging of these images, increasing user engagement and accessibility. The rapid increase in accuracy and sophistication of the algorithms will allow researchers and curators to access and analyse a larger quantity of information, making new connections between artworks and generate new knowledge.

A selection of needs museums, libraries and archives have to face on a daily basis, include challenges in the management, research and engagement activities. We can group these in three distinct areas:

Organisations are, by definition, institutions that conserve tangible and intangible heritage of people and communities . Institutions often store a large number of objects which are difficult to search and classify. Often institutions do not even have a sense of how many objects they store in their archives. In the cases where institutions have invested in building a digitalised archive of such collections, these are sometimes classified through a long manual process, which makes the data difficult to navigate and to be updated.

Challenges in collection management inevitably have a knock-on effect on the research and curation activities performed by knowledge workers employed in these institutions or conducting research independently (e.g. universities, research centers). Accessing databases and researching transversal themes in a meaningful way is still time consuming and often inefficient. Research is often based on metadata or tagging, which does not facilitate unexpected discoveries and associations between objects. This is even more complicated in the case of objects from different media formats. Narratives built from the analysis of objects follows traditional canons of curation, which in most of the cases are linear, west-Eurocentric, and bearing patriarchal and colonised narratives within them. There is a need to innovate these narratives and create inclusive and engaging stories that can continue to be meaningful for communities.

This is also linked to a third central challenge shared by museums, libraries, and archives – which is the need for the creation of meaningful and effective communication processes between audiences, the heritage preserved by these institutions and the research outputs produced by them. Organisations need to exhibit and communicate with audience in a meaningful way, both in their physical spaces and online (e.g. their website). They have to be mindful of how human attention and perception works. They also need to communicate to a wide audience, but still provide content that responds to people's interests and backgrounds.

For most institutions, the use of AI in their digital collections is still in its infancy and it is used for experimentation rather than systemic interventions. The main actors involved in these activities currently are:

- Management teams in Museums, Libraries and Archives, as well as universities, which are initiators and catalysts for interventions;
- Professional networking platforms and communities, such as EuropeanaPro, AI4LAM, The Museums + AI Network, that offer formal and informal safe space for debate among professionals and institutions on the role and implications of use of AI in the sector;
- Digital agencies and designers, which in some cases collaborate with institutions in the design and delivery of digital products and digital innovation projects;
- National and international aggregators (e.g. Europeana, Cultura Italia, Gallica) that collect digital collections, promote the use of big data in the sector and lead on advice on IP rights;

- Software companies and cloud providers, which offer the infrastructure needed for these activities. Sometimes companies also support institutions with special projects to showcase the potential of their technology products.

Business needs and value proposition

AI applications can be applied by institutions to facilitate innovative solutions to these challenges and act as a tool that can assist the researchers and designers' ability in their work in museums and heritage organisations.

Conservation

AI applications can be used in the management of digitised collections. AI could assist in cataloging, analysing and clustering artworks, books and heritage objects. Computer vision could be used to identify details, styles, materials, colours, patterns and organise data accordingly. In other words, ML can contribute in creating meaningful and searchable datasets. Examples of AI used in managing digital collections include:

- AI:Cult project, by KNAW Meertens Institute, CWI, KNAW Humanities Cluster, Sound and Vision, and the National library of the Netherlands. Financed by the Netherlands Organisation for Scientific Research (NWO) (The Netherlands). The project is using AI-assisted automated analysis to improve the descriptions of artefacts in museum collections, with a final goal to produce automated interpretation material that is inclusive.
- VVR4CH (Visual Recognition for Cultural Heritage) project, by Flemish Institute for Archives, Fashion Museum of Antwerp, and IT company Datable (Belgium, 2018). The partners employed visual recognition services to explore their museum potential in describing and categorising their image collections more efficiently.

Research and curation

Once the data is created and organised, ML applications can support in research and curation activities through analysis, clustering, identification of new connections between objects and supporting interpretation. The research community sitting outside the institution can also access those artefacts not currently exhibited by institutions. National and international data aggregators are now starting to move in this direction too. For example:

- The Saint George on a Bike project, led by Barcelona Supercomputing Centre in collaboration with Europeana (Spain): The project aims to improve the quality and quantity of open metadata associated with European Cultural Heritage imagery. The project aims to transcribe insights of evolving iconographic traditions in a dataset accessible to ML and AI, as well as to expand conventional ML approaches, centred on image recognition, with the ability to decipher the complex pictorial language that characterises iconographic symbols.

Engagement

Digital archives which include AI and ML features in their system could also benefit the way data, objects and artworks are then exhibited to the public – both in the physical exhibition spaces and in online engagement and education activities. For example, audience could take an active role in classifying, linking and interpreting data in co-creation processes facilitated by the institutions. In the future, exhibition spaces empowered by digital approaches will be able to offer highly personalised experiences based on audience interests. For example:

The Metropolitan Museum of Art (MET) in New York (US) organised an event where members of the public were invited to the Museum's Great Hall, and using a game interface on screens, manually associate tags to digitised artworks. The data obtained was fed into the museums' system and became training data, while becoming an opportunity for audience engagement and co-creation.

Technology

The central approach used in this typology of projects is Computer Vision and Recognition, an interdisciplinary approach that aims to train computers on how to recognise, classify, and analyse digital images and videos. This is already offered within some platforms as part of their 'software as a service' practices (Microsoft Computer Vision, Google Cloud Vision, Clarifai, Microsoft Azure). Museums and Heritage institutions that have experience with visual tagging of digital artworks often use these "off the shelf" solutions, given their relatively simple APIs and support services.

Natural Language Processing can be used if the objects to be preserved have a written format, and for example in the case of books and archival documents. In this way, large amount of text can be analysed, classified and indexed, assisting researchers in their work .

As with any Machine Learning solution, the system needs to be fed with some initial data to learn from. Some cloud management tools assist in this process selecting which data in a dataset needs to be labelled by humans and sending it to a manual service or third-party vendor for labelling e.g. Mechanical Turk.

Challenges

The vast majority of EU memory institutions have not yet adopted AI and ML in their day-to-day collection management, curational and exhibition activities. This is related to a number of challenges they might experience in their work.

In many cases, heritage organisations seem to be reticent to apply these systems to their work. This is mainly linked to a lack of awareness of the potential benefit of AI/ML techniques and associated technologies, which in many cases leads to reluctance in adopting change. There is a common concern among professionals, and partially, among audiences, that either algorithms or manual tagging used to train the system is likely to include human-generated bias, that is then augmented by the ML system. If embedded in algorithms and not managed properly, this could lead to limited diversity in curatorial and research outputs. Knowledge workers are also often concerned about releasing and sharing data held by their institutions, and not at ease with copyright and data control practices.

Strongly linked to the lack of awareness, heritage institutions do not often have the appropriate skills and knowledge needed to adopt these technologies. For those institutions which would like to adopt changes and bring AI/ML in their practices, management teams are unsure whether to invest on team members with appropriate skills levels or whether to collaborate with external companies or design agencies on ad-hoc basis.

Lack of awareness and skills for innovation in this area lead to challenges linked to data and the availability of such for the development of new approaches and processes. The digitisation process is often a time-consuming process, and often the data available are not stored in the appropriate format. Copyright and concerns about copyright infringement remains a barrier often cited by professionals in the sector.

Technical development of AI/ML approaches is developing fast, and innovators in this sector know that the technology will soon provide more sophisticated systems for an improved collection management through AI. More than challenges, stakeholders interviewed have reported opportunities and aspirations the technology might want to work towards in the next years. This includes for example an improved way to control internal biases that might be produced by the system. Similarly, new solutions will soon be found to increase engagement with users, and avoiding self-repeating patterns enabled by the AI/ML system. The future development of AI/ML algorithms will also improve the accuracy of these systems, reducing the human input required in manipulating the data. This will soon lead to a more sophisticated personalisation of content, which might lead in personalised learning and discovery experiences for audiences.

Museums, archives and libraries often do not have the economic means to embark on innovation processes of this scope. Salaries and the way specific skills needed to produce these changes are also considerably higher than the average levels earned by knowledge workers employed by cultural heritage institutions.

Extensive work will be needed to mitigate the challenges and perceived risks present in the sector. However, it has been reported that some actions could be taken as a step to empower organisations in innovating their practices and driving change:

- Education and continuous professional development activities delivered by publicly funded organisations and their communities can help in managing risks and challenges related to awareness and skills development, as the development of these technological applications grow.
- In Europe, national and international aggregators can play a pivotal role in providing opportunities for collaboration, development and skills development, as well offering high quality datasets and data lakes to the sector. There is also an opportunity for these players to host and develop AI-powered systems within their own databases.
- As will be described below, many of the challenges the sector is facing are also shared by professionals active in other areas. This offers an opportunity to cross fertilise ideas and applications outside the specific application and look at solutions developed in other sectors.

Market potential

As seen, a number of European institutions have already started to experiment with AI/ML application for their digital collections systems. However, financial, skills, and more fundamentally, awareness challenges, are still hindering the development of these applications. On a technical level, applications still need a significant presence of humans to check the presence of biases and assure quality of outputs.

The number of technology providers present in this field is appropriate to the demand. In most of the cases heritage institutions develop their own system in collaboration with external companies who can offer tailored products. Larger companies also often collaborate with institutions pro-bono or offer 'off the shelf' products that could be adapted by institutions to their needs. In these cases, consistency across time and continuous development of software and products based on the changing needs of the institutions can be a challenge.

Innovation and adoption of new systems and processes in this specific sector are rarely driven by market demand and economic return, especially in Europe, where heritage institutions are traditionally subsidised by governments. Applications of this kind, however, could bring significant cost reductions and improved efficiency in collection management.

12.2.2 Use of AI for audience engagement and accessibility of content

Increasing audience engagement and accessibility with a museum's collection and exhibitions is an important driver for the use of AI at museums.

A museums greatest asset is its collection. Often these collections are large and difficult to fully access for users and visitors. Museums work to curate exhibitions for audiences selecting artefacts and presenting those artefacts as part of a narrative to make a collection accessible, informative and entertaining for audiences.

AI can support the curation process, making collections and exhibitions more immediately relevant for users and visitors, potentially personalising and generating playful visitor specific experiences that reimagine and reinterpret a collection - increasing engagement with the collection. To that end AI has been used to compare artworks in a museum's collection with external references, for example submitted selfies from users[194] and photographs from the news sources.[195]

AI-enhanced online exhibition

Recognition is an online exhibition that uses artificial intelligence to compare artworks with photojournalism. The AI searches through the Tate's collection, looking for visual and thematic similarities between artworks and news images.

AI could also be deployed across many separate collections from different museums, drawing insights and curating exhibitions based on recognised patterns. Deploying AI across collections and museums is particularly useful in a European context considering the breadth and depth of Europe's collective heritage. Once a visitor is at a museum or on a museum's website, through the use of chatbots, interactive systems and robots[196], AI is being harnessed to improve and personalise a visitor's

Use of a chatbot in museums

The Anne Frank museum in Amsterdam uses a chatbot to provide visitors with more information on the life story of Anne Frank while at the museum. In addition to the extra information the chatbot provides about the exhibition, it also offers practical visitor information. The chatbot deployed by the museum uses deep learning technology known as msg.ai which allows it to offer a one-to-one tailored response to visitors.

experience. This includes the use of AI to make museums and their exhibitions more accessible. In this context AI enabled chatbots and interactive tools are enhancing exhibition experiences for visitors, providing additional historical and artistic information, and responding in real time to visitor questions about the exhibition and the museum.

At some museums robots are used to support the visitor experience and to provide multi-lingual support to enable greater access to exhibitions.

[194] https://artsandculture.google.com/camera/selfie
[195] http://recognition.tate.org.uk/
[196] https://www.si.edu/newsdesk/releases/smithsonian-launches-pilot-program-pepper-robots

Robot used to interpret art works in a foreign language

The Smithsonian National Museum of African Art in Washington uses a robot to interpret some of the artwork at the museum that is in Swahili. The robot was trained to understand and pronounce the language to support visitors better access the artworks on display.

12.2.3 Use of AI in business processes

To improve and optimise a museum's operations and business processes AI is playing an increasingly greater role.

Using AI combined with historic visitor data – museums can forecast the popularity of an exhibition and the number of visitors to an exhibition. This process can enable museums to adequately allocate resources and to consider the scale of an exhibition required to satisfy audience demand. Museums can learn what themes and artworks are popular with visitors, providing an informative feedback loop between visitors and a museum.

Predictive analytics to forecast visitors

The National Gallery in London has over 6 million visitors per year. Using machine learning, the Gallery explored how to move beyond simply analysing past visitor experiences in the museum, to employing innovative predictive analytics in forecasting future attendance and visitor engagement. This informs the museums business forecasting and resource allocation for the exhibitions ahead.

Similar to other sectors, museums could use AI to identify potential customers and visitors, analysing posts from social media or ratings from tourism websites to bring new insights into the visitor experience.[197] While these techniques are nothing new in business, the application of these AI powered processes can increase the success of museums in reaching new audiences and visitors. This, in the future, could also inform strategic decisions within organisations, especially around communication and operational activities

Museums are increasing generating more and more visitor related data. However, this data typically only refers to or is related to an individual institution. To maximise the opportunities from AI and big-data, the museum sector should consider opportunities to share data as part of a common data-pool. Pooling data would enable museums, particularly smaller museums to maximise the opportunities through AI. In addition, there is a general shortage of AI skills across all industries. AI talent that is available can be expensive. The sector should consider how it might collaborate to develop and grow the AI capabilities and talent specific to the sector through a shared AI personnel resource.

Use case: AI tools to predict visitor numbers

Overview

AI is currently used in a limited number of exhibition venues and museums to forecast the number of visitors and their movement within a museum. The interaction between people, space and the exhibitions has positive effects on institutions' operations management, visitor satisfaction and safety.

Museums and heritage organisations often struggle in forecasting the amount of visitors they will host on a given period of time. This is related to the high amount of variables that might influence this, which include internal and external factors (e.g. weather conditions, period of the year the exhibition is happening, venue location, exhibition price, popularity of the exhibition theme or artists, amount of exhibitions being displayed in other venues, etc.).

Larger institutions also are often interested in investigating how people interact with their spaces, and how they might react to different exhibition designs and flows. This would also have benefits on safety, especially at a time when social distancing is practiced and venues capacity is monitored.

There is still a limited amount of institutions that apply crowd management systems, and even a smaller number that use AI in their systems for doing that. The main stakeholders involved in this use case are:

[197] Ariana French, Elena Villaespesa, "*AI Visitor Experience, and Museum Operations: A Closer Look at the Possible*, in *Humanizing the Digital: Unproceedings from the MCN 2018 Conference*, 2019.

- Management teams in Museums, Libraries and Archives. Larger institutions with free access are the most likely to face these challenges and explore solutions in this sense;
- Specialised agencies and companies, which in some cases offer standardised solutions to institutions. These include e.g. the company Dexibit and the startup Culture Hint.
- Professional networking communities and conferences often offer a platform for institutions to exchange knowledge and experiences in this area.

Value proposition

Having a reliable figure for visitor numbers and flow would have positive implications on a number of areas and challenges faced by institutions:

- Venues could anticipate where any problems could arise and design a system to manage that movement, thus helping to optimise the visitor experience. This means that in the long run, and through these systems, institutions will be able to suggest personalised experiences based on people's interests, while managing flows effectively.
- Forecasting visitor attendance would mean that the heritage institution will be able to plan more effectively the resources needed in the space. This includes the number and location of personnel in the exhibition areas, as well as in areas such as cafés, restaurants, toilets or shops. Planning resources in this way would lead to both cost savings as well as revenue generation. Venues management are often the biggest single source of operating cost in exhibition venues and museums, and efficiencies driven by AI could facilitate cost savings.

Technology

Visitor tracking and forecast within exhibition spaces has been performed in a number of ways and using an array of technologies. This includes, for example, tracking visitor location through the Wi-Fi use on their phone, to the identification of flows through security cameras in exhibition spaces through heath mapping, to visitor trackers. Some of these approaches use AI and ML either in the form of Computer Vision or as an approach built in the optimisation model.

Challenges

The vast majority of EU cultural heritage institutions have not yet adopted AI and ML approaches in their operations and venue management. This might be related to a number of challenges:

The main resistance is related to visitors' privacy and related legal issues. Venues fear that systems used could identify visitors and that personal information could be collected when using Wi-Fi or security cameras to track their movements. Evidence collected through interviews, show that systems, however, do not need to collect personal data to function. For this reason, it might be said that privacy concerns are therefore linked to a low level of awareness and resistance to change.

Institutions rarely have the in-house capacity to develop and operate systems for crowd management. A number of companies and agencies have however started to offer services to support institutions in this transition.

Education and knowledge sharing between institutions, as well as an increased entrepreneurial attitude and innovation management skills within heritage institutions will support organisations in their transitions. The presence and support given to independent think thanks, research centres and universities will also ensure that approaches for responsible data use are defined and shared within the community.

12.3 Key challenges of AI for the museum sector

The main challenges that the Museum and Heritage sector is facing in adopting AI are related to

- Lack of awareness, availability of specific skills and knowledge among museum professionals, and the relative limited development of this field. This inevitably leads to a limited understanding or the opportunities in this space. Organisations are especially worried to infringe data protection or copyright laws.
- Level of digitisation of collections supported by high quality metadata.
- Scarcity of funds, wage imbalances between museums staff and specialised staff with AI competences
- Beyond the use of AI to better understand audiences, improve, and inform the visitor experience, there are no clear immediate business or commercial opportunities for AI in museums and heritage organisations.

All these challenges, and especially in the case of smaller organisations, induces organisations in consider this type of investments risky and less urgent.

12.4 Suggestions for actions in support of smaller players in the sector

12.4.1 Access to data

Museum and heritage organisations might need incentives to leverage existing metadata and digitised collections to develop some pivot projects. Initiatives such as Europeana are seen as well positioned to support data access. This EU-wide initiative empowers the cultural heritage sector in its digital transformation via tools and policies to embrace digital change and encourage partnerships that foster innovation. Europeana works already with thousands of European archives, libraries and museums, and it represents a valuable opportunity for future development in this space.

12.4.2 Access to skills

Initiatives and projects could be organised at a European level for the acquisition of awareness, skills, knowledge exchange and networking for connecting and training workers in the museum and heritage sectors and professionals with AI expertise. Funders might consider, for example, financial support (e.g. through voucher schemes) to third parties (e.g. technology providers, developers, designers) that might support cultural organisations or consortia.

Training schemes aiming at increasing entrepreneurial skills and absorptive capacity (an organisation's ability to recognise the value of new information, assimilate it, and apply it to commercial ends) might also be beneficial.

12.4.3 Access to funding and new collaborations

Being most of the museums and heritage organisation non-for-profit, funding for such developments might need to come from public procurement supported by national or supra-national policy initiatives and schemes. Taking inspiration from US based initiatives, there might be the opportunity for sponsorships and/or partnerships with the private sector or private businesses. Expertise on how to manage and lead effectively relationships of this kind might be needed.

Pan-European bodies consulted during the process reported that funding should allow organisations active in the cultural sphere to invest, experiment, and, as necessary, to fail in this area. Innovation funding should be available to cultural organisations as it is for companies active in other sectors.

12.4.4 New business models

The rise of startups or agencies that have sector-specific knowledge and experience in developing projects for museums and heritage sites (collection management, visitor experience and engagement) can be seen a more sustainable solution for organisations that might want to innovate in this space.

Table 33: Sector-specific recommendations for the museum and heritage sector

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Foster the use of common metadata standards in the museums and heritage sector, raise further awareness	Industry	National/regional support programmes (e.g. Europeana) European data space for Cultural Heritage
Support projects for AI experimentation that help collaboration between cultural organisations, startups and practitioners Put in place a voucher scheme that can help testing some of the available tools	EU policy National/regional incentives	Creative Europe Programme, Horizon Europe, S+T+ARTS, and national/regional support programmes
Support and enable connections between startups and organisations active in this sector	Industry	

Source: authors

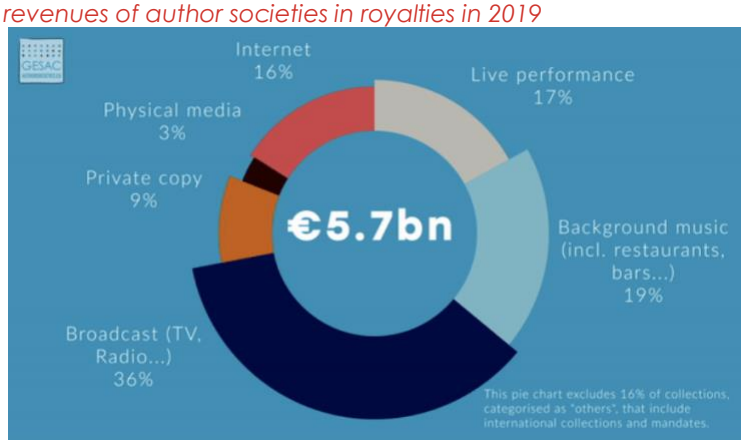
13 Sector in focus: Music

13.1 Short description of the sector and current overall challenges

The music sector is composed of three sub-industries: notably, recorded music, music licensing, and live music. The overall sector includes a long tail of small businesses and independent artists, while the market is controlled by three main record labels, the French-owned Universal Music Group, Japanese-owned Sony Music Entertainment, and US-owned Warner Music Group. Music is increasingly intertwined with other industries, such as social media, film, television and online video, and these trends are also relevant for the adoption of AI.

According to the Grouping of Societies of Authors and Composers[198], 459,000 people have received income for musical compositions across the EU27 and UK in 2018. The global recorded music market grew by 7.4% in 2020. Total revenues globally for 2020 were $21.6 billion (IFPI, 2020). The highest source of revenue for the music industry comes from broadcasting and background music.

Figure 15: Source of revenues of author societies in royalties in 2019



Source: GESAC, https://authorsocieties.eu/royalty-collections-2019-what-the-figures-reveal/

The proliferation of the internet in the music industry has radically changed the way music is consumed. Online and on-demand streaming services emerged resulting in new management models and forms of revenue distribution especially in the recorded music industry (Skoro and Roncevic, 2019). Digitalisation led to new power balances and reconfigured the relationships among artists, major record labels and the end users. The move to the digital space helped a lot for smaller players to get a new chance to stand out from the crowd and engage with their fans in new ways. The music industry's digital revenues (including streaming) represented 63.3% of total revenues in 2019 (Impala, 2019) and grew even further in 2020 (IFPI, 2020). Digitalisation enabled the industry to reach out to audiences easier on the one hand, but it made more difficult to stand out from the mass on the other hand, and finally to also monetise their content. The online consumption of music has created new rules for monetising musical content. Today, the biggest challenge for independent, unsigned artists is to find a way to attract attention and monetise their content, while also keeping their authenticity[199].

The live music industry has been hit hard by the COVID-19 pandemic and the world of music has moved even more to the digital sphere. Venue-based activities had to close down their operations and live streaming has become more standard. According to the report of IFPI (2021), the global recorded music market grew by 7.4% in 2021, thanks to a continued rise in paid subscription streaming revenues. As a result of the lockdowns, online content services benefited from increased uptake of subscriptions. Companies like Spotify enjoyed substantial business growth (KEA, 2020).

Some of the most recent key challenges of the industry include the following:

[198] https://authorsocieties.eu/royalty-collections-2019-what-the-figures-reveal/
[199] https://blog.fortunes.io/mickey-shiloh-interview/

- Reach out to a new generation of digitals: Engaging new users on a continual basis requires novel creative content but also new ways to make this content accessible. New generations do not necessarily consume music in a linear way but need more engagement with their idols, with the music experience itself. Customer value is increasingly created by providing the audience with tools that allow them to do things with music rather than just simply access it[200]. With the surge in social media use, the ability to draw attention to music is more and more linked to visual content.
- Dividing the digital 'streaming pie': The music industry is highly concentrated and dominated by major record labels[201]. Revenues generated by streaming are unequally distributed at the disadvantage of musicians. Revenue models need to be rethought to make sure that the industry can negotiate commercial rates for streaming (Impala, 2021). There are a range of new opportunities arising for artists to monetise their content through short videos on social media (even if they do not provide large revenues) or collaborating with other industries in new ways.
- Reinventing live events: As a result of the pandemic and lockdowns, many artists have been struggling to monetise their content, and had to find new ways to engage fans, converting readily available music into fee-based services through new models of livestreaming. This year (2021) has brought some relief, but the concept of events will need further innovation, hybrid models and new ways of organising them.

13.2 Key business opportunities of AI for the music sector

AI development in the music sector is driven by the AI labs run by major online platforms (Spotify, Apple Music, YouTube, Amazon Music, Deezer), tech companies (Google Magenta), work-around research centres (e.g. Ircam in France, the Music Technology Group in Barcelona), and a buoyant scene of tech startups.

The major labels are less actively investing in AI technologies, although they have strengthened their distribution technology capabilities. Sony Music invested in The Orchard (2015) and has launched a licensing division placing clients' music in films, television, advertisements, games, and elsewhere. The Orchard uses YouTube, Facebook, Amazon and Spotify for analytics and also features a Master Rights Management tool to facilitate performance rights revenue claims and opportunities. Sony bought Awal and Kobalt in February 2021, which will be enhanced by new technology and network affects. Kobalt's micro-payment collection scheme offered a new way to remunerate artists (musicians and songwriters), and thus better handling the billions of transactions.

While AI can be applied in a variety of ways for the benefit of the music sector as a whole and in supporting independents (discussed in the next sections), the music business is increasingly impacted by the spread of AI in music generation, and by the practices of online platforms. First, we discuss these challenges and then provide inspiration for the application of AI by smaller and independent stakeholders.

13.2.1 AI disrupting the music sector: AI music generation and streaming platforms

The use of AI in music has first and foremost been associated with generative AI techniques that enable the creation of sounds. Its history goes back as early as 1951, when Alan Turing, a British mathematician recorded simple computer-generated music (Copeland, 2017). Since then, thanks to the efforts of many computer scientists, music technologist and musicians, numerous experiments have enriched how 'algorithmic music' is created. At the same time, the vast information available online about artists and how music is consumed has set in motion another trend, notably machine learning algorithms and recommendation systems capable of analysing and applying data in new ways.

The status quo is being challenged the most by two movements, notably:

- The increase in use cases where automated music generation is applied or inspired by other industries, such as films, video games, hospitality.

[200] According to interviews but see also https://www.bbvaopenmind.com/en/articles/the-music-industry-in-an-age-of-digital-distribution/
[201] See also KEA, 2020

- The asymmetric access to user data collected by larger streaming platforms and the influence of their recommendation systems on the music landscape.

Automated music generation allows tech firms to leverage their tools to other industries that demand audio input (film, gaming, entertainment, advertising, retail, hospitality), which completely redefines the business model. In this respect, functional music can be produced by AI systems. The history of generating music with the help of AI is vast; research labs and computer scientists have been trying to develop richer algorithmic music for decades. For example, automated music generation has been developed in the Sony Music Research Laboratory, with support from the European Research Council. The real risk of AI-generated music is affected by various factors and the impact cannot be fully predicted:

- The threat comes from the fact that generating music with AI and matching this with the need for a certain genre or style in a game or film is far cheaper and much faster than curating original music content by browsing a long catalogue of real artists' repertoires. Other industries demanding background music may find that automatically generated music reduces their costs, but also legal problems associated with music licence fees. As highlighted above, 19% of the music industry's total revenue came from background music in 2019, the second-biggest contributor. This means that the impact of automated music should not be underestimated; it will not simply take over human-generated music, but create many new opportunities as well.
- Several startups are making fast progress. The US firm Amper and the Luxembourg-based AIVA allow users to create their own music and integrate it in their podcasts, commercials, and videos. "*Previously, a video editor would search stock music and settle for something sufficient. Now, in a matter of minutes they can create a track for their videos in the mood they want*."[202] Their AI algorithms rely on a set of existing musical sounds, but can also be trained on existing songs and music tracks. SACEM, the French authors' rights society, officially recognised AIVA in 2017, allowing the firm to release music and earn royalties under its own name.
- While AI-generated music is considered a threat by many of the interviewees participating in this study, it should not be forgotten that the science of music generation has also proven to be a driver of European innovation, with many tech startups growing up around key music research centres and nurtured by European funding. For instance, AIVA was supported under Horizon 2020[203] through a project entitled as '*AI that composes complex instrumental music for movies, games, advertising and other types of digital media*'. Europe should rethink how to make the best use of these startups within the European creative and innovation ecosystem.
- It is more another trend that some social platforms such as the Chinese TikTok have recently acquired automated music generation startups. They bought, for instance, the UK-based Jukedeck in 2019, a startup creating music with AI. With this application, TikTok can save large sums currently paid to music owners and instead make the automated AI song composer available for their members.
- The main critique of algorithmic music is to recognise the effort that has been put into mastering the 'art of music'. Partly, the issue can be tackled by clarifying the question of copyright following the music originally used to train the AI algorithm.
- A solution offered by the key European music industry associations is to apply the principle that AI tools are used in respect of the original creators' copyrighted content; however, it is still not clear how this can be put into practice.

How automated music generation will develop and continue to evolve is an open question. Some of the interviewees anticipate that users will still want to feature the songs of their favourite artists in videos or other media content, in preference to music generated by a non-descript machine algorithm.

Online platforms have been among the first to harness the power of AI thanks to their first-hand access to huge amounts of information about listening behaviour and the popularity of songs. The importance of music streaming has been growing steadily and resulted in a concentration of power and data in the hands of a small number of online platforms. AI has mainly been used to power recommendation systems.

[202] Amper
[203] https://cordis.europa.eu/project/id/876982/reporting/fr

Deep learning technologies are powerful in analysing audio and user data since they can understand and recommend music to consumers.

Recommendation systems allow the creation of personalised playlists for users according to their preferences on a platform. AI also adjusts to context such as the position of the listener or the ambiance of a venue. These algorithms can use implicit information, such as user interaction, song similarity and natural language processing to recommend songs and keep listeners engaged.

In the competitive AI-based recommendation market, online platforms such as Spotify and YouTube are clear leaders, while big record labels are losing ground, and may even become redundant if artists sign deals directly with the platforms. Spotify combines a deep learning approach complemented by a process known as 'collaborative filtering' which classifies information by using the recommendations and patterns of use from other people. Data from the recommendations of a selection of users is gathered and a weighted average is calculated to make a prediction about user interest (potential popularity). To strengthen its capabilities, in 2020 Spotify bought Niland, a music customer engagement startup. Spotify's engine is governed by an AI system called BaRT (Bandits for Recommendations as Treatments)[204].

Some platforms might favour specific types of content and manipulate the recommendation systems in order to play those hits where a lower fee rate could be agreed upon or where there is royalty free music available. Some of the interviewees expressed concerns about Spotify's Discovery Mode feature, which allows artists to receive additional exposure for specific tracks through the platform's recommendation algorithms. In exchange for the boost in visibility, artists and their labels agree to receive a "promotional" royalty rate on those streams, believed to be lower than the standard rate.

While most smaller record labels are unlikely to use AI to build their own recommendation algorithms, the music industry as a whole, but also audiences, need to better understand how recommendations are generated. Fair play and AI neutrality are needed to avoid bias such as favouring a genre, geographical area or record label.

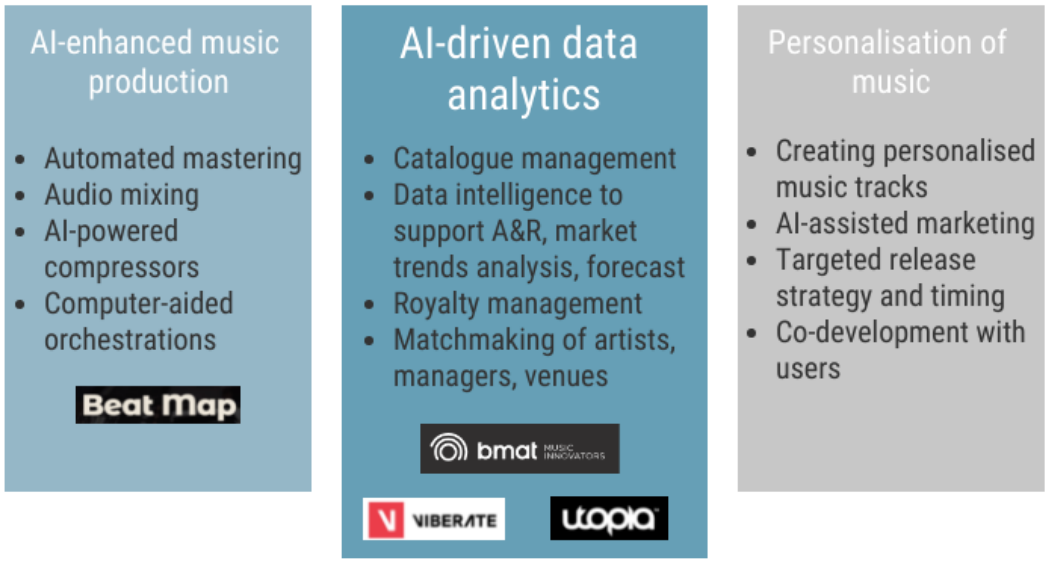
13.2.2 Opportunities of AI for the smaller and independent organisations of the sector

Artificial intelligence technologies have impacted almost every step of the music industry value chain, from content creation and production to final distribution. According to the assessment in this study and the review of startups active in AI-driven music tech, the following main business opportunities have been identified that can be beneficial for smaller players, independent labels, record studios and artists:

- AI-driven data analytics:
  - AI-supported decision-making: AI technologies can support artist, labels, sound studios and managers in their daily business, and help their marketing, advertising and talent scouting. Some record labels already use algorithm-powered analytics tools, in particular for marketing and Artists & Repertoire (A&R[205]) purposes.
  - AI-powered royalty management: One of the biggest challenges faced by the music industry is to get paid. Music royalty collection is a messy and tedious process, where AI can cut through the mass of data and assemble valuable information about the use of songs from numerous channels.
- Personalisation of music content with the help of AI tools: AI offers new pathways to engage with fans and personalise musical content. AI solutions can be used to predict which songs a particular person will like in which context and thus support more specific audience engagement.
- AI used in audio post-production: With the support of AI-based applications, creating new sounds and producing professional quality music has become easier. AI tools can help music production from audio processing and audio mastering to post-production.

[204] https://www.linkedin.com/pulse/how-spotify-recommender-system-works-daniel-roy-cfa
[205] Artists and repertoire (A&R) is the division of a record label or music publishing company that is responsible for talent scouting and overseeing the artistic development of artists (Wikipedia).

Figure 16: Key opportunities of AI in the music industry for smaller players



Source: authors

13.2.3 AI used for decision-making and forecasting

Record labels are keen to make better predictions about which songs could become hits and deserve financial backing. With the aim of supporting decision-making processes, AI-based music analysis technology can empower the industry to build a new generation of intelligence. In this respect, AI is basically a tool that helps "connect various steps in the monetisation of content and bridge the space between all the songs, all the artists, all the genres" (interview with BMAT). Data analytics can help record labels and artists to better plan their marketing campaign and plan their releases. AI-based tools also help to digest and wade through a lot of data, to reduce the amount of manual work.

The first step is tagging content, which helps by automatically classifying and annotating the tracks of a catalogue or platform using descriptive categories, such as genre, instrument, voice or ambience. It also helps by connecting data about past success, user engagement, live events and other facts related to each song. There are numerous startups and tech companies offering AI-based tools to support the music industry and make better use of available data, including Mewo from France, UtopiaMusic from Sweden, Faniak from Portugal, and Viberate from Slovenia. While some of these startups target larger record labels, many of them bring new added value to smaller and independent labels. The interviews for this study also proved that there are various concrete use cases, and many marketing and A&R representatives said they see the benefit of this technology. The growth in the number of users and recent investment trends in this field suggest future growth potential.

- Music catalogue management: AI-based tools enable music publishers and record labels to collaborate as a team efficiently, and to solve problems jointly via online music catalogue management. These catalogues can store, browse, and distribute music related work. Producers and artistic directors want solutions to streamline their workflow, such as 'audio similarity search' and similar automation tools.

Redesigning the catalogue management of record labels

Kitsuné Musique is a French-Japanese record label for electronic music. In 2019, the company decided to redesign its catalogue management and better harness the potential in music metadata. Kitsuné Musique used Mewo to regroup and centralise its musical assets. This resulted in better catalogue discoverability and music data management. Mewo is a Paris-based software-as-a-service platform dedicated allowing the music industry to manage, distribute and generate AI-based recommendations and playlists. The catalogue manager service allows publishers and labels to easily store, search and share their tracks.

- Music data intelligence: AI technologies help mine music data about artists, songs and user preferences more efficiently. This helps with A&R decisions and market trend analysis, as well as in understanding listening behaviours and artist/brand/user affinity. Innovative startups are also offering new marketing indicators, such as brand appreciation, brand identification, emotional connection level, and brand-to-music correlation. AI can track music consumption and song uses in multiple channels, such as through radio stations or streaming platforms. When the user selects the social media and streaming platforms, data are collected that can provide insights about who is playlisting and uploading the music, who writes about it, and how the audience is growing, to name a few applications.

  AI can be used by managers looking for talent and help artists looking for a contract with a label. Some of the digital platforms use predictive analytics and audio AI to link unsigned talent with music industry professionals. For instance, if a music executive is looking for a guitarist or a singer, they can save time and resources in the search for undiscovered artists.

  Data analytics is also useful for planning live concerts by optimising the event programme and predicting how many tickets can be sold. AI algorithms process past ticket data and social media activity.

Besides the potential in these data-driven predictions, not everyone wants to be "signed by an algorithm", as stressed during the interviews. There are artists, managers and also record labels that do not trust the recommendations of the AI and prefer to rely on more traditional input. Some interviewees also commented that it is the lifecycle of the artist that often determines the readiness and willingness to try data analytics tools or not. If an artist is advanced in his or her career lifecycle (trajectory), labels may be more open to using AI-based algorithms to gain further insights.

Use case: AI-based music data analytics

Overview

The music industry has seen exponential growth in data about artists, audio features, song recordings but also sales statistics and user preferences, including information on user demographics, search patterns, and more. Data analytics enhanced by AI helps to forecast sales and better understand user preferences. It provides producers and artists a real-time picture of the global music landscape, market trends, popular songs, etc.

Aggregating and organising data into a digital dashboard helps the industry produce:

- Meaningful metrics and data visualisations
- Streaming and sales analytics
- Music discovery tools
- Market intelligence (i.e. sound charts, mapping your place in your music industry)

Data analytics gives music professionals information that can help determine their advertisement spend, demographic and geographic targets, and thus helps to optimise PR campaigns and promotion networks. It helps decision-making while playlisting music and merchandise consumption. Moreover, producers and record labels can use these analytics to guide discovery of new talent and predict likely success.

A number of established technology firms are active in the music market and offer industry tailored data analytics services. Several music tech startups have also targeted better use of music data and developed specific AI-based applications. Traditional music industry players often prefer to use applications developed by these music tech companies. For advanced users, they also provide access to the underlying API.

The main actors to benefit from these tools are managers, production studios, record labels and, indirectly, artists themselves.

Value proposition

Music consumption has been moving away from physical releases towards streaming. This trend has been accelerated by digital innovations and the ongoing COVID-19 pandemic. Nevertheless, according to interviewees, current music industry revenues can take several years to be paid out to the correct music owners. A part of this revenue goes unreported and uncollected every year as further interviews highlighted. Better utilising data in music can address these problems. In this context AI-based tools can help not just increase revenues but minimise costs.

Music data analytics can boost personalisation and generate more revenue for the artists, producers and record studios who can better target their communication campaigns to reaching the right audiences at the right time. Analytics can also reduce costs and accelerate payment cycles, for instance advance payments to tide artists over in difficult times, such as during COVID-19.

Value for managers and artists: AI-based data analytics provides managers a complete overview of their artists' data. They can keep track their performance, identify local opportunities, and pinpoint industry trends that support their business strategies. A&R managers can scout for talent more easily when looking for a particular feature or remix. Artists also benefit from these tools in terms of being able to better manage their content, market themselves and increase their revenue.

Value for record labels: Labels monitor their catalogues and need information to better predict discovery while keeping an overall eye on the market. They can use AI-enhanced data analytics to support their decisions. For instance, they need to decide whether to sign with an artist or whether to release a song and, if so, in which cycle. They can also get a better understanding whether their marketing campaign is appropriate or needs adjusting. By interpreting music data and the results of machine learning algorithms they can better understand what works and what does not during the release and post-release phase.

Market potential

Music intelligence relies on a mix of technologies besides artificial intelligence and related neural networks, and includes music technology, signal analysis and advanced mathematics. Some of the AI technologies focus on the concept of 'similarity' and the classification/tagging of tracks.

Utopia-music headquartered in Sweden tracks metadata and develops specific client solutions for various actors such as collective societies, artists, publishers and labels. Utopia's technology has succeeded in tracking 3.5 million songs so far and aims to scale up this technology and create the 'Google of music', a comprehensive database that any industry player can access. The Utopia Platform is expected to form a protocol for music attribution and collection, complemented by a suite of powerful applications.

Viberate[206], a Slovenian-based startup helps artists, venues, and labels make important business decisions using AI-assisted data analytics.

Faniak is a Portuguese AI-based band manager that collects, organises and automates artists' data with collective rights societies and translates songs into money. With the tool, booking managers can keep track of their bookings and have all the contents at hand to send to clubs, festivals and promoters. It can also automate data exchange between the artist and any type of music service. Faniak feeds data both in the front and backstage.

Mewo is a Paris-based music software-as-a-service platform for managing, distributing and generating AI-based recommendations and playlists. The 'shelf catalogue manager' service allows publishers and labels to easily store, search and share their tracks. Mewo helps publishers quickly set up an e-commerce website to showcase their catalogues. Proprietary deep-learning AI based on a neural network automates recommendations, tagging and search.

[206] https://www.viberate.com/

The review of the use of AI data analytics in the sector shows that the more mainstream the label is the more it tends to pilot AI applications for data analysis and forecasting. Several record companies have already started incorporating AI into their scouting and development processes. In 2016, Warner Music Group obtained Sodatone, whose machine learning technology claims to predict which unsigned artist might have the most future success by analysing streaming, social and touring data along with measurements of loyalty and engagement levels among the artist's online fanbase[207].
Of course, while advances in AI and other technologies are attractive prospects for the music industry, human expertise and intuition in spotting market opportunities is irreplaceable.

Challenges

Data quality is an important aspect of big data and AI applications. Music tech firms face a huge challenge cleaning and linking up existing databases. Metadata interoperability is the main issue, for instance differences in how the platforms and radio channels treat their raw data. These difficulties have been amplified in recent years thanks to the massive growth of streaming platforms.

Various digital platforms are a valuable source of music data, such as digital streaming services, online broadcasters, paid advertising, editorials, video and social media networks, and sales statistics. Some startups such as Viberate have built their database following a crowdsourcing model. Others construct their own datasets, for instance Utopia music has collected more than 2 billion datapoints on its own[208]. Some service providers give away their API. In Spain, BMAT[209] is one of the music identification and monitoring companies providing music usage reports from more than 7,000 TV and radio channels, 1,000 venues and 80 digital service providers.

Both the users and developers of AI-based data analytics are under pressure to translate results into concrete actions. AI provides indicators and numbers, but more 'intelligence' is needed to look behind the data and understand the trend. As highlighted by the interviewees, the user is confronted with the question 'What does this number mean for me as a record label? What's next?

In terms of data infrastructure, currently Europe does not invest sufficiently in music data in order to take full advantage of the opportunities offered by AI, as highlighted by the scoping interviews. The US has more critical mass; Google has big contracts with large labels and is actively engaged in building its data infrastructure.

13.2.4 AI used for royalty management

Royalties are the basis for musicians to be able to monetise their work and content. However, a key challenge of the music industry is to track where and when songs are being played and to collect royalties accordingly. Utopia Music estimated that "50% of all music revenues go missing altogether in the industry" (Aaltocapital, 2020). Integrated datasets about songs and their usage can address the gaps, link the information and help artists get paid. In this endeavour, AI can help by detecting the usage of a song on TV, or at venues (with audio finger printing), by crunching data from reports, and by helping collective management organisations deal with all this information. During the pandemic, it has been especially important for artists to be able to get an advance on their royalties, so response time is vitally important.

Given the large volumes of data and records coming through new streaming channels, current practices of royalty collection are tedious and time-consuming, which can slow down artist payments[210]. Machine learning can make a prediction about the artist's future performance and help to determine the royalty advance payments for independent artists and their labels by analysing streaming history and other distribution channels.

AI tech startups offering solutions for royalty management

[207] https://mn2s.com/news/features/could-artificial-intelligence-replace-traditional-ar/
[208] https://utopiamusic.com/
[209] https://www.bmat.com/
[210] https://www.adastracorp.com/industries/telecom-media/royalty-management-solution/?edit&language=en-ca

There are various startups both in the EU and the US working to simplify and accelerate royalty collection. In Sweden, Amuse's Fast Forward[211] service offers indie artists up to six months of estimated future earnings based on custom calculations for individual music catalogues. Sound Royalties[212] in the US helps songwriters, artists, producers, and other music creators leverage their royalty streams for professional or personal funding. Utopia Music[213] is another Swedish firm that monitors global music consumption and copyright data in order to help the music industry pay music rights fairly.

13.2.5 Personalisation and audience engagement

User engagement is paramount in the music industry, and closely watched by artists and producers as well as streaming companies. Capturing audience engagement is more and more difficult as the number of artists competing with each other for attention continues to grow. A major challenge is that decisions to support certain songs depend on the number of streams compared to the conventional physical sales model, and hence digital platforms play an increasing role.

AI-assisted personalisation is considered by several interviewees as an under-exploited but very promising business model in the future. Personalisation offers an opportunity for independent labels and artists to engage with users in new ways. These AI applications also allow users to build personalised music curation at scale, and to create immersive experiences.

- AI-powered personalisation: Information about users can not only be used for a targeted recommendation but also for personalising music content. Personalisation concerns not only the profile and taste of the user but also the context. AI shows potential in playlist suggestions according to listeners' mood, location and situation (i.e. commuting, studying, partying), the time of the day, weather, etc.
- AI-assisted marketing through virtual events/online streaming: Artists have discovered they can earn money by streaming their concerts online directly to their fans. This can also reduce reliance on touring, which is also good for the environment and for the artists themselves. Artists can upload their videos onto platforms with AI tools (e.g. video Indexer) that can extract metadata and turn the online event into an augmented or virtual reality experience for fans. Virtual streaming can create a new source of revenue for musicians and way to connect to fans. Although it cannot replace the live experience, musicians expect that virtual reality will become more common even when COVID lockdowns are well over.

13.2.6 AI-assisted music production and post-production

AI is increasingly used to support music production, offering new ways for audio-mixing and post-production. A range of new generation AI-based composition tools makes it easier and, in particular, more affordable for musicians to create high-quality content. Many independent artists and small labels are reluctant to invest large amounts of money on expensive studio time. AI tools can address current gaps.

- Automated mastering: Personal music mastering platforms are an option for artists and music producers to bring their recordings up to professional and commercial standards at very little cost. Similarly, plugin companies can use AI in their offline processing, such as noise reduction or as a fine-tuning instrument finishing the initial equalising. Mastering can include, for example, AI-assisted plugins, step sequencers and drumming. The technology employs machine listening, classification and different audio processing tools such as a compressor, limiter and stereo imaging.
- Audio-mixing: AI-based applications can be used by artists themselves to make their music sound more professional. A new generation of tools can enhance old content to make it compliant with modern audio quality standards. AI technology, such as audio demixing, is promising for this purpose, providing professional sound engineers flexibility in audio editing.

  Another feature called music gesture analysis, uses AI-trained data based on input from the body movements of musicians to isolate the sounds of individual instruments. It can match movements via skeletal key points to the tempo of individual parts. This can be used in sound mixing to turn

[211] https://www.amuse.io/fast-forward
[212] https://soundroyalties.com/
[213] https://utopiamusic.com/

up the volume of an instrument in the foreground in order to augment 'live' recordings. The novelty lies in having physical data combined with music.

In fact, AI-based audio mixing has other uses in the live music industry, which is increasingly demanding better audio quality and accurate real-time audio mixing. The AI algorithm can automatically make changes in the audio levels of the mixer to enhance the quality of the vocals, drums, or other instruments.

AI-powered compressors

AI compressor algorithms can analyse sound performance and generate the required compression settings. The Canadian LANDR's AI-powered mastering engine 'listens' to an unmastered song, identifies the genre and applies relevant mastering equalisation, multiband compression and other processing.

The Swedish Reason Studios has developed a new instrument called Beat Map based on algorithms and machine learning techniques. Beat Map is a generative, experimental alternative to the workflow of writing beats in common drum sequencers.

- Drum add-ins to songs: Sony CSL Paris has developed an AI algorithm called DrumNet[214] that adds kick-drum beats to songs using a neural network which learns rhythmic relationships between different instruments and encodes them. The tool is based on pop, rock, and hip-hop tracks and spots patterns of how drums are used in relation to other instruments.
- Computer-aided orchestration: This feature helps to create the best combination of instruments based on instrument sample databases. The computer can help the composer to explore sounds in various new ways and generate new pieces of music.

13.2.7 Inspiration to musicians

AI has boosted music technology and has become a new instrument for many artists to take inspiration from, opening up new avenues and creative processes. AI-based music content has spurred industrial investment from startup companies, research institutes and also tech giants. As mentioned above, large-scale initiatives such as Google's Magenta, Sony's Computer Science Laboratories called Flow Machines in Paris and Spotify AI laboratory promote the emergence of a new branch of 'AI-assisted music'.

- AI-inspired music composition: Both corporate and public research labs and a range of startups offer tools for artists to test new sounds, get inspiration and compose music relying on algorithmic input. These applications can generate 'algorithmic music' and allow the user to choose their own instrument, tempo, emotion, musical note or melody length. These tools should be considered as new 'creative instruments' that can boost the emergence of specific new content.
- Music education enhanced by AI: Interactive music training apps (for example Crescendo) facilitate music practice and offer immediate feedback based on computer vision, AI and pitch detection algorithms.

[214] https://csl.sony.fr/high-level-control-of-drum-track-generation-using-learned-patterns-of-rhythmic-interaction/ and https://blog.richardvanhooijdonk.com/en/ai-takes-the-stage-as-it-transforms-the-music-industry/

Yacht and Dadabot – using AI for inspiration

A US band called Yacht trained a machine learning system on their entire catalogue of music in order to create new melodies and lyrics based on their own style and come up with something new but still in the same genre as of the band. This helped the artists in the band to step out of their habits and refocus attention on new patterns. The result was intriguing new sounds that the band used as inspiration to create an entirely new song.

In a similar way, the hacker duo Dadabots has its strengths in creating entirely new music experiences with the help of AI. The band is also running AI-generated death metal livestreams. According to their blog, AI acts as a trainer for musicians. Dadabots' neural networks create expressions, emotions and sounds that have never existed before and this is what makes them special.

AI can be used as a kind of 'music instrument' in its own right to create melodies and inspire musicians in new ways. These new applications can enhance human creativity and push the boundaries of music towards new horizons. Various open-source software tools have recently been commercialised including programming toolkits, downloadable virtual instruments and web-based services that enable previously unachievable tasks or make music composition more efficient and effective. Deep learning can help artists generate new material. As a current artist, MJX said: *"I don't want to take the humanity out of music. The emphasis on co-production is key. The AI is not making the whole song, it's aiding me in my music creation process."*[215]

13.3 Key challenges of AI

Artificial intelligence, together with the new systems and business models it engenders, has truly challenged the music industry in different ways.

13.3.1 Reconfiguring the landscape of the music sector

AI is opening up opportunities for some actors in the music sector and in certain cases it is limiting the activity of others.

- A new set of music tech startups has emerged that is creating a completely new activity within the music industry. Some actors in the value chain are empowered by these startups, gaining new knowledge or creating different audience pathways. Others feel threatened by this disruptive force.
- Digital service providers/distributors such as Spotify, YouTube or Apple have accumulated a vast amount of data about their users and are now heavily involved in deploying their own AI laboratories and services. Existing platforms can benefit from winner-takes-all effects to successfully develop and market AI-based tools and services. As highlighted by interviewees but also a recent article (Hodgson, 2021), AI is directly affecting the value of songs in monetary terms. While online platforms have become powerful, they have also changed the way in which users consume creative content. As a result, they enable independent artists to run their own strategy independently from large record labels, which means they can get closer to their fans and increase their streaming revenues. For some traditional gatekeepers, such as large record labels, agents and managers, the context under which they operate has changed and is expected to continue transforming as AI and new technologies extend their reach.

13.3.2 Impact on cultural diversity

The impact of cultural diversity on the music industry has been discussed during the interviews in the context of recommendation systems shaping musical tastes by influencing users in their music choices (see also Eriksson et al. 2019; Hodgson, 2021). Online platforms have become a powerful tool to direct users towards certain types of musical content. AI can create bias depending on the initial data or the point of departure of the AI engineer setting up the algorithm. There is a common concern among music professionals that algorithms and especially recommendation engines can include bias (intentionally favouring artists signed by particular labels or unintentionally neglecting culturally diverse data), which in

[215] https://joshegordon.com/articles/artist-deep-dive-mjx-music

turn is augmented by the AI system. If embedded in algorithms and not managed properly, this could lead to less diversity in curatorial and research outputs.

Despite the above considerations, many of the interviewees are upbeat about how streaming practices and digitisation trends have boosted access to broader cultural content, they predict that AI will enable artists to reach a wider audience (listeners encouraged to explore new musical styles).

13.3.3 Access to data

A handful of organisations hold key big datasets on users and provide access only partially to others. Online platforms such as Spotify release very little data or they limit access to digital distributors. If they need granular data, they ask each record label to supply it. Neither Apple Music not Amazon provide enough data to run an AI algorithm on them. Music charts provide feedback on user preferences published on music-related websites and can be scraped and aggregated with the right tools.

Several startups have been launched to aggregate music data and provide a full analytical service to the music industry. In Europe BMAT, Utopiamusic, Viberate or Soundcharts are some examples that pull data from various sources, as presented in the use case described above. Music datasets include various types of data and are available via a large number of sources and repositories.

Table 34: Type of data and data sources in the music sector (data sources are not exhaustive)

Data Type	**Data source – open**	**Data source – private/licence**
Sounds, musical attributes, annotations, audio loops (piano scores, orchestration)	IRCAM (France) e.g. Projective Orchestration Dataset, Orchestration Analysis and Research Database International Music Score Library Project The Music Genome Project (US, Pandora) - collecting musical details on a large pool of tracks including 450 musical attributes altogether	Freesound (Spain) Freeloops (Netherlands) Music Radar (UK)
Audio files: audio recording, truncated files Text files: Lyrics	Discogs – open source data of older releases Million Song Dataset (US – partially belonging to Spotify) FMA (US)	JAM https://www.justaddmusic.net (Germany) Musixmatch (Italy)
Music/Artist Metadata : Titles, songwriter, producer names, the publisher(s), the record label	International Standard Recording Code National music release databases eg muziekcentrum.be MusicBrainz (US) Discogs (US) – API to metadata on artists, releases, and labels	Online platforms : Spotify (Sweden-US) Youtube, Apple (US) Deezer (France) SoundCloud (Germany), Bandcamp (US) Music Story (France, US) Music Getaway (UK) Vevasound (US) Musixmatch (Italy)
User data		Online platforms : Spotify (Sweden-US) Youtube, Apple (US) Deezer (France) SoundCloud (Germany), Bandcamp (US) Kontor New Media Google Trends Broadcast media – radio, TV
Live events, concerts, ticket sales, venues		Songkick (US) Bandsintown (US) Setlist.fm (US) Viberate (Slovenia) Ticket providers

Data Type	Data source – open	Data source – private/licence
Data on musicians, managers (with the aim to connect musicians to managers and promoters)		Hello Stage/ be your own manager (Austria) www.hellostage.com
Data aggregators		Soundcharts (France) BMAT (Spain) Chartmetric (US)

Source: authors

Music information retrieval (MIR) has a long history since the appearance of the internet and digital music formats. It encompasses the interdisciplinary science of retrieving information from music. Music scholars have analysed the 'maths' of music extensively in the past decade and musicology has become a science in itself. MIR needs to handle the separation of original signals from a mixture of audio signals and recognise instruments. Automatic music transcription is the process of converting an audio recording into symbolic notation, such as a score or a MIDI file (Benetos et al, 2019). Academic research has focused on music similarity. Music similarity can take place between different fragments from one musical piece.

Music metadata includes secondary information about music content[216] and is used to identify songs or artists. Metadata is important because it makes music discoverable so that it can be better promoted and identified to track sales and collect royalties. Artists and record labels can rely on the International Standard Recording Code ISRC, which is a 12-character, alphanumeric code assigned to a piece of music set for commercial release. The code allows the rights holder to monitor the use of their recordings.

Metadata is crucial because when information is lost or discarded, the authors will not be able to monetise the use of their content. However, an issue is that record labels, publishers, collection societies, and others all maintain their own databases and create a fragmented system that is hard to monitor globally. There have been attempts to boost collaboration among the key actors of the music industry to share and align metadata, but these have struggled to gain momentum. Lack of interoperability and a common language are major hurdles, as well as a common governance model and agreements for cross-border or cross-sector cooperation.

Interviewees confirmed that it is a challenge to reconcile databases, and connect songs, their use and ownership data also across countries. Usually, there is an audio fingerprint that can help in recognising songs, but many challenges still remain, for instance, when a song is released for the first time without having an index number/code. Metadata is also increasing in relevance as music blends with films, podcasting, and video games.

13.3.4 Impact on skills development

As the above examples prove, AI is transforming various aspects of music creation, production and distribution. It is imperative for the future workforce of the music industry to be equipped with skills related to AI. Nevertheless, skills development is not restricted to coding or IT-related expertise only. There are a range of other skills that will be necessary in different roles and sub-sectors. Music producers will need to better understand what AI can do for their business and do not necessarily have to be trained to code an AI. Similarly, tour managers and artist managers who acquire AI skills will have an advantage over others in finding new artists and boosting their careers. Audio engineers will need to be able to handle AI tools to make their work more efficient and compete in the changed business environment induced by new technology and machine learning. Artists, composers, musicians can augment their creativity and try new avenues using AI-composer algorithms, for example. The table below summarises the overall skills needs:

[216] See for example: https://www.musicgateway.com/blog/how-to/music-metadata-for-sync-the-music-gateway-bible

Table 35: AI-related skills needs in the music industry

Jobs in the music industry impacted by AI	Role of AI in supporting various tasks	Skills needs
Music producers	Forecast success, take decisions about artists, release strategies etc.	Understand how AI and AI tools work Data management Digital strategy, AI strategy Change management
Agents, managers	Finding artists, labels, venues	Operating AI-driven matching tools for the music industry
Audio/recording/mixing engineers	Supporting and accelerating translation	AI-assisted music tools
A&R managers	Finding talent, predict sales AI supported marketing campaign, predict sales	Data science, data management, machine learning, interpretation of data
Musicians, artists, composers, DJs	Developing new music content	AI coding, AI-assisted music generation
Software/AI engineers	Music composition	Data management, search engine optimisation, programming skills (Python etc), Entrepreneurship skills

Source: authors

13.4 Suggestions for actions to support smaller players in the sector

13.4.1 Access to data

The music sector has a large number of European startups that develop data analytical solutions for record labels, studios, royalty management organisations and artists. In this sense, this new business model has been recognised by the private sector and various AI firms are competing in the arena of aggregating data and developing AI data tools. The interviews did not point out any need for public intervention. They have, however, highlighted that there is public music/user data in the hands of royalty management organisations (e.g. GEMA) and research centres that could be shared in a more systematic way. Some interviewees also highlighted the need for more sharing of AI algorithms and models and create a centre in Europe that can match the resources of Google Magenta.

13.4.2 Access to skills

Interviews stressed the need for more training to understand AI and also to be able to code and explore the potential in AI-assisted music.

Besides AI skills, more training in entrepreneurship and change management would be necessary. European music startups sometimes lack entrepreneurial skills and would benefit from more support.

Independent record studios pointed out the need to manage change when introducing the application of AI tools in their business. It is not enough that one person in one unit (e.g. in marketing) starts using AI, but a comprehensive change is necessary in the full organisations to ensure that everyone understands how decisions are being taken.

13.4.3 Access to technology

Within Europe, although there are a lot of AI tools already available on the music market, there are gaps in terms of adoption level across the sector and across the EU. AI tools are often expensive and hence less available for smaller organisations in the sector. Secondly, there is a huge difference in the use of AI

tools across European countries. Public funding, such as voucher schemes and pilot funds could address this gap and allow for all music sector stakeholders to catch up in this field.

In an international context, the data analysis shows an active music startup scene in Europe, however, startups interviewed highlighted the difficulty to access funding, for instance venture capital funding. Many of the startups leave to the US or are being financed by US or Chinese investors. This can be a danger in the long-term if the value of startups emerging in European ecosystems (sometimes through Horizon funding) is realised in other countries (or for other purposes not well-viewed by European standards – e.g. as TikTok is creating AI-generated music). This study would like to reiterate the call of key music sector associations related to copyright and algorithmic and data neutrality (the issue of copyright has been further analysed in the study on 'Copyright and new technologies: copyright data management and artificial intelligence' by Technopolis Group, Philippe Rixhon Associates, UCLouvain, Crowell&Moring & IMC University Krems, 2022).

In sum, the Table below provides a summary of the main recommendations.

Table 36: Sector-specific recommendations for the music sector

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Foster the use of common metadata standards in the music industry, raise further awareness	Industry	na
Review the availability of public music data (for instance in royalty management organisations) and explore what additional data can be shared with European AI startups	Industry/public	na
Integrate AI education into the curricula of music academies	National/Regional	National/regional university programmes
Promote AI algorithmic and data neutrality	policy	na
Support projects for AI experimentation that help collaboration between AI music tech companies and independent labels, studios, artists Put in place a voucher scheme that can help testing some of the available tools (for instance part of a larger collaborative project such as Mediafutures that has published sub-calls)	EU policy National/regional incentives	Creative Europe Programme, Horizon Europe and national/regional support programmes
Foster a public-private partnership around AI music technology with the involvement of startups, online platforms, independent record labels and artists	EU policy/Industry	Creative EuropeProgramme, Horizon Europe Cluster 2
Foster venture capital investment in AI music tech also strategically enabling European startups to be in a better position globally	Industry	

Source: authors

14 Sector in focus: News media

14.1 Short description of the sector and current overall challenges

Journalism plays a crucial role in a healthy functioning democratic society by creating transparency and holding power to account. It is therefore of high importance to safeguard journalism as a profession and industry. The key actors include the following:

- Traditional actors in journalism or news media range from media houses (traditional and new) and newsrooms through to freelancers and individual journalists.
- Online providers of journalistic or news content. For example, social media, blogs, influencers, and news aggregators are some of the new platforms and actors seen as news sources by users, while it should be noted that not all online providers produce journalism themselves.
- Organisations and powerful individuals (some with strong personal brands) also increasingly communicate directly to large audiences, often using these new platforms and bypassing the media houses and traditional news media channels.
- What a news organisation is, how news is consumed and even what constitutes "news" continues to evolve at a rapid, often dizzying pace for both the industry and its audiences. There are, of course, opportunities and challenges presented by this rapid change.

Digital journalism has reduced costs of production and distribution and the internet has made publishing and information available to a wider audience. In many ways this cost reduction is great progress. Today, although globally a digital divide does exist, anyone who has a smartphone can both publish and consume news anywhere, instantly. The overall key challenges are the following:

- The rise of information communication technology has led to the subsequent rise of information society which, as predicted by the author Herbert A Simon ("The attention economy"), has also made audience attention scarcer. So, although the news industry may benefit from the reduced costs that digital journalism has ushered in and helped them gain audiences, the greater competition from the sudden increase in new actors plus a change in audience behaviour has led to new commercial pressure and in many cases a complete change to the commercial playing field. The traditional main revenue streams of subscriptions and advertising are more volatile[217]. So, it may now be cheaper to make content and easier to grow audiences, but it is also much harder to consistently break-even.
- Over the last decade, the ad market share for traditional news organisations has decreased significantly due to the entrance of players such as Google and Facebook, which can undercut prices and furthermore influence which news brands are seen by the consumer on their platforms. A larger proportion of brands' marketing budgets have moved to digital advertising and that the majority of that advertising spend is being mopped up by the tech giants and not news organisations.
- Meanwhile, subscription revenue faces similar but different pressures from the changing market. There is more competition for subscription money as the result of new actors coming onto the scene. Plus, changes to user behaviour mean that it is increasingly common practice for users to consume information across a variety of platforms and sources, many of which are free. This has the dual impact of influencing people's willingness to pay for subscriptions to news content (news is often now seen as something that can be obtained without paying a fee) while there are more actors fighting for a piece of the subscription pie.
- To add to this commercial conundrum, the news industry and news consumers seem to be facing what sometimes feels like an existential crisis when it comes to answering the question of 'what news can we trust?'. Given the importance of trust when holding power to account, this crisis risks questioning the validity of the news industry itself. The issue here in part lies with the fact that anyone can publish a news story online, which means some of the content created as news does not have the professional rigour of a traditional newsroom. Mistakes happen and public trust is

[217] RK. Nielsen; The Changing Economic Contexts of Journalism *Draft chapter for the second edition of the ICA* Handbook of Journalism Studies 2018

eroded. Worse still, some actors in fact intentionally disseminate false information under the guise of 'news'. This has led to a perceived issue of disinformation, or 'fake news', which is seen by some to undermine the trust in news required from citizens for the healthy functioning of a democratic society. Without trust the news industry will have difficulty retaining credibility in terms of its main *raison d'être* as the fourth estate in democratic society.

AI technologies, such as machine learning and natural language processing, can possibly be mobilised to help counter some of the more negative challenges. In an internet with a low signal to noise ratio (where the signal is trustworthy news), groups with high trustworthiness and content verification in place may find themselves more sought after. The questions include: could artificial intelligence be part of a robust, speedy content verification process designed to counter the challenges the news industry faces as a result of the rise of fake news? Why aren't we rolling out anti-fake-news algorithms already?

Unsurprisingly, like the role out of AI in general, it is not that straight forward. In this scenario there is a risk that this ends as an arms race between technologies that create fake content and technologies that attempt to verify it. This could become very similar to the technique of adversarial AI, where two AIs pair up, one to generate content that can fool a human and one to disprove it, iterating quickly to create better and better deep fakes. There are always pitfalls to watch out for and in this case, technology may not be the full answer to securing the users' trust. So, the trust issue persists. Some publishers are trying to turn the issue in their favour by marketing the idea of being 'trusted' brands online to capitalise on the low cost of growing digital audiences internationally. The New York Times, aided by both these factors, claim they added 2.3 million subscriptions in 2020 [218], (this was also reiterated by other sources including interviews). An AI-only or technical solution to the problem of fake news is still unavailable.

Unlike the monolingual markets of the USA, which is of course home to The New York Times, or say, China - the EU has another challenge when it comes to using AI in news media and that is language. The wonderful diversity expressed in the 24 official languages of the EU is one of the great pillars of the institution's strength. However most European news companies find it difficult to reach an audience outside their own countries because of a language barrier. And developing datasets across different languages or algorithms that can accurately reflect the nuance of different languages remain significant obstacles for multilingual innovation in AI. Saying that, machine learning has been tested to help with automated translation in news since as early as 2013 when the BBC developed 'Project Bable' for the World Service Language Services. And at our stakeholder workshop held on 30th September 2021, at which we discussed unlocking real-world opportunities in AI technology for growth, it was agreed that AI could be used in a practical way to help with accurate, timely translation. More on that to follow in the opportunities section below.

COVID-19 is a more recent challenge that has affected the news, journalism, and the media more broadly. The story itself was a challenge. Accurate information at the outbreak became a precious and valuable asset for audiences (Andreu 2020) but, particularly at the beginning of the pandemic when information was patchy and expert theories often varied wildly, it wasn't an easy story to cover. The issue of fake news seemed to be greater than usual.

Perhaps more fundamentally, the pandemic and the subsequent lockdowns quickly accelerated the digital transformation of the news sector, as newsrooms were suddenly forced to work from home and news consumption (e.g. video streaming platforms) increased dramatically online. Digital news 'pure-plays' (organisations that produce online content only) in particular seemed to have a workflow, infrastructure and even corporate-cultural advantage over other news media. Pulling together a traditional live, TV news bulletin without a studio, autocue, talk-back and complicated TV gallery is not easily done by an editorial team working remotely from their homes. But newsrooms and journalists rose to the challenge. Workflow solutions for the TV bulletins were found. Digital pure-plays enjoyed some market gains. Editors also found ways to guide audiences through a very complex, difficult story. By the summer of 2021 people in the news industry felt their teams reacted remarkably well to the challenges posed by COVID and were proud of how the industry responded. However, a wider point was also exposed by the pandemic, namely that adaption and change is not done uniformly across the news industry and the adoption of AI/ML technology will likely vary accordingly.

[218] Charlie Beckett: New powers, new responsibilities (2019)

14.2 Key business opportunities of AI for the news media sector

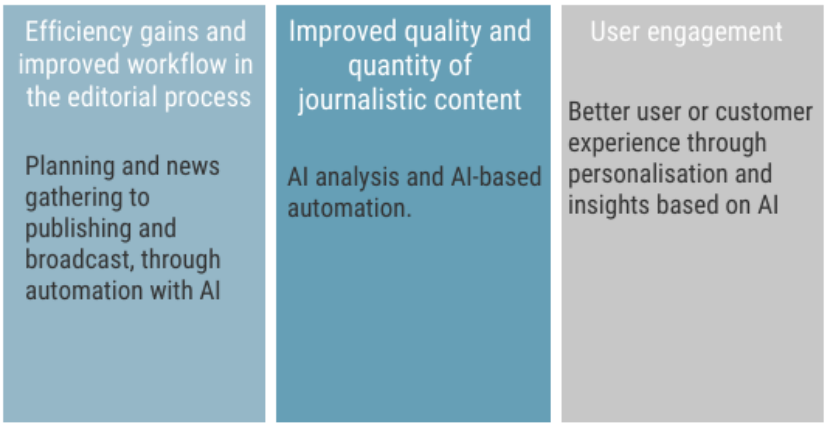
The dominant motive for news media organisations to implement AI is to create better researched and more engaging content and connect this more efficiently to audiences, creating value.

The potential advantages of using AI in the sector are numerous. News media can use AI to automate many operations that make up the value chain of journalistic production, including detecting, extracting, and verifying data, producing stories and graphics, publishing (with sorting, selection and prioritisation filters) and automatically tagging articles.

Artificial intelligence can create value throughout the production cycle and can generally be divided into the following areas:

- efficiency gains and improved workflow in the editorial process, from planning and newsgathering to publishing and broadcast, through automation with AI;
- better user or customer experience through personalisation and insights based on AI;
- improved quality and quantity of journalistic content through AI analysis and AI-based automation.
- commercial opportunities from the AI enabled production cycle such as new sources of revenue from entering new markets (for example software as a service) and/or developing new models from existing revenue streams (such as joint programmatic or subscription services and variable personalised subscriptions).

Figure 17: Some of the key opportunities to use AI in the News media sector



Source: authors

These areas, which could be described as business cases, are often overlapping. For example, new editorial processes lead to new formats but also enable new forms of customer experience. Which business case will prove to be the most valuable to a newsroom depends on the organisation's ability to adopt this technology and their strategic needs based on market and customer analysis. As we will see in the recommendations and conclusion section of this report, the industry would benefit from having an agreed set of principles for assessing the capability of organisations how they can invest and adopt data-led artificial intelligence and machine learning technology with value-for-money in mind.

AI systems offer numerous opportunities including (but not limited to); speed in mining complex procedures based on large volumes of data; support for news planning through event alerts; writing text (ideally to be supplemented with more contextual information from journalists); an expansion of media coverage to areas that were previously either not covered or not well covered due to a lack of resource; optimisation of breaking news coverage in live feeds; strengthening a media company to connect and build relational ties with its audiences by providing them with personalised content and stories according to their location or preferences.

However, the efficiency of these systems and applications depends on the availability and quality of the data as pointed out several times in this report. A reliable, accurate and precise input is essential, otherwise it is impossible to obtain reliable and accurate as well as precise output.

As we will see below, AI and related technologies could also support novel and changed revenue streams. New forms of collaboration around data and product innovation partnerships within the industry and with other industries has the potential to unlock completely new commercial opportunities. In fact, embracing data and AI may be the only way that the news industry remains commercially viable.

So how can newsrooms use AI, machine learning and data successfully? Most of the use cases that are presented in the upcoming section are very close to each other and sometimes overlap. For this reason, the following list of use cases is somewhat arbitrary, aiming towards giving an overview of different use cases rather than being a perfect categorisation.

14.2.1 AI used for content creation and production

Machine learning can be used to indicate trends, correlations and outliers in data, a process where a journalist will independently judge the newsworthiness and verify the result. It can also be used to tag data to facilitate retrieval of information when working on a story as well as automatic tagging and sensemaking from archive data.

- Open data mining: Through cognitive computing and machine learning, trends, clusters and patterns are found in large, mainly textual, data such as news articles and social media. These "insights" are then subjected to an automatic verification process built on journalistic practice and for journalists to independently verify and eventually publish.

Using open data mining in practice

Reuter's Lynx Insight identifies trends, anomalies, and key facts as well as suggests new stories. It suggests possibilities to journalists, relying on the combination of machine analysis and human judgement. It uses a combination of AI and human designed algorithms. Among other data, it looks through the structures financial data of Thomson Reuters to find newsworthy items to suggest.[219] [220]

Reuter's News Tracer is an example of mining Twitter feeds to find leads, claiming to give an 8-to-60-minute head start in breaking news. Open data mining is also done by threat intelligence companies such as Recorded Future and Geofeedia. Tagging can also be done, to make external material searchable and easy to analyse by journalists, such as with the BBC Juicer. Swedish Newsworthy and United Robots find outliers and trends in statistical data as part of their automated journalism offering. Their solutions can be used to find relevant headlines or to help journalists to find a relevant story.[221] [222]

- Image and photo recognition: Deep learning models can help identify images with specific traits and have been used to analyse, for example, illegal mining in Google maps images[223]. This is an area where more sophisticated solutions, such as machine learning, are needed. ML enabled photo recognition can simplify finding the provenance of a photo and allow a journalist to speed up fact-checking, identifying people and objects in photos and tagging images. This has been used for stock photography for a long time.

Image and photo recognition in practice

Getty images has an AI tool for publishers that recommends the best choice of images for a news story, using the text as an input.[224] Another example here is the US-headquartered Dreamstime, a leading stock photo community that has developed Photoeye, an AI solution that tags images based on content.[225] Advances in computer vision and image tagging are rapid and driven by many sectors with similar problems, such as automotive and industrial manufacturing. It is likely that there will be further rapid innovation in this area.

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[219] https://www.thomsonreuters.com/en/artificial-intelligence/thomson-reuters-brings-the-human-touch-to-artificial-intelligence.html
[220] https://storage.googleapis.com/gweb-news-initiative-training.appspot.com/upload/GNI_Training_JournalismAI_IntroductiontoMachineLearning.pdf
[221] Medievärlden: Robotjournalistikens år (The year of robot journalism) (2018)
[222] https://storage.googleapis.com/gweb-news-initiative-training.appspot.com/upload/GNI_Training_JournalismAI_IntroductiontoMachineLearning.pdf
[223] https://dida.do/blog/detecting-illegal-mines-from-space
[224] https://www.journalism.co.uk/news/getty-images-launches-a-new-ai-tool-that-helps-publishers-find-the-right-picture-for-the-story/s2/a725797/
[225] https://www.prnewswire.com/news-releases/dreamstime-releases-proprietary-ai-technology-to-third-party-companies-300973718.html
https://www.dreamstime.com/photoeye

- Automated data cleaning and data wrangling: When working with data in general as well as in journalism, data cleaning (removing errors) and data wrangling (changing data formats and structure to make it fit a use case) is often singled out as the most time consuming and least rewarding part of the job. AI solutions have been found to be very helpful in data cleaning and wrangling and are often claimed to be essential to keep up with large inflows of data.[226]
- Automated journalism: Automated journalism solutions produce story content based on structured data such as stock market changes and, according to news organisations, can make it possible to cover a wider variety of stories (where there are not resources for a reporter). They also potentially free up journalists' time to do more complex and investigative high-value work.[227] Successful use of automated journalism is often achieved when the stories have numbers and set formats as a key factor in the coverage. This can range from local sports matches to covering the latest version of a company report. It is unlikely, barring any spectacular advances in AI, that this automated reporting will replace more complex high value journalism and media coverage, such as investigations, any time soon. In addition to text, automated graphics, video (see below) and audio are all being tested and many in-house and third-party solutions exist already. External actors such as United Robots, RadarAI (which has PA and Google investment amongst others) and Newsworthy sell robot journalism services to smaller local news organisations.[228] This is a promising use case for local media that wants to cover sports. The information about scores and players is called or written in by the clubs and the algorithm turns these numbers into a short article.[229]
- Automated video journalism: Automated video journalism often involves smart cameras covering scheduled events with automated post-production of any associated video material. This again frees resource and creates opportunities for news organisations to produce film coverage of more specialised or non-scheduled material. Actors in this field are, for example, Overcam (from Belgian EVS Broadcast Equipment) and Pixellot, who make automated sport production solutions with automated cameras. This is used by, among others, American College sports and France Televisions.[230] [231]
- Bias detection: AI can support fair and trustworthy journalism through finding and quantifying bias in human reporting. An example of human bias detection by machine learning is the Amazon AI recruiting tool that showed a bias against female applicants and in doing so highlighted bias in the human decision making that had been the source of the data the AI had been trained on. Voice recognition AI has been used to measure talk time to create parity and avoid bias (e.g.: GA Tally App [232]) and face recognition AI can review groups and attempt to predict gender bias. AI could also more effectively combat misinformation, fake news and other forms of harmful content, although this is not guaranteed and may result in a form of adversarial AI described above.
- Automatic translation *for journalists*: Automatic translation of foreign news and other information on the internet helps news organisations cover other languages and territories. Unlike automatic translation of news *for user consumption*, this case can work with existing translation algorithms, as the quality of the resulting text does not need to be high. The primary example here is journalists using Google Translate to read web pages in another language as research for their journalism. For instance, the European Broadcasting Union initiated a collaboration among its members to translate and cross-promote content[233].
- Automatic translation *for users*: An example of translation for user consumption is included in the case studies below.

Use case: Automated content creation and curation

Overview

[226] https://www.cio.com/article/3240935/you-wont-clean-all-that-data-so-let-ai-clean-it-for-you.html
[227] Stray, Jonathan. "Making artificial intelligence work for investigative journalism." *Digital Journalism* 7.8 (2019): 1076-1097.
[228] Medievärlden: Robotjournalistikens år (The year of robot journalism) (2018)
[229] Jonathan Stray (2019): Making Artificial intelligence Work for Investigative Journalism, Digital Journalism, DOI: 10.1080/21670811.2019.1630289
[230] https://evs.com/products/lean-production/overcam
[231] https://www.nfhsnetwork.com/pixellot
[232] http://app.genderavenger.com/intro
[233] https://www.ebu.ch/news/2021/06/providing-a-european-perspectivepublic-service-media-allied-to-offer-an-innovative-news-sharing-model-across-the-continent

Automated content creation is the automated creation of as many formats and variations of content as possible using data and AI. Automated curation is the process of identifying, selecting and organising information or data relevant to a particular topic or context. The purpose is to add value through the process of organising information.

The availability of stored and shared data and public information continues to increase exponentially. In this use case AI is used with that data to create content. It is also used to quantify, tag, organise, cluster, and generate insight from content and data to automate its curation in different ways for users.

Automated content creation and curation solutions can also be used to monetise and understand archives, tailor automatic content curation of index and topic pages on news websites, factcheck information and find leads and errors. The solutions can work with in-house data such as user traffic and data provided openly on the net, such as social media and RSS web feeds, enabling journalists to keep track of trends and events.

This technology, when combined with audience data, can help find and show relevant personalised content and together with automated journalism to write personalised stories, which will be explored further in the second case study.

Business needs and value proposition

Media houses who can create automated processes to tag and organise their content will have an upper hand in the industry. This type of tagging facilitates content creation and curation that can be used in a variety of value adding ways.

Efficiencies in the newsroom are one benefit. Curation of content through tagging is already used for the automatic organisation of index and topic pages on news websites, as well as fully personalised recommendations and feeds for users. This efficiency is being expanded upon as the technology improves. The same applies to the efficiencies that come from AI generated content creation – they exist and are improving all the time.

There is a possibility that using the technology for the creation of content could lead to a scenario where there is significant organisational redesign based on shifting tasks and upskilling strategies. Although as noted it is important to have journalists involved in the process, businesses could decide to reallocate or be reduce costs as a result.

New sales revenue also comes from this technology. Curating archived material can be used to identify material with a market value. This has been used for instance by France Télévisions for their archived material.

AI driven content solutions and models can and are developed by organisations in the news industry and then sold as third-party plugins, applications or as a service, boosting both the organisation and encouraging innovation within the sector.

Finally, from a 'business of content' perspective, AI can be used to help media houses to monetise both live content and archived material by helping commercial teams create commercial 'creative content' (ads), target audiences for commercial campaigns and understand and order their news content for licensing and syndication to third parties.

Technology and data

The technology used for content creation and curation ranges from algorithms and cognitive computing to machine learning and neural networks. There are many different solutions at different levels of maturity.

AI solutions work especially well for complex and semi structured data, such as photos, scanned text and social media. AI can extract for example. tags, keywords, topics, or people (either by written or spoken name or by face). This information can be used to find and tag specific content, but the generated metadata can also be used to identify trends and correlations.

An example that uses data from outside sources is the Reuters News Tracer system, that continuously reads Twitter data, and attempts to filter out spam and tweets which are not about events. It then clusters tweets by event and ranks them for review by journalists. The system uses cognitive computing and machine learning models for classifying and clustering of tweets, giving them a newsworthiness ranking. After this,

it tries to verify the source by analysing the twitter profile, according to reverse engineered journalistic practice.

Clever solutions such as the one above could be written for any type of accessible data at an in-house level, if clean datasets exist. But there is even more potential in this technology if it is shared beyond in-house. When bringing data sets together the data-'whole' is greater than the sum of the data 'parts'. In other words, the more data brought together, the more there is to learn from and the better the AI product is. In order to grow that valuable data-'whole' and create more value to share around the news industry collaboration between organisations is needed. And when it comes to collaborating, standards are necessary – that could be standard terminology, standard technology or standardised data structures – to eventually bring the industry up to the same capability. Therefore, the news industry must agree on standards for data and AI/ML if it wants to strengthen its negotiation power vis-à-vis other aggregators of data. This is an area in which governments and academic institutions could help.

From a content publishing perspective, market forces are attempting to standardise some technical solutions which include AI. There is now a wide range of off-the-shelf CMS (Content Management Systems) available which are augmented by AI and for sale. The Washington Post's Arc Publishing is licenced to other actors, for example.[234] [235] [236] [237] [238]

Market potential and growth prospects

Many AI supported content management systems are recent developments and are already reporting successes.

- Forbes' Bertie is an example of an AI enabled CMS built in-house which can recommend article topics to contributors based on their earlier pieces and suggest headlines and images based on sentiment analysis.[239] Forbes claims that Bertie has doubled its number of loyal visitors since being rolled out. In addition to this, it makes the work of contributors more effective.[240]
- The appetite for growth in this technology appear to be high. The IABM report on tech trends found that 35-40% of responding media technology buyers planned to invest in AI in content management and distribution and delivery[241].
- Curating information is relevant for other sectors as well, which will likely bode well for AI development in curating images, video and text.

However, most of the investment in this type of technology is done in other industries, not media. So, there is a likelihood that some of the most disruptive innovation in AI in news will come from a sector or organisation outside news. Which leads to the conclusion that a blended approach which involves collaborating with other industries, government bodies, as well as collaboration within the news sector itself, will lead to solutions that are both good value and fit for purpose when it comes to content creation and curation.

Challenges

One problem associated with this application of AI in content creation and curation is correctness and perceived trustworthiness when automated results are not fact checked by a human. One recent example is an MSN.com story where automatic image retrieval created controversy. The story, which was about racism, was written and published by a machine. In the automated production process the article was given a picture of the wrong mixed-race member of a rock band to accompany the text[242], leading the AI algorithms to be criticised for being subject to racist bias. Bias of some form is not an uncommon accusation levelled at this technology. [243]

[234] https://www.ciodive.com/news/all-about-bertie-overhauling-cms-technology-at-forbes/554871/
[235] https://whatsnewinpublishing.com/forbes-doubles-monthly-visitors-with-bertie-an-ai-driven-cms/
[236] https://digiday.com/media/forbes-built-a-robot-to-pre-write-articles-for-its-contributors/
[237] https://www.subscriptioninsider.com/type-of-subscription-business/newsletters/forbes-launches-subscription-newsletter-platform
[238] https://whatsnewinpublishing.com/washington-posts-arc-publishing-expands-beyond-media-industry-and-becomes-a-major-revenue-stream/
[239] https://digiday.com/media/forbes-built-a-robot-to-pre-write-articles-for-its-contributors/
[240] https://whatsnewinpublishing.com/forbes-doubles-monthly-visitors-with-bertie-an-ai-driven-cms/
[241] https://theiabm.org/ai-broadcast-me
[242] https://www.theguardian.com/technology/2020/jun/09/microsofts-robot-journalist-confused-by-mixed-race-little-mix-singers
[243] https://www.nature.com/articles/d41586-020-03413-y

In order to reduce the risk of challenges like this, as discussed, there needs to be more data for training machine learning models to create better models.

14.2.2 Better user or customer experience

AI can help understand behaviour for both groups and individuals and based on this automatically serve readers relevant content or recommendations, predict likeliness of conversion, and analyse audience composition. Audience profiling and building personas for subsets of the audience has historically been primarily used for ad targeting and other commercial endeavours in news publishing. For many journalists, the audience has mainly been considered a homogenous group. Although the use of AI for the personalisation of some aspects of output such as homepages, emails and programmatic advertising is prevalent, because much of this data is not shared between organisations there is still significant untapped benefit in using AI and machine learning on visitor data to build a general understanding about audience composition, target groups and to allow for content commissioning, product design and solutions that take different subgroups into account to make the product more engaging and more accessible. In order to make the most of the opportunity, audience data should be shared or pulled across the industry. Sharing data in this way would 'increase the size of the data cake', the increased benefits of which could be shared across the industry. However, to make that sharing feasible, transparency and trustworthiness is the key. News organisations need to trust in the benefits of sharing audience data and not worry that they will somehow lose a competitive advantage in passing it on to a shared data lake. So, to truly make the most out of audience data will require a cultural shift towards sharing in the industry. It is worth noting that because of the commercial value and sensitivity of user data it is perhaps unlikely that any joint data lake with this type of data is likely to be developed between news organisations soon. However, news organisations could act together with user data when it comes to negotiating with large distributions platforms such as Spotify or aggregators (see below). This pooling of audiences is already done to an extent through programmatic advertising.

- Audience interaction: Chatbots can provide more information about a topic for users and supply natural language searching. They have been used for, for example in election coverage.[244] [245]
- Personalising news feeds: Building on the first bullet which talks about using AI to understand audience behaviour, there has been work done on how to create personalised feeds of content that provide tailored, relevant content on an ongoing basis. Given the need for balance to avoid bias in news, the most effective of these feeds, in the context of news, provide a diverse set of viewpoints in addition to the most obviously relevant content based on an individual's behaviour. The aim is to avoid the risk of "filter bubbles". Notable examples of personalisation are the New York Times' personalised newsletters and Schibsted personalised webpages but there are many more and further information on personalisation is outlined in the second case study below.
- Recommendation engines: Recommendation engines based on AI technology, such as those in Google or Amazon, are used by all news websites. These engines syndicate news content and provide a personalised set of stories to each user based usually, primarily on their search activity combined with user behaviour from similar users to predict what is most relevant. Receiving news in this way can, again, potentially lead to filter bubbles. Also, given each story is usually presented in a stand-alone way, this has led to complex questions about the value of presenting single stories versus the corpus. On a news-site an article is part of wider product that consists of a combination of many articles from that newsroom, which when brought together by the editor create balance. When that same article is consumed stand-alone from a recommendation engine, the user does not get the entire picture as the news-site may have intended.
- News aggregators: News aggregators are software or applications that compile and show a list of relevant syndicated web content, including news media articles and blogs, for easy access to users. This can be done by human editors, machine learning models, and/or human designed algorithms. News aggregation can be done by third parties linking to news. Some news aggregators such as News Break and SmartNews include geography-based push notifications for relevant local news and

[244] https://bbcnewslabs.co.uk/projects/bots/
[245] Jones, Bronwyn & Jones, Rhianne. (2019). Public Service Chatbots: Automating Conversation with BBC News. Digital Journalism. 7. 1-22. 10.1080/21670811.2019.1609371.

gives users local news where they are, now. Such geo-specifically relevant content can in turn increase audience engagement. [246] [247]

- Automatic translation for user consumption: Automatic translation of news articles to reach a wider audience is not yet good enough to create a high-quality product in another language and is unlikely to become good enough for user consumption within five years according to interviewees, but will likely be a transformative future technology, especially for the EU given the linguistically fragmented market. It should be noted, however, that AI translation technology is used as a part of effective workflows that also include human translators to ensure quality. The European Broadcasting Union (EBU) has announced a research initiative to develop tools to automatically translate and make available chosen articles between 10 broadcasters.

Use case: AI-enabled audience segmentation

Overview

Using AI to better understand user or customer behaviour is not just limited to improving users' experiences and creating process efficiencies. The news industry can also use this information to develop smart, AI-enabled audience segmentation to increase revenue. Audience segmentation methods are traditionally used to develop homogenous subgroups to help marketers, sales teams or product developers to design and tailor products that satisfy a particular target group or groups. This segmentation is already done to an extent through programmatic advertising in media, as noted. The same methodologies are used by large digital platforms; audience "trading desks", which are set up to sell audience ad space to marketing campaigns, use AI-enabled algorithms to match audience segments from publishers or social platforms to each marketing campaign's objectives. And this data is also already pooled between publishers and titles in a variety of ways, from EcoDaLo which creates an ecosystem for data management of local publishers in Flanders to the ESI trading desk at ESI Media in London that coordinates audience segmentation in-house across its various titles for ad sales.

[246] https://localmedia.org/2020/10/what-to-consider-with-the-next-generation-of-local-news-aggregators/
[247] https://www.axios.com/forbes-paid-newsletter-subscriptions-ab423ae1-0b90-4863-acad-40a373adce80.html

Business needs and value propositions

News organisations have diversified their revenue streams away from display advertising over many years. And in so doing a variety of related ways to capitalise revenue using AI to develop smart, AI enabled segmentation are being developed. A list of some of the most recent are below. Again, if data was pooled between organisations the value of these revenue streams would potentially increase.

- AI-supported payment and pay gates: AI is used to formulate automatic, personalised subscription offers and paywall access focused on conversion, such as the learning algorithm measures reader activity in order to predict the likelihood of a user subscribing or develop adaptive paywalls, such as those at the Wall Steet Journal which decides when a user is most likely to pay. The publisher Neue Zûrcher Zeitung claims its conversion rate went up to five times with dynamic paygates[248]. Another AI application is micropayments for single or bundles of articles instead of full subscriptions. However, the true value of this model remains hard to determine and recently news micropayments companies such as Blendle (Netherlands) have abandoned micropayment models as they are said to not generate enough revenue. Some media houses have tried subscription collaborations, such as Swedish Dagens Nyheter and New York Times, where AI or algorithms could be used to calculate revenue for each collaborator.[249]
- E-Mail: AI is already being used to assist with the development, writing, targeting and improvement of editorial e-mails. E-mails are premium products for commercial partners because audience segmentation is very accurate (mail sign-ups create rich datasets) and the engagement can be monitored with great detail. Some of the development of this type of technology is driven by media firms that focus on marketing and PR such as Signal AI.
- Affiliate marketing and sales: Most publishers have started to generate revenue with e-commerce, selling items through reviews on-site. The tools used to facilitate this revenue are usually third-party off the shelf solutions and there is currently little scope for publishers to influence AI solutions in this area as a result. Margins are also often subsequently low for this revenue stream. However, this could be improved if publishers coordinated policy in this area to influence suppliers or develop their own affiliate sales solutions with inbuilt AI.
- Partnering with platforms – text, visual and audio/voice: Similarly, most publishers work with large platforms to create revenue through different formats. And in most cases AI technology features in these partnerships but publishers have little input into how it can be developed. The most recent of these arenas to become popular for publishers to commercially innovate is voice-AI which has grown as the result of the proliferation of voice activated AI home assistants. Again, the news industry should coordinate to ensure that it has an active say in how AI is developed in this area by speaking to platforms with a unified voice. Organisations like Radioplayer[250] are doing so for the wider radio sector. Without this coordination in the news industry there is a chance that these formats will suffer from the same click-bait issues raised above and the full revenue potential of this technology in the news sector will not be realised.
- Lead generation and other 3rd party data sales: Innovative ways of selling on data are being explored across the news media. In one example, publishers such as Bloomberg and the New Statesman Media Group use audience segmentation data with AI to create content that targets B2B audiences with the aim of developing sales leads for paying partners. In this example the business model has the potential to grow significantly as it is based on quality journalism, which as is discussed in this section, is a unique selling point for news organisations.

Technology and data

As noted throughout, coordination across the news industry can increase the overall value AI and data can provide, including commercially. To continue to raise the commercial value of quality content (over clickbait) it may be necessary for the European news media to work together on both sharing data and setting the standard for the development of algorithms that impact the industry. Ideally, organisations need to trust in the benefits of sharing audience data and not worry that they will somehow lose a

[248] https://www.nzz.ch/; https://www.journalism.co.uk/news/how-nzz-increased-its-conversion-rate-up-to-five-times-with-dynamic-paygates-/s2/a735623/
[249] https://medium.com/on-blendle/blendle-a-radical-experiment-with-micropayments-in-journalism-365-days-later-f3b799022edc and https://www.cjr.org/opinion/micropayments-subscription-pay-by-article.php
[250] https://radioplayer.co.uk/

competitive advantage in sharing. So, to truly make the most out of audience data will require a cultural shift towards sharing in the industry. It is worth noting that because of the commercial value and sensitivity of user data it is perhaps unlikely that any joint data lake with this type of data is likely to be developed between news organisations soon. As a start, news organisations could start exploring interoperability of less sensitive data (such as metadata) and work towards development of algorithms and algorithm standards. They could also consider partnering in all the examples of revenue generation outlined above using pre-established privacy methods to solve competition-related and legal issues and mitigate against the perceived risks of data sharing. While it is clear that such commercial cooperation is a long term objective that requires further research, news media could anticipate these developments by exploring common goals and align standards where possible.

Challenges

Although using AI and audience data to assist with audience segmentation and more efficiently deliver marketing campaigns can improve ad revenue it can also have adverse impacts. Algorithms are often developed to focus on audience size, which leads newsrooms to chase traffic targets and rewards the production of clickbait, ultimately developing bad habits that arguably drive down content quality. The focus on audience volume has also driven down the price of some ads as the market is flooded with more audience 'inventory'. And generating ad revenue in this way means competing directly with the large digital platforms, which have bigger global audiences than publishers and can afford to drive prices down. All of this has, in the long term, threatened to undermine the commercial and economic viability of news. However, as advertising remains an important revenue source for publishers, publishers should ultimately strengthen their knowledge of data and AI to improve their negotiation power and build subscription as well as advertising models around quality content.

Use case: Personalisation of news content

Overview

News feeds, news websites and articles can be organised by profiling a user through a variety of means. As discussed above, analysing the users' digital tracks when interacting with content allows new organisations to respond by tailoring the content offered to the user. This tailoring can help fulfil the news organisations strategic goals such as boosting engagement or increasing subscription conversion rates. Both analysis and response can be based on real-time interaction and historical data. Most newsrooms now have real-time heads-up audience dashboards for traffic and longer-term audience and data reports intended to help with data analysis.

Some examples of measurable user interaction with content include; unique users, clicked links and conversion rates, pageviews, time spent on a page or 'dwell time', scroll depth on page and on section, watch and listen time, video and audio drop-off rates page-view per unique user, comments and shares. Analysis of these data sets can inform page organisation and recommendations in real time, as well as which content is promoted off-platform (search and social media). This data is also used for short- and long-term strategic planning and commissioning decisions. Breaking news is often 'discovered' in newsrooms as the result of an AI driven alert in the CMS about audience interaction with a story: The AI sees a familiar pattern in the audience behaviour and alerts the journalist to something that might be a story with building interest. Trends on social media operate in a similar way.

So, in this context, personalisation of news content relies on artificial intelligence from two directions. One is in the automated tagging and markup of news content that is available to present to the user. The other is in automated insights about the users themselves and of user behaviour in order to match content with users in a way that is relevant and insightful. News media must balance this match-making around personalisation by giving the user what they are interested in while at the same time providing balance and maintaining trust. Professional journalists know that in order to fulfil their obligations when reporting the news, what's newsworthy can't be decided by popularity alone but must also include what is in the public interest.

But it is a tricky balance. News is a very competitive industry under huge commercial pressure chasing what often feels like a very fickle user base. Many newsrooms get caught up chasing numbers and targets. Left unchecked, clickbait in a newsroom can become an issue.

The personalisation of news consumption based on automated tagging of news content matched with users based on the insights of their preferences and behaviours therefore ideally includes some form of editorial curation balancing "giving the user what they want" with topics that users may have otherwise overlooked but that are in the public interest.

This editorially driven approach to automated personalisation and algorithmic recommendation systems provides a welcome alternative to recommendations engines such those found on search engines and social media platforms. In fact, this blended curated/automated editorial model is already common in newsrooms and many journalists feel this is a fruitful approach to personalisation.

Business needs and value propositions

The value proposition of personalisation for the user is that it creates a more relevant and tailored news media offering, which if done properly with editorial oversight also provides a diverse perspective on the news, popping the filter bubble.

The value proposition for the industry is that the technologies can enable a deeper relationship to the customers, improving loyalty and adding value by enhancing current commercial models and developing new sources of revenue. Examples of news organisations now using their deep understanding of their audiences to provide innovative commercial products includes the development of research and consulting services, creating affiliate sales verticals and developing sales leads dashboards for commercial partners' sales departments.

Some interviewees argued that the greatest benefits of these personalisation solutions would come if the associated content curation was done in a common pool of all published news material, presenting differing viewpoints from different news organisations around the same issue. Some aggregators have attempted this but to-date none has succeeded.

For society, finally, a responsible and ethical model of personalisation based on journalistic values and practices should help strengthen democracy through public debate

Technology and data

As alluded to above there is a wide variety of technology associated with personalisation.

One common example of a current machine learning technique is collaborative filtering, a method of making automatic predictions about the interests of a user by collecting preferences from many users.

Content filtering is also commonly used, where the algorithm recommends similar items to a customer based on previously rated highest items by the same customer (where ratings can be both based on user input or on user engagement).

Solutions such as these can use both real time user data, to present personalised views and recommendations as users interact with the website, and historical data showing user preferences and trends in viewing.

Data associated with this type of personalisation is rarely shared. Sharing audience data creates user-privacy issues which most news organisations feel are insurmountable and not worth exploring as a result. From a commercial perspective audience data is used to create marketing and sales personas which have a great deal of value to the commercial team and are guarded in-house as a result.

Market potential

Personalisation technology is used in today's marketplace and is based on mature, understood, and available technology. The difficult part of realising full market value is in understanding how relevant personalisation should be designed to make sense both from a user perspective and an editorial perspective to get the most value.

The interest in personalisation and its growth potential from the perspective of the media industry now lies in how it could be a driver for new revenue models and increasing audience loyalty.

From a consumer perspective there is also an increased demand for personalisation as news is being delivered in more channels, formats and devices adapted to the needs of individual users and where the news experience is not necessarily centred around the news site front page.

Mittmedia, Sweden's largest local media news group, have used their "Soldr Personalisation Service" to automatically present the end user with personalised content but at the right time and in the right channel and context, thus replacing all but a few manually placed news stories by their editors [251]. The system operates not only on the front page of the news sites but in apps and personalised newsletters. This approach is also combined with robo-journalism writing stories for sports events as well as local housing sales, which can also be included in the personalised content. Mittmedia themselves say that the personalised feeds outperform the manual feeds curated by the editors [252]. This combination of personalised content and robot journalism also increased subscription rates significantly [253].

Designing relevant forms of personalisation that would make users want to pay for subscriptions to journalistic content in order to get a customised news experience could be a key to growth in this field. In fact, the market potential of AI-led personalisation is still great from both an industry and consumer perspective and further growth is likely.

Challenges

Data ownership gives large actors an edge because they typically have more data. Larger actors are also more likely to have the resources need to implement new privacy legislation as and when it happens, giving them a further advantage in adopting data-led personalisation technology in comparison to smaller actors.

From a practical, process perspective a challenge is that current AI-based systems for recommendation and personalisation often are based on analysing user preferences and then simply recommending more, similar content. That can mean stories that fulfil editorial priorities such as newsworthiness and public interest get left out. Public interest stories and popular stories are not always the same thing. Training AI to fix this problem without introducing bias can be difficult.

As a result, one of the main challenges with personalisation is the concept of the "filter bubble"; the idea that smart algorithms may feed users only material they prefer to see, leading to less understanding of other viewpoints and a lack of common ground with other citizens (although some academics such as Richard Fletcher at the Reuters Institute for the Study of Journalism suggest this problem is overstated). A closely related challenge is that algorithms focused on engagement may prioritise divisive but popular content, an issue that has recently been raised regarding a variety of social media platforms.

Agency and trust may be the key here. Interviewees have suggested that data and AI in the context of news media would benefit from coordination by either a supra-national body or plural bodies, including academic expert groups, press councils and other bottom-up expertise, to assist with ethical issues such as agency and trust when it comes to AI, and to provide guidance and research for industry and policy and law makers. This is outlined in the recommendations below.

AI-assisted personalisation therefore is not one single solution, as it is opening a new design space where journalistic and editorial skills, values and practices are as important as technological skills and opens the debate to be had about ethics and regulation.

14.3 Key challenges of AI for the news media sector

14.3.1 Skills and training

Introducing new technology like this is likely to change the nature of the news industry's workforce, from skillsets to future job opportunities. Like most industries, fear has been expressed by some that AI and automation may threaten jobs with machines taking over work done by humans. However, there is currently no evidence to suggest that automation of news production is linked to a loss of jobs. In fact, handled properly this technology may help journalism flourish as AI takes over repetitive and time-consuming tasks and, in this way, frees up journalists to focus on producing content with high added value (Dierickx, 2021).

However, making good use of technology impacts production processes and will mean redesigning organisations and workflows. These types of structural change have been noted by interviewees to be difficult in some newsrooms' cultures. Similarly, developing AI and data solutions is expensive and sharing

[251] https://medium.com/mittmedia/soldr-personalization-service-mittmedia-innovation-for-survival-fda26f7cdbee
[252] https://www.ai.se/en/news/ai-challenges-media-industry-1
[253] https://www.unitedrobots.ai/for-newsrooms/knowledge/mittmedia-drive-conversions-through-articles-on-home-sales

the cost across the industry would benefit all involved but culturally when it comes to sharing data resources and tools in the news media industry there is a reticence. Historically newsrooms deal in scoops and exclusives not sharing (although that culture is now changing). So, with AI and data there is a risk of a kind of prisoner's dilemma developing as each organisation wont share solutions in case they give up some misperceived competitive advantage. This could open a market for third-party actors to oversee production of data sets available in a machine-readable format and sell relevant data processing as a service to media organisations. News media organisations would then act as buyers of AI services as well as specifying the value and demand for these services, rather than building their own. To an extent this already happens with the big tech platforms. An issue that already exists with this approach is that by outsourcing problem solving in this way there is less incentive for learning and training within the industry.

Most media houses still lack the AI and data skills to successfully harness the potential of the technology. They also find it difficult to attract staff with the necessary competences. However, new professional profiles are emerging across the news value chain and the industry is trying to keep up. The following types of skills and training will be necessary:

- Training to compute AI: The news media sector will need to rely on more computer engineers, linguistic scientists and data scientists. Integrating this new type of skillset into journalism is demanding and is something that both academic institutions and professional bodies will need to help with when it comes to finding a solution. The New York Times and Financial Times have had success with data journalism groups consisting of people from different specialties that work together and often have a cross disciplinary focus. A potential way of addressing the need could be to also upskill more developers to help them become journalists.

- AI literacy for journalists: Journalists need to understand how to assess data accuracy and integrity, evaluate the quality of AI/ML models and draw correct conclusions based on the AI results even if they have not developed an AI algorithm themselves. Special attention should be given to training freelance journalists who are a vital part of the workforce but are often overlooked when training plans are being rolled out.

- Digitalised newsrooms: Using AI is part of the digital transformation of newsrooms, which affects both internal and external processes. Supporting managers and journalists to succeed with this transformation through formal change management training is vital.

- AI ethics: The sector will need to reflect on how to conduct inclusive policies and develop ethics for this technology in news. AI ethics will need to be part of the education for journalists as well as AI professionals. Third party regulation may be required. This is dealt with more in the recommendations section at the end of this study.

Collaboration between media organisations, public institutions and civil society organisations will also need to play a role in order to make sure that smaller or more specialised news media organisations can keep up. This is particularly true for local and regional news, where the commercial margins have become so tight that they do not have the ability to invest in upskilling for this technology. Leaving these news providers behind would mean denying local communities of a service that they require and would reduce the diversity of professional actors in the news industry. Collaboration can benefit large as well as small news organisations. As this paper will state more than once, when it comes to data the whole is greater than the sum of the parts. So, the more data news organisations share the bigger the 'data-cake' there is for everyone to share.

14.3.2 Specific challenges of working with News Media – training the AI

A challenge for content creation in news media when it comes to more sophisticated AI technology, such as machine learning and neural networks, is the need for transparency and objectivity (or, at least, known subjectivity). For this reason, it has been suggested by all our interviewees that the most successful rollouts of AI technology have been with human-designed algorithms, rather than machine learning or neural networks alone, because their design is deemed more transparent, and they have more accurate results. Interviewees noted that machine learning solutions have been tried and largely discarded. Forbes

noted that their AI solutions do not produce content that could be published as-is but serves more like a thought-starter.[254]

The format of news media datasets and archives also create specific challenges given the importance of context within a news site, programme or newspaper. Stories are part of a curated experience and sometimes if they are produced stand-alone the fact that they are out of context can change their meaning. This issue extends to the associated metadata. And it can be particularly complex when working with archive material

The Europeana Newspapers project has been working to analyse large amounts of historical news media and aggregates 18 million historical newspaper pages.[255] The project is an open-sourced database for the discovery of new techniques for analysis and presentation. While the source material is newspapers the main use of the platform is for cultural heritage and research, not for the news media industry. It is a great source for researchers to pose questions and test theories. How to use this data within the news media industry is much less clear. The Europeana project have supported attempts at using their data sets for AI and machine learning, but the databases are currently not directly suited for use as source data for AI applications. So, digital humanities projects like Europeana Newspapers can prove useful in developing ways of approaching historical news material to pull together data but teaching an AI to use it in a way that benefits journalists remains illusive.

14.3.3 Funding

The cost of gathering and storing data, investing in infrastructure, innovating with AI and machine learning, rolling out new products and training staff can all rack up quickly and is a barrier to most when it comes to using this type of technology. Technical teams often play around with open-source code to test hypotheses. Some flirt with the tech giants to collaborate, innovate and learn. Very few news organisations have the budgets to develop in-house, high impact data led AI solutions.

The question of access to funding is, of course, closely related to the question of access to resources. Smaller organisations have less access to funds that will allow them to innovate with this technology. They also don't have staff who have the time to write grant applications or attend free skills workshops that might be setup by third party actors such as governments or the Google News Initiative. Costs and a lack of funds remain barriers to most.

When it comes to value for money, another funding issue arises when each actor is looking to develop their own solutions and there is little sharing between actors of technologies and resources. This goes back to the prisoner dilemma mentioned above. There is little competitive advantage gained by this type of activity and it is far outweighed by the potential benefits that would come from sharing datasets. A data consortium between news media companies in Europe could be a solution. Third parties, public or private, who are not themselves news media organisations but either have a public interest in making shared resources available in the public domain to increase the quality of news media or see a potential business interest in providing AI/ML services or data services for the news media industry could also play a role in supporting this development.

14.3.4 Data access

For a data model to work it needs to be based on data sets that are large, of high quality and have known and understood provenance (historical record of the data and its origins). The data needs to also be relevant to the use case in question. For example, a model trained on a data set based on American men may not give relevant answers if used to predict the actions of Finnish women.

Table 37: Examples of type of data and data sources in the news media industry

Data Type	Data source	Conditions to access
Raw and packaged news content	Reuters News Agency	Fee based
News content metadata	Connexun	Fee-based

[254] https://whatsnewinpublishing.com/forbes-doubles-monthly-visitors-with-bertie-an-ai-driven-cms/
[255] http://www.europeana-newspapers.eu/

	EBU/Eurovision news monitoring tool	Own data
News archive data	Media organisations	Own data
Readership data, including behaviour	News organisations, Google Analytics, Chartbeat, Crowdtangle (social media)	Own data (on and off-platform)
Image content	Getty images	Fee-based
Subscription and registered-user user journey	In-house or third-party subscription solution provider	Own data
Commercial user journey and engagement	Ad tech	Own data

Source: authors

Datamining

Datamining is a process of extracting and discovering patterns in large data sets involving methods at the intersection of machine learning, statistics and database management. In the news industry that can mean monitoring specific data in order to find promising story leads. Here, public sector data (Newsworthy), social media data (Twitter) and financial data (Thomson Reuters, Bloomberg) are datasets common to datamining in journalism. Studies of data journalism have identified financial data, geodata, public records and sociodemographic data as the most used. [256],[257]

Data training

Training data is used to train an algorithm, typically making up a percentage of an overall dataset along with a testing set. Examples of general training data used are images (for correct tagging of images) and text (for text analysis, translation and tagging of text). In translation and text analysis, translated texts are used. For example, the Europarl parallel corpus, created from the European Parliament Proceedings and is useful when translating between European languages (but skews towards legal wording). Another useful data source for data training for translation is translated books. Google Books have digitised around 25 million books and won a court case on fair use. Some 15 million of these are accessible for scholars through Hathitrust[258][259].

For data for images, the large stock photo actors, such as Getty Images, have their own AI services which have been built in-house using data training techniques. There is an ongoing debate about the practice of downloading images directly from the Internet to be used as training data, such as the facial dataset released in 2019 by IBM that was gathered from Flickr without user consent.[260] [261] The photographer's rights to the image should always come first.

For data training on map data, there are a few services that provide relatively cheap APIs with global map data and sometimes satellite data, such as Google, Bing, Apple and Open Streetmap. More specialised services, such as Satellite Imaging Corporation, provide up to date satellite images as well as feature extraction services.[262]

For reader data, the news organisations seem largely to use their own data. There are several different types of data relevant here: unique visitors, page views, dwell time (further details of data types are in the 'personalisation' case study).[263] Sharing audience data would help build models, but this is currently not common practice in the news industry.

[256] Loosen, Wiebke & Reimer, Julius & De Silva-Schmidt, Fenja. (2015). When Data Become News - A content analysis of data journalism pieces
[257] Young, M.L., Hermida, A. and Fulda, J., 2018. What makes for great data journalism? A content analysis of data journalism awards finalists 2012–2015. Journalism Practice, 12(1), pp.115-135.
[258] https://www.hathitrust.org/
[259] https://www.edsurge.com/news/2017-08-10-what-happened-to-google-s-effort-to-scan-millions-of-university-library-books
[260] https://www.nbcnews.com/tech/internet/facial-recognition-s-dirty-little-secret-millions-online-photos-scraped-n981921
[261] https://www.ibm.com/blogs/research/2019/01/diversity-in-faces/
[262] https://www.satimagingcorp.com/services/raster-vector/
[263] https://www.pewresearch.org/journalism/2016/05/05/1-digital-readership-data-and-what-it-can-tell-us/

One alternative to sharing data for training AIs, pointed out in interviews, would be to share metadata standards and/or data models. These models would have to be monitored closely to maintain trust and spot any bias as the model evolves.

Data lakes

Another solution for sharing data could be the creation of data lakes, either operated for profit, by collaboration between news organisations, or as public services. A data lake stores all kinds of data, unlike data warehouses that store structured and relational data. The benefit of this is that all types of data can be stored and that the cost of adding data to a data lake is low. This approach would allow collaborations between different stakeholders who have access to different kinds of data. This could also allow for multiple uses for the same data and possible positive spinoff effects by making data openly accessible.

An example of the use of open data for journalism is the organisation Open Secrets[264] that tracks the intersection of money and politics in the USA. The site uses a tool called the Anomaly Tracker that automatically flags unusual lobby contributions that may affecting policy. This is not using AI per se but catches statistical outliers according to some established criteria. It could be possible to make this kind of data more accessible and available to media organisations.

The challenge when creating a data lake with little curation is that the data lake only provides data in raw formats. Services are then built on top of data lake using these raw formats. Building services in this way – adding data with little curation - runs the risk of large, poorly structured data dumps being added over time, eventually making it impossible to use the data lake effectively. Since data lakes put the responsibility of sorting, cleaning and querying the data on the end user for each use case it is easy to see how an unmonitored data lake could become useless quickly. The only way to avoid that problem would be to create a small data lake curation team who have the necessary expertise to sort or clean the data and make it available for easy use over time. This same team could provide content solutions (similar to a creative agency) and even develop AI models to test using the data.

For smaller players in the sector, a key recommendation is to develop a coherent digital strategy where AI-technology, including data lakes, is one of the tools in a toolbox of technology being rolled out in collaboration with other groups. Similarly, when it comes to more advanced applications of artificial intelligence there is an important role for collaboration to play both between different players in the media ecosystem, small and large, as well as academia, government bodies and third-party tech companies to be able to gather the resources, funding and skills needed to utilise these data and AI solutions.

14.4 Sector-specific recommendations

As stated at the beginning of this study, the key issue in rolling out any AI solution is trust. First the use of these technologies must not undermine the public trust required for news organisations to fulfil arguably their main function in a democratic society; namely holding power to account. Second, the news industry must place trust in the companies and actors that make up the industry in order to properly capitalise on the potential this technology offers. Given how resource intensive using some of this technology can be, this cooperation is particularly important in the case of smaller news media outlets, who may lose out if they cannot or will not collaborate with others. Cost and resourcing remain a barrier to entry for all, which is why collaboration is emphasised.

There is still much work to be done when it comes to understanding capabilities and creating frameworks which might help actors work together when using this technology. And AI and ML are not a panacea. However, as this report has shown, with the help of government agencies and cross-industry partners, AI, ML and data could provide the news media industry with some of the tools needed for new commercial and content models that protect the industry while maintaining high quality news output that serves audiences across the EU.

These recommendations are based on the research above, interviews with stakeholders, a stakeholder workshop facilitated by the authors on 30 September 2021 and information from the Media4Europe Conference: 'Business Transformation of News Media – Content Sharing, Data And Stars4Media' held on

[264] https://www.opensecrets.org/

the 6 October 2021. The recommendations are a part of that wider context and are intended as guidelines for further discussion.

14.4.1 Data sharing – centre of excellence for news

Many news actors are not prepared to share data because of the perceived value of that data to their content or commercial strategies. However, as outlined above, the larger the dataset the better for training AI. It is clear from how the tech platforms such as Facebook and Google have dominated the programmatic advertising arena by using vast amounts of user data across platforms (to target advertising, lowering prices and capturing market share) how large audience datasets can be used with AI to generate value. So, if large datasets combined with AI can create value in this way and sharing data does not take away news organisations' competitive advantage (as outlined above), news organisations could exploit this opportunity, start sharing data and extract value. Data sharing can be of mutual interest, for instance to compete with the AI-powered advertising systems of tech giants, as mentioned before.

Data coordination already exists in certain areas of publishing. EcoDaLo[265] for example is a consortium that helps local publishers in Flanders pool data to create efficiency in data management.

Journalists also increasingly see value in data sharing. There are already many data journalism initiatives such as the International Consortium of Investigative Journalists which coordinates investigations such as the Pandora Papers.

This recommendation suggests extending that type of cooperation in a wider public/private cooperative whose membership comprises of news media companies and takes the form of an Independent Centre of Data Excellence - or data agency - where publicly available data is shared by each member and repurposed into new content. The centre should focus on scale. The content it produces is returned to the cooperative's membership or sold to non-members. For example, political polling data which has already been published in article from two different countries by different publishers would be brought together in the Independent Data Centre of Excellence. Journalists in the centre, with the help of AI, would interrogate the data to create new story angles based on the insight gained by pooling such data. The new news-lines would be formatted into news items (graphics, articles, etc) 'ready-to-run' and returned to the members of the cooperative as new material to be published for their audiences. Rights issues could also be managed centrally.

- This data centre would also have to focus on AI led translation in order to make the offer viable across the languages of the EU.
- Any profits generated by selling content to news organisations who sat outside of the cooperative would be shared among the cooperative membership.
- Storage could work much like a data lake, as described above but the key to the success of this data centre of excellence would be to have a combination of human and machine expertise working together.

In this way new valuable content would be created by sharing data that was already in the public domain, growing the size of the data-cake to be shared amongst all in the cooperative. This centre of excellence would also create a space where smaller news organisations could cooperate with others to make the most of AI and data innovation, safeguarding the diversity of the news industry in the EU. And the centre would help prove the hypothesis that sharing data and working together to innovate with AI can benefit all participants while at the same time creating new value for the centre's membership, hopefully leading to further adoption of the technology, cooperation and greater innovation.

14.4.2 Capability model and future proofing news

In order to develop tools, allocate resources or cooperate efficiently there is the need to have a common language when it comes to understanding capability. How can a business know what to invest in or who to train if they cannot measure what their current capability is.

The recommendation is a checklist to prepare media and help future proof media. A model could be developed to help assess capability maturity and resource allocation ranging from staff training

[265] https://www.imec-int.com/en/what-we-offer/research-portfolio/ecodalo

requirements to data interoperability. The term 'maturity' relates to the degree of formality and optimisation of processes. The model could be set in steps, from ad hoc practices (low maturity) to formally defined steps, to managed result metrics, to active optimisation of the processes (high maturity).

Developing a capability model with the help of academic institutions and other actors could therefore make the investment in data, AI and ML technologies more transparent, better understood and subsequently easier for the news industry. Investment at all levels, from mergers & acquisitions to staff training, would also be less risky because senior leaders in news organisations would be able to take decisions about the future use of this technology with greater confidence, helping them future proof their organisations.

14.4.3 Coordination

Given the level of impact that this technology can have, many interviewees have called for increased coordination, for instance through coordination authorities, academics and press councils, or new bodies with a statutory duty to represent the interests of citizens and consumers by promoting competition and protecting the public from harmful or offensive material.

The constitution of such bodies should be a plural, bottom-up initiative, consisting of expert groups and councils. Interviewees suggested that coordination and possibly some funding could be provided centrally at a national or supra-national level.

Such bodies could look at AI across industries or just focus on news media, develop guidelines and fostering collaboration.

Table 38: Sector-specific recommendations for news media

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Create trust and collaboration in order to properly capitalise on the potential of AI technology and tech startups. Cost and resourcing remain a barrier to entry for all, which is why collaboration is emphasised.	Industry	
Create an Independent Centre of Data Excellence – or data agency - where publicly available data is shared by each member and repurposed into new content and/or algorithms and algorithm best-practice can be developed.	Industry/EU	
Develop a capability model with the help of academic institutions and other actors that can help assess capability maturity and resource allocation ranging from staff training requirements to data interoperability.	Industry/EU	
Foster bottom-up initiatives working on guidelines towards a more coordinated approach to licensing, research, journalistic codes, algorithm bias and ethics	Industry /academics/ national media authorities & EU	Support through national funds + EU coordination

Source: authors

15 Sector in focus: Performing arts

15.1 Short description of the sector and current overall challenges

The performing arts include any art form which are performed for an audience such as dance, opera, music, circus and theatre. Similar to the museum sector, the performing arts are traditionally and entirely end-to-end analogue, meaning that the process of creating, producing and consuming performing arts content is an analogue process. Performing arts content is typically created and produced in a location with practitioners physically coming together and it is experienced by audiences in a physical location, a venue i.e., a theatre, an opera house etc.

In recent times many performing arts creators and organisations have looked to digitise performing arts content and make it available to audiences online and on-screen. Leading international examples of this include the UK National Theatre's NT Live[266], the Berlin Philharmonic Digital Concert Hall[267] and The Metropolitan Opera[268]. However, these examples remain digitised versions of an analogue event, not fully digitised events. Thus, the application of AI has been limited in the performing arts.

As a predominantly analogue and location-based industry, the performing arts has been the cultural sector most effected by the COVID-19 pandemic. The research has shown the average reported decrease in revenues in the global performing arts industry for the first half of 2020 as compared to 2019 equates to 68% in the US and 46% in Europe. That is during a period while European institutions could rely on the security of government grants during the crisis. COVID-19 has also had a major impact on employment in the sector, for example, in Germany and as recently as September 2020 – over 13% of the entire performing arts work force was laid off.[269]

At the time of the writing the pandemic remains ongoing with the final impact on the workforce and industry uncertain. What is certain is that there will be a sustained shift in how the sector operates. As the sector looks to the future and considers how it emerges from the pandemic fit for the 21st century – it will need to further digitise to reach and engage audiences, and as it digitises there is a role for AI for the benefit of the sector.

15.2 Key business opportunities of AI for the performing arts sector

The immediate business opportunities for AI in the performing arts sector are limited. This is because of the traditional and persistent analogue nature of the sector. However, there are opportunities to augment the performing arts creative process through collaborations with AI. While currently an experimental process, the use of AI in content creation may result in commercial success for producers.

In addition, venues, theatres, and other attractions that rely on physical audiences and visitors to a destination have an opportunity to use AI to optimise the audience experience, understanding of audiences and to increase ticket sales.

15.2.1 Use of AI in content creation

In recent times AI has been experimentally used to support and enhance the creative process in the performing arts, for example:

- choreographers have used AI, using an archive of work to 'train' the AI, to choreograph a new performance[270]
- writers have collaborated with AI to explore how a computer might inform a new play[271]
- AI is used as part of improvisation in theatre[272]

[266] https://www.ntlive.com/
[267] https://www.digitalconcerthall.com/en/home
[268] https://www.metopera.org/user-information/nightly-met-opera-streams/
[269] https://www.oecd.org/coronavirus/policy-responses/culture-shock-COVIDCOVID-19-and-the-cultural-and-creative-sectors-08da9e0e/
[270] https://waynemcgregor.com/research/living-archive
[271] https://theaitre.com/
[272] https://humanmachine.live/

- robots are used in live performances and to theatrically interact with humans[273]

All of these creative applications of AI in the performing arts represent experimental one-off examples. They represent the use of AI to inform and augment the creative process alongside a human creator. AI is part of the creative process, in essence - AI as artist.

It is not clear yet how these experimental one-off applications will be scaled to the benefit of the sector in the future.

Beyond the use of AI as an artist, advanced AI enabled technology is being employed by producers to enable theatrical production teams including, performers, lighting designers, directors and writers to collaborate remotely and in real time, and to visualise how a performance will look on stage as a show develops. To do this, producers are using virtual production environments such as Epic's Unreal engine and Unity.[274]

The use of virtual production environments in the performing arts has become more important during the pandemic, as producers are unable to be together in a live working environment because of social distancing and the closures of venues. For the future, virtual production will enable producers to collaborate remotely, provide greater access to the sector for talent that otherwise would not have access to the performing arts. This potentially broadens the pool of available talent and skills, and it will enable the sector to produce work born-digital and for digital consumption – essentially enabling the sector to fully digitise.

15.2.2 Use of AI for audience engagement and accessibility of content

Performing arts are constantly looking to improve the visitor experience for audiences to a venue or on their websites. Like museums and other visitor attractions, AI is being used to improve and personalise that experience for audience in the performing arts.

Reach-out to the audience

For example, the USA headquartered Broadw.ai (https://www.broadw.ai/) – enables audiences to access event information, buy tickets, communicate with a venue – all from one integrated app. This is essentially an AI powered concierge for Broadway. The tool helps providing a better experience to audiences and enables venues to sell more tickets.

Venues and the performing arts are always looking for ways to make live performances more accessible to audiences. AI and other advanced technologies provide novel ways to make live performance content available to as many people as possible. For example:

- In the UK the National Theatre use augmented reality headsets to enable deaf and hard-of-hearing audiences to access subtitles and captions in real time.[275] This technology is supported by NLP and computer vision.
- Real-time voice translations, such as Google Interpreter, will soon enable venues to offer real-time translations of theatrical shows to audiences in any language. This will greatly increase the accessibility of shows to people who otherwise wouldn't attend.

Performing arts producers also rely on the feedback from audiences about what they like and dislike about a show using post-show surveys. This feedback informs the content of future productions and programming decisions for a venue.

- For example, AI has been used in the entertainment industry to understand the true emotional intent of audiences. This enables producers to identify how audiences feel and what motivates them.[276] These deeper insights enable producers to understand the types of shows that audiences are likely to positively respond to, providing producers with a powerful tool to inform creative and programmatic decisions for the future.

[273] https://www.engineeredarts.co.uk/robothespian/
[274] https://www.unrealengine.com/en-US/blog/unreal-engine-brings-virtual-character-to-life-onstage-in-the-royal-shakespeare-companys-the-tempest
[275] https://www.accenture.com/gb-en/case-studies/artificial-intelligence/enhancing-theatre-experience-hard-hearing
[276] https://canvs.ai/

15.2.3 *Use of AI in the business processes*

The performing arts rely on reaching and engaging new audiences to sell tickets to new productions. Similar to other creative and entertainment sectors, the performing arts collect and analyse audience data to inform business decisions and to reach and engage audiences. Recently AI is being used to analyse audience data and to help cultural institutions and the performing arts improve their business processes and decisions.

Activity Stream

Activity Stream is a European company that focuses specifically on the live entertainment sectors – helping those businesses to glean insights from data and information that would otherwise exist in silos. Those insights inform marketing decisions and help producers forecast attendance and ticket sales for a show.

15.3 Challenges of AI for the performing arts sector

Beyond the use of AI to augment artistic development processes experimentally, and the use of AI to better understand audiences, and improve and inform the visitor experience – there is no clear immediate business or commercial opportunities for AI in the performing arts.

The immediate challenges the performing arts sector faces involve scaling performing arts related content to reach wider audiences on digital platforms for commercial benefit. This is a digitisation challenge. While AI may be involved in this process, the digitisation challenge for the performing arts is more fundamental.

In recent times many European countries have turned to immersive technologies e.g., AR/VR etc. to explore how performing arts content could be produced for immersive[277]. Similar to the use of AI in this sector, the use of immersive technologies is experimental, and it is too early to tell if there are commercial opportunities.

The key challenge for the performing arts sector is to tackle this digitisation problem for the commercial benefit of the sector.

The next section lists a few suggestions for tackling the digitisation challenge.

15.4 Suggestions for actions in support of smaller players in the performing arts sector

Embedding AI specialists within performing arts institutions:

Accessing AI talent and skills is expensive, it is prohibitively expensive when other cultural and creative sectors provide more immediate commercial opportunities and benefits for AI specialists. Incentives and programmes should be developed that facilitate access to AI specialists for the commercial benefit of the performing arts sector.

Cross-sectoral collaboration between the performing arts and other digitised cultural and creative sectors:

Commercially focused collaborations between the performing arts and other digitally advanced creative sectors for example, the video games sector, should be incentivised for the mutual benefit of both sectors. This should include areas that support the commercial application of AI but not limited to AI.

Table 39: Sector-specific recommendations for the performing arts sector

Recommendation	Level of implementation (policy, industry, other)	Suitable policy framework
Support projects for AI experimentation that help	EU policy National/regional incentives	Creative Europe Programme, Horizon Europe and

[277] https://www.ukri.org/our-work/our-main-funds/industrial-strategy-challenge-fund/artificial-intelligence-and-data-economy/audience-of-the-future-challenge/

Recommendation	Level of implementation (policy, industry, other)	Suitable policy framework
collaboration between cultural organisations, businesses, and practitioners Put in place a voucher scheme that can help testing some of the available tools Support projects that can allow secondments and interdisciplinary knowledge exchange schemes.		national/regional support programmes
Support and enable connections between startups and organisations active in this sector	Industry	

Source: authors

16 Sector in focus : Visual arts

16.1 Short description of the sector and current overall challenges

The visual arts is a broad sector. UNESCO defines it as "*Arts which appeal primarily to the visual sense; they are art forms that focus on the creation of works, which are primarily visual in nature, or are multidimensional objects.*" Typically, arts forms which are "primarily visual in nature" include painting, drawing, sculpture, photography, video art, digital art, graphic design and street art/graffiti.

The sector has traditionally included the creation of works across different mediums including born-digital art works, for example digital video, digital photography, graphic design, animation and immersive art. Interestingly, while the sector has fully embraced the creation of art through digital – often the work remains experienced in a physical location for example, gallery and museum, site specific locations, public spaces and as part of public art installations. Consequently, AI already has relatively high adoption as part of the creation process within the digitised visual arts but less adoption on the distribution and consumption side of the sector. Additionally, AI, and the interaction between humans and machines has also been extensively investigated as a concept by visual artists.

As a result of the COVID-19 pandemic and while the sector is not completely dependent on location-based activity for creation, unlike the performing arts, with gallery and museum closures, and a general economic downturn, economic opportunities for artists have decreased. The overall market for art has fallen by 25% during the pandemic[278]. This is having a direct impact on artists livelihoods. In the UK, for example, a recent study suggests that almost 60% of visual artists are worried about the ability to get future work and almost 50% have already permanently lost work[279].

16.2 Key business opportunities of AI for the visual arts sector

The key opportunities for AI in the Visual Arts sector are mainly related to content creation and production of new artworks, as well as the enhancement of pictures and photography. Opportunities related to exhibition and consumption are not dissimilar to what has been highlighted in the section investigating Museums and Heritage.

16.2.1 Use of AI in content creation and production

As many visual arts sub-sectors and art forms are 'born-digital', AI already has a relatively high adoption in the creation of visual art works. AI is being used to create new digital imagery and visual art-forms automatically, based on selected and existing "training" datasets. This process typically relies on some form of machine learning

The application of AI to digital art, especially images, involves the generation of original images or the augmentation of existing images.

Many artists are using AI to generate original work, using the AI as a subject and displaying its output for audiences. In this context the use of AI is experimental and is integrated as part of the creative process. The use of AI as artist has generated an interest with buyers and collectors with an AI generated and created piece of art sold for almost $500,000 USD at auction in 2018[280].

[278] https://theartmarket.foleon.com/artbasel/2021/the-global-art-market/
[279] https://cvansoutheast.com/wp-content/uploads/2020/05/CVANCOVIDCOVID-19Summary-view.pdf
[280] https://www.christies.com/features/A-collaboration-between-two-artists-one-human-one-a-machine-9332-1.aspx

Use of AI as a visual artist

The exhibition, Faceless Portraits Transcending Time, is a collaboration between AI and researcher Dr Ahmed Elgammal. For the exhibition Dr Algammal developed the AI as an autonomous AI artist and collaborative creative partner. The exhibition explores audience perceptions of AI and AI-generated art.

This 'Art Work Does Not Exist' (thisartworkdoesnotexist.com)

This example is a website that automatically generates new works of art on demand. The art works are created by a generative adversarial network created by INVIDIA researchers and trained on images of Modern Art. Some of the images are available for sale and printed on canvas.

As this trend continues – there are many questions that need to be considered for the sector about how credit and responsibility should be attributed to machines and individuals involved in the creation of the work and the economic impact of AI created art works for human artists.

AI is being used to augment existing images. This process typically involves combining two or more images into a new single image or taking an existing image and augmenting and changing it into a particular chosen style.

AI image augmentation

DeepArt (deepart.io) is an application developed in Germany that transforms an input image into the style of a selected artist. A stroke-based drawing method trains machines to draw and generalise abstract concepts in a manner similar to humans.

Art Breeder (www.artbreeder.com) is a fun application that creates new images by mixing any images together. Machine learning Generative Adversarial Networks are the main technology enabling Artbreeder.

AI is also being used to process images and photographs. Processing addresses the problems of acquisition, storage, retrieval, processing and production of images and videos, for extraction, analysis and enhancement for human users, robots, and autonomous systems. Processing of this type is often applied to photography and digitised art works and is typically integrated into production workflows for visual artists by enhancing or improving digital imagery processing. Use cases for the use of AI image processing includes:

- Neural rendering is a new class of image and video generation approaches that enable control of image properties such as illumination, camera parameters, pose, geometry, appearance, and semantic structure.
- Contrast enhancement: using machine learning to synthetically enhance the contrast of an image or other media
- Colourisation: the processes that add or restores colour in visual media
- Super resolution imaging: a technique that enhances and increases the resolution of an image and video. Enabling the up sampling of images and video spatially or temporally.

The use of AI in the creation and augmentation of visual art is particularly active because of the relatively large image-based data-sets available online and on the open-web.

Use case: AI assisting post-production workflows

Overview

Artificial Intelligent is widely used in the Visual Arts (incl. photography) sector to enhance and develop design outputs. A number of widely used software packages already include in their offer, AI enabled processes for contrast enhancement, colourisation, resolution enhancement, and inpainting.

The main actors involved in this specific use case are the companies providing these tools (including Adobe's Photosphop. Skylum Luminar, or Corel Paintshop[281]), and the final users, such as designers, photographers, photo editors, illustrators, or digital artists.

Business needs and value proposition

Artists, photographers and designers are already using these AI tools to produce higher quality outputs faster, or to quickly prototype draft outputs. The increased precision offered by these tools, the level of professionalism provided by outputs, and their relative accessibility, has democratised the access to professional post-production to a wider range of artists and professionals.

These powerful software packages empower creators to work on their digital content fast and effectively, focusing on the creative output rather than the manual editing tasks. The widespread adoption of these tools among creative practitioners is leading to a series of implications. For example:

- Through the use of these tools, creators can trial and sketch various options before deciding the final version of their work. This is leading artists and creators to change their creative processes as well as enabling them to document each step of their creation process.
- Some commentators also argue that the use of these tools is having a positive effect on lowering the barrier to entry into the sector for entry-level designers and artists, as these will be facilitated to produce high quality work early in their career.
- It is also recognised that artists and creators have now access to a large variety of products, some available for free, and many of which are supported by active online communities that provide support on how to run applications.

Technology

The various tools that have been developed in this sphere are using an array of methods. Most of the times, however, CNNs and GAN structures appear to be the most used[282].

- Contrast is the difference in luminance and/or colour that allows human retina to recognise objects and make them distinguishable. Tools for contrast enhancement that employ AI use CNNs, Image Enhancement Conditional Generative Adversial Networks, autoencoders, inception modules and residual learning.
- Through colorisation artists and designers can add or restore original colour in images or video. Over the years many different methods have been used for supporting this process, from simpler CNN with three convolutional layers to more developed based on GAN structures.
- Super-resolution approaches enable the quality of low-resolution images or video. Most state-of-the art methods are based on residual learning methods. Similar methods are used for deblurring (correcting images that are distorted by blur due to poor camera focus of subject motion), denoising (determined by sensor limitations when operating in extreme conditions), and dehasing.
- Artificial Intelligence method are also used for inpainting to fix lost or damaged parts of images or videos. This includes applications where the original medium presents missing parts, scratches, dust or damage, or where the user wants to remove regions of an image or a video. GANs and CNNs have been extensively used for these purposes, allowing the creation of tools that in some case allow users to interact with the process, or leaves the system to extract semantic meaning and select the relevant regions of the media being modified autonomously.

Challenges and risks

[281] Parnell-Brookes, 2021
[282] Anantrasirichai and Bull, 2020

Besides the continuous optimisation of products, there are not particular technical and data challenges connected to this use case. However, it is important to highlight that smaller companies producing editing software tools will have to face the predominant position of large corporations such as Adobe and Microsoft in the space.

Some commentators have also pointed out that the abuse of these tools can bring to a general homogenisation of outputs, especially with regards to commercial outputs used in advertising and publishing. It has been pointed out that the clean aesthetic and overly edited images obtained thanks to "the same sky replacement tool, the same skin smoothing, the same fake fog, and the same dodge and burn tools" might end up limiting the diversity of works in the space.

The increasing number of people using these tools, their widespread popularity as well as the presence of an active community of users, will naturally increase the number of people experimenting with the medium. This will increasingly diversify the styles and aesthetics created through this medium. Some policy actions might be taken to introduce artists and creatives to these tools, as well as offering continuous development opportunities to more experienced artists.

Market potential

As discussed elsewhere, AI and ML application are already widely used in software packages for post-production of visual outputs. The sophistication of these tools is increasing and continuously optimised.

As in many other sectors, software packages used by practitioners are limited to a small number of highly developed products. This bears implications for the diversity and plurality of the players in the market.

The level of adoption of these software packages is very high among artists and creatives, who are mostly using the same products.

Tools and software packages for digital image manipulation and editing will remain a fundamental instrument used by creatives and visual artists worldwide and will continue to shape the process followed for creating new content.

16.2.2 Use of AI for audience engagement and accessibility of content

The combination of AI with the visual arts and display technologies provides exciting potential to enhance the experience of visitors in a gallery or elsewhere.

As the visual arts have digitised, digital immersive art exhibitions and installations have become popular in recent times at galleries, museums, public spaces and in architecture. These types of experiences often employ AI to inform and enhance the experience for people in a place.

Augmented reality and computer vision enabled art

Unreal city is public festival and exhibition of augmented reality art that was made available to view and interact with from audience's home. The exhibition is available to experience through an AR enabled app – and delivers AR art to audiences' homes.

Some galleries and museums are experimenting with AI to generate text-based descriptions of images and art to make visual art and art exhibitions more accessible to the blind and visually impaired.283 AI, computer vision and natural language processing is used in this context to process the artwork and to generate a text-based description. This enables the art to be more accessible to more diverse audiences and the disabled. Automated image captioning is an emerging area of research and development, and offers exciting potential for the use of AI to make visual art more accessible to the visually impaired.

16.2.3 Use of AI in business processes

The visual arts is a large industry, and AI is being used to inform collectors and buyers on where there are opportunities in the market, and to help artists discover new markets.

A few examples where AI is being used in this area include:

283 https://www.artnews.com/art-in-america/features/the-met-mca-chicago-blind-access-alt-text-park-mcarthur-shannon-finnegan-1202677577/

- Arthena uses machine learning to "assess the inherent financial value and underlying risk in works of art".[284] The company uses machine learning to develop a quantitative pricing engine for the art market to inform art collectors and investors. The company also works with individual institutions to develop bespoke AI solutions to inform art investment strategies.
- Artsy helps collectors find new works specific to their tastes in response to market trends and opportunities. In 2017, Artsy acquired the company ArtAdvisor, an AI powered service that analyses large sets of data about artists providing deeper understanding of the current and future art market for collectors. The service makes recommendations to collectors regarding the art work they might like.[285]
- ArtPI is an artwork-recommendation engine that analyses personal preferences and purchases to recommend artworks for collectors and buyers.[286] ArtPI uses AI to searcher for connections between art works, finding comparable works and informing sales projections.

The art industry also notoriously suffers from fake art works being sold as authentic works. With experts often tricked into "certifying" a fake work as authentic. AI is now being used to authenticate work assisting human intervention and speeding up the process.

AI used to certify authentic art

Art Recognition, a Swiss startup, offers AI powered authentication rulings on paintings based on photographic reproductions. The technology promises to rid the market of fake art works. The technology only requires a photograph of the work for authentication purposes. The company generates a report and "certifies" the art work within seven days.

16.3 Key challenges of AI for the visual arts sector

The main challenge of AI adoption in this sector is related to availability and access to skills and expertise among its professionals. The quick development of technologies and approaches might mean that some players are left behind. Software available might be expensive especially for early career artist, and up-to-date teaching is often not available in traditional professional development routes.

A second challenge is related to the aesthetics. Some have highlighted that software used for image correction and enhancement can bring to a general homogenisation of outputs, especially with regards to commercial outputs used in advertising and publishing, which might end up limiting the diversity of works in the space.

When looking at the software companies active in this space, it is important to highlight those smaller enterprises producing editing software tools will have to face the predominant position of large corporations such as Adobe and Microsoft.

As highlighted earlier in this chapter, AI is starting to get used in software and services used to establish the monetary value of artworks. Commentators active in the commercial visual art have highlighted the risk of over relying on such systems, as they might create barriers to entry for early career artists.

Going forward, some have also highlighted the use in AI in the- creation of Deep fakes. AI might be used to assist the creation of artworks that can be wrongly attributed to a specific artist and consequently sold in the market.

16.4 Suggestions for actions in support of smaller players in the visual arts sector

Access to data, skills and funding

As each artists practice is highly individual and their needs very diverse, funders should consider to support EU-wide organisations and research centres conducting research in this space and offering development opportunities to artists. Organisations with a long experience in supporting and producing digital and immersive arts might be well placed to act as catalysts in this space. Funders should also continue to support initiatives that allow individual artists to access databases, data lakes and digital pre-sets crowd

[284] https://arthena.com/
[285] http://files.artsy.net/documents/artadvisor-acquisition.pdf
[286] https://www.artpi.co/

sourced and accessible for free. Additionally, it is also important to continue safeguarding a fair attribution of royalties and protection of authors' copyright.

New collaborations

Visual arts have always been strongly linked with other sub-sectors of the cultural and creative sectors. Expertise, skills and outputs from the visual arts have always merged in sectors such as film, advertising, museums, videogames and music. AI and more widely, the digital context in which living artists and galleries operate make the need for collaborations across sectors more needed and fruitful than ever.

Table 40: Sector-specific recommendations for the visual arts sector

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Support research projects exploring business opportunities and applications of AI for the visual arts.	EU policy National/regional	Creative Europe Programme, Horizon Europe and national/regional support programmes
Support initiatives supporting creatives in the development of creative applications and artistic research of AI in the visual arts	Industry National/regional	
Support projects that can allow interdisciplinary knowledge exchange schemes.	Industry	

Source: authors

17 Sector in focus: Video games

17.1 Short description of the sector and current overall challenges

The video games sector is the one true born-digital sector within the cultural and creative sectors. The entire video games value chain from creation to consumption is entirely digital. Defining the video games sector is not trivial, as a sector it is constantly changing and evolving. An accepted definition is "a videogame is a game which we play thanks to an audio-visual apparatus, and which can be based on a story."[287]

The sector spans many different technologies and platforms, mobile, games consoles, web and personal computers, and augmented and virtual reality (AR/VR). There are many genres including platform games, adventure games, puzzles, children's games, educational games, sporting games and games to improve health and well-being. There is also e-sports, live entertainment competitions often hosted in large venues, where teams and individuals compete using video games in front of live audiences.

As an industry the video games sector was valued at more than $150 billion 2019 globally, larger than film box office revenues and the visual arts market combined that year.[288]

Unlike many of the other cultural and creative sectors, during the COVID-19 pandemic the video games sector has grown, with a surge in popularity during lockdowns across the world with captive users.[289] As a born-digital sector the industry has already embraced remote working and remote production, this enabled a large part of the sector, not dependant on specific equipment or infrastructure, to transition and continue to work and grow during the pandemic.

17.2 Key business opportunities of AI for video games

Within the cultural and creative sectors the video games sector pioneers the use of AI across all areas of production. AI has been an integral part of video games since the 1970s to improve the game-player experience.[290] Improving the gaming experience for players remains the primary focus for AI in video games.

Many areas of AI that have been developed specifically for the video games sector are now being applied in other contexts within the cultural and creative sectors and beyond. Video games is responsible for the development of AI enabled technologies and tools that are then adopted by other sectors. For example, synthetic voice and audio generation[291] is now used in video games and film, AI enabled game engines such as Epic's Unreal[292] is being used in the production of films and theatre, graphic cards with integrated Graphics Processing Units (GPUs) originally developed to display high resolution video for playing video games have been adapted for many applications of AI across all sectors of industry[293].

The use of AI in video games is broken down into four key areas that spread across the industry's value chain:

- Using AI to develop and control non-player-characters: Traditionally this area was the focus for the use of AI in video games. With developers using AI to create interesting non-player characters as opponents or co-players within a game and improving the game playing experience.
- Using AI to adapt games that are tailored and personalised to individual users: AI is now being applied to create tailored and personalised game experiences to players based on player behaviour and preferences.
- Using AI to track and analyse player data to model the player experience: To develop new methods for the application of AI for video games, developers must be able to recognise and model the playing style and detect the current emotional and cognitive state of a player. This area of focus is necessary for the personalisation and improvement of the playing experience.

[287] Esposito, N.. "A Short and Simple Definition of What a Videogame Is." *DiGRA Conference* (2005).
[288] https://www.grandviewresearch.com/industry-analysis/video-game-market
[289] https://www.weforum.org/agenda/2020/09/COVIDCOVID19-coronavirus-pandemic-video-games-entertainment-media/
[290] https://sites.google.com/site/myangelcafe/articles/history_ai
[291] https://www.sonantic.io/
[292] https://www.unrealengine.com/
[293] https://www.nvidia.com/en-gb/deep-learning-ai/customer-stories/

- Using AI to improve and optimise the development and distribution of video games. This includes the use of AI as part of the testing and quality assurance stage, and the use of advanced AI processes that rely on large scale infrastructure with high computation capacity and connectivity.

17.2.1 Use of AI to develop and control non-player characters

A non-player character (NPC) is any character in a game which is not controlled by a player. An NPC can have many different functions within a video game including as an opponent, to advance a story line, to provide support for a player. Traditionally NPCs had a fixed set of pre-determined functions and behaviours. With AI, NPC behaviour is becoming more sophisticated and tailored to a player's behaviours and preferences.

Prior to AI, programmers developed NPCs with a predetermined set of functions and behaviours. AI enables NPCs to develop a range of behavioural characteristics specific to any game environment and to learn from player behaviour and preferences.

Several AI applications to support the development and control of NPC are emerging that can be plugged into any game environment. These applications open the potential for new developers to access and deploy advanced AI techniques into the development and control of NPCs in any game environment. AI powered NPCs promise to imbue NPCs with more complex, engaging and 'human' or natural behaviour. This behaviour evolves as a NPCs interacts with a player. These types of complex behaviours are too complicated and time consuming for a developer to programme manually. Thus, the adoption and application of existing technology potentially reduces the development overhead for game developers.

Smart Engine AI, is a C++ machine learning engine that developers can use to improve NPC AI. The engine fully integrates with existing popular game development platforms. The engine is free for 'indie' developers i.e., small business and individual creators. The engine enables developers to use advanced machine learning techniques to train and enable NPC functionality.

Several niche AI applications to support NPC development and interactivity have emerged to support various characteristics of NPC behaviour. Different characteristics of NPC behaviour can be trained and controlled by different applications of AI. For example:

- Drama management is a way for AI to mediate between users, non-player characters and other aspects of a game. A "drama manager" is an NPC AI agent responsible for delivering an enjoyable and a coherent narrative experience to players. The agent essentially mediates between the player and the game environment to make the playing experience as enjoyable as possible.[294]
- In persistent games, long-term games that are designed to be played for many months or years, there is a type of NPC AI agent that interacts with players called life-long agents. In the context of video games, lifelong agents are NPCs that learn about you as a player over time. Lifelong agents serve as long term companions (or adversaries) that recognise and adapt to changes in players over time and use historical interactions with players to shift behaviour. Lifelong agents essentially get to know players, become familiar with the player and the player becomes familiar with the agent. This familiarity is designed to increase enjoyment and engagement with the game.
- A key to persistent games is player retention and many contemporary games have high ceilings for player skills to build up to. However, complex games often lose players early in the game. Gameplay support NPC AI agents act as mentors to players to help them overcome challenges that might otherwise cause them to stop playing a game. Gameplay support AI observes players,

Extreme AI, a NPC personality system

Extreme AI enables developers to create personalities for NPC that evolve during a game based on interactions and events. Extreme AI plugs into existing game engines and development platforms and promises to "breath life" into an NPC enabling real personality led behaviours to emerge in NPCs.

[294] Ram, A., Ontañón, S. and Mehta, M., 2007, May. Artificial intelligence for Adaptive Computer Games. In *FLAIRS Conference* (pp. 22-29).

learns their gameplay strengths and weaknesses, and intervenes to provide players with appropriate help, training materials, or content and environmental adjustments as needed.

The use of natural language processing in games would allow AI to build natural conversational elements with NPCs without the need for pre-recorded dialogue. Combine these with AI-assisted character animation and you have NPCs that can talk and act in a highly natural way.

AI powered voice and animation synthesis in the future will enable developers to create characters and stories without having to motion capture and record all the content. This would allow for much faster content generation, reducing the development overhead and enabling games to evolve and change on the fly.

Sonantic, is a company that uses AI to synthesise the voices of NPCs. The company uses deep learning techniques to build highly realistic synthetic voices for characters. The application is mostly used during the development stages to test in-game dialogue, but in the future, the technology will be applied to in-game dialogue.

The use of AI to power NPC is not without risks. Unsuccessful use of AI in this context can disengage players, reduce enjoyability of game play and "break the suspension of disbelief". Developers need to be aware of the challenges that remain with these technologies. Good game design and continued development of these technologies and methods is an area of active research.

17.2.2 Use of AI in adaptive games

Increasing player engagement with, and the enjoyability of, a video game is the primary goal of game design. Designers and developers are constantly working to increase player engagement and AI provides game designers with powerful new tools to increase engagement and the enjoyability of a game.

Adaptive games combine dynamic content generation and player analysis and modelling to tailor games to individual players. Adaptive games can automate game content based on design goals for player behaviour and player skill acquisition while maximising player enjoyment.

AI is being harnessed as part of the development of interactivity and narratives for individual players as part of adaptive game design. AI enable games to adapt based on specific user actions and input. Beyond controlling NPC behaviour, AI in adaptive gaming enables all aspects of a game to adapt and change specific to the choices, preferences, and experiences of a player.

Procedural Content Generation (PCG) is an AI powered method that enables adaptive games.[295] PCG refers to the practice of generating game content, such as levels, tasks and characters algorithmically. Beyond increasing engagement, the intention for PCG is to make a game re-playable i.e. that a game can be enjoyed many times without being repetitive. PCG also reduces the development overhead for game producers, enabling aspects of a game to be generated automatically. [296]

Voxel Plugin is a plugin for the unreal game engine. The plugin enables developers to generate "infinite landscapes" using procedural content generation methods. Landscapes and backgrounds are generated on the fly as players interact with a game. The plug-in promises to lower the development overhead and in turn the cost and time of developing a game.

AI Dungeon, is an online text-based game that is capable of generating a storyline in real time, interacting with player input. The game is powered by Open AI's GPT-3 natural language processing API. Procedural generation has been used to automatically randomise content so that a game does not present content in the same order every time.

Dynamic Difficulty Adjustment (DDA) systems make real-time adjustments to game parameters, item placement, enemy behaviour, and other content to suit player abilities. AI is used to vary the difficultly

[295] Smith, G., 2014, September. The future of procedural content generation in games. In *Proceedings of the AAAI Conference on Artificial intelligence and Interactive Digital Entertainment* (Vol. 10, No. 1).
[296] https://www.nature.com/articles/s42256-020-0208-z

level of video games to increase user engagement in real time. The more successful a player becomes the more difficult the game becomes in response. Varying the difficultly level in this way increases user engagement.[297]

More recent developments in the area of cognitive computing and emotional AI, whereby AI can assess the psychological state of a player, enable game producers to adapt games that change based on a player's emotional state as they navigate a game. [298]

As games and the expectations of players become more sophisticated, game creators and producers will need to continue to adapt and tailor experiences to players and users. Creating hyper-personalised experiences. These expectations will raise the bar for the sector and the technical ability required to work and succeed in the sector.

Use case: Player experience modelling and Adaptive Games

Overview

The development of AI and machine learning techniques is allowing games developers and researchers to create game products that adapt and personalise to the individual players. These games are called adaptive games. Applications of this kind have been used in the sector for several years. However, the increasing computational capacities available and advancing forms of AI algorithms will allow greater number of producers and players to produce and enjoy adaptive game experiences.

With adaptive games, games developers have developed systems that track and model players choices and movements within a game. This modelling informs how to adapt the game to increase engagement and the enjoyability of the game. More recently, games developers have started to implement in-game emotive and bio-feedback sensors that can collect data on players' emotional and biological responses to games i.e. changes in players' facial expressions, posture, speech, heartbeat etc.

Modelling processes recognise the playing style, preferences, skill level and the current emotional and cognitive state of the user to then adapt and personalise the game in response.

This technique promises to deliver and enable the production of highly tailored and personalised game play experiences for players.

Game development companies, universities, and academics in the fields of engineering, computer science and mathematics are the professionals and organisations most involved in the application and development of this use case. However, game design and development also include many areas across the cultural and creative sectors and beyond. Psychology is important to game design as it enables developers to utilise psychology to adapt a game in response to emotive responses during game play.

In the video games sector, there is a high level of innovation and R&D. Universities, academics and the industry tend to work closely together to ensure the latest technological development and areas of research are applied to the development of new productions. This includes player experience modelling techniques and adaptive game design.

Universities also play an important role in ensuring the development and availability of personnel, talent and skills for the video games sector.

Business needs and value proposition

This specific use case responds to the need of providing new and personalised experiences to users to maximise engagement with a game and the enjoyability of a game.

Preferences and skill levels vary widely among players of the same game. Creating an experience that adapts to an individual player is likely to increase engagement and the enjoyability of the game. This is the dominant use of AI in video games, to increase the enjoyability of a game.

Increased engagement and enjoyability increases the desirability of a game to a wider audience.

In addition, providing an adaptive game environment that changes in response to players interactions and creates a dynamic ever-changing experience, is also likely to be re-played. Increasing the re-

[297] Zohaib, M., 2018. Dynamic difficulty adjustment (DDA) in computer games: A review. *Advances in Human-Computer Interaction, 2018*.
[298] https://searchenterpriseai.techtarget.com/feature/Future-of-AI-in-video-games-focuses-on-the-human-connection

playability of game has obvious economic benefits and also reduces the development burden for producers.

With persistent games, increasing engagement means a player will spend more time on a game over a long period of time, potentially significantly increasing revenue and profitability of a game.

The more a game is tailored and responds to the preferences of a player, the more engaging and enjoyable a game becomes for a player. The more enjoyable a game the greater it's value. This increased level of engagement is the primary driver for a game designer.

Adaptive games and the associated methods and technologies can also be utilised in other sectors and there are many potential applications beyond games. For example, adaptive game methods can be used in applications that are aimed at improving the health and wellbeing of a user by reenforcing good habits based on behaviours.[299] Other applications include educational applications that are designed to provide tailored learning environments to users.

Technology

There is a variety of different technical approaches to adapt game environments based on player interactions, a common technology and method used in this area is procedural content generation.

Some approaches to procedural content generation include supervised learning (e.g., training a neural network based on existing and historical user game-play), to unsupervised approaches, such as clustering groups of players that have a similar style and approach to the game.

Data provided in both cases and inferences from that data can trigger decisions about how to adapt a game to a player to maximise enjoyability and engagement. This includes using GANs and other machine learning techniques to automatically generate tailored scenarios and content that creates the desired experience for the player[300].

Challenges

Challenges related to this use case are linked to the production of adaptive games, the technical challenges and potential for user manipulation.

One of the main technical challenges researchers have flagged is the shortage of generalised high quality and publicly accessible data to train the models used in adaptive games. Typically, historical game play data remains within a company that produced a game or for a platform that distributed the game. Without access to adequate generalised data to train and test new adaptive game models it is difficult for new and smaller businesses and methods to emerge outside of the existing dominant players in the market.

Algorithms often only work for a particular version of a particular task in response to specific data.[301] Consequently, the development of generalised models that can be applied to a wide variety of adaptive games is a challenge. There are a number of proposed solutions to these problems in research including:

- Data augmentation methods increase the diversity in the dataset, not by collecting more data but by adding modified versions of the already existing data
- Using GANs to generate game play functionality

There are also existing and persistent issues regarding algorithmic efficiency and the lack of available computational power [302] for researchers, academia and small businesses. These issues need to be continually addressed as large corporations have the available resources to pay for adequate infrastructure, but often smaller businesses do not.

As AI powered modelling and adaptive games advance, so do the opportunities for player manipulation.

Manipulation can have both a positive and a negative impact. Affective games are video games that use game design and affective computing methods to improve the well-being and mental health of

[299] https://guardians.media.mit.edu/
[300] Risi and Preuss, 2020
[301] Risi, S. and Togelius, J. (2020). Increasing generality in machine learning through procedural content generation. *Nature Machine Intelligence*, [online] 2(8), pp.428–436. Available at: https://www.nature.com/articles/s42256-020-0208-z?proof=t
[302] D. Hooshyar et al, 2018

players. For example, The Guardians[303], is an MIT developed game with the specific intent of improving players wellbeing and fighting depression. The game reinforces positive behaviour by rewarding players in response to behaviour.

However, video games are already known to cause additive behaviour in a minority of players.[304] As player modelling and personalisation through AI become more developed the potential for manipulation and encouraging addictive behaviours may increase.

Internet gaming disorder is characterised by a reduced control over gaming, resulting in increased gaming time. The behaviour can have negative consequences in many aspects of a player's life: personal, family, social and occupational. The extent of this problem is difficult to measure and is estimated at anywhere between 1% and 10% of the general population. This has led the WHO to include gaming disorders in the list of mental health conditions. [305]

As adaptive games are a relatively nascent technology in the video games sector, it is too early to tell if they will increase the potential for addiction through manipulation. Although this area does require further consideration, Article 5 of the Proposal for an Artificial Intelligence Act on 'Prohibited artificial intelligence practices' foresees the prohibition of certain particularly harmful AI practices. "The prohibition covers practices that have a significant potential to manipulate persons through subliminal techniques beyond their consciousness or exploit vulnerabilities of specific vulnerable groups such as children or persons with disabilities in order to materially distort their behaviour in a manner that is likely to cause them or another person psychological or physical harm" (European Commission, 2020).

AI models for adaptive games require access to player data to adequately model player behaviours and train the adaptive gaming algorithms. As referenced above, while a lack of access to player data can hinder the development of adaptive gaming particularly amongst small businesses and researchers – a more liberal approach to data-access may impinge on player privacy. Regulators and policy makers need to get the balance right between increasing access to player data and protecting player privacy. Policy makers need to promote innovation while also adequately protecting player privacy. This issue goes beyond video games, however in a sector where innovation is critical it is a sector that heavily relies on these issues being adequately resolved for the benefit of the sector and the public.

17.2.3 Using AI to track and analyse player data to model the player experience

As the personalisation and development of adaptive games progresses, game engines need to be able to recognise and model the playing style of a player and detect the current emotional and cognitive state of a user.

Player modelling uses AI for the tracking, analysis and construction of computational models for the behaviours of players in a video game. Player modelling involves many different AI related disciplines including affective computing, psychology, and human-computer interaction.

Player modelling enables designers to design and adapt games and NPCs based on the behaviours and experiences of a player.

Advanced areas of research in this area include the use of deep learning to provide models of individual player behaviour with high accuracy for predicting skill-use and recreating strategies from previously recorded data.[306] This enables developers to understand how players are likely to navigate within a game environment and to make design adjustments.

Other areas in development include the use of real-time emotion detection, a technology that extracts human emotions from displayed behavioural or physiological features. The use of emotion recognition functionality is still at an early stage of development. In video games, real-time facial emotion detection

Imotions, emotion recognition specialists

Imotions is a company that works with game developers to track players emotional engagement and frustration levels, and to detect reactions to game elements in real time. The company works with developers as part of the usability testing phase of a game's development.

[303] https://guardians.media.mit.edu/
[304] https://www.sciencedaily.com/releases/2020/05/200513143803.htm
[305] Gros, L., Debue, N., Lete, J. and van de Leemput, C. (2020). Video Game Addiction and Emotional States: Possible Confusion Between Pleasure and Happiness? *Frontiers in Psychology*
[306] Pfau, J., Smeddinck, J.D. and Malaka, R., 2018, October. Towards deep player behavior models in mmorpgs. In *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play* (pp. 381-392).

can use a player's webcam. Emotion recognition enables developers to track the attention and emotional engagement a player has with a game, and to adapt the game accordingly.

Using AI to model a players behaviour increases the opportunities for player manipulation. Manipulation can be both positive and negative. For example, Affective Games are video games that use affective computing to increase the well-being of users[307]. Video games are also known to cause additive behaviour in a minority of players.[308] As player modelling techniques become more developed the potential for manipulation and encouraging addictive behaviours may increase, as outlined in the section on challenges below. In these cases, Article 5 of the proposal for an 'Artificial Intelligence Act' suggests that AI practices that deploy "*subliminal techniques beyond a person's consciousness in order to materially distort a person's behaviour*" and "*exploit any of the vulnerabilities of a specific group of persons due to their age, physical or mental disability*" shall be prohibited. Moreover, the transparency obligation foresees that "*natural persons should be notified that they are interacting with an AI system, unless this is obvious from the circumstances and the context of use. Moreover, natural persons should be notified when they are exposed to an emotion recognition system or a biometric categorisation system*".

17.2.4 Using AI to improve and optimise the development and distribution of video games

AI in video games is dependent on technology infrastructure that can capture and process large amounts of data in real time while rendering and distributing content for users without any discernible lag. This requires sophisticated distributed computing and systems and cloud-based rendering services specific to video games and AI. For example, Epic the producer of the popular game Fortnite are one of Amazon Web Services (AWS) largest customer, serving over 200 million players with over 8 million concurrent players.[309] AWS has developed specific infrastructure and cloud services to support AI for games.[310]

As the integration of AI in video games increase so will the requirement for infrastructure that services and adequately distributes games to users internationally. Distributing next generation AI enabled video games will require next generation connectivity for producers to collect data in real time from users and for users to interact in high-resolution with the game across a variety of devices including AR/VR.

Next Generation Connectivity refers to anticipated technological advances which will offer greater capacity and coverage for internet connectivity for example 5G mobile networks, full-fibre broadband and satellite internet access. Without adequate connectivity producers will not be able to reach and provide an adequate experience to players.

While infrastructure and connectivity are not AI technologies per se, the success of AI enabled games will depend on those technologies to reach and satisfy players.

As the games industry continues to grow at pace, **game testing and quality assurance** checks become more critical and complex. Artificial Intelligence and machine learning promises to automate the process of game testing, accelerating the process of bringing a game to market and lowering the cost of production. There are a number of use cases and benefits for the use of AI in game testing, including:

- Executing automated tests in parallel that typically happen in serial
- Highlighting areas in game play and functionality that could be improved, and how to improve them

Glitch Finder, automated game testing using AI

Developed by modl.ai, Glitch Finder automates the process of game testing using AI. Glitch Finder can test with multiple AI agents simultaneously increasing the testing speed when carried out by humans.

Automatic and quasi-automatic testing is currently a pillar of AI research in video games. Algorithms developed for the purposes of automating game testing can be repurposed and applied across many other areas already referenced in this work for example: controlling NPC, adaptive gaming and modelling

[307] https://guardians.media.mit.edu/
[308] https://www.sciencedaily.com/releases/2020/05/200513143803.htm
[309] https://pradeepkumar-2k.medium.com/how-epic-games-uses-aws-to-deliver-fortnite-to-its-200-million-players-8a23534d99d6
[310] https://aws.amazon.com/gametech/machine-learning/

the player experience. The reusability of game testing algorithms and the potential to accelerate the development process while reducing development costs is the reason why game testing research and development is so important in the sector currently. This makes automated game testing a critical area of focus for the sector in Europe.

17.3 Key challenges of AI for the sector

As the sector continues to grow and as the application of AI becomes more integral to the production of video games, the sector faces a number of key challenges.

17.3.1 Access to data

Access to player data is critical to the development of all areas of AI in video games. Currently game playing data remains with the developers of a game or the distribution platforms that game developers use i.e. App Store, Google Play etc. In addition, as developers adopt existing game engine platforms for the development of new titles e.g., Epic's Unreal, this leaves aspects of the resulting game-playing data in the hands of the engine's developer i.e., Epic.

Access to data is critical to train and develop new AI based systems and models for the sector. The emerging model whereby player data is retained by incumbent businesses, often large multinational corporations, will reduce access to data for small businesses and researchers. Limited access to data will hinder innovation and creativity amongst smaller businesses and researchers. This has the potential to contribute to a monopoly in the sector whereby those that have access to data are best placed to innovate and grow through AI.

However, more liberal access to data potentially impinges upon player privacy and protection. If player data was more readily available or sold on the secondary market this could impact on user privacy and potentially expose users to manipulation.

Getting the balance between ensuring access to player data for businesses and researchers, while protecting player privacy is a critical challenge for the sector.

17.3.2 Access to infrastructure and connectivity

Alongside the film industry, the video games sector is one of the biggest users of commercial cloud-based infrastructure with players and games connecting remotely. Advanced AI enabled video games rely on large, distributed processing power for rendering and fast connectivity to reach users. Without adequate infrastructure, games and users will be unable to realise the full potential of AI.

Similar to the data access problem, researchers and small business also require access to appropriate infrastructure and computational power to develop and make best use of new AI powered tools and methods.

Often infrastructure of this type, while cloud based, is expensive. Universities and small businesses cannot compete with the existing infrastructure access available to large multinational and wealthy businesses. However, if the sector in Europe is to innovate and compete internationally, small businesses and researchers require access to infrastructure and computational power that is comparable to that of big businesses.

In addition, existing commercial cloud infrastructure offers are comminated by a small number of large corporations. All of which are non-European. There is no European alternative that could potentially support the market in Europe that is available to businesses in Europe. This is challenge when it comes to exploring potential partnerships and sharing data.

Also, connectivity and Internet speeds vary greatly across Europe. Without adequate Internet speeds, access to games that require high bandwidths is not possible. Increasing internet speeds and access to adequate connectivity across Europe would increase the potential market size for video games in Europe.

17.3.3 Access to skills

Beyond technology, one of the major business challenges for games producers is a shortage of the technical talent and workforce required to produce video games in the era of AI. Owing to the complexity of the technical needs of the sector, this talent shortage is acute[311].

This shortage is particularly acute in Europe, with the UK, US and China leading the world in producing adequate AI talent. [312] This challenge needs to be addressed if AI in video games is to grow as a sector in Europe.

Where adequate talent is produced in Europe, universities and small businesses cannot currently compete with the salaries and funding on offer in other countries. For example, in the US PhD programmes often provide generous packages that European universities cannot match. In addition, a PhD in the US is often seen as a direct path into one of the large technology companies that pay very high salaries for PhD level researchers and developers. This situation has resulted in a talent-drain from Europe to the US, with the US attracting the highest number of PhD students in the world.

This talent-drain problem exacerbates the problem of access to skills and talent for smaller businesses in Europe, that depend on talent for development and innovation. A lack of access to skills and talent creates a vicious circle contributing to the potential monopolisation of the sector.

Retaining talent and skills in Europe, and developing an adequate pipeline of talent to meet the demands of the sector so it can compete internationally and compete with incumbent businesses is a critical challenge.

17.3.4 Manipulation

As referenced above, manipulation in games can be both positive and negative. Some games are designed to reinforce positive behaviour and positively impact players while some video games are already known to cause additive behaviour in players. As the use of AI in video games advances to enhance personalisation and adaptability, the potential for manipulation that has a negative impact may increase.

As referenced previously, adaptive games that are tailored specific to individual user's interests, tastes and choices, have the potential to increase addictive behaviour. The purpose of adaptive games is to make a game more engaging. However, in addition to adaptive games – in-game purchases and gambling, and other damaging behaviours potentially increase through the use of AI in combination with personal-player-data.

This is a challenge for policy makers and game developers. Game developers require access to user and player behavioural data to model and train AI powered algorithms. However, player data of this nature is highly personal and can include biometric data and data related to a person's emotional state. Access to this data expose users to manipulation from advertising, misinformation, and other malevolent actors. This is particularly important considering children are known to be the largest game-playing demographic.[313]

However, innovation in this sector replies upon access to player data. There is a tension here between privacy and innovation. Less access to data will potentially hamper innovation and creativity, increased access to personal data will potentially expose players to manipulation. This is a critical challenge for the sector and policy makers need to work with developers and platforms to resolve this issue if the sector is to maximise the use and the promise of AI.

Addiction with video games is already an area of active research in psychology, further research in this area is required considering the potential increased manipulative risks associated with AI in games.

The existing EC's proposal for a regulatory framework for AI do not identify video games as high-risk application. However, the prohibitions proposed cover AI practices enabling harmful subliminal manipulation and exploitation of vulnerabilities of children that could be potentially applied to such AI systems in the gaming sector if manipulating users in a manner that causes or is likely to cause them physical or psychological harm, including addition. Further research in this area is require considering the implications for AI in video games. In addition, the AI proposal requires that people should be always

[311] https://www.awn.com/news/eu-skills-report-sites-serious-lack-gaming-talent
[312] https://www.bruegel.org/2020/08/europe-has-an-artificial-intelligence-skills-shortage/
[313] https://www.earnest.com/blog/the-demographics-of-video-gaming/

informed if interacting with an AI system (including an AI agent in an adaptive game) or when exposed to emotion recognition or biometric categorisation systems.

17.4 Suggestions for actions in support of smaller players in the sector

17.4.1 Data and models

Newly developed AI models developed by private business often remain inaccessible to the rest of the sector. If these models were shared with the sector, it would advance the entire sector.

Develop a framework to incentivise model sharing for reuse

There is a need to incentivise businesses to share their newly developed models for the benefit of the entire sector. Businesses should be incentivised to provide access to these models for the benefit of the sector and for their own benefit. Siloed development will hinder the development and growth of the sector in Europe. A more collaborative approach to the development of models will enable those models to be re-used and re-applied within new businesses. This is a complex problem to solve as businesses often strive to protect newly developed algorithms and AI models. However, if the right incentives and businesses practices were established whereby businesses benefited from sharing their models for *reuse* this would help accelerate the growth of the sector in Europe.

Develop a data-commons framework that incentivises data sharing: AI Models rely on access to data, without data new models will not be developed beyond those companies who already have adequate data.

- There is a need to develop an open-data culture and infrastructure to enable smaller companies to access player data and that incentivising data-owners to share data as part of a *commons* model. This requires complex data-governance to support data pooling as part of a data commons. This already happens ad-hoc, informally and bilaterally between companies. However, a standard framework is required to enable small business to access data and to incentivise larger businesses to share data. Policy makers should ensure that a potential culture of data sharing isn't exploited by companies that only extract data and that don't also supply data to a commons i.e. avoid a *tragedy of the commons*.
- There is also a need to get the balance right between privacy and access. Often player-data is highly personalised and sensitive. However, any regulatory framework for data sharing needs to ensure that Europe is competitive internationally. Consequently, businesses need to be able to share player data securely while also protecting players privacy.

17.4.2 Talent and skills

There is currently an acute shortage of AI talent across Europe. It is difficult to attract and retain talent in Europe considering incentives in other countries particularly USA and China. Currently Europe cannot compete with the USA and China and the salaries paid there. There are also issues with immigration in Europe that stops workers coming to Europe and working remotely as researchers in Europe. This includes universities that want to bring in foreign talent, but they don't qualify for a visa.

Explore targeted immigration reform to support international AI experts to work in Europe

There is a need for immigration reform to support AI experts and developers to work in Europe, this includes remote workers, and academic workers, researchers and PHDs. Europe needs to consider a targeted approach to incentivise and enable AI experts to work in Europe. This problem is not unique to video games, however a solution to this problem for video games would benefit the sector greatly and have positive impacts with other sectors.

In addition to existing AI talent, Europe needs to support the development of new talent. The existing curriculum in schools doesn't adequately teach and prepare young people for work in the games sector, or the AI related and technology sectors more broadly.

Develop targeted school curriculum reform and informal educational services to support children learn the coding skills required for AI and video games

- Europe needs to review the existing formal and informal educational curriculum, programmes and supporting services. The review should consider how the existing curriculum encourages and prepares students for work in the video games sector and for the development of AI.

- A review in this area should also include a review of the need to upskill teachers so they have the necessary tools to teach children in this area. This would benefit all sectors and industries that are looking to adopt AI.

17.4.3 Community and player protection

There is a need to further protect online communities and players from bad actors and inappropriate content; this includes fraud, age appropriateness of games, addiction, and manipulation. The video games sector already leads the use of AI and self-regulation for this purpose. However, more work is required considering advances in player modelling and adaptive games technology.

Implement a standardised approach to safety and privacy in collaboration with the sector and that encourages innovation

- Existing data protection and safety regulations are complex and not joined up. For example, it is not explicitly clear if video game addiction and the use of videos games for manipulation is covered by the prohibitions in the EC's regulatory framework for AI or how GDPR aligns with a potential model for sharing player data. A standardised approach to safety for gaming communities is important for the safe development of the sector. Also, a failure to harmonise and clarify data access rules will create a market access barrier for small European game developer studios.
- Any standardised approach to safety will need to take a balanced approach to safety and innovation. This is important because of the more liberal approach to game development in other countries. Although safety cannot be ensured without certain requirements and long-term mental health should not be sacrificed over economic gains, Europe could adopt a careful approach where innovation is encouraged in the gaming sector, while fostering practices that protect European citizens and communities.

17.4.4 Connectivity and infrastructure

Universal access in Europe to advanced video games that utilise high-bandwidth advanced game technology including AI and VR/AR, is not possible without adequate connectivity and Internet speeds. Europe has very different connectivity and bandwidth across the continent. A standardised approach to increase internet speeds across the continent would increase the potential market size.

Increase connectivity and internet speeds across Europe to increase the market size

- A standardised approach to increasing Internet speeds and connectivity would have a benefit beyond video games as market sizes would increase for almost all digital content sectors. Increasing the market demand and access to digital content and advanced content offers that use AI would greatly benefit European producers.
- The three big cloud infrastructure providers are US companies. Europe does not have an equivalent provider. There is an opportunity to develop an infrastructure provision that is European centric, that supports access to best-in-class cloud infrastructure and computation power for the benefit of European businesses and researchers.

Incentivise the development of a pan-European cloud provision for businesses and universities: The development and growth of a European centric cloud provision should adhere to and reenforce European values. For example, a European cloud infrastructure could be developed that better supports researchers and small businesses to access high-end infrastructure and AI tools at lower cost. Also, a European centric cloud provision, should support the issues around data access and privacy, see above.

17.4.5 International collaborations and global markets

Often European companies and universities want to collaborate with non-European businesses, but European funding can limit funding being spent on and invested in non-European companies. This limits the potential partners for research and R&D, and consequently limits international collaborations and potential access to international markets.

Liberalise funding and collaboration requirements that use EC funding and actively support international collaborations through and with EC funding : The USA and China are leading the way in the development of and lobbying for standardised technology regulations. Europe needs a strong voice in this area to protect European values.

Explore how European values are protected beyond Europe and through international bodies like the UN, ISO and other international technology regulatory bodies : It is critical that Europe has a strong voice and lobbies for European interests and values through these international bodies. This requires active participation and coordination with Europe's video games sector and AI industries.

17.4.6 Cross-sectoral collaborations

Video games and other sectors across the cultural and creative sectors need to be incentivised to collaborate through AI for the collective benefit of the cultural and creative sectors, not simply for the benefit of one sector or another.

Incentivise cross-sector collaborations through AI that focus on the development of the cultural and creative sectors ecology.

- The video game sector leads the industry in the use and development of AI, the technology and methods born out of the video games sector has the potential to be employed cross-sector. Innovation in video games is beneficial for all cultural and creative sectors.
- Programmes to incentivise cross-sectoral collaboration need to recognise the technical and economic asymmetry that exists between the video-games sector and other more traditional cultural and creative sectors i.e. museums, performing arts. However, while collaborations may reinforce video-games technical and economic position in the cultural and creative sectors it may also encourage creators from other sectors to adapt video-game methodologies and practices. This should be encouraged.

Table 41: Sector-specific recommendations for the Video Games sector

Recommendation	**Level of implementation (policy, industry, other)**	**Suitable policy framework**
Data: Develop a framework and data-common to incentivise data and model sharing for reuse.	Industry	Digital Europe
Skills: Explore targeted immigration reform to support international AI experts to work in Europe.	EU policy	
Skills: Develop targeted school curriculum reform and informal educational services to support children learn the coding skills required for AI and video games.	National/Regional Industry	National/regional university programmes Erasums+
Safety: Implement a standardised approach to safety and privacy in collaboration with the sector and that encourages innovation.	EU policy	AI regulation
Infrastructure: Increase connectivity and internet speeds across Europe to increase the market size, and incentivise the development of a pan-European cloud provision for businesses and universities.	EU policy, National/regional incentives	
Collaboration: Liberalise funding and collaboration requirements that use EC funding and actively support international collaborations through and with EC funding.	EU policy	Funding calls
Collaboration: Explore how European values are protected beyond Europe and through international bodies like the UN, ISO and other international technology regulatory bodies.	EU policy	Creative Europe, Horizon 2020
Incentivise cross-sector collaborations through AI that focus on the development of the cultural and creative sectors ecology.		S+T+ARTS, Creative Europe, Horizon

Source: authors

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19 Interviews (non-exhaustive list of organisations)

3pc GmbH, ACE, adtech business, AEC, AIE, Art and Artificial Intelligence Laboratory at Rutgers, ART COM, BMAT, Bookalope, Bright Sites, Charisma ai, Cinelytic, Cinema Defacto, Codemill, Deep Mind, DFKI, MTF Labs (Music Tech Fest), Eurocinema, European Composer and Songwriter Alliance, European Game Developer Association, Europeana, Europeana Newspapers, European Commission, Faniak, Fondazione Lia, Hederis, France Television, Global Data, GMX, Impala, Institute of Digital Games, Interactive Software Federation Europe, International Union of Cinemas, IRCAM, ISI, Johannes Gutenberg-Universität Mainz, Kaspar A.I. , Largo Films, LSE, Mewo, modl.ai, National Technical University of Athens, NewsChain, Nextatlas, Nordic publishing, Playground Music Scandinavia, Reuters Inst, RSC, AotF/Dream, Snakefilm GmbH, Snafu Records, Sound of AI, Spacemaker, Storytek, the Museums AI Network, UN Studio, United Robots, UdK Berlin, University of Gothenburg, University of Michigan, UPF, Utopiamusic, VDFP, Viberate, Vision Denmark, Vixen Labs, VK Media, Yewno.

20 Agenda of the workshop (30 September 2021)

The stakeholder workshop was an occasion to present and discuss the preliminary findings of the study: the results of the collection of use cases, challenges and preliminary recommendations for actions. The objectives were to:

- Identify which of the presented use cases in each sector are most promising for the growth of the sectors;
- Discuss the opportunities, but at the same time the challenges and limits of using AI , in particular for small, independent players;
- Discuss growth prospects and the actions needed to unlock the real potential in AI technologies e.g. in terms of pooling data, skills and investment.

Time	**Agenda item**
Moderator: Kincsö Izsak, Technopolis Group	
09:30 – 09:45	Welcome and introduction, Lucia Recalde, Head of Unit, European Commission, DG CNECT, Audiovisual Industry and media support programmes
09:45-10:10	A European approach to Artificial Intelligence - Snapshot of recent initiatives, Tatjana Evas, European Commission, DG CNECT Evangelia Markidou, European Commission, DG CNECT Marijn Duijvestein, European Commission, DG CNECT
10:10 – 11:00	**AI growth prospects and challenges** Highlights from the study: Conor Roche, BOP Consulting *Panel discussion* • Kati Bremme, Executive Product Manager Innovation, France Television • Juliette Prissard, General Delegate, Eurocinema • Piero Attanasio, Head of public affairs, Italian Publishers Association

11:00– 12:30	**Break-out Discussion Groups: the main business opportunities of AI in the sector and from the perspective of smaller actors and the related challenges** *1 Music, moderated by Kincsö Izsak, Technopolis Group* *2 Film, moderated by Sten Saluveer, Storytek* *3 Video games, moderated by Conor Roche, BOP* *4 News media, moderated by David Tomchak, University of Oxford* *5 Publishing, moderated by Apolline Terrier, Technopolis Group* *6 Visual art, museums, performing arts, moderated by Paul Owens, BOP* *7 Architecture, moderated by Stephan Kreutzer, Technopolis Group* *8 Fashion design, moderated by Thorben Straehle, Technopolis Group*
14:30– 16:00	**Break-out Discussion: solutions to unlock the potential of AI technologies** 3 groups: Discussion of industry actions *1 Data pooling and data governance* • *Goncal Calvo, BMAT* • *Jose Eduardo Cejudo, Europeana* *Discussion* *2 Skills development* • *Yiannis Kompatsiaris, CERTH-ITI* *Discussion* *3 Collaboration between technology firms and the cultural and creative sectors* *Discussion*
16:00 – 16:30	**Wrap-up** **Cross-sectoral lessons and take-home messages**

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