ROADMAP ON AI TECHNOLOGIES & APPLICATIONS FOR THE MEDIA INDUSTRY

SECTION: "OVERVIEW OF EXISTING AI ROADMAPS, SURVEYS AND REVIEWS: AI APPLICATIONS FOR THE MEDIA SECTOR"

Authors	**Filareti Tsalakanidou** (Centre for Research and Technology Hellas – Information Technologies Institute) Authors of section 1.1 **Werner Bailer** (Joanneum Research) **Georg Thallinger** (Joanneum Research)

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1 Overview of existing AI roadmaps, surveys and reviews: AI applications for the media sector

A large number of roadmaps, surveys, review papers and opinion articles focusing on the trends, benefits, and challenges of the use of AI in different industry sectors as well as in the public sector have been published during the last years. In this section, we summarise the most important findings from selected surveys, reports and papers examining the use of AI in the media and entertainment industry. Our aim is to identify the most important applications of AI in the media sector, both existing but also future, and also provide some insights on the main challenges (ethical, societal, business) that these technologies and the adoption of AI in general involve.

This section does not claim to provide a comprehensive review of all literature on AI or AI for media, rather it is a selective review that focuses specifically on reports, papers and opinion articles that explore the potentials, impacts and challenges of AI in the media industry. The selected works were identified through a snowballing method where the involved AI4Media Consortium members identified core reports, which were considered good starting points for this overview. From these selected works, more reports, papers and articles were identified and considered based on their bibliographies. Furthermore, topic-specific searches were conducted for selected AI media applications or media sectors to ensure that some topics or areas are not underrepresented. For all these works, three criteria of relevance were determined: 1) they should explicitly deal with AI (either specific technologies or more widely), 2) they should either address directly AI for media or technologies typically used by media AI, and 3) they should offer insights regarding the impact, opportunities, future outlook and challenges of AI for the media industry.

1.1 AI.AT.Media – AI and the Austrian Media Sector: Mapping the Landscape, Setting a Course (2021)

A study titled "*AI.AT.Media – AI and the Austrian Media Sector: Mapping the Landscape, Setting a Course*" was commissioned by the Austrian Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) in 2020. The aim was to identify the research potential of AI in the media sector in Austria, to describe thematic challenges, and to point out suitable options for actions for exploiting the AI potential. The final report (in German) was published in October 2021[1].

The methodology of the study consisted of a literature survey and web research, of a survey among media consumers (*n*=500), interviews with technology providers (*n*=19), media professionals (*n*=7) and researchers (*n*=9), and two half-day workshops bringing together participants from these three groups (mostly focusing on defining the challenges). In addition, a panel of three experts (IT, journalism, and law) provided inputs to the work.

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[1] V. Krawarik, K. Schell, V. Ertelthalner, G. Thallinger, and W. Bailer, "AI.AT.Media -- AI and the Austrian Media Sector: Mapping the Landscape, Setting a Course," Austrian Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (2021): https://www.bmk.gv.at/themen/innovation/publikationen/ikt/ai/ai_at_media.html

AI application areas and automation levels

The study proposes a taxonomy of application areas, that extends and details of the one proposed in the "*World Press Trends 2020-21*" report[2]. As the top level structure, it uses the three main stages of the media value chain: ***sourcing*** deals with collecting, organising and assessing information; ***production*** is concerned with the actual creation of content, and ***distribution*** involves publishing, monitoring impact and interaction with consumers. The next level structures these stages into tasks or applications for certain types of content, with one additional level where needed. The granularity of the taxonomy was chosen based on the heterogeneity of the task and the amount of existing AI solutions (i.e., coarser groups were formed, where the available technology is still sparse). The study provides an assessment of the maturity of AI technology for each application area. The scale of this assessment goes beyond that of technology readiness level (TRL)[3], as it also assesses specifically the experimental or productive use in the media industry. The analysis shows a relatively high level of technical maturity in many applications (e.g., information extraction from text, visual classification, recommendation and content selection), with products and services being available, and experimental use being reported by media organisations. However, only a small share of applications (e.g., named entity recognition (NER) in text, automatic speech recognition (ASR) for large languages, content recommendation, and moderation of discussions) have moved into productive use beyond a few early adopters. This is mostly due to the lack of robustness, but also due to the lack of trained models on data relevant for the particular media organisation (e.g., non-English language models). Closing this gap is not feasible on the short term, and human-in-the-loop approaches are required to enable the gradual introduction of AI technologies in these application areas.

In the different application areas, AI may take a rather supporting role, being applied to very specific tasks, or have a higher degree of autonomy and contributes to decisions or makes them alone. The acceptable degree of automation depends very much on the application area, where media creators are usually more concerned about AI technology creating content or making decisions interfacing with customers. The study thus proposes five levels of automation (similar to the well-known automation levels for autonomous driving[4]: ***AI-enhanced tools***, ***AI-based assistance***, ***Conditional automation***, ***High automation*** and ***Full automation***. Descriptions of the levels and examples for different stages of the media value chain are provide in Table 1. For some applications in the media industry, the higher automation levels may be entirely out of scope, or limited to specific cases. One reason is the technical feasibility, as journalism's task is to report about ``the world'', i.e., news may involve all possible domains and topics. Thus, the requirements for a fully automatic solution may come close to that of artificial general intelligence (AGI). Another important reason is the wish to keep human oversight over information and processes that may have a strong impact on democracy and society, rather than

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[2] F. Nel and C. Milburn-Curtis: "World Press Trends 2020-21," Frankfurt: WAN-IFRA, the World Association of News Publishers (2021): https://wan-ifra.org/wp-content/uploads/2021/04/WAN-IFRA-Report_WPT2020-21.pdf

[3] Space systems - Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment, ISO 16290, 2013.

[4] Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. SAE J3016_202104, 2021: https://www.sae.org/standards/content/j3016_202104/

leaving automated content generation and recommendation algorithms to negotiate public opinion.

Table 1: Automation levels and examples for different stages of the media value chain.

Level	Description	Sourcing	Production	Distribution
Level 0 - No automation	Humans control non-AI-based tools	Topics monitored by humans, content analyzed and verified by humans	Content created by humans, tools based on non-AI technologies	Content selection and playout by humans
Level 1 - AI-enhanced tools	Humans operate tools using AI for specific tasks in their workflows	Content quality analysis, content similarity/near duplicates, model fitting, prediction	Content modification and enhancement tools use AI for low level tasks (e.g., colour correction, spell checking, inpainting)	Media monitoring tools
Level 2 - AI-based assistance	AI-based tools generate information that is used in subsequent steps, with human verification/correction, no decision	ASR, content tagging, classification, object/logo/face detection, trustworthiness scoring, knowledge modelling	Content suggestion/completion, summarisation, subtitling support	Suggestion of content and ads
Level 3 - Conditional automation	Processes including AI-based decisions, with human intervention required at some points	Selection of relevant topics and sets of source content	Text/media generation from highly structured information, preparation of accessibility content	Automated choice of encoder settings, bitrate selection, content recommendation, automated compliance checking
Level 4 - High automation	Fully AI-based processes under human supervision (in particular for consumer facing decisions)	Automatic filtering and selection of sources, automatic content verification	Automatic generation of content (with review), fully automatic generation of versions	Automated user targeting and content adaptation to user (with human checks), chatbot with handoff
Level 5 – Full automation	Fully AI-based processes directly interfacing consumer, without human supervision	Automated relevance assessment, and analysis, assessment of content	Automated content creation/adaption tools for all modalities, automatic accessibility	Automated user targeting and content adaptation to user, chatbot without handoff

Key challenges identified

In terms of relevant emerging research fields, the study highlights *question answering and captioning*, *media verification and forensics*, *content generation and improvement*, *learning-based media coding*, *moderation and discourse analysis*, *AI explainability and transparency* as well as *learning with scarce data*.

The study identifies four key challenges for making AI more widely usable in the media industry. First, the availability of *localised AI tools and data*. Many solutions work well for English, but less so for smaller languages, and not at all for local dialects. Apart from this issue with language processing resources, a similar problem exists with the *availability of (linked) open data for regional or local matters,* as well as *image content* (e.g., for training landmarks or face recognition). Second, *content generation tools* have not yet matured beyond filling templates. Any other media generation does not yet meet the quality expectations of media companies and audiences. In addition, content generation tools need to meet journalistic standards in order to be usable, i.e., ensure that generated content is factually correct, that information and opinions about it are clearly separated, etc. The third challenge concerns *better targeting, respecting the consumers' privacy and avoiding filter bubbles*. Especially smaller media companies lack data on their consumers, and drilling further down in small audiences raises privacy issues. Fourth, *assistive tools* specifically targeted to journalistic needs are required, providing support in standard tasks in content sourcing and creation (e.g., summarising the state of the story so far, before giving further updates). While some of the technology for these tasks is already available, it often does not meet requirements of journalistic workflows, e.g., ensuring that the source of every piece of information provided can be traced back and easily checked.

1.2 The AI Disruption in Media & Entertainment (Dataiku, 2020)

This survey[5] by Dataiku offers a comprehensive overview of the ways in which AI can disrupt and transform the media and entertainment industry. This is achieved through the presentation of high value AI use cases for the media, key AI opportunities per media sector, and main challenges and upcoming trends for AI in media. The central themes running through the report are the need for the adoption of data-driven business models and the trend of personalisation of services that allow media companies to expand their business by offering their content "not at audiences of billions, but at billions of individuals".

The report offers a comprehensive list of **high-value AI-driven use cases** for the media industry, which includes AI applications like:

- *Smart recommendation engines*: AI can enable the shift from simple recommendation engines into fully personalised content experiences, improving content relevance and distribution.
- *Hyper-targeted advertising*: By combining and analysing large volumes of data, AI can enable accurate prediction of user churn rates, steer advertising placement, and increase

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[5] The AI Disruption in Media & Entertainment (2020): https://content.dataiku.com/ai-media-entertainment/ai-media-entertainment

conversion through personalised offers like personalised movie trailers appealing to different audiences.

- ***Real-time predictive modelling for anticipating demand and segmentation***: This can help media companies react in real time to consumers' changing needs, predict future needs to direct investments accordingly, and anticipate content engagement per audience segment.
- ***Programmatic ad buying***: Based on real-time analysis of audience dynamics across multiple channels and ad space, the process of ad buying on different media platforms can be efficiently automated.
- ***Personalised programming***: By collecting and analysing a steady stream of customer data, streaming companies can offer not only personalised program recommendations based on sophisticated user profiles but also personalised formats for the presentation of the content.
- ***Automated "robot reporting"***: NLP technologies are already used to automatically produce news content for topics like financial news or minor-league sports but also to detect trends in social media thus identifying topics that may interest the audience. AI can be exploited to assist (or replace) journalists in tedious or boring tasks, allowing them to focus on more meaningful work like news analysis or investigative reporting.
- ***Video game development***: New AI technologies like evolution learning are already transforming the industry, helping design more sophisticated games with virtual characters that can think and act like humans (reacting to or anticipating the human players' actions).
- ***Automating HR, legal and administrative tasks***: Apart from AI functionalities to improve offered services and expand business, media companies can also exploit AI advances to automate administrative, legal or HR tasks. Some prominent examples include *forecast of residual payments* to anticipate or explore scenarios of how talent (e.g. actors in a movie, music creators, etc.) will be compensated based on content distribution across platforms; *compliance with copyright standards* by automatically analysing relevant legal documents; *AI-based casting* for TV shows/films based on cross-analysis of historical data of film performance and relevant cast profiles and prediction modelling.

In addition to identifying high-value use cases along the media production chain, the report also highlights **how AI can help individual media & entertainment sectors**:

- **Music**: AI has already disrupted the music industry by offering innovative solutions in areas such as recommendation engines for content personalisation, forecasting of music trends & sales, segmentation of customer base based on audience and user behaviour analysis, forecasting for content monetisation and payments to talent.
- **Film & TV**: AI offers the potential of radical transformation especially for film studios, which unlike streaming services have not fully embraced yet the data-driven model. AI-enabled analysis of user behaviour and operational data can revolutionise content recommendation systems, churn prediction, hyper-targeted marketing, sale and residual payment forecasting, but also analysis of sentiment and trends is social media for market research.
- **Video games**: AI can facilitate game development, design and graphics, aiming to produce sophisticated games and maximise user engagement while it can also support personalised marketing of games and social and customer analysis, aiming to maximise revenue, understand the players, and maximise their satisfaction.

- **News**: AI can help to reinvent the news industry model through applications like robot journalism, hyper-targeted advertising, sales forecasting etc. Interestingly enough, the report does not delve into more journalistic aspects examined in similar works (e.g. AI for countering disinformation, for automated news production or coverage, or for content archiving and search).
- **Sports entertainment & gambling**: Aiming to improve the online gambling experience, AI is used not only for personalisation or user behaviour prediction but also for modelling the uncertainty surrounding user actions. Prominent applications of AI for this sector include fraud detection, lifetime customer value prediction, and ad-hoc analysis of AB/test data.
- **Advertising**: AI is already transforming the way ads are bought or sold by enabling hyper-targeted advertising, programmatic ad buying, and customer base segmentation.

The use of AI in the media sector also comes with a set of **challenges**, including:

- Creating *sustainable and effective production pipelines* to process and exploit data.
- Issues of *data governance, data privacy and compliance with relevant regulations*. The need for advanced collection of personal data (even sensitive) to support personalisation of media experiences often clashes with relevant regulation.
- *Misinformation in social media*. The business model of social media, which is based on maximising user engagement/reaction, creates well-founded worries in the news industry since it has been shown to significantly contribute to misinformation spread.
- *Recommendation engines and filter bubbles*. While recommenders are fundamental in helping to maximise user engagement by providing users content they like, they are also responsible for creating filter bubbles by feeding users news content biased towards their beliefs, thus failing to provide the bigger picture or alternative views and isolating users in an eco-chamber. AI can be used to improve recommender systems by increasing transparency and identifying biases.
- *Attracting AI talent*. Media companies have a different set of unsolved problems and thus different needs when it comes to hiring AI talent compared to big tech companies.

The report concludes by nicely summarising the **main trends in AI and ML for the media sector**:

- *More personalisation.* Media experiences will become highly personalised. In addition to content personalisation, the trend is towards integration across media experiences and also use of AI assistants to facilitate content discovery.
- *Convergence of technology, telecom and media industry*. Tech and telecom companies acquire media companies in a fast pace, driven by increased demands for data and AI tech.
- *ML to enhance user experience*. Based on use of text and image analysis, advanced recommender systems will suggest images for news articles or search for images of the same type. At the same time, AI will facilitate multi-lingual content translation as well as transformation to different writing styles for different audiences.

- **AI for immersive VR experiences**. AI will facilitate the creation of fully immersive AR/VR experiences based on intelligent avatars and VR content created by AI.
- **AI beyond content**. Media companies have already started adopting AI technologies for administrative, legal, HR or other tasks.

1.3 The Technology, Media & Telecommunications AI Dossier (Deloitte, 2021)

This report[6] by the Deloitte AI Institute highlights the most business-ready cases of AI for the Technology, Media & Telecommunications (TMT) sector while also presenting emerging AI applications with future potential. Below, we briefly discuss those most relevant to the media sector. Current applications include:

- **Increased user engagement**, using AI to automate engagement and two-way communication with users through NLP and sentiment analysis but also to improve content and services personalisation via AI-powered DM platforms.
- **Digital Contact Centers,** using NLP to build virtual assistants that deliver a more human-like communication but also adopting predictive analytics and sentiment analysis to monitor interactions and provide useful insights for customers and staff.
- **Fake media content detection**, based on video and text analysis to detect deepfake videos but also other media content like fake articles.
- **Monetisation of customer data,** based on analysis of user behaviour (e.g. conversations on social media) to provide content they like or advertise products they are likely to buy but also based on the combination of different sources of user data for more efficient targeting.

Future trends include:

- **Language translation services**, using NLP technology for automatic real-time translation of content and elevated communication experience, free of language barriers.
- **Video content analysis**. Use of ML, DL and computer vision to automatically analyse video content and thus facilitate tasks such as real-time monitoring and trend detection in social media aiming at increased personalisation but also enable monetisation of video archive collections.
- **Audio and video mining,** using AI to transform video and audio in structured data and thus easily mine the vast volumes of user generated content for useful information.
- **Ad analytics based on emotion detection**: using data collected by sensors installed in the viewer's living room, the film/TV industry as well as advertisers will be able to understand how the viewer is emotionally affected by the content presented to them and will thus be able to extract useful insights about user preferences or predict future engagement with content.

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[6] Deloitte AI Institute, The Technology, Media & Telecommunications AI Dossier (2021): https://www2.deloitte.com/content/dam/Deloitte/us/Documents/deloitte-analytics/us-ai-institute-dossier-tech-media-telecomm-dossier.pdf

- *Self-healing networks*, using AI-enabled predictive analytics to predict network maintenance needs, e.g. for broadcast infrastructure, thus minimising failures and costs.

1.4 Artificial intelligence systems for programme production and exchange (ITU-R, 2019)

This report[7] by the Radiocommunication Sector of the International Telecommunication Union (ITU-R) of the United Nations presents an overview of **AI applications across the whole value chain of the broadcasting sector**, from workflow optimisation to personalisation of content:

- *AI for workflow optimisation,* aiming to automate tedious routine tasks. This includes analysis of archived content and historical scheduling data for optimising content programming for different audiences; automatic camera selection and framing; automated content generation, e.g. creation of highlights for sports events; automated creation of video digests based on image analysis of content and analysis of user comments on social media; optimisation of live footage based on learned relationship dynamics of group interactions, etc.
- *Automated content creation*, including news alerts based on analysis of social media posts (text/image/video) to detect newsworthy trends or trustworthy news; automatic generation of content based on analysis of data released by different agencies or organisations (e.g. financial data, weather data, etc.); automatic captioning based on speech recognition; chatbots to dialogue with users/audience; automated AI-driven announcer systems; automated commentary for live programmes like sports events; translation in different languages; sign-language CG synthesis; automated programme creation based on analysis and synthesis of archived data.
- *Metadata creation* to optimise content management and search in vast audio-visual broadcast archives. For the creation of high-level metadata, AI algorithms for video and audio analysis and detection, face detection and recognition, detection of text in video (e.g. detection of signs), object detection and recognition, and speech recognition are used.
- *Dynamic product placement and advertising*. Use of AI technologies that will decouple product placement from the initial content generation. E.g. placement of different products (e.g. a drink from a different brand) on a broadcast film depending on audience or timeslot will be able during post-production and distribution.
- *Content personalisation*. Personalisation of content has become significantly important in broadcast to target efficiently audiences of different demographics. More recent trends in this direction include user-decision-driven modular storylines as well as personalisation of content based on the user's affective state, captured by real-time sensors.

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[7] Artificial intelligence systems for programme production and exchange, Report ITU-R BT.2447-0 (2019): https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BT.2447-2019-PDF-E.pdf

The report concludes by highlighting the need for large volumes of real and high-quality data for training AI models for the media industry.

1.5 AI in the media and creative industries (NEM, 2019)

This white paper[8] by the NEM initiative aims to offer a detailed overview of AI technological advances and their potential impact on the media sector, also identifying relevant challenges. The paper is structured upon five creative application areas (**music, images & visual art, digital storytelling**, etc.) and three axes (**creation, production and consumption of media content**). In Table 2 below, we attempt to briefly summarise the findings for each application area. As can be seen, the authors of this report go into significant depth on the ways in which AI can be used to achieve different tasks in the selected creative areas. The report offers also details on the specific AI technologies used in each case (e.g. GANs, CNNs, etc.).

Table 2: Overview of AI technologies for the media industries and relevant challenges in NEM white paper on "AI in the media and creative industries"

Application areas	Content creation	Content production	Content consumption	Challenges
Music	- Generative models able to handle advanced audio features such as timbre - Style transfer - Tools for personalised music generation	- AI-based music production systems for independent musicians - Audio demixing - Processing of different music signals at the same time without losing audio quality	- Personalised recommendations - Improved playback allowing user control over sound - Delivery of personalised music content	- Models that leverage information in raw audio signals -Learning long-term temporal dependencies - Transfer between different timbres - Denoising and demixing
Images and visual art	-Apps for AI generated art images - Generation of pastiches - Generation of images from captions	- Reproduction of scene-dependent image transformations - Image quality enhancement - Style-based image transformation - Image inpainting - Image retrieval based on visual features or text	- Automatic metadata creation based on image/text analysis - Object/face detection &recognition	- Image generation from description - Understanding image content - Cross-media search - Automatic reconstruction of missing parts
Digital storytelling	- Searching archives to find suitable content to fit the narrative		- Multimodal	-Transdisciplinary storytelling bringing together

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[8] AI in the media and creative industries, New European Media Initiative (2019): https://arxiv.org/ftp/arxiv/papers/1905/1905.04175.pdf

Application areas	Content creation	Content production	Content consumption	Challenges
	-Sensor-based storytelling for immersive experiences - AI cinematography - Authoring tools for non-experts - Transmedia storytelling		interactive and virtual experiences - Content personalisation - Audience segmentation	writing, tech and gaming - Automation of narration in interactive entertainment - Ensuring authors remain in control of stories partly created by AI
Content in games, movies, engineering and design	- Automatic content synthesis (detailed landscapes, textures, objects, etc.) - Generative game design - By-example synthesis		-Personalised games adapted dynamically to player profiles - Modelling player behaviour, skills and affective state	- Synthesis of large environments - Methodologies that directly sample instances by directly enforcing requirements - Reliable estimation of user emotional state -Ethics by design to prevent addiction
AI and Book Publishing	- Automation of processes in publishing houses - Improved accessibility for people with print impairments (e.g. automatic text creation to describe image concept) - Publication tagging - Copyright management (e.g. using visual and text info from the web to provide relevant licensing info, combination of AI and blockchain) - Book recommendations based on book content analysis and user profiles			-Addressing IPR issues related to AI input and output
Media access services	- Automatic subtitling (contextualised, multi-lingual, complying with legislation) - Sign language production - Audio description of content			- Streamline circulation of audio-visual content through translation - Automatic multilingual translation
News	-Analysis and cross-examination of various information sources in multiple languages - Fact-checking - Content verification (detection of manipulated content/ deepfakes) - Social network analysis to monitor disinformation spread		- User profiling & recommender systems - Public tools for assessing information reliability	- Heterogeneous data integration and search - Security of multimodal information retrieval systems

Application areas	Content creation	Content production	Content consumption	Challenges
	- Automatic creation of personalised news digests		- News aggregation and summarisation -Intelligent tools for high-quality participative journalism	and video forensics - Trust and transparency of AI algorithms
Social media	- Content personalisation - Recommender systems - Content search - Opinion mining	- Ad placement - Trend detection - Moderation		

Apart from the challenges identified for each media/creative sector, the NEM white paper also identifies a set of transversal challenges across sectors, summarised below:

- *Data challenges*, including building large annotated databases not only of content but also of user preferences.
- *Robustness challenges* with regard to performance of pattern recognition algorithms.
- *Cross-domain challenges*, i.e. development of cross-domain multi-modal analysis tools.
- *Challenges of human-machine collaboration,* including AI explainability and adaptation of AI tools to user needs.
- *AI transparency and accountability challenges*.
- *Ethics challenges*, including development of ethics-by-design tools as well as improved AI transparency and trustworthiness.

1.6 Artificial Intelligence in the Creative Industries: A Review (BVI, 2021)

This paper[9] by the Bristol Vision Institute of the University of Bristol offers an overview of the state-of-the-art for the use of AI technologies in the creative industry. The authors classify AI applications in five areas (***content creation, information analysis, content enhancement & post production workflows, information extraction & enhancement,*** and ***data compression***). For each area, several topics are identified and examples of AI applications are provided for each topic. Unlike most of the works presented in this section, this survey focuses a lot on the actual AI technologies deployed for each application, i.e. CNNs, GANs, RL, BERT, VAE, etc. In the following Table, we summarise the different examples of AI application in the creative industries classified per area and topic.

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[9] N. Anantrasirichai and D. Bull, Artificial Intelligence in the Creative Industries: A Review (2021): https://www.researchgate.net/publication/343228503_Artificial_Intelligence_in_the_Creative_Industries_A_Review

Table 3: Summary of AI application areas in the creative industries from the "Artificial Intelligence in the Creative Industries: A review", a survey by BVI.

Application area topic	Examples of application
Content creation	
Script and movie generation	• Script generation for film • Automated generation of movie trailers • Interactive narrative for games • Procedural content generation for games
Journalism and text generation	• Robot journalism for generic news • Language translation • Video to text • Text transformation to different writing styles
Music generation	• Search in audio databases • AI-assisted music creation
New image generation	• Automatic image creation • Image transformation/style transfer (e.g. from one painter style to another, face aging, etc.) • Talking video from facial image
Animation	• Character animation for film and games • Scene and object rendering for film and games • Human-like virtual assistants
AR/VR/MR	• Game design • User motion detection • Dynamic virtual environments for film and games • Object and user detection
Deepfakes	• Improved realism in film industry (e.g. replacement of one actor's face with another) • Manipulated/fake audio/video/text for disinformation • Manipulated/fake digital content detection
Content and captions	• Text generation from image/video analysis/interpretation • Image generation from text analysis
Information analysis	
Text categorisation	• Document indexing and retrieval • Sentiment classification • Topic classification • Spam detection
Advertisements & film analysis	• Recommender systems for music and movies • User profiling/ behaviour analysis • Dynamic ad programming/placement • Social media analysis for opinion mining • Content performance prediction (e.g. by historical data analysis that associates box-office performance with film content)
Content retrieval	• Automatic annotation and metadata creation (based on audio/object recognition and scene understanding) • Image/video search based on image analysis and understanding • Music retrieval based on search by sound, query by humming, etc.
Recommendation engines	• Content-based filtering based on single user preferences • Collaborative filtering based on other user suggestions • Knowledge- based filtering based on user queries

Application area topic	Examples of application
	• Content summarisation
Intelligent assistants (based on text or voice)	• Information retrieval (e.g. relevant news, weather reports, etc.) • Recommendation of content • Chatbots for dialogue with audience
Content Enhancement and Post Production Workflows	
Enhancement	• Contrast enhancement • Colourisation to add or restore colour in images • Super-resolution images
Post-production	• Image deblurring, denoising, dehazing/mitigating atmospheric turbulence • Inpainting (e.g. for removal of unwanted objects or restoring missing parts) • Visual Special Effects to create realistic 3D virtual characters, animations, environments
Information Extraction and Enhancement	
Segmentation	• Object detection & classification • Semantic segmentation (in 2D and 3D)
Recognition	• Object recognition • Face recognition • Speech and music recognition • Emotion detection (based on video, audio) • Action recognition • Sign language recognition
Tracking	• Object and face tracking in video
Image fusion	• Combination of multiple images to aid human perception
3D reconstruction & rendering	• 3D scene reconstruction from video or RGBD sensor output
Data compression	
Data compression	• Deep compression methods to optimise existing coding tools • Compression for super-resolution videos

The review also points out ethical issues related with the use of AI in the creative industries such as *authorship of AI creations*, *AI-induced inequality* (with regard to information access*), use of AI with malicious intent* (e.g. for creation of deepfakes aiming to spread disinformation), and *AI algorithmic bias*. It also stresses that having a **human in the loop** is necessary for current AI systems, especially for creative processes. This necessitates the establishment of a feedback mechanism that will allow humans to check AI outputs, make critical decisions based on AI output, and provide feedback about AI failures to the AI system. While the most effective AI algorithms are still based on ground truth and labelling, in truly creative processes there is usually no way to evaluate the quality of the generated outcome in advance. Thus new methods going beyond traditional ML algorithms, e.g. methods like generative models, should be further explored and extended to generate new creative content.

With regard to the future of AI, the report singles out the following areas that hold great promise but require further research efforts:

- Increased diversity and context in AI training for new *creative content generation*. This will require high-dimensional datasets including info on audience preferences and current trends but also modelling human perception of quality;
- *Convergence of AI with blockchain* technologies to support improved and trusted data labelling and model training;
- Techniques for *unsupervised or self-supervised learning* will be significantly important as the volume of collected data grows exponentially;
- *Reinforcement and transfer learning* to provide greater generalisation capabilities for AI learning algorithms;
- Research on *human learning mechanisms*, aiming to imitate human brain capabilities.

1.7 New powers, new responsibilities - A global survey of journalism and artificial intelligence (LSE, POLIS, Google News Initiative, 2019)

This report[10] by London School of Economics, POLIS and Google News Initiative is based on a survey of 116 journalists in 71 news organisations in 32 countries focusing on AI for journalism. The report finds that AI is already used in newsrooms for a variety of tasks, mainly for automating tedious tasks and supporting journalists in creating better and more trusted journalism; but also for delivering more relevant and useful content and services to users, helping citizens to cope successfully with information overload and misinformation rise. The main three areas where AI can improve newsroom functionality include *automated tagging/entity extraction* (for newsgathering), *automatically generated content* (for news production), and **enhanced recommendation engines and content personalisation** (for news distribution).

At the same time the respondents identified several challenges related to the use of AI in the newsroom: *algorithmic bias* leading to bad editorial decisions or discrimination against groups of people; *disinformation spread and filter bubbles* - AI is instrumental in creating these phenomena but it can also help newsrooms counter them; AI can help increase *transparency* as well as increase diversity of stories and audiences; ensuring *balance between AI and human intelligence*; and the power of Big Tech companies that control development of AI technology. Overall, the newsrooms were confident that the impact of AI could be beneficial, given that they would retain ethical and editorial principles.

Half of newsrooms saw themselves as AI-ready while the other half were just starting to use such technologies and were already fearing that they were falling behind (especially small newsrooms). The main challenges for adopting AI include financial resources to build/manage AI systems, need for personnel with AI skills, cultural resistance (e.g. fear for loss of jobs or hostility against technology) but also lack of AI literature or clear AI strategy in the company.

Interestingly, the role of AI is characterised by the respondents as supplementary or catalytic but not transformational (yet). With regard to the future, the report identifies nine ways in which AI can reshape newsrooms and journalism:

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[10] C. Beckett, New powers, new responsibilities - A global survey of journalism and artificial intelligence (2019): https://blogs.lse.ac.uk/polis/2019/11/18/new-powers-new-responsibilities/

- Improved content personalisation;
- Automated production of content;
- Dynamic pricing for ads and subscriptions;
- Automated transcriptions;
- Improved content moderation;
- Detection of fake news and deepfakes;
- Debunking of information;
- Enhanced content search based on video/image analysis;
- Sentiment analysis of user generated content.

In this direction, some interesting ideas collected from the journalists participating in the survey include: *automatic text to anything* (voice, video, other text); production of news enriched with more sources and personal aspects; *journalism of things*, exploiting everyday devices to collect data (e.g. sensors in a political event to record crowd reaction to parts of the speech, or in sports to detect the most important highlights of a game); *augmented journalism* using drones, wearables, voice, VR technologies for novel content creation and delivery; transforming news from unidirectional communication to bidirectional communication through *enhanced user understanding* (incl. emotion analysis) and increased user engagement; working with news patterns rather than case-by-case stories; *conversational agents* that can reliably answer questions about current affairs.

The need for improved AI training and education was an issue of unanimous consent. Respondents pointed out the need for: **improved AI literacy** (what is AI and how it works) across a news organisation; **basic AI training** (e.g. basic skills on AI coding or data model training) for newsroom employees; innovation training through **experimental AI projects**; raising **awareness about AI** use in the industry and what other newsrooms do; **understanding AI ethical concerns** (bias, robustness, etc.) – how they work and how to address them; enhanced understanding of technology big picture and of wider role/impact of AI on society.

Although the news industry is highly competitive, the appetite for collaboration with regard to AI technology is notable. This collaboration may take various forms: across different units of the same organisation; between news organisations; between news industry and tech companies, start-ups or research/academic organisations; on a national or international level (e.g. to build transnational tools, adaptable to different audiences, languages, etc., or stories, e.g. on climate change, crime, etc.). Such collaboration can have a positive impact not only on news content and stories, but also on the development of novel AI solutions tailored for newsrooms and on financial costs.

The report concludes with how the news industry can learn from other industries when it comes to the adoption of AI: the retail industry can offer useful examples of recommendation engines, dynamic pricing or customer experience analysis; the gambling industry can offer examples of user behaviour analysis and audience understanding; the gaming industry offers examples of how to use AI to automatically interact with the users; medicine and biotech companies offer examples of standards for AI ethics; and of course big tech companies can offer insights on the

next big trends of AI but also examples of success stories and failures/mistakes with regard to market and ethical challenges.

1.8 AI predictions 2021 - Technology, Media & Telecommunications (pwc, 2021)

This pwc survey[11] offers a good overview of the top priorities, benefits and challenges for the deployment of AI technologies by the tech, media and telecom industries. The survey unveils that the media companies' top goal with regard to the use of AI is to increase efficiency and productivity (53%), followed by revenue growth (45%), innovative products/services (34%), improved internal decision-making (29%), employee training (29%), and better user experiences (26%).

With regard to challenges, media companies identify as top challenge the development of AI models and datasets to be used across the company (47%), followed by recruitment of skilled personnel to work in AI (32%). Training of current employees (24%), making AI responsible and trustworthy (24%) and measuring AI's return on investment (21%) are deemed as important only by one fourth of respondents. At the same time, 45% of media companies report that they fully address risks related to AI and add necessary controls while 47% have a plan in place to identify new roles required as a result of the adoption of AI technology.

The survey concludes with three main takeaways about what should media companies do with regard to the adoption of AI:

- Take advantage of all the emerging AI technologies to **transform their workflows**, **improve consumer experience**, **forecast demand for content and services**, and **improve their marketing**.
- Operationalise AI across the organisation by creating a new operating model, adopting a new approach to technology, and new ways of work.
- Minimise AI-related risks, by updating **data governance, data policy and security** as well as by addressing issues of **AI bias** in their models.

1.9 Selection of online articles on AI applications and trends for the media sector

In the previous subsections, we briefly presented the findings of roadmaps, studies and surveys that aim to offer an accurate glimpse into the future of AI and it application in the media sector. These works usually follow a structured approach involving a co-creation process that aims to collect the opinions of different AI experts (or the public in some cases) and then synthesise these opinions to provide some insights and proposals about the future of AI research and applications. In addition to these works, in this subsection we briefly present the main AI trends and challenges identified in a selection of interesting articles posted by individual AI experts or groups of experts and published in relevant popular online magazines, websites, blogs, etc.

1.9.1 How Artificial Intelligence is transforming the media industry? (CMF Trends and Méta-Media, 2019)

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[11] AI predictions 2021 - Technology, Media & Telecommunications: https://www.pwc.com/us/en/tech-effect/ai-analytics/ai-predictions/technology-media-and-telecommunications.html

This two part overview by CMF Trends and Méta-Media[12,13]presents a wide list of AI applications covering the whole information and entertainment media value chain. Some examples are presented below:

- **AI for augmented information**: 'Robot' journalists can be used to speed up the news production process, however their use is currently limited to financial reporting, election reporting or small-scale events. Advances in NLP can help extend robot journalism to cover more complex topics, by identifying relevant content, context and appropriate presentation format. In addition, AI can help journalists to analyse vast amounts of data by combining multiple sources of information. It also enables monitoring trends in social media and providing relevant automated news updates. To remain relevant, smart collaboration is required between journalists and AI assistants.
- **AI for countering fake news**: AI plays a significant role both in the generation and spread of disinformation but also in the detection of disinformation. AI can be used to automate fact-checking of information and verification of content using advanced text, image, video and audio analysis.
- **AI for improving online conversations**: NLP technologies are used to moderate online conversations, by identifying hate speech, verbal violence, etc. In addition image analysis is used to detect hate-filled or violent images. Such automatic moderation techniques are especially helpful in cases where the lack of human moderators and the toxic comments have obliged editors to turn off comments on sites and online articles. Using automatic moderation tools will give the audience the opportunity to express themselves in a civilised online environment.
- **AI at the service of voice**: NLP and voice recognition have led to conversational agents capable of understanding humans and dialoguing with them. AI enables high quality text-to-speech synthesis, speech-to-text translation and support for different languages and dialects. These capabilities are extremely helpful for the whole media industry.
- **AI for interactivity and engagement**: Many online news sites use such bots to interact with their audience and share news, while interactive fiction content has also become a thing, e.g. with interactive stories for children or adults. The conversational and personalisation capabilities of chatbots create a closer user experience, enhance interaction with the user and foster engagement. This type of AI technology can provide new storytelling experiences and increase user engagement in sectors like advertising, marketing, film and audio.
- **AI in XR**: AI has the potential to advance storytelling with virtual characters that are capable of advanced interactions with human beings. AI can augment virtual character design (facial expressions, body movements, voice), can identify human emotions and can enhance interaction between humans and virtual characters by making it more natural.
- **AI for indexing, archiving and search**: by combining image analysis, NLP and ML, AI can automate metadata creation for multimedia content thus enhancing archiving and discoverability. AI can also automate other content management tasks like data format

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[12] K. Bremme, How Artificial Intelligence is transforming the media industry? – Part 1: https://cmf-fmc.ca/now-next/articles/how-artificial-intelligence-is-transforming-the-media-industry-part-1/

[13] K. Bremme, How Artificial Intelligence is transforming the media industry? – Part 2: https://cmf-fmc.ca/now-next/articles/how-artificial-intelligence-is-transforming-the-media-industry-part-2/

conversion or sub-title extraction, thus enabling real-time indexing. Automatic metadata creation more effective content search, increases monetisation opportunities, helps media practitioners in their daily tasks (e.g. reporters to search video archive content to write a news story or fact-check a piece of information).

- *AI for targeting and customisation*: AI can revolutionise recommendation algorithms and help provide the right content to the right person at the right time, based on user profile and activity, also considering the context (e.g. place, time, weather). Most of media already use AI to recommend content while giants like Amazon or Netflix heavily rely on personalisation of services.

- *AI for accessibility*: AI can help make content more accessible for people with disabilities or limitations, e.g. by automating subtitles production, text-to-speech technologies, image recognition for audio description, and real-time translation.

- *AI for video production and creation*: AI can be used for automated video editing and creation. For example, lengthy videos can be analysed to create short versions with highlights (e.g. short summaries tailored for social media use) or produce automatically edited versions ready for distribution. AI can also be used for post-production to offer different montages of a scene or add special effects.

- *AI for monetisation and prediction of success*: based on techniques such as analysis of behavioural data, audience analysis and trend detection, AI can predict the success or engagement of content before this is made available to users. To this end, AI is present in the whole marketing chain: from customer acquisition (audience analysis and segmentation, scoring and targeting, visual context identification), to transformation (customisation and recommendation, content creation, optimisation of sites and media, automated campaign piloting), and loyalty building (conversational agents, customer program automation, behaviour analysis, predictions). Another more recent trend involves the use of AI-enabled emotion recognition that will also allow content recommendation based on the user's emotional state at any given time.

- *AI and media ethics*: issues such AI bias, data and user privacy, AI interpretability and explainability are challenges that should be addressed to ensure ethical use of AI in the media sector.

The article concludes by pointing out the potential of AI for content access and monetisation, personalised recommendations and manipulation prevention, but also stressing the need for collaboration of humans and AI when it comes to content creation or management.

1.9.2 Transforming the media industry with AI (The Record, 2018)

This article[14] featured in The Record magazine tries to explore how AI can transform the entire media and entertainment industry from content creation to user experience. Based on interviews with experts that either provide AI technologies for the media sector or analyse the media sector, the following AI technologies with a potential to bring transformational changes in different parts of the media business chain are identified:

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[14] L. James, Transforming the media industry with AI: http://digital.tudor-rose.co.uk/therecord/issue09/64/

- ***Automatic metadata tagging and extraction*** based on image analysis and speech-to-text technology. This feature can help media companies effectively organise their content and archives and is going to be extremely useful for driving content exploitation and relative monetisation strategies.
- ***Use of AI tools to strengthen predictive capabilities***, e.g. to predict content demand and subsequently adjust resources in the cloud or predict disruption to supply chains, thus ensuring considerable savings for companies.
- ***Personalised content distribution*** to media consumers, including title recommendations or content curation based on user profiles which are built by collecting data about user interactions with content in the cloud.
- ***Personalised media advertisement campaigns*** based on AI that autonomously understands product properties, consumer preferences and willingness to pay per product, purchase of likelihood at a given time, etc.
- ***Automation and digitalisation of existing workflows***, enabling content production and distribution to meet growing demands.
- ***AI-enabled feedback for artists*** based on real-time metrics of consumption that has the potential to increase creativity and increase production of content.

The main challenge identified for the realisation of AI's potential for the media sector is the collection and management of data (audience/operational/content data) at large scale to train relevant AI algorithms and the adoption of a "data-first" approach by media companies.

1.9.3 Emerj AI Sector Overviews (Better Software Group, 2019)

A series of reports on AI sector overviews have been published by AI market research and publishing company Emerj, aiming to explore important AI trends across industries, from automobile and financial to creative industry and beyond.[15] In the following, we summarise the insights offered by some of these reports, focusing on the news sector, streaming services, entertainment companies, and marketing.

Automated journalism

This article[16] presents different ways in which AI is being integrated in newsrooms. The main enhancements offered by AI include:

- ***Streamlining media workflows*** and automating tedious tasks to allow journalists to focus on creative tasks like reporting;
- Revealing insights by exploring correlations between data;
- Accelerating journalistic research;
- ***Countering disinformation***; and
- ***Automatic creation of news stories*** from raw data.

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[15] Emerj AI Sector Overviews: https://emerj.com/ai-sector-overviews/
[16] C. Underwood, Automated Journalism – AI Applications at New York Times, Reuters, and Other Media Giants (2019): https://emerj.com/ai-sector-overviews/automated-journalism-applications/

The article offers examples of AI tools used by popular news outlets like the Editor[17] app of NY allowing efficient editing of news articles through real-time semantic discovery of people, events, locations and dates mentioned in an article; the Perspective API[18] organising reader comments in articles based on their toxicity and thus allowing users to only interact with useful comments; the Juicer[19] app by BBC that monitors the RSS feeds of outlets around the world, extracts stories and assigns semantic tags to them, allowing journalists to quickly find the most relevant articles on a search topic; Washington Post's Heliograf[20] software for creating automatic real-time news reports for sport events and election results; Associated Press' NewsWhip[21] app for trend detection in social media and also analytics on user engagement with specific content or topics; the Wordsmith[22] platform used by Associated Press to write financial recaps; and Guardian's chatbot[23] that delivers personalised news content on demand based on real-time text exchange in Facebook Messenger.

AI for entertainment

This article[24] offers an overview of how top entertainment companies like Disney exploit AI to increase customer satisfaction and improve their revenue. Relevant AI application areas include:

- Development of *interactive virtual characters*;
- *Chatbots* for famous cartoons of movie characters to promote relevant content;
- *Improving image quality* in older movies;
- *Automatic creation of movie trailers* tailored to different audience preferences;
- *Audience analysis based on sensor data* (e.g. from camera) and prediction of audience reactions to specific content;
- *Sentiment analysis* (from social media, product reviews, surveys, etc.) to measure audience engagement with content;
- *Social network data analysis* to assist marketing across multiple platforms.

In addition to these applications, Netflix is using AI not only for its recommender system but also to personalise its interface to keep user interest alive. For the latter, two applications are discussed in another similar article[25]: selection of appropriate still images for thousands of titles (considering actor prominence in film, image diversity, and maturity filters for offensive content) and also personalisation of thumbnail images for viewers, which has shown to benefit the promotion of less well-known titles.

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[17] Editor, an experiment in publishing: https://nytlabs.com/projects/editor.html

[18] Perspective API: https://www.perspectiveapi.com/how-it-works/

[19] The Juicer API: https://bbcnewslabs.co.uk/projects/juicer/

[20] Heliograf: https://www.wsj.com/articles/washington-post-to-cover-every-major-race-on-election-day-with-help-of-artificial-intelligence-1476871202

[21] NewsWhip https://www.newswhip.com/

[22] Wordsmith: https://automatedinsights.com/wordsmith/

[23] Guardian Chatbot: https://www.theguardian.com/help/insideguardian/2016/nov/07/introducing-the-guardian-chatbot

[24] E. A. Rayo, Artificial Intelligence at Disney, Viacom, and Other Entertainment Giants (2019): https://emerj.com/ai-sector-overviews/ai-at-disney-viacom-and-other-entertainment-giants/

[25] R. Owen, Artificial Intelligence at Netflix – Two Current Use-Cases (2022): https://emerj.com/ai-sector-overviews/artificial-intelligence-at-netflix/

AI for advertisement and marketing

The article[26] presents the most popular and some emerging cases of AI use in the advertisement and marketing sector. These include:

- *Improved **product search** (more accurate, faster, personalised). Future trends in this direction include search based on input images.*
- *Improved **recommendation engines** based on collected data about user behaviour, content engagement, sales, etc.*
- ***Programmatic advertisement**, allowing automated buying and selling of ad inventory and real time campaign optimisations based on audience/user behaviour analysis.*
- ***Marketing forecasting**, using marketing data like clicks, views, time-on-page, purchases, etc. to predict the success of a marketing campaign.*
- ***Conversational e-commerce**, using chatbots that help users to select products and make purchases.*
- ***Content generation**, including automated product descriptions or promotion articles.*

1.9.4   AI Can and Will Revolutionize the Media Industry (Better Software Group, 2019)

This blog article[27] tries to map areas where AI can benefit the media sector, providing real-life examples of its impact. The following areas of application are examined:

- ***AI for automation of routine and mundane media workflows**, e.g. extraction of audio and creation of subtitles in video, automated content delivery, A/B testing of different product parameters to enable better decisions, etc. Examples of such automation include technologies that allow automated A/B testing for optimising Netflix's recommendation engine or automatic production of financial reports and news summaries by news organisations like Associate Press and Reuters.*
- ***Archiving, metadata creation and improved content search** based on video and audio analysis (recognition of faces, voices, objects, places etc.) Such techniques make content discovery easier and more accurate while also enabling automatic content moderation. In addition they facilitate content personalisation and thus content engagement.*
- ***Content personalisation** based on analysis of vast amounts of collected user data. AI can help find the balance between customisation and giving the user more of what they like on one hand and smart new content promotion on the other. Large media platforms like Facebook and Netflix but also Amazon have invested heavily on such technologies and their success is tightly connected to their personalisation services.*
- ***Audience analytics** capturing user behaviour and interactions with content and increasing insight on audience needs that allow media companies to understand their audience and effectively monetise their content. This feature allows better*

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[26] D. Faggella: Artificial Intelligence in Marketing and Advertising – 5 Examples of Real Traction (2019): https://emerj.com/ai-sector-overviews/artificial-intelligence-in-marketing-and-advertising-5-examples-of-real-traction/
[27] AI Can and Will Revolutionize the Media Industry, Better Software Group (2019): https://www.bsgroup.eu/blog/ai-will-revolutionize-media-industry/

product/content recommendations, targeted advertisement at the right moment, and expansion of the audience base.

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info@ai4media.eu   www.ai4media.eu