



Artificial Intelligence in Filmmaking Process

Future Scenarios

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Abstract

The filmmaking industry is awakening to the fact that immanent changes are approaching by dint of Artificial Intelligence (AI) integration. Attitudes vary from excited aspirations and proclamations of revolution in the movie production to desperate resistance and warnings about the end of movie as an art. The audience has already had a chance to encounter prominent AI-composed videos, and it becomes obvious that further AI incorporation into filmmaking is inevitable.

The intention of the study was to comprehensively review present application of AI in filmmaking process and to investigate possible ways of their integration and causal impacts in the future.

To reach defined objectives, the study relied on qualitative reasoning and utilized simultaneous multi-method – Future Scenarios method and Multiple Perspectives method, which complemented each other in order to get more structured outcomes. Primary data was collected through five semi-structured interviews with film industry professionals. Based on combination of literature review and interview results, phenomena trends were identified and extrapolated into the future.

The research implementation resulted in formulation of three future scenarios as the potential ways for filmmaking and AI integration in the timeframe of ten years, and possible challenges and benefits that will follow the process. During the study, the importance of few factors influencing integration process was revealed: the AI technology readiness, its correspondence with the requirements of film industry, and readiness of industry professionals to adopt new technologies. Being in continuously changing environments of highly technological areas, those factors are the subject for further observation and consideration.

Keywords/tags (subjects)

Artificial Intelligence, Machine Learning, Filmmaking, Future Scenarios

Miscellaneous (Confidential information)

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1 Introduction

1.1 Context

In recent years, the reports on momentous advances in Artificial Intelligence (AI) has become habitual. One may not be surprised but rather anticipates encountering news about self-driving vehicles, robots performing surgeries without guidance, or virtual assistants booking a table in a restaurant by phone. The development of technology takes impressive leaps. Nowadays, AI capabilities range from data-driven management to building strategic future scenarios, from content recommendations to awareness and disruption management, from connecting complex data systems to interactive individual assistance. Experts drive their expectations of near future even further: the smart world will change the way human interacts with environment through digitalization; AI will learn to create brand-new content for both, science and commerce; security transparency will be predominant and enabled through homomorphic encryption (Gartner 2021). AI algorithm-based solutions are already broadly implemented in healthcare for agile and precise patient services, in retail digital services, in automated journalism, in automotive industry and bioscience, in well-being and entertainment, in logistics and fintech, and many more. Predictably, filmmaking industry cannot escape global trend of deploying AI to its service.

In 2016, two meaningful events happened – first trailer of the science-fiction thriller “Morgan” produced by the supercomputer IBM Watson, and first short movie, “Sunspring”, fully scripted by AI named Benjamin. Probably, any person can recall at least one futuristic image of human-like machine from a movie, whether it is “Star Wars”, “Blade Runner 2049”, “The Matrix”, or TV series “Westworld” – this way AI is portrayed on the screen, this way movie creators imagine it in the future. Although neither Watson, nor Benjamin looks anything like C-3PO or Agent Smith – only like regular machines, these two episodes signal that AI is becoming reasonably educated to switch the sides of the camera and to participate in filmmaking process. Remarkable enough, however, the trailer and the film remain curiosities as both still needed a human touch to present a coherent story.

Certainly, it was not the first collaboration of filmmakers and AI. Previously, AI was narrowly used as an assistant in visual effects and a predictive tool for analysis of box-office success and audience preferences. And since 2016, the leverage of AI in movie production only increases. “Morgan”

trailer and “Sunspring” movie in themselves do not represent revolution in filmmaking but rather proclaim forthcoming immanent changes to the industry professionals. It is an indicator that AI researchers aim at incorporating a creative thinking in computers. Naturally, a thrilling question occurs: what role will AI play in the filmmaking process in the future? Is it long until AI computers will be able to produce fully coherent content, that will not require human editors’ attention?

This research focuses on reviewing existing practices and trends of AI in the filmmaking and attempts to foresee the potential of alliance of these two fields.

1.2 Motivation

Needless to say, the world undergoes enduring and ubiquitous technological transformation. Artificial Intelligence is probably one of the most significant parts of it. Being resonating and enthralling topic, AI is a subject for study to plenty of academic researchers, who have written numerous works in various fields. The application of AI in filmmaking, in turn, is commonly discussed in thematic journals and media by professionals, critics, and enthusiasts. They express their opinions, share insights and speculations. Despite the multitude of articles, without holistic approach together they represent dispersed image of the phenomenon. In addition, available academic literature on the matter is rather scarce.

The motivation for this research is driven by two factors. First is the author’s personal interest in artistic and technological aspects of filmmaking, especially in the light of AI development. Second factor is the lack of sufficient scholar research and structured knowledge about AI in filmmaking process. Consequently, the author is attracted by opportunity to explore the potential impact of flourishing AI solutions on the way the movie is produced. The desired outcome of this study is to provide comprehensive view on the current level of technology leverage and to prognosticate how and to what extend the AI will affect film creation processes in reasonable future. The purpose of this paper is to indicate approaching changes in filmmaking, increase clarity and awareness of ongoing processes, and propose topics for further consideration. The conclusions may be beneficial for filmmakers, who regularly deal with technology, or whose work may significantly be influenced by technology, for filmmakers, who may gain advantages from technological transformation, for professionals in related fields, such as movie distribution, music composing, game development.

1.3 Research objectives and questions

Technology is variable and continuously evolving matter. Its ever-changing capabilities and attributes deliver greater uncertainty into foreseeing the future of technology-dependent areas, such as filmmaking. To understand one, it is required to understand both inseparably. Therefore, the objective of the research is defined as follows:

1. To explore potential level of AI integration into filmmaking process in the reasonable future;
2. To identify the probable impacts of AI integration on filmmaking process.

In order to avoid vagueness and increase accuracy of the outcomes, the timeframe for futures research is set at approximately 10 years. To meet the research objective, it is necessary to answer the research questions.

Research Question 1: What are possible ways of AI integrating into the filmmaking process in the forthcoming future? – By answering the first question, the study aims at discovering the points of connection between two fields and outlining feasible scenarios of their mutual development.

Research Question 2: What potential impact will AI integration have on the filmmaking process in the future? – Answering second question implies explaining likely benefits the integration brings and challenges it evokes.

1.4 Structure of the thesis

This paper presents a study in the field of filmmaking process and AI integration with a purpose to systematize existing knowledge about phenomena and deliver awareness of their possible interrelation in the future. The definition of research topic, the motivation for the research and its objectives and questions are articulated in the opening Chapter 1. The introduction is followed by Chapter 2, that describes the coherent methodological framework of the study implementation. Literature review in the Chapter 3 overviews and arranges the knowledge about the current state of studied subjects, providing the basis for future scenarios formation. Chapter 4 concentrates on the results of semi-structured interviews, that were analyzed for trends in AI and filmmaking in

accordance with research objectives. Chapter 5 answers the research questions, provides arguments on reliability of the study, contemplates on its limitations, and suggests the ideas related to current topic for further discussion and elaboration.

2 Implementation

The chapter 2 outlines the systematic approach that was applied during the study implementation and explains method and techniques choices that were made to meet the research objectives and to answer research questions.

2.1 Research methodology

Research approach

The approach of the study is important segment of entire methodology plan, it defines the relationship direction between research process and theory, and justifies further selection of research methods. Inductive approach is a path from understanding the context of phenomena through reviewing literature and gathering knowledge and opinions to finding patterns in collected data to building a theory. (DeCarlo 2018.) Hence, this paper adheres to inductive reasoning, as it pursues to formulate hypothesis about the future upon preliminary made observations and collected data, that describe present state of the subject.

Research design

Since the research aims at investigating the phenomenon of Artificial Intelligence and filmmaking integration, deriving insights from obtained data and contemplating the future development, the research purpose corresponds with exploratory study. Exploratory study correlates well with the logic of inductive approach. It focuses rather on subject clarification and generalization of the findings than formulating conclusions and precise solutions. Also, it allows certain level of adaptivity to changes occurring during the study, yet within the boundaries of chosen topic. (Saunders, Lewis, & Thornhill 2009, 139-140.)

To support research purposes and provide the depth of context understanding, qualitative data is used. The chosen research methodology is simultaneous multi-method: qualitative data is

collected with a single technique – in-depth interviews, – however, same set of data is analyzed using two techniques simultaneously – multi-perspective analysis and trend extrapolation for future scenarios. Simultaneous multi-method enables deeper and more comprehensive discovery of a matter. (Morse 2016, 483-484.)

Though the research objective is to explore phenomena in the future with a timeframe of 10 years, it is rather to foresee particular conditions by given moment of time through identifying present trends than to describe transformation progressively. Such “a *“snapshot” time horizon*” is defined as cross-sectional (Saunders et al. 2009, 155).

2.2 Collection of data

Types of data

Two types of data are presented in this paper: primary and secondary. Secondary data – data that has been previously gathered by third parties and available from various sources, libraries, online scholar databases, peer-reviewed journals, etc. – intends to comprehensively describe present context of the studied phenomena. Primary data, in turn, was collected from interviews in order to aid in answering research questions. Both, primary and secondary, data is qualitative non-numerical kind, assuming that the environment is dynamic and providing extensive ground for observation (Minchiello, Aroni, Timewell, & Alexander 1990, 5).

Sampling

According to Saunders and colleagues (2009), the population sampling varies widely depending on the research goals. For this study, non-probability homogeneous purposive sampling was chosen to collect primary data. It usually implies small sub-group of population, where members can be characterized with similar features. Yet it allows to conduct thorough analysis. (237-239.) As the research topic belongs to rather specific area, it was decided to select the respondents of the interviews from filmmaking industry. Professional knowledge in filmmaking process was the only compulsory parameter, any other socio-demographic characteristics did not play a role, hence were disregarded.

Method of data collection

Interviews were decided to be the technique for primary data collection. Based on the format, interviews are categorized into standardized, or structured with strictly predetermined list of questions, and non-standardized, or semi-structured with flexible predetermined list of questions and unstructured with no preset list of questions (Saunders et al. 2009, 320). Considering the objectives of the research and the nature of studied phenomena, semi-structured interview was prepared, as it allows to follow the respondent, freely adjust to the conversation flow, yet to obtain exhaustive information and remain within the boundaries of research topic. The general interview guide (see Appendix 1) proposed the set of questions for discussion. According to the respondents' answers, the sequence was adjusted, some questions were replaced, some questions were expanded in order to get in-depth responses.

2.3 Analysis of data

For the analysis of primary data verbatim transcription – in exactly same words as spoken language – was used to avoid mishandling and to maintain the results accuracy. However, the “Results” chapter represent edited transcription for clarity and readability.

Future scenarios method

The nature of the research questions implies exploration of Artificial Intelligence and filmmaking cooperation in the future, which inevitably introduces uncertainty and fuzziness. Hines and Bishop (2015) claim that *“open-endedness of foresight requires a mindset that encourages imagination and creativity”*, at the same time *“it requires the ability to recognize patterns, ... that involve relationships and systems that are nonlinear and complex”*. These abilities should be transformed into systematic future thinking for purposes of the study. (32-34.) Future scenarios method corresponds with this approach and suggests assuming the developing paths from perspective of today to probable future models and identifying driving factors. It is important to understand, that in comparison to predictions scenarios are not precise image of the future, but merely hypothetical assumption of future state based on researcher's knowledge about the present. (Kosow, Gaßner 2008, 11-12.) Scenarios can be normative, or reverse in time, facilitating steps to desired future, or exploratory, direct in time, simply following from present to future disregarding

its desirability (ibid., 2). The latter kind serves the purpose of this study, as it aims at investigating and informing about future orientees, rather than formulating action plan.

According to Kosow and Gaßner (2008), the scenarios process can be described in four phases:

- **Phase 1 – Identification of the scenario field**, when the borderlines of research field are demarcated and the context for future scenarios is explained. The phase 1 is implemented through the literature review.
- **Phase 2 – Key factor identification**, when the key trends are discovered within the determined field. The knowledge base is partly provided in the “Literature Review” chapter and then significantly enhanced with primary data collected through semi-structured interviews.
- **Phase 3 – Key factor analysis**, when identified trends are streaked and imprinted into the particular future timepoint through imaginative assumptions.
- **Phase 4 – Scenario generation**, when projected trends are systematized and organized into narratives, depicting hypothesized future. This phase is implemented as an answer to one of the research questions. (26-28.)

The fifth phase supposes transferring scenarios into strategic decision-making area. Howbeit, it is outside of this research scope, and first four steps are considered to be sufficient for the research goals.

Trend extrapolation technique

When analyzing the patterns and effects of a particular trend, the trend’s starting point and direction must be considered. Trend extrapolation is a future scenarios technique, that recognizes the trend, observes its behavior over the period of time and projects it onto timepoint in the future (Donnelly 2003). Projecting trends into the future may open the “*funnel*” of probable developments as well as create only single possible one (Kosow, Gaßner 2008, 46). This technique is used during the phases 2 and 3 of scenario process.

Multiple perspective method

Being complex fields both, filmmaking and AI, generate variety of factors influencing their potential integration and multiply points for research application. In order to organize trends, identified with trend extrapolation technique, and provide structured basis for building future scenarios, multiple perspective method is used.

Formulated by Graham Allison in 1977 to improve the corporate decision-making process, multiple perspective method allows to regard the subject from different angles – technical, organizational and personal perspective (Linstone 2009, 2).

- **Technical perspective** oriented at rationality, quantification and problem solutions. Problems are well-structured and obedient. This perspective neglects the importance of individuals and their appearance in communities.
- **Organizational perspective** focuses on the process organization and action taking, relies on experts and questions analytic tools. Key principle is standardization and optimization.
- **Creative perspective**. Originally this perspective is called “personal”, however, the name is adapted within this research due to specifics of filmmaking industry, where creative aspect plays crucial role being inherently connected with humans. This perspective emphasizes focus on individuals and their importance in contributing to changes. (ibid., 8-9.)

Multiple perspective is a holistic and pragmatic approach. The aspects of all perspective interrelated and can be used in a versatile, yet critical manner. (ibid., 11.) Multiple perspective method is applied at phases 2 and 3 of scenario process as additional dimensions for filmmaking process context for improved trend concentration and analysis.

2.4 Ethicality

As the part of the research implementation was to conduct semi-structured interviews with professionals from filmmaking industry, ethics was a subject for consideration and obligation. Ethical aspects were addressed proactively. The respondents were contacted via publicly available means. The invitation contained detailed description of the interview purpose and process, informing that conversations would be recorded and results would be used for scholar study. All

interviewees participated voluntarily and granted consent for videorecording. The privacy was guaranteed to them. Information presented in Table 1, Chapter 4 contains generalized description of professional and educational background and is not considered as personal data.

The secondary data was reviewed responsibly. All direct and indirect citations are indicated with author and proper referencing.

3 Literature Review

The purpose of literature review is to provide comprehensive analysis of existing and available literature that has been previously written by other authors on the topic. It integrates and summarizes theoretical knowledge related to key subjects being studied and creates the basis upon which the research is built (Saunders et al. 2009, 65-66).

In this chapter Artificial Intelligence and film production are initially reviewed separately to explain two phenomena environments and to understand their present capacity and future expectations. Afterwards prevailing points of contact are discovered to define direction and depth of their present interconnection and to outline the area for future scenarios development.

3.1 Filmmaking today

How technologies shape filmmaking industry

For decades there are ongoing debates on who invented the film. On the American continent one would name a creator of kinoscope Thomas Edison. In 1891, he created a device that reminded a big wooden box and allowed one person at a time to watch rapidly moving sequences of pictures. (Understanding Media and Culture 2016, 306.) Yet to many people in Europe, the names of Auguste and Louis Lumiere symbolize the beginning of new era of the movie. In 1895, Lumiere brothers designed a lighter camera that recorded, developed and projected film, and later significantly improved the process of color photography by inventing autochrome. (Martin 2019.) Whoever holds the title of originator, Thomas Edison and Lumiere brothers are pioneers, whose projection systems contributed greatly to the art in general and gave a start to the whole new industry of filmmaking.

Since the very beginning and throughout its history, production of motion pictures has been inherently connected to evolution of technology. The change is so big, it can be witnessed even by outsiders. Just a few decades ago, the film was recorded on a physical medium by a ponderous camera, that at times required several crewmembers to operate. Aerial shots would need a heavy construction to be mounted on aircraft. Editors would carefully cut, splice and thread the film for further seamless exhibition in the cinema. Even the tiniest scratch would ruin all the effort and lead to losing entire scenes. Animation was hand-drawn by artists on celluloid. Props and sets for visual effects were man-made and they would occasionally create unrealistic viewing experience. Besides, the whole filmmaking process was time-consuming, and the cost was rather significant factor. (Understanding Media and Culture 2016, 314-317.)

Today, though the film medium has not completely gone and been kept from obsolescence by notable filmmakers such as Christopher Nolan, JJ Abrams, Steven Spielberg, digitalization has seriously transformed the overall way the movie is created and various sub-processes in particular. Modern digital cameras, equipment for audio recording, autonomous drones for aerial shots are much more convenient to use due to compact size, portability and accessibility. They enable high-resolution, different-angle shooting, multiple shot takes and immediate feedback on the scenes that have just been filmed. Computer-generated imagery (CGI) has been progressive step in filmmaking, and its potential is presently enhanced by 3D printing. 3D printing brings design of fictional objects into physical space, improving level of customization, scalability and quality of props and sets and allowing their realistic interaction with actors. Computer software opens wide spectrum of possibilities from footage editing to designing visual effects (VFX), animation, or new imaginary world, and harmoniously compositing them with real shots. With the help of 3D motion capture technology or depth sensors, the movie can be inhabited with fictional characters that look natural. Cloud systems hosting all recorded content allow collaboration of industry professionals from around the globe, increasing flexibility of filmmaking process. Altogether, implementing these innovations has gradually decreased production costs. (Sheldon-Hicks 2015.)

Not only the advancement of technologies had impact on growing capacity of filmmaking process, but it also enabled complex intricate narrative a filmmaker could not convey before. Andrew (1985, 24-15) defines filmmaking as "*technological art*" that "*is composed of pieces of the culture it represents*". Through the films filmmakers communicate with the audience, they translate values,

beliefs of the culture they belong to, or they invite to entirely new culture of fictional worlds, they send a message to viewers and launch influential discussions, they create pieces of art and stamp instant entertainment. Nowadays they do not even need to lure people out to watch a movie in the cinema theatre. The audience can be reached in their homes through mobile devices and over-the-top media services, which are also known as streaming services.

According to Byrnes (2003, 73), at all stages of filmmaking development the new technologies were adopted rapidly following commercial interests. As integration progressed professional labor market of the industry was changing dramatically. And the adaptation period never ended, it remains a permanent process. Outdated jobs are replaced by new ones, new competences are employed in order to correspond with evolving filmmaking industry requirements. (ibid., 74.)

These days, film industry comprises various businesses of all sizes, such as film studios, production companies, cinema theatres, catering companies, independent filmmakers, academies and festivals etc. Hundreds of professions across all fields contribute to industry operation, from director to runner, from writer to music composer, from actor to hair and makeup artist, from program researcher to VFX artist.

Filmmaking process

Film may be produced by one of the “Big Six” (20th Century Fox, Warner Bros., Paramount Pictures, Columbia Pictures, Universal Pictures, or Walt Disney Pictures), or by independent team; the budget may be worth millions of U.S. dollars, or be as low as few thousands; it may be a blockbuster, amusing audience with dynamic plot and expensive visual effects, or short commercial video with simple narrative. Despite genres, investments, or the size of film cast, the outline of filmmaking process stays universal. Generally, it consists of four stages: development, pre-production, production, post-production (see Figure 1 on page 14). Oftentimes distribution is named as a fifth stage, however, it is excluded from the research scope. This study focuses on the path from initial idea to complete product ready for further exhibition. Besides, short customer-tailored films and videos are not subject for distribution, hence, only first four phases are hereby considered.

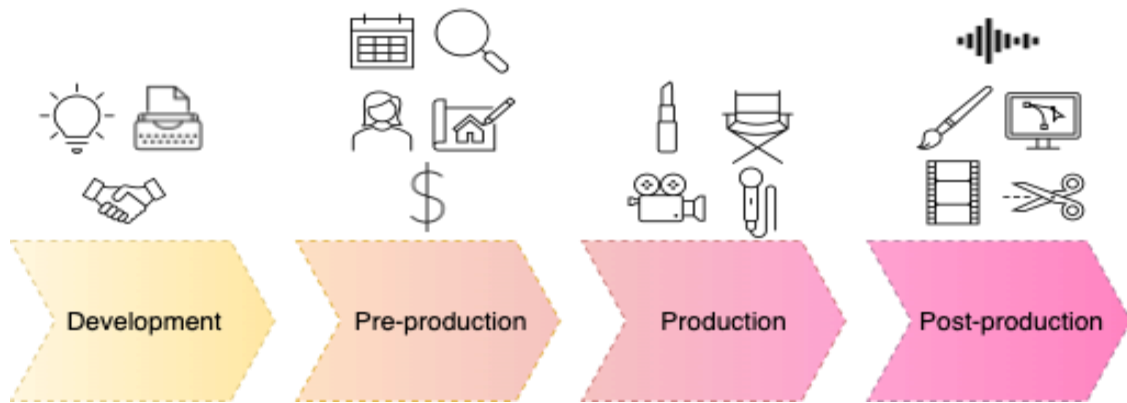


Figure 1. Stages of filmmaking process and activities they include

Development. The first step begins with a script. The writer creates the script inspired by original idea or existing story from a book, movie or the one that happened in real world. When the screenplay is greenlit, the film premise is decided, the key cast members are determined, and finance is secured. (How Films Are Developed & Organized 2018.)

Pre-production. This is organizational stage, where the actual shooting is arranged. As the script is locked, preliminary works start: scheduling and budget planning, hiring film crewmembers, casting actors, searching film locations, setting design, requisites and constructions.

Production. After all preceding preparations are done the shooting begins. At the early phase of production additional crewmembers may be hired. Costume, hair and makeup artists handle the appearance of performing actors. While the shooting process goes, footage and sound are recorded. Already during this stage sound and video editors create a draft cut of the film.

Post-production. This stage is considered to be the most daunting and time-consuming. Howbeit, it is the time, when the director and creative and editing artists work on the final result. Post-production includes footage assembling, audio and music editing, VFX creation. In the end the film is ready for distribution and exhibition to audience. (ibid.)

Major trends and expectations

In 2021 the value of the film and video global market was assessed at 244,43 billion US dollars and is forecasted to be worth of 409,02 billion US dollars in 2026 at the compound annual growth rate (CAGR) of 10,6%. The growth is prompted, firstly, by industry recovery after pandemic restrictions and, secondly, by innovative technologies. (The Business Research 2022.) According to Bar Am, Furstenthal, Jorge, and Roth (2020), around 85% of technology field representatives believe that there is direct relationship between former and latter factors: the needs caused by pandemic constraints inspire new opportunities for technology ingenuity and accelerates their development. As a technology-dependent industry filmmaking falls under the trend.

Emerging technologies may significantly influence on the way video is produced and watched. Incorporating latest achievements in virtual reality and 3D technologies into filmmaking process enables to create realistic immersive 360-degree videos and shoot 4K-resolution 3D-image scenes even under the water. These technologies combined with digitalization democratize the filmmaking in general and facilitate workflows between production and post-production stages, as they allow to edit footage in real time and add VFX when the shooting still continues. Additionally, virtual reality (VR) and augmented reality (AR) are presently approaching a stage, when filmmakers are able to employ interactive storytelling and invite their audience to become a part of the virtual environment and encounter characters on previously unknown emotional level. (Mixson 2021.)

In recent two years, one of the major shifts in entertainment and media industry is change in consumers behavior, whose preference for convenient access to entertaining content, such as movies, dictates the rules on the market. The popularity of OTT platforms is growing. Consequently, the competition among the biggest players – HBO, Netflix, Amazon, Disney – intensifies, and the ability to fill and update large film libraries becomes vital, creating opportunities for all filmmakers and diversifying distribution options. (Ballhaus, & Chaw 2021, 11.)

Film industry experts share their opinion, that this is good time to explore full potential of AI solutions to assist filmmaking process at all stages. Consistent integration of machine learning, natural language processing, computer vision can be impactful and take monotonous work from

human hands, releasing space for creativity, and optimizing costs, which are normally a very important factor in movie production. (Mixson 2021.)

However, Piccirillo (2011) thinks that abundant presence of novel technologies alone does not necessarily result in the quality of the film, or its success. It is rather to the talent of filmmakers to wield technological advantages for broadening creative potential and presenting a story that impresses public (ibid.).

3.2 Artificial Intelligence today

What is Artificial Intelligence?

There is no one conventional definition of Artificial Intelligence as this is rather extensive concept, and the meaning may largely depend on area of application and public perception. Nonetheless, Wang (2019, 1-3) emphasizes the importance of giving clear description of a term, because it helps to outline the boundaries of the study, and suggests four criteria of “*good working definition*” – simplicity, accuracy, true to its general usage and leading to productive research. Following these principles, AI can be defined as a system that is developed to interact with complex environment by receiving and processing information and responding with actions, which imitate human thinking or behavior and generate output such as decisions, predictions, or content through cognitive computing techniques. (Samoili, López Cobo, Delipetrev, Martínez-Plumed, Gómez, & De Prato 2021, 10; Russel, & Norvig 2021, 1).

The key attributes of AI are:

- autonomy – “*the ability to perform tasks without constant guidance by a user*”;
- adaptivity – “*the ability to improve performance by learning from experience*” (Elements of AI 2018).

In their study, Samoili and colleagues (2021) provide and explain classification of AI by the range of technology potential.

- Artificial Narrow/ Weak Intelligence (ANI) is the only type of AI that has been successfully developed and exploited until today. ANI is oriented at domain-specific tasks and perform within established environment. Augmenting productivity and efficiency with computing advantages, ANI technologies are equal or superior to human intelligence in an assigned niche, however they are inept to generalize experience and extrapolate it to other areas. Examples of ANI lay from image recognition to voice assistant, to disease mapping, to self-driving cars.
- Artificial General/ Strong Intelligence (AGI) is a type of “*human-level AI*” that is capable of thinking and creating. In contrast to ANI, AGI demonstrates common sense and performs tasks equally to or exceeding human mind in a wide range of problem contexts. The image of AGI can be recognized in science-fiction movies, when illustrated machines show own self-awareness and motives. Currently, the state of AGI development is far from reaching finishing line, and the predicted accomplishment stretches between years of 2040 and 2060. (11-12.)
- Artificial Super Intelligence (ASI) is a theoretical type of AI, surpassing the potential of human intelligence far beyond. It is hypothesized that ASI machines will become conscious, self-vigilant and will possess ability to think of complex concepts and interpretations outside human understanding. Yet, the question about forms of ASI implementation or foreseeable timeframe remains open (Russel, & Norvig 2021, 33-34).

Artificial Intelligence appeared in early 1950s as an idea by polymath Alan Turing, who suggested that machines can use information and reasoning for problem solving and decision making just like humans do. Later, in 1956, John McCarthy coined and introduced the term “artificial intelligence”, when he was hosting the conference where Allen Newell, Cliff Shaw, Herbert Simon presented the first AI program mimicking rational thinking skills. The biggest challenge for AI those times was computers’ underdevelopment, scarcity and expensiveness. The problem eased in 1980s, as computers thrived, became cheaper and more accessible, algorithmic toolkits expanded and funding increased dramatically. Then “deep learning”, a technique allowing machines to learn from experience, was introduced by John Hopfield and David Rumelhart. Simultaneously, various industries started deploying Edward Feigenbaum’s expert system, a program that was predecessor to modern help desks, planners, virus detectors and stock market traders. Ever since the initial idea of making machine to make decisions as a human was enriched and deepened by

achievements, such as Go playing program, speech recognition software, workflow management tools, computer vision, neural networks and many others. In the present day the paramount challenge for AI researchers is to eventually build an AI similar to human intelligence and complete transition from Artificial Narrow Intelligence to Artificial General Intelligence. (Rockwell 2017.)

Description of general purpose and historical development steps of AI as well as its classification gives an understanding of phenomenon evolution, what is the present state, what led to it and how the anticipated progress is outlined. This is essential for accomplishing futures research. Further in the study, ANI, AGI and ASI are mainly referred to as just “AI”, due to the latter two types being in theoretical stage. On the other hand, these terms are used separately when the context requires preciseness.

Technologies in AI landscape

In the same way, as there is no unity in defining AI, various approaches are suggested to explain the nature of AI and determine its sub-disciplines. This study pursues the optimal comprehensive way to describe the phenomenon of artificial intelligence, while staying in the boundaries of research topic connected to filmmaking. Therefore, in this paper the place of AI among other knowledge areas is found and classification by algorithms and tasks, which AI aims to perform, is elaborated through synthesis of other authors' works.

If AI is regarded from two perspectives – allegiance to human behavior and rationality, then it is possible to identify its relation to few adherent disciplines, which underlying principles contribute to building a core of Artificial Intelligence. First of all, logic and mathematics seek for problem solution with the help of reasoning and inference. Secondly, biology and psychology, being empirical sciences, study human brain as a collection of neurons and as a fount of mind. Then, together they constitute a ground for cognitive computing, which simulates thoughts processes while augmenting human capabilities. Finally, from combination of cognitive computing and big data, where big data serves as a material for learning and experience, AI ensues. (Bullinaria 2005, 5-8; Russel, & Norvig 2021, 1-2.) AI and its sub-disciplines in the context of knowledge areas collaboration is shown on the Figure 2 (see page 19).

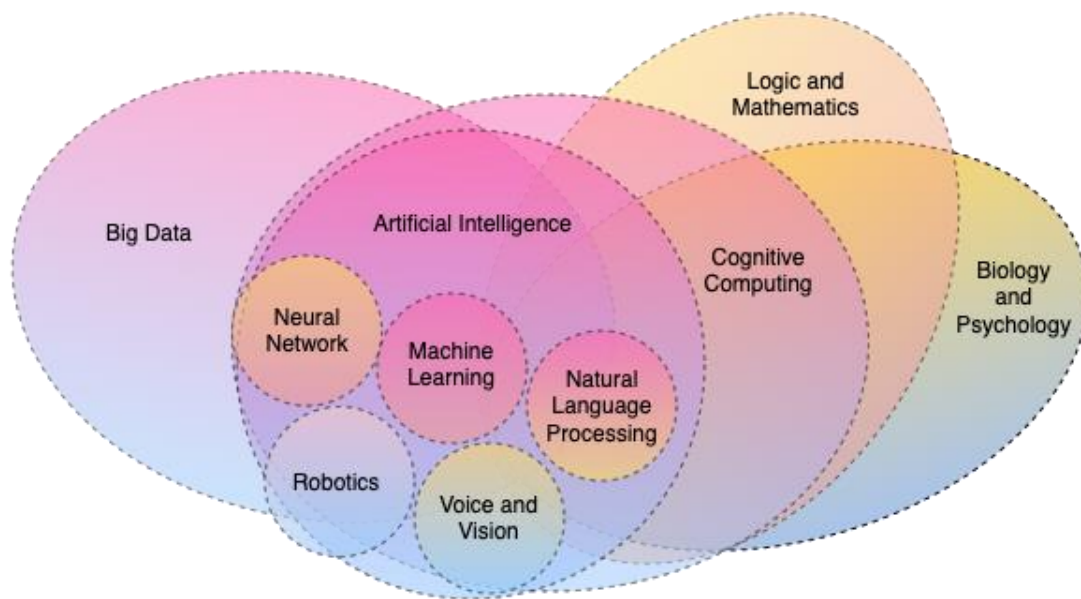


Figure 2. Artificial Intelligence context

When Alan Turing raised a question whether computers can think, to answer that question he designed game rules, which later were called the Imitation Game, or the Turing Test. Machine passes the test, if human interrogator, after sending a number of written inquiries, cannot guess whether responses are made by person or computer. Interestingly, The Turing test does not require physical simulation of a human. (Oppy, & Dowe 2021.) Harnad (1989) considers it as a serious downside and claims that appropriate improvement to the research is allowing computer to interact with real objects and people in a form of robot. He calls it Total Turing Test (ibid.).

Machine Learning, neural network, natural language processing, voice and vision, and robotics are the branches that comprise most of AI and, in theory, configurate the whole entity, capable to pass Total Turing Test (Russel, & Norvig 2021, 3).

Machine Learning (ML) stands for a set of statistical algorithms that enable computer to continuously learn from data and solve various real-world tasks without explicit programming. Unlike ML that needs to be fed with data, deep learning is a sub-field of ML that is able to train independently through the concept of neural networks. (Wang, Cuiqin, & Zhou 2009.) The

aforementioned self-driving cars, like Tesla and Google's Waymo, targeted emails, Netflix recommendations, online shopping with virtual body analysis – all these innovations have ML as underlying technology.

Neural network is interconnection of multitude of simple processing elements, artificial neurons, which imitate human brain work to seek the patterns across data and learn from it. Neural network algorithms are widely used in trend predicting, fraud detection and risk analysis. (Tyagi 2021.)

Natural language processing (NLP) is an algorithm that combines principles of ML and linguistics, enabling machine to process human language and to understand it in the context. In other words, computer learns the spoken language as a person learns a foreign language. Apple's Siri and Amazon's Alexa, as voice assistants, Twitter's Twippy, as sentiment analyzer, are examples of NLP techniques application. (Littman, Ajunwa, Berger, Boutilier, Currie, Doshi-Velez, Hadfield, Horowitz, Isbell, Kitano, Levy, Lyons, Mitchell, Shah, Sloman, Vallor, & Walsh 2021; Tyagi 2021.)

Voice and Vision is the ability of computer to recognize speech and images or faces respectively. Pictures and spoken language are transcribed into data sets with the use of deep learning algorithms. Textual data sets may be further analyzed with NLP techniques. Image and face recognition technology can be found nowadays in social networking applications, when the background is changed or blurred, in applications, which allow to alternate a person on existing picture and video, also known as deepfakes, in video surveillance. (Littman et al. 2021; NDA 2018, 3.)

Robotics is a branch of Artificial Intelligence, uniting mechanical and electrical engineering, advanced sensor systems, machine learning, and cognitive communication. Presently, robots take many forms and shapes – arm-like, wheeled, bipedal, four-legged, humanoid-like. The application varies from manufacturing industries to home and individual assistance for repetitive and labor-intensive assignments. (Littman et al. 2021; Tyagi 2021.)

Major trends and expectations

As much as has already been achieved, the ample potential of Artificial Intelligence is merely discovered. Alongside with persistent improvement of existing technologies in robotics, NLP, machine and deep learning, image recognition, the nearest future aspirations of AI researchers are addressed towards emerging technologies. Among the most tangible trends in the forthcoming years is generative AI. It refers to an AI algorithm that learns data elements in the context and produces completely new content, such as documents, images, videos. Generative AI may be used in diverse fields, including creative and entertainment areas, research and development, science, energy, commercial and automotive industry. Despite experts has already proclaimed the technology to be revolutionary in content production, concerns regarding privacy and security should be raised to public attention. (Gartner 2021.)

Another notable emerging technology is responsible AI that aims at overcoming biases and operating with transparency and fairness, decision intelligence to refine decision-making processes in organization, and metaverse, a complex digital environment, accommodating and connecting numerous of networks. Figure 3 below represents a categorization of technology adopters based on their openness to innovations (Rogers 2003, 296). Most of the mentioned emerging technologies are estimated to reach “Early Majority” stage in the timeframe of 3 to 8 years, However, metaverse is beyond eight-year line (Gartner 2021).

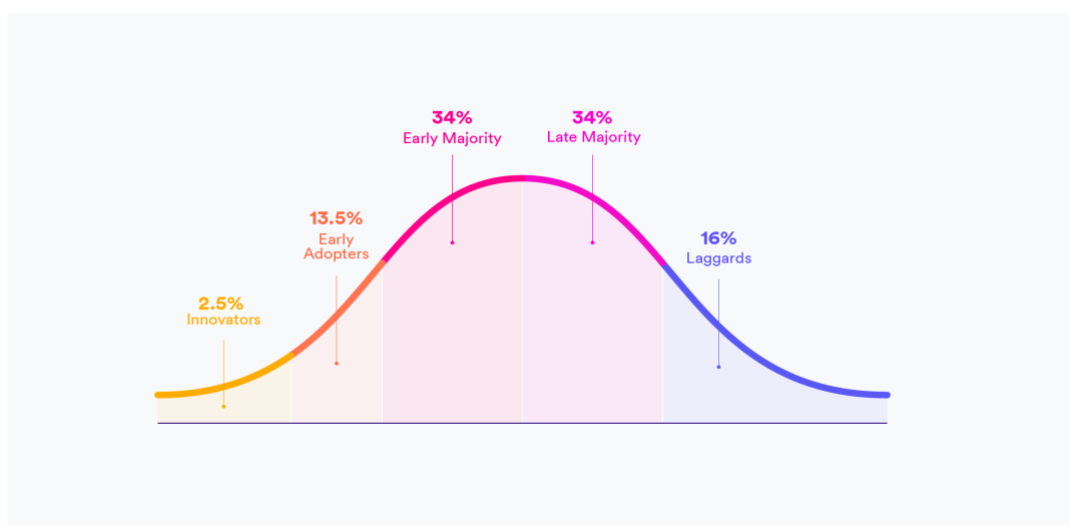


Figure 3. Rogers' bell curve representing technology adoption (borrowed from Yalo.com 2020)

Although AGI is yet to be long awaited, AI researchers gradually strive on approaching it while working on generalizing AI technologies through self-supervised and multitask learning. Thus, algorithms may be stretched across domains instead of solving niche problems. An important issue in this regard is lack of solution on how to permeate machines with abstract thinking and common sense. And this solution is still to be found. (Littman et al. 2021.)

3.3 Application of Artificial Intelligence in filmmaking process

According to Burrus (2017), Artificial Intelligence coming to every industry and every company is inevitable *“future fact”*. He names AI among *“Technology Hard Trends”* and explains that *“Hard Trends will happen, no matter who you are ... None of us can stop Hard Trends from occurring, but there are ways to see them coming”*. Burrus supports his anticipations with 30 years of research and analysis. (17-18.) Indeed, today one can witness continually increasing number of known cases, when AI is employed by filmmakers.

As Cappello (2020, 175-177) suggests, that leveraging AI in filmmaking process may follow several purposes:

- first of all, to perform a function of operational tool for routine task automation and costs optimization;
- secondly, to create *“a data-savvy culture”* with strategic approach, based on settable and measurable objectives;
- thirdly, to participate and assist in creative processes of unique content production.

The schema presented on Figure 4 (see page 23) shows all the sub-processes at each filmmaking stage that already have opportunity to employ AI solutions to their assistance. There is no direct connection between particular AI branch technology and the area where it operates due to complexity and possible interconnection of algorithms targeting at domain-specific task. Every point of touch between filmmaking process and AI is explained in practical cases.

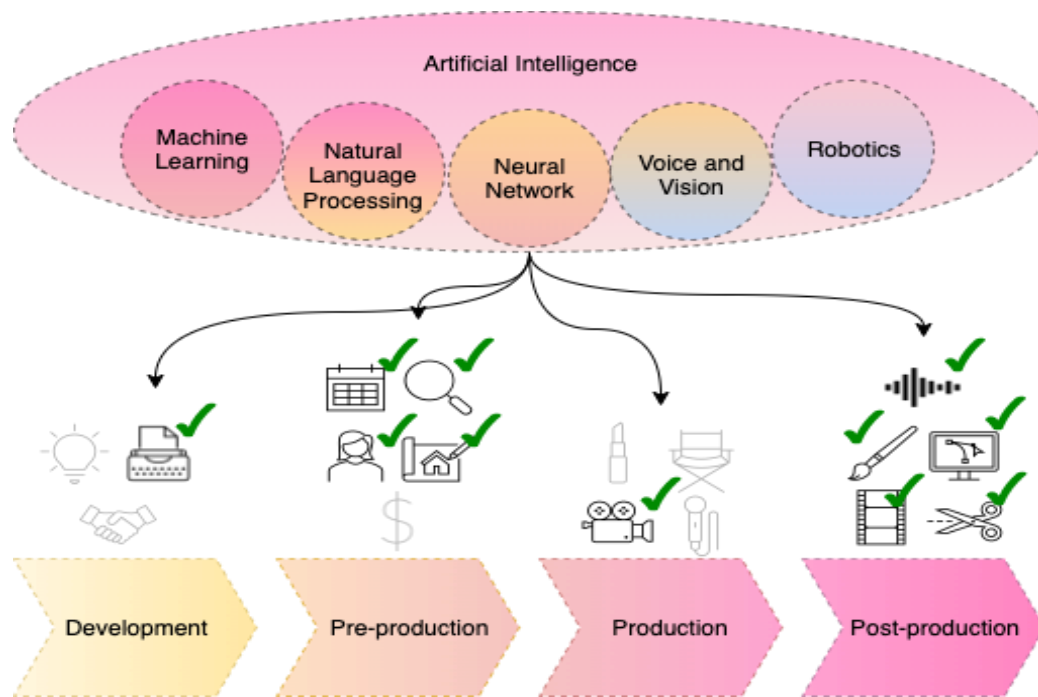


Figure 4. Application of AI in filmmaking sub-processes

The case of Benjamin the AI

Benjamin is a long short-term memory (LSTM) recurrent neural network, the type of AI that predicts next words in a sentence, similar to those used in mobile phones. The name Benjamin became recognized after director Oscar Sharp and AI researcher from Google Ross Goodwin released a nine-minute film “Sunspring” as a part of 48-hour challenge at Sci-Fi London Film Festival. The resonance was caused by the fact that script was fully written by AI. Benjamin learned from hundreds of screenplays of 1980s – 1990s movies and output a text while adhering to preset requirements. The dialogs were bizarre and meaningless, but earnest intent of actors and rest of the crew attracted attention to film. (Godde 2018.)

A year later, “Sunspring” was followed by another movie “It’s no game”, based on Shakespeare works this time. It was presented at the same contest and awarded third place. In 2018, however, Benjamin stepped further and created entire movie, including screenplay and direction. The actors from “Sunspring” were engaged in project again. They made acting and voice pre-recording, which was later placed with face-swapping and voice-generating techniques on collection of scenes from existing films. The final result was called “Zone Out” and characterized as “nonsensical” by Benjamin’s team. It looked odd and unappealing, voices were difficult to comprehend due to

intense computer effect, faces flickered, features were occasionally dislocating, producing horrifying emotions. (ibid.) According to Sanders (2014), evolution gave humans infinite facial variability, so that every face is unique and distinctive. This process was facilitated by human brain organization, oriented on social interaction. Unlike animals that recognize other individuals with smells and voices, people recognize each other with facial features. This is humans' evolutionary skill, and its responsibility to give a signal, when face looks unnatural or bizarre. (ibid.) Inevitably, pictures and videos with poor-quality image composition and deepfakes are easily detected with a human eye and perceived by viewers as unfriendly experience.

Although Benjamin is not capable of producing comprehensive content yet, efforts are crucial for the industry. It serves as awakening signal to other filmmakers that Artificial Intelligence and potential changes cannot be ignored anymore.

Other use-cases

Development. Scriptwriting. After “Sunspring” and “Zone Out” releases, scriptwriting AI advanced further. In 2019, BAFTA- and Oscar-winning director Kevin Macdonald shot a sixty-second advertisement for Lexus, which was fully AI composed, and in this occasion the video is perceived as coherent story (Rose 2020).

Belgium-based company ScriptBook has launched their own AI scriptwriting tool “DeepStory” for public use (DeepStory 2022). The project is being presently at development stage and available only for testing. It is assumed that the quality of the generated screenplay may be regarded as mediocre. However, it already provides an access to creative assistant for filmmakers, game developers and content creators.

Pre-production. The current AI algorithms are sophisticated enough to aid the filmmaking crew with research and organization tasks during the pre-production stage. Using NLP techniques for text analysis, key information elements can be derived from the script, including characters and their interaction in the scenes, audio effects, necessary props, location description and further scouting. Through ML algorithms complicated non-linear schedules can be outlined with consideration of plenty of variables, such as available dates of all key participants, location availability, budget restraints, weather. With a holistic approach, AI assistance in preparational

assignments is able to significantly contribute to film production value chain by time optimization, overlap mitigation, improved organizational control and transparency of made decisions. (Ray 2017.)

Movie analysis: casting actors and predicting success. Linell (2017) provides a remarkable research data showing correlation between movie revenue and celebrities performing in that movie. A single celebrity does not have any significant impact on a film revenue. A number of famous actors, on the contrary, demonstrate a positive effect on the box-office figures. (11.) However, it does not seem to be a trivial task for a human mind to make a rational decision on actors for commercial success, when there is overwhelming amount of names, markets and factors for consideration. In the recent years, more and more start-up projects appear, claiming they have a technology to solve the problem. Cinelytic, the official partner to Warner Bros., Ingenious Media, Sony Pictures, offers their solution to forecast film success: actors are regarded as variables with weight score. As different teams are formed, the success is estimated and additionally the production budget is adjusted. ScriptBook, in turn, make their predictions based on the script, paying attention to characters, structure of the plot, location, target audience. The other company on the market that works in a same manner is Israel-based Vault AI. 20th Century Fox announced development of their own AI “Merlin” in collaboration with Google. Accuracy of predicting algorithms is estimated at the range between 83% and 86%, opposed to human decisions between 27% and 31%. (Rose 2020.)

On the other hand, Gilpatrick (2020) is concerned that outsourcing casting actors and script decisions to technology would ruin creative vision and presentiment of the right choice. He provides an example of successful casts that were opposite of the obvious pick: Mark Hamill and Carrie Fisher in “Star Wars”, Lady Gaga in “A Star Is Born”, Robert Downey Jr. in “Iron Man” – the former three persons had never played in a movie before, the latter actor was known as “*box office poison*”. Gilpatrick emphasizes the importance of further discussion, whether the film industry should rely on technology decisions only. (ibid.)

Production. Robotics. Film industry professionals are continuously looking for convenient solutions to optimize the fulfilment of burdensome tasks in a complex and multi-layered filmmaking process. Robotization occurs to be one of them. Presently, robots are capable of

operating shooting cameras following predetermined settings and can be programmed to handle 3D printing or to carve sculptures for props and sets. Thus, rather laborious and effortful tasks are automated, synchronized with other processes and accomplished with computational preciseness. (Joshi 2018.)

Post-production. Post-production is rather time-consuming part of filmmaking that consists of both, creative and monotonous, mechanical processes. Also, post-production is probably the most accommodated with AI that can be helpful with routine tasks. Starting with **editing**, when it is required to sort the shots into sequence, reveal light and sound noises, make proper cuts, correct resolution, erase unwanted elements, implement subtitles, to creating **trailers** – deep learning, NLP and image recognition algorithms may significantly reduce time needed for accomplishing work, allowing specialist to contribute more into creative aspects. (Xagoraris 2020.)

In **VFX and Animation**, with the help of neural networks and generative algorithms, CGI becomes less challenging to implement objects, characters, effects, or entire environment into existing footage. The major issue with AI technologies available nowadays for post-production is that it cannot be utterly relied on. The necessity for supervision by a human professional may be as little as only final check, or as big as monitoring throughout the task with required manipulations. (ibid.)

Music. The soundtrack for the movie is inherent part of the storytelling. Normally, composers and artists inspired by the film idea create tailored composition that translates the atmosphere of that film in full and expressional manner. Nowadays, together with many other tasks this process can be outsourced to machines. The most known AI-composers are AIVA and Flow Machines by Sony. According to Karpov (2020), the doubts regarding AI-composers are caused by questionable authenticity of the music they produce. It is claimed that beside the knowledge of task-domain, the extensive cultural experience is essential in creating artistic work. (19-20.)

The list of examples involves different filmmaking stages and sub-processes they enclose. These are notable, however, discrete cases. They are curious and crucial to observe as “opening steps”,

but yet cannot be called a common practice. Albeit potential is great, researchers must be patient until AI make stable progress in that direction and gives quality result in most of the occurrences.

Concerns

According to Gartner (2019), when entering the industry AI technology may face barriers. The first one is requirement of new skills to handle novel technologies. Professionals are precautious about being overwhelmed with potentially extended duties. Secondly, persons with conservative approach may be vigilant for unknown impact of technologies on their work. Lastly, professionals may be hesitant on where to start. (ibid.) Film industry consists of large organizations as well as of small companies, independent creators, and freelancers. And representatives of each of them can simultaneously be involved in the same production. Discrete implementation of AI solutions may cause confusion and imbalance in processes. However, ubiquitous AI adoption looks promising regarding the process optimization and unification across the industry.

Another concern is related to legal area. Cases like the one of Benjamin, AI-composers, or image generators raise the questions whether AI can be creative and original author of the content that falls under lawful protection and regulation. Cappello (2020) assembles knowledge from statutes of different countries and known examples of legal concerns about AI applications, and he concludes that AI machines, being arguably conscious, are not entitled to obtain legal personality. Consequently, they cannot be a body for neither authorship, nor originality. At the moment the presence of a human or organization is intrinsic when discussion relates to legal issues around AI. Normally, it is a person who created AI machine, or a company that employs that person or owns the right for the AI machine. (91-114.)

Given that the AI advancement is certain, the revision of laws is required not only in audiovisual sector, but also in closely related ones. Instead of situational context, a proper functioning regulatory system needs to be created. Therefore, this matter continues with further discussion and elaboration until adequate solution is found for systematic and effective use. (183-184.)

4 Results

In order to investigate the specifics and depth of AI integration into filmmaking, contemplate the future development and answer the research questions, primary data was collected by means of five semi-structured interviews. After recording the fifth interview, the search for new respondents was discontinued due to obtained data saturation. Table 1 introduces the participants of interviews, showing relevance of their educational and professional background, their experience in using AI technologies and their openness to AI integration into filmmaking. To properly address the authors of below provided citations, interviewees were assigned ID.

Table 1. Overview of respondents' profiles

ID	Occupation/ Field of work	Profile	Experience in AI	Attitude towards AI
Int-1	Producer, director, scriptwriter	Master of Arts in Film Directing; in the filmmaking industry in general for 9 years; participant of international film festivals.	Familiar with AI practices, has an experience working with AI script generator	Neutral
Int-2	Ideation and scenario, pre-production	2,5 years in the industry of commercial videos, such as promotional, music, corporate videos.	No experience	Neutral/ protective
Int-3	Ideation, production (shooting, directing), post-production	More than 5 years in the filmmaking industry, doing documentary and commercial videos for corporates; co-owner of small filmmaking company.	Familiar with AI practices, little experience working with AI (subtitles, background editing)	Positive
Int-4	Post-production (VFX)	Degree in Visual Design; works in filmmaking since 2006; co-founder of animation and VFX company; founder of videotech startup for automation of visual creation processes (including AI technologies).	Good experience, technology enthusiast	Positive
Int-5	Screenwriting, directing, production, post-production	Studied media production; More than 5 years in filmmaking industry; owns a video production business.	No experience using AI, but familiar with AI practices	Positive

4.1 Key trends identification

To decrease vagueness and provide shaped visualization of identified trends in complex and multi-layered structure of filmmaking, the process is sliced into three dimensions – creative, technical and organizational perspectives.

Creative perspective

This dimension is strongly connected to such abstract terms as “creativity”, “talent”, “feeling”, “vision of an artist”. In this regard, respondents tried to deliberate the AI fitness into rather intangible environment. The major concern for all interviewees is ability to have a free artistic will. The creative process is described as *“being in-between”, the feeling of God’s presence”* (Int-1), *“meditation”, “A sound of fine-tuned instrument”* (Int-2). Nowadays, those states cannot be understood by AI.

The readiness of creative professionals to adopt AI and share the ideation step of the filmmaking is still rather low. *“Everything about the stories and about making things happen is the last resort the humans will have”* (Int-2). And another interviewee agrees: *“Working with ideas, working with people is a very special state of mind. And these are the key elements when the film is born. In my opinion, AI will take all other places before it comes to replace our imagination and joint creativity”* (Int-1). According to Int-4, and Int-5 sympathizes, emotional aspects of the films are also presently unreachable for AI: *“For AI in general, that is a huge problem to overcome and to become able to create something that would be so complex and directly tied to human emotions. I don’t see in the near future”*.

Int-4 suggests that eventually it will be a professional who decides whether the technology should be adopted and what for: *“AI solutions will first be in the hands of the people who would be doing the manual work. Imagine, a person is given a task to process few images, for example. It will be exactly that person who assesses and chooses the right tools for task accomplishment, whether it will be AI or not. I think that is definitely the first logical step. And then for quite a while, few years maybe still, there will be the gap between the professional and the AI, because no AI solution will be good enough to compete in solving cases”*.

The clear difference is defined between the content produced by human creators and with assistance of AI: *“It is important to understand what art is and what entertainment is. I want to believe that art is a value in itself, it is something bigger than us. In that way, AI is out of business”* (Int-1). In contrast to that, potentially AI-generated films are defined as *“mass-market movies”* (Int-1), *“sample movies”* (Int-2).

The judgements about AI’s ability to write screenplays divide into opposite. Some respondents see an opportunity in delegating simple scripts generation to AI. There is a possibility for technology to take its role in ideation and scriptwriting for entertainment movies and for TV series: *“If you have a long TV series with plenty of characters, I think, it would be interestingly helpful to play with their backstories and originate ideas for more episodes”* (Int-1). AI can successfully *“stamp films”* based on predetermined template that contains necessary for film production elements. Yet, Int-3 expresses concern about AI scriptwriting abilities for at least commercial area, where narrative is built upon communication with customers: *“It would need strong NLP algorithms. The specifics of my job sometimes lay in a very niche area. I don’t think technology is that advanced yet”*.

Technical perspective

Technical perspective is focused on technologies and solutions. This is where all respondents see a good potential for AI and a room for improvements for both sides of integration.

Respondents admitted that they don’t consider AI to be presently ready to enter filmmaking process on a general basis: *“It is in the showcase world still. Cool things are happening, but really rarely you can have the actual connection of what you have in hand to your professional work. For example, really attention-worth thing was DALL-E 2 from Open AI, which can basically generate fairly high-resolution images from text. That was a really crazy leap. That is not publicly available, and I don't have anything in mind what I could actually use it for at the moment”* (Int-4).

Nowadays, AI is sufficient for a limited amount of domain-specific use-cases. From the perspective of entire filmmaking process, this is still a miserable portion. (Int-5.) Still, interviewees indicate the cases of AI application at different stages of filmmaking. Along with mentioning those cases, they reveal incompleteness of technologies: casting actors has not proven its efficiency on smaller country markets due to lack of data and cultural specifics increasing uncertainty; speech

recognition algorithms for languages spoken by smaller populations require significant improvement; there is a considerable gap between present needs in VFX assistance and available tools; machine learning-based algorithms for rotoscoping are suitable for amateur videos only (Int-1, Int-3, Int-4).

However, the respondents keep high expectations on the evolution of AI tools in the future: *“First digital computers, that were able to do handle any type of movie resolution images – they were incredibly poorly-functioning and super-expensive. I think that is something that will probably happen as well with the AI solutions, they will gradually get better and better”* (Int-4).

Organizational perspective

This is “process” dimension oriented at organizational aspects of any examined field and revealing how trends behave on a structural level.

First of all, some respondents expressed their doubt of AI and filmmaking mutual interest. The potential of AI technologies is extensive, and solutions will be first developed and advanced for those industries that have a greater demand for AI and more pronounced need in its assistance. *“My feeling is that AI will change any other industry before film business, because it is capable of so many practical and helpful things in demand”* (Int-1). *“I don’t see AI is close to changing the film industry profoundly on the short distance”* (Int-2).

Further concerns relate to occupational aspect of the process. There are multitude of tasks that are repetitive, monotonous and exceptionally time-consuming and that are accomplished by human professionals. People fear to lose their jobs to machines (Int-4). In spite of that, Int-3 does not see a problem in AI integration as it is good opportunity for upgrading qualification, stimulating good competition and involving more AI technology research and development for the needs of the industry.

In plenty of cases, the project budget determines in what balance human-machine labor is applied at work. Besides, depending on the type of work and on the novelty and performance of technology, efficiency ratio may waver between humans and computers. (Int-3.) Nonetheless, it is commonly believed that the better technology becomes, the broader it is applied, the cheaper it is

(Int-1). Int-4 provides following example: *“The costs of VFX has come down tremendously during past few decades. And still, it's not especially cheap to do any visual effects. At the same time, VFX is also quite heavily growing aspect of filmmaking, and has been, and still is. What deserves attention is virtual environments and post-production rather than building actual sets. It can save a lot of money”*.

4.2 Trend projections

Creative perspective

All five respondents share an opinion, that in the next 10 years AI will not be able to overcome the creative skills of professionals. The authentic movies and videos, that impress public beyond explicable will be entirely human domain still.

Nevertheless, it is believed that technology may advance to an extent, when it integrates broadly into development and post-production stages of filmmaking and becomes primary assisting tool for content generation: *“It also will democratize production of blockbuster hits, for example, so that smaller teams from anywhere in the world could create much higher quality things on their own, rather than employing thousands of artists to do really basic boring things in the VFX, at least”* (Int-4).

Creative tasks may be distinguished from their monotonous elements and assignment division between humans and AI may take place: *“In the end, artistic, creative people would be free telling the computer what needs to happen, and what the computer would need to generate for them by their creative input, and then the creative AI would just do it”* (Int-4). However, none of interviewees suppose that in 10 years AI will be ready to bear creative functions independently: *“In the future, I think of it more as the tool than actual creative work, such as writing, directing, cutting, you know, creating the emotional ups and downs, the drama. I don't think we're very close to solving those problems with the computer these days”* (Int-5).

Technical perspective

It is supposed that simple monotonous tasks will be outsourced to AI, additionally, the tasks where computational advantage of AI over the human skills is undisputed. Automatization of some

processes may advance to a level, when those processes are built-in and hidden within other more complex activities. Withal, the average level of AI proficiency in filmmaking will stay on the basic level, though exceptions are possible. In general, the filmmaking will be optimized and shortened releasing the creative capacity. (Int-2, Int-3, Int-4, Int-5). It is assumed (Int-1, Int-3, Int-4, Int-5) that the most affected part of filmmaking will be post-production: *"I think that's going to be incredibly helpful for the industry in general and for artists in particular, many people are going to appreciate it"* (Int-5).

Despite intensive outsourcing of repetitive tasks to AI, there will still be need in human manual work for especially non-trivial cases: *"There would be the need for manual work. And even for combining manual work with the AI. For instance, removing the logo from the shirt, it might be quick assignment for AI for the first 95% of the sequence, but then the last 5% would have some edge cases when the professional would need to do the handiwork"* (Int-4).

It is assumed that in a longer-distance future AGI will in fact be developed and automatization will be possible across the entire filmmaking, or significant parts of it: *"When it comes to actual, complete movie – it is a huge pile of work, there are so many steps. But, in my opinion, we are steadily going towards the point, when it becomes real"* (Int-4). But before AI of next generation officially exists, there will conceivably be alternative solutions imitating AGI to certain extent: *"Thinking of actual AI used by any business anywhere - it's mostly different types of AIs put together. There would be specific tasks for each neural network, just strictly its job. And then the data is moved to another separately trained AI to do its job. So, it is like a sequence of AIs and hard-coded processes in between"* (Int-3).

Additionally, Int-4 proves the anticipation of industry professional for generative AI and divides the achievements by milestones: *"Next step would be to have generative AI solution to turn a movie script into some type of image form. And I'd say, that's definitely doable. Like some type of a cartoon, a storyboard or a comics. But then bridging the gap from the still images to a meaningful and enjoyable moving image - that's a whole another thing"*.

Organizational perspective

The holistic view at the filmmaking process – it will become faster, cheaper, more efficient. The professional market will go through transformation, AI integration will replace manual work, but it will require new competences both in technical and creative fields. Most likely, the key creative roles, like directors, actors, unique design artists will be preserved or face minor changes. The overall balance on the market is impossible to assume due to high uncertainty of technology development and readiness for adoption. (Int-1, Int-2, Int-3, Int-4, Int-5.) Regarding cost efficiency of AI in some specific domains, it will remain questionable: *“Definitely in 10 years, there will be plenty of people still doing those things that are fairly well done by AI solutions. But, of course, AI solutions are not for free”* (Int-4). Int-3 supports this point of view: *“AI will stay only a machine, in my opinion. I think, the machines will only do the base level job, they can cut out, take and make the base-level stuff. But when we need more advanced things to get done in the next 10 to 15 years, we have to ask humans”*.

Table 2. Summarization of trend projections (continues on page 35)

Trends		
Creative perspective	<ul style="list-style-type: none"> • Humans dominate in creative functions • Experiments with AI scriptwriting • High resistance of creative professionals, except individual cases 	
	↓ ↓	
	<table border="1"> <tr> <td> <ul style="list-style-type: none"> • Humans still dominate • Incremental change in leveraging scriptwriting tools • Readiness for technology adoption remains low • Minor monotonous works are outsourced to AI </td> <td> <ul style="list-style-type: none"> • Humans and machines are in collaboration • Division of creative functions • AI adoption grows • Supervised creative work for AI • Creative professionals have more possibilities </td> </tr> </table>	<ul style="list-style-type: none"> • Humans still dominate • Incremental change in leveraging scriptwriting tools • Readiness for technology adoption remains low • Minor monotonous works are outsourced to AI
<ul style="list-style-type: none"> • Humans still dominate • Incremental change in leveraging scriptwriting tools • Readiness for technology adoption remains low • Minor monotonous works are outsourced to AI 	<ul style="list-style-type: none"> • Humans and machines are in collaboration • Division of creative functions • AI adoption grows • Supervised creative work for AI • Creative professionals have more possibilities 	
Technical perspective	<ul style="list-style-type: none"> • Extensive need for AI tools • Technology readiness is low • Adoption readiness is moderately high 	
	↓ ↓	
	<table border="1"> <tr> <td> <ul style="list-style-type: none"> • Technology capabilities increased across functions • Average technology complexity remains on basic level • Discrete solutions applied </td> <td> <ul style="list-style-type: none"> • Technology capabilities increased across functions • AI solutions are moderately complex, good performance • Ubiquitous implementation of AI </td> </tr> </table>	<ul style="list-style-type: none"> • Technology capabilities increased across functions • Average technology complexity remains on basic level • Discrete solutions applied
<ul style="list-style-type: none"> • Technology capabilities increased across functions • Average technology complexity remains on basic level • Discrete solutions applied 	<ul style="list-style-type: none"> • Technology capabilities increased across functions • AI solutions are moderately complex, good performance • Ubiquitous implementation of AI 	

Organizational perspective	<ul style="list-style-type: none"> • Filmmaking is time-consuming, multiplex, expensive process • Plenty of manual work is done by human professionals <ul style="list-style-type: none"> • Fear of being replaced by machines
	<div style="display: flex; justify-content: space-around;"> ↓ ↓ </div>
	<ul style="list-style-type: none"> • Cost-efficiency improved in general • Transformation of professional skills • Plenty on repetitive processes are automated (most likely unevenly across the whole filmmaking) • Little manual work is done by humans

To summarize results of semi-structured interviews' analysis and implementation of future scenarios phases 2 and 3, Table 2 shows identified key trends of AI integration into filmmaking from multiple perspectives. In creative and technical perspectives existing trends behavior may unfold in two possible ways in the next ten years. In organizational perspective it is agreed that trends have one potential imprint to the future.

5 Discussion

5.1 Answers to research questions

Research Question 1: What are possible ways of AI integrating into the filmmaking process in the forthcoming future?

Negative scenario – “Merely a Guest”, undesired from the respondents' point of view, but probable. In this scenario, the resistance of creative professionals in filmmaking industry to AI integration is high, as they are protective over their functional domain of ideation and content creation. Humans are skeptical and mistrustful towards technology. Concerns regarding job losses to machines persist. The general attitude slows down the technological advancement in the industry, merely monotonous works employ AI solutions as a tool in selective tasks insignificantly contributing into organizational improvement. Processes within filmmaking are stable. AI researchers show little interest in developing solutions for the industry purposes due to lack of request. However, individual technology devotees are to be met among filmmakers.

Possible scenario – “Creative Conservators and Technological Enthusiasts”. This scenario describes creative professionals as sticking to traditional way of ideating the film and relying on

human imagination and decision-making with selective insignificant assistance by AI tools. On the contrary, computational power of digital works flourishes due to novel technologies, extensively covering wide spectrum of repetitive tasks. Error ratio is low, machines perform similar to human professionals or exceeding their capabilities. Professional transformation happens in technical dimension, as digital artists employ new competences in order to handle innovative AI solutions. Time required for computational processing of footages, editing images and sounds, and VFX decreases. Budget adjusts accordingly with technology implementation.

Positive scenario – “Friends with Technology”, according to professionals’ opinion, is desired yet too optimistic. In this scenario progressive technical dimension is accompanied by creative openness to AI achievements. Adoption of solutions happens ubiquitously across the filmmaking process. Content creation divided between machines and professionals. Outsourcing dull and routine tasks as well as trivial template assignments to AI releases creative potential. Computational part of filmmaking is significantly trusted to algorithms and solutions, that perform on high or moderately high level. Costs, time schedules and process unification are optimal throughout the structure involved into film production.

Scenario with advanced creative dimension and backward technology is not feasible, as there are no technologies ready for adoption, therefore advancement in creative perspective is impossible.

Research Question 2: What potential impact will AI integration have on the filmmaking process in the future?

Filmmaking is a multiplex process which capacities continuously grow. The demand for extending technological competences is caused by snowballing expectations of audience and ideas convolution.

The major positive impact is AI taking significant amount of manual work from professionals and artists. Especially it will be notable at post-production stage, the most massive phase of film creation and the most time-consuming. This stage includes incredible multitude of tasks, that are very effortful, yet provide only small – proportionally to entire movie – result. Rotoscoping, 3D-tracking, background cleaning, removing undesired elements – these activities may take days and weeks. AI solutions potentially accomplish them within hours.

While relieving artists from long and repetitive or scrupulous tasks, AI gives opportunity for creative workers to focus on creativity itself. Without necessity to be distracted by dull part of the process, creators are able to explore their talents and imagination in order to produce authentic and remarkable content.

Democratization of filmmaking process happens through immanent AI solutions implementation. Through content processing technologies, cloud solutions and adaptive algorithms, the gap between production and post-production can be mitigated, filmmaking becomes agile, information is easily managed through all layers and by all stakeholders involved.

Outsourcing work to AI makes processes faster, cheaper and more reliable, if it's proven to be able to work without human supervision. These factors are particularly important for small production companies, where relation between budget and quality of work is especially evident.

Among the challenges the most essential is technology readiness. During this study, significant gap between the real need of filmmakers and present state of available technologies was discovered. This may be caused as a reaction to moderately low technology adoption readiness and discomfort in front of forthcoming changes. People of technical specializations are more favorable towards AI than creative workers. Howbeit, concerns regarding potential unemployment growth persists as in many other fields.

5.2 Implication

In accordance with established methodological framework, the paper provides extensive overview of filmmaking and Artificial Intelligence integration and suggests probable future scenarios of the phenomenon for next 10 years. Through thoroughly introduced knowledgebase about the nature of two complex areas and their interconnection the field for future scenarios formation was outlined. The scenarios differed by desirability from negative that stands for undesired yet probable, through possible, to positive, or most desired, but unlikely to happen in the given timeframe. It was discovered that important factors for AI integration into filmmaking process are technologies' availability and capacity, their ability to suffice the needs of filmmakers and the openness of filmmakers for emerging technologies. All of them may be identified as future

challenges. The benefits can be generalized as overall optimization of the processes and industry capacity uplift.

Remarkably that, despite widely discussed prominent Benjamin and Lexus cases among the rest, the general awareness of AI technologies being applied in filmmaking is on average level and adoption is relatively low. Mostly, big production companies invest into AI, thus they are considered pioneers. However, primary data indicated that small productions equally show interest, but they lack sufficient budget for own research and development, and the tools available for use require significant improvements.

The research can be useful to raise the general awareness of the ongoing processes, provide systematized knowledgebase regarding the subject and indicated potential direction of development. The intention of the paper was never to prescribe further actions, or supply precise probabilities.

5.3 Research reliability and limitations

Validity and reliability of the research depends on validity and reliability of the data, methods of analysis and results representation. Though interviews, that provided primary data, were semi-structured and implied free expression of opinion by interviewee, to support validity the author selected respondents with relevant to research topic background and remained within the subject boundaries, when asked the questions. Reliability was supported by careful analysis of verbatim transcriptions, moreover, when edited for results readability, it was of special control to provide the original meaning.

Secondary data was obtained from peer-reviewed literature, books, scholar research. Data collection occurred to be challenging in the part, where it describes present application of AI in filmmaking. Available academic articles on the subject are eminently scarce, which caused necessity to scrutinize online sources for validity and reliability.

Some limitations are true to this research. Due to complexity of filmmaking industry and multitude of stakeholders and processes involved, only the process of film creation from script to “ready-for-screen” product is explored in the research work. Some aspects, such as music composing and film

distribution, are excluded from consideration as they, although related to filmmaking, may be regarded as independent fields. Hence, topic restriction could have caused limited or reduced descriptions of technology applications.

5.4 Conclusion and development proposal

Filmmaking and Artificial Intelligence are complex by their nature. Integration of two rather extensive multi-layered environments tangle together intrinsic processes. Attempt to foresee their co-development for decision-making purposes faces significant uncertainty. This research suggests qualitative outcomes, which are three possible courses of future events. However, the topic can be studied from other angles with altered methods and parameters pursuing both qualitative and quantitative goals.

There are many related to filmmaking industries, that can be impacted by AI emergence in film production with a snowball effect – music, game development, distribution and exhibition, media and entertainment. Moreover, technologies continuously develop affecting the areas they serve. Hence, previously conducted studies tend to outdate, and uninterrupted observation and knowledge updated is required.

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Appendices

Appendix 1. Interview Guide

1. Tell a little bit about who you are and what you do.
How are you related to filmmaking? How many years do you work in the filmmaking?
2. Do you use any AI technologies in your work?
3. Do you know any existing practices of AI leverage for filmmaking? What do you think about it?
4. Let's imagine several possible scenarios of future AI development: 1) it will be a helpful tool; 2) it will bring new opportunities into filmmaking process and be efficient collaboration; 3) it will take over certain processes or functions, or professions in the industry and become an independent actor. In your opinion, in-between these extremes what is likely to happen? What role will AI play in the filmmaking in the next 10 years? Why?
5. In your opinion, how may the filmmaking industry benefit from developing AI technologies? What positive impact may AI have on the process and professionals?
6. What kind of challenges may filmmaking industry face when integrating AI technologies in the future?

Which factors may help/affect AI and filmmaking industry integration?
7. Which parts of filmmaking process will be most affected by AI technologies development in your opinion?
8. Will there be organizational changes or changes in professional roles?
9. Would you like to use AI in your work/ to extent the use of AI in your work? What is your attitude towards AI?