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The Circus Arts in the Era of Artificial Intelligence: A study of the current and future usage of A.I. in Circus Arts

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Master in Studies and Management of Culture,

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SOCIOLOGIA
E POLÍTICAS PÚBLICAS

Department of History

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Dedicated to all who have supported me during this busy time.

Acknowledgement

Thank you to everyone who helped me through this time. Either by providing emotional support, or a more technical one. To those who offered to help me in any way they could, even if it was just to answer a survey.

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Resumo

Esta tese explora a interseção das Artes Circenses e da Inteligência Artificial (I.A.), especificamente a I.A. generativa, examinando como é que a I.A. está a ser integrada atualmente no circo e nas artes performativas. A pesquisa tem como objetivo identificar e explorar alguns conceitos, como artes circenses, I.A. e I.A. generativa, as aplicações da I.A. nesses domínios artísticos e abordar as preocupações relacionadas ao seu uso. Utilizando uma metodologia mista de métodos qualitativos e quantitativos, que incluem pesquisa, entrevistas e um inquérito, este estudo descobre alguns usos da I.A. em performances circenses, revelando tanto práticas inovadoras quanto lacunas significativas na literatura existente. Os resultados indicam que, embora a I.A. esteja a ser experimentada em várias áreas, ainda é necessário que sejam feitas análises mais aprofundadas do assunto. Esta pesquisa contribui para a discussão relativamente ao papel da evolução tecnológica nas artes, particularmente no contexto específico das artes circenses.

Palavras-chave: circo: inteligência artificial; artes performativas; integração; evolução tecnológica

Abstract

This thesis explores the intersection of circus arts and artificial intelligence (A.I.), specifically Generative A.I., examining how AI is currently being integrated into the circus and performing arts. The research aims to identify some key concepts, such as circus arts, A.I. and generative A.I., the applications of A.I. in these artistic domains and address concerns related to its use. Employing a mixed methodology of qualitative and quantitative methodology, that includes research, interviews and a survey, this study discovers some uses of A.I. in circus performances, revealing both innovative practices and significant gaps in existing literature. Findings indicate that while A.I. is being experimented with in various capacities, we are still missing in-depth analysis of the subject. This research contributes to the dialogue surrounding the evolving role of technology in the arts, particularly in the unique context of circus performance.

Keywords: circus; artificial intelligence; performing arts; integration; technological evolution

Contents

1. Introduction

November 2022, the world watches a revolution in technology. An evolution that filled the hearts of many with apprehension, but it mostly brought new opportunities. It was named *ChatGPT*.
This technology is an extraordinary advancement for Artificial Intelligence (A.I.). Although A.I. has existed since 50's, it became the protagonist of many headlines.
This was generative A.I. becoming easily accessible to everyone. Similarly to the World Wide Web, there is an adjustment that needs to happen in the world.
But, as it happens with every novelty, not everyone sees this new technology positively. Artists are amongst those who are worried, as they fear that A.I. could eventually replace them and their creativity.

There are many subjects in the arts and amongst them we can find the Circus Arts. These are a type of performative art, one that demands not only creativity, but also physical preparation to ensure the safety of the artists.
Art and technology don't always go hand in hand, yet, as a student of one and a professional of the other, I'm always searching for ways to create a bridge between them.

As a former Circus Arts learner and a Cybersecurity worker with a curiosity in A.I., there really was only one theme that I could've picked for this thesis: "The Circus Arts in the era of Artificial Intelligence".
This was my main motivation, curiosity on this subject. On the other hand, the further I looked into the way people are seeing and discussing A.I., especially when it comes to arts, I wanted to show how this technology can be used to facilitate, accelerate and help in creating shows even more impressive than they can already be, rather than looking at this tool as a human substitute.

Taking into context all the controversies on this subject, I formulated several questions that I must search an answer to: "How has A.I. evolved since *ChatGPT*?"; "What are the exact details on the controversy surrounding A.I.? And why are the artists the ones that seem to be the most concerned?"; "How has technology helped the Circus Arts evolve?".
But the main question, and which all the previous ones will provide support in answering, is: "How can A.I. be used to support the Circus Arts, considering the current state of this technology?"

These questions helped me plan and strategize on how to write this thesis.

I started by searching for articles, books and studies that would relate A.I. with Circus, but to my dismay, I could not find such subject. I found regarding A.I., some even correlated A.I. and art, and regarding Circus Arts, but none as specific as originally intended.
Instead of feeling disheartened, I saw it as an opportunity to study and research materials regarding similar contexts, and regarding the two separate subjects, and then formulate plausible scenarios, based on evidence on the A.I. capabilities and how it has been used in other arts.

To build this thesis I have used a mixed-method research methodology, with a focus on a qualitative rather than a quantitative method, due to the subject chosen, where a more numerical base would not provide the needed information.
I have researched articles, news and reliable websites, since this theme is regarding such a recent technology. Most of the sources ended up being online articles, due to the lack of research on such a specific usage of Artificial Intelligence, and due to how recent it is. Most books that I managed to find were not available, neither in the libraries, nor on online libraries.
I have also done a survey, to understand people's opinion on artificial intelligence being used in performances. This is the only quantitative method applied to write the thesis.
The survey was sent online, via social media, also by asking to direct colleagues and friends to participate and share it. It gathered 53 answers. The survey was divided into two parts, being that the first was directed at anyone and regarding the usage of A.I. in performing arts in general, while the second part was directed at people with experience in either performing arts or information technology and had more direct questions for A.I. usage on Circus Arts.
Lastly, I have conducted three interviews. The interviewees had different backgrounds, being that two of them are professors at ISCTE, both in the A.I. area; and the other interviewee owns a circus company. The two professors, although with a similar background, had one major difference, one of them also dabbles in art in his free time (and has some projects inside ISCTE), while the other enjoys art, but does not practice any form of it.
These interviews were intended to gather their professional opinion on A.I. being used in art, performing arts and mostly circus. Attempting to understand if they have knowledge of A.I. already used in these areas, if they believe that people can be substituted, to how they think the future will be.
With this dissertation I want to show how the Circus has always been very keen on adapting to new technologies and how A.I. can be used as a tool. I also wish to study what exactly is already being done in the arts and especially in Performing Arts and see if they can be transposed to the Circus Arts, that is if they are not already in use in it. There's also interest on my side in knowing how exactly people see and think about the usage of A.I., and if they know that it is already being used in Performing Arts.

And lastly, understanding what professionals with different expertise and background see the emergence of A.I. in performing arts and how they feel about it.

The dissertation starts by defining a couple of important terms, such as “Circus Arts” and “Artificial Intelligence”, followed by how A.I. and arts related, with a special focus in the Performing Arts. The final chapter will discuss the main topic, A.I. in Circus Arts; where it finishes with the results from the survey and the interviews.

Without further ado, I hope this thesis helps us better understand how A.I. can be beneficial for the Circus Arts.

2. Definitions and Concepts

In this chapter we will have some important definitions to understand what is being discussed in the rest of the thesis. We start by defining Circus Arts and Artificial Intelligence; followed by understanding the different types of A.I. and finishing in Generative Artificial Intelligence.

2.1. A Defining Circus Arts

To understand what the Circus Arts are, we must understand its history, as it explains how they have started and later evolved into what exists today.

The Circus Arts as we know them are a concept created by Philip Astley in 1768. This year is considered as the birth of the modern circus. This is a fact agreed by Anna-Sophie Jürgens in *Circus, Science and Technology* (Jürgens, 2020), Dominique Jando in *Short History of the Circus* (Jando, n.d.) and Jocelyn Wensjoe in *The Evolution of the Circus* (Wensjoe, 2019). However there is some discussion if this is the actual year of circus creation as "(...) it is said that this form of entertainment has been around since ancient Roman times." (Wensjoe, 2019)

Philip Astley was "(...) a former cavalry Sergeant-Major turned showman." (Jando, n.d.), and in 1768, in England, he opened a riding school, becoming a showman due to his tricks on top of the horses. Astley's school and place of performance was a circular arena, which "(...) he called a *circle*, or *circus*, and which later would be known as the ring." (Jando, n.d.). Astley ended up combining his tricks with various performances, such as "(...) clowns, rope dancers, and jugglers." (Wensjoe, 2019). All of these performances can be traced back to other cultures and early and ancient civilizations, like "(...) African civilizations who did acrobatic routines, ancient Chinese juggled, and Greeks practiced rope dancing," (Woensjoe, 2019). All of these together made the Astley's circus performance.

The concept of circus, was a success and in 1771 Astley was invited to go to Paris, to perform in the Fontainebleau palace, for King Louis XV. Having had success and returning several times, in 1782 "Astley opened Paris's first circus, the Amphithéâtre Anglois (...)" (Jando, n.d.)

It seems that the concept of circus at the time had mostly to do with a circular arena and had mostly people performing horse tricks. However, this concept changed when the circus arrived to the United States, as "(...) it imitated everything the circus' in England consisted of, but new performances were added." (Woensjoe, 2019). The United States was still "(...) a new, developing country with few cities large enough to sustain long-term resident circuses." (Jando, n.d.). The first to introduce the circus as a family entertainment activity was Victor Pepin, and later "(..) other showmen showcased a different approach, they started to use other trained exotic animals besides horses to entertain a big crowd of spectators (...)" (Woensjoe, 2019). In 1825 Joshua Purdy Brown, a circus entrepreneur, changed the

wooden construction used until then to a canvas tent. This became the norm in mid 1830's. All these changes and additions to the circus created the American circus: "It was a traveling tent-show coupled with a menagerie and run by businessmen, a very different model from that of European circuses, which for the most part remained under the control of performing families." (Jando, n.d.).

In 1871 Phineas Taylor Barnum, together with William Cameron, started the *P.T. Barnum's Museum, Menagerie & Circus,* a traveling show, where there was an exhibition of animals and "human oddities" (Jando, n.d.). Later in 1881, P.T. Barnum and James Anthony Bailey entered in a partnership to create Barnum & Bailey *Greatest Show on Earth*. "Barnum and Bailey presented several different performances, they had a bit of everything from acrobats to clowns, trained elephants, seals, and elephants, but most importantly they introduced a freak show!" (Woensjoe, 2019).

Many of the circus companies that appeared at this time went on international tours, since the circus "(...) is essentially a visual performing art and therefore unfettered by language barriers." (Jando, n.d.). Which is another definition of it. Previously it was mainly a show with tricks on a horse, together with some other performances. Meanwhile in the United States, exotic animals and people with "(...) natural deformities or talent (...)" (Woensjoe, 2019) were added, all the while travelling around with these shows, due to being a visual performing art. The success of American circus owners inspired showmen in Europe and started copying this type of circus.

"Sales decreased dramatically once reaching the 20th century due to an increase in animal rights awareness, this was the reason why Barnum and Bailey closed their business in 2017 after having had a long run in the circus industry." (Woensjoe, 2019). The 20th century brought not only a change regarding animals' rights, but in 1919 the Soviet circus was nationalized by Lenin, leading to many performing artists (who were of Western Europe origin) to flee the country. In "(...) 1927, the State *College for Circus and Variety Arts*, better known as the *Moscow Circus School.*" (Jando, n.d.) was established by the Soviet government, in order to train performers of Russian origin. This school "(...) developed training methods modeled after sport-gymnastics, created original presentations with the help of directors and choreographers, and even originated innovative techniques and apparatuses that led to the invention of entirely new kinds of acts." (Jando, n.d.). In the 1950's these performers from the school started showing in the West, and there were visible differences between these artists that had trained in the school and the ones that were trained by the traditional circus families. These traditional circus families attempted to compete, but "(...) they did using the only weapons at their disposal: time-tested traditional acts. But resistance to change had transformed tradition into routine." (Jando, n.d.). This led to a few producers to attempt to change their circus acts by the end of the 20th century, "(...) by modernizing staging, lighting, musical accompaniment (...)" (Jando, n.d.).

In the 1960's a new concept for circus was taking shape in Europe. In the 1970's a circus named *Pickle Family Circus* inspired the *Cirque du Soleil*. The *Pickle Family Circus* did not use animals in their shows

and the "(...) circus act comprised of different stories similar to that of a play but with special effects and acrobatic acts." (Woenjoe, 2019). In 1984 *Cirque du Soleil* appeared in Canada, using "(...) special effects such as light and sound, prompts, colorful and unique costumes different in every show (...)" (Woensjoe, 2019).

In general, the *Contemporary Circus* appears around this time. It does not include animals, the performances have some sort of story, like a play, together with the performer's acts and have use of special effects to aid in the ambience of the show.

This is a very resumed story of the circus, but enlightens the way the concept of circus evolved. However, it appears that the idea of having people performing incredible acts was kept throughout the years. Nowadays the circus includes the idea of a story/play and special effects to add to the show.

2.2. What is Artificial Intelligence (A.I.)

According to Selmer Bringsjord and Naveen Sundar Govindarajulu, in the Stanford Encyclopedia of Philosophy, it is not easy to define Artificial Intelligence, and find it quite complex, similar to when it was needed to define any other discipline (Bringsjord and Govindarajulu, 2018).

However, Artificial Intelligence, mostly known by its initials A.I., refers, according to B.J. Copeland in the Encyclopædia Brittanica, to the ability of computers or robots to perform tasks that are usually linked to sentient, rational beings. The intent of A.I. development is to create programs and systems that exhibit human-like intellectual processes, such as reasoning, understanding, and learning from experience.

International Business Machines Corporation (IBM), a technological multinational, also shares a definition for Artificial Intelligence. The corporation defines it as a technology that allows for computers and machines to perform tasks realted with human abilities, such as "learning, comprehension, problem solving, decision making, creativity and autonomy." (Stryker and Kavlakoglu, 2024).

Artificial Intelligence is not new, it recently became more popular with the appearance of *ChatGPT*, which is based on Generative A.I., a specific type of A.I. In general, it is considered that Artificial Intelligence appeared in the 1950's. Either with Alan Turing's article *Computing Machinery and Intelligence*, published in *Mind*. In this article, Turing proposed a game, which nowadays is called *Turing test*. This game would be one of imitation and deemed a machine as intelligent it could engage in a blind conversation without being distinguishable from a human.

However, the term “artificial intelligence” was first published in 1955, by John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon, in *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence*. And in 1956, John McCarthy, coined the term “artificial intelligence” at the first A.I. conference at Dartmouth College. In the same year, the first computer program, run by A.I. was developed by Allen Newell, J.C. Shaw and Herbert Simon.

Throughout the years many breakthroughs have happened to make A.I. what it is today. Some relevant dates are:

- 1967:The first computer based in a neural network that was able to get more accurate through trial and error, built by Frank Rosenblatt;
- 1980: Neural networks becoming a popular use for A.I. applications;
- 2004: John McCarthy writes an article, *What is Artificial Intelligence*, where he suggests a definition for A.I. Around this time big data and cloud computing are being more developed, which would allow for the evolution of A.I.
- 2015: a supercomputer built by Baidu, a Chinese search company, was able to identify and analyse images more precisely than the average person.
- 2022: there is an increase of large language models (LLMs), like *ChatGPT*. These new deep learning models are now pretrained in huge amounts of data.

As with any tool, there are benefits and possible risks associated with it and Artificial intelligence is not an exception. IBM lists quite succinctly the benefits, as such:

- “Automation of repetitive tasks.
- More and faster insight from data.
- Enhanced decision-making.
- Fewer human errors.
- 24x7 availability.
- Reduced physical risks.” (Stryker and Kavlakoglu, 2024)

They later define these benefits a bit further and why they are considered as positive points for the usage of A.I. They indicate how automating reduces these types of tasks and allows for people to focus on more creative work. A.I. can provide faster data-drive insights and can reduce human mistakes via guided processes and automation. A.I. systems also operate continuously without downtime. Finally, by automating dangerous tasks, it is able to improve safety for workers.

Concerning the risks, IBM indicates a few and explains each one of them:

- The data risks come from the data that AI systems depend on, and how this data can be vulnerable to issues such as data poisoning, tampering, bias or cyberattacks. Organizations that wish to use A.I. much ensure data integrity and should implement security measures from development to deployment, meaning the whole A.I, lifecycle.
- The A.I. models can also present risks, such as being targeted from theft, reverse engineering or unauthorized manipulation. The model can have its integrity compromised by attackers tampering with its architecture or parameters, which would affect behaviour and performance.
- Operational risks and challenges may also occur with A.I. models, such as deterioration of the model or governance breakdowns. These issues can lead to system failures and cybersecurity vulnerabilities.

Lastly, IBM mentions ethics and legal risks, which can result in privacy risks and biased outcomes when safety and ethics in the development are neglected. An example is biased training data used for hiring can perpetuate stereotypes and favouring certain demographics.

One risk not presented by IBM but mentioned by many is job displacement, as with automation, many tasks now done by people, will become obsolete.

2.3. Different types of A.I.

Artificial Intelligence, like any other discipline, can be divided into different subsets, or types. Different technological companies divide differently. IBM only indicates two different types of A.I.: Weak A.I. (or Narrow A.I.) and Strong A.I. (or Artificial General Intelligence – AGI). However, Microsoft divides it in three: Narrow A.I, AGI and Artificial Super Intelligence (ASI). Both have a similar definition for the two types of A.I. they share (Narrow A.I. and AGI).

Narrow A.I. refers to systems built for specific tasks. The system excels at this very narrowly defined task, but operated within predetermined frameworks, this lacking conscious or emotional understanding. In general, it represents the current state of A.I. development. Some examples of this A.I. are like voice assistants, chatbots and autonomous vehicles.

Artificial General Intelligence, also known as as AGI is for now just a theoretical type of A.I. Since it is stated to possess the ability to understand, learn and apply knowledge across several tasks at a level equal to or surpassing human intelligence. In theory it would be capable of complex problem-solving, judgement, creativity and independent thought. It approaches the way robots are portrayed in science

fiction. As mentioned before, this is only in theory as there are no A.I. systems that reach this level of sophistication, and there is still need for further computing power advancement.
Finally, Microsoft defines ASI as a computer system that would outperform humans in every field, including social skills. If AGI is still far from being reached, ASI is even further. (Microsoft, n.d.)

2.4. Generative A.I.

Generative A.I. has been discussed more since the appearance of *ChatGPT* in 2022, making A.I. available to the general public and bringing innovation to this field.
IBM defines generative A.I. as "artificial intelligence (AI), that can create original content (...) in response to a user's prompt or request." (Stryker and Scapicchio, 2024). It further indicates that this type of artificial intelligence uses deep learning, a type of machine learning that simulates how the human brain learns and makes decisions. Deep learning identifies and encodes patterns and connections in big amounts of data and then uses the information found to understand and answer the user's request.

This technology appears to be appellative to businesses, since according to the management consulting firm McKinsey, 65% of the respondents to its 2024 survey regularly use generative A.I. These businesses report that they have seen a cost decrease and higher revenue from the departments that use it.

IBM also describes how Generative A.I. works, and divides it into three stages: training, tuning and generation, evaluation and returning.
The multinational indicates that the training stage uses foundation model (a type of deep learning model), and the most used are LLMs. These models then serve as a core to generate text, image, video or audio. To create these foundation models, the algorithms of deep learning are trained on huge amounts of "raw, unstructured, unlabelled data" (Stryker and Scapicchio, 2024) coming from a source, in many cases, the source is just the internet. During this phase, the algorithms learn to guess the next part of a sequence (for example, the next word in a given sentence, or the next element in a given image), by continuously adjusting the prediction in order to diminish errors. This creates a neural network that can generate content in response to prompts. This type of training demands a lot of computing power, usually needing thousands of GPUs (graphics processing units) and weeks to finish, thus costing a lot (amounts in the millions).

After training, there is finetuning. There is a need for tuning because foundation models have a lot of knowledge, but can have difficulties generating, in an accurate way, specific types of content, adapted for a given domain.

IBM mentions that these models need to be tuned towards the specific task, like for example, if the intention is to create a chatbot for customer service, the developers would compile hundreds or thousands of documents containing customer service questions and answers, and then these documents would be put into the model for training.

To make sure they achieve the desired end-result, the models can be tuned in different ways.

The multinational mentions 2 specific types of tuning: fine tuning and Reinforcement learning with human feedback (RLHF).

For fine tuning the model is trained on labelled data, specific for the task required, such as the example given above. This is a laborious method, and it is quite common for the development team to need to outsource the data labelling process.

For RLFH, users evaluate the generated content providing feedback, that will help the model to adjust its accuracy and the pertinence of what it generated. One way this can happen is having people scoring different outputs. Another could be having users correct a chatbot or virtual assistance while interacting with it.

The final stage, generation, evaluation and returning, would appear to be a stage that will happen regularly and constantly. Developers and user will continue to evaluate the applications using generative A.I., sometimes weekly, thus tuning it for better accuracy. On the other hand, the foundation model is only updated every 12 to 18 months.

Another way to improve the generative AI app's performance is through retrieval augmented generation (RAG). This is an approach allows the foundation model access to more information, outside of its training data, thus allowing it to stay up to date. RAG brings more transparency to its sources, as it allows users clear access to the information, unlike the foundation model.

3. Artificial Intelligence and Arts

In this chapter we will start relating A.I. and Arts, as the title suggests. We start by seeing in general the usage of Artificial Intelligence in Arts, followed by the specific examples and cases for Performing Arts. We will also discuss what are the concerns that artists have regarding A.I. and we finish the chapter by a small look into the regulations proposed and applied by the European Union regarding artificial intelligence.

3.1. A.I. usage in Arts

A.I. is being used in Arts in general. In this chapter we will discuss what is happening for non-Performing Arts.

One of the most mentioned tools is *DALL-E,* created by *OpenAI*, the owners and creators of *ChatGPT*. *DALL-E* is a generative A.I. tool, but it generates images after receiving text prompts. *OpenAI* explains a bit about what is *DALL-E* is and how it works. They say that it "(...) is a 12-billion parameter version of GPT-3(opens in a new window) trained to generate images from text descriptions, using a dataset of text–image pairs." (OpenAI, 2021). Followed by an overview of how it works, "Like GPT-3, DALL·E is a transformer language model. It receives both the text and the image as a single stream of data containing up to 1280 tokens, and is trained using maximum likelihood to generate all of the tokens, one after another." (OpenAI, 2021).

Claudia Baxter wrote an article for BBC, named *AI art: The end of creativity or the start of a new movement?* (Baxter, 2024) in which she wonders if the existence of A.I. art signifies the end of human art; or if it means a shift in the perception of art. Baxter starts by giving the example of *Ai-Da*, "(...)the world's first humanoid robot artist," (Baxter, 2024). *Ai-Da* can draw, do performance art and collaborative paintings and sculptures, according to the website dedicated to this robot (Dedicated Art Ltd, 2019). Still according to *Dedicated Art Ltd*, *Ai-Da*'s work should be considered as art. Nowadays humanity has a humanism mind-set, "(...) where art is an entirely human affair, stemming from human agency." (Dedicated Art Ltd, 2019). But current thinking seems to believe that society is stepping away from the humanistic type of thinking and approaching a time where technology (machines and algorithms) influences people's decisions and behaviors more.

Baxter then wonders if robots like *Ai-Da* will end with human artistry, or if it will in fact be a way to enhance it. To answer this question she talked with Alice Helliwell, a philosopher from Northeastern University London, who questions back that if Marcel Duchamps' urinal and Tracey Emin's bed as art, why wouldn't generative algorithms also be considered as such. "Historically, the way we understand the definition of art has shifted. It is hard to see why a urinal can be art, but art made by a generative

algorithm could not be." (Helliwell, n.d. in Baxter, 2024). Baxter then suggests that A.I. is not going to end human creativity and art, but rather help to change it "(...) and move us towards totally different ways of seeing and creating," (Baxter,2019). The author also adds that there have been technological advances that created some discussion, debate and "(...) as the antithesis of an artist," (Baxter, 2019), and one of such was the invention of photography in the 1800's. As the author mentions, photography did not substitute painting but ended up being the impetus for experimental modern art of the beginning of the 20th century. Baxter then questions who should be credited for these A.I. art pieces, especially considering the plagiarism concerns voices by artists and even questions if this could really be considered as art.

The author mentions that the answer might be the intent, according to Marcus du Sautoy, a mathematician at the University of Oxford and author of *The Creativity Code: Art and Innovation in the Age of AI,* this is "what truly distinguishes the creativity of the human and the machine" (du Sautoy, n.d. in Baxter, 2019). Machines are prompted by the intention of a person in order to create, and therefore there is no intent from the machine to create. However, this definition goes against Helliwell's idea that a generative algorithm could create art.

The author concludes that "Art, goes the idiom, is in the eye of the beholder." (Baxter, 2019), and adds how some animals seem to present artistic behaviours, and although they might not have an intent to create, they have an intent to either attract a mate or ward off competitors, for example.

We are seeing A.I. being able to create paintings and other art forms, but there is still much discussion on whether or not to consider it as art, and if so, who would be the owner of said piece; and even more regarding copyright and plagiarism due to how these tools are trained.

3.2. Performing Arts and A.I.

Like in other types of art, A.I. is also being used in Performing Arts. In this chapter we will focus on some cases where this is happening.

Baptiste Caramiaux and Marco Donnarumma, in 2020, in Artificial Intelligence in Music and Performance: A Subjective Art-Research Inquiry, introduce what was a 5 year long research. They mention Machine Learning and Artificial Intelligence, being that the first was used in their first experience, named Corpus Nil, and the second in Humane Methods. Corpus Nil was an attempt to "design improvised and markedly physical music performance, exploring the relation between computation and corporality." (Caramiaux et al, p.2, 2020); while the second "to utilize and reflect on AI as an actor in a performance, an entity whose functioning can be used to question the understanding of computational intelligence in Western society." (Caramiaux et al, p.2, 2020).

Corpus Nil was a 20 minute dance and music performance. It included a dance that had attached two types of biosensors. One was a chip microphone that would capture the sounds from the muscles and the internal organs; whilst the other were electrodes that would capture muscle voltage. These sensors transmitted information to a Machine Learning software, developed by the researchers.

Later the software analysed the data provided and would emit sounds, creating music, that would change depending on the movements done by the performer. These movements would be mostly slow, as to make sure they would be captured and analysed by the software.

In Humane Methods, a dance-theatre production, nine people performed a "ritual of a prayer in a loop" (Caramiaux et al, p.13, 2020). Each loop had some sort of variation, either minuscule or a more substantial one. Meanwhile, an algorithm of deep reinforcement learning attempted to reach a sequence of 10 digits. This A.I. algorithm was linked to an audiovisual system, meaning that while it would be calculating the sequence, there would be variation in sounds and light.

The authors mention that they used Machine Learning in the first project, since the software developed had a "low-capacity movement recognition" (Caramiaux et al, p.20, 2020), and the algorithm it used, did not show a distinctive behaviour. However, for the second project, the algorithm used was very different and the intent was not to assess the ability to reach a certain objective, but rather to assess the computational behaviour that drove the learning mechanism, which led for the authors to feel that Machine Learning was a too constraining and lacking definition.

The usage of A.I. in performing arts appears to be rising, since there have been more news articles on it from the past two years.

One such case is mentioned by Lauren Wingenroth, who writes in *Dance Magazine*, a magazine where the main subject is dance, and in one of her articles, *How are Dance Artists Usaing AI – and What could the Technology Mean for the Industry?*, indicates how artists of this area are using this technology.

The author starts by giving the possible uses that A.I. can have in dance, according to *Chat GPT*. The tool indicated using A.I. to brainstorm, help planning rehearsals, a tool that generates new movements or document work. However, according to the author, *Chat GPT* also stated how it should not substitute “(...) the artistic intuition and expertise that come from years of training and experience.” (OpenAI, n.d. as cited in Wingenroth, 2023). According to Lauren Wingenroth this is a way of the tool to acknowledge the concerns that are rising among the dance artists, especially since “These technologies are further complicating the dance world’s already-broken relationships to copyright, crediting, compensation, and consent. And yes, they could potentially remove artists from the dancemaking process.” (Wingenroth, 2023)

Nevertheless, dance artists are curious and interested about A.I. and ways of using it. Some are trying it as a “choreographic tool, a topic to probe onstage, or an entryway into the broader intersection of

dance and technology." (Wingenroth, 2023). But this curiosity and interest go both ways, as A.I. data companies want to use dancers to gather movement data. This could lead to new opportunities for dancers, or a "movement-data-harvesting free-for-all." (Wingenroth, 2023).

Sydney Skybetter, a choreographer and founder of the Conference for Research on Choreographic Interfaces shows interest in the use of A.I. tools, as he believes they can "(...)generate creative outputs that couldn't be imagined years ago" (Skybetter, n.d. as cited in Wingenroth, 2023). However he also shows concern for the way these tools can use the data withdrawn from the body.

Several chroreographers have partnered with A.I. tools. One of these choreographers was Catie Cuan, who is also a roboticist. Cuan danced with an A.I. robot, her experience was what could be described as transformative: "it felt as though I had exported a part of myself into this agent, and then I could experience it back and move alongside it, which felt as though I had collapsed space and time, and could externalize my physical being and then re-engage with it." (Cuan, n.d. as cited in Wingenroth, 2023).

Valencia James and Pontus Lindberg have also reported similar feelings in their experiences.

James has a project, *AI_am*, since 2013, which aims to create a duet between an AI and a dancer. The duet is improvised, and uses an avatar projected on stage. This avatar, powered by machine learning techniques in the context of dance, would learn and evolve from the movements done by the dancer; and would then add its own variations. Throughout the show, the lines between the roles of the A.I. and the dancer blur, and the dancer ends up getting inspired by the A.I.'s movements. Valencia explains how the A.I. did not get any real-world physics, allowing it to "(...)do movements that would not be humanly possible, but I found that was really inspiring and generative to explore what it means to move in the style of impossibility." (James, n.d. in Wingenroth, 2023).

Lidberg, in a series of short films named *Centaur* in 2020 for the *Danish Dance Theatre*, also explored the use of an A.I. avatar. This avatar gave instructions, that changed between each performance, to dancers that were onstage. Lidberg related that the algorithms were able to create intricate arrangements, in unpredictable ways.

Other dance artists decided to create pieces about A.I. rather than with A.I. Two of these artists are Katherine Longstreth and Daniel Gwirtzman.

Longstreth has a more negative idea of this technology, and in her work in progress *the last dance picture show*, she argues with an A.I. (which is in fact a scripted voiceover) regarding originality and creativity. She is mostly interested in showing how A.I. does in fact copy artists' work, rather than only using it for training. She believes that "Your training defines who you are – I believe that to be true for humans and for these machines. It's baloney to day that they can train on your artwork, and yet not have your artwork show up in their creative output." (Longstreth, n.d. in Wingenroth, 2023).

Gwirtzman, on the other hand, in his collaboration with Saviana Stanescu, a playwright, incorporates A.I., figuratively. This piece, named *e-Motion*, was inspired by *ChatGPT*, more specifically by conversations with it. Gwirtzman has a less negative idea on A.I. as "(...) he can't envision artificial intelligence independently authoring true choreography." (Wingenroth, 2023).

Lauren Wingenroth ends the article with a look into the future. She states that most probably there will always be a need of "human artistic labor involved at the intersection of AI and dance (...)" (Wingenroth, 2023). She also adds that Cuan hopes that the rise of AI in the dance will create new opportunities for choreographers, instead of substituting them. Wingenroth ends with a note that dance artists should be called upon as collaborators; which also means that these artists must understand that they much to offer to this technology.

Still in the dance area, in 2022 a team of researchers from Stanford University introduced an A.I. tool to generate dance moves. The team composed by Jonathan Tseng, Rodrigo Castellon and C. Karen Liu proposed a method for dance generation, named *Editable Dance GEnerator*, also known as *EDGE*. *EDGE* "(...) creates realistic, physically-plausible dance motions based on input music(...)" (Tseng et al., 2022, p.1).

The authors mention how there were similar tools previously built, but there were specific issues with them, namely how they "(...) tend to create unrealistic choreographies that lack the complexity of human dances." or, when they are able to create more complex choreographies "Despite achieving impressive performance, many such systems are complex (...) often involving many layers of conditioning and sub-networks.". The researchers indicate how they were able to create a simple model with a simple objective, but that is able to generate more complex choreographies, and also has editing abilities. (Tseng et al., 2022, p.2).

For film and music, Tarun Krishnan gives a general overview of several generative A.I. applications being used in both of these performing arts, in his article for *Medium*, called *How Generative AI is Revolutionising Film and Music*. Krishnan starts by presenting three cases where Generative A.I. was used in film, followed by four examples in music and finishes his overview with case of Pop Stars and Virtual Musicians and for Film Scoring and Sound Design.

For film, the author mentions how Generative A.I. was used for the visual effects (VFX) of the underwater sequences of James Cameron's *Avatar: The Way of Water* (2022). The author mentions how "(...)generative AI was used to simulate realistic environments and characters' fluid movements." The author adds how the A.I. was trained on marine life and real-life water physics, which generated more lifelike and realistic scenes underwater, instead of having animators manually do it to every detail. The whole process ended up taking much less time, and much more complexity to the scenes. Similarly, *The Mandalorian* (2023), used generative adversial networks to produce landscapes and backgrounds. The GANs were trained on "(...)photorealistic visuals that blend seamlessly with live-

action footage." . This system created realistic environments, while also cutting costs. Finally, the author mentions two A.I. tools that help with storyboard, *StoryboardHero AI* and *StoryboardThat.* The filmmakers "(...) input text-based scripts, which the AI interprets to generate visual storyboards." The A.I. is trained on datasets of films and scenes, and then it can "(...) create visuals for each part of the script,". These tools allow for a rapid and effective way for directors to conceptualize their ideas and story. (Krishnan, 2024)

For music, Krishnan, presents three different tools: *Holly+*, *Jukebox* and *Endlesss.* And lastly the author mentions the case of music videos generated bu A.I. *Holly+* was introduced in 2022 by Holly Herndon, an experimental musician. The tool is able to generate vocal in Herndon's style, after having melodies or lyrics input into it. "This project opened up collaborative possibilities between AI and musicians, allowing other creators to experiment with her AI-generated voice.". Regarding *Jukebox*, this is a generative A.I. model by OpenAI, and it is able to generate "(...) complete songs in various musical genres and styles.". The model is trained on a multitude of songs, allowing for several artists to use it, in 2023, in several projects and experiments, where the tool was able to copy the style of several musicians. The last tool presented by the author is *Endlesss*, a generative A.I. of beats, melodies and loops, but in real-time. The "(...) musicians can then manipulate or combine with their own input.". According to the author this helps musicians with experimenting with sounds and music styles to which they do not have time to create, or when they need support to surpass a creative block. Finally, Krishnan mentions that in 2022 a festival named *Piknic Electronik*, used A.I. tools, such as *Runaway*, to generate music videos. These music videos used GANs that had been "(...) trained to transform sound waves into dynamic and visually engaging digital art that matched the electronic music played at the festival." This allowed to show how A.I. was not only able to generate music, but also could synchronize it with visual elements. (Krishnan, 2024)

Regarding A.I. generated Pop-Stars and Virtual Musicians, the author introduces *FN Meka* and *Aiva*. *FN Meka* is a virtual pop start that was generated via A.I. This is a digital persona, where everything from music to social media posts are A.I. generated. The creators are also able to use feedback and preferences from their audience to adapt the music that is being generated. Regarding *Aiva,* the author says that *"Aiva* (Artificial Intelligence Virtual Artist) is a generative AI that specialises in composing classical music.". The tool was trained on classical music, and is then able to generate music of this style that resembles what is already known, and yet is still new. "In 2022, *Aiva* was used to co-create albums with human artists by generating classical compositions based on specific emotional themes." (Krishnan, 2024)

Finally, in 2022 *Amper Music* was used in the film *The Batman* (2022). It was used to create parts of the soundtrack, where the tool was "(...) used to generate musical compositions that blended dark,

orchestral tones with eerie, electronic sounds.”. This allowed for a faster composition process and "(...) enabled composers to try more variations than traditional workflows would allow.” (Krishnan, 2024)

3.3. Artists concerns regarding A.I. usage for art

There are many concerns to when it comes to using A.I. in art. With many artists renouncing this technology and denouncing it.

In September 2022 there was a controversy in Colorado State Fair’s annual fine art competition, with a piece built with A.I. being the winner of the competition. The Colorado State Fair’s annual fine art competition happens yearly and gives prizes to several categories, such as painting, quilting and sculpture. In 2022, there was a contest for emerging digital artists. That contest was won by Jason M. Allen, who entered a piece done using Midjourney, that *The New York Times* defines as “an artificial intelligence program that turns lines of text into hyper-realistic graphics”. (Roose, 2022)

The work, named Théâthre D’opéra Spatial, was submitted with the author’s name and “via Midjourney”, indicating the means used to create the piece.

Image 1 - Théâthre D'opéra Spatial by Jason M. Allen via Midjourney. Picture taken from U.S. Copyright Office Review Board, from a decision of 5th September 2023 in https://www.copyright.gov/rulings-filings/review-board/docs/Theatre-Dopera-Spatial.pdf

Once the author found out he won, he posted it in a Discord server chat, to which he had been invited earlier in the year to test Midjourney. After this, the photo of the piece and how it had been made, reached the social media Twitter, now named X, and raised negative reactions from many users.
However, many artists came to support Jason M. Allen, indicating that using A.I. tools to construct a piece is similar to using Photoshop or any similarly digital image altering tool; and that like those tools, there was creativity on the prompt provided by the author.
*The New York Time*s article also indicates that controversy due to technologies that make art always existed, and as an example, the invention of the camera, caused debate amongst painters, with many seeing it as a corruption of art. When editing tools and design programs appeared in the 20th century, these were set aside by "purists for requiring too little skill" (Roose, 2022) or people.
Some critics think that these new A.I. tools are different due to how they work. DALL-E 2 and Midjourney, two apps that generate images based on users' prompts, were built based on images available online, then the algorithms were taught to understand patterns and connections in the images; then the tool generates a new image in the same style. Which means that images that have been uploaded by artists, are being used to train the algorithm of these tools, which can be seen as competitors.
Some people are concerned with the ethics of these tools, such as RJ Palmer, a digital artist, and Andy Bayo, a technologist and writer, due to these tools being trained on real artists' works.
Jason M. Allen showed empathy towards the artists but stated that he thinks the artists should get over their opposition to these A.I. tools, since they will continue to evolve, and that the anger should be directed at companies who decide to fire their artists, and not at people who decide to use the tools.

The Institute of Electrical and Electonics Engineers (IEEE) Computer Society (CS) is a not-for-profit organization that allows for debate and publications. In one such publication, written by Sam O'brien, it is possible to read regarding the concerns of artists on A.I. In *AIArt: Why Some Artists Are Furious About AI-Produced Art*, several points are made on A.I. Art Generators, namely on the data collection and human work.
On the first topic, the author states that there are many concerns on copyright; since the tool creates pieces that are not exactly the same as the ones made by artists, since the tool uses the data available online, and then mixes what it found to create a new piece. But the creations done by A.I. are very similar to the artists ones, yet not equal and by a very reduced price, thus leading the artists with no way of defending themselves, as this does not fit in the copyright laws, and there is no protection for the artists in this case.

Continuing on the topic of data collection, O'brien also states how the artists did not give consent for their work to be used to train these A.I. generators. As the author compares, unlike someone studying a famous painter and trying to create unique work based on that painter's style, this would be equivalent to a person tracing over a famous painting and then claiming it as their own work. In the end, for both cases, there was no consent from the artists that have their work available online, to be used in this manner.

And lastly, there is a general feeling of lack of respect for the work done by artists. In general, they feel that their pieces, in which they spent time and energy, are being butchered and then put back together by anyone that uses an A.I. Art Generator. O'brien also provides an analogy to this case, comparing it to a software developer that made an app, which was bought by a client who later changed its name and some code lines. The client then does not give the right acknowledgement to the original creator, since they decided this was their own creation due to the code changes. However, unlike this software developer, that was paid for the first transaction, many artists post their work online for free.

When it comes to the topic of human work, the author indicates how, in general, A.I. seems to be here to support people, but that is not how it is when it comes to A.I. art. And even though A.I. cannot fully substitute artists, it is already devaluing their work.

The impact can be seen on income, since many artists rely on their work, by selling their pieces or creating commissions. With the usage of free A.I. art generators, these artists are having difficulties maintaining their revenue. And many might not make any type of income at all, since they might not have access to the type of audiences who prefer to buy from an artist, instead of using these free tools.

The creation process that a traditional or digital artist goes through is more laborious, as it already started when they began learning how to create their art, and it takes much more time and energy. An A.I. "artist", usually just writes a prompt in the tool, and then they may or may not edit the result provided by the tool, which takes much less time and costs much less, since there was no need to study and learn for so long as a traditional or digital artist.

Finally, an artist will take a long time and go through a hard process to reach their unique style, which would then have followers who would commission their art for that specific and unique style. With the rise of A.I. art generators, someone would only need to ask for something and require a specific style, since these tools can learn to imitate almost all styles. And these tools are being taught these styles without any type of acknowledgement or compensation to the artist.

4.2. The European Union A.I. Act

The European Union (E.U.) has created the first regulation on Artificial Intelligence usage, adopting it in March 2024, three years after the first proposition (April 2021). This act introduces a set of rules and obligations for users and providers, and every A.I. systems should be evaluated even if most of them have a very minimal risk for people. There will be different timetables when it comes to the enforcement of the regulations, being that it should be fully applied twenty-four months after it started.

This regulation is part of E.U.'s digital strategy. The digital strategy is a set of policies that guarantee individual's rights, while also making sure Europe bolters its competences with the new digital technologies. To support in ensuring the implementation of the E.U. A.I. act, the European A.I. office was established in February 2024, it is, as the name indicates, an A.I. expertise centre, and will also help in the development and use of trustworthy A.I. and support for international cooperation.

This act divides A.I. systems according to three levels of risk for users applying as well different measures and policies accordingly. The three levels of risk are: Unacceptable Risk, High Risk and Transparency Requirements. The Parliament's priorities with the regulation is to make sure that the A.I. being used is "safe, transparent, traceable, non-discriminatory and environmentally friendly" (European Parliament, 2023); there's also an intention to create a uniform definition for Artificial Intelligence. Ultimately the A.I. systems should also be overseen by humans, rather than by other digital systems.

The highest level of risk is the Unacceptable Risk, and it is considered as a threat to people, therefore it will be banned from E.U. countries. These policies will be applied six months after the entry of the A.I. act.

In this level, we will encounter A.I. systems that provide:

- "Cognitive behavioural manipulation of people or specific vulnerable groups: for example, voice-activated toys that encourage dangerous behaviour in children
- Social scoring: classifying people based on behaviour, socio-economic status or personal characteristics
- Biometric identification and categorisation of people
- Real-time and remote biometric identification systems, such as facial recognition" (European Parliament, 2023)

In general, these systems will not be allowed to exist inside the E.U., with some exceptions for law enforcement.

The next level of threat is the High Risk systems. These systems will then be divided into two different categories and are, in general, systems that can affect the safety or basic rights of people. Although the regulation is supposed to be fully applicable in a maximum of 24 months, these systems in specific will have thirty-six months to comply with it.

The first category that enters in this level is regarding A.I. being used in products under the E.U.'s product safety legislation, these can include aviation, cars, medical devices, etc.

The second category is regarding A.I. systems in specific areas, these systems will need to be registered in the E.U.'s database. They are:

- "Management and operation of critical infrastructure
- Education and vocational training
- Employment, worker management and access to self-employment
- Access to and enjoyment of essential private services and public services and benefits
- Law enforcement
- Migration, asylum and border control management
- Assistance in legal interpretation and application of the law." (European Parliament, 2023)

All of these A.I. systems will be evaluated before being launched and also while active, meaning a recurrent evaluation to check if they still meet the standards of safety. In addition to these recurrent assessments, people will be able to make formal complaints to their national authorities.

Finally, the Transparency Requirements, for systems that do not belong neither to the Unacceptable Risk, nor the High Risk tiers. Generative A.I. systems fit into this category and must comply with these rules and also with the E.U. copyright law. The regulation will be fully applicable 12 months after the entry of the A.I. act.

For systems that fit in this level, the requirements are:

"Disclosing that the content was generated by AI" (it should be clearly labeled as such, and it is also applicable for cases where the content was A.I. modified, not only created);

“Designing the model to prevent it from generating illegal content

Publishing summaries of copyrighted data used for training" (European Parliament, 2023)

In cases of "High-impact general-purpose AI models that might pose systemic risk, such as the more advanced AI model GPT-4" (European Parliament, 2023), there will also be intensive assessments on their risks, and any severe case must be reported to the European Commission.

4. Artificial Intelligence in the Circus Arts

In this chapter we will delve into the main subject: A.I. in Circus. Starting by a small historical context regarding circus and technology, followed by a glimpse on Cirque du Soleil. Next, we discuss the possible issues that may come with the usage of this technology in circus and then the possibilities of usage. We finish this chapter with the results and analysis of the survey and the interviews.

4.1 The evolution of the Circus Arts brought by technology

Circus Arts have historically adhered to new technologies and might have inspired some technological and engineering innovations. There are many studies on the issue, as Anna-Sophie Jürgens showed in *Circus, Science and Technology* (Jürgens, 2020), a book which she edited with many studies by different authors regarding this subject. I will focus mostly on the part regarding electricity, since it was one of the biggest technological developments that have affected the circus. However, Jürgens mentions how circus and other technologies might mix, such as movie and animation; however she focus mostly how the circus was and is represented in these mediums, rather than how they affected the circus.

Jürgens starts by indicating how entertainment has always been interlaced with technology, and therefore engineering. "This also applies to the many facets of the circus,". The author provides already some examples in the introduction. For example, in 1884, *Circus Renz* presented in Berlin an "electric lady", at a time where light bulbs were still new to the world. This was in a pantomime named *Harlequin à la Edison, or everything electric*, which included two thousand "(...) differently coloured light bulbs and a sword fight with electric weapons." Or at the beginning of powered aviation in the 20th century, barnstormers, commonly known as "air circus performers", were already doing performances, specifically exhibition flights and aerial stunts, at country shows and fairgrounds. (Jürgens, 2020, p.1-2).

In this era (around 1900) the circus was one of the major cultural entertainments that would travel around the world with huge productions and menageries, together with lots of performers (both human and animal ones). Before the technologies gave way to the cinema industry, the circus that toured internationally were not only showcasing new transportation methods (which by itself is a type of technology), "but also offered exciting new opportunities for experiencing reality through visual turmoil and displays of mobility and speed." (Jürgens, 2020, p.2).

There are many examples and cases of engineering and technology being used in circus, but I will be mentioning and highlight just some cases that seem more pertinent, cases where there was a big change for the art or when it was a greater technological advancement.

One of these cases was the introduction of electrical systems. Before this happened, it was difficult for circus to find systems that were safe as well as affordable and efficient. There are many cases of circus, between 1870s and the early 1900s, having lighting systems be referred to as "(...) 'gassaline', 'kerosene' and 'acetylene'.". (Jürgens, 2020, p.65). However, in 1884 in Australia, there was *Woodyear's Electric Circus*, promoted as such by Jenny Woodyear and her husband. Similarly, in 1887, Gus and Alf St Leon had the *New York Beacon Light*, which was described by the *Ballarat Star*, a newspaper, in 19 January 1887 as "superior to gas" and "nearly equal to the great electric light" (Ballarat Star, 1887 in Jürgens, 2020, p.66). In the 1900s large circuses would use electric power from towns. And many more circuses followed the previous examples.

However, electricity was used also as part of the performance and not only as a means to illuminate. Events that showcased electricity, especially electric light, fascinated people. As such, circuses also used light as a show on its own. For example, in 1893 at London's Tivoli Music Hall, "(...) a performer named Maria Leyton performed a Serpentine Dance," (Jürgens, 2020, p.90-91). This performer had a long and flowing skirt, and she was also "(...) clad in voluminous swathes of fine fabric that she swirled and whipped up around her body." (Jürgens, 2020, p.91); her dress also had electric lamps that would light up suddenly. This intended to personify light and progress. Another example was Loie Fuller, who "(...) experimented with the creation of coloured light and the ways that light aources could be projected onto her extravagantly fluttering gowns." (Jürgens, 2020, p.92) There were also many circuses, who had specialty acts connected with health sciences, who advocated for electricity as being a cure for many diseases and ailments.

As mentioned in the beginning, I have focused on how the circus evolved from the invention of electricity and especially electric lighting. This is mostly important since the rest of the technological advancements applied in circus come from this. All the lighting and sound effects we see nowadays come from this one invention, therefore it is the most important one.

4.2. *Cirque du Soleil*: a circus and technology in harmony

The Cirque du Soleil is nowadays a reference for the circus arts, with shows all over the world. But it wasn't always like this.

The company was founded in 1980's, near Québec, Canada, by a group of performers known as *Les Échassiers de Baie-Saint-Paul*. The group included fire breathers, dancers, jugglers and musicians.

In 1984, one of the members, Guy Laliberté, decided to take the group on a tour in the province. The show taken on tour was different from what people were used to seeing in circus, since it did not include animals and was "striking, dramatic, beautiful and reflective". The street performances were

also innovative, with "outrageous costumes, magical lighting, and original music". Eventually this group was named by Laliberté as *Cirque du Soleil*.

This new circus eventually led to a change in the circus arts.

The *Cirque du Soleil* went on an international tour in 1987, specifically to the United States, with the *We Reinvent the Circus* tour. The shows stunned media and fans, with the "set design, a stage flanked by seating on all sides, and dynamic audience interaction(...)" (Cirque du Soleil, History, n.d.). *We Reinvent the Circus* ended up being the first overseas tour of the group, in Europe, in 1990.

In 1993 the group performed *Mystère* in Las Vegas, which became the first permanent show. Throughout the following years, *Cirque du Soleil* expanded with several shows on tour through Asia, Europe and South America.

Nowadays the company incorporates technology in a seamless way in its shows. There are several accounts of the application of it, either through announcements of partnerships, shows that use new types of technology, or during the production.

The *Cirque du Soleil* blog makes several announcements and provides several insights on the shows. One of these was regarding Costume Design, where the company explains what a costume designer is and how do they work while also discussing a bit of the development of costume design (while explaining a bit of the history of it). In this article, the author, Maxim Potvin, mentions how costume designers nowadays use "(...) computer programs to create detailed patterns and 3D models, like we do at Cirque du Soleil." (Potvin, 2024b)

Later, the author explains how clothing and costume design in the 19th century was affected by the technological advancements. Due to the Industrial Revolution, new patterns, materials and sewing techniques were introduced in society, and in performances, leading to a change in the fashion at the time, and therefore in theatre.

In the 20th century, with the emergence of cinema, costume designers had to adapt their creations for camera. And in the late 20th century, with the fantasy genre being a popular film type, costume designers changed their creations in order to make "fantastical, yet believable costumes". (Potvin, 2024b)

On other blog entries, mostly regarding specific shows, the authors sometimes bring attention to the technological incorporations, even though all shows have some type of technological application (even if just the usage of lights). The entries with such mentions, refer to show insights on *ECHO*, *KÀ* and *Mystère*.

Starting by *Mystére*, this entry makes a call out for the light and sound in the show, more specifically "(...)just under 1200 lighting fixture and 800 light cues(...)" (Editorial Team of Cirque du Soleil, 2022), followed by an explanation on how each of the musicians has their "own independent, stereo, in-ear monitor(...)"(Editorial Team of Cirque du Soleil, 2022), and each of these in-ear monitors has 16

speakers. Considering these are in-ear, this is a very small technology, one that must fit inside of each of the musicians' ears.

In the entry regarding *ECHO*, the author, Maxim Potvin, wrote a small section regarding the video projectors, which were 10. These projects had the objective of creating lighting effects on stage, and 3D effects on the central piece of this shows, a Cube. According to the author the light and visual effects are "(...) a key component in bridging the gap between reality and the universe of ECHO." (Potvin, 2024a) These projects ended up having a special structure built just to ensure the mobility they had to have, for company needs.

Regarding *KÀ*, Potvin specifically mentions the location of this show. The theatre has built in speakers on each of the seats, allowing for a better sound customisation and manipulation, per seating zones. The stage also tilts and rotates, to allow for spectators to have a top-view of a fighting scene.

The theatre is 9 storey-high, to allow for the pyrotechnics, which included 120 fireballs and 90 devices that are fired.

In a press release from May 2023, *Cirque du Soleil* announces a partnership with *Cosm*, an "(...)immersive technology, media, and entertainment company," (Cirque du Soleil, 2023). This partnership means that the circus company would be able to create a more immersive show, or a "Shared Reality" as mentioned in the press release, with the usage of curved LED technology. This press release also indicates that this partnership will help with the company's goals of expanding the project to areas such as "gaming, premium content, filmed and immersive entertainment (...) licensing and merchandising." (Cirque du Soleil, 2023).

According to Matt Ryan Allen, in Medium, a publishing platform, *Cirque du Soleil* is working on a show that for now remains as a concept, with no debut date. The show, already named *Mécanique Mystique*, is supposed to be presented in Las Vegas, in the Encore Theatre.

Cirque du Soleil proposes an A.I. robot show, where the robot performers are capable of movements almost organic, mixing it with mechanical movements. The creators of this show have been working with A.I. experts and robotics engineers.

In general *Cirque du Soleil* shows some concern with keeping up with the innovations in the technological worlds and finds varied ways to incorporate in its shows. Although not all the shows have a specific mention of the technology used, we would just need to look at the photos from the shows, or even go to one, to understand that the company does rely in technology to help create the amazement in fans and media.

4.3. Issues that may arise with A.I. usage in circus

Although many concerns have already been mentioned regarding the usage of A.I. in art, for circus and possibly other performing arts, such as theatre and dance, where there is a live performance, the concerns and problems related with the usage of A.I. may be different.

In *How are Dance Artists Using AI—and What Could the Technology Mean for the Industry?* by Lauren Wingenroth in Dance Magazine (Wingenroth, 2023), there is reference to how "(...) dance artists are already being taken advantage of." (Wingenroth, 2023). This refers to A.I. tools, similar to *ChatGPT* but for dance, that have been developed by *Facebook* and *Stanford University*. According to Laurel Lawson, an artist-engineer and choreographer, who Wingenroth cites, some technology companies are using online videos as data, without any type of consent, compensation or acknowledgement. She also mentions that, even though some companies do hire dancers for their projects, they might not know how the data will be used in the future. "It is critical that artists contractually specify and have knowledge and control about how their movement might be applied, recombined, or used in training data in the future," (Lawson, n.d. in Wingenroth, 2023).

Kate Sicchio, also cited by Wingenroth, is an assistant professor at Virginia Commonwealth University for Dance and Media Technologies. Sicchio mentions how she creates her own data sets for her projects, since the ones already existing in training data have no information on whose body was used. As Sicchio says "If I have a data set that I just got off the internet, whose body is in there?". Sicchio questions how to "(...)protect people's identity and cultural knowledge(...)". (Sicchio, n.d. in Wingenroth, 2023)

Another choreographer mentioned by Wingenroth is Irina Demina. Demina created a piece, *KLOF. cyberographies of folk*, by using an A.I. that was trained in folk dances, twenty-six dances more specifically. The choreographer mentioned trusting A.I. more than a human counterpart, as the intent was to create a new and "universal" folk dance. Her issues relay with human bias, since she mentions how it is practically impossible to do so. "AIs constantly make value judgments about whose bodies matter based on the data they're trained on." (Skybetter, n.d. in Wingenroth, 2023). This bias could erase certain body types, that are not considered as the norm, due to the data used to train the A.I. and the patterns that exist.

Although all these issues refer to dance, they could be applied to circus, due to the similar nature of both.

Other issues that could arise relate with the copyright and substitution of human labor, thus making many jobs obsolete. All of these issues are previously mentioned and discussed in Chapter 3.3 *Artists concerns regarding A.I. usage for art* of this dissertation.

Unfortunately, there aren't many studies done on this specific subject, as most of the issues mentioned refer to the same shared with artists that are not from performing arts. Although these can apply to Circus Arts, they are not specific for this case.

Out of curiosity I have asked *ChatGPT* for what are the issues that may arise from the usage of A.I. in circus. Asides from already mentioned issues (job displacement and data collection and privacy issues), the tool also indicates issues in the safety, as it indicates how the A.I. tool could fail or have an unpredictable behaviour; the creation of ethical dilemmas, and gives as an example the animals used in circus; how the content that is A.I. generated can be seen as less authentic and creative; audiences that look for more human connection in shows, might avoid going to shows that rely more in A.I.; the costs associated with using A.I. technologies might be difficult to sustain by smaller companies and dependency on technology might be an issue as well, such as in cases where there might be a failure from the tool, thus disrupting a show. I was not able to find any reliable source that mentions these issues; however, I felt that it was worth mentioning them.

4.4. Possible applications of A.I. in the Circus Arts

In *The Integration of AI in Circus and Performance Art*, Jennifer Hill, presents us with a myriad of examples where AI has been used in circus shows (Hill, 2024). The author mentions how Cirque du Soleil has been using AI to support in the construction of the show, and during the show, in order to have better audience interaction.

By using motion sensors and facial recognition software, and then an AI algorithm that analyses real time data during the show, the software can adjust light, sound and even performers' movements dynamically, thus creating more personalized and unique experiences.

AI in this case is being used to enhance the sensory experience via coordination between choreography, sound and visual effects.

Although it is a rather interesting concept, there is some concern regarding the displacement of the more traditional performers, and it requires some adaptability to these new technologies. Artists need to learn how to change their routines in order that they can interact with the AI elements, while on stage. Performers may need to get new training techniques or just to learn how to synch their choreography and movements with the technology.

Nevertheless, the more general consensus is that creativity and emotion brought by the performers cannot be easily replaced by technology, since it is one of the things that connects the most with the audience.

In *AI in Circus and Performance Arts*, from *The AI NEWS LETTER*, available at a domain that has now been parked, and needed to be accessed by using a website (Internet Archive) with captures done on 31st October 2023, the author provides several examples of AI being used in Performance, including in Circus.

In general, the usage of AI is to enhance the performance, providing better entertainment and making the experience more immersive, as well as providing real-time feedback to the performers.

To enhance the performance, AI has been used for lighting and other stage effects, by creating more complex choreographies, designing the costumes, suggesting ways to keep the audience focused by analysing previous performance and via interactive chatbots.

For a more immersive experience, AI has been used to integrate augmented and virtual reality in the performances.

And by analysing movement patterns and potential risks, it is being used for real-time feedback, in order to guarantee not only a more engaging performance, but also the safety of the performers.

When it comes to costume design, there are A.I. algorithms able to create innovative costumes with intricate designs, that appeal to the audience and improve the overall ambience of the performance.

These costumes built using A.I. algorithms use machine learning predictive models and take less time and resources than it usually would. It allows for designers to create intricate patterns and use different textures and materials in the costumes.

It has also supported in creating costumes that are more comfortable, lightweight and flexible, benefiting the performers.

Some cases where A.I. was used to create costumes include:

"The Cognitive Dress", co-created by IBM Watson (a system by IBM that uses natural language processors, machine learn and A.I.) and Marchesa (a fashion brand). This dress, according to Ann Rubin in "Weaving Cognitive into Couture: Watson and Marchesa Collaborate for the Met Gala" (from the IBM Think Blog), was designed to convey colours associated with five different emotions (joy, passion, excitement, encouragement and curiosity). Data regarding the emotions, colors associated with said emotions, image aesthetics and images associated with Marchesa dresses were all fed into the cognitive colour design tool from IBM Watson.

During the show (Manus x Machina-themed Met Gala), the tool would gather user's sentiments regarding the dress and then the colours would change in real time, according to the feedback from the show's viewers, as they tweeted about it.

The "Living Character Initiative" from Disney, is another example provided by The AI News Letter. This project uses A.I. algorithms for facial recognition and animatronics, with the intent to facilitate the performers' interactions with the public, in a way that would be more similar to that character's personality.

Finally, the third and last example provided by the author of this article is the usage of generative adversarial networks (GAN) in the patterns of the costumes of "The Tempest" by the Royal Shakespeare Company. The intent was to have designs with stormy seas and seascapes, that were also unique; and the company was able to achieve it by using GAN.

Regarding lighting and stage effects, the author of this article mentions how sensors, together with A.I. algorithms are being used to create an interactive atmosphere.

Lighting designers are able to create reactive environments, with the support of this technology. These are environments that react to the actions and movements of the performers, by using sensors.

The sensors, on stage, detect where exactly the performers are, and which movements they are doing at that exact moment. Lighting designers can then create a setup that reacts in real-time.

A.I. also facilitates the creation of custom setups that are unique and change for every single performance, by using machine learning algorithms that "complement the mood and tone of the piece". (The AI NEWS LETTER, 2023)

For choreography and movement, the author indicates that by using machine learning algorithms that analyze movement data, can identify patterns and help create new routines. It is a tool that also helps performers receive real-time feedback, so that they can adjust and improve quicker. There are several benefits of using A.I. in this parameter, from more ideas and creativity to movement analysis that improves accuracy and even by generating and refining the routines, saving time and resources for rehearsals.

The article also refers to the usage o A.I. in Virtual Reality (VR) and Augmented Reality (AR). These technologies are already used to create more immersive experiences. Some ways that A.I. can be blended in VR and AR are:

- "Performances in which the audience can interact with virtual performers
- Interactive displays that allow audiences to explore performances in greater detail
- Virtual reality experiences that simulate the performer's perspective
- Augmented reality experiences that blend physical and virtual elements" (The AI NEWS LETTER, 2023).

All of these possibilities, can help the show be more immersive, create more personalized experiences for each person, provide multi-sensory experiences and provide a better storytelling experience.

Concerning audience engagement and interaction, the author mentions a few ways to use the technology in this way, such as "(...) AI-powered chatbots, interactive displays, and personalized experiences (...)", which allows audiences to " (...) enjoy a more immersive and interactive environment during shows." (The AI NEWS LETTER, 2023).

The author provides examples, such as AI chatbots that provide real-time information

can answer questions, give recommendations or help with buying tickets, through a messaging interface, thus diminishing the staff workload. Or for interactive displays, there could be displays that react to the audience's movements or sounds, allowing for a more unique experience. For example, "a display could allow a user to control the lighting or sound during a performance, adding a new level of interactivity and personalization to the show."

Still in audience engagement, the use of A.I. can allow for a more personalized experience for the audience. The experience can be tailored to each audience member, just by having A.I. "(...) analyzing data such as past purchases, demographics, and viewing preferences (...)" (The AI NEWS LETTER, 2023). Some of the examples provided by the author are:

- "Customized merchandise recommendations based on past purchases
- Customized pre-show messages welcoming the audience member by name
- Customized email marketing campaigns based on viewing history" (The AI NEWS LETTER, 2023)

These strategies can provide several benefits, such as an increase in engagement, enjoyment, loyalty and repeat business from the audience, also marketing strategies that are more effective.

Lastly, in *AI in Circus and Performance Arts*, the author mentions the safety and security of the performance. One of the ways to improve in this subject is by the use of sensors. "For example, wearable sensors can be used to monitor a performer's heart rate, body temperature, and movement patterns" (The AI NEWS LETTER, 2023). These sensors, together with an A.I. algorithm, help detect risk factors in the performers, such as fatigue and dehydration, sending real-time alerts, and allowing the performers to have breaks when needed.

Another way to improve safety is with A.I. powered cameras. These cameras can monitor the performers and detect possible falls and mistakes, and send an alert, thus possibly preventing an accident. These cameras can also assist in improvement and feedback by analyzing the footage of previous performances; thus, helping in improving the show and performance, and also in reducing injury risks.

4.5. Survey Results

As a means to gather more opinions I have prepared and shared an online survey.
The survey had several questions directed at everyone, regardless of their work and study experience. It was aimed at understanding people's opinions regarding the usage of A.I in Performing Arts. At a later stage, the questions were directed towards people with experience in either Performing Arts or Information Tecnology (I.T.), regarding the usage of A.I. in Circus Arts.

It has reached 53 people. Out of 53 answers, 16 people indicate that they have some experience (either studies or work) in Performing Arts, while a total of 38 participants have some experience in the I.T. area. And 12 people said they have experience in both areas.

Figure 1 - Understanding participants knowledge of the usage of A.I. in shows

I have noticed that there is a general lack of awareness that there is already A.I. being used in shows, as only 24,5% (12) of the respondents were aware of it. These 12 respondents were mostly aware of A.I. being used to improve the artists' performance and for the ambience (lights and sound); some also mentioned it being used in the creation of choreography and script or to support in recording and for visual effects. There was one person mentioning that Cirque du Soleil has been using A.I. to accelerate the creation process, and one other respondent mentioned robotic cameras in football games.

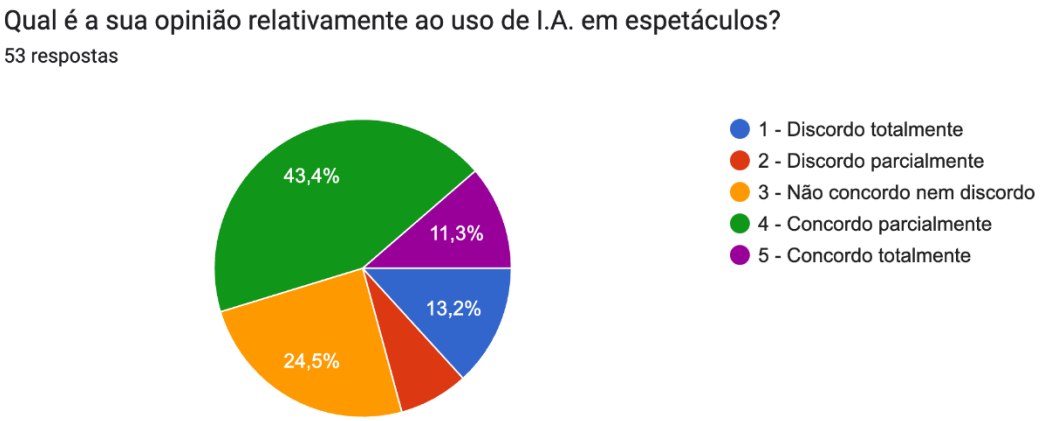

Figure 2 - Participants opinion on the usage of A.I. in shows

Most people (43,4%) partially agree with the usage of A.I. in shows. These respondents believe that A.I. can improve the show, either by accelerating its production, improving the ambience, ensuring the artists' security or assisting in more administrative and monotonous tasks. There seems to be a general consensus that the creative part of the show should still be done by humans. There also seems to be some concern with having A.I. substituting people and with copyright.

24,5% of participants did not agree nor disagree with the usage of A.I. in performing arts, with many indicating that they do not have enough knowledge and information on the subject, and most sharing the same concerns as the previously mentioned group.

13.2% of people completely disagree with the usage of A.I. in performing arts, with most people indicating that they believe that A.I. should not be used in art, and that this should be reserved for people, and many indicating that A.I. is already taking jobs from people. 100% of these respondents would also not buy a ticket for a show that has used A.I.

On the other extreme, respondents that completely agree with the usage of A.I. in shows (11,3%), mention how A.I. should be used for security reasons, to help creators have more and new ideas, to assist in planning and in general, that A.I. is just another tool that can help artists in general.

Finally, 7,5% of respondents partially disagree with the usage of A.I. in performing arts, and similarly to people who completely disagree with the usage of A.I this way, these participants think that art should be kept as a fully human area, with some lenience towards using A.I. as a support tool; and concern regarding people being substituted by A.I. 50% of these respondents would not buy ticket for a show that has used A.I.

Figure 3 - Understanding if there would be a difference in buying a show's ticket for the participants, if they know A.I. was used in its production

For most people (67,9%), knowing that a show they were interested in, used A.I (either in its creation, production or during the spectacle), would make no difference when deciding if they would buy a ticket or not. For 28,3% of respondents, it would impact negatively, leading them to not buy the ticket; while only 3,8% (2 people) would have a positive impact, leading them to buy the ticket if they were in doubt previously. As per this survey, it would seem that there is not a big impact for ticket buyers if they were to be aware of the usage of A.I. in a show.

As for A.I. substituting performing arts' professionals, 67,9% of respondents do not think this could happen, while 32,1% believe the opposite, that there is a possibility for these professionals to be replaced.

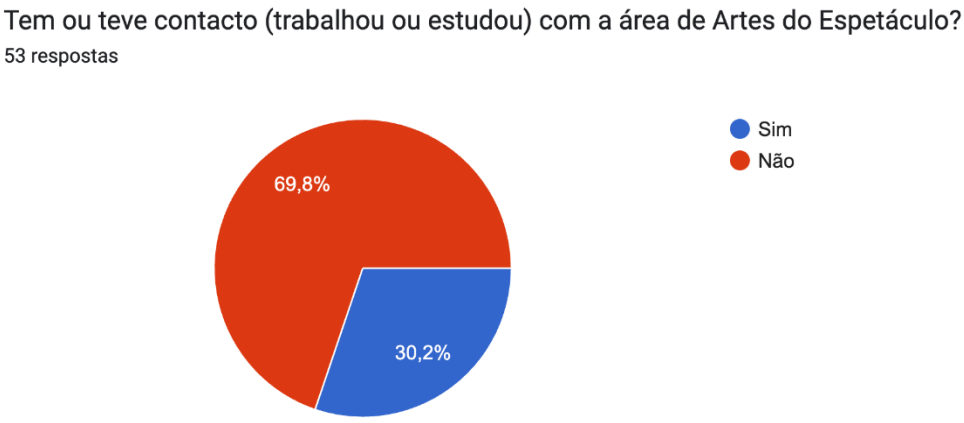

Figure 4 - Participants experience in Performing Arts

Regarding participants who have had some experience in Performing Arts (30,2%), 50% agree partially with the usage of A.I. in shows, with 25% that do not agree nor disagree 12,5% partially disagree and 6,25% completely agree and 6,25% completely disagree.

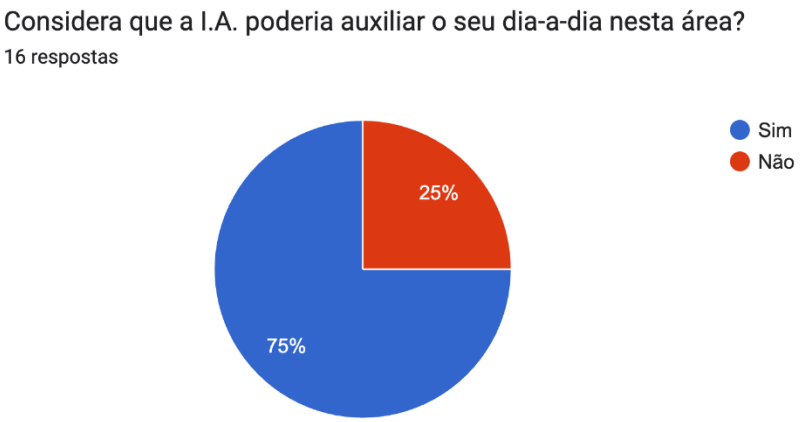

Figure 5 - Understanding if participants with Performing Arts experience think that A.I. could support them on their daily tasks

Out of these respondents, over half of them think that A.I could help them with their work in this area. Most indicate they believe A.I. could help them have new ideas (such as script and music) by brainstorming and exchanging ideas, others indicate the design of costumes and scenery, while some mention using it as an auxiliary tool for more logical and monotonous tasks. For the ones that believe A.I. could not help them in performing arts, only 2 people do not have any kind of experience in I.T. While regarding people who do not think A.I. would support them in this area, half of them have experience in the I.T. area.

When it comes to the I.T. area, there was a total of 38 respondents who have either studied or worked in this area. Out of which 12 also have experience in the performing arts area. Out of these 38 people, 86,8% believe that A.I. could help the performing arts' professionals.

Figure 6 - Understanding if people with I.T experience believe that A.I. could support professionals of Performing Arts

These participants gave similar answers on the possible usages of A.I., as the ones who believe it would support them in their performing arts tasks. Most indicate using A.I. for more technological parts of the show, such as music, lighting, special effects and scenery transition; or for the administrative tasks, such as scheduling and accelerating processes, some indicate using A.I. to support artists in getting more ideas. In general, people with experience either in I.T or performing arts (or both) believe that the creative and artistic process should remain in the human side, and that A.I. should be used as a support tool, for more technical and logistical tasks, but not as a full creator.

The second part of the survey would only count participants that have either worked or studied in one of the areas surveyed. This means that out of the 53 initial participants, 42 have answered the next set of questions. This section would ask about the respondents' opinions on specific usages of A.I. in circus shows.

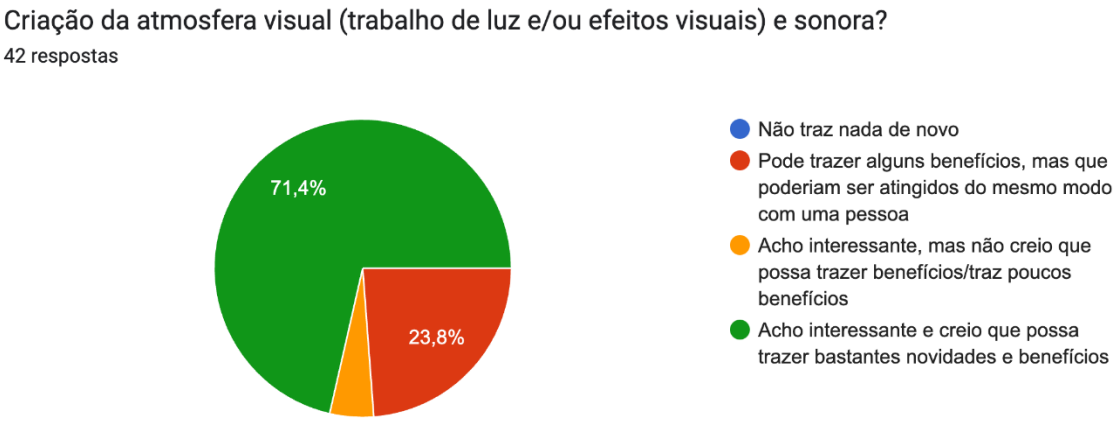

Figure 7 - Participants opinion on using A.I. for ambience

The usage that got the most positive answers (where participants thought it could be interesting and would bring novelty and benefits to the show) is to the ambience creation, such as lighting, visual effects and sound/music, with 71,4% picking this option.

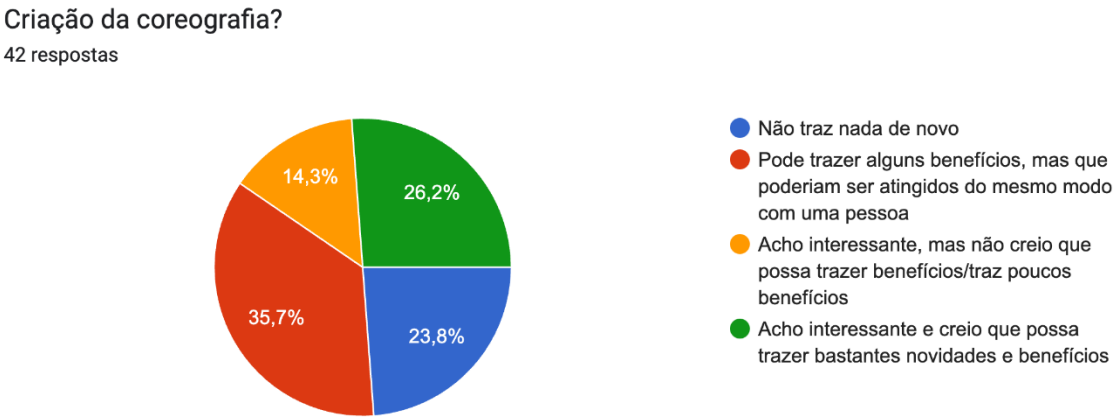

Figure 8 - Participants opinion on using A.I. for creating the choreography

While having A.I. creating the choreography had the least enthusiasm, with 23,8% of participants considering that it cannot bring anything new and 35,7% saying that it can bring some benefits, but the same could be achieved with human labor.

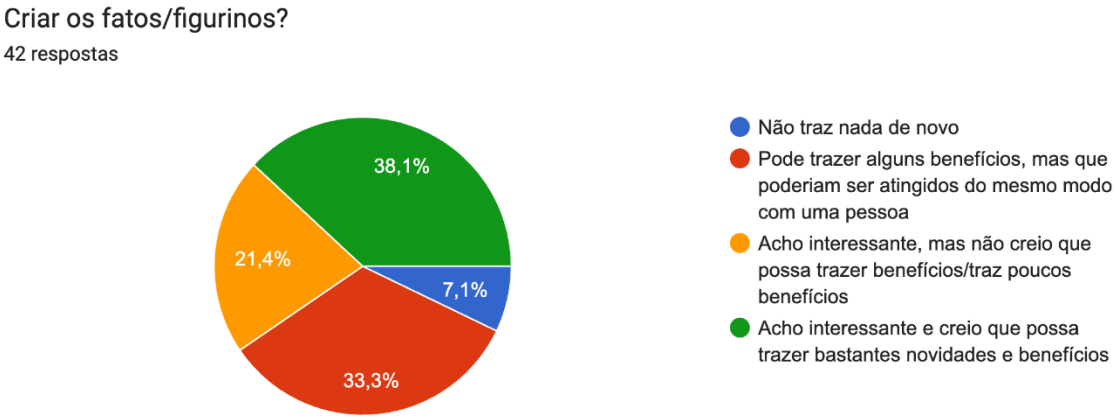

Figure 9 - Participants opinion on using A.I. for costume creation

The opinion on using A.I. to create the costumes is more divided, with 38,1% considering it would be interesting and would bring benefits, 33,3% think it can bring some benefits, but the same could be

achieved with human labour and 21,4% think it can be interesting but wouldn't bring many benefits.

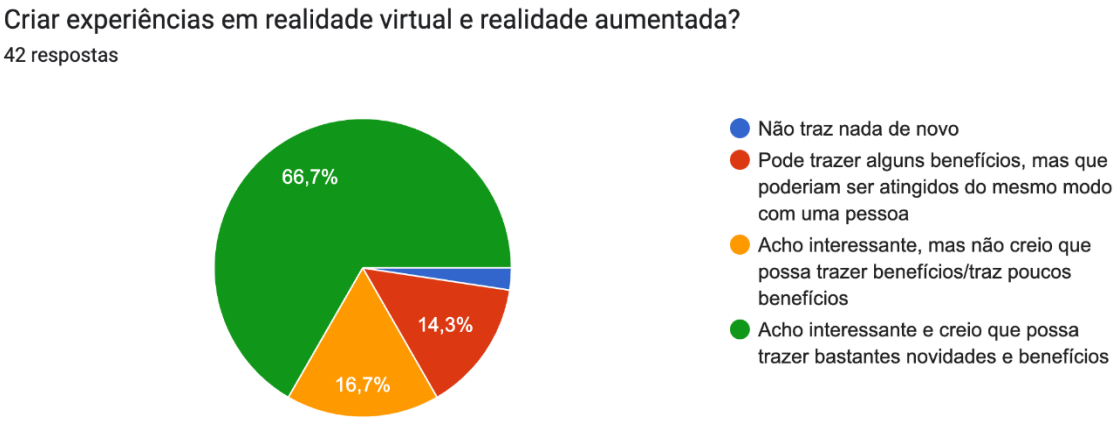

Figure 10 - Participants opinion on using A.I. for augmented and virtual reality experiences

When it comes to using A.I. to create virtual and augmented reality experiences, 66,7% of respondents think it could be interesting and could bring novelty and benefits to the show, and 16,7% think it is interesting, but there wouldn't be many benefits if any at all.

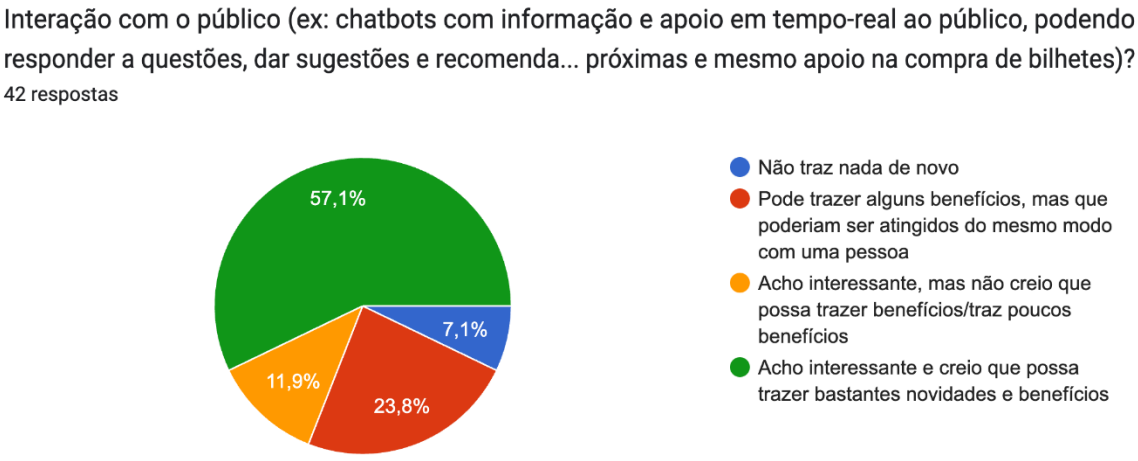

Figure 11 - Participants opinion on using A.I. for public interaction

Regarding the usage of A.I. to interact with the public (like chatbots for real-time information and support, recommendations and support to buy tickets), 57,1% of the participants are of the opinion that it is an interesting usage of this technology and could bring benefits and innovation.

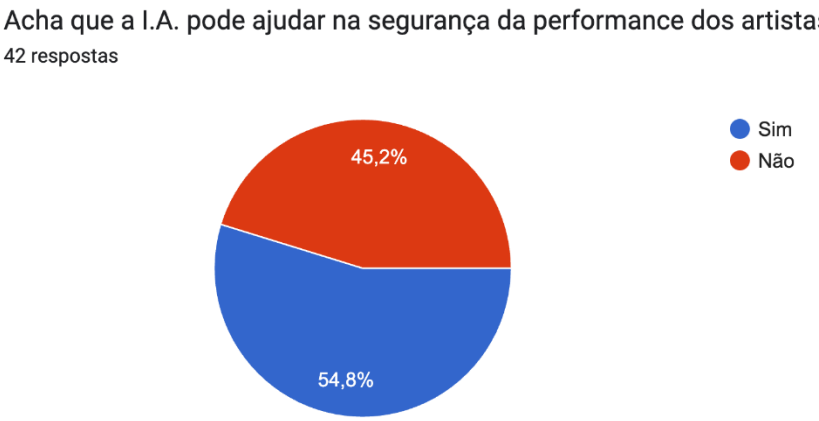

Figure 12 - Understansing if participants think that A.I. could help in the performers'security

The last question was to understand if people believe A.I. could help with the performers' security, 54,8% believe that yes, it could, while 45,2% think it cannot help.

The survey shows that most people believe that all that is more creative and artistic should be left to artists and other creators, while the A.I. should be a support tool, used either for more monotonous tasks, technical areas, such as lighting and music, or to brainstorm ideas, but not to create from scratch. It also shows that there would be barely any difference in the ticket office if showgoers were to know that a certain show had used A.I.

Lastly, people with experience in either performing arts or information technology seemed to find some perks in using A.I. in performing arts and, specifically in circus arts for the ambience.

4.6 Analysis of the Interviews

I have conducted three informal interviews to three people with different experiences, being that one was with Susana Alves Costa, circus teacher and owner of *Gato Ruim Teatro-Circo*, a theatre-circus company; and the other two were with two A.I. professors of ISCTE-IUL, Ana de Almeida and Luís Botelho. The interviews were quite informal, mostly a conversation with some questions that would allow me to guide the interview towards certain topics.

Starting with the interview with Susana Alves Costa, she is very open to the idea of using A.I. in the circus. In general, she thinks that it can open new creative opportunities, and can support in the creation of music, lighting, scenarios and ambience. However, she believes that it is not possible for A.I. to substitute humans when it comes to circus, since per her opinion, what makes the audience enjoy the circus is the incredible techniques that performers are able to learn and act and how they, the audience, think they would not be able to do such things ; while having the same type of

performance done by a robot, would not be the same feeling and would remove a certain impressiveness.

Susana mentions how she doesn't know if there are any circus companies already using this technology, and therefore is not aware if she has already seen anything with it. However, she has plenty of ideas where A.I. could be used, she even provides as examples lighting and scenarios, how she would like to have interactive scenarios, allowing for an easier set up of the scenario, or to create the music. She says that for now she does not use A.I. in her shows due to lack of knowledge, how it's done and how it can be used. She shows some concern for the artists in these areas, however she mentions hiring musicians and set designers that were able to use A.I. in their work, thus not fully removing the artist behind it, but having one that has adapted their work to this new technology. She thinks that people, especially artists, need to adapt to what is to come, and this includes A.I., which will always need someone to create the prompts and to verify its works. On the other hand, she is not aware of the type of investment that would be needed to implement A.I. in the circus, which could be an impediment. She is aware that there would need to be a software bought, people trained on the software (which means a money and time investment) and/or hiring specialists. This might end up being cheaper than what is now the cost of materials, copyrights to a music and the work of one or more artists for what might be needed for a show. She thinks there might already be big circus companies, with investment possibilities, that can be using A.I., but is not sure who exactly.

Susana believes that the circus companies and artists will need to adapt to this new technology, she even mentions how the traditional circus, some that still use animals in their shows, have been losing audience since they were not able to adapt to the new circus. Since the audience also learns of new technologies and shows curiosity with it, the circus will need to adapt and create new types of shows using A.I., if not in music and lighting, perhaps even attempting to integrate it in the artists' performances. She even suggested using projected juggling balls instead of real ones, however it would remove the impressiveness of having someone juggling with real objects, just like she had already mentioned, the impressiveness of humans being able to do certain performances.

Concerning the adaptability of the circus to new technologies, Susana thinks that circus artists that are on the vanguard of new techniques, new circus and new technologies will possibly want to experiment with all these novelties; however, the traditional circus, as previously mentioned, seems to be more reticent to adapt, but she states she might be wrong and they might look to quickly adapt in an attempt to regain spectators.

Lastly, I have asked Susana if she was aware if there were any circus courses that already had a component regarding A.I., to which she is not aware if there is any course that includes such a component, however she thinks that, in the case A.I. starts to have a more prominent role in circus shows, then the schools and courses need to create study programs that include A.I.

Next, I will delve into the interview with Ana de Almeida, professor and researcher in ISCTE-IUL with a degree in Applied Mathematics and a specialization in Computer Science and delivering Artificial Intelligence classes in the same institution. Ana de Almeida starts by explaining how she loves the arts and has many creative and artistic ideas but does not put them to practice in an artistic medium; however, she has dabbled with some A.I. tools to conceptualize information, knowledge or step-by-step processes.

The professor believes that A.I. will not substitute artists but will rather be a tool to help them. She thinks that some jobs might become obsolete but none regarding creativity and artistry, as this tool will only provide further support to invent, reinvent and create new things. She thinks that people will need to learn and adapt to the technology, including how to communicate with it.

Ana de Almeida mentions how she was present in some performances where A.I. was used either in the creation or during the performance. In one of the cases it was a reactive installation, where the ambience could be manipulated depending on the audience, in a reactive way. In the other case, she was present in a show where the scenario had been built with an A.I. that reacted to conversations, sounds and movement and adapted accordingly.

Regarding circus the professor is not aware if there already is some specific software being used, but she believed that A.I. could perhaps help the performers in their specific acts. For example, having sensors in more complex movements and performances, or to enhance creativity, help plan or to simulate. She even suggested that new acts could be seen and simulated with an A.I. to understand if it is doable or not. However, this type of software and technology still needs to be further developed, which implies employing a team, including a specialist in this area (which there aren't many) and also some resources. All of this is quite costly, and at least in the short run does not seem accessible, but it is also not a very far future, since there is more investigation and also easy sharing and access of new findings and products. The researcher thinks that social acceptance might be a harder obstacle to surpass, but she believes that it will be something humanity will end up adapting to, especially since people have the tendency to humanize technology. As an example, Ana de Almeida mentions how many people react to *ChatGPT*, having conversations with it as if it was a human or even a friend. She also thinks that it will become part of day-today life, since so many objects already integrate A.I., and people don't even think about it.

To conclude I asked the professor if she believes that artists tend to resist more to technological advancements, to which she told me that she doesn't think so, since art has evolved, always being a bit disruptive on its own, and causing some oddness, but later and slowly being accepted by society and artists in general.

As for the final interview, it was with Luís Botelho, professor and researcher at ISCTE-IUL with a degree in Electrical and Computer Engineering and having delivered Artificial Intelligence classes. The

professor indicates how he has worked in computational creativity, more specifically in automated story generation. Regarding how does technology and art relate to each other, the professor indicates how, in a personal level, is not a fan of this mixture, except to what it comes to dadaism, which represents machinery and technology in its pieces. He adds that there has been more use of technology in art, and even provides an example of a Portuguese artist that uses A.I. in his pieces, Leonel Moura. The professor adds how Leonel Moura's painting works are done. The artist conceptualizes robots and then orders them done, to engineering companies; and then he put the robots doing art, drawing. Sometimes it's more several robots drawing in the same canvas. The canvas has words that the robots either can read, or already know what it is there, and paint/draw depending on what is already in the canvas. The professor also adds that Leonel Moura also had some projects where the robots would write. Most times it didn't make sense, but these "poems" have been published in books.

The professor then adds that he is aware of programs that paint depending on what the user writes, and that sometimes is not distinguishable from what a human would do. He then adds that there is something that is missing from these A.I. programs, in order to consider what they do as art: intention. The professor considers that to have a piece considered as art there needs to be an intention of actually doing that piece. However, he thinks that it would be possible for a program to have emotions and sentiments, perhaps not right away since it is a very complex and sophisticated system, but sometime in the future.

I then inquired if Luís Botelho thinks that it is art that learns with technology, the other way around, or one with the other. He instantly said it was one with the other. He then adds how a person, an artist, can learn with technology, at least how to use it; and then a system like an A.I. will also learn, as it needs to be trained using examples, which can be seen as learning.

Luís Botelho then adds how he has never seen a circus show that uses A.I., but gives an example of something that has happened in a *La Bienalle di Venezia* performance, a cultural institution in Venice that researches and promotes new contemporary art trends. In *La Bienalli di Venezia*, Luís Botelho attended a performance, that was also happening in the streets, where A.I. would send details and what to do to the performers. The performers were not aware what they had to do, then they would receive on their mobile phones instructions on what to do.

I then asked the professor if he thought that art had more tendency to resist technological advances, to which he answered that it would depend on the artist, as some are very open to it and will experiment with the new advancements, while others resist. He suggested that this resistance might have to do with being substituted, with the idea of having our space occupied.

Later we went to more specific topics and questions, starting with if Luís Botelho thinks that A.I. will be easily accessible to any company, including the ones that do not have many ways to invest. He indicates that everyone can have access to a part of the A.I. programs, but not the same as a company

that is available to pay for it. He gave the example of *ChatGPT*, which has a free version that everyone can use; however, if someone wants a specific program, or to create a program, they would need an API (Application Program Interface), which costs money. The professor later makes a distinction between those who want to use A.I. and those who want to do A.I., and those who want to do A.I. have much higher costs, due to the computer resources it needs.

The last question was if the professor thinks that circus professionals can be substituted by A.I., and if they need to learn how to use this technology, to which he automatically responded that these professionals need to learn how to use A.I., as their art can be greatly enhanced. He then provided the example of robots by *Boston Dynamics*, which are not being used for arts, but are used in a myriad of ways, including military. The professor provides this example as he thinks these robots could be used in circus due to how resistant they are and how they can do many things, like somersault jumps. Luís Botelho ends with stating that history cannot be stopped, and therefore it's better for the circus artists to learn and adapt.

After having these three interviews I realized how similarly these three specialists looked at A.I. in arts and even circus. All have agreed that the artists, including circus artists, need to adapt to the new technology; but they all also agreed that it won't be possible for A.I. to substitute the artists, either because there's no intent coming from the tool, or because having a robot performing in a circus is not as impressive as having a person doing it. In general, all seem interested in the possibilities of A.I. in arts, and even more in circus arts, which has such a heavy human presence. These interviews also seem to align with the answers from the survey, where there's a lot of interest in A.I., but there's a general belief that it is not possible to remove the human factor from it. Although we can empathize with the concerns coming from artists, we can also see that many people do not believe they are that serious, especially when it comes to job displacement. There's also a clear need for more research regarding A.I. in performing arts, especially in Circus, since there has been such a lack of knowledge regarding its usage in this type of art, and on what exactly could it be used for.

In the end, all three interviewees seemed to have a positive and open mindset regarding A.I. in the Circus Arts and how it can enhance and help this art.

5. Conclusion

This thesis explored the intersection of Artificial Intelligence (A.I.) and the Circus Arts, driven by a curiosity about how technology can enhance this unique form of performance. The central question, which was “How can A.I. be used to support the Circus Arts, considering its current state”, revealed many opportunities and challenges within this field.

Throughout the research, I found out about some key concepts surrounding the history and development of both Circus Arts and A.I., showing the evolving relationship between technology and performance. The findings indicated that A.I. is already in use in various parts of the performing arts, circus included, including costume design, choreography creation, lighting, sound, public interaction, and safety measures. These applications suggest a promising future where A.I. not only supports but also enhances the creative process.

However, the research also highlighted significant concerns among artists regarding A.I.'s impact on copyright and the potential for job displacement. Despite these apprehensions, survey results demonstrated a general acceptance of A.I. in performances, with most participants willing to engage with shows that incorporate A.I. tools. This suggests that although there’s still much resistance to these tools, there’s also a growing recognition of A.I. as a valuable asset that might help either with monotonous tasks, or as a creative partner.

Interviews with industry specialists, being one a specialist in circus and two A.I. specialists, reinforced this sentiment, with consensus around A.I.'s role in enhancing show elements such as ambiance and technical design, while expressing skepticism about its effectiveness in choreography. This nuanced perspective reflects the broader dialogue in the arts community regarding the balance between human creativity and technological assistance.

Despite facing challenges, such as limited resources, due to the specificity of the subject and lack of research already done in it, the findings of this thesis contribute to a deeper understanding of A.I.’s potential within the Circus Arts. Future research could further explore specific applications of A.I. in choreography and audience engagement, as well as ongoing discussions about ethical implications and copyright considerations; perhaps even research that could find plausible and doable solutions regarding this issue.

In conclusion, this study affirms that A.I. can serve as a powerful tool for circus performers, enhancing creativity and efficiency while complementing, rather than replacing, the artistry that defines this form of entertainment. As the circus arts continue to evolve, embracing A.I. presents an exciting opportunity to innovate and inspire new generations of performers and audiences alike.

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