Datafication, Artificial Intelligence and Images: The Dominant Paradigm in the Representation of Knowledge in Images

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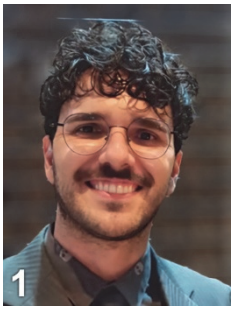

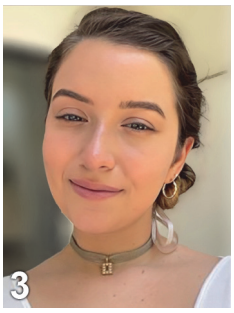

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Abstract: This paper aims to verify whether Generative Artificial Intelligence tools for image generation replicate biases and social stereotypes present in the dominant paradigm. A case study was carried out using the Leonardo.Ai tool, which generated images using simple combined terms, namely: "Scientist, person"; "Cook, person"; "Doctor, person"; "CEO, person"; "Housekeeper, person"; and "Nurse, person". The images were analyzed using Rodrigues' (2007) image documentary analysis methodology and Gemma Penn's (2008) contributions. The analysis criteria included gender, age group, ethnicity, body type, clothes, and circumscribed elements. The images generated by the Leonardo.Ai tool were found to have a series of characteristics that perpetuate bias and social stereotypes. Given the likely impact that generative Artificial Intelligence will have on the production and sharing of information, we conclude that, in addition to the ethical issues related to the creation of the tool itself, there is a need to discuss ways of making it more inclusive and responsible for the representation of information.

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1. Introduction

Generative Artificial Intelligence tools for image generation have become increasingly popular and accessible. These tools can produce images in mere seconds based on textual input. By analyzing billions of images, these AI models can replicate the styles, techniques, and visual attributes present in their database.

We acknowledge that the effectiveness of AI tools in the learning process depends on the data fed into them by their programmers. However, we are concerned about the potential for generative Artificial Intelligence to reproduce biases and social stereotypes within the dominant paradigm.

To investigate whether generative Artificial Intelligence tools for image generation replicate gender and racial stereotypes, we conducted a case study using the *Leonardo.Ai* tool. We searched for images using combined terms such as "Scientist, person,"; "Cook, person";"Doctor, person"; "CEO, person"; "Housekeeper, person"; and "Nurse, person." The obtained images were then analyzed using Rodrigues' (2007) image documentary analysis methodology and Gemma Penn's (2008) contributions. The analysis criteria included gender, age group, ethnicity, body type, clothes, and circumscribed elements.

After conducting a study, it was discovered that certain images tend to promote stereotypes and biases, particularly around gender, age, skin color, physical appearance, and attire in specific professions. As a result, it is essential to address the ethical concerns regarding the development of generative Artificial Intelligence tools and discuss ways to enhance their inclusivity and responsibility in representing information. Given the potential impact of such tools on information production and dissemination, it is crucial to ensure that they avoid perpetuating biased and stereotypical representations.

2. Images in Knowledge Representation

Images play a crucial role in Information Science by conveying visual information more effectively than written text. They condense a vast amount of information into a visual representation, making it easier to transmit (Roberts 2001). Images are also used to record and document events, situations, and other important information. They contribute to the development of collective memory and scientific knowledge (Torres and Maculan, 2019).

Museums, libraries, and archives often have collections of images that are used to depict, document, and contextualize information in different media, such as books, articles, and reports (Maimone 2018). In addition, image analysis is a significant area in Information Science that facilitates the extraction of relevant information, such as object detection, character recognition, and pattern identification, contributing to the development of new technologies for searching, retrieving, and analyzing visual information (Manini 2002).

Between 2001 and 2010, a new way of using the internet emerged, known as Web 2.0. This model allowed users to freely publish and process information, leading to the development of social networks. As a result, tools for accessing and sharing images became more widespread and accessible to people around the world.

The ability for users to freely publish images on the internet has brought up concerns about how these images should be treated and retrieved. Due to the various factors involved, such as the type of image and the medium on which it is found, the scientific literature in the field of Information Science has not yet reached a consensus on how best to handle images. However, there are some efficient models for indexing images (Manini 2022; Rodrigues 2007) that can be found in the literature.

Manini (2002) suggests using documentary analysis of photographs to address gaps in the analysis of images. To do

this, the author applies methods and techniques used in the analysis of written texts to photographs. This involves taking into account the expressive dimension of the photograph, as well as its written representation and the retrieval of image information by the user. The aim is to identify the informational content of the photographic image and to understand the gap in the documentary analysis of images. Indexing should be based on image attributes and can be applied to groups of images.

Rodrigues (2007) proposed a methodology that highlights the fact that an image does not just depict something but also represents something that may not be directly related to the objects shown. This means that an image can have two main levels or meanings. The first level is called denotative, which refers to the precise representation of the object in the image. The second level is called connotative and refers to the figurative and symbolic interpretation that the image can convey in a given context.

When analyzing a photograph through documentary analysis, it is important to first read the document. This requires some prior knowledge of the content, but it's not necessary for analysis. The professional's reading can prepare the user's reading, including creating an abstract and index. The abstract is a crucial part of documentary analysis and can be useful for indexing, even if it doesn't contain any additional information. While the title and caption may be similar, the abstract should not be confused with the subtitle. The abstract is usually less concise and may be abandoned, but it is important for providing keywords or indexing terms (Manini 2002).

The indexing term is the translation of visual information into verbal language. It is crucial for an information professional to have a good understanding of the document's content, the interests of the users, and the policies of the institution. A photograph can be analyzed on three levels: pre-iconographic, iconographic, and iconological. These levels respectively refer to the image's referent, the meaning attributed to the referent, and the symbolic values. The iconographic level is where symbolic values are found, which may refer to cultural, social, philosophical, or ideological meanings. This is also where the image's author moves furthest away from the reader, as explained by Manin (2002).

The caption is a significant aspect of documentary analysis to identify and interpret the image. The caption describes the principle of anchorage (Barthes 1990), and function as a limiter of meaning that the image can or cannot be associated with. This anchorage serves as a static fixation of the image's potential for meaning and, consequently, the limitations of its interpretation.

According to Barthes (1990), language is a system of signs that has an unstable and ambiguous nature, making it necessary to use mechanisms to fix the meaning of words. In this context, anchorage is a process by which an element of discourse is fixed to a specific meaning, limiting possible interpretations. Thus, anchorage is "repressive" (Barthes 1990), insofar as it reduces polysemy, ambiguity and uncertainty in the images' interpretation. Additionally, it is an important resource for making discourse more objective and clearer, allowing meanings to be understood more precisely.

The caption is the text that accompanies an image and is crucial for interpreting it correctly. It can include the title and explanations about the production of the image, as well as reflect its content in a generic, specific, or abstract way. The caption directs the viewer's attention and can be used to give the image specific characteristics such as identification, context, and intention. Similarities between captions and the language used in command prompts for Artificial Intelligence can be seen in this process of documentary analysis of images.

Within the new virtual environment, both image captions and command prompts are ways of guiding the production of images by Artificial Intelligence. An image caption is a textual description that accompanies an image and aims to provide an interpretation of what is being shown, while a command prompt is an instruction that guides an Artificial Intelligence system to generate an image with certain characteristics.

Both image captions and command prompts are essential for the creation of images using Artificial Intelligence. They define the context and desired characteristics of the image and can be adjusted to produce different results. This allows for variations in the characteristics of the images created. There is a significant distinction between image captions and command prompts. Image captions describe what is already present in the image, whereas command prompts provide guidance for creating a new image. Therefore, while an image caption is an interpretation of what is visible in the image, a command prompt is an instruction to generate a completely new image.

3. Datafication, Artificial Intelligence and images

With the advent of Web 2.0, a plethora of new digital tools and resources have become a part of our social lives. As a result of their growth and innovative applications, these tools have made their way into the fields of science and humanities. Here, more and more research is being conducted, proposing the use of Artificial Intelligence tools to automate problem-solving activities. These endeavors are increasingly bold and experimental, seeking to push the boundaries of what AI can do.

Studies on Artificial Intelligence and the automation of management, organization and curation activities for digital collections have come to occupy privileged spaces in ac-

ademic discussions, whether through events in the field, textual productions, specialized subjects in training courses or inter and transdisciplinary projects. It should be noted that the efforts to expand studies on the application of Artificial Intelligence in Information Science and Knowledge Organization mean advances in the treatment and curation of collections, as well as in the relationships between institutions and users and, while the term was previously avoided due to its uncertainties and the fears of its researchers (Martínez-Ávila 2015), it is now being presented as a synonym for a solution to various issues in the technological scenario, providing automation and facilitating activities in various sectors.

The beginnings of the study and development of this technology can be traced back to the mathematician, computer scientist, philosopher and biologist Alan Turing (1912-1954). However, it was only in 1956, during a meeting of researchers on the subject at Dartmouth College in New Hampshire (USA), that John McCarthy, a computer scientist and one of the pioneers in this field, coined the term.

In his 2007 article titled "*What is Artificial Intelligence*?" McCarthy provides fundamental questions and answers regarding the subject. He defines Artificial Intelligence as "the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable" (McCarthy 2007, 2).

After giving it some thought, we can define Artificial Intelligence as the creation of programmed machines capable of "learning" through the use of algorithms. This allows them to provide responses and interact with humans based on the data provided (Damaceno and Vasconcelos 2018). This learning process happens through the data that is entered and stored and the algorithm formulas that enable the software to generate responses to the presented problems.

These tools can be classified according to their layers: Machine Learning and Deep Learning. As the name suggests, the former promotes continuous machine learning, where its algorithms are structured with equations that organize and store the data provided, promoting more appropriate responses to solve a problem. Deep Learning, on the other hand, is a type of Machine Learning that performs more complex tasks, such as image identification and speech recognition, where it establishes basic parameters on the input data and uses them in layers to recognize patterns, seeking to imitate human learning and performing various tasks with "experience" (Damaceno and Vasconcelos 2018).

Generative Artificial Intelligence falls under the category of Deep Learning-based technology that more closely resembles human natural language (see Figure 1). This type of technology is designed to generate results by analyzing the data and training stored in the system. One example is the Generative Pre-trained Transformer, or ChatGPT, which has gained popularity for its ability to solve problems at various levels, such as finding film streams and providing answers for software engineering activities. It highlights the potential of applying technological tools to solve diverse problems.

Generative Intelligence offers a wide range of resources for representing content in various media, including images. *Leonardo.AI* is a tool that allows users to generate visual representations of subjects using simple and complete terms. By providing detailed descriptions of the desired image, the software translates the information it receives along with the stored data to produce the content in an imaginary form.

According to Schuhmann et al. (2022), the size and quality of the dataset used to train artificial intelligence are critical factors for the system's performance. In the past, the datasets were created by using images from the internet along with descriptions, annotations, and textual metadata entered by humans. However, with the recent computational advances and the use of AI, the datafication process has become more efficient resulting in datasets with over 5 billion image-text pairs.

The availability of resources powered by Artificial Intelligence (AI) has opened up new opportunities for the fields of art and design, paving the way for innovative ways of working. However, the increased use of AI technology and its growing importance in social discourse has raised some ethical concerns. For instance, the use of images in data sets to train AI tools without the consent of their authors raises questions about the legality and morality of the practice.

In 2018, Marc-Antoine Dilhac, a philosophy professor and researcher at the University of Montreal in Quebec, in an interview published in the UNESCO journal[1], highlighted the ethical risks of using artificial intelligence. The biggest concern is the possibility of using these tools to discriminate based on factors like race identification and sexual orientation, as well as to make inaccurate predictions about people's behavior.

It is paramount to uphold ethical and moral values and to prevent the dominant paradigm from overshadowing the representations produced by emerging technologies. Therefore, discussions regarding the application of these resources should be approached with caution. Ethical debates surrounding the use of AI, particularly in information representation, must be conducted conscientiously. The knowledge organization field has long grappled with ethical issues pertaining to the processes and tools used to organize knowledge, especially concerning historically marginalized communities. Ensuring an accurate organization and representation of knowledge remains a central concern in these discussions.

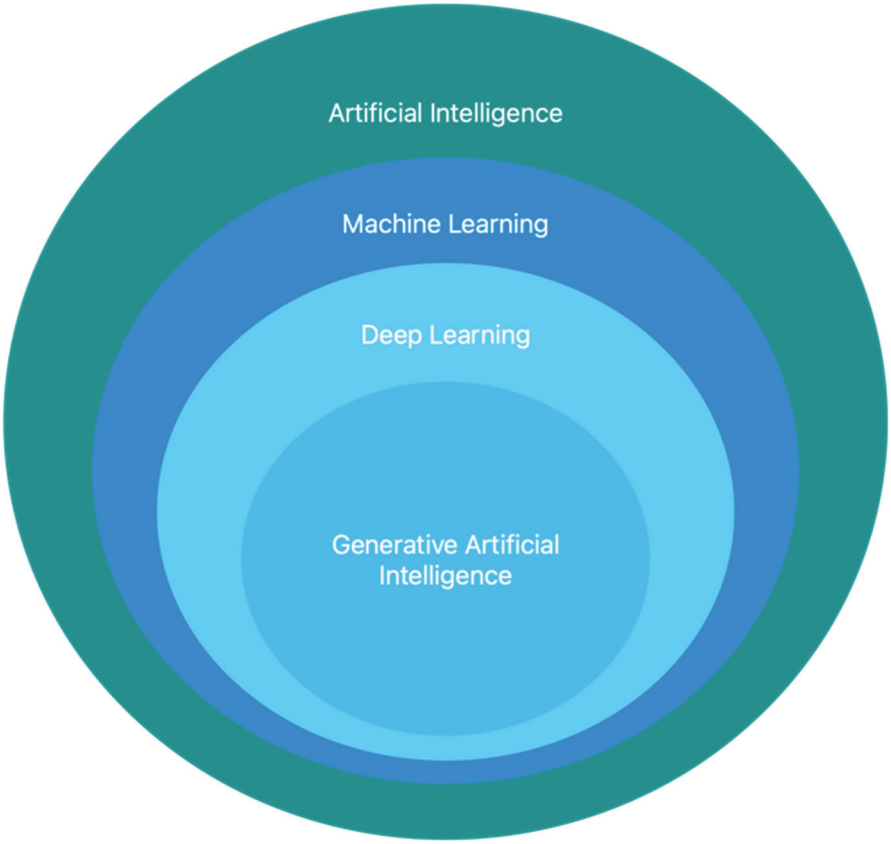

Figure 1. From Artificial Intelligence to Generative Artificial Intelligence

4. Dominant Paradigm in AI

Knowledge production is a natural human process in which observations and transformations are structured and synthesized into logical forms and methodologies for possible dissemination. As these processes and constructs evolved, there was a need and interest in mapping these normative investigation concepts, their validity, and procedural viability. This philosophical strand is called Epistemology.

For Epistemology, knowledge is a form of belief involved in processes of assertion and justification of observed phenomena as a way of imprisoning reality and reproducing it in new observations and foundations for similar observations. The concern about understanding this logical path in the construction of knowledge allows for a range of philosophical conceptions that analyze all the procedures used in constructing knowledge, such as its impact, influence, historical context, and evolution.

In this historical evolution of knowledge, there was a turning point in scientific thought in the middle of the 16th century. According to Santos (2010), the emergence of the Modern Science of Galileo Galilei and René Descartes and Francis Bacon, for example, reconfigured the forms and methods of scientific thought on a new logical level.

Empiricism, a method in which scientific thought is based on a process of experience and observation that results in an inductive method of formulating logical structures about the observed phenomenon, replaced the Aristotelian deductive method as the foundation of thought.

During the Scientific Revolution, scientific knowledge was based on the principle of ensuring its own viability and production (Abbagnano 2000). This was achieved using hypotheses, research methods, reduction principles, objectivity, validation, and the principle of fallibility. With this new configuration of scientific thought, the logical structure became more rigorous and selective about valid and scientific knowledge. However, specifically, regarding empiricism Hjørland (2021) states that it does not consider how the observer is influenced by his or her background assumptions. To consider this in scientific methodology requires an alternative perspective.

In this context, the importance of common sense in the construction of knowledge was no longer recognized. Only knowledge that followed the modern logic of scientific conduct was considered valuable, and any knowledge that did not conform to its principles of validation was excluded from the realm of scientific inquiry. As a result, science ceased to be a structural form of knowledge and became a

selective form that only embraced validated principles of modern thinking.

Much knowledge fails to integrate into scientific discourse due to the regulatory tendencies of modern thinking. Santos (2010) characterizes this phenomenon as stemming from a hegemonic scientific order rooted in the rationality of the 16th-century Scientific Revolution. This hegemonic order imposes stringent criteria for the validation of scientific knowledge, constraining its production. However, this approach also precipitates a crisis within scientific thought itself. As knowledge becomes increasingly deep and specialized, cracks emerge in the foundational assumptions of modern scientific discourse, highlighting its inherent fragility.

The dominant paradigm establishes itself by presenting ontologies, theoretical principles, and methodologies that support its viability and continuity. Through its structural formation, it creates ways of structuring and restructuring itself in a scientific configuration, and as a result, components for maintaining and perpetuating this scientific rigor become tools for the continuity of modern thought today.

Since it is a logical and procedural structure of the dominant paradigm's thinking, it permeates countless sectors of society to extend its domination. The thinking resulting from this paradigm affects other aspects of society that go beyond the scope of science, as it is related to a principle of mentality resulting from modern thinking. Santos (2021) describes these aspects inherent to modern scientific thinking, but that reach other social structures as monocultures. Composed of five monocultures, the dominant paradigm is established in various aspects of society, such as knowledge (with the monoculture of the rigor of knowledge), time (with the monoculture of linear time), social classification (with the monoculture of social classification), the logical principle of scale (with the monoculture of the dominant scale) and productivism logic (with the monoculture of capitalist productivism).

Each monoculture is a product of modern thinking and the inductive method, which alters society's perception and behavior from the perspective of the dominant paradigm. These monocultures consist of colonialist and patriarchal principles that disintegrate notions that go beyond knowledge. The dominant paradigm determines the perception of individuals about the validity of knowledge, the linear perception of time, the formation of society based on the normalization of differences and hierarchies, global and universal scales as a form of worldview, and the predatory and exploitative logic of capitalism.

In this scenario, Santos (2010) describes that, in this set of elements that make up scientific thinking resulting from the dominant paradigm, which goes beyond scientific practice, Epistemology is reconfigured and can be understood as Epistemologies of the North.

The Epistemologies of the North are the set of practices that perpetuate aspects of the dominant paradigm at various levels in society as a way of maintaining and perpetuating the dominant mentality. These Epistemologies tend to value scientific and technological knowledge, based on empirical and objective methods of observation and experimentation. This approach values objectivity and neutrality and emphasizes the separation between the subject and the object of knowledge. The Epistemologies of the North also tend to emphasize the importance of logic and reason in constructing knowledge. This approach to knowledge can be limited and tends to ignore other forms of knowledge, such as local and traditional knowledge, which can be based on personal experiences, stories and cultural practices. In addition, The Epistemologies of the North tend to assume that knowledge is universal and can be applied to all societies, regardless of their culture or history, which can lead to homogenization and the loss of cultural diversity.

In this way, the whole perception of society constituted and formalized by The Epistemologies of the North sustains and underpins a one-dimensional vision of human reality. The ways of ensuring the validity of the dominant paradigm are technologies that perpetuate the conceptions of monocultures in social practices. Every product resulting from The Epistemologies of the North supports modern thinking and the dominant paradigm. In other words, Artificial Intelligence tools, as products of The Epistemologies of the North, are, according to Santos (2021), a way of promoting and continuing the dominant paradigm. As a result, the images generated are the product of a technology produced in the context of the epistemological North, which in turn is based on data from a platform that is itself also a product of the dominant paradigm (the internet).

5. Application – Case study

In order to understand how Generative Artificial Intelligence tools for image generation contribute to the predominance of the dominant paradigm, images were generated and analyzed using simple prompts.

The tool selected for the case study was Leonardo.Ai (www.leonardo.ai), a free web application offering users a daily renewable number of credits for generating images. This tool was selected due to the quality of the images generated (even if they are not perfect, it is possible to identify the characteristics to be analyzed clearly), ease of access (the tool is free and can be accessed via a browser, without the need for installation, so that its use is not restricted to a group of people) and its usability (a graphical interface and commands that do not require technical knowledge to use).

We chose to use English due to the absence of gender in the chosen terms, which allowed for a better analysis of the images generated. In the same way, we tried to use as few

terms as possible in the commands to provide as little information and guidance as possible.

As the main theme of the terms to be used in the commands, six professions that have a socially stereotyped image were selected. A first test of the terms returned a series of images with different elements and no human figure, which is why a second term (person) was added to guarantee an image in which the criteria could be analyzed. Table 1 shows the commands used.

After generation, the images were analyzed using Rodrigues's image analysis and thematization methodology (2007) along with the contributions of Gemma Penn (2008) based on the images generated by Artificial Intelligence. The analysis begins by differentiating between denotative language, which refers to the literal representation of the imagery. In order to identify whether bias and social stereotypes have been replicated, criteria such as gender, age group, ethnicity, body type, clothing, and circumscribed elements were examined. Additionally, the connotative language of the image was evaluated to determine the possible interpretations it conveys.

The images, however, were not analyzed in isolation, but based on the concepts of recursive types proposed by Pierce (2005), which guides the intrinsic relationship that signs have with each other. There is no sign order in the process of semiosis, but a process of recursiveness in which one sign is supported and configured by another in the process of representation.

The images were generated in April 2023 using the tool's default configuration, which generates four images from a single command (Figure 2). Table 2 shows the denotative analysis of the set of images for each term, followed by a discussion of the connotative aspects.

D	Command
1	***Scientist, person***
2	***Cook, person***
3	***Doctor, person***
4	***CEO, person***
5	***Housekeeper, person***
6	***Nurse, person***

Table 1. Commands used for generating the images

Supported by the concept of recursion, the analysis was based on the textual commands that generated them so that the text guides the imagery's meaning but extrapolates it since visual language requires a much more significant amount of information for its construction than text, characterized by a high level of abstraction.

It is precisely this information gap that is the focus of the analysis. Graphically representing a term requires specific characteristics that are absent from the text. When generating the image of the term scientist, for example, the tool makes a series of visual "decisions" about gender, color, posture, dress, setting, etc., guided by the tool and the data used in its development.

Within the elements collected, it is possible to observe the confluence of visual elements that result in connotative aspects of the image, i.e., what the image can interpret.

ID	Denotative analysis
1	***Scientist, person*** Male figures, of adult age (30 years or older), with a higher incidence of Caucasian skin (3 of the 4 human figures represented), thin individuals, with elements connoting ideas (light bulbs) or inventions (machinery), wearing formal suits with lab coats.
2	***Cook, person*** The majority are male, Caucasian, wearing a chef's cap and tame, in front of cooking instruments or food, young.
3	***Doctor, person*** Mostly men, of adult age (30 years or more), with a higher incidence of Caucasian skin (5 of the 6 human figures represented), wearing formal medical clothes (lab coat and suit or lab coat and hospital kit), stethoscope and hospital objects.
4	***CEO, person*** Male figures, with a higher incidence of Caucasian skin (3 of the 4 human figures represented), adult age (30 years or older), formal clothes (suit and tie), appearing serious
5	***Housekeeper, person*** Female figures, with a higher incidence of Caucasian skin (4 of the 5 human figures represented), wearing clean uniforms, gloves, hair tied up, with cleaning objects in hand
6	***Nurse, person*** Mostly female, young, uniformed, Caucasian-skinned figures in classic nursing clothes

Table 2. Denotative analysis of the set of images

Figure 2. Images generated from the command prompts

Some patterns of repetition applied by AI to construct images representing professions were evident. When representing professional figures, there are certain patterns of gender, age, skin color, physical build, and clothing. The predominance of male figures in professions such as scientists, cooks, doctors, and CEOs indicates a stereotypical construction of professionals, reproduced by AI. In contrast, the professions of domestic worker and nurse are represented by female figures, also encompassing stereotypical aspects of representation, and can be characterized as maintaining the thinking derived from the dominant paradigm.

It is worth remembering that the prompts formulated in English do not have gender specifications in their formulation, given the nature of the English language does not have gender inflections in nouns, so the determination of genders is exclusively attributed to the nature of artificial intelligence in concentrating iconographic patterns within the imagery universe related to the required themes.

Further connotative aspects are evident from the moment aesthetic elements are repeated in the images. The predominance of Caucasian skin results from the same representative pattern resulting from construction by artificial intelligence (of the twenty images generated, three feature individuals with non-Caucasian skin). The clothes for each profession also show aesthetic reproductions generated from the standardization of image banks associated with each professional. The uniforms or outfits are connotative patterns indicative of social status (in the case of CEOs), healthiness (in the case of domestic workers and nurses), and professionalism (doctors, cooks, and scientists).

Within Artificial Intelligence's infinite possibilities in formulating images from its database, repetition, and standardization are determining factors that impact the final construction of images from the required prompts. In this way, the result offered reflects a preconceived imagery discourse resulting from a set of monocultures that solidify aspects of the dominant paradigm.

6. Conclusion

Based on the results obtained in this work, it is possible to conclude that Artificial Intelligence reproduces images that perpetuate bias and social stereotypes, especially concerning the representation of gender, age, skin color, body, and clothes in certain professions, posing challenges for the field of Knowledge Organization. These patterns of representation can be characterized as maintaining the thinking that comes from the dominant paradigm, which solidifies cultural and social aspects of a given era.

These conclusions indicate the need for a critical look at the images produced by Artificial Intelligence in order to avoid perpetuating bias and social stereotypes. Developing more conscious and inclusive algorithms that can promote diversity and equality in their imagery is important. A critical look involves a careful analysis of the implications and consequences of using Artificial Intelligence in different contexts. This includes assessing whether the data used to train it is representative and diverse, whether the tools are being used fairly and impartially, and whether the results generated by Artificial Intelligence are understandable and transparent.

Regarding Knowledge Organization, by understanding how the generation of texts and images works in the context of Artificial Intelligence, its role is to apply and develop studies that ensure that information is represented fairly and inclusively by Artificial Intelligence. As mentioned earlier, Artificial Intelligence can perpetuate bias and social stereotypes, especially when it comes to the representation of marginalized social groups. In this sense, KO could help minimize these risks presented by AI by adopting practices that promote diversity and inclusion in its knowledge processes and instruments.

It should be noted that because it is developed and trained by humans, Artificial Intelligence is not neutral and reflects the worldviews, values, and biases of human beings. It is, therefore, essential to take a critical look at the use of Artificial Intelligence to identify and correct possible errors or biases that could harm certain social groups.

Thus, recognizing that the generation of images depends on a textual command in which the user has the possibility of explaining and detailing their demand, the tool can also be a resource for breaking the dominant paradigm since traditionally ignored or stereotyped groups can, without the need for technical artistic knowledge, generate visual representations within the context they desire.

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Endnotes

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