Exploration and Interpretation of Current Bibliometric Data: Ethical Implications of Artificial Intelligence

Exploración e interpretación de datos bibliométricos actuales: implicaciones éticas de la inteligencia artificial

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INFORMACIÓN DEL ARTÍCULO

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Abstract
This study submerges into the bibliometric data of AI ethics and explores the different conclu-sions regarding the ethical implications of AI to answer what is the current state of knowledge on the ethical dilemmas that AI brings, while discussing what are the ethical principles or con-clusions that are being identified as ethical in AI implementation. By gathering the data from Scopus and Web of Science, using keywords of ethics, AI, business and social, in order to be able to identify the ethical implications of AI in both society and companies. Then analyzing it using Litmaps, Tree of Science, Core of Science, and Vos Viewer. Concentrating on different sources of the field reveals important information of AI ethics: the countries that are researching the topic, the journals, the years of publications, the main keywords within the field, and other fields or areas of studies related to it. The observations can serve as potential directions for future re-search, policies, and more.

Keywords:
Ethics; artificial intelligence; business; social; bibliometrics.
JEL Classification: O33 - M14.

Resumen
Este estudio se sumerge en los datos bibliométricos de la ética de la IA y explora las diferentes conclusiones con respecto a las implicaciones éticas de la IA para responder cuál es el estado actual del conocimiento sobre los dilemas éticos que trae la IA, al tiempo que discute cuáles son los principios éticos o conclusiones que se identifican como éticos en la implementación de la IA. Al recopilar los datos de Scopus y Web of Science, utilizando palabras clave de ética, IA, negocios y sociales, para poder identificar las implicaciones éticas de la IA tanto en la sociedad como en las empresas. Luego, analizándolos utilizando Litmaps, Tree of Science, Core of Science y Vos Viewer. Concentrarse en diferentes fuentes del campo revela información importante de la ética de la IA: los países que están investigando el tema, las revistas, los años de publicación, las principales palabras clave dentro del campo y otros campos o áreas de estudio relacionados con él. Las observaciones pueden servir como posibles direcciones para futuras investigaciones, políticas y más.

Palabras Clave:
Ética; inteligencia artificial; negocios; redes sociales; bibliometría.
Clasificación JEL: O33 - M14.

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Introducción

Code is both our greatest threat and our greatest promise (Lessig, 2006, p. 6). The evolution of artificial intelligence across the world over the last years has led to a new eth-ical dilemma that experts around the world still do not seem 100% certain of its solution. AI-powered machines and algorithms have changed people´s lives and works, it should be safe to say that something with that impact should at least have a general set of rules and overall ethical principles; but it does not. Ethical topics such as corporate social responsibility has already being studies, however, AI brings a whole new urgent need for a deeper understanding of both corporations that use AI, individuals, the developers, and society.

While obtain the different bibliometric data, multiple differing hypothesis were found. Some studies claim that there is a normative obligation of developers of the ethical implications of algorithms, and corporations and firms are responsible for the design of the algorithms within the firm stating that the ethical obligation behind AI is the developers, the creators, or the firms/companies that create it (Martin. K, 2019). On the other hand, other studies defend that AI could be overused and ends in devaluating the human skills, removing human responsibility, reduces human control, and overall ends human self-determination arguing that the final responsibility of the ethical implications of AI falls in the shoulders of the user, and it is up to the user to not take away the human and fair side of the work by overusing AI and removing the responsibility of the work they do by claiming later it was done with AI (Floridi et al., 2018). Falling in between, other studies claim that both involved have responsibility: the company or developer should include implementing strong data protection measures, ensuring transparency in the collection and use of personal data, and regularly assessing and updating security protocols; the in-dividuals have the responsibility of being aware of protecting their personal information online and to stay informed about new developments and opportunities with AI (Mazurek & Malagocka, 2019).

As a whole, these studies find that there are ethical implications in the use of AI, and the use of this tool is compromising the ethical principles and general rules already stablished. Calls to tame and prevent undesirable consequences of AI on humanity are multi-plying (Fioravante, 2024). AI is failing, AI systems are developed not in accordance with societal values such as justice. When firms apply ethics in their use of AI is most of the times because of a marketing strategy and not as a decision from the software or algo-rithms developers (Hagendorff, 2020).

The body of knowledge that scientific research contributes to the topic of AI ethics is vast and as explained previously, varied, specially over the last few years. With this last growth of research, also emerges the urgent need to keep track of all this research and to be able to recognize the current state, and to analyze

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the evolution of the topic over time, its tendencies, trends and more. This is why the bibliometric study of AI ethics can provide important conclusions about the future trajectory of the study of artificial intelligence, its application, its impact, and its ethical implications and considerations, and do a mapping of the topic to analyze the numerous and diverse opinions worldwide. Doing this type of study is important because prior editorials and review papers highlight a range of important purposes and key potential contributions. At the end, a bibliometric study of a field of study can highlight gaps in the body of research, derive future research directions, note important temporary and location interests, etc (Hulland & Houston, 2020).

This paper starts by analyzing the work of Luciano Floridi, Josh Cowls, Monica Beltrametti, et al (2018): AI For People - An Ethical Framework For AI In Society; which presents a synthesis of five ethical principles and 20 recommendations to assess as AI ethically while recognizing the opportunities and risks associated with it (Floridi et al., 2018). This is the starting point of all the bibliometric data of this study, that appears as the interests in this specific paper opened the door for the exploration of the whole research field on the topic. The different conclusions and theories regarding ethical implications of AI and how to implement ethical principles in AI use and development, are explored to reach the final goal of answering the following question: What is the current state of the knowledge of the ethical dilemmas that AI can bring and their solutions?

Materials and Methods

This paper attempts to do an interpretation of the tendencies of the current knowledge available about the ethics of artificial intelligence as a tool for business, individuals, consumers, etc. To have the base for the results further presented, a bibliometric extraction was made, in order to have a structure of the research of this area and to be able to analyze the different aspects of it.

The study method of bibliometric analysis provides structuring and evaluation of components of the chosen area, key to analyzing the scientific output published around the world, by identifying, and organizing the main elements or indicators of the topic in question (Aria & Cuccurullo, 2017).

This study was done with different tools: Litmaps, Scopus, Core of Science, Web of Science, Tree of Science and VOS viewer; each with its own stages and purposes:

Litmaps

This paper starts by analyzing with Litmaps the work of Luciano Floridi, Josh Cowls, Monica Beltrametti, et al (2018): AI For People - An Ethical Framework For AI In Society. Litmap creates interactive literature maps with collections of articles that make up a research topic. It has a literature database and automatically generates a map that helps with the research process, by

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helping find rele-vant papers related to the research scope, and builds connections between pa-pers, authors, journals, etc. With Litmaps, a "literature mapping" was made, which explored connections between the publication we used a "base" in order to conclude if there were connections and finally decide if there was a need to do this exploration or not.

Scopus

To do a proper literature review for this paper, it was important to retrieve the bibliometric data. Scopus was the main and first tool to do so, given the wide-spread availability of sources in this database, which are relevant, transparent and reliable research.

Scopus is a multidisciplinary database of review literature that includes books, conference proceedings, papers, articles, scientific journals and more. As a tool, it delivers an overreaching complete overview of the research output in different fields such as technology, medicine, social sciences, arts and much more.

In order to get the bibliometric data needed, four key words were selected from the field of research: ethics, AI, business, social. With these four key words the huge scope of research was narrowed down to four words that could accurately describe and summarize the research topic in order to find the most aligned research documents of this field of research. Scopus had a total of 124 documents that aligned with those keywords.

The data was extracted and exported following these steps:

1. Select export to initiate the process of exporting
2. Select file type

- Bib text file type was selected in order to use it for Core of Science
- CSV file type was selected in order to use it for VOS Viewer

3. Select range of documents (0 to 200 was selected in this case)
4. Select the information to export (all information was selected)
5. Besides exporting to use in other tools, Scopus also gives a further analysis of the sources by selecting "Analyze results".

Web of Science

Is the collection of databases of bibliographic references from publications of science, social science, arts, humanities, and more, that collects information from more than one century ago. In order to get the bibliometric data needed, three key words were selected from the field of research: ethics, AI and business. Web of Science had a total of 142 documents that aligned with those keywords.

The data was extracted and exported with the following steps:

1. Select export to initiate the process of exporting.
2. Select type file.

- Plain text file has selected in order to use for Tree of Science.

3. Select range of documents (0 to

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100 was selected in this case).

4. Select the information to export (full record and cited references was selected).

Core of Science

Core of Science is a web-based tool used for scientific articles selection, based on effectiveness (accuracy of the results), simplicity, and innovation (continuous improvement), with three main advantages:

1. Decreases the time interval bias in the search.
2. Decreases bias of the databases indexed.
3. Diminishes the rigor of the keywords.

In order to properly use this tool, the database extracted from Scopus (Bib text file type) was used.

The data was processed following these steps:

1. Drop the Bib text file downloaded from Scopus into "browse".
2. Wait for the data to be processed
3. Download any practical and relevant analysis.

Tree of Science

Tree of Science is a pioneering division of Core of Science. It is as well dedicated to advancing science as a tool that opens the world of scientific discovery and analysis by offering visual analysis of the complex science data. As Core of Science, this tool also offers a division of the data and references into different groups: roots, trunk, branches and leaves.

The data was processed following these steps:

1. Select the "Plain text file" as the file type from Web of Science.
2. Drop the file into "plant your seeds".
3. Wait for the tree of science to be created and do any relevant analysis.

VOS Viewer

VOS Viewer is a software tool to construct and visualize bibliometric networks based on different aspects such as citation, cocitation, countries, etc. This allows to explore the structure and dynamic of the research in a specific field, in this case AI ethics, in a further and deeper way.

To run the analysis in VOS viewer:

1. Open VOS Viewer.
2. Go to "Create" to create a map based on the references, sources or bibliographical data.
3. Select "Create a map based on bibliographic data".
4. Select "Read data from bibliographic databases files".
5. In this case, since working with Scopus: choose Scopus and "scopus.csv" or the downloaded file.

For an analysis by keywords:

1. Select "Co-ocurrence".

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2. Select “All keywords”.
3. Select “Full-counting” and click next.
4. Minimun number of occurrences was set at 4.
5. 32 words met those criteria click next and finish.

For an analysis by countries:
1. Select “Citation”.
2. Select “Countries”.
3. Maximum number of countries per document was set at 2.
4. Minimum number of citations of a country was set at 2.
5. 50 countries met those criteria.
6. Select the option of only doing the analysis with those which are connected when asked by clicking “yes”. Only 30 met that criterion.

For an analysis by journal:
1. Select “Co-citation”.
2. Select “Cited sources”.
3. Minimum number of citations was set at 14.
4. 21 Sources met those criteria.
5. Select the option of only doing the analysis with those which are connected when asked by clicking “yes”. Only 20 met that criterion.

Results

The results are divided into nine parts, each focusing in a different element of the bibliometric analysis conducted. Further explanation and the most relevant implications of the results will be discussed in the following section (Discussions).

LitMaps

Figure 1 demonstrates that AI ethics does has a relevant sources to explore from in order to continue this study. Only one reference got multiple connections with other sources from this field of study. Litmap was able to find connections with more research docu-ments which provided a clear idea that there are in fact a vast scope of research in this area.

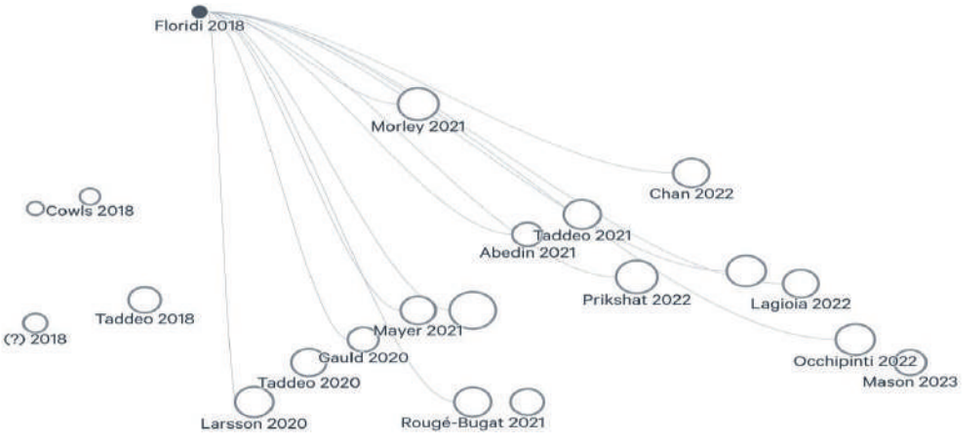

Figure 1. Litmap of base study: AI For People – An Ethical Framework For AI In Society (Floridi et al., 2018).
Source: Made by Litmap.

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Tree of science

The tree of science in figure 2 gives a first general impression of the structure of the bibliometric data of the field of research: AI ethics. It divides the references in four main groups: roots, trunk, branches and leaves.

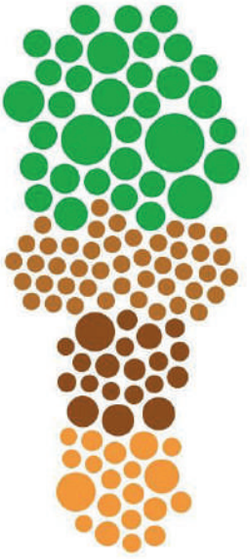

Figure 2. Tree of Science.
Fuente: Made by Tree of Science.

The roots (yellow) symbolize the foundational works in the field, the building blocks, the base of the whole knowledge. This are the origin point for the rest of the publications. In the tree of science of this field, it is possible to see that there are not as much roots as there are other publications. Within the roots of the field of AI ethics, 20 results were given. The first article of the "roots" concluded that there were five ethical principles that consti-tute the current state of what AI ethics is (transparency, justice and fairness, non-maleficence, responsibility and privacy) (Jobin & Ienca, 2019). Another root was the main document this study is based from which talks about the risks and opportunities of AI, offers 20 recommendations to ethical AI and suggest to take them into consideration for policies (Floridi et al., 2018). Regarding the development of AI, another root states the fact that we should not yet celebrate a consensus around ethical principles, such as the previous principles stated, because AI development lacks common aims and fiduciary duties, professional history and norms, proven methods to translate the principles into practice, and a robust legal accountability mechanism (Mittelstadt, 2019). Overall, the 20 "root" documents are base references of the field, and share general but important infor-mation of AI ethics as a whole.

Next, the "trunk" (dark brown) publications serve as the central column, and are works derived from the roots. They tend to establish further theories that have continue over time and give a structure to the field of research or find the applicability of the stud-ies. Within the trunk, the field of AI ethics got 20 results. The first one explored ethics based AI auditing, reviewing on the conceptualization of the ethical principles. It structured AI auditing in three types of knowledge contributions: guidance, methods tools and framework, and awareness and empowerment (Laine et al., 2024). Other trunk docu-ment attempted to bridge the gaps between the theoretically discussed ethical principles of AI and the practical steps for effective governance of AI with the goal of limiting the dangers and increase the benefits of AI to individuals,

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organizations and society (Shneider-man, 2020). Another one, tried to contribute from three angles grounded in international human rights Law, Law and Technology, Science and Technology Studies and theories of technology, to the field of AI governance; it reviewed the last regulatory development and focused on human rights to extend the human rights obligations to the context of AI governance (Koniakou, 2023). As a whole, the trunk documents tend to explore the application of AI ethics in reality, and apply it to more practical concepts such as governance, law, human rights, and review the explorations from the "roots" in order to structure it.

Then, the "branches" (light brown) of the tree are the publications that open different subfields or specialized areas in the field. It is possible to interpret that there are already multiple bibliographical references that establish diverse opinions, theories and topics is this area of research, which makes the need to do this bibliometric study even bigger. This, since the bibliometric data was divided into three main branches.

Branch 1: The first reference of branch number one addresses the perks and limits of CSR (Corporate Social Responsibility) when confronted with the debates of AI ethics in business organizations and even explores "digital washing" which is an event in which a company uses the term "digital" or use technology to create a misleading idea of a product, company or individual. This study reviews how to treat moral cases in companies when confronting AI-related ethical dilemmas (Fioravante, 2024). Other document from this branch, took three business books on AI and explored the automation in management, machines taking over humans and humans working close with machines for a task, and analyzed the possible negative and positive organizational (business) and societal outcomes, concluding that management scholars should research the use of AI in organizations (Raisch & Krakowsli, 2021). As a whole, this first branch navigates towards the business management part of AI ethics.

Branch 2: Branch number two gathers more field-specific studies, directed towards medicine, such as "AI and Professional Liability Assessment in Healthcare. A Revolution in Legal Medicine" that explores how AI has changed healthcare delivery but still pre-sents ethical and legal dilemmas (Terranova et al. 2024). As well as "Understanding Lia-bility Risk from Using Health Care Artificial Intelligence Tools" that reviews the challenges arising in malpractice litigation related to software errors in health care (Mello & Guha, 2024). Further analyzing of the research of AI ethics related to medicine is explored in the discussions of this study.

Branch 3: The first reference of branch number three explores how AI systems has brought ethics into Software Engineering, and how to explore abstract ethical principles into features when developing AI and other systems in Software Engineering (Halme et al., 2024). Another study from this branch explores how the growing impact of AI

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may arise issues from its utilization, such as data privacy issues, which results in a need for ethical AI systems by developing ethical AI, and implementing ethical principles as requirements for their creations (Vakkuri, et al. 2021). This branch of the bibliometric data gathers documents that try to answer the question: What should developers and the or-ganizations that develop AI do?

Finally, the leaves (green) represent the most recent publications in the field of AI ethics, in a time lapse of less than 5 years. The result of this first part of the study concludes that there are in fact enough publications to analyze. Within the leaves, the field of AI ethics had 31 results, most of them from 2024. One of them, explored a very debated topic in AI ethics: Chat GPT use. "Ethical Considerations in the Use of ChatGPT: An Exploration Through the Lends of Five Moral Dimensions" explores the ethical challenges (information rights, property rights, accountability, quality of life, etc) in the use of this tool, and underscores the importance of developing comprehensive ethical guidelines and policies since sophisticated AI is increasing its applications (Ghandour et al., 2024). For example, this document navigates the cases in which Chat GPT has generated rich creative output such as composing music, or creative writing tasks, which generate issues related to copyright, privacy, misuse and more (Ghandour et. al., 2024). Other document within the leave explores bibliometric data regarding fake news and also emphasizes in the tool of ChatGPT´s artificial intelligence in this topic, stating it shows promise is democratizing access to information and aid in research, however, ethical and accuracy related challenges arise since the model has the capacity of generating misleading or false information, which is both an ethical concerns and a problem in the fake news generation (Raman et al., 2024).

Analysis of bibliometric data as a whole

Table 1 shows the 15 most relevant academic documents published in the field of AI ethics according to Scopus and Core of Science. The result suggests that there is multiple academic interest in the ethical issues that regard artificial intelligence, and various areas of research such as marketing, digital transformation, community well being, spirituality, art and ethics as a whole. The analyzed bibliometric data collected is mostly dominated by documents that emphasize the relevance of structuring a framework to AI ethics, clearly stating the principles of it, and applying them.

The paper authored by Floridi et al, AI for People – An Ethical Framework For a Good AI Society, states that there is a need to find a direction of ethically and socially preferable outcomes from the development of artificial intelligence technologies, which should be done by acknowledging both the opportunities and the risks of AI in the world. It ended with formulating 5 concrete ethical principles that should be adopted in the design of AI (Floridi et al., 2018). Other of the academic documents also highlight the need to concentrate in finding a consensus of what AI ethics is, such as

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Aligning AI Optimization to Community Well Being by Jonathan Stray, that concludes that following community well -being metrics and putting it as the goal is a well-developed public policy that can be translated to the AI development (Stray, 2020).

Overall, most of the collection of the bibliometric data has a similar path of research, but some followed the research of AI ethics by focusing in a more specialized area like marketing, or arts. This gives a good impression of what is to come for this field of research, that is expanding into subfields in a fast rate, and complements the previous analysis of figure 2.

Analysis by author

Scopus had more than 100 documents that aligned with the field of AI ethics, however, the frequency of the authors.

Table 1.
Core of Science

Title	Year	Main author	Journal
AI for People – An Ethical Framework for a Good AI Society	2018	Floridi L	Mind and Machines
Unified Framework of Five Principles for AI in Society	2019	Floridi L	Harvard Data Science Review
The Ethics of AI Ethics: An Evaluation of Guidelines	2020	Hagendorff T	Minds and Machines
The Global Landscape of AI Ethics Guidelines	2019	Jobin A	Nature Machine Intelligence
Ethical Implications and Accountability of Algorithms	2019	Martin K	Journal of Business Ethics
Principles Alone Cannot Guarantee Ethical AI	2019	Mittelstadt B	Nature Machine Intelligence
Investigating the Impact of AI on Ethics and Spirituality	2023	Chakraborty S	Human Centered AI
From What to How: An Initial Review of Publicly Available AI Ethics Tools, Methods, and Research	2020	Morley J	Science and Engineering Ethics
Artificial Intelligence in Business: State of The Art and Future Research Agenda	2021	Loureiro Smc	Journal of Business Research
Leveraging Artificial Intelligence in Marketing for Social Good – AI Ethical Perspective	2022	Hermann E	Journal of Business Ethics
Aligning AI Optimization to Community Well-Being	2020	Stray J	International Journal of Community Well-Being
Ethical Considerations of Service Organizations in The Information Age	2024	Camilleri Ma	Service Industry Journal
Mapping AI Ethics: A Meso-Scale Analysis of Its Characters and Manifestos	2024	Gornet M	ACM Conference FAccT
From Reality to World: A Critical Perspective on AI Fairness	2022	John-Mathews Jm	Journal of Business Ethics
AI Led Ethical Digital Transformation: Framework, Research and l Implications	2022	Saurabh K	Journal of Information of Community Ethics Soc.

Source: Made by author.

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Table 2 shows the 10 most frequent authors in the bibliometric data extracted according to Scopus and Core of Science, which have a relatively low frequency of published documents.

Table 2.
Frequency of authorship

Author	Frequency
Floridi L	5
Morley J	4
Ryan M	3
Camilleri Ma	2
Cunneen M	2
Du S	2
Hagendorff T	2
Jobin A	2
Kaplan A	2
Ahmad K	1

Source: Made by author.

Analysis by journal or source

Table 3 and Figure 3 both serve as a visual representation of the frequency of the sources in the bibliometric data extracted from Scopus. Table 3 gives a better understanding of the quantity of publications per source, being the topic of AI ethics most pertinent in the Journal of Business Ethics, with 10 publications.

Table 3.
Frequency of journal publications in the field

Journal	Frequency
Journal of Business Ethics	10
AI and Society	5
Business Horizon	5
Ethics and Information Technology	3
Journal of Business Research	3
Minds and Machines	3
Nature Machine Intelligence	3
Business Information Review	2
AI Ethics Journal	2
Advances in Neural Information Processing Systems	2

Source: Made by author.

On the other hand, Vos viewer (Figure 3) gives an idea of the frequency of citation, represented by the size of the nodes, however, it serves more as a tool to see the connections between sources. It is possible to see than four main groups or clusters were formed. This can show the co-citation between journals, and which are more common to work together than others and are represented by the different colors in figure 3.

Analysis by year

The amount of research documents,

Figure 3. VosViewer: Map of scientific journals with the highest number of citations in the area of AI ethics.
Source: Made by VOS Viewer.

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academic literature, or bibliographical references published each year can provide valuable information and insights about the development of the research in this area, and the interest and knowledge in this field of science. In figure 4, it is possible to interpret with this data an indicator of interest seeing the significant increase in the number of documents published since 2018. This can mean that AI has had more relevance in ethics and more implications in society since this year and is currently in its all-time-high.

There has been a notorious knowledge expansion of AI ethics, that shows a notorious need for this knowledge as well. AI ethics has become an emerging priority for academics which proves again the increase in the influence of this topic in the world.

Analysis by country or location

The number of documents from this field published per country can provide insights about the research focus worldwide. It is interpreted with figure 5 that United States is by far more productive and focused on AI than any

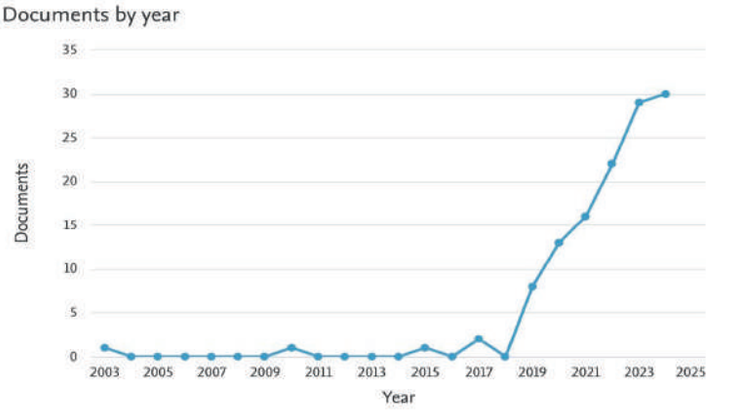

Figure 4. Scopus: Graph of documents in the field of AI ethics by year.
Source: Made by Scopus.

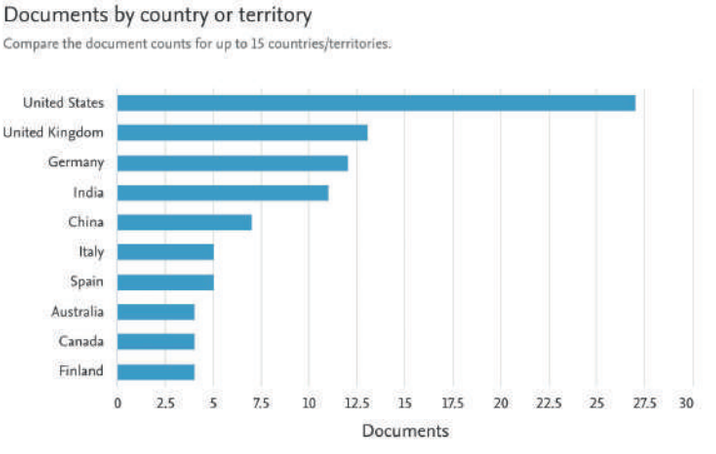

Figure 5. Scopus: Graph of number of publications in the field of AI ethics by country of origin.
Source: Made by Scopus.

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other country, which demonstrates expertise and specialization in this field and can also be an indicator of the influence AI and AI ethics has in United States, that consequently creates a higher need to be investigated than in other countries. Besides the United States, countries such as United Kingdom, Germany, India and China have also conducted most of the publications of the field.

VOS Viewer on the other hand (figure 6), also shows the connections between countries when researching and producing hypothesis in this field. More marked collaboration networks between certain countries were shown, represented by the different colors in figure 6 which formed 8 main clusters.

Table 4.
Clusters of countries collaboration networks

Cluster	Countries
Cluster 1	China, New Zealand, Norway, Singapore, Taiwan, United States
Cluster 2	Canada, Indonesia, Italy, Poland, Switzerland, Vietnam
Cluster 3	France, Germany, Saudi Arabia, Slovenia
Cluster 4	Ireland, Netherlands, United Arab Emirates, United Kingdom
Cluster 5	Cyprus, Greece, Hong Kong
Cluster 6	India, Portugal, Turkey
Cluster 7	Australia, Belgium
Cluster 8	South Africa, Spain

Source: Made by author with information from Vos Viewer.

This can give a further analysis of the collaborative efforts and importance of knowledge exchange in a topic that has become so relevant so quickly, and its rapid increase in impact has created the

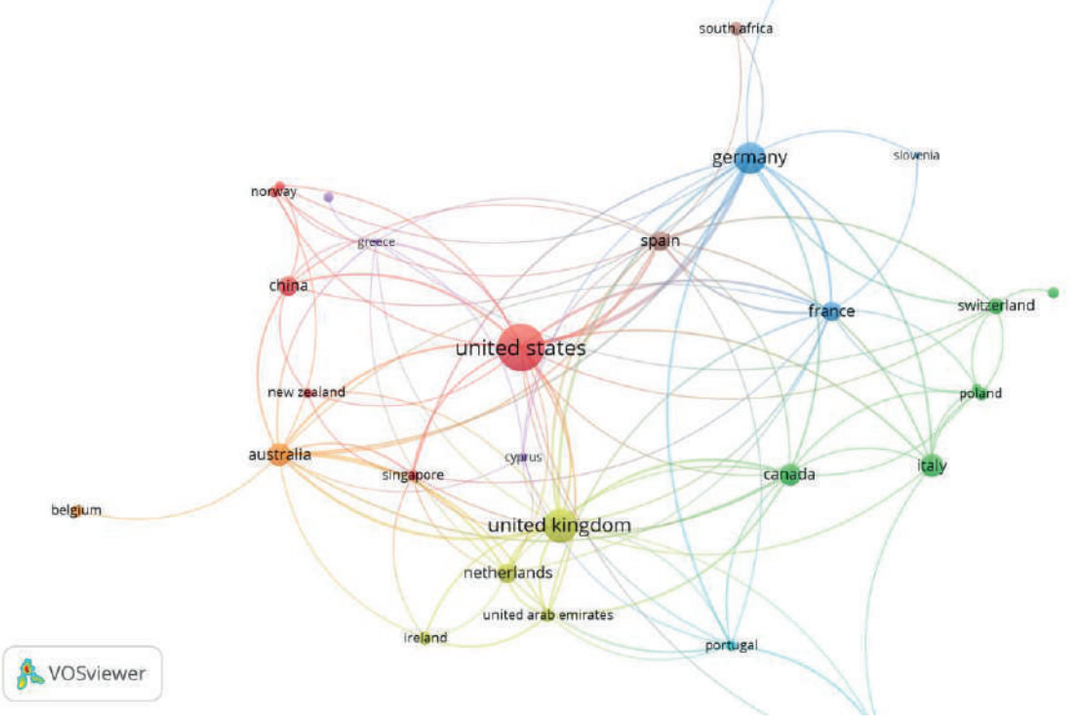

Figure 6. VOS Viewer: Map of connection of documents from different countries.
Source: Made by VOS Viewer.

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need for crosscultural perspective and a boost for complementary expertise from different regions.

Analysis by field

Analyzing the research publications regarding AI ethics connected with other interdisciplinary areas is important in this study because it can show in a deep way the emerging trends and the evolution of the scientific knowledge of AI ethics. For instance, the results demonstrate that AI ethics is evolving and becoming relevant in fields such as Business management, Social Sciences, and Computer Sciences. This information can be interpreted as a visual representation of the integration of AI in each area, which would create a need to know the ethical implications within it.

Analysis of keywords

During the analysis 32 available terms were identified. To better represent and sum-marize the results the minimum number of occurrences of the keywords was set to four. VOS Viewer provided a map of occurrence and connections (relationship of the keywords within the context of their use). This map shows the frequency of occurrence by representing them with different sizes. The most significant and most frequent keyword in the bibliometric data is artificial intelligence, which frequency is represented by its size.

This analysis can help identify the topics most frequently address when studying AI ethics and helps to understand as well what other fields of

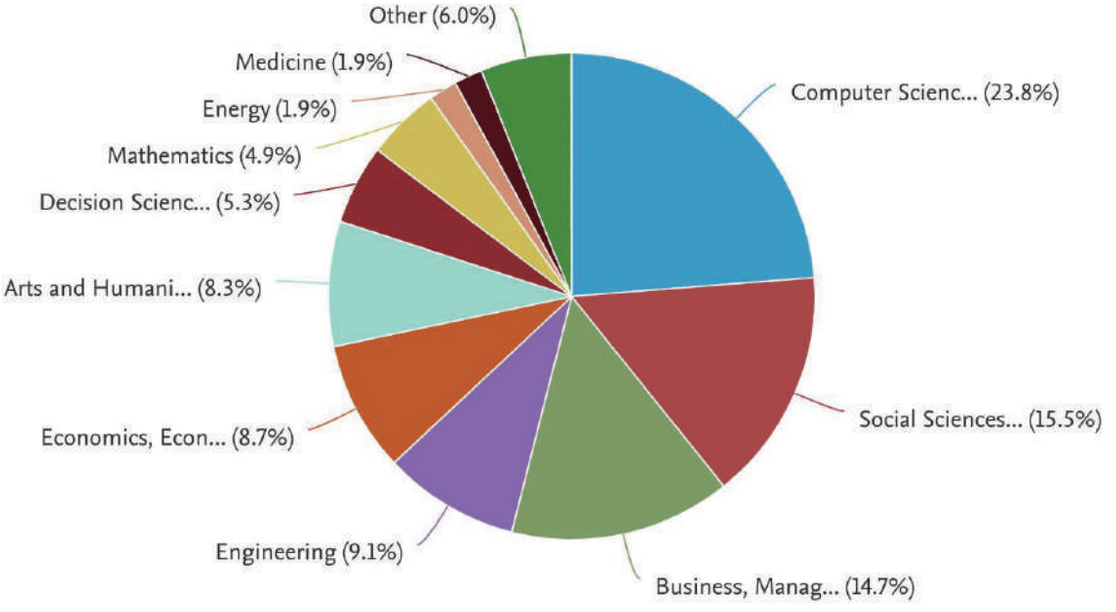

Figure 7. Scopus: Pie Chart of percentages of the bibliometric data in different subject areas- documents by area.
Source: Made by Scopus.

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science could be studied or connected when starting off ethical AI. This makes easier to understand the issues related to AI ethics and classify those AI ethics studies in different areas of interest. Four main clusters were identified by Vos Viewer in figure 8 and are represented by the colors:

Discussion

Structure of the bibliometric data

Figure 2 and its analysis offer a clear visualization of the structure of the references of AI ethics. Specially the branches, which demonstrate that this

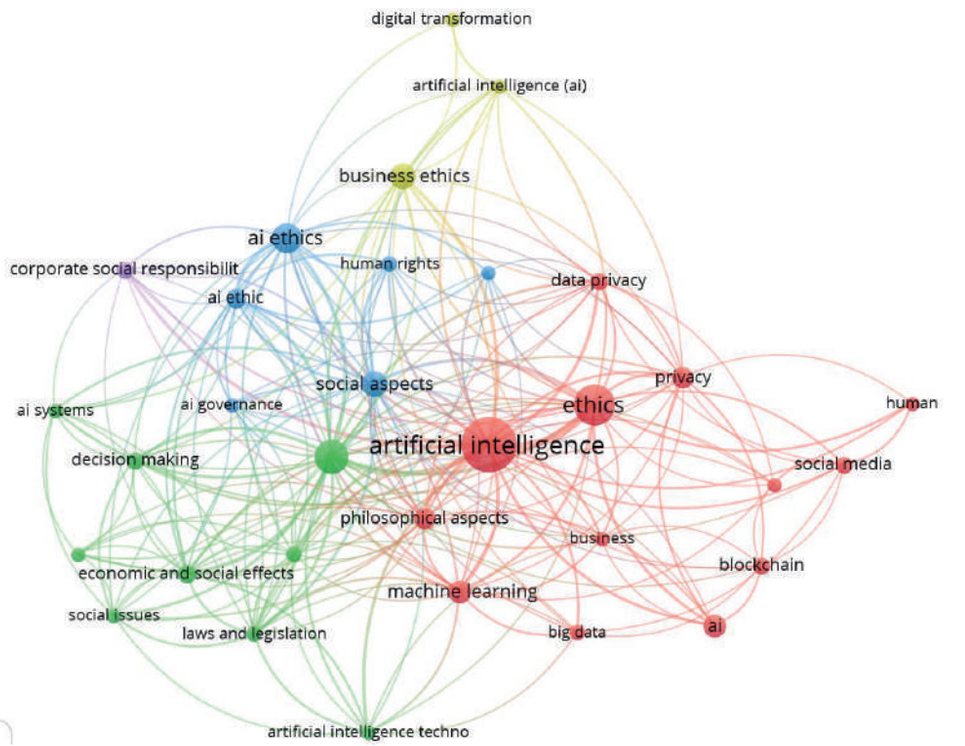

Figure 8. VOS Viewer: Keywords in the bibliometric data.
Source: Made by VOS Viewer.

Table 5.
Clusters of keywords

Cluster	Keywords
Cluster 1	AI, artificial intelligence, Big Data, Business, Data privacy, Ethics, Human, Machine Learning, Philosophical aspects, Privacy, social media, Social networking
Cluster 2	AI Systems, artificial intelligence technology, decision making, economic and social effects, ethical technology, laws and legislation, risk assessment, robotics, social issues
Cluster 3	AI Ethics, AI governance, Explainability, Human Rights, Social aspects
Cluster 4	Artificial intelligence, business ethics, digital transformation

Source: Made by author with information from Vos Viewer.

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field of research is starting to divide into topics: Business Management and AI ethics, Medicine and AI ethics, and the responsibility of the developers in AI ethical implications. Regarding Business Management, how algorithms are developed and implemented within managerial decision making is critical for business ethics, to understand and research (Martin. K, 2019). Regarding medicine, this study discuss this field separately later on, and those discussions lead to infer that the mere reason why medicine was interpreted as a whole other branch by Tree of Science was because of the extremely different topics discussed on medicine, which are almost impossible to mix with other areas of study, and not because medicine has taken a huge part of this field of research (AI ethics). Regarding the ethical responsibility of developers, the main discussion is how to implement principles of ethics in the construction of AI systems without limiting the whole amazing reach that the tool can have. The im-portance of this the research in this branch is reflected in the fact that 79% of tech workers report that they would like practical resources to help them with ethical considerations (Miller and Coldicott, 2019).

Finally, the leaves represent the most current information published, which is tending to enlarge knowledge in ChatGPT and generative AI. The fact that the research is focusing in this tool is extremely important since the decision making in a society is proportional and has a strong relationship with the quality of the information that society has. Tools like ChatGPT can both improve or decrease the assertiveness of the decision in a society, since it has the power to both detect or create false or misleading information. This research can serve both governments and firms to apply policies such as labeling AI-generated information.

Journal and authors

It is optimal to analyze the current state of the knowledge in the field of AI ethics when analyzing the bibliometric data by the amount of journals and the amount of authors that have entered this field of investigation. There is a big reference of AI ethics in the different journals worldwide: Journal of Business Ethics. This journal is at the top of the list of frequency of documents published in regards of this field, doubling the number of documents published by the number two and three journals in this list (AI and Society and Business Horizon). The rest of the list has only three or two documents published, even when being in the top 10 journals with most documents published in this field. The top 10 authors that have published documents in regards of this field also show a low amount which is concerning since they are the key reference nowadays to AI ethics information and most of the other authors are citing them for their research. This means, most researchers are basing their investigations in less than 25 documents if they are using these authors as the main source. The top 1 author has only 5 documents published and, most of the rest of the top 10 list authors have only 2. Connections between journals for further exploration

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is already taking place (figure 3) and the cooperation between is excellent for a better work and investigation of AI ethics. However, the data discussed before proofs that this field of investigation is not yet even near to being fully explored.

This is not a bad result, since this can serve as motivation to journals worldwide to enter a primarily new area of study and be part of the pioneer journals that create relevant conclusions of AI ethics that can be used in years to come. This last statement takes more strength when concluding that there is still multiple different versions, or perspectives of what AI ethics is as figure 2 and the analysis of it demonstrated. This means that there is no agreement between authors of a full truth, which opens the door for new theories and opinions, and demonstrates that the door is still open for that one author or journal that builds the idea that can be agreed as the best or truth by others.

Year of publication

When analyzing the documents published per year in the field of AI ethics, it is very clear the growing interest this field of science has had in the last 5 years. From the total of 124 documents gathered with Scopus that aligned with ethical AI, before 2019 less than 5 documents were produced each year, with almost every year from 2000 to 2010 producing zero documents. However, in 2019 the number of documents published in this field was doubled, in 2020 it increased again to almost 15, and in 2024 this number was doubled to 30 published in just half the year, being July 2024 the date of extraction of the data. It is clear with this data, that this field of research is maturing, more researchers are getting involved and getting interested in the topic which leads to the increase in exploration.

This is not a coincidence, since in the last 5 years AI has improved drastically in a fast rate that suggest that AI has gained prominence as a critical area of study since it has been applied in multiple fields, by governments, by individuals, by companies, and more. AI technologies has gained strength in the last years, especially after the global pandemic of COVID-19. The COVID-19 pandemic paved the way by increasing people´s openness toward these technologies (Van Quaquebeke & Gerpott, 2023).

With this bigger impact of AI, an ethical interrogate and threat was born. Just as every time a new medicine is created, a new way of working is rising, or a new policy is being debated, every new invention brings ethical implication with it. While developers and computer scientists enhance their abilities by creating algorithms that can function as AI, philosophers around the world, governments, the academia, and companies, need to study the ethical problems it can bring, and with it, they have the need to bring it to a concise set of principles or rules so that they can be interpreted and followed. Specially, be-cause they recognize the importance and relevance it has taken the last years, and the importance and relevance it will

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take in the years to come: Technology such as AI will inevitably solve problems in a more efficient, more predictable, less expensive and less risky way. The future is one which AI takes over leadership roles (Van Quaquebeke & Gerpott, 2023).

Countries

Figure 5, figure 6 and table 4 show both the quantity of publications and the dynamic of different countries in the field of research of AI ethics. This analysis is important because it can guide countries to start researching about the topic and highlights the global impact the United States has in the field. Besides that, eight clusters of countries were identified by Vos Viewer, which demonstrated the global collaboration that exists for re-search in the field. However, reinforcing the idea that this field of research is little explored worldwide, only 30 countries met the criteria of both researching in the field and collaborating with others to form a research network.

The clear dominance of the United States in this research field is correlated to variables such as funding, public policies, and big academia. United States, during Donald Trump´s administration, published the "American AI Initiative" in 2019, which states that the US promotes public and private partnerships to invest in AI development and resources of AI researchers, and includes promoting the responsible and ethical use of AI and implementing policies to do so (Johnson, 2019).

Besides the United States, other nations have recognized the transformational poten-tial of AI (Fatima et al., 2020). More than 60 countries have published their AI national strategies in the past 5 years, being Canada the first to do so in 2017 (Vats et. al 2022). The majority of countries that launched these strategies are developed countries (Holon IQ, 2020).

This study can serve as a call to action to countries to focus on funding of AI research and AI ethics research, because it is needed to construct a strong legal framework to both empower using AI across several sectors and protect consumers and developers in case of any AI-related legal problem. The previous statement is relevant specially to countries in South America, that have the opportunity to start researching and focusing towards AI ethics. Referencing Figure 5, Figure 6 and Table 4, no South American country entered the scope of the analysis because of the lack of research done by these countries.

Field of science

Regarding the evolution of AI ethics research in other fields of science, is also useful to conclude different ideas about interdisciplinary collaboration, which can help tackle different obstacles. For instance, Business Management is such a varied and complicated field, which encounters multiple ethical dilemmas. Responsible business, corporate social responsibility (CSR), and ethical conduct in overall are profitable for business (Juho, 2019). This would explain how mitigating an ethical implementation of

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AI is important in the field of Business Management, since there is a profit incentive. On the other hand, other authors state that AI ethics has itself become the subject of criticism. Most prevalent is the claim that AI ethics is merely "ethics washing" (Metzinger, 2019). This shows that there are diverse opinions in why AI ethics is being investigated in Business Management and used in this field, it could be for profit, or it could be as a mere tool to improve a compa-ny´s image. Despite the fact that there are diverse opinions, figure 7 shows that business management has a strong 14,7% of the bibliometric data related to it. With the integration of AI, new ethical dilemmas take place, and it is a good sign that they have started to integrate ethical AI in this field.

On the other hand, areas such as Medicine also encounters multiple medical dilemmas in its daily basis, and it has also started to incorporate AI as a tool in different medical fields. AI application in modern health care has boomed with the advancement of science and technology (Kermany et al., 2018). In the field of medicine, the implementation of AI technologies can foster predictions, diagnosis, and even treatment of diseases which benefits both the patients and the health care provider (Reddy. S, 2018) by increasing the health care quality for the patient and serving as a work tool for the medicinal personnel. Regarding the high functionality AI has and can have in medicine, figure 7 shows that only 1,9% of the bibliometric data of the field of AI ethics is related to medicine. These re-sults can be revelatory but useful to medical researchers that can be part of the pioneers in these investigations in its area. The results have important implications, because a lack of research of AI ethics in an area of science could mean a lack of funding, or a need to re-organize the priorities of the field as AI is becoming so relevant.

These results can be furtherly discussed when connecting it with the analysis by countries. According to the study published in the Journal of Medical Internet Research more than 95% of AI in medicine investigation was done by just 10 countries, mostly high-income countries, being United States the country of origin of more than 45% of them (Guo Y, et al. 2020). If other countries start focusing its funding or its academia in AI ethics research, AI ethics related to medicine can be created consequently.

Keywords

The identification and the analysis of different keywords of the bibliometric data can be an insight to how the research of this field is structured or categorized by themes. Referencing table 5, cluster 2 of keywords has words or phrases such as "decision making", "economic and social effects", "laws and legislation", and "social issues". This cluster gives a key insight that the research field is taking into considerations the implications of AI in humanity, which has led the research to start focusing on how it affects economy, the society, the human decision making, and has already started to question how laws and legislation needs to cover it.

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Cluster 3 has keywords such as “AI governance”, “Human Rights”, and “Social Aspects”. These two clusters show interest in the effect of AI in humans in a deeper way, not just in AI itself. On the other hand, Cluster 1 has a more technical focus, with keywords that integrate the development of AI and its reach to other digital tools (“AI”, “Big Data”, “Data Privacy”, “Machine Learning”, “Privacy”, “Social Media”) but still focuses also on its relationship with humans (“Human”, “Philosophical Aspects”, “Privacy”, “Social networking”).

Conclusions

AI ethics are taking huge predominance in research, since algorithms are implemented with the hope of being more neutral and taking better decisions that those per-formed by individuals by removing the human part of a decision. Examples of this could be sentencing, college admission, formalities prioritization and much more. AI systems and other can be less biased, more rational, and leave problems such as discrimination out of the equation. However, some authors conceptualize algorithms as value-laden ra-ther than neutral and recognize that they create moral consequences for stakeholders or people involved, so there are still ethical dilemmas taking place.

The final goal of this study is to answer the following question: What is the current state of knowledge of the ethical dilemmas that AI can bring and their solutions? To answer this question, the bibliometric data of AI ethics was analyzed, extracting it from Scopus and Web of Science and processed in other tools such as Vos Viewer, Tree of Science and Core of Science. The answer to this question, is that there is still no agreement between authors since there are still new theories being developed and authors are still studying other authors´ theories on how to take AI ethics into real life, translating already accepted ethical principles of society, such as justice, autonomy, nonmaleficence, beneficence and more, into clear instructions that can guide AI into a more ethical development and use, without limiting its scope of reach and utility.

Adding to that, the field is studying areas such as business implementation of AI ethics, medicine in AI ethics and the ethics behind the development of AI. The journals and authors more specialized in the research of the field, still have relatively a small amount of research conducted, which means that this are of research is still being explored and maturing, which can serve as motivation to researchers around the world to enter this area of study. Specially, since during the last years AI ethics research has been increasing and is now in its bigger level, consequently, this study should be done again in the future, since, according to the tendency, the bibliometric data is still being produced.

United States is the country producing the most of this bibliometric data, so it has a clear dominance in this field of science, and this study should serve as motivation for other countries to invest or incentive funding in this field of research,

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especially in its application in medicine, area in which AI has a high ethical implication but has a little per-centage of the bibliometric data related to it. Continuing research in this field is extremely important, because technology such as AI will inevitably solve problems in a better way (more efficient, predictable, less expensive or risky), however, there are a lot of threats attached to it, ethical threats that should be controlled. As an example, some of these threats are being research in the last years with the integration of Chat GPT or generative AI, which can both improve or decrease the assertiveness of the decisions taken in society since it has the power to create or detect fake information.

The importance of the research in this field is enlarging, since AI is experiencing a period of rapid expansion, and new tools are being created constantly, and AI is feeding, nourishing or training itself every second.

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Authors' contribution

María Emilia Luna carried out the primary literature review, analyzed the data, and reported the findings. Givanna Triviño and Emilia Rosas were involved in the extraction and verification of individual study data. Cristian Sáenz De Viteri supervised the process, reviewed the draft manuscript, and provided feedback.

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Data availability

Data is provided within the manuscript.

Declarations

Conflicts of Interest

The authors declare no conflicts of interest.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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