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REVIEW

AI in Scientific Research: Automation, Original Discovery, and Ethical Collaboration

La IA en la investigación científica: automatización, descubrimientos originales y colaboración ética

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ABSTRACT

Generative artificial intelligence (AI) is dramatically changing scientific research processes because of its ability to contribute to the various phases of the scientific method, allowing researchers to accelerate the scientific production process. However, the obstacles and restrictions posed by the use of AI are significant due to biases related to the ethical use of models and frameworks that foster a sense of responsibility and ethical principles in the application of AI. The aim of this study is to identify the main research trends related to the use and application of AI in scientific production; accordingly, this article presents a systematic literature review using the Preferred Reporting Items for Systematic Reviews and Me-ta-Analyses model (PRISMA). A total of 4334 records were obtained from the Scopus and Web of Science databases and thoroughly reviewed, selecting 233 for qualitative and quantitative analyses. Four major trends in the use of AI in scientific research were identified, associated with the conceptual cycle of the scientific method: 1) scientific discovery, 2) data management, 3) academic writing, and 4) scientific communication. The ethical considerations highlighted in the literature advocate for the establishment of clear policies and frameworks within academic institutions that enable researchers to use the tools effectively throughout educational processes. Rather than focusing on debates about the use of AI, this approach promotes an ethical and efficient integration of AI into scientific.

Keywords: Artificial Intelligence; Bibliometric; Scientific Publication; Scientific Writing; Trends.

RESUMEN

La inteligencia artificial generativa (IA) está cambiando drásticamente los procesos de investigación científica debido a su capacidad para contribuir a las diversas fases del método científico, lo que permite a los investigadores acelerar el proceso de producción científica. Sin embargo, los obstáculos y restricciones que plantea el uso de la IA son significativos debido a los sesgos relacionados con el uso ético de los modelos y marcos que fomentan el sentido de la responsabilidad y los principios éticos en la aplicación de la IA. En consecuencia, este artículo presenta una revisión sistemática de la literatura utilizando el modelo Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Se obtuvieron un total de 4334 registros de las bases de datos Scopus y Web of Science, que se revisaron minuciosamente, seleccionando 233 para análisis cualitativos y cuantitativos. Se identificaron cuatro tendencias principales en el uso de la IA en la investigación científica, asociadas al ciclo conceptual del método científico: 1) descubrimiento científico, 2) gestión de datos, 3) redacción académica y 4) comunicación científica. Las consideraciones éticas destacadas en la literatura abogan por el establecimiento de políticas y marcos claros dentro de las instituciones

académicas que permitan a los investigadores utilizar las herramientas de manera eficaz a lo largo de los procesos educativos. En lugar de centrarse en los debates sobre el uso de la IA, este enfoque promueve una integración ética y eficiente de la IA en la ciencia.

Palabras clave: Inteligencia Artificial; Bibliométrica; Publicación Científica; Redacción Científica; Tendencias.

INTRODUCTION

Recent advances in large linguistic models (LLMs) and generative artificial intelligence (GAI) have transformed scientific research, facilitating everything from conceptualizing ideas to analyzing results.[1,2]These algorithms can create new content, including text, code, image, video, and audio,[3] revolutionizing the way research is documented. High-quality academic research is crucial for addressing problems and facilitating decision-making based on logical findings.[4]Therefore, AI offers new perspectives and solutions by understanding existing literature.[5]

However, researchers face challenges in developing methodologies, as AI tools become essential for making progress in various research phases. These tools are im-proving the familiarization with new topics, data analysis, hypothesis generation, and experiment automation.[6,7] Artificial intelligence is accelerating the discovery process and raising expectations for quicker scientific publishing.[8] A study conducted in December 2022 using ChatGPT showed that 68 % of AI-generated summaries were correctly identified, and 86 % of the original summaries were properly classified.[4]

Artificial intelligence technologies, especially natural language processing (NLP), are revolutionizing the analysis of large data sets, improving research efficiency.[9] Since 2015, there has been significant growth in AI applications in research, suggesting a paradigm shift in how research is conducted and validated.[10] However, the integration of AI also raises ethical challenges, such as plagiarism, false research, and potential biases, which must be addressed to ensure transparency and reproducibility.[6]

The current scientific ecosystem is facing significant challenges due to a notable absence of comprehensive frameworks, robust tools, and clear guidelines that would facilitate the responsible integration of artificial intelligence (AI). This deficiency not only hampers the effective deployment of AI technologies but also poses a risk of stifling innovation. In an era where AI has the potential to revolutionize various fields, it is crucial to establish a balanced approach that encourages creativity and discovery while ensuring ethical considerations and societal impacts are adequately addressed. Without these essential structures in place, the scientific community may struggle to harness the full potential of AI, leading to missed opportunities for advancement and a reluctance to explore groundbreaking ideas that could benefit humanit.

METHOD

A systematic literature review analysis was conducted in Web of Science and Scopus to identify the main research areas and trends surrounding the use of AI in scientific research. These two scientific databases were selected as they have the broadest coverage and highest importance worldwide. Thesauri were identified for exploration, and independent search equations were constructed. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology proposed by Moher[11] was followed for the systematic literature review. This methodology con-sists of four stages: i) identification, ii) screening, iii) eligibility, and iv) inclusion. Two search blocks were defined: the first associated with byproducts of the coffee processing process, and a second block related to valorization alternatives (see table 1). Below are the words that comprise each block.

Table 1. Definition of search thesauri

Block 1	Block 2
AI Artificial Intelligence	Scientific research science research Scientific publication*

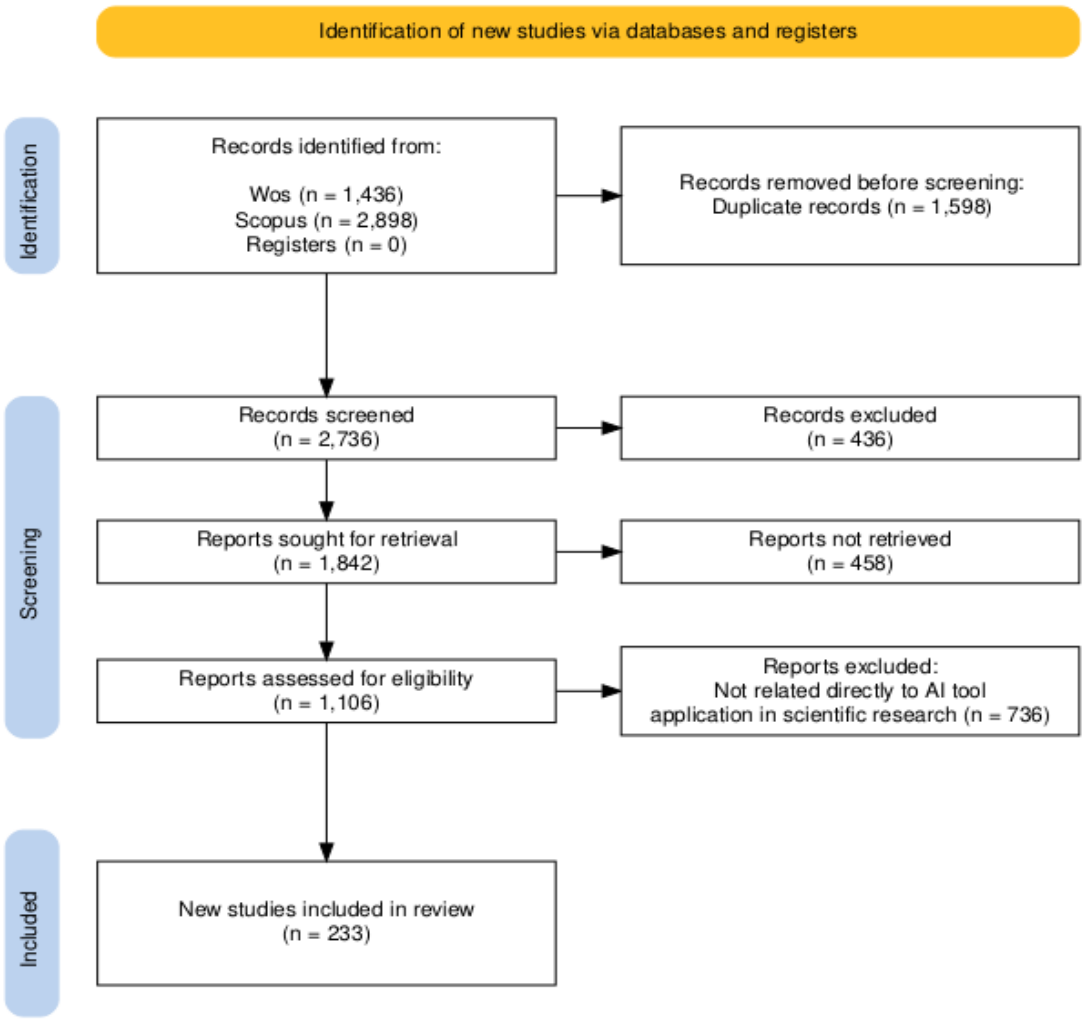
With the keywords defined, the search equations were constructed in each of the selected databases. Then, both Boolean operators and those specific to each of the databases consulted were considered. A 10-year period from 2016 to 2025 was selected as the observation window (table 2).

In the identification or first stage, 4334 records were obtained, derived from the arithmetic sum of the results obtained in the two databases consulted.

Table 2. Search equations for the databases Web of Science (WoS) and Scopus. Searches were carried out on May 26, 2023

Search equation	Number of results
WoS (((TI=”AI” OR AB=” AI “ OR AK=” AI “) OR (TI=”Artificial Intelligence” OR AB=”Artificial Intelligence” OR AK=”Artificial Intelligence”)) AND ((TI=”Scientific research*” OR AB=”Scientific research*” OR AK=”Scientific research*”) OR (TI=”science research” OR AB=”science research” OR AK=”science research”) OR (TI=”Scientific publication*” OR AB=”Scientific publication*” OR AK=”Scientific publication*”))) AND PY=(2016-2025)	1436
Scopus ((TITLE-ABS-KEY (IA)) OR (TITLE-ABS-KEY (“Artificial Intelligence”))) AND ((TITLE-ABS-KEY (“Scientific research*”) OR TITLE-ABS-KEY (“science research”) OR TITLE-ABS-KEY (“Scientific publication*”))) PUBYEAR > 2015	2898

In the second stage or screening, duplicate records were eliminated using the method described by Caputo et al.[12], which employs the Bibliometrix software, yielding 1598 du-plicate records. For the eligibility or third stage, a single exclusion criterion was established: articles not related directly to AI tool application in scientific research. This was based on the different articles that associate AI with academic aspects, such as learning and evaluation processes, among others. Under this criterion, 2503 documents were excluded. Finally, in the inclusion or fourth stage, 233 records were selected for the qualitative and quantitative analyses, since no records outside the ones obtained in the consulted databases were included. Figure 1 outlines graphically the methodological procedure of the stages defined in the PRISMA model for systematic reviews and meta-analyses:



Source: adapted from Moher et al.[11]
Figure 1. PRISMA Methodology.

The Bibliometrix 4.0 software developed by Aria et al.[13] was used for the analysis of results, facilitating the quantitative analysis of bibliographic records related to a specific area of knowledge based on different bibliometric techniques and supported by the R programming language.

RESULTS

Scientific production related to the impact of AI on scientific research during the 2016-2025 period shows a positive trend, increasing from two articles in 2016 to 94 articles in 2024 (figure 2), for 233 knowledge products and a year-on-year growth rate of 37,87 %. These studies were carried out by 796 authors and published in 205 journals around the world.

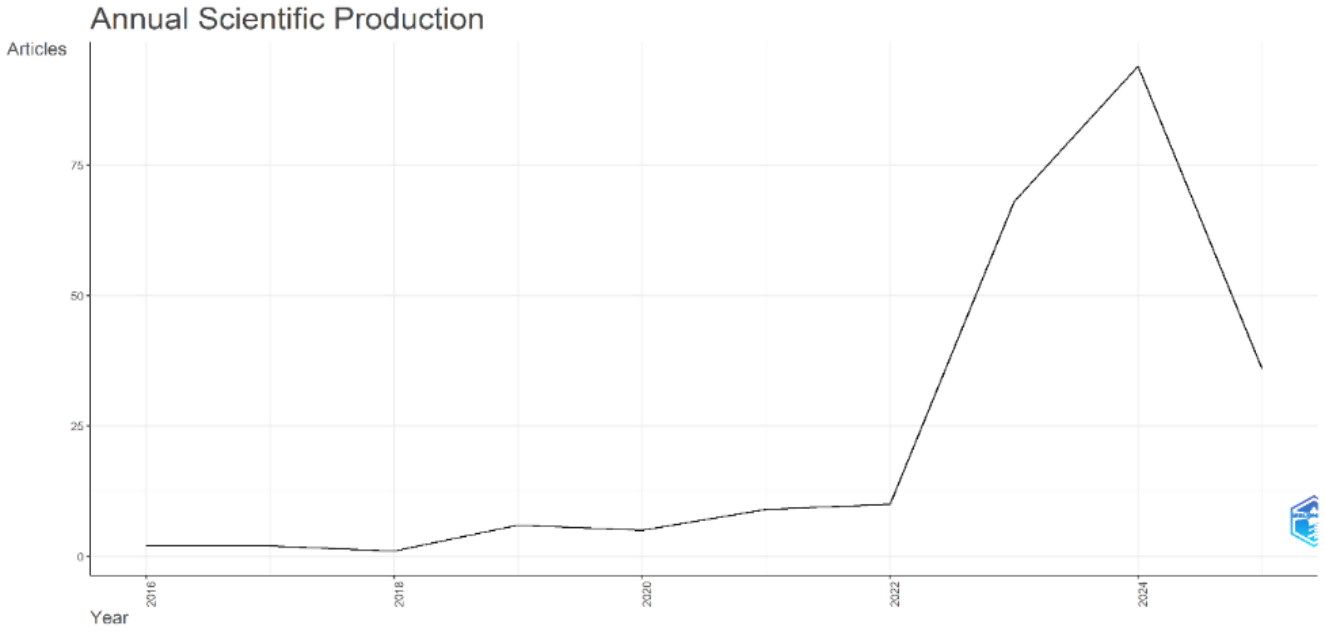


Figure 2. Scientific production (number of articles) in a 10-year period, from 2016 to 2025

Regarding the leading journals that publish knowledge products related to the impact of AI on scientific research, two journals occupy the first place with four publications each. The Bulletin of the Chinese Academy of Sciences, an expert journal directed and sponsored by the Chinese Academy of Sciences (CAS) that focuses on strategic and decision-making research, and the Educare Electronic Journal. This journal is edited and published by the Center for Educational Research and Teaching (CIDE, for its Spanish acronym) from Universidad Nacional de Costa Rica. With three publications each, the journals Scientific and Technical Information Processing, the Chinese Journal of Medical Science Research Management, and the publications of the 15TH International Conference on Computing Communication and Networking Technologies, ICCCNT 2024 Conference Proceedings, stand out in second place (figure 3). Finally, it is interesting to note that three journals appear in the top 10 in medicine and health sciences.

Among the leading authors, four authors appear with four publications each. Lina Penabad-Camacho and María Amalia Penabad-Camacho stand out as they are linked as editors of the Educare Electronic Journal and Revista Géneros, Feminismos y Diversidades, respectively, both of Universidad Nacional de Costa Rica. Their publications focus on defining guidelines to use and disseminate AI in academic scientific journals, as well as on constructing joint declarations by different editors that propose, from the perspective of scientific editing, a series of considerations for the responsible use of AI in research processes leading to the scientific publication, called "The Heredia Declaration". Another prominent author in the research area is Aldeniz Rashidov, from the Department of Information Systems and Automation Control of Gabrovo Technical University, Gabrovo, Bulgaria. This author mainly researches the development of algorithms to automate the processes of generating summaries and systematic reviews of scientific articles. Finally, Yongjun Xu is an author who appears in association with the Institute of Information Technology of the CAS in Beijing. This author focuses his research on evaluating the impact and limitations of the use of AI in scientific research, as well as the development of tools such as OpenResearcher, an advanced scientific research assistant designed to provide a useful answer to a research query (figure 4).

Among the leading institutions to which researchers in the area are linked (affiliation) are the Chinese Academy of Sciences, with 22 articles, followed by the University of California, with eight articles, and finally Universidad Nacional de Costa Rica, with six documents (figure 5).

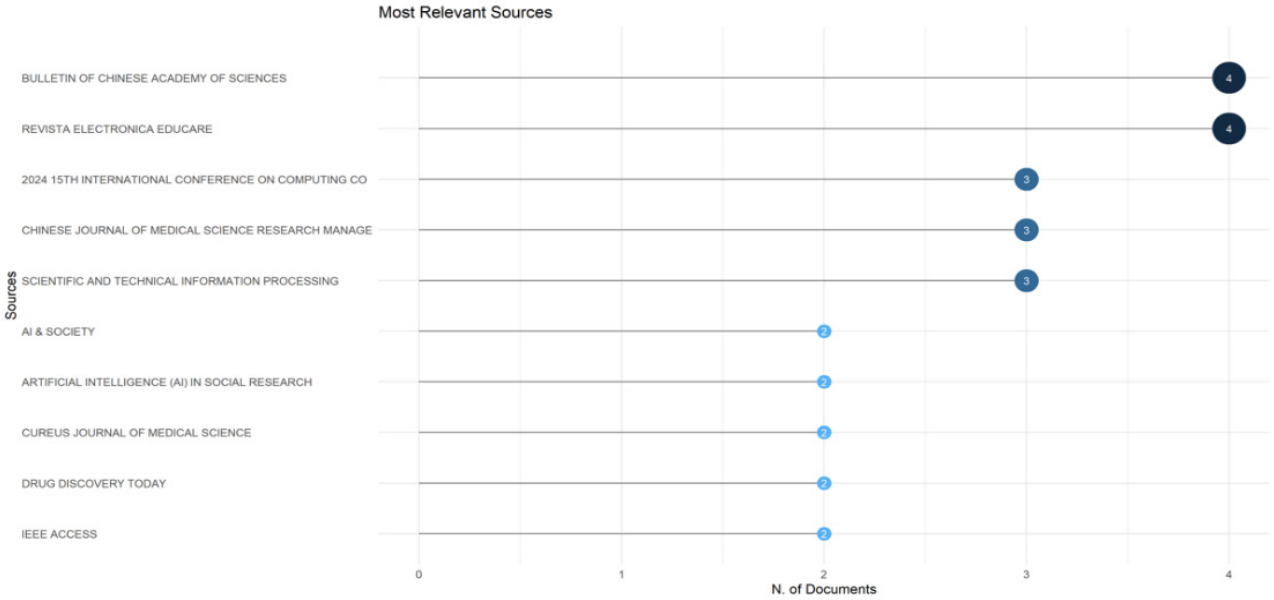


Figure 3. Outstanding journals that publish results associated with the topic of interest

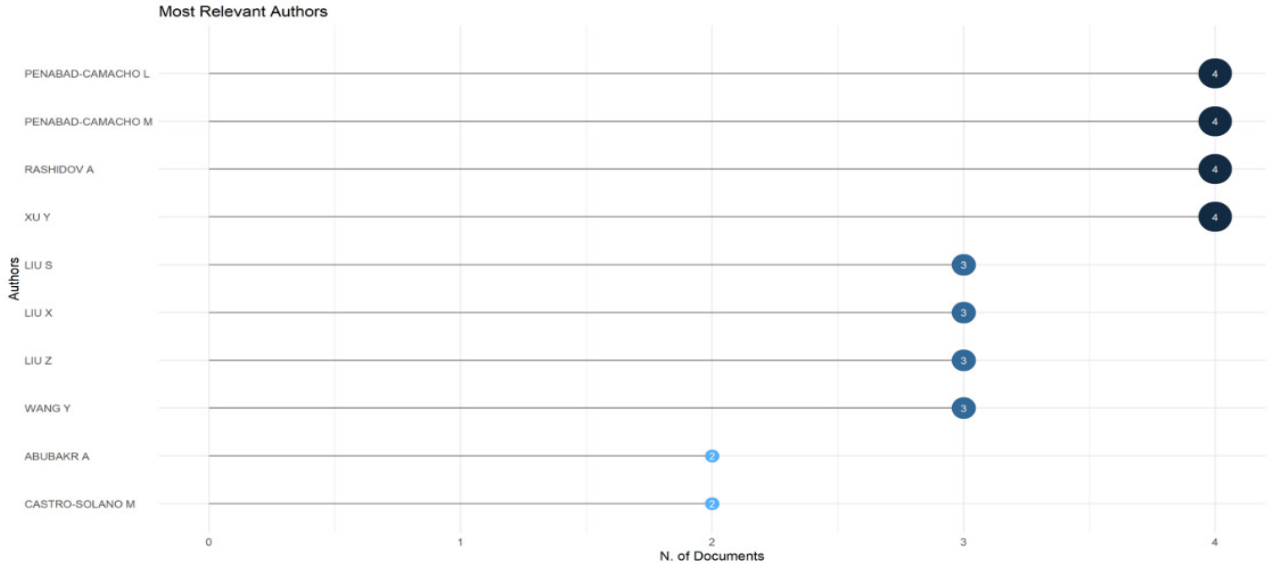


Figure 4. Outstanding authors who publish results associated with the topic of interest

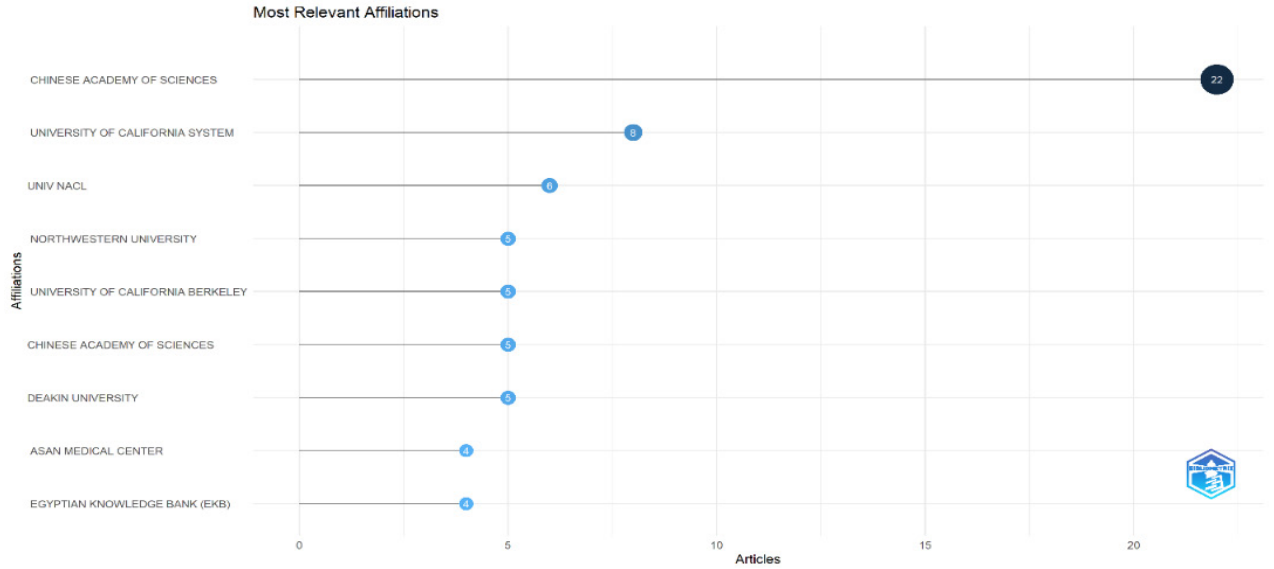


Figure 5. Most relevant affiliations of the authors who publish results associated with the topic of interest

Regarding the social structures of institutional interaction and cooperation, three interconnected nodes are evident (figure 6): a node illustrated in green, a red node, and a blue node. The green node, led by the Chinese Academy of Sciences, conducts research with the University of Chinese Academy of Sciences and Fudan University. This node is connected to the blue node led by the National University of Singapore, which is linked to the University of London and the Tehran University of Medical Sciences. This blue node is connected to the red node through the University of California, Los Angeles (UCLA), which collaborates primarily with American universities such as the University of Texas, the University of California, Berkeley, UCLA, and the University of Pennsylvania. It is worth noting that between the universities that form the red and the blue nodes, there is interaction beyond that exercised by the node leaders.

Among the leading countries highlighted in scientific production for the study topic China stands out, linking 87 researchers, the United States with 75 investigators, and the United Kingdom with 19 researchers (figure 7).

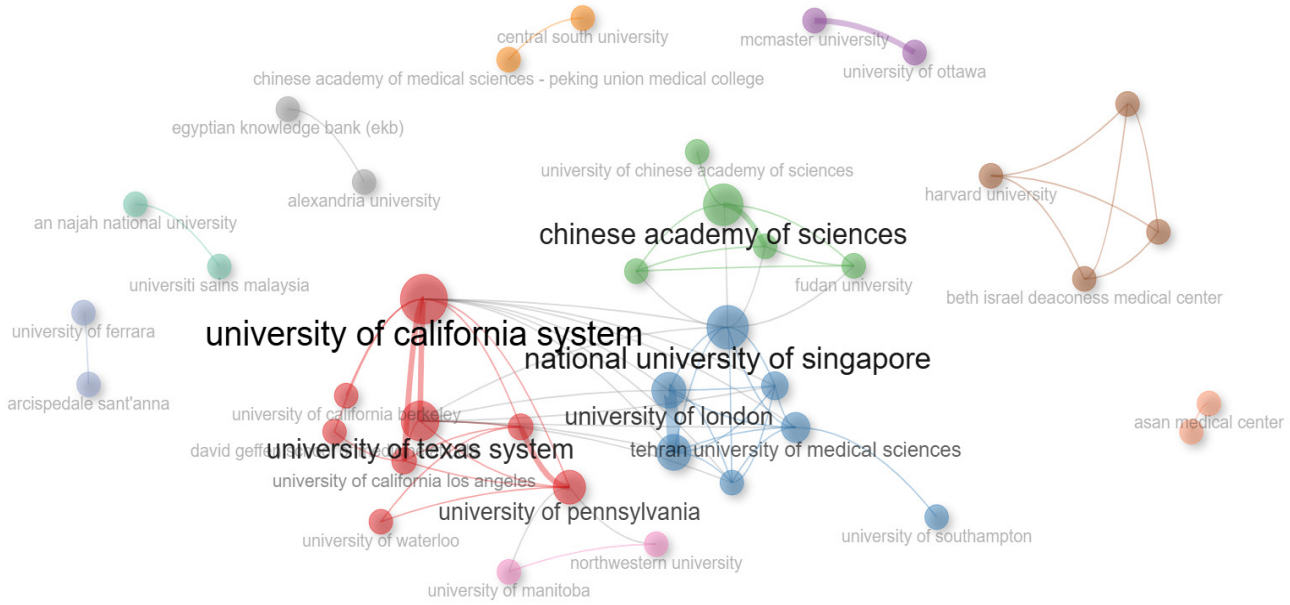


Figure 6. Social structures of interaction and cooperation between institutions

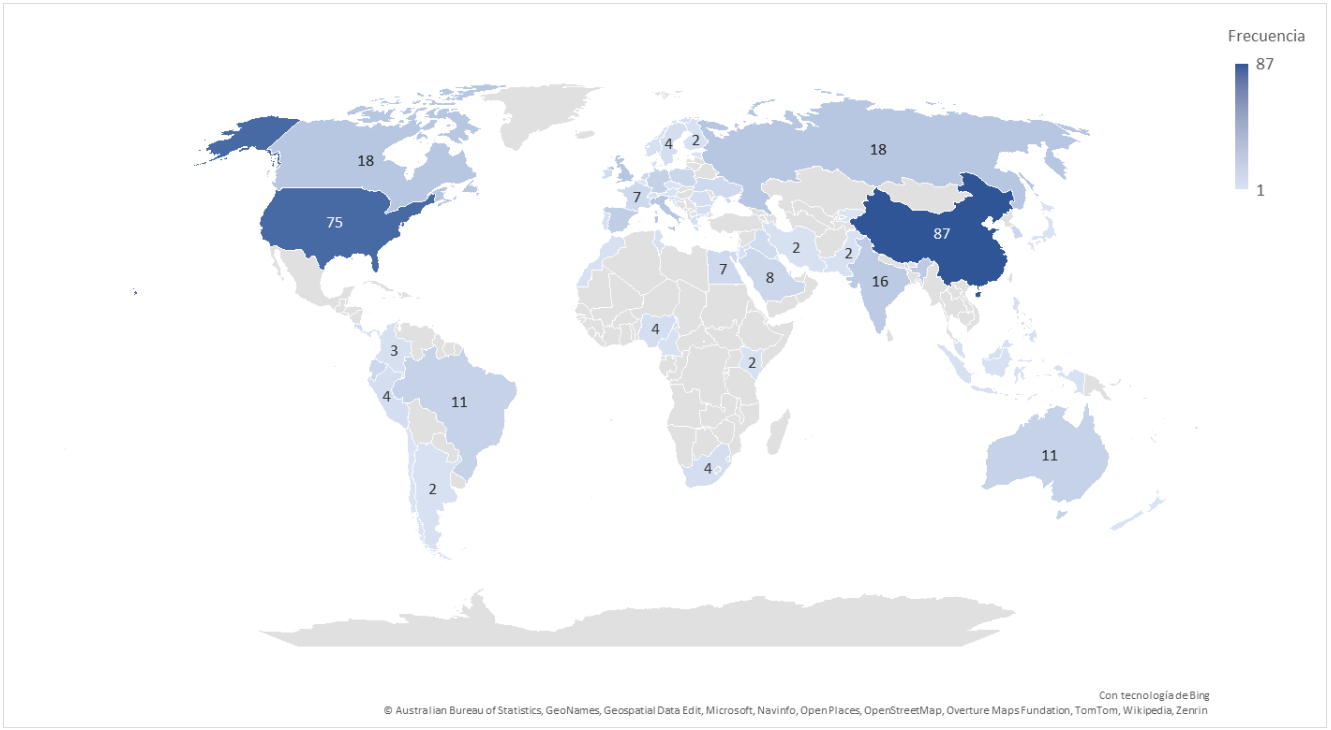


Figure 7. Countries highlighted in the publication of results associated with the topic of interest

Regarding the social structures of interaction and institutional cooperation between countries, two leading nodes are found: a brown node and a purple node. The brown node, led by China, shows interactions with Norway, Korea, Finland, Ireland, and the Netherlands. This node connects to the purple network primarily through the United Kingdom; however, this network is led by the United States. Furthermore, three other networks appear: a blue, a green, and a red network, which interact primarily with the purple network. Likewise, the green network, led by Saudi Arabia, also connects to the United States (figure 8).

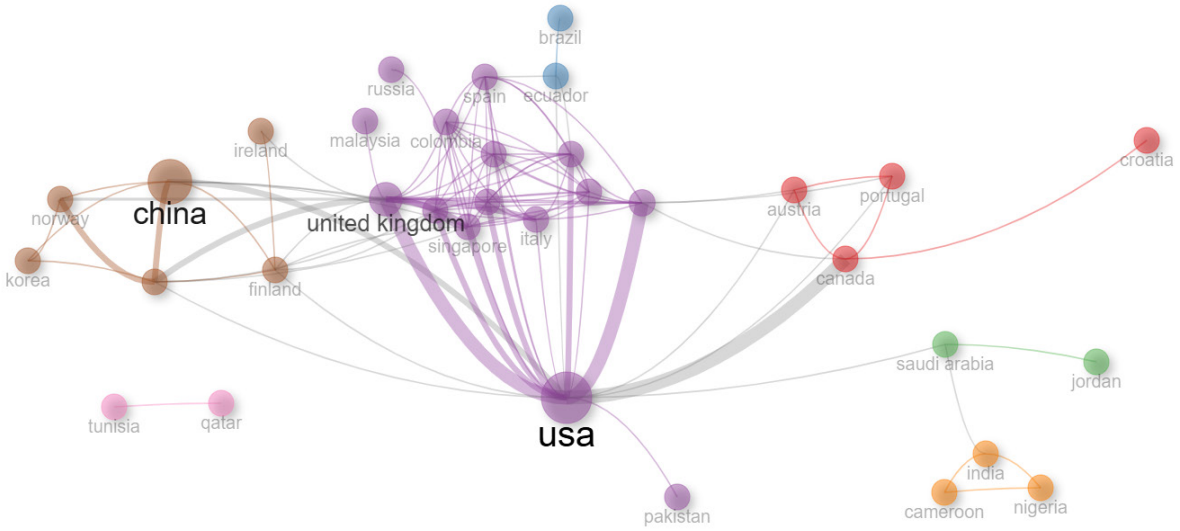


Figure 8. Social structures of interaction and cooperation between countries

Trends in scientific production in using AI in scientific research

Artificial intelligence accelerates the research process by automating routine tasks such as hypothesis generation, identifying gaps in the literature, data collection and analysis, scientific writing, plagiarism checking, abstract generation, and report writing.[14,15,16,17] This efficiency improves productivity and allows scientists to focus on more creative aspects of research.[18,19] From the documents analyzed in depth, four major trends in using AI in scientific research were identified, associated with the conceptual cycle of the scientific method[20,21] (figure 9): i) scientific discovery, ii) data management, iii) writing academic texts, and iv) scientific communication.

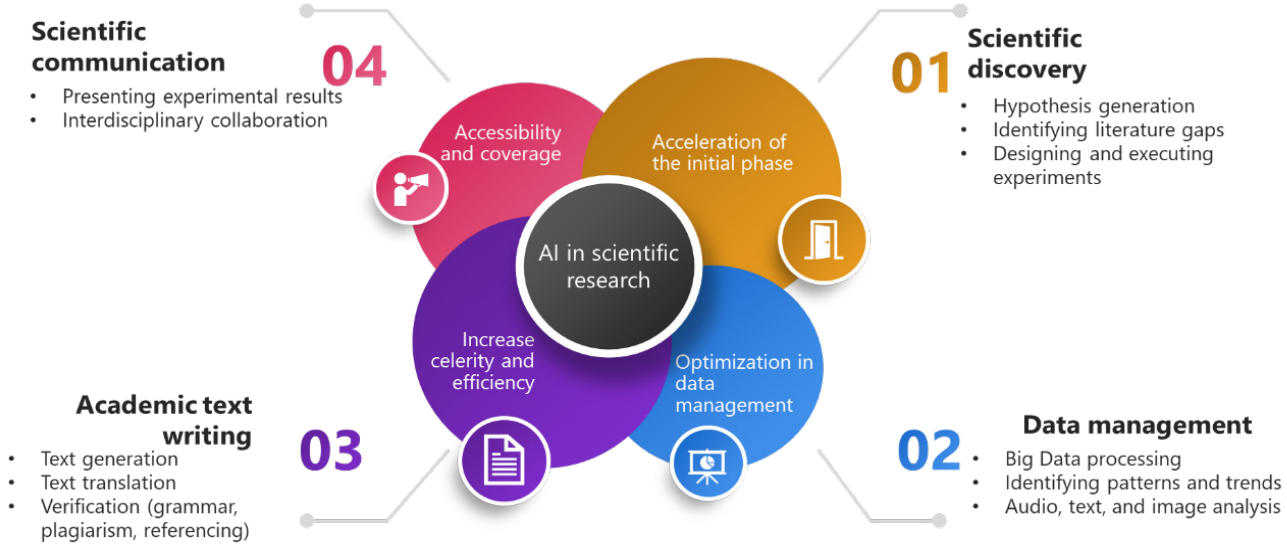


Figure 9. Trends in scientific production in using artificial intelligence (AI) in scientific research

Scientific discovery

The early stages of scientific research require reviewing large volumes of information to build solid knowledge

that informs subsequent processes. Artificial intelligence tools can quickly search, analyze, and synthesize scientific literature, allowing researchers to understand the state of the art and identify gaps.[22,23] Generative chatbots, designed for this phase, improve the understanding of complex texts and overcome language barriers. By interacting with these systems, researchers can break down complicated concepts and receive explanations tailored to their level, facilitating more profound and more accessible learning and promoting inclusion in research.[24]

Hypothesis generation and methodological design: artificial intelligence plays a fundamental role in scientific research by analyzing and interpreting large volumes of data.[25] It also suggests new directions for exploration, enriching the discovery land-scape in various disciplines.[23] Artificial intelligence is especially valuable in the initial stages of the research process, facilitating the generation and refinement of ideas through brainstorming techniques.[5,25] These tools can identify gaps in current knowledge and guide researchers toward questions that require deeper investigation, thereby driving knowledge generation.[26] Collaboration between humans and machines enables the formulation of novel hypotheses that may escape human observation.[15,16] However, the question arises whether AI can exhibit creativity in hypothesis generation or if it is limited to identifying data patterns.[16] Furthermore, the "illusion of exploratory extent"[21] poses a bias in the validation of AI-generated hypotheses. Researchers must validate these hypotheses through experimentation, asking AI to design precise methodologies and identifying biases that may affect the results,[26] especially in sensitive areas such as genetics and social sciences.[16]

Table 3. Artificial intelligence (AI) tools for scientific discovery

AI tool / Platform	Use/Function	Web page
Semantic Scholar	AI-powered scientific literature repository	https://www.semanticscholar.org/
Explain a paper	Explains confusing sections of a scientific document, saving time	https://www.explainpaper.com/
Brevity	Text summary	https://brevity.sh/
ASReview	Software for literature screening and prioritization processes (literature review)	https://asreview.nl/
Elicit	Generative AI tool for scientific research	https://elicit.com/
Jenni AI	Assistant for writing text and processing scientific documents	https://jenni.ai/
Scholarcy	Tool to analyze, organize, and summarize scientific research	https://www.scholarcy.com/
SciSpace	Identification of relevant literature through key questions	https://scispace.com/
Consensus	Literature search and identification of relevant papers through in-depth analysis	https://consensus.app/
Inciteful	Literature identification	https://inciteful.xyz/
Research RabbiT	Identification of literature associated with areas of knowledge from networks	https://www.researchrabbit.ai/
Connected Papers	Browsing academic documents through a graphical interface	https://www.connectedpapers.com/
Litmaps	A tool for discovering relevant scientific literature in a field of study	https://www.litmaps.com/
Humata	A tool for interacting with PDFs through questions	https://www.humata.ai/
Perplexity	AI-powered search engine for literature discovery	https://www.perplexity.ai/
Qualtrics	Analyzes the experiences of customers, employees, and potential customers to understand personal preferences and anticipate needs	https://www.qualtrics.com/
Epsilon	Scanning multiple papers to solve scientific problems	https://www.epsilon-ai.com/

Source: elaborated by the authors based on Lorenc-Kukuła[32], Petrenko[16], Sampaio et al.[33], and Pinchuk et al.[34]

Literature review and synthesis: artificial intelligence facilitates the rapid acquisition of contextual information and guides research processes by answering basic and advanced questions from students and researchers, especially in new or beginner areas.[27] Its ability to evaluate and articulate relevant information sources improves content quality, particularly when using peer-reviewed publications. This allows AI to generate quick summaries of key information, helping authors synthesize the literature and make comparisons between studies.[28] Furthermore, the combination of AI and bibliometrics enables the identification of research clusters, increasing the accuracy and efficiency in the analysis of large volumes of data from scientific publications.[1] AI-powered query algorithm generation is also crucial, requiring researchers to appropriately choose keywords to capture relevant articles and understand the state of the art.[29] Comparisons between tools such as Elicit and Scispace reveal differences in the retrieval of key articles, with Elicit excelling at rapid analysis and Scispace offering a balance between detail and summaries.[30] In this sense, different studies have evaluated the capacity of tools such as ChatGPT and Gemini for this construction, evaluating not only the capacity to retrieve relevant information, but also whether these tools can access databases such as Scopus or Web of Science.[29,30,31] Artificial intelligence also saves authors time, especially when writing in a language other than their native language,[22] and helps organize references through maps that show connections between academic materials.[28]

Design and execution of experiments: In empirical research, generative AI tools can be very useful for designing research instruments such as survey questionnaires, interviews, or observation scripts, suggesting questions based on research objectives.[18] Table 3 presents some AI tools that can support the scientific discovery phase.

Data management

Artificial intelligence tools enable complex calculations and analysis of large data sets, helping researchers discover patterns and extract valuable insights that were previously inaccessible.[35] This remarkable capability is especially advantageous in fields that rely on large amounts of data, such as genomics and climate science, which examines atmospheric changes and environmental impacts.[36] Likewise, in fields such as astronomy, biology, engineering, and computer science, where large-scale data collections are common,[37] "Big Data + artificial intelligence" represents a new research paradigm with a profound impact on future scientific research:[7,38]

Big Data processing: one of the most notable contributions of AI in research is its ability to process and analyze large volumes of data (Big Data) quickly and efficiently, surpassing the capabilities of traditional methods.[37] Among the applications of AI in data processing and analysis are: (i) natural language processing for data extraction from scientific literature, (ii) summarization and synthesis of complex data sets, (iii) automated identification of patterns and trends in data, and (iv) predictive modeling and forecasting.[26] Generative AI tools can enhance analysis in qualitative research, streamlining coding processes and assisting in initial data sets exploration,[5] which is why some qualitative analysis software are incorporating AI.[33] Despite the capabilities of AI to analyze data, it is clear that human researchers are still needed to interpret the results and make sense of them through theoretical frameworks,[39] human over-sight, critical reasoning, common sense, and skepticism; all are crucial when using AI tools.[22]

Identification of patterns and trends: one of the advantages of using AI in data analysis is the ability to handle large volumes of data efficiently by using algorithms that can quickly identify patterns, trends, hidden connections, and correlations that could be difficult to detect by humans,[7,18] revealing dynamic structures of data.[1] Automatic learning (machine learning), a subfield of AI, can recognize patterns and make predictions.[37] Deep learning, another AI area, is an important tool for the successful application of Big Data technology.[40] Deep learning, implemented based on the com-bination of deep learning and neural networks, can reveal hidden patterns that natural intelligence cannot.[40] Other tools used to detect hidden connections include topic modeling.[1]

Audio, text, and image analysis: in qualitative research, data is collected from complex contexts that require efficient tools for processing, such as images, documents, and recorded interviews.[18,41] Artificial intelligence can facilitate transcription and data extraction through tools like Midjourney, Whisper API, Twilio, Clippto, Turboscribe, and Sider.ai, which convert images, audio, and video into text. These technologies use techniques such as optical character recognition (OCR) and robotic process automation (RPA), although their accuracy can be affected by factors like font styles and text quality.[41] Researchers must validate the effectiveness of these processes to maintain data quality. Furthermore, tools such as ATLAS.ti and NVivo are incorporating NLP and machine learning algorithms for automated coding and sentiment/feelings analysis tasks.[42] An interesting application of text and image analysis is the use of AI, such as Claude.ai, to interpret graphs resulting from statistical analysis, allowing the creation of new graphs that facilitate understanding and generate in-depth analysis, acting as experts in the field or forming committees of experts for these tasks. Table 4 shows some AI tools that can support the data management phase.

Table 4. Artificial intelligence tools for data management

AI tool / Platform	Use/Function	Web page
Pandas	Open-source AI agents for data analysis	https://pandas-ai.com/
Intellectus Statistics	Statistical analysis software that incorporates AI for automated interpretation of results and tests	https://www.intellectusstatistics.com/
Rows AI	The only spreadsheet that offers the analytical capabilities of AI Analyst and a native set of AI-powered formulas	https://rows.com/ai
Tableau Pulse	Incorporates generative AI across its platform to democratize data analysis.	https://www.tableau.com/
Numpy	It is a library for the Python programming language that supports creating large multidimensional vectors and matrices, along with a large collection of high-level mathematical functions for operating with them	https://numpy.org/
Midjourney	Image generation from text	https://www.midjourney.com/
Whisper API	An AI model for speech recognition that allows transcribing audio from podcasts, videos, or meetings	https://whisperapi.com/
Clippto	AI-powered transcription of audio and video files	https://www.clipto.com/
Turboscribe	Converts audio and video to accurate text	https://turboscribe.ai/
Fireflies	Audio-to-text transcription	https://fireflies.ai/
Lateral	Paper organizer for content extraction	https://www.lateral.io/
Claude	Among its many applications, it allows for the simplification of graphics and their detailed analysis	https://claude.ai/

Source: elaborated by the authors based on Borger et al.[43], Misra et al.[44], and Sampaio et al.[33]

Writing academic texts

Writing academic articles is essential for researchers, allowing them to communicate their findings to diverse audiences.[45] This skill requires clear organization and the use of precise technical language to facilitate dissemination in the scientific community.[46] Generative Artificial Intelligence (GenAI) has emerged as a valuable tool in scientific writing, generating unique content and acting similarly to a human.[47,48] Artificial intelligence can structure articles into sections such as title, abstract, introduction, methods, results, and more,[5,22,23] besides suggesting attractive titles.[44] Its ability to generate "human" text enables complex interactions with researchers,[25] improving the efficiency and quality of publications. However, its use must be cautious and ethical, as improper use can lead to incorrect conclusions.[48] The literature warns that AI relies on computational thinking, which can differ from human logic, limiting the creativity needed for scientific progress.[33] Therefore, the responsibility for the final content lies with the authors.[49]

Text generation: the fundamental capabilities of AI offer significant support in the early stages of the writing process, allowing researchers to generate initial drafts more quickly than with traditional methods.[5] The integration of AI into scientific writing not only improves content quality but also optimizes the review process and style, which is essential for authors writing in a foreign language. This frees researchers to focus on critical thinking and analysis, rather than on writing techniques.[5] Text generation tools also suggest improvements in aspects such as language, structure, and grammar.[24,25,26] Although using ChatGPT may improve certain aspects of scientific writing, it could also limit creativity. The differences in the results are subtle but statistically significant, demonstrating detectable effects of AI use on academic writing.[50]

Text translation: the global nature of scientific research demands effective communication that transcends language barriers.[51] Artificial intelligence tools offer instant translations.[28] The ability of ChatGPT to translate in real time and generate multilingual content facilitates collaboration and information sharing with colleagues

and international audiences.[26] This multilingual capability can break down language barriers and democratize access to scientific knowledge by allowing non-native authors to write fluently and accurately, and by enabling researchers to access literature in languages other than their own.[33] Furthermore, also helps non-native English speakers write high-quality scientific articles much faster,[51] improving language usage, spelling, fluency, and grammar in manuscripts,[44,45] and using the tone and expected structure in an academic language.[41] Translation helps access research from different language sources,[25] expanding the body of literature that a researcher can consult, review, and synthesize.[52]

Verification (grammar, plagiarism, and referencing): artificial intelligence tools are transforming academic writing by correcting grammar, and improving the style and structure of manuscripts.[28] These technologies not only identify mechanical errors but also generate expressions that resemble the language of native speakers, facilitating the expected tone and structure.[33] A predominant use of these tools is the search for references, positioning ChatGPT as a support in preliminary research.[53] Among the leading tools are Grammarly, ProWritingAid, and Hemingway Editor, which allow checking spelling, style, and even plagiarism.[18,22] AI also poses ethical challenges, particularly concerning plagiarism. Several types of plagiarism have been identified associated with the use of AI: i) Direct plagiarism, ii) Paraphrasing, iii) Hid-den plagiarism, and iv) Code plagiarism.[54]

Table 5. Artificial intelligence tools for academic writing

AI tools / Platform	Use/Function	Web page
Academic GPT	AI service for writing, reviewing, or providing feedback on sections of a paper, such as the abstract and conclusions, among others.	https://academicgpt.net/
Trinka	Spelling, style, and clarity verification for academic writing.	https://www.trinka.ai/
Elicit	Automated systematic review tool (search, screening, and data extraction).	https://elicit.com/
Scispace	A tool that supports AI-powered text generation, citation verification, and source identification, as well as simultaneous translation of texts.	https://scispace.com/
QuillBot	It is a tool that improves writing, checks for grammatical errors, and supports citation and paraphrasing.	https://quillbot.com/
Hemingway Editor	Writing and proofreading app	https://hemingwayapp.com/
ProWritingAid	Writing and proofreading app	https://prowritingaid.com/
Grammarly	AI-powered spell checker, grammar checker, and editor	https://www.grammarly.com/
Rytr	Writing assistant for short texts	https://rytr.me/
Lateral	Collaborative paper organizer for academic writing.	https://www.lateral.io/
Underleaf	AI-powered LaTeX text writing tool	https://www.underleaf.ai/
Originality	Originality and plagiarism check	https://originality.ai/
AIDP	Detection and removal of AI-powered texts	https://aidetector.pro/
GPTZero	AI detector in texts	https://gptzero.me/
Wordtune	Application for paraphrasing, rewriting, summarizing, and grammar verification texts	https://www.wordtune.com/
Sider.ai	AI-powered image, PDF, and text translator	https://sider.ai/es
DeepL	Text and file translator with AI-powered correction	https://www.deepl.com/
NotebookLM	Video, audio, document, and web page processing tool that summarizes and connects for information and knowledge extraction	https://notebooklm.google.com/
Paraphrasingtool.ai	Text paraphrasing tool with different modes and languages	https://paraphrasingtool.ai/
ZeroGPT	AI-generated text detector	https://www.zerogpt.com/
Smodin	Anti-plagiarism text correction	https://smodin.io/

Source: elaborated by the authors based on Borger et al.[43], Hind et al.[30], Krasnoselskyi et al.[54], Lin[6], Lorenc-Kukuła[32], Misra et al.[44], Ramos-Castillo[22], and Sampaio et al.[33]

The phenomenon known as "Text Laundering" seeks to generate texts that imitate human writing, using stylometry to analyze linguistic characteristics.[55] Tools like GPTZero and AI Detector can help in this process, although careful review by researchers is required because of ethical implications. Recent studies have shown limitations in tools such as ChatGPT, Bard, and Bing, especially in the accuracy of the generated references, which are often inaccurate or completely fabricated.[5] To mitigate these issues, the recommendation is to provide the AI with lists of peer-reviewed publications, increasing content validity.[22] Additionally, there are tools like Inciteful, Connected Papers, and Litmaps that, when fed with references, use AI to generate maps of citations and connections.[33] Table 5 presents some AI tools that can support the writing phase of academic texts.

Scientific communication

Artificial intelligence can act as a bridge beyond the university or academic context, helping to communicate the research benefits to the entire world.[14] Likewise, it contributes to public outreach and improvement of scientific literacy, promoting the understanding of concepts in society and making science more accessible.[26,37] On the other hand, regarding cooperation and collaboration, AI plays a key role in streamlining and improving the exchange of ideas and information within the broad and diverse scientific community, which includes, among others: (i) facilitating collaboration and cooperation among researchers by effectively connecting them with relevant experts who possess specialized knowledge and a variety of valuable resources that can assist their work, (ii) improving communication and understanding between researchers versed in their fields and non-experts or the general public through the sophisticated application of natural language processing techniques that enable clearer and more accessible dialogue, and (iii) providing substantial assistance in the meticulous development and preparation of critical documents, such as grant proposals, comprehensive research papers, and impactful conference presentations, which are essential for moving scientific knowledge forward and fostering innovation.[26]

Presentation of experimental results: the functions of Generative AI (GAI) services in scientific research include organizing and presenting results.[16,56] Other generative AI tools, such as NotebookLM, can create mind maps from text, which facilitates the interpretation of patterns or trends in a text corpus. It also allows the creation of audio podcasts that summarize topics, facilitating the presentation of concepts or research results. A specific study found that GPT-4 could produce photorealistic images and generate credible analytical data from a research hypothesis.[47] While caution should be exercised regarding the value of these generated results, this illustrates a potential capacity of AI to create elements that represent erroneous "results". In this sense, other research shows the potential of AI for the disclosure and dissemination of experimental results, primarily associated with the creation and editing of images and videos from text that represents information about research results in a more user-friendly way.[57]

Table 6. Artificial intelligence tools for scientific communication

AI tool / Platform	Use/Function	Web page
Slide GPT	Generates presentations on scientific topics	https://slidesgpt.com/
Canva AI	Conversational assistant for visualizing ideas and designs through concept creation	https://www.canva.com/ai-assistant/
DesignerBot	A powerful creative partner that quickly designs slides, helps produce ideas, and generates text and images in an instant	https://www.beautiful.ai/
Appypie - Research Poster Maker	Quickly creates custom posters	https://www.appypiedesign.ai/
NotebookLM	Generates audio (podcasts) and mind maps from PDFs	https://notebooklm.google.com/

Source: elaborated by the authors based on Yaroshenko et al.[56]

Interdisciplinary collaboration: collaborative research using advanced Generative Artificial Intelligence (GAI) tools can transform information accessibility and enrich results with diverse perspectives. This approach not only fosters an innovative mindset but also generates more comprehensive research results than traditional methods, facilitating global collaboration and accelerating scientific progress.[5] However, some studies have pointed to a decline in scientific engagement among researchers, resulting in a phenomenon known as "lone crowds". This term refers to less interconnected re-search projects, which can lead to the redundancy of ideas

and innovations.[58] Young researchers must use artificial intelligence thoughtfully and strategically, prioritizing interaction and collaboration with international colleagues. Repeated and uncritical use of these tools can compromise the depth and rigor of research, affecting the validity of findings and the progress of scientific knowledge.[24] Therefore, new researchers must develop skills to integrate AI effectively, ensuring that its application contributes to robust and meaningful research. Collaborative AI tools can refine questions and hypotheses, suggest new proposals, and encourage brainstorming between senior and junior researchers.[41] For example, ChatGPT can facilitate interaction between re-searchers and experts, identifying opportunities for collaboration with like-minded professionals and recommending participation in research groups and conferences.[26] This collaborative approach can ultimately drive progress in various scientific disciplines. Table 6 presents some AI tools that can support the scientific communication phase.

Artificial intelligence in literature review

Literature review is essential to answer research questions by synthesizing empirical evidence and identifying gaps in specific fields.[59] Given the rapid expansion of scientific production, researchers must stay up to date.[60] This process involves mechanical and repetitive activities, mostly performed manually.[42] Therefore, the in-corporation of AI tools is presented as a viable solution to optimize these tasks, allowing researchers to concentrate on creative activities that require their expertise.[42] Artificial intelligence can assist in various stages of literature review, from problem formulation and literature search to in-depth review, quality checking, and data extraction.[42] These tools can generate lists of potential articles from keywords or research questions, saving time in the initial stages of the process.[25] By synthesizing information, AI transforms fragmented data into coherent and polished narratives, im-proving the clarity and understanding of the topics covered in the literature.[25]

In addition, AI allows the establishment of research trends and facilitates the identification of gaps in existing literature.[25] It can also extract and organize concise topics and notes from a disorganized body of knowledge.[25] As for usage strategies, the recommendation is to use AI tools to generate initial drafts that are then refined by the authors.[45] Subsequently, the final draft can be reviewed with AI to detect errors and inconsistencies.[45] Tools such as Scispace and Elicit allow for capturing documents and re-viewing them in depth, while Google NotebookLM facilitates the extraction of content from document databases provided by researchers. However, most of these tools are paid, which may limit access for some researchers.[28] A distinctive aspect of AI tools is their use of natural language, unlike databases like Scopus or Web of Science, which require keyword-based search algorithms. Artificial intelligence tools, through prompts, offer more natural and human-like responses, facilitating the identification of research topics, grammatical correction, and style improvement.[43,61]

Finally, the article eligibility process, following the construction of search equations, is still manual and requires time and expertise. However, there are machine learning-based tools that use algorithms to classify articles according to their eligibility for inclusion in in-depth reviews, thus optimizing the process.[60] In this line, some research is oriented towards the development of mobile applications, or the use of programming languages such as Python for the creation of automated literature review systems, among which mHealth, ChemDataWriter (Available at: https://chemdatawriter.readthedocs.io/en/latest/) PYBIBX (Available at: https://bit.ly/442wD5z) and PYGEOWEAVER (Available at: https://pygeoweaver.readthedocs.io/en/latest/) stand out.[2,62,63,64] These systems use libraries that integrate AI capabilities for bibliometric analysis, do not require specific technical expertise, and have been designed using intuitive models,[64] identifying research trends and key insights into the body of knowledge.[2] For the specific case of ChemDataWriter, this tool allows the automated generation of books in the areas of chemistry, mainly involving downloading records, screening papers, topic modeling, data extraction, data organization, auto-generation of references and contents.[63]

These AI-powered tools, libraries, and routines have immense potential to optimize speed and significantly reduce the time researchers spend on the literature review process. This makes them crucial elements to consider within this process, justifying the need to consciously and strategically consider their adoption. However, despite the apparent benefits they offer, several barriers to acceptance and adherence to the use of these tools persist that must be overcome. These barriers may include a lack of familiarity with the technology, resistance to change by traditional researchers, and the need for adequate training to maximize their use. Therefore, addressing these difficulties is essential to facilitate the effective integration of AI tools into academic research practice. Some studies reveal that researchers who use AI tools publish significantly more articles (a 67,37 % increase) and receive more citations (3,16 times) compared to those who do not adopt AI, leading to them occupying leadership positions earlier in their careers.[58]

Challenges and limitations of AI in scientific research

Artificial intelligence in scientific research faces multiple challenges and limitations, primarily because of the rapid evolution of tools and the lack of clear policies for their ethical use. One of the most significant problems is bias, which can distort the results of AI applications, as it is often difficult to understand how

models generate their predictions.[65] This can lead to erroneous conclusions that do not reflect the data or reality adequately.[18] Furthermore, biases can be amplified and spread in the aca-demic community and the general public,[19] affecting collective thinking on specific issues. Journals should require the publication of AI model specifications and bias audits for research that critically relies on AI-generated insights.

Artificial intelligence lacks human cognition, critical reasoning, and common sense,[22] limiting its ability to evaluate novel scientific findings. Current models are based on existing public knowledge, which contradicts the goal of scientific publishing, which seeks innovation.[66] The interpretation of the context carried out by AI is based solely on user input and its training data, which restricts its understanding.[25,41]

Over-reliance on AI in research can impair the development of critical and creative skills essential for academic progress.[67] Critical thinking involves analyzing and evaluating information objectively, which can be compromised if researchers become mere recipients of algorithm-generated results.[25] Creativity, the engine of innovation, can also be restricted if academics rely excessively on automated responses.

Although AI can facilitate access to information and accelerate analysis, its excessive use could diminish the ability of researchers to formulate in-depth questions and develop original solutions. This acceleration of research can narrow the scientific focus, covering fewer topics and promoting less exploration of new fields.[58] Therefore, it is crucial to balance the integration of AI, using it as a complement that enhances human skills, fostering an approach that combines technology with the development of critical and creative skills to ensure sustainable and significant scientific progress.

Ethical considerations of using ai in scientific research

Scientific research enjoys many AI benefits, yet faces significant challenges de-manding serious considerations. One of the main problems is the biases inherent in algorithms, which can distort results and perpetuate inequalities.[68] Furthermore, biases generated during model training, as well as data privacy, are critical concerns.[48]

The collection and analysis of large volumes of sensitive data may compromise the confidentiality of individuals involved in the studies.[69] Effective collaboration be-tween humans and AI systems is critical to maximizing the positive impact of these technologies. This collaboration requires not only technical integration but also a mutual understanding of the capabilities and limitations of each part.[70] Addressing these issues is essential to harnessing the potential of AI in research and ensuring high ethical standards that protect the rights of participants.[18]

The ethical implications of AI transcend academic discussions, raising social issues that require the attention of all stakeholders, including researchers, developers, citizens, and policymakers. These groups must come together in constructive dialogue and implement responsible actions to ensure that the benefits of AI are inclusive and accessible.[48]

Therefore, it is imperative to establish clear ethical frameworks and foster a culture of responsibility that prioritizes social well-being and respect for human rights. Dialogue between different stakeholders must be continuous and open, promoting collab-oration that allows identifying risks and creating effective solutions. Only through joint efforts can we ensure that AI is a tool for technological progress and a driver of equity and social justice, benefiting all sectors of the population.

Artificial intelligence systems rely on vast data sets, which can come from reputable or dubious sources, and can influence the quality of the information produced. The use of AI in scientific data generation represents a new paradigm, as most data in the scientific literature comes from traditional experimental methods. This poses the risk that the proliferation of AI-generated data will increase the amount of information that lacks authenticity and accuracy.[47]

Researchers should be cautious in assessing the credibility of these sources and the biases they may introduce, ensuring that AI-derived insights are reliable and ethically sound.[71] This is vital to reduce the risk of producing fraudulent scientific articles due to over-reliance on AI technologies, minimizing doubts about the integrity of scientific work and the authenticity of results.[72]

Future prospects and recommendations

Universities and research centers must train researchers in using AI for scientific research.[16] This process includes developing "AI literacy" which encompasses competency in data management and an understanding of the underlying algorithms.[16,33] Such training not only fosters a sense of ethics and responsibility in using AI[73] but must also be continually updated because of the rapid evolution of technology.[48]

In addition, policies, guidelines, and protocols are identified as key areas for implementing effective AI strategies. These documents guide the appropriate use of AI and mitigate ethical, legal, and academic risks, promoting transparency in knowledge generation.[3,19,48] Moreover, it is essential to foster interdisciplinary collaboration between researchers, AI tool developers, and decision-makers to address the ethical aspects of AI.[48,74,75,76] Finally, the need for regulations requiring disclosure of AI use in scientific writing, especially by

editors of indexed journals, is highlighted.[77,78,79]

The use of AI to improve spelling, grammar, and general editing does not need to be declared by the authors, but any substantial use in content generation or data analysis for the publication must be explicit and transparent.[80,81,82] Authors are expected to mention the AI model used, its version, date of use, how it was used, what products were integrated, and cite the model used.[74] In light of this, some scientific invaginations conclude that the use of AI technologies in scientific writing must be declared at the end of the manuscript, establishing some elements,[75] as follows.

Section title: declaration of generative AI and AI-assisted technologies in the writing process.

Declaration: during the preparation of this work the author(s) used [NAME TOOL/SERVICE] in order to [REASON]. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.[83]

The Heredia statement addresses the responsible use of artificial intelligence in scientific research and publishing, proposing key considerations from the perspective of scientific publishing.[74] The need to establish standards for policies on the use of AI in content production, peer review, and alignment with commitments to academic excellence and integrity is emphasized.[76] Transparency is essential to foster trust in the review system, along with accountability and confidentiality.[44,52,77] An open review process protects the integrity of scholarly communication and promotes a culture of honesty.[45,78]

CONCLUSIONS

Artificial intelligence is transforming scientific research by optimizing various stages of the investigative process, introducing new methodologies, and improving knowledge productivity. Artificial intelligence analyzes trends in publications, identifies challenges, and automates the preparation of scientific texts. It also facilitates the formulation of methodologies, source translation, hypothesis generation, and verification of the originality of publications, including plagiarism detection. This evolution is considered a fundamental driver for innovation and scientific progress.

However, the rapid evolution of AI poses significant challenges regarding aca-demic integrity, content reliability, transparency, intellectual property, and bias. Establishing clear guidelines and promoting responsible use of AI, with human oversight and transparency, is crucial to ensure its ethical use and benefits for society and the advancement of scientific knowledge. Despite being a valuable tool, AI does not re-place the scientific method or human cognition.

Furthermore, AI can limit the exploration of new fields by focusing on established domains, which could reduce scientific diversity. Reliance on a corpus of public knowledge also limits its ability to offer innovative information, contrasting with the objective of scientific publishing to promote the progress of knowledge.

Universities must adapt their curricula to prepare future researchers, emphasizing skills such as scenario-based thinking and uncertainty management. The “impact premium” suggests that AI-supported articles are more cited, reflecting their influence on knowledge progress. Rather than debating the use of AI, what is critical is to foster a learning environment that allows researchers to explore both its transformative potential and its limitations. This will ensure ethical and effective adoption of AI in scientific research.

Despite existing resistance in the scientific community to the use of AI tools, their adoption continues to increase. Recent studies indicate that the main sources of initial interaction with these tools are friends, colleagues, and social networks. Researchers must become critical users of AI and be able to discern when and how to apply it to maximize its positive impact on their fields of study. Education and training in using AI are essential for researchers to integrate these technologies effectively and ethically into their practices.

Artificial intelligence not only has the potential to improve scientific research processes within universities, but it can also impact academic and administrative processes significantly, which is a future aspect of review. To fully leverage the benefits of AI in science, it is essential to develop AI systems that align with the scientific method, ensuring that they contribute positively to the integrity and progress of research.

However, excessive use of AI in research can result in a lack of originality, as the generated content may be mere derivations of the data training of the model used. Besides, AI can generate false information or “hallucinations”, underscoring the need for researchers to verify the data provided by these tools. In conclusion, the adequate integration of AI into scientific research is a challenge that requires rigorous training and a critical approach to avoid its potential drawbacks

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CONFLICT OF INTEREST

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