European Research Council
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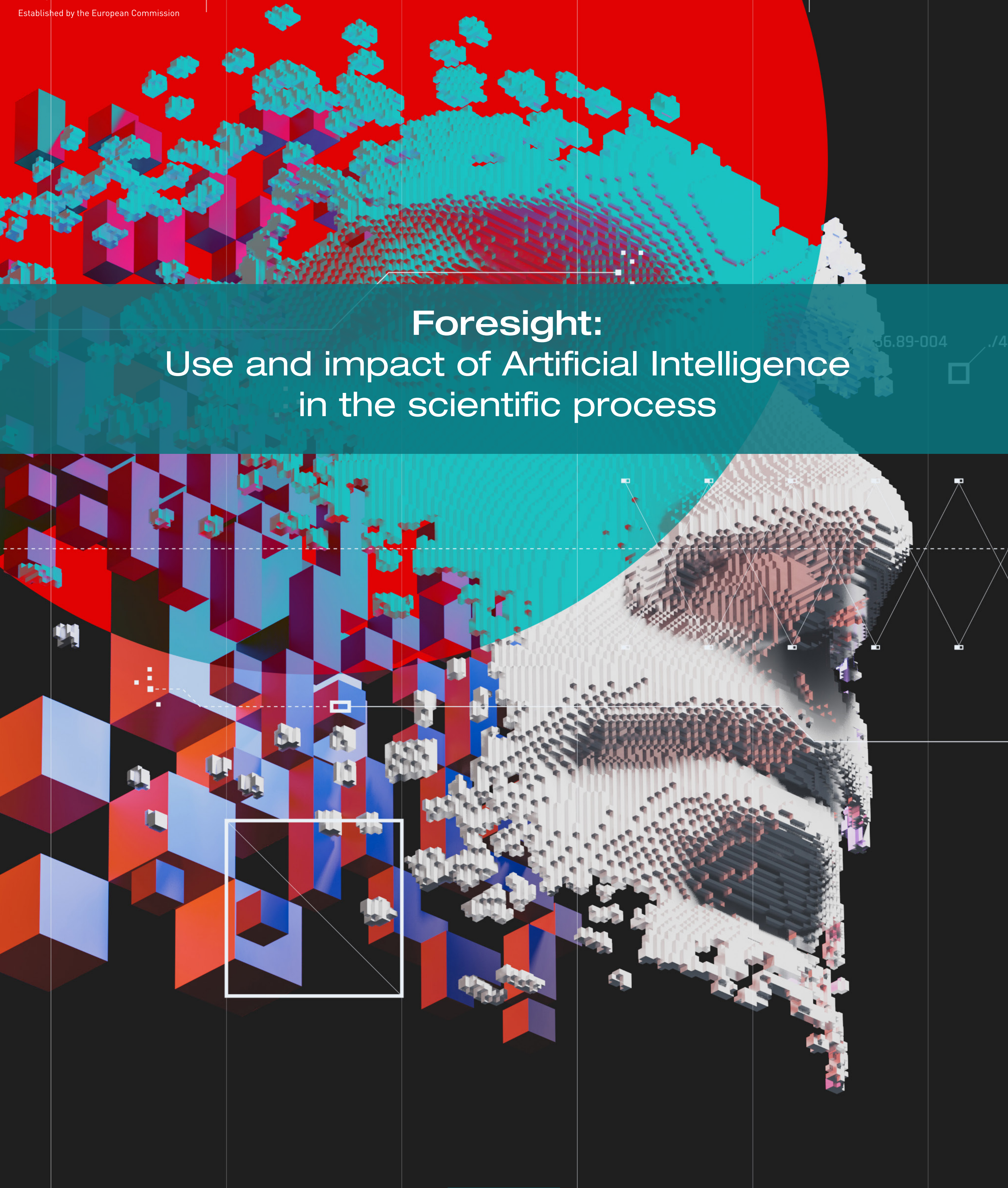
European Commission

Foresight:
Use and impact of Artificial Intelligence in the scientific process



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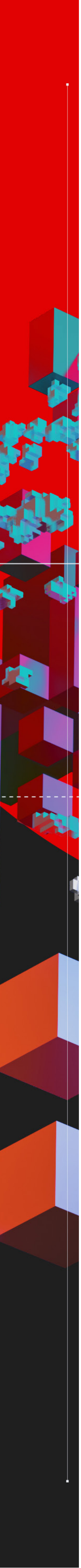

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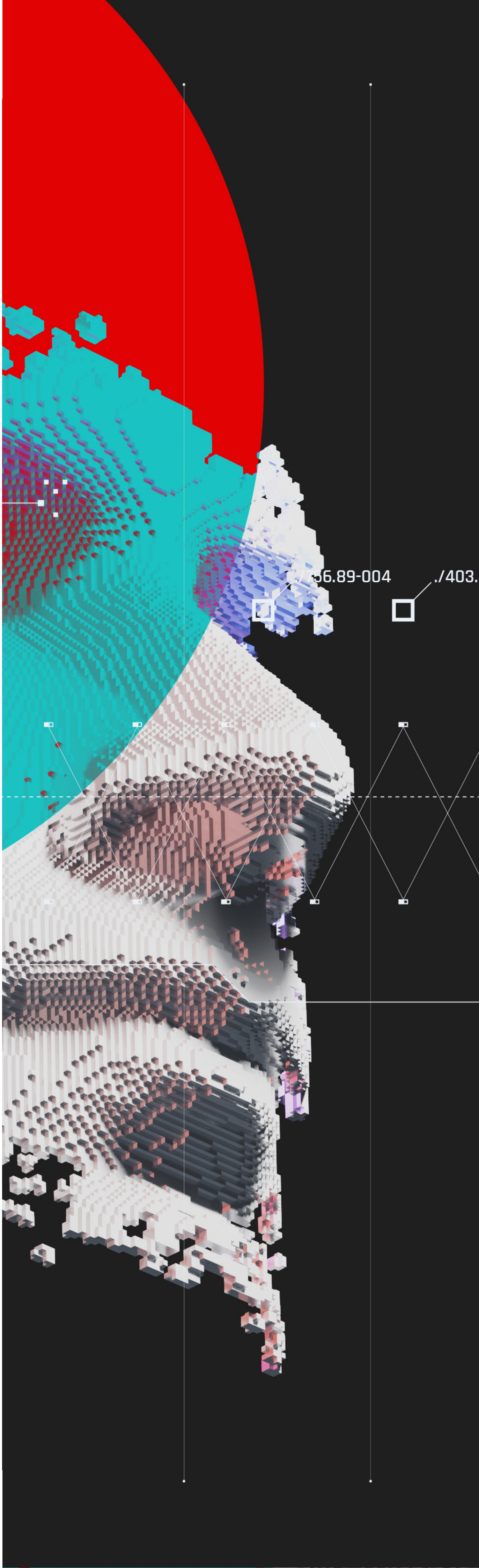


Context

The European Research Council (ERC) is the premier European funding organisation for excellent frontier research. Since its establishment in 2007, the ERC has played a pivotal role within the EU's funding programmes for research and innovation. With a commitment to nurturing excellence, the ERC gives its grantees the freedom to develop ambitious research projects. These projects have the potential to propel advancements at the frontiers of knowledge and set a clear and inspirational target for frontier research across Europe.

The ERC funds a rich and diverse portfolio of projects spanning all fields of science and scholarship, without any predefined academic or policy priorities. These projects can have an impact well beyond science and provide frontier knowledge and innovation to help solve societal challenges and also contribute insights to shape and inform key EU policy objectives.

This report highlights how ERC funded researchers are using artificial intelligence (AI) in their scientific processes, and how they see its potential impact by 2030. It summarises the findings of a **foresight survey conducted among ERC grantees**, which focused on their **present use of AI and their views on future developments by 2030**, **potential opportunities and risks**, and the **future impact of generative AI in science**, such as large language models (LLMs). Developed in collaboration with DG Research & Innovation (R&I) and its unit Science Policy, Advice & Ethics/ Scientific Advice Mechanism (SAM), this report was prepared in the context of the upcoming Scientific Opinion on the responsible uptake of AI in science (more info below). The aim is to provide evidence that can inform the development and implementation of policies related to AI in the realm of science.

The **use of AI in scientific and scholarly practices** remains a subject of ongoing academic and policy debates at both European and international levels (Nature 2023, OECD 2023, Birhane et al. 2023, van Dis et al. 2023). AI's deployment spans various disciplines and serves many purposes, ranging from large-scale data processing, patterns and predictions generation, experiment design and control, as well as writing and peer-reviewing of scientific papers or grant proposals. The actual and potential effects and drawbacks of AI in these contexts are widely debated.

This topic has come to the foreground of a European Commission policy initiative focusing on the impact of AI in research and innovation (R&I) (Arranz et al. 2023b). In terms of research that can inform policy-making, CORDIS Results Pack on the use of AI in science has showcased a collection of EU funded projects on the topic (including 8 ERC projects). Furthermore, an upcoming Mapping Frontier Research (MFR) report on AI from ERCEA (scheduled for release in early 2024) will bolster these efforts within the framework of its Feedback to Policy (F2P) activities, as requested by the ERC Scientific Council.

Methodology

The term 'AI' is generally defined here as *"machines or agents that are capable of observing their environment, learning, and based on the knowledge and experience gained, taking intelligent action or proposing decisions"* (Annoni et al. 2018, p.19). It includes a variety of models and approaches (as defined in the European AI Act):

- logic- and knowledge-based (e.g. inference and deductive engines, symbolic reasoning and expert systems, etc.);
- statistical approaches, Bayesian estimation, search and optimization methods;
- and machine learning (e.g. supervised, unsupervised and reinforcement learning, deep learning, etc.).

The survey also included specific questions on generative AI, e.g. large language models such as ChatGPT. It is defined here as technologies that can *"create new content—including text, image, audio, and video—based on their training data and in response to prompts"* (Lorenz et al. 2023).

This report is derived from a **survey conducted among 1,034 ERC grantees** out of a total of 1,046 ERC projects. The variation in numbers is attributed to cases where certain researchers received more than one ERC grant. The projects were or are developing AI technology or systems, or using AI in concrete applications, or studying its impact and effects, or a combination of these elements. Spanning across all ERC scientific domains (cf. ERC Panel structure, 2024 calls) - Physical Sciences and Engineering, Life Sciences, Social Sciences and Humanities, and Synergy Grant - **the survey was completed by 300 ERC grantees (representing a 29% response rate)** between 16 October and 12 November 2023. Notably, direct quotes with attribution were included in the report only when respondents gave explicit consent in the survey form (adhering to the corresponding Data Protection Notice).

Figure 1: Distribution per scientific domain

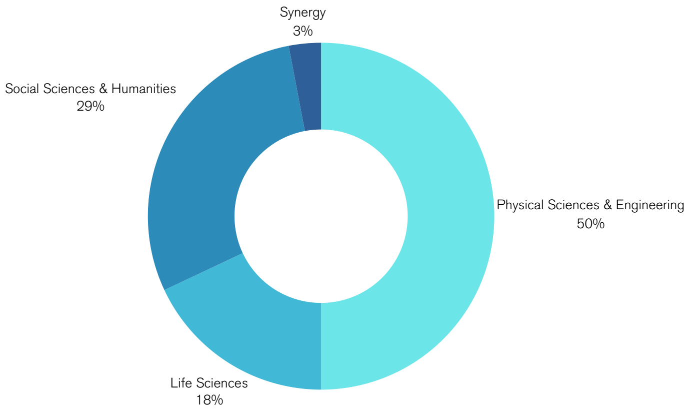
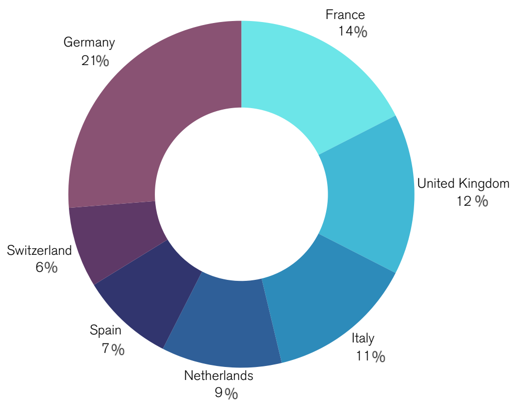


Figure 2: Top countries of the Host Institution



It is important to note that this portfolio of projects is not exhaustive and does not encompass all ERC projects involved in the development, use or study of AI. More details about the methodology used to build this portfolio will be included in an upcoming Mapping Frontier Research (MFR) report on AI from ERCEA, to be available here (scheduled for release in Q1 2024).

A comprehensive list of **14,829 ERC projects, as of 31 March 2023,** was extracted from the Commission's internal CORDA database. This list spans all ERC scientific domains – Life Sciences (LS), Physical Sciences and Engineering (PE), and Social Sciences and Humanities (SH) – covering projects funded under the FP7, Horizon 2020, and Horizon Europe framework programmes, as well as all ERC grant schemes (Starting, Consolidator, Advanced, Synergy and Proof of Concept).

To identify projects related to AI, a keyword search was performed on projects' titles, abstracts and keywords, resulting in approximately 1,453 projects. The definition of AI was primarily based on a study of Australia's National Science Agency CSIRO (Hajkowicz et al. 2022) and an OECD report (OECD 2022).

Additional projects were identified through insights from ERCEA Scientific and Ethics Officers and the internal classification exercise Mapping Frontier Research (MFR), which included policy factsheets on ERC frontier research contribution to the European Green Deal, Europe fit for a digital age, and EU4Health. A re-check through analysis of abstracts, reporting and results (CORDIS), along with grant agreement information (CORTEX), grant status as of 21 September 2023, resulted in a **consolidated list of 1,046 projects.**

1. Present use of AI in the scientific process

In a recent survey, the percentage of scientists from around the world reporting extensive use of AI in their research increased from 12% in 2020 to 16% in 2021 (Elsevier 2022). Bibliometric analysis reveals a consistent increase in the share of research papers mentioning AI or machine-learning terms across all fields over the past decade, reaching around 8% in total (Van Noorden and Perkel 2023). Another study indicates an average year-on-year growth of 26 % in publications related to AI within specific fields of research over the past 5 years, surpassing the 17% average for all preceding years (Hajkowicz et al. 2023). Another bibliometric analysis states that global scientific activity has grown by around 5% per year between 2004 and 2021, while in the same period, the annual growth rate of AI-related publications has consistently remained at or above 15%, except for the years between 2010 and 2012 (Arranz et al. 2023a).

The ERC survey takes place in this context of a demonstrated use of AI in the scientific process, especially targeting ERC grantees already using or developing AI. When asked about their **concrete use of AI in scientific practices,** the responses from ERC grantees illustrate the extensive and diverse applications of AI in their scientific work. Many respondents also mentioned non-domain specific uses of AI-based tools (namely generative AI), that is, as support for text writing and editing, language translation, coding and programming, generation of images for presentations, literature retrieval, among others.

Life Sciences

In the Life Sciences (LS) domain (18% of total respondents), ERC researchers are using AI methods, for instance, to understand individual differences in large cohorts, and to **make predictions about diagnosis or outcome** of targeted therapies. AI tools are seen as an essential support to **analyse datasets of genomic, epigenomic and transcriptomic data**, and compare healthy to disease states and between disease states. Furthermore, AI tools are used in this domain to analyse large volumes of imaging data and to **find complex patterns and/or to generate simulations and models** for clinical applications. In the field of neuroscience, AI can be critical for automatically detecting neuronal synaptic connections or serving as computational models for human conscious experiences. Moreover, it has become an essential tool in **computational proteomics**, leveraging deep neural networks to decipher protein sequences and predict their properties.

Physical Sciences and Engineering

In the Physical Sciences and Engineering (PE) domain (50% total respondents), the development or use of AI ranges from fundamental or core AI in computer sciences to more applied research. It is an essential tool in general for data analysis, and to advance **simulations in physics, chemistry, and biology**. Cross-disciplinary applications include **classifying hearing loss patterns** based on a diagnostic marker, running **quantum-mechanical calculations** for chemistry and materials design, and **modelling human-computer dialogue**. In astronomy, AI and machine learning enhance the control of instruments during **observation of extrasolar planetary systems** and to determine types of massive stars photometrically. In engineering, neural networks are used for **control and anomaly/fault detection in complex systems**, e.g. electricity grids, water distribution networks, and autonomous vehicles. AI has also become a tool for **analysing, classifying and forecasting physical phenomena,** e.g. weather patterns, air pollution, volcano deformation, and earthquakes.

Social Sciences and Humanities

In the Social Sciences and Humanities (SH) domain (29% total respondents), neural networks and natural language processing (NLP) tools are used for a wide range of applications, e.g. **models for handwritten text recognition** and **automatic speech recognition**, or the **automatic classification of musical compositions.** Large language models (LLMs) are leveraged for analysis of data sets of historical texts, from image segmentation, text mining, up to conceptual and linguistic models. Furthermore, AI is used to **identify vocal biomarkers** of stress in voice samples, to detect extreme speech in online discussions, to identify **hidden advertising online**, or to **classify media articles** related to finance and financial regulation (scandal, crisis, business as usual, etc). AI is also a tool for model-based data analysis for **decoding and comparing mental representations** in the brain or **predicting/simulating human learning and decision making**.

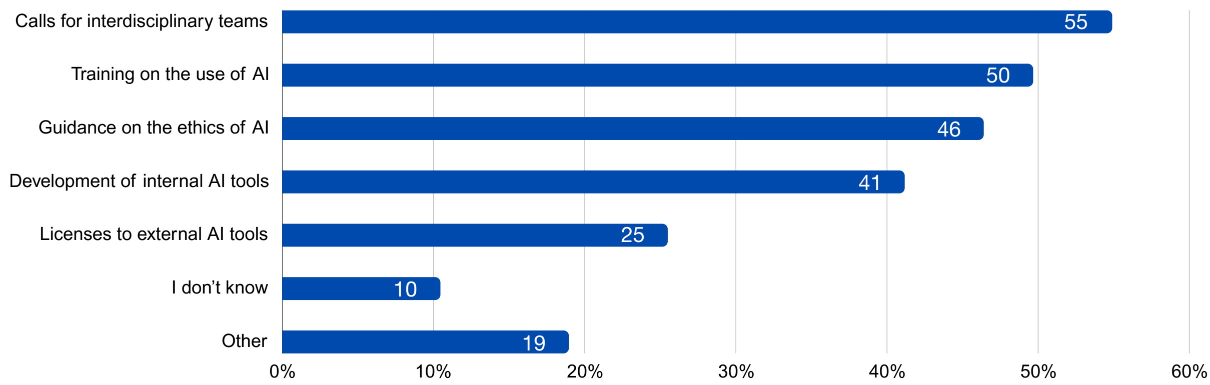
Host institution

When asked about institutional support, **half of respondents (51%) stated that their host institutions provided support to researchers using AI in their scientific practices** (while the other 49% stated no support). When looking at replies from the scientific domains, 57% of respondents from LS and 52% from PE signalled this support, compared with only 42% from SH.

The top four types of support were calls for interdisciplinary teams (55%), training on the use of AI (50%), guidance on the ethics of AI (46%), and development of internal AI tools (41%).

Some respondents added that they had access to institutional computing resources or a High-Performance cluster (for instance GPU facility, storage, cloud computing, etc.) including dedicated support by IT personnel. In other cases, their organisations hosted or were part of an AI Centre of Excellence, or had in place dedicated research groups or institutes and/or organisation-wide support structures. These structures offered access to funding for teaching and training (also for students and young researchers), and connections to experts in AI. Collaborative networks with local and multidisciplinary expertise on a broad range of aspects of AI were also mentioned.

Figure 3: Type of support offered by the researchers' organisation



2. Future developments and applications

ERC grantees were asked to envision **the development of AI in the scientific process by 2030, both in general and within their specific fields, together with key applications or advancements.** The majority said that AI will serve as a support tool, play a pivotal or essential role, and, in some cases, even accelerate, revolutionise, or transform certain elements of the scientific process or of their own field.

> *AI will blur boundaries between quantitative and qualitative research and make "mixed methods" (…) the normal procedure. It will not replace humans in qualitative interpretation, but it will provide for a back-and-forth between methodological approaches that still today is extremely labour intensive.*
>
> Eeva Luhtakallio, University of Helsinki, FInland)

The most common application was **data analysis and processing**, that is, AI will speed up analysis, quantification and visualisation of massive, complex datasets. It will rapidly and accurately identify correlations or patterns that may not be retrieved by hypothesis-driven research. In some fields, AI will be used to develop simulations or surrogate models for processes for which there is incomplete information, for example for detailed computational models of neural systems that can make fine-grained predictions about cognition, behavior and disease outcomes.

Many respondents noted that **AI as coding or programming aid**, spurred by developments in natural language processing, will be (and already is) an essential support to accelerate research. Also, by suggesting parameters for trial setups, AI can help in **designing experiments** more quickly, towards "*AI guided workflows that will significantly reduce the number of experiments or computations to reach the goals*" *(Matthias Scheffler, FHI-Max Planck Society, Germany).*

Another potential development was **cross-linking of data**, identifying relevant methods, or discovering related results from a different field. AI-based summarisation and consolidation of knowledge could contribute to more **interdisciplinary projects** that require in-depth knowledge in different fields, and at the same time, help to identify new/promising yet unexplored ideas or research questions.

> *I think of AI first as an ""exocortex"", amplifying our cognitive skills and in principle subserving our objectives, our goals. This is the first level of AI impact. Then we will see autonomous AI take over science to collaborate with humans. For this, we have to carefully provide them with objective functions (goals). Later, humans may be too primitive to be relevant to research, but they may still help asking questions, and leaving the details to AI. At some later stage, AIs will become a new species*
>
> Giulio Ruffini, Neuroelectrics, Spain & US

Expectations regarding the use of **AI for scientific discovery**, however, varied among respondents. A possible future scenario is a human scientist to "*brainstorm on scientific ideas while discussing with increasingly responsive and "science aware" AI companion (this could be crucial for more isolated scientists in certain institutions and countries)"* (Jean Barbier, ICTP, Italy).

Others highlighted a broader role for AI in generating new scientific hypotheses, emphasising its potential to "being in the driver's seat of the process. (Søren Hauberg, Technical University of Denmark)

Only a few, however, mentioned a fully autonomous process. In this scenario, an AI system would not only develop detailed plans for testing specific hypotheses (provided by a researcher), but also take actions such as selecting the best resources in the lab or accessing additional data if needed.

For some respondents, a higher level of contribution by AI to the scientific process is still limited by **our understanding of what AI can actually do better and the consequences of its use**. It was echoed by concerns over the current underdevelopment of uncertainty quantification, that is, the assessment of the reliability of models and simulations, and also concerns over the transparency of AI systems. The need for human validation or critical manual checking and interpretation was also underlined, under the threat of leading to incorrect, biased and compromised data.

> *AI-based support tools can also be of help in clearly formulating project proposals and for brainstorming on managerial aspects such as potential risks, data and team management practices, writing concise summaries, and helping to report about published works.*
>
> Tias Guns, KU Leuven, Belgium

Instead of AI systems acting as autonomous agents, our survey results point more towards a **collaboration between human scientists and AI**. In some instances, "there is an outside chance that something out of the paradigm is turned out by an AI search.", in a sense of a "second opinion" (Javier Jimenez, Universidad Politecnica Madrid, Spain). "Humans in the loop", or AI as a "research assistant", "co-pilot" or as "hybrid decision support system" assisting humans in performing their tasks were more frequently mentioned.

In particular, for many respondents when it comes to tasks such as **writing and editing**, AI-based tools will play a role in automating certain aspects, e.g. extracting and summarising information from documents, making visualisations, restructuring and adapting texts for different purposes (papers, grant proposals, conference presentations, press releases, etc.) – the human scientist "*as a conductor of an orchestra of AI tools*". (Martin Schultz, Research centre Jülich, Germany).

Some respondents believed that at least parts of scientific writing, reviewing and grant applications that are seen as "mechanical" or "non-creative" (that is, not requiring "original research thinking") could be automated to increase accuracy and speed.

Yet, others underlined the continued value of human researchers in the reviewing and analysis of scientific reports, literature, and data. Some expressed their concern about the overall impact on grant submission, publishing and reviewing.

3. Future opportunities and challenges

When asked to assess the likelihood of **opportunities and benefits of AI in the scientific process by 2030**, respondents expressed strong convictions. 93% found it either ‘highly likely’ or ‘likely’ that the use of AI in science would require the **implementation of ethical guidelines for AI**. These guidelines would address concerns such as privacy and data protection, algorithmic fairness, and the prevention of potential misuse.

> *I imagine that by 2030, AI will revolutionise scientific progress by automating tedious work, detecting patterns, and providing creative prompts. However, human guidance will remain crucial in directing these AI capabilities.*
>
> Ricardo Henriques, Instituto Gulbenkian de Ciência, Portugal

Another prevalent perception, shared by 88% of respondents, was the belief that AI will **accelerate the scientific process**, e.g. by shortening time to find scientific literature, analyse data, discover patterns, design studies or simulations.

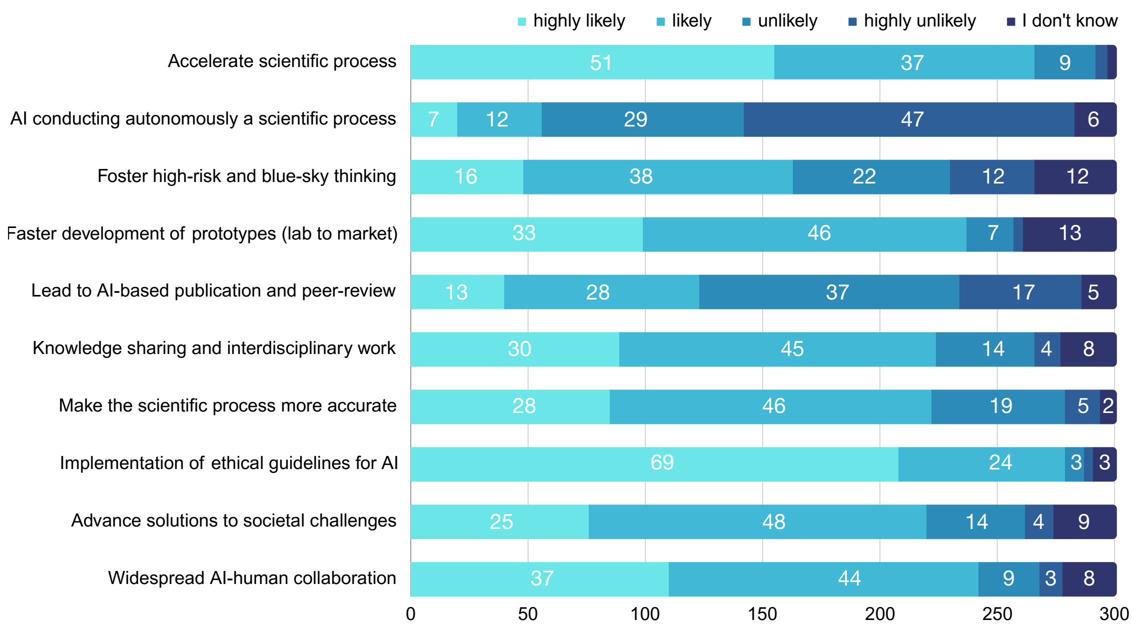
While maintaining a positive outlook, respondents exhibited more moderate optimism towards other key opportunities. Notably, 81 % found it ‘highly likely’ or ‘likely’ that **AI-human collaboration would become widespread in the scientific process.** Concurrently, 79% expressed similar sentiments about the **faster development of prototypes** and transfer of new technologies from the laboratory to the market.

Additional opportunities, also seen with moderate optimism, included **knowledge sharing and interdisciplinary work** within and across scientific fields (75%), more **accuracy of the scientific process,** e.g. checking for errors and discrepancies, cleaning and classifying data, presenting conflicting views (74%), and the **advancement of solutions to societal challenges,** e.g. climate change or antimicrobial resistance (73%).

There is, however, more scepticism regarding the deployment of AI in certain tasks by 2030. A large majority (76% in total) perceived it as **‘unlikely’ or ‘highly unlikely’ for AI to autonomously conduct the entire scientific process end-to-end**, e.g. generate hypothesis, carry out experiments, interpret results, and make extrapolations.

To a lesser degree, 54% of respondents expressed a similar opinion about AI-based scientific publication and peer-review, e.g. AI writing and reviewing research papers, evaluating and monitoring of grants, or scientific fact-checking. These results, together with the belief in a widespread AI-human collaboration as pointed above, imply a prevailing view that AI will for the most part serve as an “assistant” or “support” to human scientists, rather than operating as an autonomous agent in the scientific process.

Figure 4: Opportunities and benefits for the use of AI in science by 2030

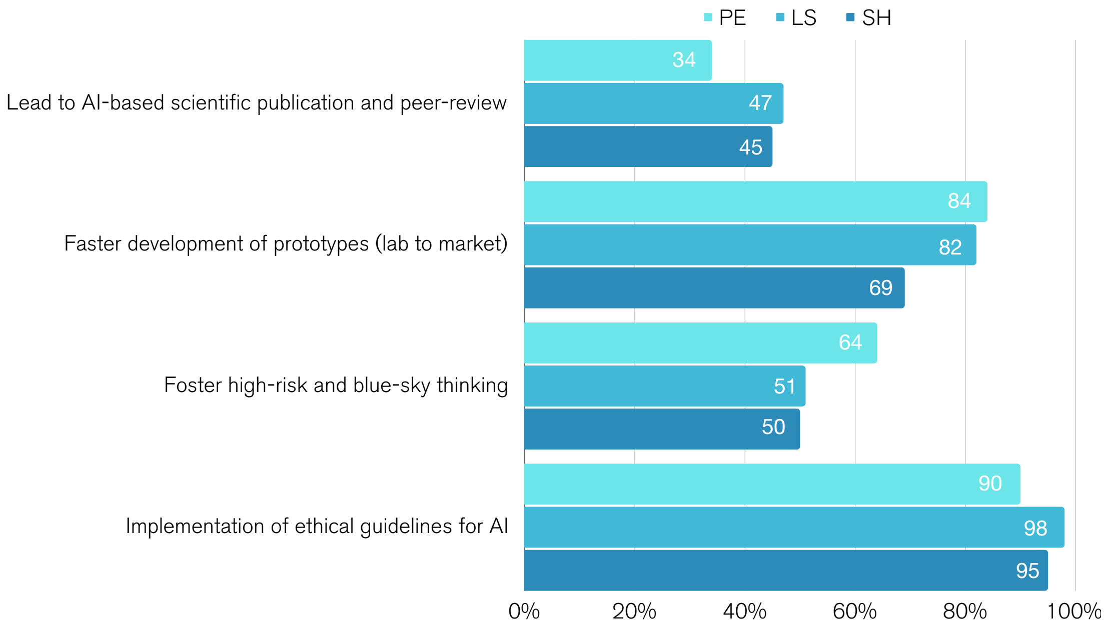


When **comparing replies from different domains,** respondents from Physical Sciences and Engineering (PE) were more sceptical about AI-based scientific publication and peer-review, with only 34% finding it 'highly likely or 'likely'.

On the other hand, respondents from the PE domain were more optimistic about the faster development of prototypes (84% 'highly likely' or 'likely'). This sentiment was also shared by 82% of Life Sciences (LS) respondents. Respondents from Social Sciences and Humanities (SH) were less optimistic (69%) or unsure (23%).

Respondents from LS were more positive about AI fostering high-risk and blue-sky thinking (64%) when compared with respondents in PE (51%) and SH (50%). They were also the most positive about the implementation of ethical guidelines for AI (98%), although respondents from SH and PE were also very positive (95% and 90% respectively).

Figure 5: Opportunities and benefits by domain ('highly likely' or 'likely')



When it comes to the likelihood of **challenges and risks associated with the use of AI in the scientific process by 2030**, the results reveal a combination of more moderate perspectives and uncertainty among respondents.

The most worrying prospects were the lack of transparency and replicability ("black box" problem) (35% found it 'highly likely' and 36% 'likely', 71% in total), and the **widespread deployment of AI systems that are intrusive, manipulative or discriminatory**, e.g. social scoring, automated behavioural profiling, mass surveillance (37% 'highly likely' and 42% 'likely', 79% in total).

Other concerns were also raised, closer to the internal workings of the scientific endeavor. These included the **risk of bias in data or models** due to non-representative sampling, inaccurate labeling, low-quality curation, among others (71% 'highly likely' or 'likely'). Additionally, respondents expressed concerns about **inequalities between researchers and organisations** regarding access to training data, computing capacity, and maintenance costs of AI technologies (68%). Moreover, there were apprehensions about the **reliance on correlation-driven models over deterministic approaches**, with 66% expressing concern, and 14% indicating 'don't know'.

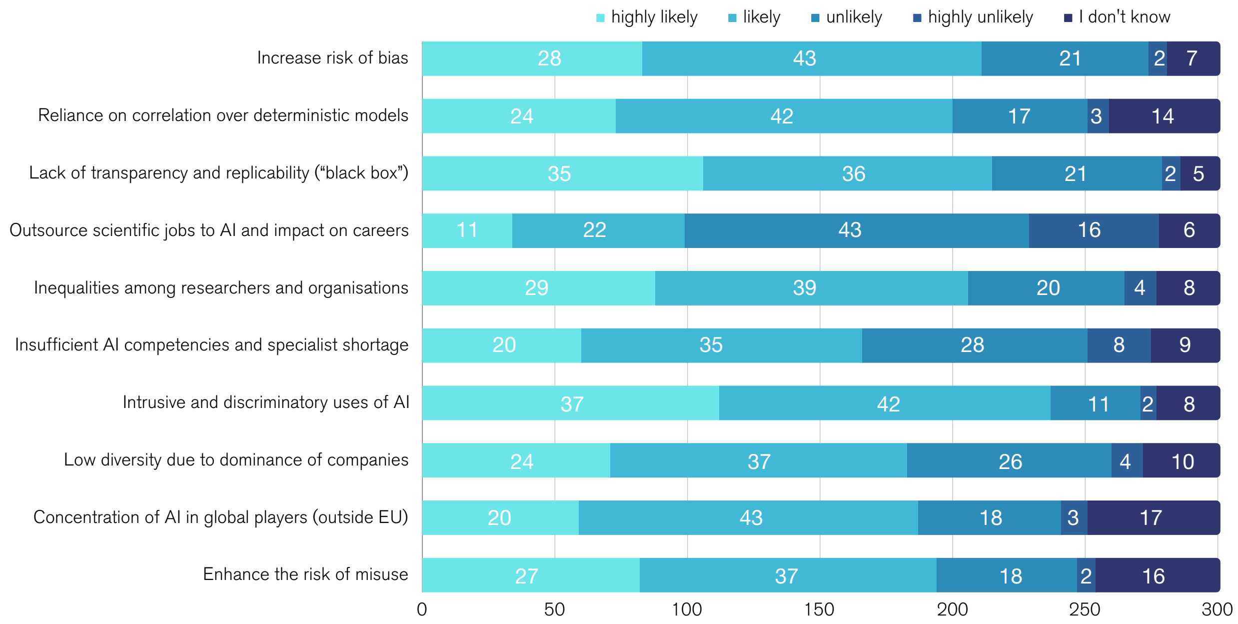
Another concern over the **risk of misuse** e.g. bio hazard, or lethal drugs development was pointed out (64% but 16% 'don't know'), which confirms partially the emphasis on ethical aspects noted above.

> *The key advancements would be (…) understanding what the AI model is predicting. This would provide in many cases mechanistic inkling that we are sadly missing when we use AI and develop ways to ensure AI models to not hallucinate.*
>
> Marcelo Nollmann, CNRS, France

The **concentration of AI resources and development in global players, tech companies, or governments outside the EU** was acknowledged as a concern by 63% ('highly likely' or 'likely,' with 17% responding 'don't know'). Additionally, the potential **loss of creativity and diversity in AI research** due to the increasing dominance of the private sector or large tech companies was noted by 61% of respondents. Though not ranking high on the list, more than half of the participants (55%) expressed concerns about the potential **lack of competencies in AI** among researchers, coupled with a shortage of AI specialists.

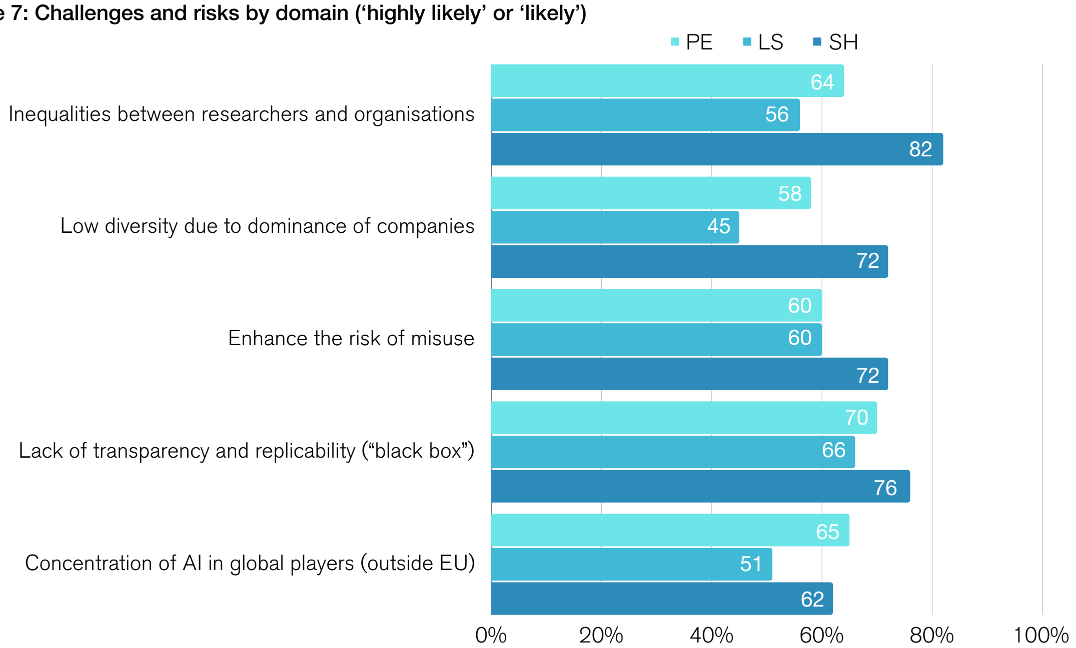
The least concerning aspect, as perceived by respondents, was the outsourcing of scientific jobs to AI-based systems and its potential severe impact on researchers' careers (59% found it 'unlikely' or 'highly unlikely'). This aspect could be linked to the earlier mentioned strong belief in AI-human collaboration rather than AI operating as autonomous agent.

Figure 6: Challenges and risks for the use of AI in science by 2030



When looking into **differences between domains**, respondents from SH tended to be more concerned about inequalities between researchers and organisations (82% mentioned it as 'highly likely' or 'likely'), losses of creativity and diversity in AI research (72%), risk of misuse (72%), and to a lesser extent **lack of** transparency and replicability (76%).

Figure 7: Challenges and risks by domain ('highly likely' or 'likely')



In terms of concentration of AI resources and development outside the EU, respondents from SH and PE were the most concerned (62% and 65% respectively, compared with 51% from LS).

4. Future perspectives on generative AI

When considering the **opportunities and benefits of generative AI (e.g. large language models such as ChatGPT) for the scientific process by 2030**, researchers were asked to select up to three key aspects. The most evident advantages laid in a lower-level deployment, where generative AI can efficiently handle **repetitive or labour-intensive tasks**, e.g. conducting literature reviews, writing materials from presentations to papers, among others (85%), and **improve access to documents in different languages**, while also reducing language barriers for non-native speakers (75%).

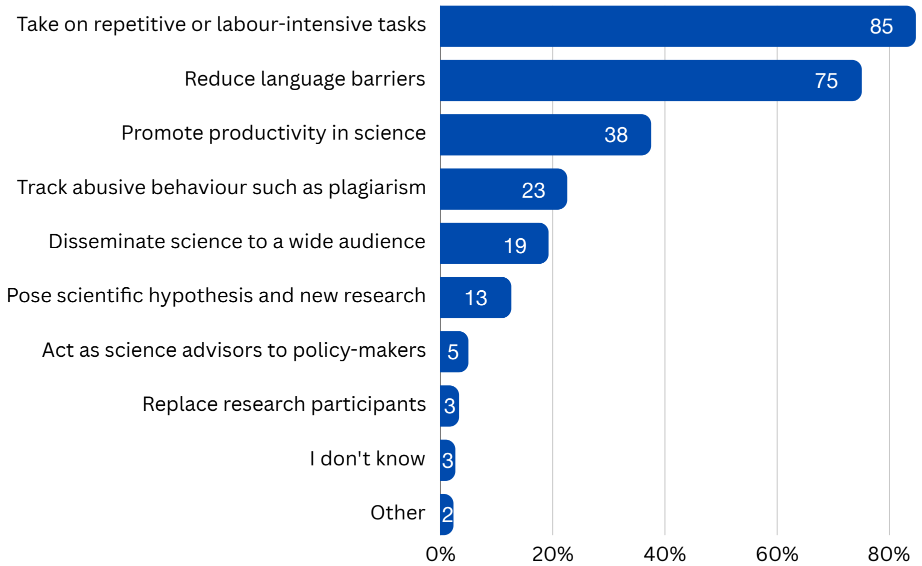
Another set of possibilities was also highlighted, though in lower numbers. These include the **promotion of productivity**, for instance, researchers being able to write more analyses or papers at a faster pace (38%). Additionally, there was mention of the **tracking of abusive behavior**, such as plagiarism (23%), and the potential for researchers to become **science communicators**, disseminating scientific knowledge in a clear and easily accessible manner to a wide audience (19%).

> *While I do not have any doubt that AI will increase "productivity" in science in terms of the number of papers, I think this is the wrong way to measure progress. (...) There is already so much "salami-publishing" (publishing really small incremental steps with few new insights)*
>
> Marloes Eeftens, Swiss TPH, Switzerland

In terms of more radical future impacts, only 13% of the respondents believed that by 2030, generative AI could pose research questions and offer suggestions for potential research directions. This finding aligns with earlier mentioned results highlighting the (in)capacity of AI to autonomously conduct a scientific process from end-to-end.

Additionally, only 5% believed that generative AI could serve as science advisors to policymakers, non-governmental organizations, and industry—this would involve synthesizing scientific knowledge and drafting briefings. Furthermore, a mere 3% indicated that AI could replace humans as research assistants or participants by acting as autonomous agents, for example, in focus groups or simulations.

Figure 8: Opportunities and benefits of generative AI by 2030



There were some differences in the replies according to domains, albeit to a limited extent. Researchers from Social Sciences and Humanities (SH) were more inclined towards the opportunity for generative AI to handle mostly repetitive or labor-intensive tasks and reduce language barriers. In the first case, 91% of SH researchers expressed this view compared to 83% in Physical Sciences and Engineering (PE) and 81% in Life Sciences (LS). In the second case, 80% of SH researchers held this opinion, while the corresponding figures were 74% for both PE and LS. However, SH researchers were more sceptical about generative AI acting as science disseminators, with only 10% expressing this view compared to 23% for both PE and LS. The idea of generative AI posing research questions and suggesting new research directions was mentioned more often by respondents from LS (19%) compared to those from PE (9%).

Overall, the survey results revealed a moderate level of concern regarding a specific set of **challenges and risks associated with generative AI, such as large language models like ChatGPT, in the scientific process by 2030.** 62% expressed concern that generative AI could spread **false information or inaccurate scientific knowledge**. Additionally, 50% believed it could impact research integrity, potentially encouraging plagiarism, authorial and source misrepresentation, or non-disclosure of the use of generative AI. Furthermore, 46% noted that it might lead to **overreliance and dependency** on generative AI tools, posing a threat to the development of researchers' critical thinking and analytical skills.

Some respondents were also concerned about potential intellectual property rights issues, e.g. unlicensed content in training data, potential copyright, patent and trademark infringement of AI creations, and ownership of AI-generated works (37%), and increased dependency on commercial or private providers (35%).

The challenges considered least concerning included data access and open-source software (16%), dilution of responsibility over the scientific process (16%), and the potential endangerment of peer-review quality in journals, funding bodies, etc. (13%).

Figure 9: Challenges and risks of generative AI by 2030

In terms of differences based on researchers' domains, respondents from LS expressed more concern about the spread of false information or inaccurate scientific knowledge (72%, compared to 56% from SH). Increased dependency on commercial or private providers was more prominently noted by ERC grantees from SH (45%, compared to 19% from LS). Grantees from PE tended to be more worried about issues related to intellectual property rights (44%, compared with 28% from SH and 32% from LS).

Key takeaways

Within its broad scope of models and approaches, artificial intelligence (AI) is widely used across various research fields and purposes, ranging from domain-specific tasks to more cross-cutting applications. This widespread usage has been, at least, partially spurred by recent advances in generative AI, including large language models. This report provides a **snapshot of the current use of AI in the scientific process from the viewpoint of ERC grantees. Additionally, it offers a future-oriented outlook on potential developments, opportunities, and risks by 2030.**

One notable future opportunity identified in the survey was the **use of AI for data analysis and processing.** It could greatly speed up or help with specific aspects of the scientific process, such as literature summarisation, patterns discovery, and experiment design.

Another clear direction highlighted was the need for **ethical guidelines to governe AI, covering areas like privacy and data protection, algorithmic fairness, and prevention of misuse.** This was coupled with concerns over **lack of transparency** and potential issues with **intrusive, manipulative, or discriminatory AI systems.**

There was, however, more scepticism regarding the extent to which AI systems can contribute to scientific discovery by 2030, especially in scenarios envisioning AI as a fully autonomous agent. Instead, the prevailing view was that **AI functions as a tool or support to human researchers, emphasising collaboration over replacement or posing a threat to scientific careers.**

Generative AI tools, especially large language models, received positive feedback for their current and near-future usefulness, particularly in handling **repetitive or labour-intensive tasks** such as literature reviews, content generation (from presentations to papers), and **improving access to documents in different languages**. Still, concerns persist regarding the **spread of false information or inaccurate scientific knowledge**, as well as threats to **research integrity**, notably in the forms of plagiarism and source misrepresentation.

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Under the Horizon Europe programme, the European Commission has delegated a new task to the ERC Executive Agency (ERCEA) to identify, analyse and communicate policy relevant research results to Commission services. The ERCEA has developed a Feedback to Policy (F2P) framework for ERCEA to guide these activities adapted to the specificities of the ERC as a bottom-up funding programme.

This report is part of a series aiming to demonstrate the relevance of ERC-funded frontier science, for addressing acute societal, economic, and environmental challenges and thus their contributions towards key EU policy goals. This F2P series does not offer any policy recommendations.

More information: https://erc.europa.eu/projects-statistics/mapping-erc-frontier-research

Annex: ERC survey

Section A.

1. Please select the scientific domain of your last or ongoing ERC grant:

- Physical Sciences and Engineering
- Life Sciences
- Social Sciences and Humanities
- Synergy Grant

2. Please detail your specific field of research.

(up to 1000 characters)

3. In which country is based the Host Institution of your last or ongoing ERC grant?

(drop-down menu)

Section B. Present use of AI

4. Artificial Intelligence (AI) can be used as a tool in the scientific process. Either within or outside your ERC grant, are you currently using AI in your research or as support to your scientific practices?

No (If no, go to Question 5)

Yes

If yes, please detail how you are using AI in your scientific practices. Please also mention the importance of AI in such practices (e.g. a support tool, an essential tool, etc.)

(up to 1000 characters)

5. If you are not currently using AI in your research, please select below the main reasons why (up to three).

- Not relevant for my current research.
- Insufficient funding.
- Lack of high quality and domain-specific data.
- Shortage of AI competencies.
- Lack of infrastructure and computing resources.
- Insufficient interoperability and sharing of data.
- Inadequate support from your organisation.
- I don’t know.
- Other (please specify)

6. Does your Host Institution provide support to researchers using AI in their scientific practices?

No (If no, go to Section C)

Yes (If yes, please list below the type of support offered by your organisation).

- Development of internal AI tools.
- Licenses to external AI tools.
- Training on the use of AI.
- Guidance on the ethics of AI.
- Calls for interdisciplinary teams.
- I don’t know.
- Other (please specify)

Section C. Future applications and opportunities

7. By 2030 how could the use of AI further develop scientific process in general and in your specific field? In your view, what will be the three key applications or advancements?

(up to 2000 characters)

8. Please assess the following statements on potential opportunities and benefits.

By 2030 the use of AI in the scientific process will:

(four-point scale: highly likely, likely, unlikely, highly unlikely)

- Accelerate the scientific process *(e.g. by shortening literature reviews, discovering patterns, designing studies, etc.)*.
- Lead to AI conducting autonomously a scientific process end-to-end.
- Lead to widespread AI-human collaboration in the scientific process.
- Drive high-risk and blue-sky thinking that leads to scientific breakthroughs.
- Make the scientific process more accurate *(e.g. checking for errors and discrepancies, cleaning and classifying data, etc.)*.
- Lead to AI-based scientific publication and peer-review *(e.g. AI writing and reviewing papers, evaluating grants, etc.).*
- Require the implementation of ethical guidelines for AI *(e.g. privacy and data protection, algorithmic fairness, misuse, etc.)*.
- Allow for faster development of prototypes (from the laboratory to the market).
- Improve knowledge sharing and interdisciplinary work.
- Advance solutions to societal challenges *(e.g. climate change, antimicrobial resistance, etc).*
- Other (please specify).

Section D. Future challenges and risks

9. Please assess the following statements on potential challenges and risks.

By 2030 the use of AI in the scientific process will:

(four-point scale: highly likely, likely, unlikely, highly unlikely)

- Increase the risk of bias *(e.g. due to non-representative sampling, low-quality data curation, etc.)*.
- Increase reliance on correlation-driven models over deterministic approaches.
- Lead to lack of transparency and replicability ("black box").
- Outsource scientific jobs to AI and severely impact researchers' careers.
- Reinforce inequalities among researchers and organisations *(e.g. access to training data, infrastructure, etc.)*.
- Lead to insufficient AI competencies and shortage of specialists.
- Lead to intrusive and discriminatory uses of AI *(e.g. social scoring, automated profiling, mass surveillance, etc.)*.
- Lead to low diversity of AI research due to dominance of private or large companies.
- Be impaired by the concentration of AI development in other global players (outside the EU).
- Enhance the risk of misuse *(e.g. bio hazard, lethal drugs development, etc.).*
- Other (please specify)

Section E. Future perspectives on generative AI

10. Please select below up to three opportunities and benefits of generative AI (e.g. large language models such as ChatGPT) for the scientific process by 2030.

By 2030 generative AI will:

- Take on repetitive or labour-intensive tasks.
- Pose scientific hypothesis and new research directions.
- Promote productivity in science *(e.g. write more papers and faster).*
- Reduce language barriers *(e.g. write and access to documents in different languages).*
- Track abusive behaviour such as plagiarism.
- Replace research participants *(e.g. in focus groups or simulations).*
- Disseminate science to a wide audience.
- Act as science advisors to policymakers and other stakeholders.
- I don't know.
- Other (please specify)

11. Please select below up to three challenges and risks of generative AI (e.g. large language models such as ChatGPT) for the scientific process by 2030.

By 2030 generative AI will:

- Affect research integrity *(e.g. plagiarism, source misrepresentation, etc.)*.
- Spread false information or inaccurate scientific knowledge.
- Raise issues of intellectual property rights *(e.g. infringement, ownership of AI-generated work, etc.)*.
- Lead to overreliance on AI *(e.g. threatening researchers' critical and analytical thinking)*.
- Dilute responsibility over the scientific process.
- Increase dependency on commercial or private providers.
- Require wider data access and open-source software.
- Endanger peer-review quality assurance *(e.g. in journals, funding bodies, etc.)*
- I don't know.
- Other (please specify)

12. Would you like to make any final or additional comments?

(up to 1000 characters)

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