Scientific Advice Mechanism

European Commission's Group of Chief Scientific Advisors

Scoping paper: Successful and timely uptake of Artificial Intelligence in science in the EU

4 July 2023

1. SCOPE

The present scoping paper outlines a request to the Group of Chief Scientific Advisors on how the European Commission can accelerate a responsible uptake of AI in science. Innovation holds the promise for economic prosperity and solution to global challenges. Science is at the heart of EU's research and innovation (R&I) policy, aiming to deliver new knowledge and breakthroughs for the benefit of society. Therefore, when referring to the global picture and outlook, this document uses the term R&I and when describing the particular request to the Group of Chief Scientific Advisors, we look more specifically at science as driver of innovation and the focus of our policy design.

2. ISSUE AT STAKE

Artificial Intelligence (AI) is one of the most disruptive sets of technologies our society has. AI has some characteristics of a 'General Purpose Technology', being applied in all sectors at high speed and in a disruptive manner, with the promise that it could achieve, and even surpass in some aspects, human abilities[1]. While science may serve as basis for developing AI-based applications, science is also to be considered as a specific field in which AI can be applied - some of the most complex scientific problems can be tackled with AI technologies (in general data-intensive ones, but not only). AI can be a big booster to research, accelerating scientific discoveries and bringing higher societal benefits faster.

AI is quickly becoming a transformative tool for the scientific processes, and already established new paradigms in diverse fields such as (but not limited to) biotechnology[2], material science[3], medical research[4], and social sciences[5], also in combination with other technologies (such as robotics). While AI is itself a product of research, it has also been recognised as a powerful research tool, supporting scientists in their work. Its capabilities are very relevant to the process of scientific discovery[6] and innovation. For example, AI is already a key asset in the processing of scientific data on a large-scale and for the extraction and generation of patterns, predictions, or models. In addition, it is facilitating the understanding of scientific outputs (information retrieval, natural language processing or recommender systems in large repositories of scientific papers).

The use of AI is increasing among scientists and in all fields of science. The share of scientists using AI in their research increased from 12% in 2020 to 16% in 2021[7]. In the ERC, the use of AI is spread in almost in all fields, for instance in 'Geology, tectonics, volcanology'

[1] That is the case in some Narrow Artificial Intelligences that are focused on concrete tasks in which they could perform better than humans. i.e.: playing chess, finding patterns in data, etc.
[2] https://www.sciencedirect.com/science/article/pii/S1871678423000031
[3] https://www.nature.com/articles/s41524-022-00765-z
[4] https://www.nature.com/articles/s41591-021-01614-0
[5] https://link.springer.com/article/10.1007/s00146-022-01540-w
[6] Krenn, M., Pollice, R., Guo, S.Y. et al. On scientific understanding with artificial Intelligence, Nature (2022) .https://www.nature.com/articles/s42254-022-00518-3
[7] https://www.elsevier.com/connect/research-futures-2022

(18% of the projects have an AI component), linguistics (18%) or 'Sociology, demographics' (8%). Additionally, in the 2021-2022 work programme of the European Commission's Joint Research Centre (JRC), AI and its related technologies were present in around one quarter of the research projects[8]. This trend will likely accelerate in the coming years[9].

The application of AI in R&I would be a revolution rather than an incremental evolution. AI can be catalogued as a "general method of invention"[10] and its application in science and innovation is generating new paradigms. As such, it turbocharges the current trend of data-driven scientific discovery. It can reverse the slowdown in scientific productivity seen in recent years[11]. In particular AI can increase significantly the scientific production because it helps to accelerate the time to obtain results[12] (e.g.,. by using existing computational resources) and carry out research in ways that were not feasible before AI (e.g.,. by analysing large amounts of data or incorporating more complex models of prediction or by using AI methods to design and automatically control experiments[13]).

There are already discoveries anticipating the future of R&I when applying AI. For example, Google's AlphaFold, has made one of the most important discoveries in recent years. A multidisciplinary team of around 20 people (including chemists, physicists, and computer scientists) worked over 5 years on an AI model that has solved a problem that was at the core of biology for several decades. AlphaFold has modelled the folding of all known proteins (200 million) when before it took a PhD student several years to model a single protein. This means **an increase in productivity by a factor above 1 million**. And that discovery has already led to an enormous amount of additional work and discoveries by the scientific community.

Another innovation – OpenAI's ChatGPT – propelled the AI discussions and terminology straight into the mainstream. Based on the generative pre-trained transformer (GPT) family of language models, the tool is able to provide well-articulated human-like responses to prompts from a wide range of knowledge domains.

The functionalities of tools based on large language models (in addition to ChatGPT, there are also tools like Elicit and Perplexity) – the chatbot-style interface, enabling researchers to interact dynamically with the machine, to search for information, receive summaries of key points, to pose research questions and receive suggestions for potential research directions, to improve the researchers' prose – could turn these tools into virtual assistants to scientists, making their work more efficient and helping them to communicate their ideas more effectively.

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[8] https://joint-research-centre.ec.europa.eu/jrc-science-and-knowledge-activities/trustworthy-artificial-intelligence-ai_en

[9] Nature Editorial, The scientific events that shaped the decade, Nature, 576 (2019), pp. 337-338

[10] Bianchini, S., Müller, M., & Pelletier, P. Artificial intelligence in science: An emerging general method of invention. Research Policy, 51(10), 104604 (2022).

[11] https://oecd.ai/en/wonk/ai-future-of-science

[12] In only an hour and a half, AI helped researchers narrow down thousands of potential chemicals to a handful that ultimately led to the discovery of a potential new powerful antibiotic: New superbug-killing antibiotic discovered using AI - BBC News.

[13] National Academies of Sciences, Engineering, and Medicine. 2022. Automated Research Workflows for Accelerated Discovery: Closing the Knowledge Discovery Loop. Washington, DC: The National Academies Press. https://doi.org/10.17226/26532

The success of ChatGPT triggered a race in AI investment[14] in the beginning of 2023 but also intensified the debate about the far-reaching consequences of the use of AI technology.

OpenAI emphasizes on the potential of AI to aid "in the discovery of new scientific knowledge that changes the limits of possibility". Other leading figures in the tech world have also pointed to the promise AI holds for science:

> *"I believe we are on the cusp of an exciting new era in science with AI poised to be a powerful tool for accelerating scientific discovery itself." "I believe (AI) could usher in a new renaissance of discovery, acting as a multiplier for human ingenuity"* (Demis Hassabis, CEO DeepMind)

> "*one of the things I find pretty promising about AI is the use of the AI in science*" (Yann LeCun, chief AI scientist for Meta)

... and to the urgent need for society to adapt to a world with powerful AI and for policy-makers to catch up with the latest technology developments[15].

Further into the future, there are predictions about AI being able to autonomously make scientific discoveries - the Turing Institute launched a challenge to develop by 2050 an "*AI Scientist*" capable of making Nobel-quality discoveries comparable, or superior, to the best human scientists[16].

The EU still has no dedicated and systemic policy to facilitate the uptake of AI in science. This is in spite of being among the most active global players in AI, and having a powerful and dynamic research community. The Commission launched different policy actions for the successful take-up of AI in the EU and development of "Core AI" technologies. These policies complement each other in different ways, and some of them would be key enablers to the adoption of AI in R&I. However, there is a risk of missing out on some benefits that AI could bring to science.

There is a need for a policy that can connect and complement the different AI initiatives that can impact the uptake of AI in science and for new, better targeted policies on its application. The successful adoption of AI by the scientific community should trickle down into more science-based start-ups, research spin-offs and deep-tech companies. Therefore, we as policy-makers need to anticipate these changes and steer them to ensure that accelerated scientific progress thanks to AI provides faster, larger, and positive societal outcomes.

There are specific needs and gaps in the adoption of AI in R&I that need targeted, systemic policy. AI opens a significant amount of opportunities for R&I but its successful adoption faces specific challenges, such as, the impact on the scientific process (to ensure accurate,

[14] https://www.economist.com/business/2023/01/30/the-race-of-the-ai-labs-heats-up , https://www.reuters.com/markets/deals/biontech-acquire-british-artificial-intelligence-startup-instadeep-2023-01-10/

[15] Pause Giant AI Experiments: An Open Letter - Future of Life Institute

[16] https://www.turing.ac.uk/research/research-projects/turing-ai-scientist-grand-challenge

robust and reproducible results, to avoid the misuse of AI, , to address issues with IP rights), the need for transdisciplinarity[17] in policy design and multi- and interdisciplinarity of researchers teams (bringing researchers with domain- and AI knowledge together), the optimisation of human-machine collaboration in R&I activities, ensuring that the R&I community has easy access to the right infrastructure and data[18], or the challenges to attract AI talent to work in R&I projects, dedicated AI technology for science etc. Well-designed policies to address these specific issues will provide earlier and more successful results.

The AI in R&I policy design should include new policies, but also adapt existing ones. In R&I the impact of AI is relevant in many different areas, and R&I policies should be AI-friendly or AI-ready. Following the proposal for an AI Act and the Coordinated Action Plan on AI, the adoption of sectorial policies to AI is starting in many areas (education, health, public sector etc.) and R&I policies should not be an exception. Furthermore, the advance AI could bring to research would have a spill-over effect on policy areas which rely on innovation and scientific breakthrough to deliver on societal challenges (such as medicine, climate, etc.)

While the rewards of successfully adopting AI are promising, the threat of lagging behind other global players is major. The US and China are investing massively in the development of AI, with US Big Tech leading many fields, and with large state support in China[19]. Assuming that the science of the future will be tied to the application of AI, that could lead to network effects where the most technological advanced in terms of AI will accumulate an even higher share of scientific discoveries at a faster pace. That could have strong implications in terms of technological and scientific sovereignty. Europe could be left out, or even worse, locked out of the next breakthrough discoveries.[20]

Additionally, current applications of AI in R&I are strongly conditioned by the private agenda and foreign-owned tools. Big companies are leading in many aspects the AI revolution, and that can lead to biased priorities, as some scientific areas might not be seen as immediately profitable. At the same time, they have a big influence on the technical solutions that then will be used by scientists. The EU needs to set its own agenda and build the adequate set of resources to ensure public goods in R&I, complementing the private sector.

[17] Editorial-Transdisciplinary-Innovation-August-2018.pdf (researchgate.net)

[18] Data are, as a general rule, considered to be facts and therefore do not give rise to intellectual property rights. However, in specific cases, e.g. the rights set out in the database directive (Directive 96/9/EC of 11 March 1996), data availability for scientific research purposes may be hampered.

[19] See, Geopolitical Lens: AI Policy and Grand-Strategy in 2030, page 10, Trends in Artificial Intelligence and Big Data, ESPAS paper

[20] Feijóo et al., Harnessing artificial intelligence (AI) to increase wellbeing for all: The case for a new technology diplomacy, Telecommunications Policy, Volume 44, Issue 6,2020

3. EU POLICY BACKGROUND

The European Commission's strategy on AI was first articulated in April 2018 with the Communication "**AI for Europe**", and was further operationalised in subsequent communications.:

In December of 2018 the first version of the **EU Coordinated Plan** was adopted. This was developed jointly with Member States, and listed a number of actions both at EU and at national level.

In April 2019 the Commission adopted the Communication "**Building Trust in a human centric AI**." It was accompanied by a Staff Working Document developed by the High Level Expert Group on AI, which proposed "Ethics Guidelines for trustworthy AI."

The White Paper on "**Artificial Intelligence: a European approach to excellence and trust**" adopted in February 2020 was the first deliverable of the von der Leyen Commission. It outlined a number of actions, which aimed at a) Developing an AI European ecosystem of Excellence in AI, and b) Developing an ecosystem of trust.
The White paper resulted in the adoption in April 2021 of:

- The cover Communication "**Fostering a European approach to Artificial Intelligence**"
- An updated **AI coordinated plan** corresponding to the "AI European ecosystem of excellence "requirement of the AI white paper,
- The proposal of the **AI act**, which corresponds to the "Ecosystem of trust" requirement of the AI white paper.

The **updated coordinated plan** details new and already running actions for boosting capacity on AI technologies and their use in Europe. It includes:

- Funding in Horizon Europe and Digital Europe Programmes. Examples:
    - AI networks of excellence centres designed to boost the development of AI technologies
    - Digital Innovation hubs with focus on AI, which provide companies with a possibility to test AI technologies before investing as well as related services, such as financing advice and advice on training and skills development that are needed for a successful digital transformation.
    - The AI on demand platform designed to give access to all relevant resources (eg software, algorithms, etc.) to innovators that would like to develop or use AI
    - Actions on Data including the creation of European Data Spaces,
- Actions on Skills

- The announcement of legislation that is designed to make more data available, such as the Data Governance Act, the Data Act, etc. The **AI Act**, sets requirements for the development of high risk AI systems. It also bans AI systems that are considered of unacceptable risk. In the process of negotiations on the AI Act, the co-legislators have explicitly maintained that the AI act does not apply to research. The Council general approach added an explicit exclusion for research.

Since it will take some time before the EU regulation on AI enters into force, and as pressure for a coordinated global action on AI is mounting[21], EU decision-makers have proposed measures to step up global cooperation on AI to establish minimum standards even before legislation enters into force.

A European Centre for Algorithmic Transparency (ECAT)[22] was established with a commitment to improved understanding and proper regulation of algorithmic systems. It is set out to contribute to a safer, more predictable and trusted online environment for people and business, by providing technical assistance and practical guidance.

In 2022, the European Commission also published a set of **ethical guidelines for educators** on the use of AI and data in education[23]. Awareness raising on the use of AI in education is currently ongoing, including numerous articles, webinars and resources published on the European School Education Platform and a MOOC for teachers under preparation. Studies on the use of (generative) AI in education are underway, in collaboration between DGs EAC and JRC, as well as studies on the future of education (including AI) and on the convergence of the green and digital transition in schools.

In 2023, in the context of the European Year of Skills, the Commission reiterated the importance of high-quality, inclusive and accessible digital education and skills, and published two proposals to address the lack of a whole-of-government approach to digital education and training, and the difficulties in equipping people with the necessary digital skills.

4. REQUEST TO THE GROUP OF CHIEF SCIENTIFIC ADVISORS

The request to the Group of Chief Scientific Advisors is:

[21] 100506878.pdf (mofa.go.jp)
[22] https://algorithmic-transparency.ec.europa.eu/index_en
[23] https://education.ec.europa.eu/uk/news/ethical-guidelines-on-the-use-of-artificial-intelligence-and-data-in-teaching-and-learning-for-educators

How can the European Commission accelerate a responsible uptake of AI in science (including providing access to high quality AI, respecting European Values) in order to boost the EU's innovation and prosperity, strengthen EU's position in science and ultimately contribute to solving Europe's societal challenges?

The Group's advice should be based on a thorough assessment of the barriers which currently exist to a wider uptake of AI in science across domains at EU and national level, of the potential opportunities to seize and of the risks to anticipate and mitigate.

Keeping in mind the wide scope of the topic and its far-reaching consequences, and in order to inform the GCSA's policy recommendations, we ask the SAM to gather evidence in four key areas related to AI in science: **1/Vision and foresight, 2/Scientific process, 3/People, 4/Policy design.**

In addition, the evidence review phase should include two "deep dives": one on the **disruptive potential of AI in different fields of science** and one on the **impact of AI on everyday scientific practice and workflow.**

The Group is requested to finalize and publish their Scientific Opinion during the first quarter of 2024. An intermediate output specifically focused on the benefits of AI for scientific productivity and the European innovation ecosystem (Key area 1) is expected as soon as possible and at the latest before the end of 2023.

In the following, the guiding questions for each of these key areas and deep dives are presented.

Key area 1 – Vision and foresight

What impetus could AI give to scientific productivity and what benefits, incentives and challenges would AI-enabled research bring to the European innovation ecosystem and the society as a whole?

The Group's advice should be informed by evidence on the effect of the use of AI in science in the EU and on the expected impact of AI on the productivity, quality and accessibility of European science, as well as on EU's strategic priorities (climate neutrality, strategic autonomy, digitalisation, security, health, social fairness, etc.)

Key area 2 – Scientific process

What is the impact of AI on the scientific process, and its potential to re-shape science and its governance practices?

The Group's advice should be informed by evidence on how to best integrate AI tools, and the processes involved with using AI, in everyday scientific practice and workflow across domains (hypothesis generation, experiment design, monitoring and simulation, scientific publication) and on AI's potential to identify new research questions and opportunities, to develop new scientific fields, to improve networking, community-building and collaboration in science (including human-AI collaboration and the use of collective intelligence). The Group should also explore the potential gaps of AI technology, as well as AI tools that can be trusted in the scientific process. The Group should take into consideration the possible risks of applying AI in the scientific process and any specific workflows and checks that could be put in practice.

Key area 3 – People

How can the EU best prepare for the impact and requirements of AI on the education and careers of the scientists and researchers of today and tomorrow, and what skills and competencies should education policies prioritise in this context?

The Group's advice should be informed by an assessment of ways to ensure that researchers (at all stages of their education and professional development) and organizations have sufficient knowledge on using AI in science (and on related skills such as IT and computing, statistics, data analytics) and affordable access to infrastructure, data, computing capacity and AI tools and technologies. It should also consider which scientific jobs carry a high risk of being outsourced to AI-based technology; and the impact of AI (taking over some of researchers' tasks) on scientific workforce and researchers' careers. .

Key area 4 – Policy design

How should the Commission (through policy initiatives, regulation, communication, and outreach) facilitate responsible and timely AI uptake by the scientific and research communities across the EU?

The Group's advice should be informed by an assessment of the current regulatory context[24], and should give guidance on the role the Commission and other EU institutions should play to boost application of AI in science; on the potential needs and ways of promoting/communicating AI use in scientific communities; and on measures to ensure a level-playing field between big technology companies and public/smaller/independent research organisations, whilst ensuring that the EU does not lose the battle for talent in AI-powered research. The need for balancing costs and benefits (including the related issues of energy consumption and sustainability; of the interoperability, availability and reliability of data underpinning AI; and of diversity and inclusiveness in research, for example related to culture/language bias) should also be taken into account.

Deep dive 1 – AI's disruptive potential

Which scientific domains are experiencing (or could experience in the near future) the most positive impact of AI-enabled research, and in what areas does one expect major breakthroughs? Conversely, in which R&I fields is AI not sufficiently developed yet, also in comparison to other countries?

The evidence review should consider which scientific domains are better prepared to embrace AI and, conversely, in which the use of AI is not sufficiently developed yet; which are the barriers to ensure that AI is widely used in all scientific domains, overcoming potential technical issues; and what would be the impact of geopolitical divisions on AI-enabled research (e.g. on the access to diverse and quality scientific data and expertise).

Deep dive 2 – AI's impact on scientific practice

What is the impact (positive and negative) of AI on everyday scientific practice and workflow (such as on hypothesis generation, experiment design, monitoring and simulation, scientific publication of research results, intellectual property rights, etc.)?

[24] In relation to this, a study commissioned in the framework of ERA Action 2 ("Propose and EU copyright and data legislative and regulatory framework fit for research") will i) identify the relevant provisions for researchers, research organisations, research infrastructures and research services providers under the AI Act and ii) assess and present how they can comply with the obligations and benefit from the rights they may have under this act.