BROOKINGS

CENTRE FOR EUROPEAN POLICY STUDIES

REPORT

OCTOBER 2022

GLOBAL AI COOPERATION ON THE GROUND

AI RESEARCH AND DEVELOPMENT ON A GLOBAL SCALE

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FORUM FOR COOPERATION ON ARTIFICIAL INTELLIGENCE

Introduction

The Forum for Cooperation on Artificial Intelligence (FCAI) has investigated opportunities and obstacles for international cooperation to foster development of responsible artificial intelligence (AI).[1] It has brought together officials from seven governments (Australia, Canada, the European Union, Japan, Singapore, the United Kingdom, and United States with experts from industry, academia, and civil society to explore similarities and differences in national policies on AI, avenues of international cooperation, ecosystems of AI research and development (R&D), and AI standards development among other issues. Following a series of roundtables in 2020 and 2021, we issued a progress report in October 2021 that articulated why international cooperation is especially needed on AI, identified significant challenges to such cooperation, and proposed four key areas where international cooperation could deepen: Regulatory alignment, standards development, trade agreements, and joint R&D.[2] The report made 15 recommendations on ways to make progress in these areas.

For joint R&D, recommendation R15 of the progress report called for development of “common criteria and governance arrangements for international large-scale AI R&D projects,” with the Human Genome Project (HGP)[3] and the European Organization for Nuclear Research (CERN)[4] as examples of the scale and ambition needed. The report summarized this recommendation as follows:

> “Joint research and development applying to large-scale global problems such as climate change or disease prevention and treatment can have two valuable effects: It can bring additional resources to the solution of pressing global challenges, and the collaboration can help to find common ground in addressing differences in approaches to AI. FCAI will seek to incubate a concrete roadmap on such R&D for adoption by FCAI participants as well as other governments and international organizations. Using collaboration on R&D as a mechanism to work through matters that affect international cooperation on AI policy means that this recommendation should play out in the near term.”[5]

FCAI convened a roundtable on February 10, 2022, to explore specific use cases that may be candidates for joint international research and development and inform selection and design of such projects based on criteria outlined below. Potential areas considered were climate change, public health, privacy-enhancing technologies for sharing data, and improved tracking of economic growth and performance (economic measurement). This working paper distills the discussions and our analysis and research. We recommend that FCAI governments, stakeholders, and other likeminded entities prioritize cooperative R&D efforts on (1) deployment of AI as a tool for climate change monitoring and management and (2) accelerating development and adoption of privacy enhancing technologies (PETs).

These distinctly different subject areas reflect the complex interaction of criteria explored in our discussions and appear to offer the most promising avenues of progress for international cooperation on AI R&D. Both areas emerged as clear favorites in discussion and polling among participants at the February 10 FCAI dialogue for the following reasons. On the one hand, climate change presents an urgent global challenge with a recognized need for collective action, where AI affords a tool that—building on existing efforts, data sources, and machine learning technology—could augment earth observation, energy management, and other fields important to meeting the climate challenge. On the other hand, privacy-enhancing technologies (PETs) are a budding technology field where collective resources can accelerate development to help overcome barriers to data access due to concerns about privacy, security, and ethics, as well as proprietary interests and economic protectionism. Together, these subjects present a balance between applying existing AI to tackle pressing global issues and expanding the frontiers of AI in ways that promote responsible use of this powerful combination of techniques.

Criteria for selection of projects

To identify potential subjects for global R&D initiatives, our October 2021 report proposed five criteria: Global significance, global scale, the public good nature of the project's subject and goals, its deeply collaborative nature and the need for its impacts to be measurable and assessable. Feedback from FCAI participants substantially validated these criteria but demonstrated that they have diverse facets, synergies, and overlaps that add complexity to choices. Furthermore, discussion among participants clarified intersections and contrasts among these suggested criteria that provided a sharper lens to examine differing choices of areas for international R&D collaboration.

We recommend that FCAI governments, stakeholders, and other likeminded entities prioritize cooperative R&D efforts on deployment of AI as a tool for climate change monitoring and management and accelerating development and adoption of privacy enhancing technologies.

1. ***Global significance*** implies that such a project should be aimed at important global issues that demand transnational solutions. The shared importance of the issues should give all participants a common stake and, if successful, could contribute toward global welfare. As emerged from discussion with FCAI participants, global significance has several different facets, encompassing impacts on humanity or the environment ("people, planet, and prosperity"). Another closely related dimension is urgency, which refers to the opportunity costs of failing to act. From this latter standpoint, climate change and global health stand out as obvious priorities. On narrower planes, however, it is important to consider dimensions such as the impact on AI innovation, the project's impact on international cooperation, and its impact on specific fields of research. Ultimately, the selection depends on balancing priorities.

2. ***The global scale criterion*** expresses that the scope and ambition of the project require resources—funding, access to data, computing power, knowledge, talent, and financial resources to support these—on a large enough scale that the pooled support of leading governments and institutions adds significant value. Such resource needs correlate in significant part with the magnitude of the global problem targeted. Nonetheless, this magnitude does not correlate directly with project complexity: Climate, health, and economic measurement all involve massive complex systems, but data and computational methods to address climate are more available in the present than they are for global health or econometrics. By contrast, PETs involve a much more discrete set of problems but highly complex computation. Again, scope and ambition must be balanced with feasibility.

3. ***The public good nature of the project*** means that, if successful, the output of the project would benefit the global community at large. Both the project and its results should be available to all participants as well as used to improve access to data, talent, and computing capacity in less developed countries. A public good should provide wide benefit and be widely available, inclusive, and non-rivalrous. Hence, this criterion requires assessment of who benefits and, with significant R&D and data sources in private hands assessments of the private marketplace, how to incentivize private sector participation. All the subject areas discussed have significant public good aspects; some feature significant amounts of needed data in private hands (especially from the health and payments sectors, though varying in degree by country).

4. ***The collaborative nature of the project*** means that the project is likely to necessitate a multi-disciplinary approach addressing regulatory, ethical, risk, and technical questions in a context that is concrete and in which the participants have incentives to achieve results. It would amount to a large-scale, shared, and international sandbox or test bed for AI methods, governance, and regulatory models. Our series FCAI dialogues in 2020-2022 led us to observe that abstract issues of regulation and ethics are addressed most effectively in the context of concrete use cases, and a shared commitment to seek concrete solutions would provide incentives to resolve differences. Hence, appraising this criterion means considering how strong incentives for collaboration are: How much do the global impact or public good nature of the project motivate participants to collaborate; and where may this motivation be reduced by inevitable differences in policies, culture, or resources?

5. ***Finally, the impact must be assessable***. Any project will need to be monitored and audited commensurately with its scale, public visibility, and experimental nature. Participants will need to assess progress toward both defined project goals and impact in addressing ethics, risk, regulatory issues, and other, broader goals. Lessons from the projects should be shared widely. As pointed out by FCAI participants, this is an especially cross-cutting criterion. Here, feasibility enters into consideration, as well as an assessment of how AI can contribute value. Our progress report alluded to the spinoff benefits of scientific programs like the Apollo program or the Human Genome Project;[6] these are collateral benefits of projects with very defined objectives—going to the moon and mapping the entire human genome, respectively. The targeting of areas should not engage in "techno-solutionism," the assumption that because a subject is big and complex, AI necessarily can and will find solutions. To the contrary, in most fields this will be at most a tool in the context of multi-pronged strategies. The potential impact of AI on some subject areas is more defined, on others more speculative. Subjects with more established datasets and pathways for data access and deployment of machine learning offer greater probability of definable impact.

   The choice of most highly deserving areas for collaborative R&D projects therefore involves important balancing of factors, for example between seeking to mature emerging technologies versus exploiting readily available technologies for immediate public benefit. These trade-offs result from technical issues. Different subject areas will present different issues such as what data and computing capacity is needed, what is available, and applicable data governance considerations. For example, NASA,[7] the European Space Agency (ESA),[8] and meteorological agencies[9] make public vast databases of observations, while sharing of health data is subject to institutional and privacy constraints. Similarly, different subjects call for different AI methods, and some require greater or more disruptive innovation to achieve results. As discussed in our progress report, differences in data formatting and metadata may present obstacles to sharing data sets even where these are available. What consideration should be given to availability of data and proven AI technology? What priority should be given to expanding the boundaries of AI versus impact on targeted global problems?

6. ***Governance*** is a potential additional criterion not discussed in our October 2021 report. Effective governance will be necessary to the success of large-scale collaborative projects. The extent to which the product of joint R&D is a public good will depend on governance rules, among other factors; so will the operation of any kind of international regulatory sandbox and the call on resources to support a project. The progress report pointed to CERN, the International Space Station (ISS), and HGP as potential models. The Appendix below provides a general summary of the different governance structures, funding models, and outcomes of these entities, which range from a body of government representatives overseeing a structure of research contributors (CERN), to a handful of government agencies (ISS), to an aggregation of research institutions supported by government grants (HGP). These models provide starting points for considering governance. This range of variation along with common sense nevertheless suggest that governance is likely to depend on the nature of the R&D and the stakeholders and funding sources involved. It follows that any extensive discussion of governance should follow from discussion of subject areas for R&D. In addition, governance could be affected by other subjects identified for deeper FCAI discussion, especially topics on regulatory alignment, including coordination on regulatory sandboxes (recommendation R7). For these reasons, we did not address governance in our February 2022 roundtable or in this paper. A group of scholars from the Stanford Institute for Human-Centered Artificial Intelligence (HAI) have a proposal that resonates with ours in proposing an international AI research institute but take a different tack in beginning structure by recommending that the United States take the initiative to establish such an institute that would resemble CERN.[10]

With the background of this refined understanding of selection criteria, the February 2022 roundtable turned to specific areas of potential international R&D collaboration discussed below and the opportunities and challenges involved.

Assessing areas for R&D collaboration

In this section, we first provide a brief look at the four proposed areas for large-scale collaborative R&D projects: Climate change, public health, privacy protecting technologies, and economic measurement, with a focus on AI-related developments and policies in the field and existing efforts to develop international cooperation. We then turn to a comparison of these subjects through the lens of our analysis and discussions with FCAI participants. Finally, we explain why this comparison led to climate change monitoring and PETs as prime prospects.

Overview of potential projects

1. Privacy-Enhancing Technologies (PETs)

PETs may enable some of the benefits of data sharing, cross-border data flows, and open government data while protecting data privacy and compliance with data protection laws and other restrictions on data. This category of technologies is broad: It can encompass technologies for secure communications and transactions such as secure messaging and other applications for encryption; tools for privacy management such as anonymization and pseudonymization of individual records and other data governance and compliance; software to prevent or limit tracking; and methods of computation and data analysis that make it possible to derive useful information from data without access to the data itself. It also can extend to networks or systems in sectors such as banking and payments that enable secure, privacy-preserving transactions without the need to share underlying data.

Our progress report and roundtable focused primarily on methods that can contribute to R&D in AI. These are computation methods such as synthetic data (which in turn relies increasingly on AI), federated learning, differential privacy, homomorphic computation, and zero knowledge proof. These methods often may be used in combination with one another along with encryption and data governance.

These methods have been the subjects of academic and corporate research interest, but the marketplace uptake for general use has so far been limited. Guidance on PETs from the UK Information Commissioner's Office advises, "[s]ome PETs may be theoretical, immature and unscalable" and "can be challenging to implement."[11] For synthetic data, however, a study by the European Commission's Joint Research Centre found that "[s]ynthetic data have proven great potential and are the go-to methods ready to be deployed in real-life scenarios."[12]

Our 2021 progress report enumerates various initiatives by FCAI governments to incorporate PETs into government uses of data and foster their use at the national level.[13] A common theme is the development or investigation of federated learning systems among government agencies and of differential privacy for publicly released datasets. Since the report was issued, cooperation on PETs has become a topic in the data governance working group of the EU-U.S. Trade and Technology Council[14] and, at the Summit for Democracy in December 2021, the U.S. and UK announced plans to issue a set of prize challenges for PETs, which aims to feature winning solutions at the second Summit for Democracy in the first half of 2023. In announcing these challenges, President Biden's science adviser and director of the White House Office of Science and Technology Policy at the time, described the proposal as a way of helping democracies "unlock the economic, scientific, and societal benefits of emerging technologies protecting shared values such as privacy, accountability, and transparency."[15] In addition to these bilateral initiatives, the United Nations Committee of Experts on Big Data and Data Science for Official Statistics announced a "UN PET Lab," a pilot project among four national statistical offices (the Italian National Institute of Statistics, Statistics Netherlands, the UK Office for National Statistics, and U.S. Census Bureau) to demonstrate PETs for data sharing and analysis among each other.[16]

In summary, the high potential benefits, inhibiting factors, and common interests mentioned above make PETs a suitable area for increased R&D cooperation. As these technologies mature and become more familiar, they may provide a foundation for wider systems and networks with broader ranges of data.

2. Economic measurement

Economics has long employed computation—from the simple supply-and-demand curve to complex and compute-intensive predictive models widely used for economic forecasting, trading on markets, and many other high stakes applications, as well as analytics. Given this experience, it is not surprising that there is great interest in applying AI to take computational economics to a new level. Use of AI in economic measurement includes:

- **Large scale automated data collection and analysis:** Short-term economic conditions can change rapidly depending on a wide variety of factors, such as interest rates, labor market participation, inflation, supply chain constraints, public health conditions, natural disasters, politics, and more. AI can rapidly collect and analyze large quantities of economic data and news headlines to inform economic modelling.

- **Better forecasting:** AI could improve the accuracy of predictions—both for broad metrics like GDP, inflation, and employment, as well as sector-specific estimates. According to International Monetary Fund economist Prakash Loungani, traditional economic forecasting is often unreliable because the economy fluctuates according to many complicated variables, including less foreseeable factors like human behavior—as a result, human economists did not anticipate 148 out of the most recent 150 recessions.[17] AI can alter this paradigm by capturing data and identifying patterns more efficiently than the algorithms economists currently use to forecast economic outcomes. For example, MIT and Harvard ran the "Billion Prices Project" from 2008 to 2016 to track how prices of goods and services both online and at brick-and-mortar stores change daily.[18]

- **Informing economic policy decisions and actors**: AI can be used to simulate more equitable and effective policy measures. For example, an AI economic policy tool developed by Salesforce, the AI Economist, uses reinforcement learning to simulate different tax scenarios to achieve a desired policy outcome, while controlling for various factors.[19] In the future, this model could be applied to other policy decisions, such as those relating to interest rates, trade, health and safety regulations, and more.

The broad scope of the data collection involved in applications such as these and the extent to which such data can reveal information about individuals present ethical and privacy challenges that will need to be addressed. For example, payment systems such as credit card networks provide a widespread source of digitized information that card providers can mine for their benefit and that of their customers. Such systems could have wider use for economic measurement if aggregated, as in China where the massive mobile payment systems of WeChat Pay and Alipay provide the leading example—and also present a prospect of significant government access and systemic risks.

Profit motive provides incentives for private development of AI-driven economic models in sectors such as finance, where accuracy of predictions and speed of information can beat markets. Use of AI has also become common for fraud protection and investment management. There is parallel interest across governments in broadening the tools for economic measurement, especially in view of the growing global significance of the digital economy. As Erik Brynjolfsson and Avinash Collins point out in a Brookings paper, traditional GDP measures are based on what economic actors pay for goods and services, and therefore do not account for the economic well-being that comes from free or lower-cost services made possible by digital technology.[20] Moreover, traditional measures of international trade do not capture much of the flow of services and information across borders. As a major element of its work on the digital economy over more than a decade, the Organisation for Economic Co-operation and Development (OECD) developed a series of "key Information Communication Technology indicators" to understand better the economic effects of digital technology and commerce.[21] This work stream culminated in a book-length report in 2019, "Measuring the Digital Transformation," which articulated "the challenge is to improve the international comparability of current indicators and make statistical systems more flexible and responsive to the introduction of new and rapidly evolving concepts driven by the digital transformation" and outlined areas of focus to address these.[22]

Part of the OECD's effort is aimed at developing greater comparability across countries' digital economy metrics to enable more global measures as well as comparability among countries. Such measurements can complement AI (and broad digital) development by measuring its growth and its economic contribution and impact on national economies and labor.

Beyond measurement of the digital economy, there is opportunity to harness the digitization of everything for broader measurement of economic activity and other aspects of societies and to employ AI in this effort. As Sandy Pentland and others (including Alondra Nelson, now deputy director of the White House Office of Science & Technology Policy), have written on the growing interdisciplinary field of computational social science: "Privacy-preserving, shared data infrastructures, designed to support scientific research on societally important challenges, could collect scientifically motivated digital traces from diverse populations in their natural environments, as well as enroll massive panels of individuals to participate in designed experiments in large-scale virtual labs..."[23] This reflects the challenges of this new field: There is much to measure, a wide variety and volume of data that may measure it, and limits on wide use of this data. As the OECD work in the field reflects, it is evolving, with member countries working to develop effective and consistent measures.

3. Climate Change

AI can be a powerful tool to understand climate change much better and to respond more effectively. For example, by identifying patterns or anomalies within complex and large-scale environmental and energy datasets, AI can help optimize resource usage, identify climate impacts in real time, and predict future trends. It can analyze data from satellites and sensors to identify methane leaks in gas pipelines, track heat and lighting within buildings, make transportation schedules more efficient, predict wildfires, and more. After Hurricane Maria hit Puerto Rico in 2017, Columbia University and Data Science Institute researchers used AI to analyze NASA photographs of trees to help understand how tropical storms affect forestry on a larger scale.[24] In recent years, Google adopted a machine learning model to predict flooding in India and Bangladesh and partnered with electricityMAP to provide both live and predicted carbon emissions data by country.[25]

Such applications can enable more granular monitoring of climate change and its effects across wide array of indicators and lead to better management of mitigation and adaptation measures, energy usage and carbon emissions, and other responses. Already, large amounts of data have been collected that could support AI systems for climate change modelling and analysis. For example, the UN Food and Agriculture Organization hosts approximately 2,000 datasets on environmental and atmospheric conditions,[26] and the UN Satellite Center maintains a "Rapid Mapping Service" with satellite imagery to aid with climate crisis response.[27] In addition, the Global Partnership on AI (GPAI) established a Committee on Climate Action and Biodiversity to address the role of AI in climate efforts,[28] and in November 2021, in collaboration with the NGOs Centre for AI & Climate and Climate Change AI, issued recommendations on government action especially use AI to improve climate predictions and continues explore recommendations for biodiversity preservation, decarbonization of key industries, and the environmental impact of AI.[29]

In addition, each FCAI government has taken action to promote open datasets in the context of earth observation and climate data:

- To facilitate to satellite imagery, mapping, ocean, and geospatial data, the Australian government recently funded a new Australian Space Data Analysis Facility and partnered with Digital Earth Australia to maintain a "DEA Sandbox."[30]
- The Canadian Space Station has provided over 20 publicly available datasets on earth observation, astronomy, and atmospheric sciences on open.canada.ca.
- The European Space Agency maintains open satellite data through its "Earth Observation data access portal,"[31] and the European Environmental Agency maintains approximately 169 public datasets[32] on topics including energy and sustainability. The European Commission announced a large-scale modeling project, Destination Earth (Destin-E), focused on "the effects of climate change and extreme weather events, their socio-economic impact, and possible adaptation and mitigation techniques" using high-performance computing.[33]

- The Japan Aerospace Exploration Agency has publicly released satellite and sensor data on greenhouse gases, earth observation, and more.[34] Japan's 2012 Open Government Data Strategy also included a commitment to publish "high value datasets" in the areas of earth observation, energy, environment, and geospatial observation.[35] Singapore's Centre for Remote Imaging, Sensing and Processing maps water, aerosols, and oceanography, based on satellite imagery and remote sensor data.[36]
- The U.K. Space Agency has invested over £150 million on projects in over 40 countries (e.g., the Earth and Sea Observation System, real-time satellite imagery, and marine observation projects) through its International Partnership Programme.
- The U.S. National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information publicly maintains over 37 petabytes of atmospheric, marine, and geophysical data.[37] NOAA also maintains climate.gov,[38] the Climate Data Online search feature, the Data Discovery Portal, and the National Weather Service GIS Portal. The United States Geological Survey (USGS) has published approximately 242 Geographic Information Systems (GIS) datasets,[39] in addition to over 15,000 other datasets or research frameworks on seven energy and environmental observations.[40] The U.S. Environmental Protection Agency publishes geospatial and non-geospatial datasets on climate and environmental conditions on its website.[41] NASA maintains an open data catalogue with over 10,000 datasets on space or earth science.[42]

These efforts take place under the umbrella of large-scale modeling under the auspices of the World Climate Research Programme and its network of climate research organizations. This in turn informs the climate change assessments of the Intergovernmental Panel on Climate Change (IPCC) and its wide international network of scientists. In its contribution to the IPCC's Sixth Assessment Report, Working Group II of the IPCC (which assesses impacts of climate change), reported with "high confidence" that:

> "Enhancing knowledge on risks, impacts, and their consequences, and available adaptation options promotes societal and policy responses. A wide range of top-down, bottom-up and co-produced processes or sources can deepen climate change sharing, including…participatory modelling and climate services…"[43]

There are two leading climate models that inform this research and assessments: The Atmosphere-Ocean General Circulation Model (versions of which are employed by Australia, Canada, Italy, France, Germany, Japan, Norway, Russia, the UK, and the U.S.) and the Earth System Model (employed by Canada, Denmark, Germany, the Netherlands, Russia, Switzerland, and the U.S.). Both employ massive supercomputing to analyze massive sets of data on atmosphere, oceans, land, and ice. AI might combine an even wider array of data into meta-models with higher resolution.

Although much of the relevant data—such as large-scale astronomical or earth observation data—is neither personal nor sensitive, other sources of information could potentially link back to individuals or groups of individuals, especially when combined with other data. For example, as of 2019, over 90 million U.S. homes had installed smart meters to monitor energy usage.[44] These can collect or infer data on behavioral habits, physical presence in (or absence from) a home, and more—which could lead to potential harms such as loss of privacy, unauthorized home entry, or theft.

Satellites can collect data from diverse geographic locations without extensive on-the-ground infrastructure, but low- and middle-income countries may still be underrepresented in climate data collection if they have less funding, sensor technologies, and internet connectivity. Bias or disparate outcomes could potentially occur if AI is disproportionately trained using data in some geographic locations. For example, governments can use AI to optimize the locations of charging stations for electric vehicles (EV) based on historical usage, but there may be a correlation between income and EV ownership. In addition, data collection via smartphones may exclude communities with relatively low smart device usage.

Finally, it is important to consider ways that AI may harm the environment as well, starting with improved data on AI energy usage. This usage is high as a result of the energy to power extensive computing for machine learning or deep learning using on large datasets and relying on large-scale data centers. Some predictions project that data centers will consume as much as 20% of the world's energy by 2025.[45] The International Energy Agency, on the other hand, observes that data center demand for energy has been essentially flat over the decade 2010-2020 despite rapid growth in output, due to improvements in efficiency by equipment providers and cloud providers.[46] By 2030, The European Commission predicts that by 2030 data centers will use 28% more energy and has adopted a strategy to promote data center energy efficiency.[47] These divergent estimates indicate a need for a more holistic understanding of the environmental impact of AI's overall environmental impact.[48]

4. Health.

The potential for AI to increase the efficiency of health care systems, improve outcomes for patients, and monitor population health has led governments and multinational organizations to explore how to harness AI for health. The World Health Organization, the World Bank, and the International Telecommunications Union (ITU) have undertaken broad studies of this potential. The Broadband Commission of the ITU and the Lancet-Financial Times Commission on Governing Health Futures 2030 brought together international experts to explore the implications of digital technology on health. The U.S. National Academy of Medicine has done the same at the national level. In the U.K., the National Health Service established NHSx (now NHS Transformation) to work with industry and care providers to introduce digital innovation, including an AI Lab.[49] While estimates of the global market for AI in health care vary widely and wildly, the Broadband Commission put it at $31 billion by 2025.[50] The most concrete benefits appear to be in better detection, prediction, and care delivery, which has led governments to support R&D investments or establish AI programs.

Perhaps the most notable impact has been on medical imaging. In the field of radiation oncology, studies show that machine reading is interpreting mammograms with greater accuracy than that of humans, while saving time for physicians and speeding results for patients.[51] The same techniques are affecting other areas of radiology and diagnostics. AI can also be used to enable remote care outside the clinical setting, broadening access for patients, improving waiting times and the patient experience, and reducing costs. For example, at-home urine testing kits interpreted via smartphone cameras can be used to detect early signs of chronic kidney ailments and eye disease and extend the reach of advanced diagnostics and care.[52]

The COVID-19 pandemic has presented many challenges for health and care systems around the world while shining a spotlight on the role of AI in the development of vaccines and treatments. Data sharing, machine learning models, and computational genetics enabled rapid design of gene sequences and predictions regarding specific biomolecular structures that enable identification of promising biomolecules for testing as vaccines or antivirals far more rapidly than laboratory trial-and-error. These built on existing knowledge to identify, produce, and approve COVID-19 vaccines and treatments with unprecedented speed and tailor treatments for individual patients.

The chief hope for AI in health is that integration of information about prevention, diagnostics, and care; information about individual patients; and information about health care logistics and staffing can optimize care for individuals and for care providers.[53] The result would be the delivery of better care for more people at a lower cost.[54]

The pandemic also spotlighted the hopes and challenges for harnessing AI for population health more broadly, including for disease surveillance. This has been evident in efforts by numerous governments at various levels to develop applications to automate contact tracing for COVID-19 exposure, with Apple and Google jointly developing mobile apps for exposure notification.[55] The UK contributed robust data on COVID-19 spread and risk factors and possible reduction of infections with its adaptation of the app in combination with secure analytics of some 50 million health records via its Open SAFELY platform.[56] However, this success appears to have been the exception: Most contact tracing systems had at best mixed success due to uptake by populations concerned about privacy, difficulties of location tracing, and limitations on mobile infrastructure.[57] Even Singapore; with early mobilization, a dense population, high social cohesion, and trust in government saw limited uptake.[58] This experience provides a cautionary note for large-scale deployment of AI as a tool for global epidemiology. Such obstacles loom even larger when it comes to using health data on a transnational basis. Health care is heavily regulated in most countries and administered through national health systems in many countries. Personal health information is highly sensitive and therefore widely subject to restrictions on sharing. Even when data may be available, differences in recordkeeping systems and language present threshold challenges.

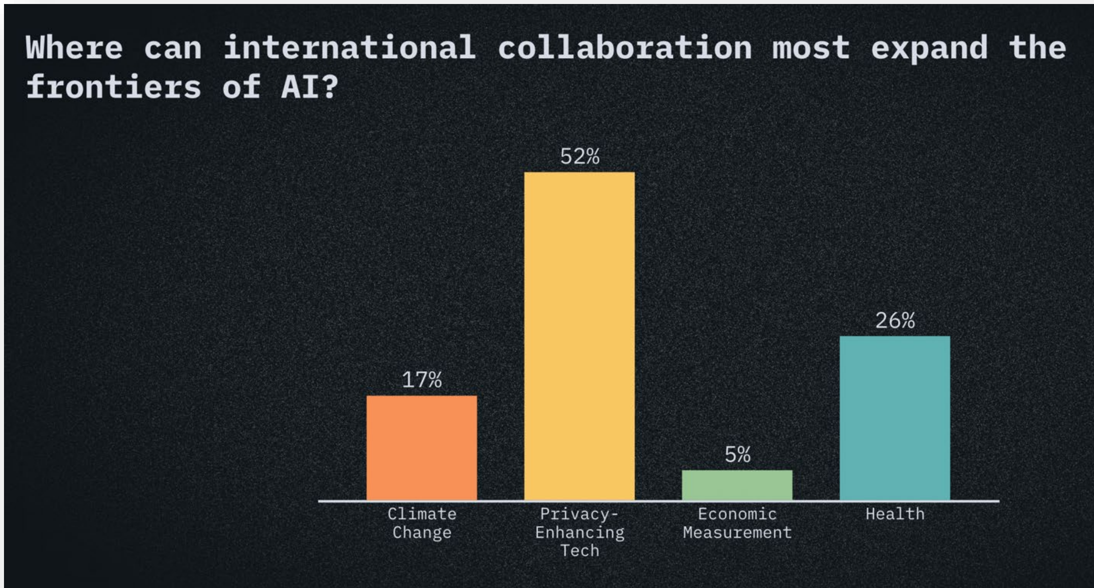
The work of the WHO, the U.S. National Academy of Medicine, and the Broadband and Lancet-Financial Times Commissions has focused on the need for digital infrastructure and data governance. As the latter put it, the primary public purpose in the digital transformation of health and health care should be to address "power asymmetries… public trust…and public health and [universal health care]," which require expansion of digital technology, governance architecture, and new approaches to data collection and sharing.[59] These conclusions suggest that the challenges of distribution and access to both health care and digital technology should take precedence over application of AI in global health.

Sizing up opportunities for international projects

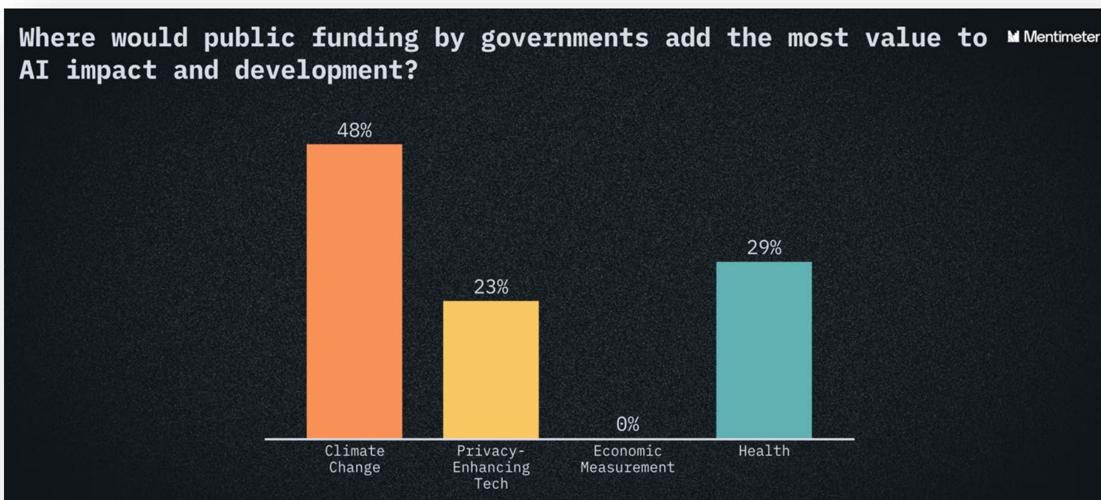
At the FCAI Dialogue on February 10, 2022, after a discussion of the five criteria in the four proposed areas for cooperation on AI, we asked participating experts and officials three questions: (1) Where do you think international collaboration on AI can deliver the greatest global impact? (2) Where can international collaboration most expand the frontiers of AI? and (3) Where would public funding by governments add the most value to AI impact? The first two questions were designed to capture different facets of global impact—impact on broad global problems and impact on AI development. The third question was aimed at both the public good criterion and the suitability of AI as a tool. The answers below display distinctly different results for each question that place in relief advantages, disadvantages, and opportunities presented by each of the four subjects for AI cooperation.

Poll Results

Sample size: 41



Sample size: 43



Sample size: 32

These responses illuminate the discussion of the relative potential and impact of each of the project areas.

Climate Change

Climate change was the overwhelming choice for global impact. This is not surprising given the global dimensions of climate change and the urgency of climate change monitoring and mitigation. Climate change was also perceived as the area where public funding can add the most value to the impact and development of AI. Yet, when it comes to whether international cooperation is needed to expand the frontiers of AI, climate change ranked third, behind health care and substantially below PETs.

These responses suggest that the perceived global impact of AI on climate is not simply a function of scale, but also of feasibility. Indeed, the availability of rich earth observation data and advances in image recognition technology to analyze this data means that significant deployment of AI as a tool for climate change can be accomplished with established technology and available data sets, adding to developed climate models. In addition, while this data may be more robust for the countries or regions that operate the satellites, many satellite orbits can be adjusted to change the area to visualize additional areas; thus, earth observation AI can help overcome challenges of inclusion and representation of low-to-medium income countries.

The existing availability of such resources may explain why FCAI participants ranked climate work highly for impact and as a target for public funding even though they considered the impact on AI development as such to be relatively low: AI can be deployed for climate change monitoring at greater scale and higher speed than for the other purposes considered. In addition, AI for climate has a head start in that there is widespread interest in applying it to the climate change response. This convergence suggests that the high level of support for public funding for AI for climate change work among FCAI participants is a statement that government engagement can leverage and magnify these efforts.

PETs

It is striking that PETs were the second choice for global impact, with more responses than economic measurement and health combined. This is somewhat surprising given that, unlike the other subjects considered, it is arcane and does not have direct impact on the planet or its population. However, this appears to be explained by the responses to the second question, where PETs came out as the top choice for expanding AI development. Where climate change primarily calls for applying existing data and technology to solve a complex global problem, PETs involve developing new computational solutions and systems that can enable AI for a spectrum of applications. The strong support for PETs as a way to expand the frontiers of AI underscores this role.

Two other aspects of the advancement of AI were not addressed in our roundtable discussion of subject for joint R&D: Explainability of algorithms and machine learning and fairness. Progress in both of these areas is vital to responsible AI. Fairness is necessary to ensure the outcomes of AI applications do not discriminate against or otherwise harm. Explainability helps ensure against such outcomes, enables evaluation of the reliability and robustness of the AI, as well as validation and debugging, and protects interaction with humans. Because these are issues for existing AI systems, developers of these systems have incentives to address such issues and, because the products or outcomes of these systems can be tested, there is a reasonable prospect they will be addressed. PETs, on the other hand, enable access to data sources and potential learning that is constrained today.

Indeed, discussion of AI in the context of health and economic measurement highlighted the importance of PETs as an enabler of AI. In each of these areas, access to data and data governance are major issues because they rely heavily on sensitive personal information. Even in countries that have national health systems able to aggregate health data, a significant amount of data resides outside of these databases and in the hands of diverse providers and institutions. Moreover, national data can be difficult to share across national borders for a range of regulatory reasons, the most prominent of which relate to privacy and data protection.

In the economic arena, there is a Babel of data sources encompassing both national and international statistical systems and a wide variety of private sector and academic actors including banks, payment systems, business intelligence forms, and economic analysts. The variety of data analyzed covers the spectrum of economic activity from crop planting and investment to manufacturing, shipping, sales, and paying taxes. Transaction information from credit cards and other payment systems and mobility data have proven to be especially granular sources for analysis, but these also include sensitive information and, even more than health information, reside in dispersed and usually private hands. In addition to privacy and data protection concerns, proprietary interests and logistics present barriers to sharing this data. It is no surprise then that the FCAI's February 10 discussion on econometrics focused mainly on the need for PETs to unlock the diverse data sources as on AI applications.

Enabling broader access to data may have the additional benefit of improving the robustness and quality of data by adding diversity and in turn, helping reduce energy usage by improving the efficiency of data sets used for training.

Advances in AI for health care have come primarily in imaging, diagnostics, drug discovery, and care management, areas where care providers have taken significant initiative.

Health Care

In addition to data governance and the dispersion, diversity, and volume of data, the existing ecosystems of AI in health and econometrics cloud the questions of feasibility, assessability, and impact of public investment on AI in these fields. Advances in AI for health care have come primarily in imaging, diagnostics, drug discovery, and care management, areas where care providers have taken significant initiative. Increased public investment in AI for public health can accelerate these areas of development as well as expand disease surveillance. Even so, public investment in this field might more profitably be prioritized at the moment on addressing barriers to data collection and use as a precondition to setting up health care and public health systems for wider use of AI. There are enormous gaps in these areas for which there are simpler solutions than AI. And the challenges of reaching and sustaining scale in health data make this area less feasible than others.

Economic Measurement

Some of the same considerations apply to economic measurement. There is a stronger case that AI can be a helpful tool in understanding the vast complex systems of national and global economic activity but doing so at a global scale is as challenging as for disease monitoring. In contrast to some other fields, though, much economic measurement comes with powerful incentives to invest in research because there is money to be made or collected both for private actors and governments. When it came to value added by public funding, economic measurement garnered zero votes from FCAI participants; we suspect this outcome was affected by the extent of private sector investment in this field. Most of this is for private benefit, but governments can and do piggyback on information and knowledge from the private sector.

Policy Recommendations

These reasons lead to our recommendation that FCAI governments, stakeholders, and other likeminded entities prioritize cooperative R&D efforts on (1) application of AI in climate change monitoring and management and (2) accelerating development of privacy enhancing technologies (PETs). To implement this overarching recommendation, we propose the following steps toward cooperative R&D projects in these two areas and plan to hold workshops with FCAI participants and other relevant experts to explore these and other steps.

Cross-cutting

- The U.S. should consider whether to establish a multilateral AI research institute along the lines of the Stanford HAI proposal as a way of jump-starting international collaboration on AI R&D.
- FCAI countries should put multilateral R&D on the agenda of the G-7 and other appropriate multilateral and multistakeholder bodies.

Privacy Enhancing Technologies

- There is significant convergence among FCAI governments on interest in PETs and growing collaboration in fostering and adopting these technologies. FCAI governments should scale up and coordinate these efforts. The U.S. and UK are developing prize challenges for PETs to assist in combating financial crime and improving pandemic preparedness, and it is reported that the U.S. and EU may partner to undertake a similar effort.[60] Singapore is partnering with the GPAI offshoot, the International Centre of Expertise for the Advancement of Artificial Intelligence (CEIMIA), to demonstrate PET systems.[61] Additional participants in such efforts can increase the scale or number of these challenges and collaborations.
- The pool of participants should extend beyond the governments participating in FCAI to the G-7 and GPAI. The UK's ICO presented its guidance on PETs to G-7 data protection and privacy regulators and called for "development of industry-led governance, such as codes of conduct and certification schemes" to encourage development and use of PETs."[62] A G-7 prize challenge on PETs would give increased visibility to this highly technical but significant issue and support goals of the G-7's Data Free Flow with Trust roadmap. GPAI members have been exploring PETs, and GPAI should support projects on PETs as part of its data governance work.
- ENISA, the European Union Agency for Cybersecurity, and the U.S. National Institute of Standards and Technology (NIST) both bring expertise in PETs through their work on cryptology that encompasses differential privacy, zero-knowledge proof, and homomorphic encryption. The two agencies should step up their cooperation, each with an eye toward joint projects, other international channels of collaboration on PETs, and internationals standards development on PETs.
- International standards development organizations (SDOs) have laid important foundations for PETs through a growing body of cryptology standards. These

include homomorphic encryption and attribute-based entity authentication in ISO/IEC JTC 1/SC27 and an industry connections committee initiated in the IEEE's IC21-013 to explore a possible synthetic data standard.[63] International SDOs should explore additional opportunities for development of standards on other forms of PETs.[64]
- As efforts in these channels progress, participants can explore further how to scale up development and deployment of PETs.

Climate Change

- The variety of multilateral and NGO efforts to use AI for climate monitoring and management shows that the ground is seeded for significant collaboration. The challenge is in organizing them on a scale commensurate with the scope and urgency of climate change problems. There is value to diversity of efforts, but also to distribution of work and information and pooling of resources.
- Ultimately, collaborative projects in this area, like broader efforts to address climate change, require broad participation of nations to maximize the impact. This makes governance questions loom large.
- The critical path begins with the U.S. and EU working together as the two largest likeminded economic players and largest sources of earth observation data, in collaboration with additional likeminded countries like those in FCAI. AI discussions in the EU-U.S. Trade and Technology Council should explore a joint initiative on AI for climate change to bring to the table in the IPCC and other forums.

FCAI, in parallel with other international forums, can identify data needed and sources of such data among governments, companies, and other institutions, as well as other challenges to putting collaboration into practice in this field.

Appendix

Overview of CERN, ISS, and Human Genome Project Governance & Finance

Project | Lifespan	Origin	Participants | Governance	Outcomes	Funding
Human Genome Project (HGP) (1990–2003)	Emerged from exploratory discussions by U.S. National Institutes of Health (NIH) and Department of Energy (DOE) in late 1980s.	International Human Genome Consortium included 20 separate universities and research centers across the United States, United Kingdom, France, Germany, Japan, and China.[65]	Public release of genome data jumpstarted rapid and wide genomics, including speedy development of effective mRNA vaccines for COVID. Budget commitment toward ethical, legal, and social issues made Consortium the world's largest bioethical program at the time[28] and led to U.S. Genetic Information Non-Discrimination Act in 2009.	Total U.S. spending on the project was $437 billion.
International Space Station (1998–Present)	Developed from memorandum of understanding between U.S. National Aeronautics and Space Administration in the U.S. and Roscosmos in Russia. Russia has announced plans to withdraw from the project as of 2025.[66]	Expanded into an international agreement encompassing the Canadian Space Agency, European Space Agency, and Japan Aeronautical Exploration Agency, with 15 participants including ESA member countries. Participants contribute to construction of components and modules and operation of the space station as well as ground support and research.	Operates as an observatory and laboratory for scientific research across a range of disciplines. NASA touts a wide variety of scientific experiments and advances in water purification, earth monitoring, materials science, and disease.	Funded by all 15 participating nations. NASA contributes approximately $3-4 billion each year to the ISS.
European Organization for Nuclear Research (CERN) (1954–Present)	The European Organization for Nuclear Research was founded in 1954. Began as a joint venture among European nations. Now has 23 member countries, with the EU, Japan, Russia, and the U.S. participating as "special observers" and numerous other countries participating through cooperation agreements.	CERN operates as a hybrid between a laboratory with an immense concentration of unique experimental equipment and a supporting system of distributed collaboration. Programs and budget as well as appointment of the laboratory's Director-General are overseen by the CERN Council, made up of two delegates from each of the member states.	Best known for development of the World Wide Web Protocol, and also spawned the first touch screen for use as a controller in experiments. Its main focus, however, is basic research on particle physics, where its most ambitious project has been the development and operation of the Large Hadron Collider, at 27-kilometers, the largest and most powerful particle accelerator in the world.[35] This project has enabled discovery of various subatomic particles.	Budget in 2020 was 1.4 billion CHF, contributed by participating governments.

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Acknowledgements

We are grateful for the research assistance of Caitlin Chin, Mishaela Robison, and Aaron Tielemans at the Brookings Institution and of Clément Perarnaud at the Centre for European Policy Studies. Aaron Tielemans also acted as project manager for FCAI throughout the evolution of this paper. We are also thankful for the editing and production assistance from Kelly Parsons, Esther Lee Rosen, and Tracy Viselli of the Brookings Institution.

Apple, Google, Salesforce, and the World Bank are donors to the Brookings Institution. Brookings and CEPS recognize that the value they provide is in their absolute commitment to quality, independence, and impact. The findings, interpretations, and conclusions in this report are not influenced by any donation.

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