Technical Note

ARTIFICIAL INTELLIGENCE IN BRAZIL: ADOPTION, SCIENTIFIC PRODUCTION AND REGULATION

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Nº 125

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January 2024

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1 INTRODUCTION[1,2,3]

Among the opportunities for the development of artificial intelligence (AI) in Brazil, data shows that the adoption of the technology by Brazilian enterprises and the availability of data scientists and machine learning experts is on par with European counterparts. The adoption by government organizations is also significant. Bibliometric analysis shows that the United States and China are isolated in their dispute for the leadership in scientific production on AI. Brazil lags behind most developed countries.

The recent launch of ChatGPT created a buzz around AI in general and large language generative models in particular. Famous personalities, like the entrepreneurs Elon Musk and Steve Wozniak, as well as AI experts like Joshua Bengio and Stuart Russel, signed an open letter calling for a six-month pause in AI development.

In the meantime, several countries are in a rush to develop AI regulations. The European Parliament has just approved its negotiating position on the proposed Artificial Intelligence Act.[4] In Brazil, the Chamber of Deputies has approved Bill 20/2021 regulating AI,[5] while the President of the Senate has presented Bill 2.338/2023, prepared by a Committee of jurists.[6]

Given the nature of legislative processes, approving these legal instruments will require significant time.[7] While considerable attention has been devoted to these legislative proposals, we focus on AI regulation by the Executive branch in this article. On the one hand, Brazilian Congress has advanced in the discussions regarding AI regulation compared to their international counterparts. On the other hand, the federal government seems to be lagging when compared to the countries analyzed in this article.

This article is organized as follows. The second section presents an outlook of AI adoption by enterprises and the government in Brazil. The third section presents a bibliometric analysis of the scientific production about AI. The fourth section shows regulation and guidance by the Executive branches of Brazil and G7 countries. The fifth section presents reasons why the Brazilian Executive branch should be more active in AI regulation. The sixth section brings the concluding remarks.

2 AN OUTLOOK ON AI ADOPTION IN BRAZIL

This section presents some statistics about AI adoption in Brazil's enterprise and public sectors. In the first case, it was possible to develop an international comparison.

2.1 Enterprises

The 14th edition of the ICT Enterprises survey has broadened the framework developed by the Statistical Office of the European Union (Eurostat), making it possible to compare Brazil with Europe. When compared with European countries,[8] Brazil does not lag behind most of them, with 13% of its enterprises using some type of AI. Based on the data presented in figure 1, Denmark is the leader in the European continent, with 24% of its enterprises declaring they use some type of AI technology, followed by Portugal and Finland. The low adoption level in countries such as Germany, Norway, and Sweden suggests that the AI development frontier is not on the European continent (Kubota and Lins, 2022). Regarding the size of the firms, figures are always more significant for Brazilian companies than the average European enterprises.

FIGURE 1

Enterprises that used AI technologies by country and size (2021)

(In %)
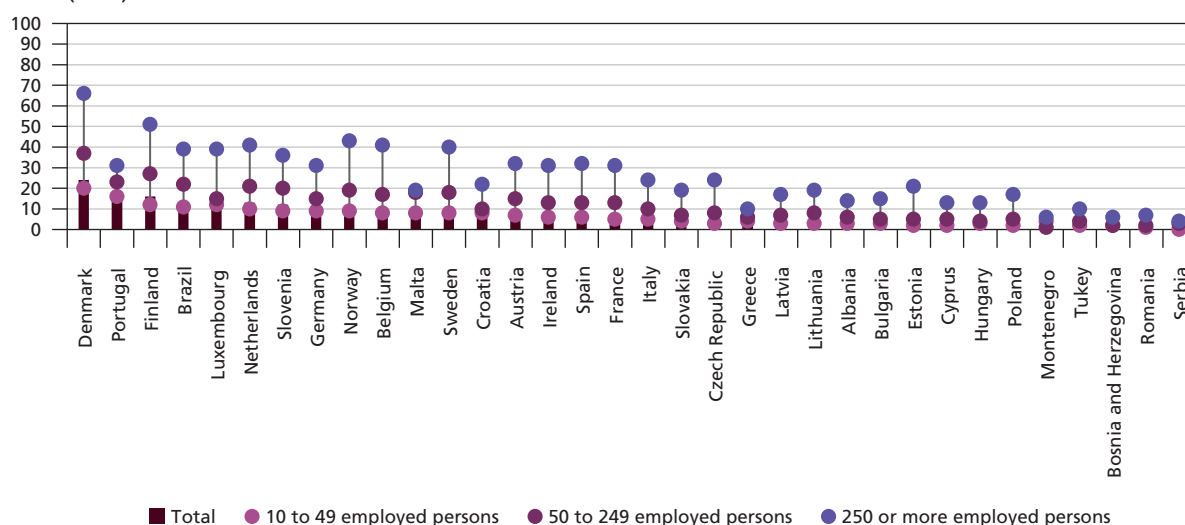
Sources: Kubota and Lins (2022, p. 7); Eurostat (available at: https://ec.europa.eu/eurostat/cache/metadata/en/isoc_e_esms.htm; accessed on: Dec. 12, 2023); and NIC.br (2022).

Upon analyzing the characteristics of AI adoption as depicted in figure 2, Brazil stands out with a larger number of companies that used AI for workflow automation, followed by image recognition and processing, compared to Europe. There is little difference between the Brazilian and European firms regarding other types of use. In the European continent, the different types of AI use are more distributed, although in very small proportions (Kubota and Lins, 2022).

8. Countries covered by Eurostat.

FIGURE 2
Enterprises that used AI technologies by type (2021)
(In %)
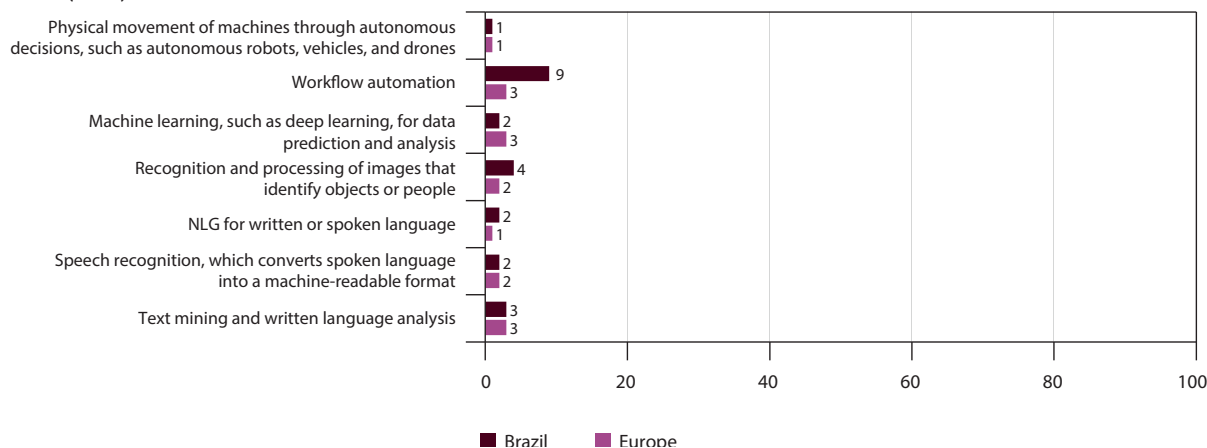
Sources: Kubota and Lins (2022, p. 7); Eurostat (available at: https://ec.europa.eu/eurostat/cache/metadata/en/isoc_e_esms.htm; accessed on: Dec. 12, 2023); and NIC.br (2022).
Obs.: NLG – natural language generation.

Finally, it is worth analyzing enterprises' difficulties in inserting AI into their routines. According to the findings illustrated in figure 3, in the case of Brazil, the two main reasons for not using any AI application were the incompatibility with existing equipment, software, or systems in the enterprise (19%), followed by the idea that AI technologies are not useful to the enterprise – 18% (Kubota and Lins, 2022).

FIGURE 3
Brazilian enterprises that did not use AI technologies by reason (2021)
(In %)
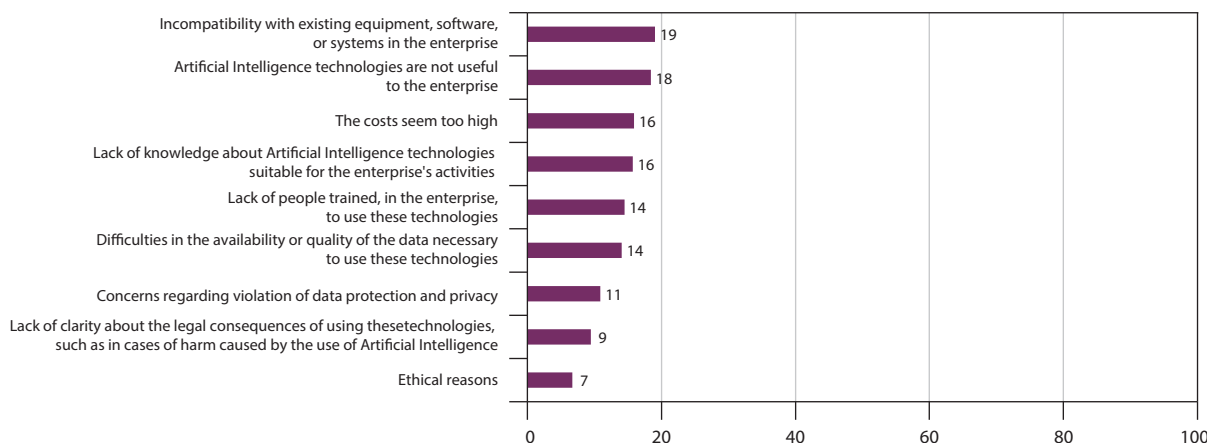
Sources: Kubota and Lins (2022, p. 8) and NIC.br (2022).

Figure 4 illustrates that Brazil has a population of data scientists and machine learning experts similar to European countries like Italy. On the other hand, such figures fall below those observed in Germany, India, and Canada. In relative terms, Brazilian numbers are much lower than those of Italy, Germany, or Canada, given the population sizes.

FIGURE 4
Data scientists and machine learning experts by country (2022)
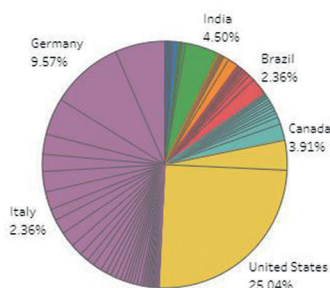
Source: OECD.AI. Available at: https://oecd.ai/en/data?selectedArea=ai-demographics&selectedVisualization=ai-demographics-by-country. Accessed on: July 2, 2023.
Obs.: Figure whose layout and texts could not be formatted due to the technical characteristics of the original files (Publisher's note).

2.2 Public sector

The Brazilian Artificial Intelligence Strategy (Ebia) mentions examples of AI adoption in the public sector (Brazil, 2021a).[9] There is also an inventory of use cases in Brazilian public administration by the Organization for Economic Co-Operation and Development (OECD).[10] Figure 5 shows that AI adoption is very high in the country's Legislative, Judiciary, and Public Prosecutor's Office. It is lower in Executive and State organizations.

FIGURE 5
Federal and state government organizations that used AI in the last 12 months, by total, branch, and level of government (2021)
(In %)
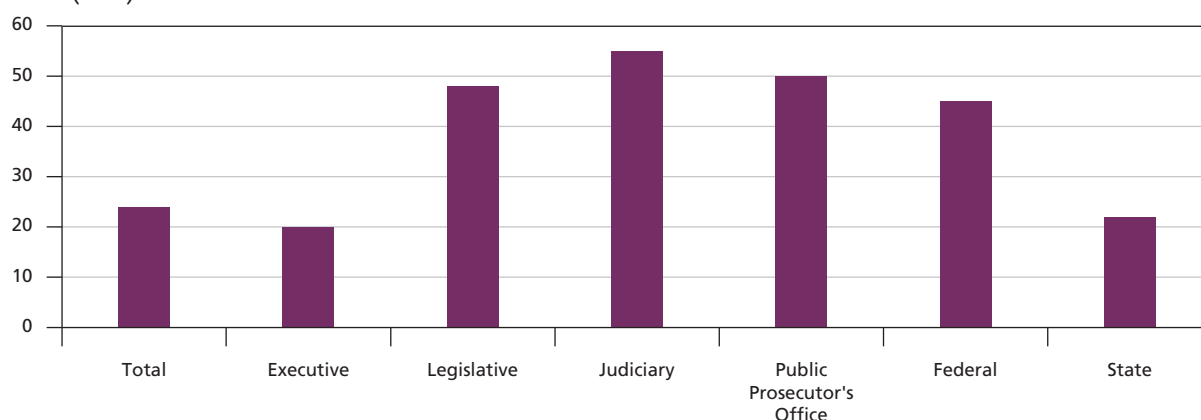
Source: NIC.br (2022).

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9. See an analysis of the strategies not only for Brazil, but also for Argentina, Chile, Colombia and South Korea in Chiarini and Silveira (2022).

10. Available at: https://oecd.ai/en/dashboards/policy-initiatives/http:%2F%2Faipo.oecd.org%2F2021-data-policyInitiatives-27107. Accessed on: July 2, 2023.

3 BIBLIOMETRIC ANALYSIS

OECD has a business intelligence tool that allows the user to make easy queries. In figure 6, for instance, it is possible to observe that China and the United States lead the number of publications per capita from 2010 to 2022. The two countries are followed by G7 members India, Austria, South Corea, and Spain. Brazil appears in the following group, along with Netherlands, Russia, Indonesia, and Ireland.

FIGURE 6
Per capita publications on AI – accumulated (2010-2022)
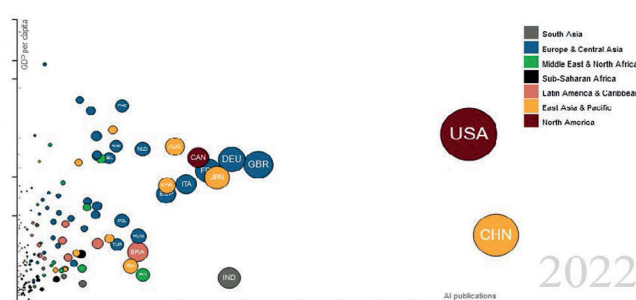
Source: OECD.AI. Available at: https://oecd.ai/en/data?selectedArea=ai-research. Accessed on: July 13, 2023.
Obs.: 1. The bubble size represents the total number of scientific publications, and the color represents the region.
　　　2. Figure whose layout and texts could not be formatted due to the technical characteristics of the original files (Publisher's note).

The OECD business intelligence tool is available to anyone. This section continues with a bibliometric analysis to characterize scientific papers on AI. The study utilizes documents created between 2000 and 2023, sourced from both the Scopus[11] and Web of Science (WoS)[12] databases. The exponential growth in the number of documents over the last few decades has made bibliometric analysis a powerful tool for investigating subjects of interest and identifying future areas of research (Bonilla, Merigó and Torres-Abad, 2015). Moreover, as stated by Donthu et al. (2021, p. 285):

> bibliometric analysis is useful for deciphering and mapping the cumulative scientific knowledge and evolutionary nuances of well-established fields by making sense of large volumes of unstructured data in rigorous ways. Therefore, bibliometric studies that are well done can build firm foundations for advancing a field in novel and meaningful ways—it enables and empowers scholars to (1) gain a one-stop overview, (2) identify knowledge gaps, (3) derive novel ideas for investigation, and (4) position their intended contributions to the field.

Other bibliometric analyses have been conducted on AI; however, these studies typically focus on specific sectors or domains. For instance, Dhamija and Bag (2020) conducted an evaluation of AI in the operations environment, Guo et al. (2020) performed an analysis of the healthcare-related AI literature, and Goodell et al. (2021) identified the foundations, themes and research clusters pertaining to both AI and machine learning in the field of finance.

11. Available at: https://www-scopus.ez87.periodicos.capes.gov.br/search/form.uri?display=basic#basic. Accessed on: June 27, 2023.

12. Available at: https://www-webofscience.ez87.periodicos.capes.gov.br/wos/woscc/basic-search. Accessed on: June 27, 2023.

There are differing opinions regarding the most suitable database for effectively characterizing each subject – Scopus and WoS are widely utilized. Riahi et al. (2021) argue that Scopus offers broader coverage than WoS, encompassing diverse fields of science, technology, and others, ensuring high accuracy and comprehensiveness. Conversely, Bircan and Salah (2022) assert that WoS, as the oldest indexing service for scientific publications, is extensively used and indexes journals of the highest quality. Therefore, both the Scopus and WoS databases are employed in this analysis to leverage their respective strengths and advantages.

The search expression employed in both databases is exclusively "artificial intelligence." The selected timeframe ranges from 2000 to 2023, encompassing various types of documents, including: i) articles; ii) conference papers; iii) reviews; iv) editorials; and v) book chapters. The search was conducted across each document's title, abstract, and keywords, resulting in 428,072 and 112,587 document matches for Scopus and WoS, respectively.

Figure 7 illustrates the temporal evolution of the number of AI documents in both databases.[13] The left and right y-axes correspond to Scopus and WoS, respectively.

FIGURE 7
Number of AI documents in Scopus and WoS (2000-2022)

Sources: Scopus (available at: https://www-scopus.ez87.periodicos.capes.gov.br/search/form.uri?display=basic#basic; accessed on: June 27, 2023); and WoS (available at: https://www-webofscience.ez87.periodicos.capes.gov.br/wos/woscc/basic-search; accessed on: June 27, 2023).
Authors' elaboration.

Not only does the Scopus database boast a significantly larger document repository, but it also showcases a more prominent upward trend since 2000, with a steeper incline observed after 2019. Conversely, the numbers in WoS appear to reflect a linear trend from 2000 until 2017, followed by a substantial surge from 3,000 to over 25,000 documents in just five years.

Table 1 presents the top 10 countries that have contributed the highest number of documents in both databases, plus Brazil. The latter occupies the 14th and 16th positions in Scopus and WoS, respectively, as indicated at the bottom of the table.[14]

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13. 2023 is excluded from this figure as it was still incomplete by the time the technical note was finished.

14. The presentation of results for countries, document types, and author affiliations is depicted as percentages due to variations in the total number of documents. This variation arises from the classification of a single document into multiple categories.

TABLE 1

Country-wise distribution of documents in Scopus and WoS

Scopus			WoS		
Rank	Country	%	Rank	Country	%
1	China	15.7	1	United States	14.3
2	United States	15.0	2	China	14.3
3	India	6.2	3	England	5.0
4	United Kingdom	5.3	4	India	5.0
5	Germany	4.3	5	Germany	3.9
6	Italy	3.3	6	Italy	3.5
7	France	3.1	7	Spain	3.2
8	Spain	3.0	8	Canada	3.0
9	Canada	2.9	9	South Korea	2.8
10	Japan	2.9	10	Australia	2.7
14	Brazil	1.4	16	Brazil	1.7

Sources: Scopus (available at: https://www-scopus.ez87.periodicos.capes.gov.br/search/form.uri?display=basic#basic; accessed on: June 27, 2023); and WoS (available at: https://www-webofscience.ez87.periodicos.capes.gov.br/wos/woscc/basic-search; accessed on: June 27, 2023).
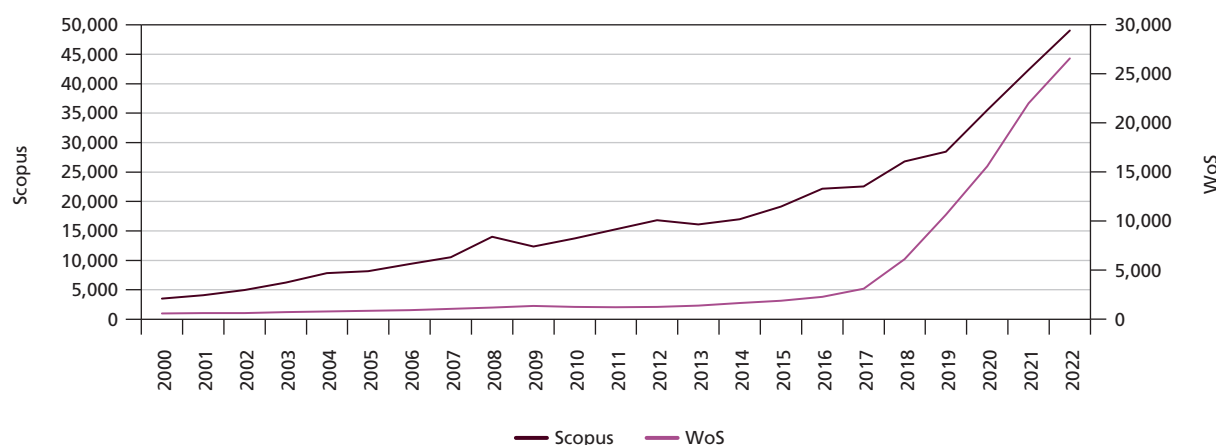Authors' elaboration.

China and the United States consistently vie for the top position, engaging in a tight competition in both instances. Noteworthy mentions include India, the United Kingdom, and Germany as prominent contributors. Notably, most countries in the top 10 are classified as high-income countries, with all G7 nations featuring prominently.

Table 2 provides the percentage distribution of each document type within both databases. In Scopus, conference papers comprise nearly 60% of the total AI literature, positioning them at the top of the list. Conversely, articles claim the number one spot in WoS, accounting for 58.5% of the total. This distinction may confirm that WoS primarily indexes higher-quality journals, leading to a more restricted number of documents in the search process.

TABLE 2

AI literature classification by document types

(In %)

Type of document	Scopus	WoS
Conference paper	58.7	26.5
Article	32.4	58.5
Review	4.2	9.7
Book chapter	2.8	1.4
Editorial[1]	2.0	3.9

Sources: Scopus (available at: https://www-scopus.ez87.periodicos.capes.gov.br/search/form.uri?display=basic#basic; accessed on: June 27, 2023); and WoS (available at: https://www-webofscience.ez87.periodicos.capes.gov.br/wos/woscc/basic-search; accessed on: June 27, 2023).
Authors' elaboration.
Note: [1] Editorial material refers to articles that express the opinions of individuals, groups, or organizations. This category encompasses editorials, interviews, commentaries, discussions between individuals, post-paper discussions, round table symposia, and clinical conferences.

According to our analysis, Scopus and WoS highlight computer science and engineering as the top two fields of study when categorizing AI documents based on research areas. Table 3 details the five main research areas in the AI literature, both for the world and for records in which Brazil is the country (or one of the countries) of origin. Additionally, table 4, showcases the primary affiliations of the authors.

TABLE 3
Distribution of AI literature by area of research, Brazil and World, Scopus and WoS

Scopus				WoS			
World	%	Brazil	%	World	%	Brazil	%
Computer science	38.2	Computer science	38.4	Computer science	22.7	Computer science	25.4
Engineering	15.4	Matemática	15.0	Engineering	17.8	Engineering	18.3
Mathematics	14.5	Engineering	14.0	Telecommunications	4.0	Chemistry	2.8
Medicine	5.1	Medicine	4.6	Science technology other topics	3.1	Telecommunications	2.6
Social sciences	3.2	Social sciences	3.7	Chemistry	2.7	Agriculture	2.3

Sources: Scopus (available at: https://www-scopus.ez87.periodicos.capes.gov.br/search/form.uri?display=basic#basic; accessed on: June 27, 2023); and WoS (available at: https://www-webofscience.ez87.periodicos.capes.gov.br/wos/woscc/basic-search; accessed on: June 27, 2023).
Authors' elaboration.

The gap between computer science, which ranked first in all analyses, and the second-ranked research area is wider within the Scopus database – on the order of 20 percentage points; in WoS, such magnitude is only around 5 points. Within the Scopus database, mathematics is in the second position for Brazil, swapping positions with engineering when compared to the global context. In WoS, where research areas have a higher degree of granularity, the agriculture sector stands out as the fifth-ranked field in Brazilian AI literature. Such data reinforces the strength of agribusiness and the wide applicability of technologies in the area.

TABLE 4
Author affiliations in Scopus and WoS

Scopus			WoS		
Rank	Affiliation	%	Rank	Affiliation	%
1	Chinese Academy of Sciences	2.75	1	Chinese Academy of Sciences	0.56
2	CNRS	1.98	2	University of California System	0.56
3	Ministry of Education China	1.72	3	Udice French Research Universities	0.49
4	Tsinghua University	1.69	4	University of London	0.47
5	Carnegie Mellon University	1.65	5	Harvard University	0.46
6	Shanghai Jiao Tong University	1.19	6	N8 Research Partnership	0.44
7	Nanyang Technological University	1.19	7	Egyptian Knowledge Bank Ekb	0.39
8	Stanford University	1.16	8	CNRS	0.38
9	Massachusetts Institute of Technology	1.13	9	University of Texas System	0.31
10	Zhejiang University	1.12	10	State University System of Florida	0.29
11	University of Chinese Academy of Sciences	1.09	11	Stanford University	0.28
12	National University of Singapore	1.05	12	IIT System	0.27
13	University of Oxford	1.00	13	University College London	0.26
14	University of Toronto	0.99	14	Tsinghua University	0.26
15	Imperial College London	0.92	15	Harvard Medical School	0.26
41	University of São Paulo	0.69	67	University of São Paulo	0.14

Sources: Scopus (available at: https://www-scopus.ez87.periodicos.capes.gov.br/search/form.uri?display=basic#basic; accessed on: June 27, 2023); and WoS (available at: https://www-webofscience.ez87.periodicos.capes.gov.br/wos/woscc/basic-search; accessed on: June 27, 2023).
Authors' elaboration.

The Chinese Academy of Sciences holds the first position in both databases. Numerous universities from China, as well as from the United States, lead the ranking. Further, UK, Canadian, French, and Indian

institutions are among the top fifteen positions. The University of São Paulo is the first to represent Brazil; it is placed at positions 41 and 67 in Scopus and WoS, respectively.

Moving on to funding sponsors, the National Natural Science Foundation of China claims the top spot in both Scopus and WoS. The second and third positions are held by the National Science Foundation and the National Key Research and Development Program of China in the former and the European Commission and the United States Department of Health and Human Services in the latter. Brazilian institutions are positioned at 15 and 22 in Scopus (Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES, respectively), and 19 and 25 in WoS (CNPq and CAPES, respectively).

4 BRAZILIAN AND G7 EXPERIENCES OF AI REGULATION AND GUIDANCE BY THE EXECUTIVE BRANCH

Brazil (2022) developed a benchmarking of AI regulation of a large group of countries. Melo et al. (2022) developed a benchmarking of AI regulation of the selected group of countries: the EU, the United Kingdom, the United States, Australia and Japan. In this paper, we bring some information updated until 2023. Chiarini and Silveira (2022) developed an evaluation of AI strategies for Latin American countries and South Korea. Filgueiras (2023) has also analyzed the AI strategies of Latin American countries. Radu (2021) has studied the AI strategies of a group of countries. Filgueiras (2022) has examined the AI strategies of the United States, Brazil, Saudi Arabia, China, Singapore and Russia. This section brings some updated information for Brazil and G7 countries.

Japan and the United Kingdom were the countries with more profound studies on different regulation models (Brazil, 2022). Habuka (2023) classified G7 countries into two groups regarding AI governance. The first group – France, Germany, Italy, and Canada – is trying a holistic and hard-law-based approach, setting obligations and hard sanctions in case of violation. The second group – Japan, the United Kingdom, and the United States – follows a sector-specific and soft-law-based approach.[15]

4.1 Brazil

Legislation, regulation, and ethical use is the first (transversal) axe of Ebia. Ebia highlights the importance of finding a balance between: i) protection and safeguarding of rights; ii) adequate structures to encourage the development of a technology whose potential has not been fully comprehended; and iii) establishment of legal parameters to provide legal certainty for the different actors in the value chain of autonomous systems (Brazil, 2021a).

Ebia states that it is necessary to study the impacts of AI in different sectors, avoiding regulatory actions that may unnecessarily limit AI innovation, adoption, and development. On the other hand, ethical principles should be followed in all stages of AI development and use. They may even be raised to normative requirements. Table 4 highlights strategic actions related to legislation, regulation, and ethical use in Ebia (Brazil, 2021a). While we agree with all the recommendations, there seems to be a lack of implementation.[16]

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15. Martin-Bariteau and Scassa (2021) gives the following examples of soft law: codes of ethics, data governance frameworks, policies, standards, impact assessment tools, ethics boards and other informal declarations.

16. The development of Ebia implementation can be tracked at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/transformacao-digital/inteligencia-artificial-estrategia-repositorio. Accessed on: July 2, 2023.

BOX 1
Strategic actions – legislation, regulation, and ethical use

• To stimulate the production of an ethical AI by financing research projects that aim to apply ethical solutions, mainly in the fields of fairness, accountability and transparency, known as the matrix FAT.

• To encourage partnerships with corporations that are researching commercial solutions for these ethical AI technologies.

• To establish as a technical requirement in tenders that bidders offer solutions compatible with the promotion of ethical AI (for example, establish that facial recognition technology solutions acquired by public agencies have a false positive percentage below a certain threshold).

• To establish, in a multisectoral way, spaces for the discussion and definition of ethical principles to be observed in the research, development and use of AI.

• To map out legal and regulatory barriers to the development of AI in Brazil and identify aspects of the Brazilian legislation that may require updates, in order to promote greater legal certainty for the digital ecosystem.

• To stimulate actions of transparency and responsible disclosure regarding the use of AI systems, and promote the observance, by such systems, of human rights, democratic values and diversity.

• To develop techniques to identify and mitigate the risk of algorithmic bias.

• To develop data quality control policy for the training of AI systems.

• To create parameters about human intervention in AI contexts where the result of an automated decision implies a high risk of harm to the individual.

• To encourage the exploration and development of appropriate review mechanisms in different contexts of use of AI by private organizations and public bodies.

• To create and implement best practices or codes of conduct regarding the collection, implementation and use of data, encouraging organizations to improve their traceability, safeguarding legal rights.

• To promote innovative approaches to regulatory oversight (for example, sandboxes and regulatory hubs).

Source: Brazil (2021b, p. 6).

Recently, the National Agency of Data Protection (ANPD) has released documents about AI (ANPD, 2023a; 2023b). ANPD defends that it is the key authority in regulation of AI and data protection.

4.2 Canada

The Pan-Canadian Artificial Intelligence Strategy was one of the first to be launched worldwide.[17] It supports and enhances AI researchers, skilled graduates, and the national research community. The Advisory Council on Artificial Intelligence was established in 2019 to advise the Federal Government on AI-related policies.[18] The government has created an AI source list with 73 pre-approved suppliers of AI solutions.[19] The Canadian government has launched several regulations and guidelines related to AI: a Directive on Automated Decision-Making, taking effect on April 1, 2019,[20] an Algorithmic Impact Assessment tool,[21] and Responsible use of AI.[22] The National program of activities includes training students from high school to

17. Available at: https://ised-isde.canada.ca/site/ai-strategy/en. Accessed on: July 2, 2023.

18. Available at: https://ised-isde.canada.ca/site/advisory-council-artificial-intelligence/en. Accessed on: July 2, 2023.

19. Available at: https://oecd.ai/en/dashboards/policy-initiatives/http:%2F%2Faipo.oecd.org%2F2021-data-policyInitiatives-24197. Accessed on: July 2, 2023.

20. Available at: https://www.tbs-sct.canada.ca/pol/doc-eng.aspx?id=32592. Accessed on: July 2, 2023.

21. Available at: https://www.canada.ca/en/government/system/digital-government/digital-government-innovations/responsible-use-ai/algorithmic-impact-assessment.html. Accessed on: July 2, 2023.

22. Available at: https://www.canada.ca/en/government/system/digital-government/digital-government-innovations/responsible-use-ai.html. Accessed on: July 2, 2023.

postdoctoral fellows and empowering women in AI. The provincial government of Québec has launched the Forum AI Québec, to help the province take full advantage of AI potential,[23] and Québec AI Strategy (Brandusescu, 2021).

Brandusescu (2021) argues that there are many questions about varying jurisdictional regulations of AI. In the same line, Martin-Bariteau and Scassa (2021, p. 9) highlight that "AI implicates a broad range of legal subject matter that is not always within federal jurisdiction." Moreover, AI has been dealt with by different siloed departments and agencies of government.

4.3 France

France prepared the first AI development strategy by a EU member in 2018. It is the AI for Humanity: French Strategy for Artificial Intelligence. The country has an extensive list of AI strategies and regulations. The Ministry of Armed Forces considers AI as a priority of national defense.[24] Ministries of Cohesion of Territories and Economics and Finance sponsored a report focused on sectorial development (Atawao Consulting, 2019). The second phase of the national strategy for AI emphasized the importance of attracting talents (France, 2021).

The government has entrusted Afnor[25] with the mission to define a national strategy for the standardization of AI (Afnor Normalization, 2021). In September 2022, the government launched a call for proposals for projects to evaluate the benefits of medical devices based on AI[26] and industrial products with embedded AI. The government has issued recommendations for good practices for integrating ethics in developing AI solutions in health (France, 2022). The government has also supported the initiative Confiance.ai, a group of French academic and industrial players with excellence in AI to build trustworthy AI applications for critical systems.[27] France has also partnered with Germany and Japan regarding AI[28,29] while simultaneously sponsoring a network of interdisciplinary institutes for AI.[30]

4.4 Germany

The Artificial Intelligence Strategy of the German Federal Government was published in 2018. The Observatory on AI in Work and Society, linked to the Policy Lab Digital Work and Society of the Ministry of Labor and Social Affairs, was created in March 2020 (Brazil, 2022). The Observatory has the following tasks: i) enabling interaction between AI developers, users, experts, and society; ii) ensuring long-term competitiveness of the German economy; and iii) promoting AI that is people-centered and oriented to the common good.[31]

The Strategy states that the Federal Government would review whether the legal framework covers all aspects related to algorithm and AI-based decisions, services, and products and make the necessary

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23. Available at: https://forumia.quebec/en/. Accessed on: July 2, 2023.

24. Available at: https://www.inria.fr/fr/le-ministere-des-armees-et-l-intelligence-artificielle. Accessed on: July 2, 2023.

25. The standardization organization in France.

26. Available at: https://gnius.esante.gouv.fr/fr/strategie-dacceleration-sante-numerique/strategie-structurante. Accessed on: July 2, 2023.

27. Available at: https://www.confiance.ai/en/. Accessed on: July 2, 2023.

28. Available at: https://www.bmwk.de/Redaktion/EN/Downloads/R/roadmap-research-and-innovation-network-on-artificial-intelligence.pdf?__blob=publicationFile&v=2. Accessed on: July 2, 2023.

29. Available at: https://www.universite-lyon.fr/international/lancement-d-un-appel-a-projets-trilateral-france-japon-allemagne-autour-de-l-intelligence-artificielle-117992.kjsp?RH=1487584195571. Accessed on: July 2, 2023.

30. Available at: https://instituts-3ia.fr/. Accessed on: July 2, 2023.

31. Available at: https://www.ki-observatorium.de/en/the-ai-observatory/faq. Accessed on: June 27, 2023.

adjusts in order to make it feasible to verify whether there is any undue discrimination or bias, ensuring that AI systems are transparent, predictable and verifiable (Brazil, 2022).

The Strategy foresees that the Federal Government would verify whether there are loopholes for algorithms or AI applications and that the Data Ethics Commission and the Study Commission on Artificial Intelligence of the Bundestag would make recommendations for the Federal Government. It was created to develop answers to technical, legal, political, and ethical issues. The Study Commission recommended that the supervision and application of the rules should be mainly the role of sectoral supervisory authorities with sector-specific expertise. In its turn, the Data Ethics stated that legislation is one of a series of tools that can be used to make ethical principles tangible. It is vital to use several governance instruments – legislation, normalization, and coregulation or autoregulation (Brazil, 2022).

4.5 Italy

The Ministry of Economic Development sponsored a group of specialists who recommended an anthropo-centric AI policy using the precautionary principle in adopting the technology (Brazil, 2022). The specialists recommended the alignment with existing legislation, the observance of the precaution and transparency principles, the promotion of the augmentation of human creativity instead of substitution, and the introduction of civil responsibilities by providers (Italy, 2021b).

The Strategic Program Artificial Intelligence 2022-2024 was sponsored by several Ministries.[32] It has the aim of promoting the technology. At the same time, in the governance chapter, it emphasizes the importance of coordination within the administration to monitor the efficacy of the plan (Italy, 2021a).

4.6 Japan

The Technological Strategy for AI was published in 2017 (Radu, 2021). In 2019, the government published the *Social principles of human-centric AI*, emphasizing three basic principles that could help Japan accomplish Society 5.0:[33] human dignity, diversity and inclusion, and sustainability. The document also set forth seven additional principles necessary for achieving a society with the three fundamental principles abovementioned: human-centric, education/literacy, privacy protection, security, fair competition, fairness, accountability, transparency, and innovation (Japan, 2019).

In July 2021, the government published the *Governance guidelines for implementation of AI principles*, presenting "action targets to be implemented by an AI company, with the aim of supporting the implementation of the AI principles that is required for the facilitation of deployment of AI" (Japan, 2021, p. 3).[34]

Guidelines and policy recommendations regarding the protection and utilization of data, the promotion of fair contracts for AI development and data transfer, and machine learning quality management have also been published. There are also sectoral regulations regarding automated driving vehicles, credit amounts using data and AI, and the use of AI and drones for gas pressure inspections.

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32. Available at: https://www.hwupgrade.it/news/web/intelligenza-artificiale-il-governo-italiano-pronto-a-creare-un-fondo-da-150-mi-lioni-di-euro-per-le-startup_117278.html. Accessed on: June 27, 2023.

33. "A Society that realizes Society 5.0 is a sustainable human-centric society that implements AI, IoT (Internet of Things), robotics and other cutting-edge technologies to create unprecedented value, and a wide range of people can realize their own well-being while respecting the well-being of others" (Japan, 2019, p. 1).

34. It is interesting to note that the document was updated in January 2022, only six months after the first version.

4.7 United Kingdom

The United Kingdom has an Office for Artificial Intelligence, part of the Department for Science, Innovation and Technology. The country seems to be one of the most ambitious in its plans, with the Prime Minister stating, "I want to make the UK not just the intellectual home, but the geographical home of global AI safety regulation" (MacLellan and Smout, 2023). He added that the tech sector was at the heart of his priority to grow the economy. United Kingdom has decided to split regulatory responsibility for AI between several bodies, which oversee human rights, health and safety, and competition (MacLellan and Smout, 2023).

The United Kingdom established the United Kingdom AI Sector Deal in 2018, the National AI Strategy in 2021, and the policy paper *A pro-innovation approach to AI regulation* in March 2023 (United Kingdom, 2023). We will focus the analysis on the latest.

On the one hand, the Secretary of State for Science, Innovation, and Technology foreword emphasizes the goal to become a science and technology superpower by 2030. Another goal is for the United Kingdom to become the best place in the world to build, test and use AI technology. On the other hand, she acknowledges the need to address the several risks AI poses. For example, she highlights the need to build trust among consumers, public services, and businesses on the technology (United Kingdom, 2023).

Instead of targeting specific technologies, the framework focuses on the context in which AI is deployed. The United Kingdom approach relies on collaboration between government, regulators, and businesses; initially, they do not intend to introduce new legislation. They plan to monitor in real-time how the regulatory framework is performing. The five principles that underpin the framework are safety, security, and robustness; transparency and explainability; fairness; accountability and governance; contestability and redress (United Kingdom, 2023).

The information regulation organization in the United Kingdom is testing the impacts of AI products and services through regulatory sandboxes, especially regarding privacy issues (OECD, 2023).

Recently, the United Kingdom managed to unite representatives of several countries to issue the Bletchley Declaration.[35]

4.8 The United States

In February 2019, former President Donald Trump signed *Executive Order 13859: maintaining American leadership in artificial intelligence*. The document has recommendations for: i) government, industry, and academia innovation for competitivity and national security; ii) development of technical standards; iii) training of current and future workforce; iv) development of public trust and protection of civil liberties and privacy; and v) protecting critical AI technologies from the acquisition of strategic competitors and adversarial nations (United States, 2019).

In 2019, the government published the document *AI principles: recommendations on the ethical use of artificial intelligence by the Department of Defense*, emphasizing the following AI Ethics principles for the Department of Defense (DoD): responsible, equitable, traceable, reliable, and governable (DIB, 2019).

In November 2020, the United States Director of the Office of Management and Budget issued a *Memorandum for the heads of executive departments and agencies* encouraging innovation and growth in AI and stating the following principles for the stewardship of AI applications: public trust in AI, public participation, scientific integrity and information quality, risk assessment and management, benefits and costs, flexibility, fairness and non-discrimination, disclosure and transparency, safety and security, inter-agency coordination (Vought, 2020).

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35. Available at: https://www.gov.uk/government/publications/ai-safety-summit-2023-the-bletchley-declaration/the-bletchley-decla-ration-by-countries-attending-the-ai-safety-summit-1-2-november-2023. Accessed on: Nov. 8, 2023.

In October 2022, the White House issued the *Blueprint for an AI Bill of Rights*, warning that:

> systems supposed to help with patient care have proven unsafe, ineffective or biased. Algorithms used in hiring and credit decisions have been found to reflect and reproduce existing unwanted inequities or embed new harmful bias and discrimination. Unchecked social media data collection has been used to threaten people's opportunities, undermine their privacy, or pervasively track their activity – often without their knowledge or consent (The White House, 2022, p. 3).

To tackle these threats, the document includes recommendations for: safe and effective systems; algorithmic discrimination protections; data privacy; notice and explanation; human alternatives, consideration, and fallback. Its framework describes protections that should be applied to automated systems that can impact citizens' exercise of civil rights, liberties, and privacy; equal opportunities; and access to critical resources or services (The White House, 2022).

The General Services Administration has issued an *AI guide for government: a living and evolving guide to applying Artificial Intelligence for the US federal government*, a document targeting agency senior leaders and decision-makers.[36] The government has launched an Alfa version of an Algorithmic Impact Assessment tool.[37]

According to Schreck, Gomez, and Charkoudian (2023, p. 3), the landscape of AI regulation is less clear than in the EU or the United Kingdom scenario: "there are few hard and fast rules that US AI companies can look to in order to guide their conduct". The main regulations worth mentioning are the Artificial Intelligence Risk Framework, blogspots by the Federal Trade Commission,[38] and the Guidance for Industry and Food and Drug Administration Staff (FDA, 2023). The government recently made a deal with major AI companies to establish guardrails on AI tools (Shear, Kang and Sanger, 2023).

Recently, President Biden issued an Executive Order on Safe, Secure, and Thrustworthy Artificial Intelligence. A summary can be consulted in appendix A.

4.9 Conclusion of the section

Analyzing the different experiences, it is possible to highlight a few points of interest. The first is that there was a close partnership between the Executive and Legislative branches in the French and German cases. Even though Japan and the United Kingdom are also parliamentarian countries, their Executives seemed more autonomous. The Canadian case highlights the complex division of responsibilities at the federal and provincial levels. The British case is the one where AI seems to be more strategically considered by the higher level of Executive power. In Brazil, Ebia proposes several sound strategic actions related to legislation, regulation, and ethical use of AI. However, there seems to be a lack of implementation.

5 REASONS WHY THE BRAZILIAN EXECUTIVE BRANCH SHOULD PROMOTE AI REGULATION AND GUIDANCE

On the one hand, the first reason for promoting regulation is that AI can potentially exacerbate issues regarding service delivery, privacy, and ethics (Mehr, 2017). On the other hand, AI can be used to improve the provision of public services, for instance, when citizens request information or need to fill out and search for documents. In the United Kingdom, AI is being used to improve the National Health System medical care

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36. Available at: https://coe.gsa.gov/coe/ai-guide-for-government/print-all/index.html. Accessed on: Dec. 12, 2023.

37. Available at: https://www.cio.gov/aia-eia-js/#/. Accessed on: July 2, 2023.

38. See, for instance, Atleson (2023).

and making transport safer (United Kingdom, 2023). Moreover, sound regulation can be a tool to promote the adoption of such technologies by the government and private sectors.

The second reason is the reality of the Brazilian de facto[39] federalism. When it comes to technology-related issues, it is common for the Federal Government to take the lead in deploying many public policies. Therefore, Federal Government AI policies can have a good example effect on subnational entities. The scenario seems much simpler than in the abovementioned Canadian case.

The third reason is vertical regulation. As expected, both Bills in Congress's discussion are more conceptual and would not detail sectoral AI regulation. This vertical regulation is traditionally developed by sectoral Ministries and regulatory agencies. Following the United Kingdom regulation framework, expert regulators are the best suited to understand risks in their sectors. Moreover, they can take a proportionate approach to regulating AI (United Kingdom, 2023). We believe that sectoral agencies have the needed knowledge to regulate AI in their respective domains.

It is interesting to highlight that the proposal of regulatory sandboxes – an important component of both EU and Brazilian regulation projects – involves several regulatory authorities, typically part of the Executive branch, for instance, regulatory, intellectual property, standardization, data protection agencies, among others.

The most advanced experiences of regulatory sandboxes in Brazil are in the financial system. On June 13, 2019, a joint publication of the Special Secretariat of Treasury of the Ministry of Economy, the Central Bank, the Securities Commission (CVM), and the Private Insurance Agency (Susep) announced the intention to implement a regulatory sandbox model in Brazil. The principles of the three agencies are similar, but each authority has distinct legal competencies.[40]

The fourth reason is that the three powers of government are heavy users of this technology. Large AI models are being deployed by government entities, exploring the vast amounts of data produced by delivering public services. Federal regulation should guide not only the internal development of such models but also the procurement of AI services. Moreover, the government is also promoting the technological development of AI technology (Silva, 2023).[41]

As mentioned before in this paper, the fifth reason is that Ebia proposes several sound strategic actions related to legislation, regulation, and ethical use of AI. Nonetheless, there seems to be a lack of implementation.

6 CONCLUDING REMARKS

On the one hand, the Brazilian Congress has made significant progress in discussing AI regulation. Kubota and Lins (2022) have shown that Brazilian enterprises are relatively well-positioned in adoption of AI technologies and on the availability of data scientists and machine learning experts when compared to their European counterparts. Brazil has also interesting examples of AI adoption in the public sector (Brazil, 2021a). On the other hand, the Brazilian volume of scientific production is not as significant as the observed in developed countries. Moreover, the Brazilian government seems to be lagging behind regarding AI regulation and guidance compared to Japan, the United States, France, and the United Kingdom. We have presented a series of reasons why there should be an effort to close this gap for the citizens' well-being, for advancing public services, and for developing enterprises. Designing governance systems

39. Latin expression meaning "in practice" as opposed to *de jure*.
40. Available at: https://www.bcb.gov.br/estabilidadefinanceira/sandbox. Accessed on: July 18, 2023.
41. Available at: http://www.finep.gov.br/chamadas-publicas/chamadapublica/705. Accessed on: June 19, 2023.

for new general-purpose technologies is not an easy task (Radu, 2021), and recommendations regarding this matter are suggestions for future research.

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APPENDIX A

SUMMARY OF EXECUTIVE ORDER ON SAFE, SECURE, AND TRUSTWORTHY ARTIFICIAL INTELLIGENCE

A.1 NEW STANDARDS FOR ARTIFICIAL INTELLIGENCE (AI) SAFETY AND SECURITY

As AI's capabilities grow, so do its implications for Americans' safety and security. *With this Executive Order, the President directs the most sweeping actions ever taken to protect Americans from the potential risks of AI systems*, as follows.

1) *Require that developers of the most powerful AI systems share their safety test results and other critical information with the United States government*. In accordance with the Defense Production Act, the Order will require that companies developing any foundation model that poses a serious risk to national security, national economic security, or national public health and safety must notify the federal government when training the model, and must share the results of all red-team safety tests. These measures will ensure AI systems are safe, secure, and trustworthy before companies make them public.

2) *Develop standards, tools, and tests to help ensure that AI systems are safe, secure, and trustworthy*. The National Institute of Standards and Technology will set the rigorous standards for extensive red-team testing to ensure safety before public release. The Department of Homeland Security will apply those standards to critical infrastructure sectors and establish the AI Safety and Security Board. The Departments of Energy and Homeland Security will also address AI systems' threats to critical infrastructure, as well as chemical, biological, radiological, nuclear, and cybersecurity risks. Together, these are the most significant actions ever taken by any government to advance the field of AI safety.

3) *Protect against the risks of using AI to engineer dangerous biological materials* by developing strong new standards for biological synthesis screening. Agencies that fund life-science projects will establish these standards as a condition of federal funding, creating powerful incentives to ensure appropriate screening and manage risks potentially made worse by AI.

4) *Protect Americans from AI-enabled fraud and deception by establishing standards and best practices for detecting AI-generated content and authenticating official content*. The Department of Commerce will develop guidance for content authentication and watermarking to clearly label AI-generated content. Federal agencies will use these tools to make it easy for Americans to know that the communications they receive from their government are authentic — and set an example for the private sector and governments around the world.

5) *Establish an advanced cybersecurity program to develop AI tools to find and fix vulnerabilities in critical software*, building on the Biden-Harris Administration's ongoing AI Cyber Challenge.

Together, these efforts will harness AI's potentially game-changing cyber capabilities to make software and networks more secure.

6) *Order the development of a National Security Memorandum that directs further actions on AI and security*, to be developed by the National Security Council and White House Chief of Staff. This document will ensure that the United States military and intelligence community use AI safely, ethically, and effectively in their missions, and will direct actions to counter adversaries' military use of AI.

A.2 PROTECTING AMERICANS' PRIVACY

Without safeguards, AI can put Americans' privacy further at risk. AI not only makes it easier to extract, identify, and exploit personal data, but it also heightens incentives to do so because companies use data to train AI systems. *To better protect Americans' privacy, including from the risks posed by AI, the President calls on Congress to pass bipartisan data privacy legislation to protect all Americans, especially kids, and directs the actions*, as follows.

1) *Protect Americans' privacy by prioritizing federal support for accelerating the development and use of privacy-preserving techniques* – including ones that use cutting-edge AI and that let AI systems be trained while preserving the privacy of the training data.

2) *Strengthen privacy-preserving research and technologies*, such as cryptographic tools that preserve individuals' privacy, by funding a Research Coordination Network to advance rapid breakthroughs and development. The National Science Foundation will also work with this network to promote the adoption of leading-edge privacy-preserving technologies by federal agencies.

3) *Evaluate how agencies collect and use commercially available information* – including information they procure from data brokers – and *strengthen privacy guidance for federal agencies* to account for AI risks. This work will focus in particular on commercially available information containing personally identifiable data.

4) *Develop guidelines for federal agencies to evaluate the effectiveness of privacy-preserving techniques*, including those used in AI systems. These guidelines will advance agency efforts to protect Americans' data.

A.3 ADVANCING EQUITY AND CIVIL RIGHTS

Irresponsible uses of AI can lead to and deepen discrimination, bias, and other abuses in justice, healthcare, and housing. The Biden-Harris Administration has already taken action by publishing the *Blueprint for an AI Bill of Rights* (The White House, 2022) and issuing an Executive Order directing agencies to combat algorithmic discrimination (Fact..., 2023), while enforcing existing authorities to protect people's rights and safety. *To ensure that AI advances equity and civil rights, the President directs the following additional actions*:

- *provide clear guidance to landlords, Federal benefits programs, and federal contractors* to keep AI algorithms from being used to exacerbate discrimination;

- *address algorithmic discrimination* through training, technical assistance, and coordination between the Department of Justice and Federal civil rights offices on best practices for investigating and prosecuting civil rights violations related to AI; and

- *ensure fairness throughout the criminal justice system* by developing best practices on the use of AI in sentencing, parole and probation, pretrial release and detention, risk assessments, surveillance, crime forecasting and predictive policing, and forensic analysis.

A.4 STANDING UP FOR CONSUMERS, PATIENTS, AND STUDENTS

AI can bring real benefits to consumers – for example, by making products better, cheaper, and more widely available. But AI also raises the risk of injuring, misleading, or otherwise harming Americans. *To protect consumers while ensuring that AI can make Americans better off, the President directs the actions*, as follows.

1) *Advance the responsible use of AI* in healthcare and the development of affordable and life-saving drugs. The Department of Health and Human Services will also establish a safety program to receive reports of – and act to remedy – harms or unsafe healthcare practices involving AI.

2) *Shape AI's potential to transform education* by creating resources to support educators deploying AI-enabled educational tools, such as personalized tutoring in schools.

A.5 SUPPORTING WORKERS

AI is changing America's jobs and workplaces, offering both the promise of improved productivity but also the dangers of increased workplace surveillance, bias, and job displacement. *To mitigate these risks, support workers' ability to bargain collectively, and invest in workforce training and development that is accessible to all, the President directs the actions*, as follows.

1) *Develop principles and best practices to mitigate the harms and maximize the benefits of AI for workers* by addressing job displacement; labor standards; workplace equity, health, and safety; and data collection. These principles and best practices will benefit workers by providing guidance to prevent employers from undercompensating workers, evaluating job applications unfairly, or impinging on workers' ability to organize.

2) *Produce a report on AI's potential labor-market impacts*, and *study and identify options for strengthening federal support for workers facing labor disruptions*, including from AI.

A.6 PROMOTING INNOVATION AND COMPETITION

America already leads in AI innovation—more AI startups raised first-time capital in the United States last year than in the next seven countries combined. *The Executive Order ensures that we continue to lead the way in innovation and competition through the following actions*:

- *catalyze AI research across the United States* through a pilot of the National AI Research Resource – a tool that will provide AI researchers and students access to key AI resources and data – and expanded grants for AI research in vital areas like healthcare and climate change;

- *promote a fair, open, and competitive AI ecosystem* by providing small developers and entrepreneurs access to technical assistance and resources, helping small businesses commercialize AI breakthroughs, and encouraging the Federal Trade Commission to exercise its authorities; and

- *use existing authorities to expand the ability of highly skilled immigrants and nonimmigrants with expertise in critical areas to study, stay, and work in the United States* by modernizing and streamlining visa criteria, interviews, and reviews.

A.7 ADVANCING AMERICAN LEADERSHIP ABROAD

AI's challenges and opportunities are global. *The Biden-Harris Administration will continue working with other nations to support safe, secure, and trustworthy deployment and use of AI worldwide. To that end, the President directs the actions*, as follows.

1) *Expand bilateral, multilateral, and multistakeholder engagements to collaborate on AI*. The State Department, in collaboration, with the Commerce Department will lead an effort to establish robust international frameworks for harnessing AI's benefits and managing its risks and ensuring safety. In addition, this week, Vice President Harris will speak at the United Kingdom Summit on AI Safety, hosted by Prime Minister Rishi Sunak.

2) *Accelerate development and implementation of vital AI standards* with international partners and in standards organizations, ensuring that the technology is safe, secure, trustworthy, and interoperable.

3) *Promote the safe, responsible, and rights-affirming development and deployment of AI abroad to solve global challenges*, such as advancing sustainable development and mitigating dangers to critical infrastructure.

A.8 ENSURING RESPONSIBLE AND EFFECTIVE GOVERNMENT USE OF AI

AI can help government deliver better results for the American people. It can expand agencies' capacity to regulate, govern, and disburse benefits, and it can cut costs and enhance the security of government systems. However, use of AI can pose risks, such as discrimination and unsafe decisions. *To ensure the responsible government deployment of AI and modernize federal AI infrastructure, the President directs the following actions*:

- *issue guidance for agencies' use of AI*, including clear standards to protect rights and safety, improve AI procurement, and strengthen AI deployment;

- *help agencies acquire specified AI products and services* faster, more cheaply, and more effectively through more rapid and efficient contracting; and

- *accelerate the rapid hiring of AI professionals* as part of a government-wide AI talent surge led by the Office of Personnel Management, United States Digital Service, United States Digital Corps, and Presidential Innovation Fellowship. Agencies will provide AI training for employees at all levels in relevant fields.

REFERENCES

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