



artificial intelligence in Brazil and the United Kingdom

opportunities
for cooperation
in research,
business and
government



presentation letter British Embassy

Artificial intelligence (AI) and machine learning are transforming the global economy and bringing significant social and economic benefits to our societies – new jobs, increased productivity and better public services.

British scientist and computer pioneer Alan Turing is widely regarded as the primary proponent and inspiration for much of the development of AI. The UK remains a world leader in AI and one of the best places in the world for companies developing and deploying AI to start, grow, and thrive. We are committed to working with international partners to ensure that AI is developed and used ethically, safely, and responsibly.

This report was made possible by our strong partnership with the Ministry of Foreign Affairs of Brazil and the C4AI of the University of São Paulo. It provides important information regarding our shared capabilities in AI, and provides indications for future collaborations in AI and data for government, academia, civil society, and the private sector. My team and I look forward to exploring these opportunities with you. Together we will continue to strengthen the partnership between the UK and Brazil in AI, unleashing the power of artificial intelligence to improve all our lives.

Peter Wilson
Ambassador of the
United Kingdom

presentation letter Itamaraty

The strategic dialogue that links Brazil and the United Kingdom is firmly based on historical relations between both countries, and sustained by innovative projects. The British Government has singled out Brazil as one of the countries of interest within the framework of its “Global Britain” foreign policy in the new scenario of international role played by that country. Brazil is identified as a bilateral partner in important international forums, in view of the convergence of values and the capacity for international activity of both Ministries of Foreign Affairs.

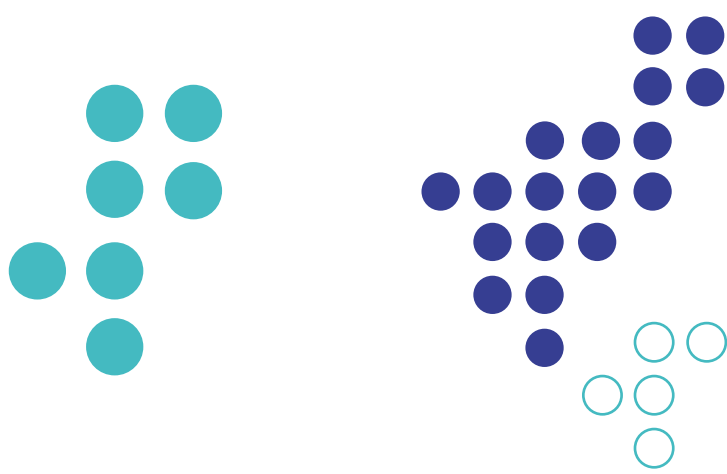
Science, technology and innovation play an important role in the relations between Brazil and the United Kingdom, with transversal connections in the fields of trade, investment, sustainability and development. Artificial Intelligence (AI) is identified as a pivotal and strategic issue for the strengthening of the bilateral partnership, as the present launch of the Report on AI in the United Kingdom and Brazil makes it evident. The publication was conceived, thought and elaborated together, with which both countries take a step forward in the direction of a fruitful partnership. The Report provides an overview of the recent evolution and the state of the art of national AI systems, which makes it possible to increase mutual knowledge about Brazilian and British potentialities in the area, while giving rise to concrete understandings for cooperation and partnerships.

The United Kingdom is acknowledged for its digital transformation model which inspires other countries, as well as for displaying one of the most developed digital ecosystems in the world. Brazil, in turn, has made progress in improving its digital transformation and AI ecosystem, as it has been made clear by relevant international indicators, in addition to having had active participation in international forums and mechanisms on the subject. With the Report on AI, both countries inaugurate another chapter and innovative project in their traditional bilateral relationship in science, technology and the digital agenda, which will certainly yield concrete results and will also allow them to face the challenges and seize the economic opportunities related to the advance of AI both in the national and international contexts.



José J. B. Sarquis
Secretary for Foreign Trade
and Economic Affairs

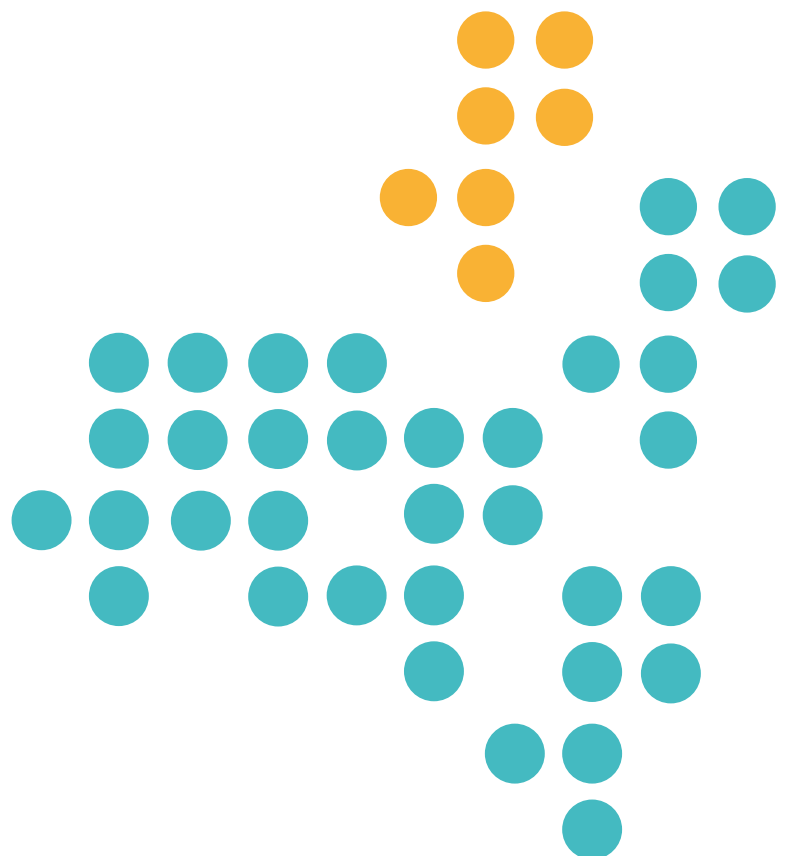




This report was sponsored by the Embassy of the United Kingdom in Brazil in partnership with the Ministry of Foreign Affairs of Brazil and written by researchers from the Center for Artificial Intelligence (C4AI) USP-FAPESP-IBM Corporation (process number 2019/07665-4) and the Brazilian Center for Analysis and Planning (CEBRAP).

team C4AI (USP)

Glauco Arbix
Marcelo Finger
Fábio Cozman
Rodrigo Brandão
Hugo Neri
Laura Camargo



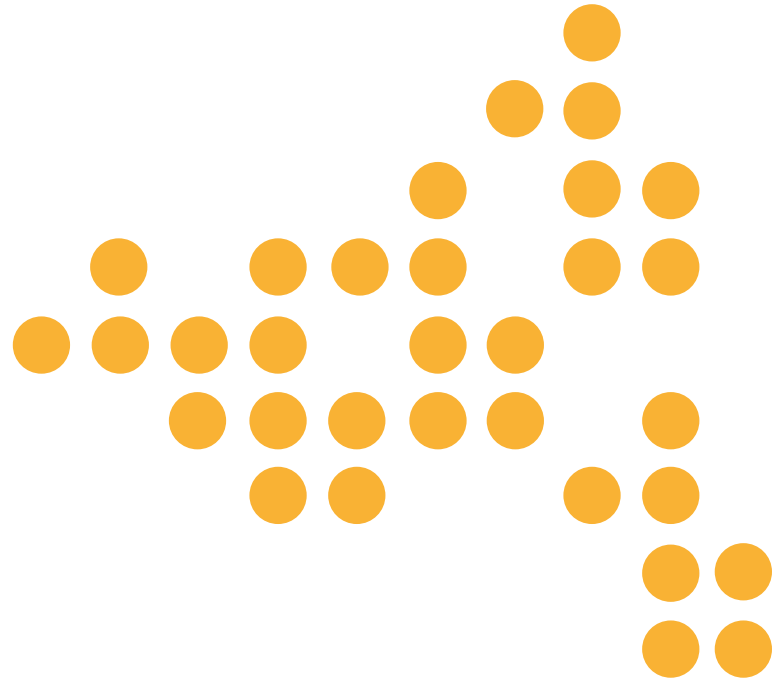
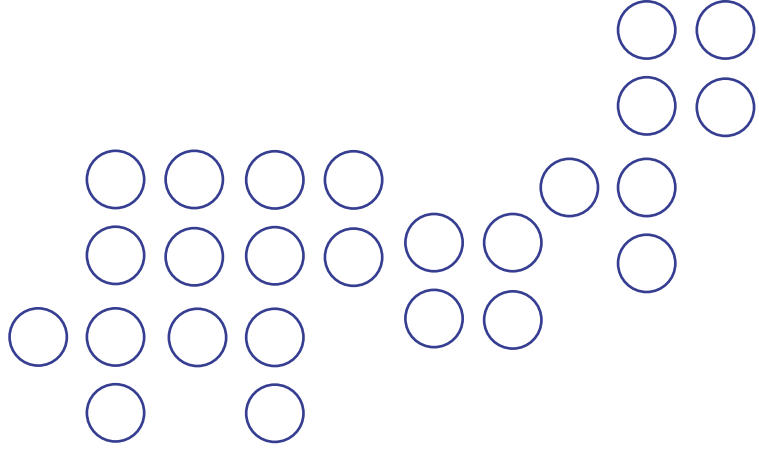
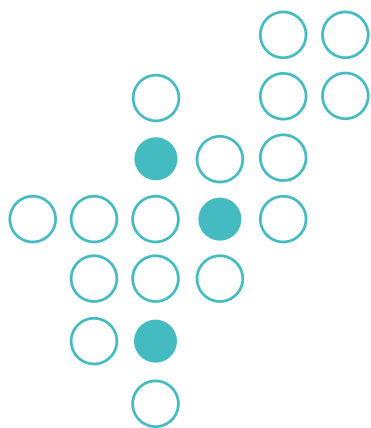


table of contents

1. introduction	6
2. Brazil's emerging sector	8
3. innovation ecosystems	10
4. institutional overview	16
5. legal framework	23
6. research in AI	26
7. AI in the economy	35
8. UK-BR: ways to intensify cooperation	43
acknowledgement	46
research team	47



introduction

The United Kingdom (UK), one of the cradles of Artificial Intelligence (AI), has for decades maintained an active environment for innovation linked to the ambition to create things with intelligent behaviour. Its academic environment has generated numerous groundbreaking advances in AI since Alan Turing published his influential articles in 1950, from the development of logical programming to more recent argument-generating techniques. Its business environment benefits from global connections, a solid base, and has been responsible for revolutionary advances, such as deep learning.

Brazil, more recently, has also experienced a profusion of entrepreneurship linked to AI, which has spread throughout universities and percolated through the financial sector, agribusiness, industry, education, and healthcare. Opinion polls demonstrate that about 60% of the 210 million Brazilians see themselves as early adopters and open to new technologies. In addition to its large population (the sixth largest on the planet), Brazil represents one of the largest and most diversified markets among middle-income countries and serves, in numerous sectors, as an entryway to the Latin American market. With hundreds of universities as well as traditional data collection and production entities, Brazil has a mature and sophisticated innovation ecosystem, which contributes to the country being the primary investment recipient in Latin America.

The United Kingdom and Brazil enjoy an historic relationship of friendship, with active cooperation across a range of sectors including the sciences, the economy, and the arts. The strength of these ties can be seen in the more than 800 British companies currently operating in Brazil, and in trade flows worth £6 billion¹ in 2020. Trade is supported by a diversified flow of Brazilian raw materials and manufactured goods to the UK, and imports from the UK concentrated in pharmaceuticals, fuels, machinery and engines².

Bilateral ties will continue to strengthen in the coming years, particularly given the current international scenario. Both Brazil and the United Kingdom need to recover momentum for growth and AI technologies offer valuable potential to stimulate advances in productivity to support post-pandemic economic recovery and increase. The shared commitment to leverage advanced AI technologies to raise the standard of living of both populations, opens up new horizons for deeper cooperation between Brazil and the United Kingdom.

This report, sponsored by the Embassy of the United Kingdom in partnership with the Brazilian Ministry of Foreign Affairs (MRE), presents an overview of the AI ecosystem in both countries, with a focus on the current situation of AI in Brazil, including its effective capacity and potential. The primary objective is to build

¹ <https://www.gov.uk/government/news/uk-and-brazil-to-boost-economic-relationship>

² http://londres.itamaraty.gov.br/en-us/bilateral_trade.xml

benchmarks so that companies, universities, and government institutions of the United Kingdom and Brazil can recognize the points of contact and improve collaboration between the two nations. Brazil's AI sector is expanding fast, the report provides an overview of the functioning of Brazil's core institutions, its legal mechanisms, and development agencies, and presents the major public and private sector initiatives that mark the Brazilian innovation system.

The primary conclusion of this report is that the rapid evolution of research and the application of AI technologies opens up new opportunities to further deepen the collaboration between companies, universities, and governments in Brazil and in the United Kingdom.





2.

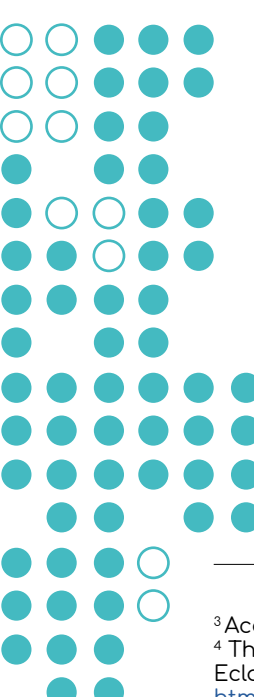
Brazil and the United Kingdom

Brazil's emerging AI sector

AI has the potential to increase the value of the Brazilian economy by more than US\$ 400 billion over 15 years³. In other words, the synergy between intelligent automation processes and the dissemination of digital innovations – such as visual computing, audio processing, natural language processing techniques, big data, and machine learning – has the potential to accelerate the development of emerging countries in an unprecedented way.

There are clear indications that Brazilian companies are beginning to use AI in multiple dimensions in order to leverage its transformative potential. Together with universities, researchers and centers of education, they are also using and developing AI technologies to generate significant advances in health, agriculture, energy production, finance, and the pursuit of well-being, quality of life and sustainable growth. At the federal and state level, government understands the importance of the new wave of digital technologies to drive efficiencies and improve the delivery of public services.

Global companies such as Unilever, Vale, Shell, Google, Microsoft, IBM, Motorola, Apple, Amazon, AstraZeneca, Huawei, Sony, Weg, Bayer, Panasonic, Lenovo, Midea, Basf, ADM, Bunge, Cargill, L'Oreal, Carrefour, Tata, Arcelor Mittal, representing major banks, pharmaceutical companies, energy giants and the automotive and logistics sector, choose to invest in Brazil, taking advantage of the size of the market and the scope for regional expansion⁴.



A study conducted by Microsoft⁵ concluded that the Brazilian economy could see a 7% increase in GDP by 2030 with the large-scale adoption of AI, (taking into account the negative impacts of the COVID-19 pandemic)⁵. Estimates from the MIT Technology Review⁶, in partnership with Genesys, have identified that Latin American companies are aware of new development tools, and increasingly use AI to address critical issues such as food security, natural resources and unemployment, with a level of sophistication similar to that of advanced economies. The same paper showed that about 80% of large global corporations based in South

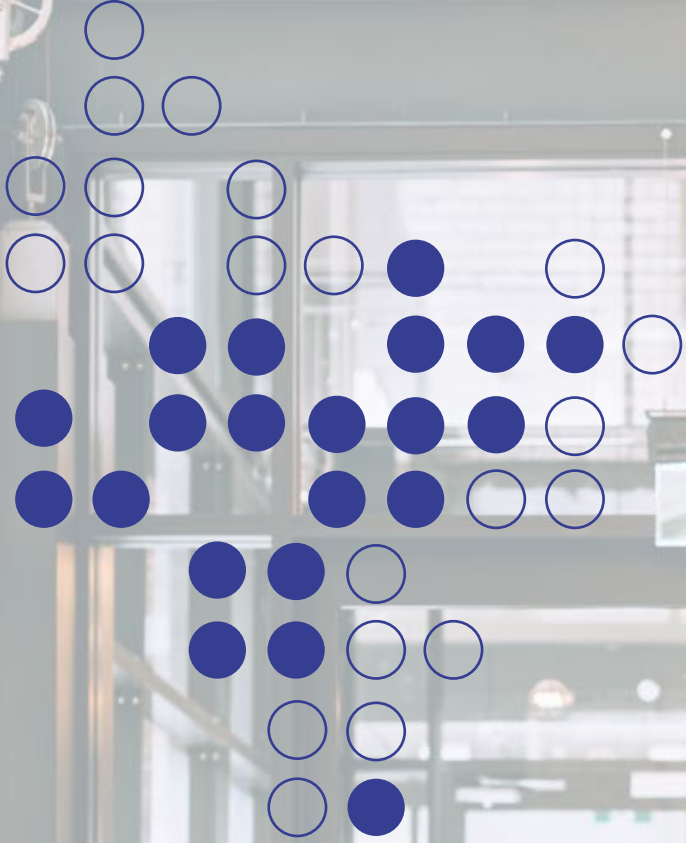
America develop digital projects seeking to improve the efficiency of their operations and decision-making processes, a rate similar to that of the U.S. (87%) and Asian (95%) economies.

³ Accenture-Frontier Economics (2020). In-Depth: Artificial Intelligence 2020.

⁴ The Brazilian economy accounts for about 35% of the added value of all the Latin American economies. Eclac. Cf. EclacStat Database (<http://estadisticas.cepal.org/cepalstat/PerfilNacionalEconomico.html?pois=BRA&idioma=english>)

⁵ Microsoft and DuckerFrontier (2020). "Real impact for a better future - Commitment plan with Brazil 2019-2020". Available in: <https://www.microsoft.com/cms/api/am/binary/RE4yqRL>

⁶ MIT Technology Review Insights & Genesys. "The Global AI Agenda: Latin America". Available in: The global AI agenda: Latin America.



3.

innovation ecosystems



Brazil

The construction of Brazil's national innovation system has advanced rapidly over the last three decades. World-class universities across the country have helped to train an elite corps of professionals, including engineers, mathematicians, statisticians and programmers working in areas including biology, health, nanotechnology, agrarian sciences, physics and chemistry. AI researchers and professionals have benefited from investment in institutions which promote and finance Science, Technology and Innovation (ST&I), similar to those operating in developed economies. Currently, Brazil is the 13th largest producer of scientific publications in the world, and the country with the 10th largest body of research produced on AI between 1980 and 2020, according to the OECD⁷.

In recent decades, the Brazilian innovation system has benefitted from the participation of top public and private universities in post-graduate schemes⁸, the creation of technology parks, as well as hundreds of incubators, accelerators and innovation centers. This innovation ecosystem enables governments, research centers and public and private sector companies to interact, and provides a solid base on which to build a dedicated AI infrastructure⁹. Initiatives of federal, state, and municipal governments have also been important, such as the National Plan for The Internet of Things and the Brazilian Strategy for Digital Transformation¹⁰ (E-Digital), launched in 2018, which has begun to form a network of its own focused on digital and AI development.

In 2020, the Brazilian Ministry of Science, Technology and Innovations (MCTI), in partnership with the São Paulo State Research Support Foundation (FAPESP) and the Internet Steering Committee (CGI.br), announced the formation of eight research centers dedicated to AI, focusing on the application of AI to address challenges in the areas of Healthcare, Agriculture, Manufacturing, Defense, Education, Cybersecurity, and Smart Cities. The centers will be public private partnerships, based on consortia between research institutions and private companies.

⁷ Research in Brazil: A report for CAPES by Clarivate Analytics AI publications by country in time - <https://oecd.ai/data-from-partners?selectedTab=AIResearch&selectedAIResearchTab=tab14>.

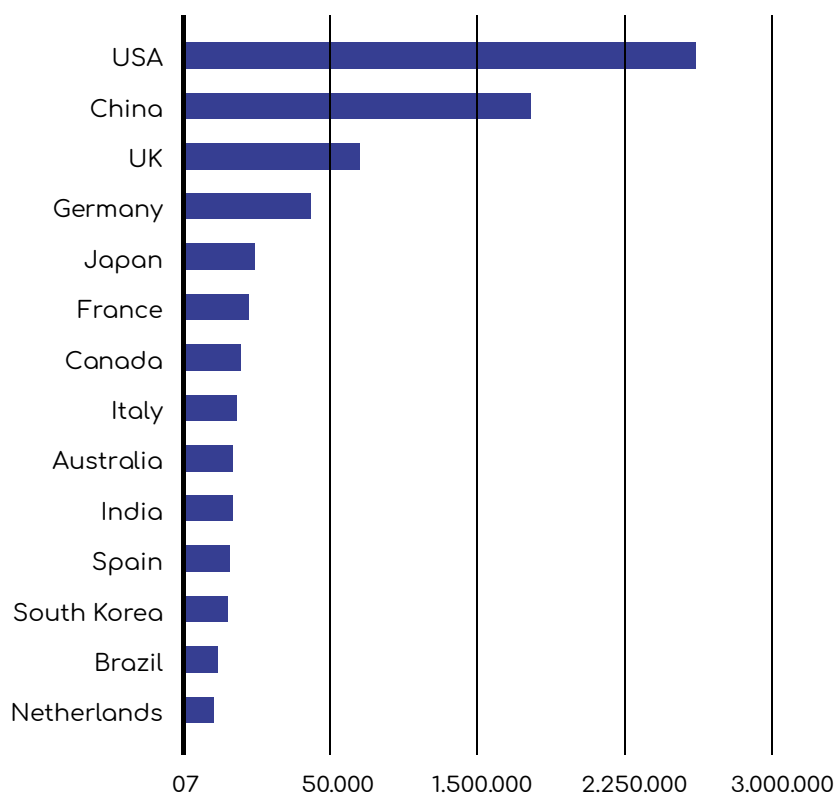
⁸ Such as the University of São Paulo, Federal University of Rio de Janeiro, Unicamp, Federal University of Minas Gerais, Federal University of Rio Grande do Sul, Federal University of Santa Catarina, FGV, INSPER, PUC-RJ, to mention only a few of those which have gained prominence in the major international rankings

⁹ Like Embrapa (a government research company created to support agriculture), the National Scientific Computing Laboratory (LNCC), the Institute of Space Research (INPE), the Pure and Applied Mathematics Institute (IMPA), the Center for Research and Development of Petrobras (Cenpes), the Center for Research and Development in Telecommunications Foundation (CPqD), and the National Center for Research in Energy and Materials (CNPEM), all with international recognition and scope.

¹⁰ Federal Government Decree No. 9,854 of 2019.

The evolution of recent years has included Brazil on the in AI publications map ranking

Articles added to Web of Science (2013-2018)



Source: Web of Science. Accessed on 03/12/2021.

The new AI centers are part of efforts to develop Brazil's National Artificial Intelligence Strategy¹¹, in synergy with the National Cyber Security Strategy (E-Ciber), the National Internet of Things Plan¹² and the Brazilian Strategy for Digital Transformation (E-Digital)¹³. The international dimension of this strategy gained greater prominence with the entry of Brazil into the *Global Partnership on Artificial Intelligence* (GPAI)¹⁴ in December 2020. The GPAI is a multisectoral partnership

¹¹ Coordinated by the MCTI, a consultation is underway to consolidate the national AI policy, according to an interview by the Secretary of Entrepreneurship and Innovation of the MCTI, Paulo Alvim. The initiative seeks to collect suggestions from civil society organizations and bring together ongoing initiatives and projects in Brazil, in both the public and private sectors, as well as consolidating plans, policies, strategies, and initiatives from other countries. The data collected should also serve as the basis for a methodology of dialogue with society at large on topics related to AI.

¹² Instituted by Decree N. 9854 of 2019, the plan seeks to increase Brazil's participation on the international stage, by means of participation in forums concerning standardization, as well as cooperation in research, development, innovation, and the internationalization of IoT solutions developed in Brazil.

¹³ The Digital Transformation Strategy of Brazil (E-Digital), of March 2018, articulates different government initiatives connected to the processes of digitization of the economy and society.

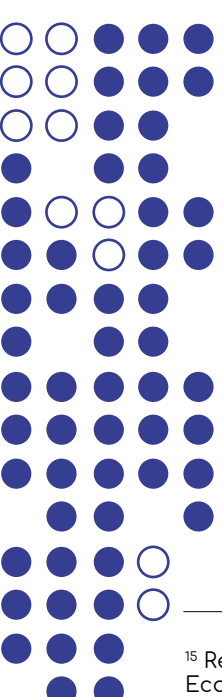
¹⁴ The founding countries of GPAI are The United Kingdom, United States, Australia, Germany, India, Italy, Japan, Mexico, New Zealand, Republic of Korea, Singapore, Slovenia, and the European Union. Brazil, Spain, the Netherlands, and Poland were accepted in December 2020. GPAI: <<https://gpai.ai/>>

built around a shared commitment to OECD Recommendation on AI.¹⁵ GPAI brings together expertise from science, industry, civil society, governments, international organisations and academia to foster international cooperation. It promotes the development of AI in a manner which is reliable, responsible, respectful of democratic values, human rights, inclusion and diversity. As a member of GPAI, Brazil will have access to its working groups and centers of excellence such as the *International Centre of Expertise in Montréal for the Advancement of Artificial Intelligence* (ICEMIA, Montreal) and *L'Institut National de Recherche en Sciences et Technologies du Numérique* (INRIA in Paris).

"It is strategic imperative for Brazil to train human resources, develop companies and produce research in the various fields of AI and digital technologies and thus overcome our fear of facing a new culture" - Paulo Alvim, Secretary of State for Innovation, MCTI

This compendium of government policies seeks to stimulate the transformation of the Brazilian economy and society and also encompasses the protection mechanisms provided for by the General Law for the Protection of Personal Data¹⁶. Looking to the future, it is expected that Brazil will advance quickly and become a global reference in AI in the coming years. To this end, the stability of technological policies, research funding, corporate support and additional emphasis on international cooperation are essential components of the entire project.

United Kingdom



The UK is internationally recognized for its leadership in research and for the excellence of the institutions that make up its Science, Technology and Innovation (ST&I) system. Its pioneering contributions in two industrial revolutions has carried on to the present, including the discoveries of graphene, contributions to the decoding of the structure of DNA and the decisive advances in deep learning techniques, which altered the context of AI throughout the world.

Government resources provide stability to a system that seeks to increase investment in R&D to 2.4% of GDP by 2027, even as the economy suffers the negative impacts of the coronavirus pandemic. The British government understands the potential of emerging technologies and has made a number of decisions to encourage and expand the AI ecosystem.

One of the most visible of these initiatives was the creation of the Alan Turing Institute in 2015 as a national institution dedicated to

¹⁵ Recommendation of the Council on Artificial Intelligence, adopted on 5/22/2019, proposed by the OECD Digital Economy Policy Committee. <<https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449>>

¹⁶ Inspired by similar European legislation, Law No. 13,709 of August 2018, regulated the processing of data by individuals or public or private sector entities. Its purpose is to protect the fundamental rights of freedom and privacy. To protect fundamental rights related to personal data, the LGPD has set up the National Data Protection Authority (ANDP), scheduled to enter into force in January, 2021.



data science and AI. Initially, the Alan Turing Institute was supported by the Universities of Cambridge, Edinburgh, Oxford, University College London and Warwick. Since 2018, additional universities (Leeds, Manchester, Newcastle, Queen Mary University of London, Birmingham, Exeter, Bristol and Southampton) have joined the Institute. The Alan Turing Institute has been a key center not only for AI development, but also for developing operational support and government policy recommendations.

Another important initiative oriented to technological innovation was the creation from 2013 of a number of Catapult centres across the country. Coordinated by Innovate UK, they form

the Catapult Network which integrates nine centers of excellence with the purpose of catalyzing disruptive technologies in fields including Digital Technologies, Genetics, Semiconductors, Connected Cities, Energy, Manufacturing, Medicine, Renewable Energy and Satellites.

In 2017, the British government sponsored an exercise to identify priority actions based on the proposals from an independent report, entitled *Growing the Artificial Intelligence Industry in the UK*, written by professors Dame Wendy Hall (Regius Professor of Computer Science, University of Southampton) and Jérôme Pesenti (CEO, BenevolentTech). The study highlighted the need for close partnership between government, academia and the private sector to advance the training of professionals, the building of infrastructure and the implementation of a long-term strategy for AI in the UK. These recommendations led to the creation of the Data Trusts, as well as a government department dedicated to AI (Office for AI), the AI Council (focusing on the AI economy and ecosystem), and the Centre for Data Ethics and Innovation (CDEI), whose main objective is to connect policymakers, the private sector and civil society organizations in order to develop recommendations for the use of data in AI. Government efforts are geared towards improving the positioning and competitiveness of the economy on the international stage and increasing R&D investment in UK companies.

The UK is currently ranked 4th in the *Global Innovation Index*. Brazil currently ranks 62nd and 16th in innovation among 37 middle-income countries. Similar to Brazil, government authorities and planners in the UK strive to ensure that bureaucratic barriers do not smother innovation. Currently, all regulatory mechanisms for ST&I are being examined and reformulated to adapt to the characteristics of the new technological era, starting by improving the means of financing innovation and enabling rapid responses to major national and global problems.

During the pandemic, both the Alan Turing Institute and the Catapult Network made relevant contributions to epidemiological analyses, the discovery of new drugs, tests, ventilators, applications and equipment that saved lives and demonstrated the vital importance of science, technology and innovation (ST&I). As in Brazil, British researchers have played a leading role in efforts to develop vaccines, including clinical and antiviral tests, such as rapid genome decoding and coronavirus synthesis by the *COVID-19 Genomics UK consortium*, which sequenced the majority of the variations of SARS-CoV-2.

It is important to note that institutions supporting innovation are oriented towards a low-carbon economy capable of protecting the environment in order to improve safety, productivity and quality of life for the population. In the medium and long term, the biggest challenge the UK seeks to overcome is the decarbonisation of the economy and the mitigation of the effects of climate change¹⁷.

Collaboration with nations that share similar values and the expansion of the AI community are essential to increase the capacity to co-create technological solutions capable of generating new products and responding to global challenges.



¹⁷ Currently, CO2 emissions averages in the UK are 5,500 tons/capita, while the Brazilian average is 2,100 tons/capita. (OECD). <<https://data.oecd.org/united-kingdom.htm>> | <<https://data.oecd.org/brazil.htm>>

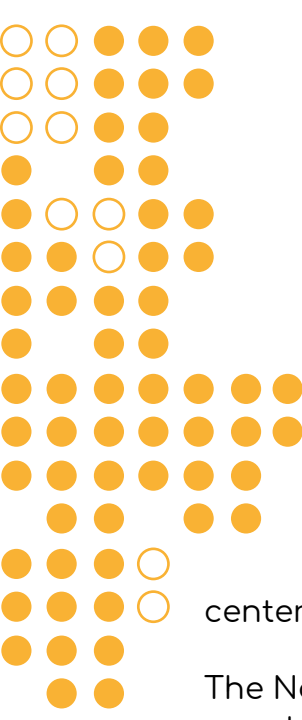


4. institutional overview

public sector

Brazil's institutional infrastructure is comprised of dozens of institutions that support the innovation ecosystem and constitute a solid foundation for the development of AI, starting with support for ST&I financing by means of large institutions and development funds, which are directly or indirectly connected to the agencies and departments of federal, state and municipal governments.

The largest ST&I fund is the National Fund for Scientific and Technological Development (FNDCT), the legal management of which is the responsibility of the Studies and Projects Financing Office (FINEP), the Brazilian agency for supporting innovation. Created in the 1970s to support research infrastructure and ST&I projects, FINEP also supports innovation in the private sector (large, medium, and small enterprises), with subsidized loans and investments in startups. FINEP also maintains cooperation agreements with a number of countries to issue calls to strengthen partnerships between Brazilian and foreign companies, such as those in field of bioeconomy (with Germany). In addition to FINEP, which is coordinated by MCTI, Brazil has in recent years seen the rapid growth of funds and programs to support technological innovation which are directly connected to departments and agencies of the federal government, such as the Ministries of Education, Health, Defense, Communications, Economy, and Agriculture. Additionally, FINEP also supports programs directly connected to AI, such as *Editais Tecnologias 4.0*, *Inovacred 4.0* and *FINEP Startup*.



Closely aligned with FINEP, the National Council for Scientific and Technological Development (CNPq), the oldest science sponsorship agency in the country, also coordinated by MCTI, is of particular importance. Founded in 1951, its primary function is to formulate and conduct ST&I policies. Its activities also contribute to the training, recognition and networking of Brazilian researchers with the international scientific community. Around 1,000 research groups are currently registered at CNPq comprising various different fields of AI, primarily involving machine learning, deep learning, and natural language processing techniques.

For research training activities, the Brazilian Ministry of Education maintains the Coordination for the Improvement of Higher Education Personnel (CAPES), which also works to expand and improve the quality of undergraduate and graduate courses (Master's and Doctorate) throughout the country. CAPES, which is responsible for scholarships and research in Brazilian and foreign institutions, is one of the major centers for the promotion of international scientific cooperation.

The National Bank for Economic and Social Development (BNDES) is the country's main instrument for long-term financing and investments in all segments of the economy. In addition to activities focused on infrastructure,

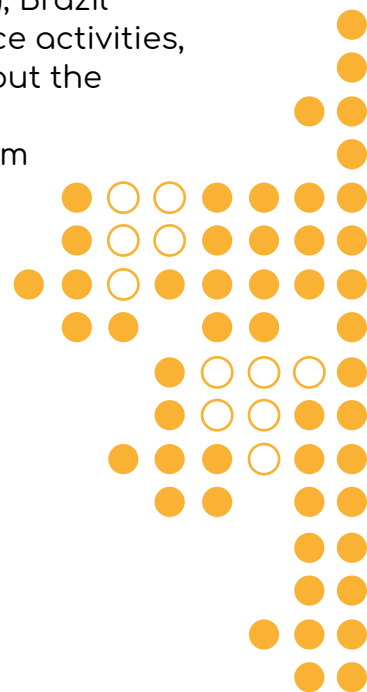
exports, regional and socio-environmental development, capital markets, culture and the creative economy, BNDES has innovation as one of its primary lines of operation. Created in 1952, BNDES is currently one of the largest and most important development banks in the world. With a sizable budget, it offers subsidized loans for micro, small and medium-sized enterprises and supports innovation in products and processes by means of structured and continuous investment. BNDES has an extensive portfolio of credit lines for industry, trade, agriculture and services, as well as providing financing for exports and infrastructure, and support for micro, small and medium-sized enterprises. BNDES maintains special programs and lines of credit for digital innovation, the Internet of Things (IoT) and the promotion of high-tech companies and research centers.

In the Brazilian system, an important part of the development of innovation takes place in technological parks and incubators, which bring together innovation centers and private R&D laboratories and which have the systematic support of municipal, state, and federal governments. According to MCTI and the National Association of Entities Promoting Innovative Enterprises (ANPROTEC), Brazil currently has 96 technology parks, 28 of which have high-performance activities, and 369 incubators, which host more than 2,300 companies throughout the country. In order to further increase the interaction and connection between the stakeholders in this ecosystem, MCTI has the IA2 program for the purpose of supporting investments in R&D projects and to facilitate matchmaking between startups, accelerators, and large companies.

In addition to agencies and institutes of the federal government, Brazil has a network of State Government Research Support Foundations (FAPs), which also promote the exchange and dissemination of S&T. The primary FAP in Brazil is the São Paulo State Research Support Foundation (FAPESP), which administers an annual budget equivalent to 1% of the revenues of the State of São Paulo (the largest state economy in Brazil). Two other major funding agencies are the Rio de Janeiro State Research Support Foundation (FAPERJ) and the Minas Gerais State Research Support Foundation (FAPEMIG), both of which play prominent roles in supporting innovation in their respective states.

The FAPs are linked to the National Council of Research Foundations (CONFAP), which coordinates all 27 foundations throughout the country and which seeks to support the immense capillarity of the national innovation system.

In 2020, FAPESP, in partnership with IBM, announced that a consortium of schools and researchers led by the University of Sao Paulo (USP) had been awarded a government contract for the construction of an AI Engineering Center. FAPESP's financing, about US\$ 500,000/year, planned for a period of 10 years, will have IBM's support with an investment of equivalent value, and a counterpart from USP that should be equal to the total value of the external investment. The Center for Artificial Intelligence (C4AI) USP-FAPESP-IBM brings together more than 150



researchers from different fields. C4AI is headquartered at InovaUSP, a space for innovation and multidisciplinary research located at the Butantã campus of USP, in São Paulo. International cooperation is one of the priorities of C4AI, which seeks to accelerate research into and application of AI throughout the country. The quality of USP's research, coupled with FAPESP's support and IBM's expertise, marked C4AI as a pioneering initiative and a national reference for the construction of other AI centers.

"FAPESP strongly supports the formation of engineering and AI centers by means of partnerships between companies and universities" - Carlos Américo Pacheco, CEO of FAPESP

FAPESP also funds a series of programs and initiatives which seek to support scientific and technological research in micro, small and medium-sized enterprises in the state of São Paulo, such as the Innovative Research Program for Small Enterprises (PIPE), created in 1997.¹⁸

Another important initiative was the RFP issued in the state of Rio de Janeiro by FAPERJ, in 2020, in support of thematic AI Networks. The RFP offers funding for three networks, comprising professionals from different fields, university leadership, research institutes, public and private sector companies and government agencies.¹⁹

In Minas Gerais, FAPEMIG launched a special edition of the Seed Program (Startups and Entrepreneurship Ecosystem Development). Through the provision of grant, in the form of an economic subsidy, proponents are encouraged to work on the challenges announced by FAPEMIG, using AI and machine learning techniques as tools.²⁰

In order to stimulate the creation of innovative projects, the Spark Program was created from a partnership between MCTI, CNPq, FINEP and CONFAP in addition to the CERTI Foundation, which manages the initiative. Resources offered by the program include: (i) monetary grants; (ii) online training; (iii) benefits, services and discounts from program partners;



¹⁸ According to Carlos Amisrich Pacheco, CEO of FAPESP, about 1/3 of PIPE companies in recent years work with new technologies (interview held on 06/01/2021).

¹⁹ https://www.google.com/url?q=http://www.faperj.br/downloads/Apoio_Redes_Tematicas_Inteligencia_Artificial_2020.pdf&sa=D&source=editors&ust=1613914493267000&usq=AOvVaw2GETHAfOEJTMlUdo43Wsy

²⁰ <http://seed.mg.gov.br/wp-content/uploads/2016/11/Edital-consolidado-07042021.pdf>

(iv) access to incubators and potential investors; and (v) network creation. The program is active in 20 states. In 2019, the Spark RS Program (RFP 07/2019 Spark Program) from the state of Rio Grande do Sul selected 28 projects, having a primary thematic focus on: biotechnology and genetics, chemistry and new materials; automation; artificial intelligence and electronics.²¹

private sector

The private sector also offers important points of support for technology projects. Brazil has 26 innovation institutes in the National Industrial Training Service (SENAI), which develops high complexity products and processes for companies. SENAI is a non-profit private sector entity connected to the network of industry associations, especially the National Confederation of Industry (CNI). Created in 1942, it is currently one of the five largest professional education complexes in the world and the largest in Latin America, with increasing influence in encouraging business innovation. The special agreement concluded with the Fraunhofer Institutes (of Germany) strengthened research and innovation in AI and robotics in several states around the country.

Like SENAI, the network of industry associations in Brazil maintains the Brazilian Support Service for Micro and Small Enterprises (SEBRAE) which, in addition to business capacity building activities, also finances innovative ideas and projects for small business entrepreneurs, whether on its own or in association with medium or large companies.

EMBRAPII: institutional novelty

In order to bridge the gap between the public and private sectors, the innovation system in Brazil created the Brazilian Industrial Research and Innovation Company (EMBRAPII), in 2013, in the form of a non-profit organization.²² It is the latest innovation support institution in Brazil and its tripartite operations model, inspired by the Fraunhofer Institutes, is based on cooperative action between the public sector, technological research institutions and companies in the industrial sector. This new model has made EMBRAPII both relevant and cutting-edge; it has already sponsored more than 1,000 impactful projects addressing the environment, healthcare, agroindustry, subsea engineering, energy, advanced materials and telecommunications. Its innovative risk-sharing system stimulates the competitive ambition of companies both in the domestic and international markets, unlike the traditional actions of the older agencies operating in the country. In its public sector connection, the financing for EMBRAPII is obtained via MCTI and MEC

²¹ <https://fapergs.rs.gov.br/programa-centelha-rs-chega-ao-final-com-28-projetos-aprovados-na-fase-iii>

²² Non-Profit Organizations in Brazil were regulated by law in the late 1990s as a way to streamline government institutions, then considered ossified by a bureaucratic-legal network that made it difficult to offer the needed services to society. The inspiration for the Brazilian version came from the more flexible system adopted in the UK during the government of Margaret Thatcher.

and is strongly anchored in mechanisms for cooperation and investment sharing with research centers and companies.²³

"94% of Embrapii's (Brazilian Industrial Research and Innovation Company) units believe that AI will have a significant impact on the industrial sectors for which they carry out RD&I projects and 40% of them claim to have the computer laboratory infrastructure to meet this challenge." - Jorge Almeida Guimarães, CEO of Embrapii

At the end of 2020, MCTI and EMBRAPII created a national network of cooperation in AI. Initially, 17 units make up the network, whose main objectives are stimulus, cooperation, sharing of infrastructure and training of professionals in all aspects of AI. Network funding will gradually expand to other sectors of the economy that want to develop innovation. As EMBRAPII's operational model provides for joint investment with the private sector, it is estimated that the creation of the Network will generate nearly R\$ 140 million in innovations (when adding EMBRAPII's resources, companies' counterpart investments and the non-financial resources of the EMBRAPII Units – such as the use of equipment and person-hour payments).²⁴

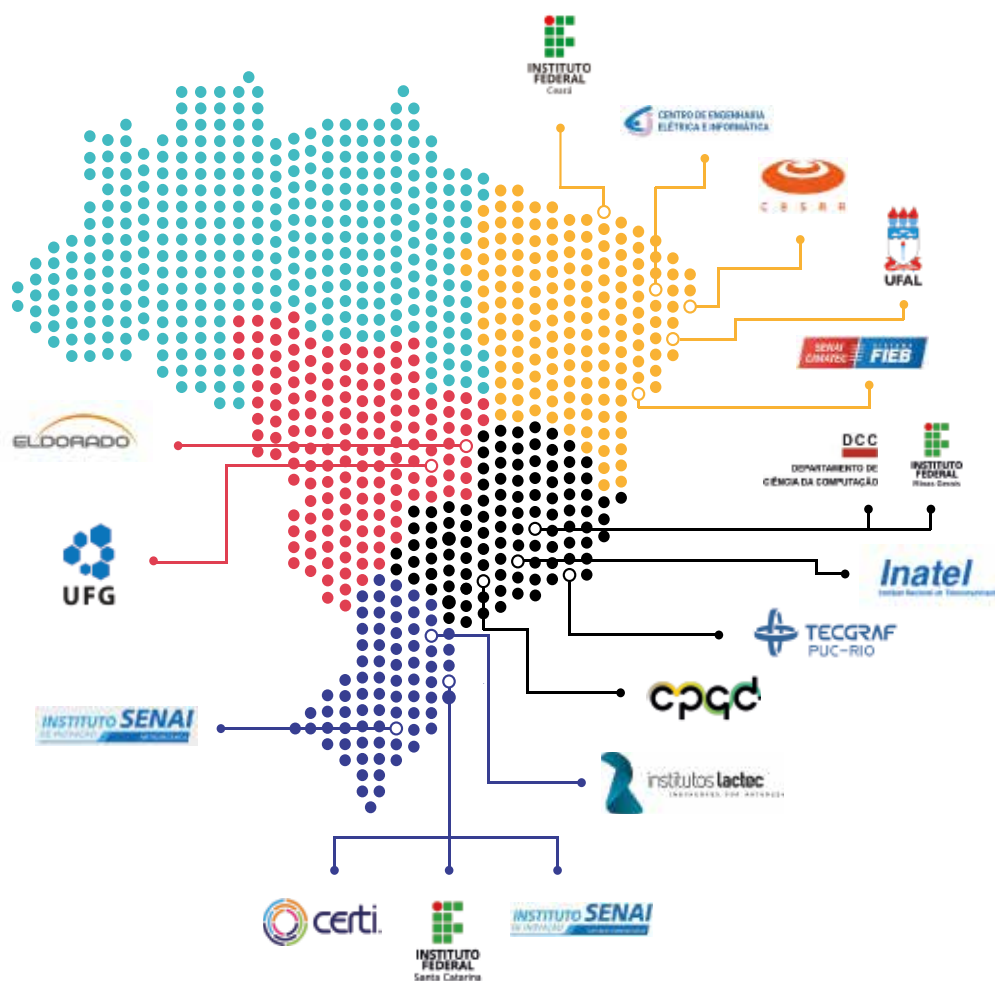


²³ Mais sobre a EMBRAPII: <https://embrapii.org.br/>

²⁴ Available at: <https://embrapii.org.br/mcti-e-embrapii-lancam-a-maior-rede-de-inovacao-em-inteligencia-artificial-do-pais/>

The network is coordinated by the Center for Research and Development in Telecommunications (CPqD), a private sector foundation, and its Board of Directors includes representatives of institutions such as the Brazilian Association of Information and Communication Technology Companies (BRASSCOM), the Brazilian Computer Society (SBC), the Brazilian Association of the Electrical and Electronics Industry (ABINEE), the Association for the Promotion of Excellence in Brazilian Software (SOFTTEX) and the Brazilian IoT Forum.

unities of EMBRAPII's network





5.
legal
framework

legal framework

To account for the complexity of the innovation system, Brazil has enacted a number of federal and state laws that stimulate the development of ST&I throughout the country. Most of these legal and regulatory instruments are derived from the Innovation Law (#10,973, 2004), which created measures to simplify the relationship between companies and research institutions. Contemporaneous to the Innovation Law is the Law of Assets (#11,196, 2005), which grants tax incentives to companies that perform R&D and technological innovation. Even with subsequent modifications, the Law of Assets guarantees significant incentives for companies which (i) are taxed on their actual profits, (ii) have made a profit during the previous fiscal year and (iii) invest in Research and Development (R&D).

In 2016, the Innovation Law underwent profound modifications through Law No. 13,243, which further simplified the relationship between companies and research institutions. Among the novelties introduced that have boosted the innovation system are: (i) the exemption from mandatory bidding for the purchase or contracting of products for R&D purposes; (ii) the reduction of taxes for the importation of research material; (iii) the authorization for professors of public universities under exclusive contracts to carry out research activities in the private sector as well, with remuneration; (iv) authorization for public universities to share the use of their laboratories and research teams with private companies for research purposes.

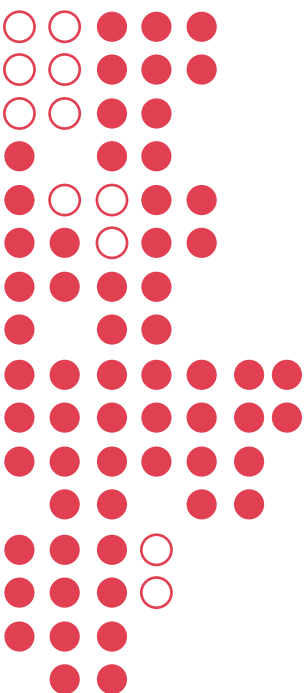
The new Legal Framework for ST&I (Law 13.243/2016) entered into force in February 2018, consolidating the following instruments to support innovation:

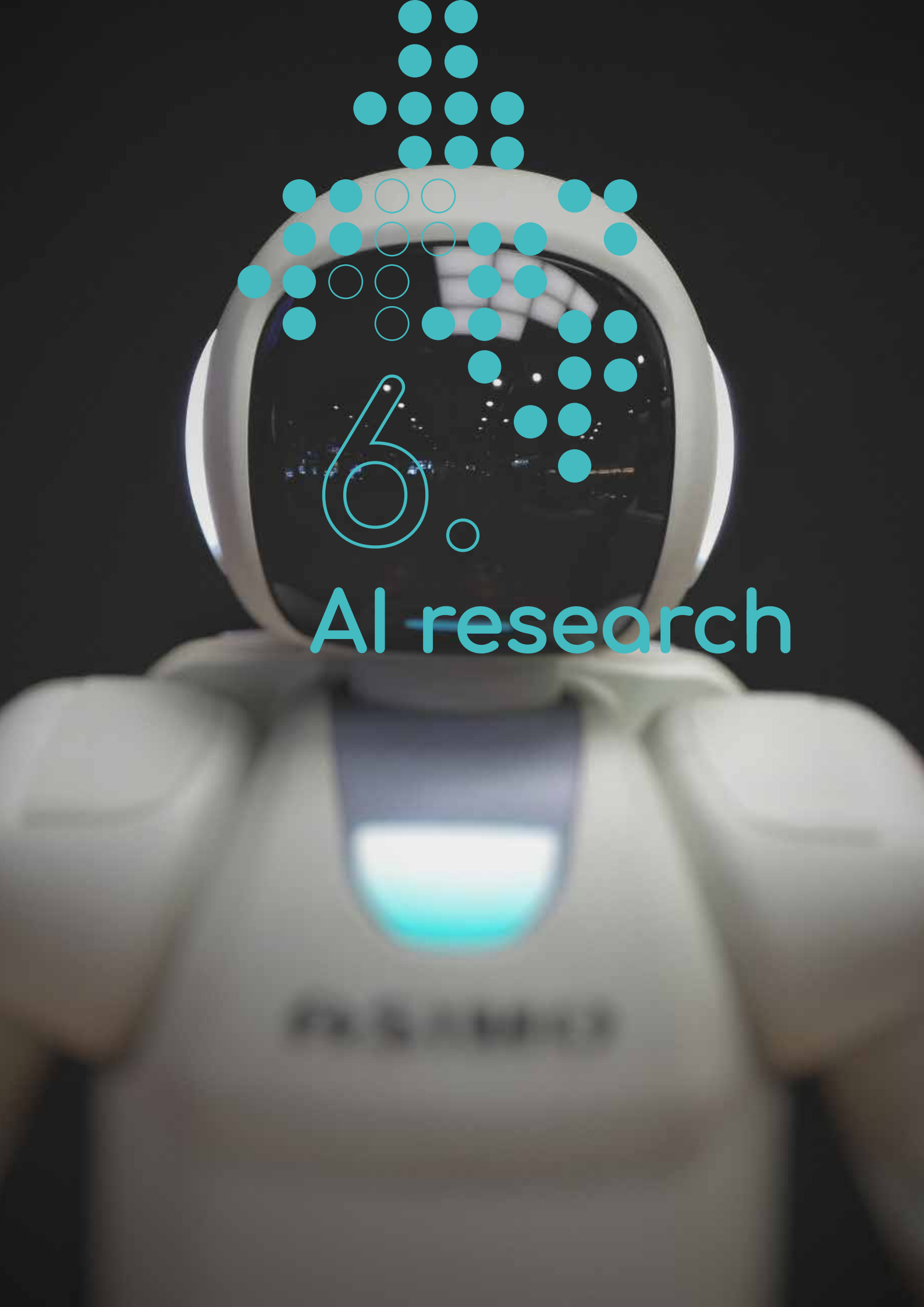
- Financial Grants (non-reimbursable government funds invested directly in private companies);
- Financing (loans granted under special conditions for purposes of innovation);
- Shareholding (public sector entities are now allowed to hold stock in a private company);
- Technology Bonus (subsidies to micro and small businesses for the contracting of specialised technological services and technology transfers);
- Technology Orders (allows the government to contract with companies to perform R&D for the solution of specific problems without the requirement for a bidding process);
- Tax Incentives (tax waivers granted by the government to promote business investment, via deductions, amortizations, tax credits among other means);

- Research Grants (direct financial support to researchers focusing on the training of human resources);
- Use of government purchasing power (granting additional preferred margins for manufactured products and innovation services created in Brazil);
- Investment funds (investments in innovative companies via equity funds, securities, investments in government concessions and special regimens managed by regulatory agencies).

Some FAPs, such as FAPESP, offer programs in partnership with the private sector for the construction of engineering centers, similar to C4AI. There are several centers in full operation, , such as the research center in Oncology (with GlaxoSmithKline), in Biological Control (with Koppert), in energy (with Equinor), in gas innovation (with Shell), in Human Welfare and Behavior (with Natura) and in biofuels (with the PSA group).

These various initiatives will take time to consolidate and mature, but demonstrate that: **Brazil has an advanced and diversified regulatory and legal system that is second to none of the countries that are at the forefront of scientific knowledge. In order to advance innovation support mechanisms even further, MCTI defined AI as one of the priorities for the period 2020-2023.**





AI research

United Kingdom

The UK is an advanced hub in the global race to develop and apply AI. It is the only European country that competes directly with the United States and China for leadership in several AI modalities. The combination of a broad spectrum of government initiatives, funding for specialist research centres and universities and strong engagement with the private sector has stimulated the development of new technologies.

AI has the potential to boost the UK economy by more than 20% by 2030, reflecting the preparedness of its economy and a willingness to take advantage of the new technology cycle. According to Oxford University indicators²⁵, **the UK ranks second (behind the US) in an assessment of government preparedness, infrastructure, data availability, governance and ethics, digital capacity and, primarily, human capital, which is a critical point for the advancement of AI.**

The UK's solid culture of innovation requires only scale and audacity to compete for the top position in the global technology arena.

Universities of the caliber of Oxford, Cambridge, Imperial College London and the University of Edinburgh interact with major institutes such as the Alan Turing Institute, the Ada Lovelace Institute, the Artificial Intelligence Applications Institute, the Centre for Intelligent Systems and their Applications, and the Future of Humanity Institute to form one of the most dynamic AI research spaces in the world. London is the second most globally connected technology ecosystem, behind Silicon Valley in the United States. British companies work to increase their efficiency and scale by means of: (i) expanding investments in training and capacity building for new professionals; and (ii) creating more robust and responsive links between cutting-edge research and market innovation.

Diversified AI applications have filtered down into all segments of the British economy, which has become a global reference in the techniques of finance, healthcare, communication, adaptive robotics, games, law, manufacturing and a multitude of digital services. The recently established company DeepMind, is a major example of this dynamism, gaining global recognition for its advances in machine learning techniques and creating algorithms which beat the world champion of Go – a strategy game which computers had previously been unable to master. DeepMind, which is currently part of the Alphabet conglomerate, shook the scientific world again in 2020 with the AlphaFold program, which enabled a giant leap forward in predicting protein structures. Its findings put biological and medical sciences on a higher level, as highlighted by *Nature*²⁶ magazine, showing how AI can produce profound impacts on people's lives, starting with vaccine development²⁷.

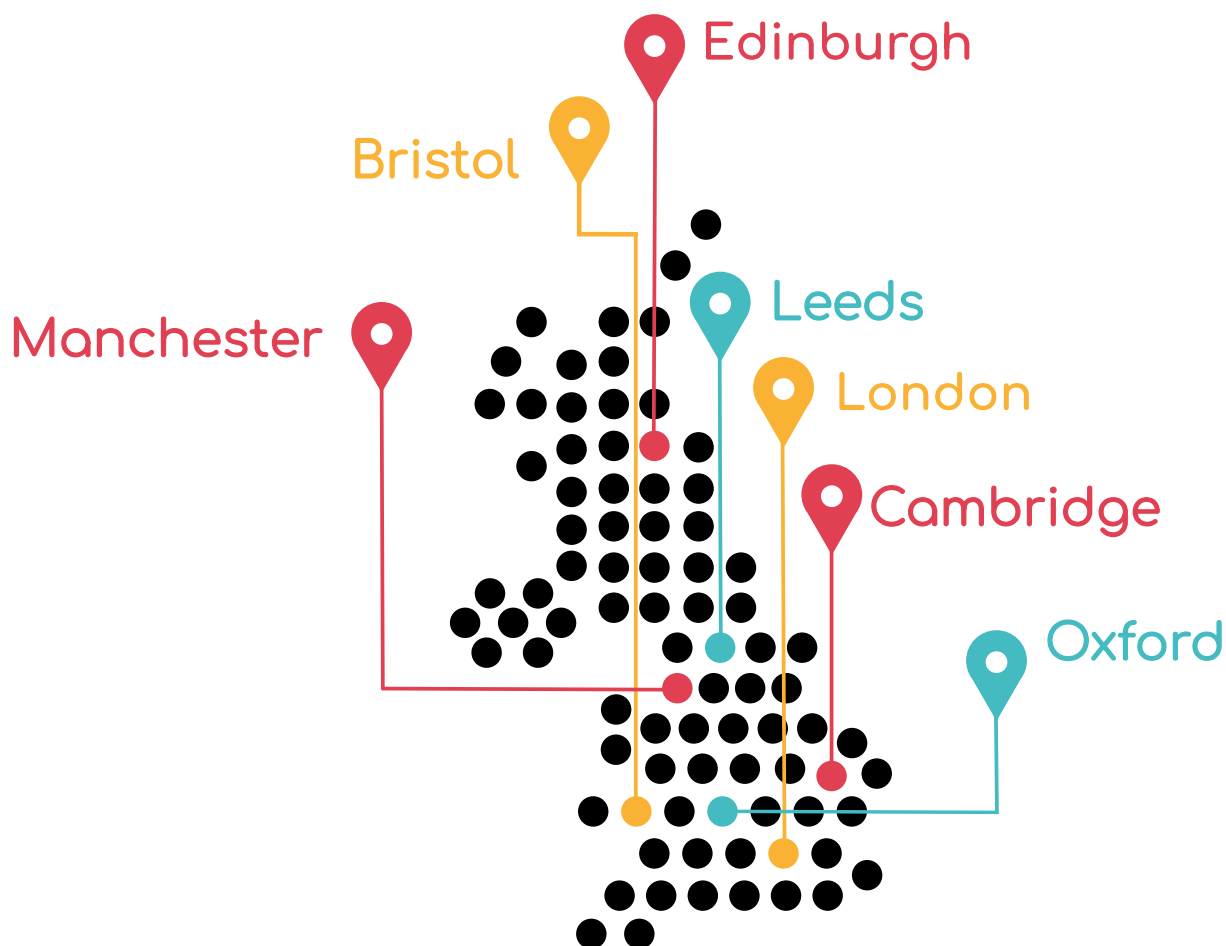
²⁵ Oxford Insights and the International Research Development Centre (2020). AI Readiness Index 2020.

²⁶ Ewen Callaway (2020). 'It will change everything': DeepMind's AI makes gigantic leap in solving protein structures. *Nature* 588, 203-204.

²⁷ In addition to DeepMind, companies such as Swiftkey and Babylon have also gained international prominence, as did startups such as Kwiziq, Cleo, and Mindtrace that operate in areas such as education, personal finance, and autonomous vehicles.

In addition to healthcare, numerous UK government reports identify other areas where AI is able to generate synergies and expand international collaboration, such as: (i) government, (ii) human resources, (iii) transport and infrastructure, (iv) security, (v) finance, (vi) marketing and advertising, (vii) entertainment, (viii) education and research, and (ix) law. In all these areas, the UK has important companies and research projects, encompassing such fields as robotics, visual computing, data intelligence, chatbots and natural language processing.

top AI research clusters in the UK



Notable among the advanced centres in the UK are:

- London: leading small and medium-sized startups centre in the UK with nearly 800 companies in AI.
- Cambridge: The University of Cambridge and the Anglia Ruskin University are global references in computer science and mathematics. The city houses the headquarters of The Samsung AI Centre Cambridge, Amazon's AI Development Centre, Microsoft and Apple R&D.
- Oxford: Oxford University is an advanced hub for AI research, particularly in machine learning and deep learning.
- Leeds: Data analysis models applied to the fields of healthcare, sports and advanced manufacturing highlight Leeds in the AI ecosystem.
- Edinburgh: The University of Edinburgh is a pioneer in AI and a global leader in natural language processing. The city houses the headquarters of the Amazon Development Center with a focus on machine learning.
- Manchester: home to about 1,500 AI and data science institutions. The University of Manchester is a partner of the Alan Turing Institute.
- Bristol: Bristol University is a global reference in Intelligent Systems and Robotics. The city is home to Oracle's Cloud Development Centre.

Brazil

In recent years, Brazil has sought to accelerate the adoption, implementation and development of AI with large scale national plans. The maturation of companies, the attention dedicated to digitization and AI, combined with a series of government initiatives have begun to produce preliminary results.

A University of Oxford (UK) evaluation of the preparedness and consistency of 194 governments concerning AI, placed Brazil in 40th position, reflecting its rapid emergence as a hub for business and AI research in Latin America.

This assessment is corroborated by the AI Index of Stanford University (USA), whose This evaluation is part of a general framework for the modernization of companies and the consumer market, which presents Brazil as the second largest user of social media (such as Facebook, Twitter, and YouTube, behind the USA), with over 200 million e-commerce and entertainment transactions per year and with 100 million regular internet users.

Among the most important points of support for research and business are the public universities, the network of government technological institutes (federal and state) and development funding institutions. Background research in AI, which adheres to international standards, is concentrated in federal and state public universities. There are currently 296 public institutions of higher education in Brazil and 2,152 private institutions of higher education. Of these, 106 are public universities and 93 are private universities²⁸.

Pursuant to OECD criteria²⁹, the ten major research institutions for AI in Brazil are:

- USP - University of Sao Paulo
- UNICAMP - University of Campinas
- UFMG - Federal University of Minas Gerais
- UNESP - Sao Paulo State University
- UFRGS - Federal University of Rio Grande do Sul
- UFRJ - Federal University of Rio de Janeiro
- UFSC - Federal University of Santa Catarina
- UFPE - Federal University of Pernambuco
- UFPR - Federal University of Paraná
- UnB - University of Brasília

Until the 1980s, Brazilians were not active participants in the leading international AI conferences (IJCAI, AAAI, ECAI), nor did Brazilian authors publish in the only and prestigious AI journal of the time, the Artificial Intelligence Journal (AIJ)³⁰. With the hosting of the first conference of the Brazilian Society of AI (SBIA)³¹, in 1984, the AI community in Brazil began

²⁸ Census of Higher Education in Brazil, MEC-INEP, 2019

²⁹ OECD. AI, Policy Observatory, 2020.

³⁰ In 2000, Alexandre Linhares and Fábio Cozman published the first articles by Brazilian authors in AIJ. Since then, about 4 to 5 articles by Brazilians are published each year in this important journal.

³¹ From 2012 on, it was called BRACIS – Brazilian Conference on Intelligent Systems.

to gain prominence. In the initial phase, from 1984 to 1994, material was published in Portuguese, with a local scope and a focus on symbolic AI, especially natural language processing and specialist systems. In the second phase, from 1995 to 2012, Brazilian researchers bridged the gap between symbolic AI and the currently dominant paradigm of production, connectionist AI, using neural networks with widely diversified architectures and a large data set. This period marked the internationalization of Brazilian scientific production. Since 2013, research has focused on connectionist AI, which has led Brazilian AI research to align itself with international scientific production.

Starting in 2018, the main AI centers in Brazil focused on machine learning techniques, which became the primary sub-section of AI research in Brazil.

The production of scientific articles by Brazilian and British researchers highlights the importance that AI gains each year. In the history of scientific publications, the United Kingdom is in third place, behind the United States and China. Brazil, with a contribution that grows every year, is currently ranked 15th.

The internationalization of research between Brazil and the United Kingdom has accelerated over the past five years. The UK has emerged as one of the major partners of Brazilian scientists who publish in journals of international reputation, particularly in sectors such as healthcare and agriculture. Between 2016 and 2020, Brazil published 2,683 scientific papers regarding AI, while the United Kingdom published 8,954, according to the *Elsevier Scopus* database.

According to data from the the OECD AI Observatory (2021), Brazil increased its contribution on AI in the healthcare field from 97 articles in 2016 to 164 in 2020. The UK, in turn, had 403 papers published in the same field in 2016, rising to 678 in 2020. In agriculture, where Brazil has a long tradition of research, the number of published papers jumped from 600 in 2016 to 750 in 2020, while in the United Kingdom, the numbers went from 368 to 515.³²

Scientific production resulting from cooperation between Brazilian and British researchers increased from 212 papers in 2016 to 401 in 2020.³³

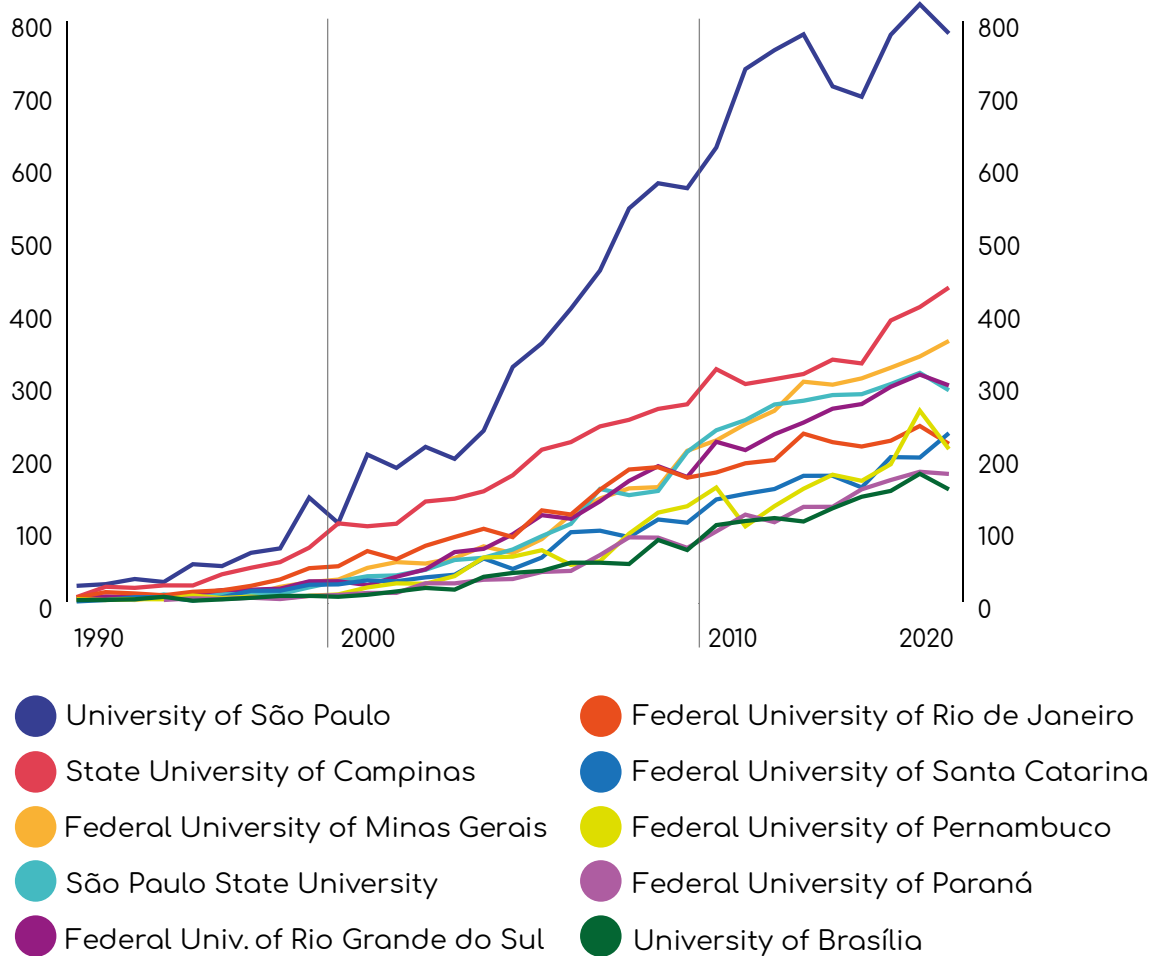
McKinsey Global Institute's *AI Readiness* synthesis indicator positions the UK in 8th and Brazil in 25th, which reinforces the effort to further improve the research environment and commercial applications, as well as stimulating the adoption and use of AI technologies.



³² OECD.AI (2021). Accessed on 2/13/2021

³³ OECD.AI (2021). Accessed on 2/13/2021

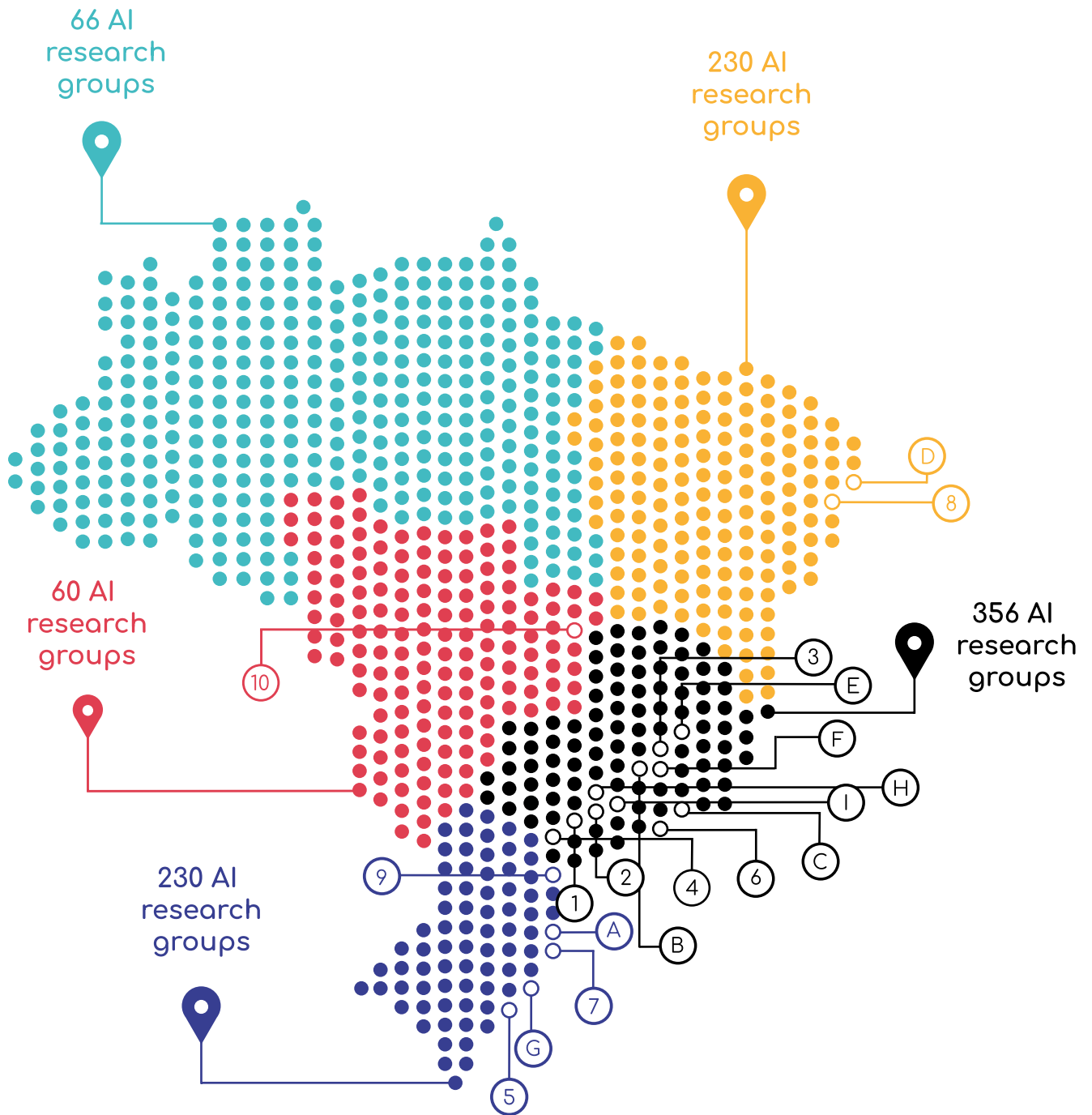
AI Production in Brazil by Institution (1990-2020)



Source of data: Microsoft Academic Graph. Please cite CIS: OECD.AI(2021), visualisations powered by JSI using data from MAG. version of 21/12/2020. Accessed on 28/2/2021, www.oecd.ai

In addition to the intensity of scientific production on AI and cooperative work, Brazil also seeks to make progress on issues related to ethics, transparency, and data protection, which have been addressed by specific and not always comprehensive regulations. Many companies that participated in the public consultation on AI, organized by MCTI, expressed an opinion that the regulation of AI should be sectoral and that the Brazilian legal framework is already sufficiently equipped to deal with possible adverse consequences arising from the use of intelligent systems.

Primary points to support the development of AI in Brazil

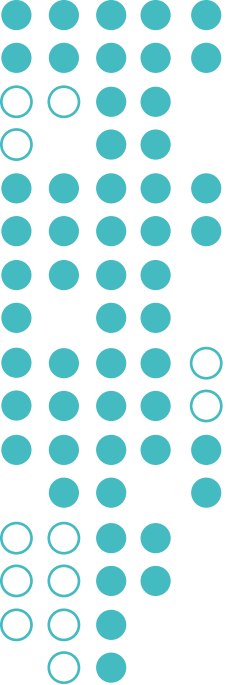


Top AI Research Institutions

1. University of São Paulo
2. University of Campinas
3. Federal University of Minas Gerais
4. Federal University of Rio Grande do Sul
5. São Paulo State University
6. Federal University of Rio de Janeiro
7. Federal University of Pernambuco
8. Federal University of Santa Catarina
9. Federal University of São Paulo
10. Federal University of São Carlos

Top Technology Parks in Brazil

- A. Sapiens Technology Park - Florianópolis
- B. Technology Park of São José dos Campos
- C. Technology Park of Rio de Janeiro
- D. Technology Park of Poigital - Recife
- E. Technology Park of San Pedro Valley - Belo Horizonte
- F. Technology Park of Vale da Eletrônica - Santana do Sapucaí
- G. TecnoPuc Technology Park - Porto Alegre
- H. CPqD Technology Park - Campinas

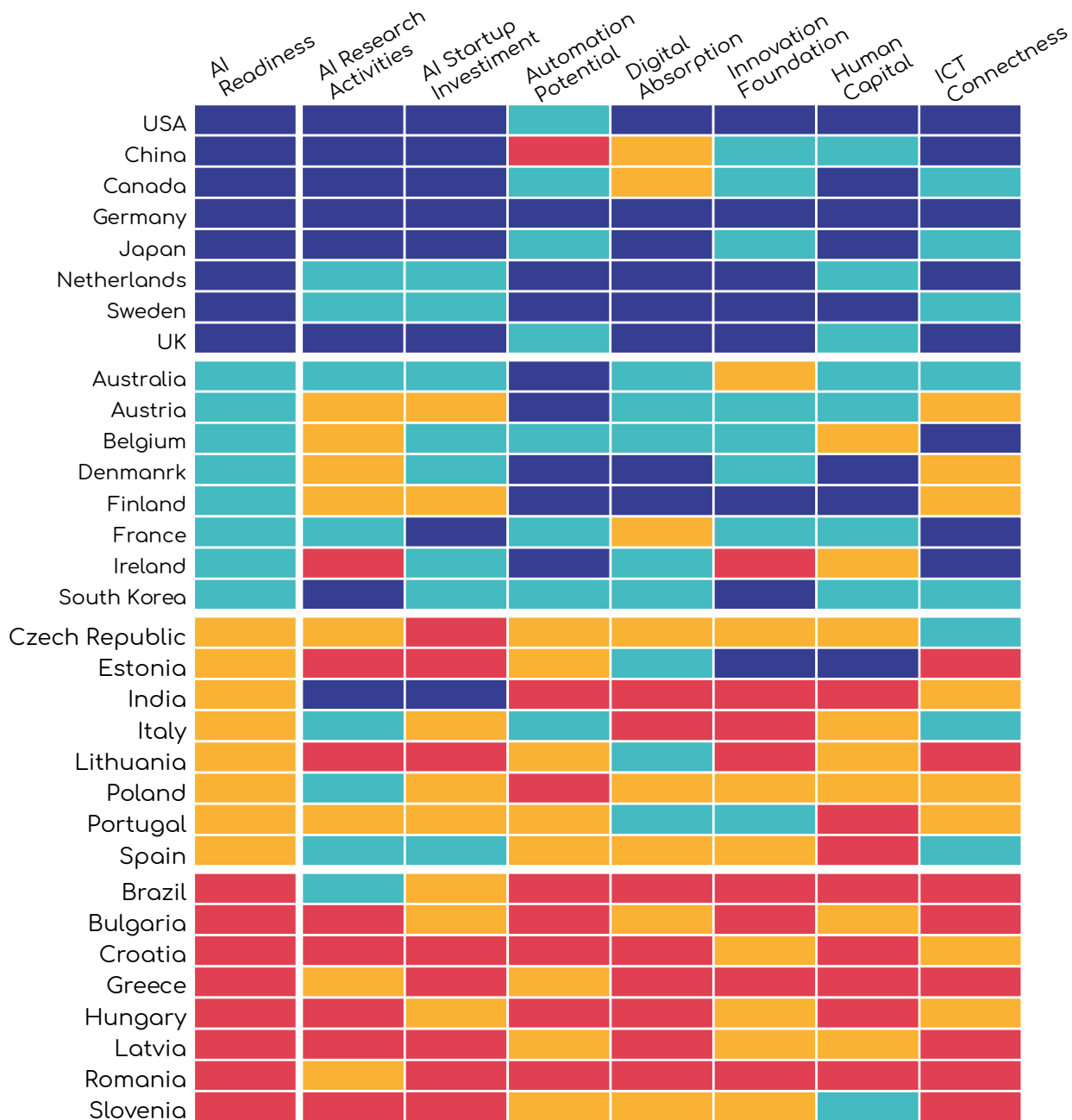


Concerns regarding the ethical implications of AI feature strongly in international debates and events. The adoption of the OECD Recommendation on AI has established a benchmark and parameters for the G20, in particular for the work of the Digital Economy Task Force, as well as for UN initiatives such as the *Secretary-General's Roadmap for Digital Cooperation* and the creation of UNESCO's recommendations on ethics and AI. This topic is also a point of emphasis for public and private sector agendas. Brazil, like the United Kingdom, is a signatory of the Principles defined by the OECD in 2019 that seek to ensure a transparent, reliable AI that respects human rights and democratic values. The OECD terms complement the existing standards for addressing issues related to privacy, digital security and responsible corporate conduct. Adherence to the OECD recommendations, although not a full guarantee, helps consolidate healthier AI ecosystems which are able to guide research and business with the responsibility and trust that society and humanity deserve³⁴.

The graph below is broader in scope and explains the degree of preparedness for the reception and development of AI in those countries which are at the top of the AI Readiness Index ranking. Classification takes into account topics such as research, automation potential, digitization, innovation, human capital and connectivity.

³⁴ Of the Principles, we select and adapt the following, by their importance: (i) AI should benefit people and the planet by boosting inclusive growth, sustainable development and well-being; (ii) AI systems should be designed in such a way as to respect the rule of law, human rights, democratic values, and diversity; (iii) There must be responsible transparency and disclosure regarding AI systems to ensure that people understand the results and are able to challenge them; (iv) Organizations and individuals that develop, employ, or operate AI systems should be held accountable for their proper functioning in accordance with the above mentioned principles.

AI Readiness Index



Fonte: McKinsey Global Institute Analysis



7.

AI in economics

AI in the economy

Research and applications of AI have advanced rapidly in a short period of time and have filtered down into all sectors of the economy and social life, with strong impacts on the way people work, study, and live in cities and rural areas. Competition between companies, climate and the environment, the pace of universities, hospital activity, healthcare and diagnostic centers, traffic, logistics, entertainment, energy, and communications drives profound transformations employing state-of-the-art technologies. The potential for expansion of AI is enormous, as can be seen from its development in some sectors and fields of activity.

healthcare

In healthcare, the Brazilian market is full of possibilities. Brazil's SUS - Unified Healthcare System - created the new Brazilian Constitution in 1988, is the only public healthcare system in the world that serves more than 190 million people and was inspired by the British National Health Service (NHS). SUS, like the NHS, provides full healthcare services free at the point of delivery. Every year, SUS conducts billions of outpatient procedures and more than 1 billion medical consultations nationwide.

The vast purchasing power and sheer volume of supplies needed to stock the network of ambulances, outpatient clinics, specialist clinics, healthcare centers and hospitals have given the Brazilian system its own peculiar characteristics, which require a network of diversified suppliers whose demand for computerization and technology is increasing, as shown by advances in the area of patient diagnosis and in the performance of procedures supported by AI algorithms.

Like Brazil, the United Kingdom has a public healthcare system, with a mass of data that increasingly deserves attention from technology for decision-making."
- Luís Lamb, Secretary of Innovation, Science, and Technology of Rio Grande do Sul

financial and legal sectors

In the Brazilian financial system, all major Brazilian banks have their own virtual assistants, such as Bia from Bradesco, Avi from Itaú, Babi from Inter, and Din from the Banco Central. Data from Bradesco indicates that Bia has a resolution rate of 95% of demands. The growth of virtual banking in Brazil has been meteoric and has allowed banks to lower the cost of services for millions of users, increasing competition between specialized institutions.

In the legal sector, the use of AI resources is expanding, enabling an increase in the productivity of courts at all levels, essential for the judiciary of a country that has a backlog of 78 million lawsuits. The fields of application extend from data integration, caseload centralization and policy integration all the way to decision-making. A study by Columbia University has identified that there are several experiments currently underway in Brazil, such as the Victor system (in the Supreme

Court), the Socrates system (in the Superior Court of Justice) and in several state courts. Despite these advances, as the study notes, there are enormous challenges, particularly in terms of governance and the scale of tools and their suitability to the courts. In addition to this expansion, the legal universe offers a huge range of data, fields, and situations in which³⁵ AI applications can develop. Law firms (such as Deep Legal, Finch Solutions, Juristec+, Legal Insights) develop AI applications to organize documents, monitor court movements, track deadlines and appointments, and for mapping and developing litigation strategies. It is a huge market for the so-called legal techs or law techs, both in Brazil and in the UK.

“UK AI companies will look for market, ease of doing business, and growth opportunities. In Brazil there is a large market, and it can also be the gateway to doing business across the broader LatAm region”. - Chris Moore, Department for International Trade, UK. Technology Specialist

mining

The mining sector has also proven to be a fertile field for the advancement of AI. Given the inherent risks and insecurity of mining processes, automation and emerging techniques in machine learning and data analysis, offer potential to significantly improve safeguarding of lives and communities. In mining, the most important goal of AI research is to increase productivity and determine more sustainable ways of harnessing increasingly scarce mineral reserves located in remote and deep regions. Vale, Brazil's largest mining company and one of the largest in the world, began a process of digital transformation five years ago, with investments of US\$500 million to move towards a 4.0 industry. An Integrated Operations Center was established in Minas Gerais with the objective of integrating the production chain and the different business areas through digital technologies. On an experimental basis, gigantic fully autonomous trucks are already in operation to increase mining safety and productivity, reducing the risks caused by detonations, landslides, vibrations, noise at high levels, handling of heavy loads and the use of toxic materials. Research is now focused on improving remote rock detonation systems, online control of the movement of equipment and workers, drones that can perform geophysical surveys of the ground, sensors integrated with video software, data analysis for monitoring dams, and AI platforms that analyze ore content in real time.

The demand for AI is so strong that since 2018, a microsystem of innovation, a mining hub, supported by 25 mining companies, has been in operation researching renewable energy mechanisms, water management, waste, security and social development issues. Brazil's major mining companies operate with technological resources similar to those of global corporations. Many of those global companies - Anglo American, BHP Billiton - have operated in Brazil for decades and apply dam,

³⁵ National Council of Justice and the Institute of Technology and Society of Rio de Janeiro (2020). Andris Corrêa D'Almeida (advisor), "The Future of AI in the Brazilian Judicial System. NYC: SIPA, Columbia University.

waste and risk monitoring technology, as well as advanced research centers, such as the Hazard Centre in University College London. Even non-profit organizations (such as InSar) have developed highly sophisticated dam displacement measurement systems.

agriculture, food security, and the sustainability of the planet

Agribusiness represents about 25% of Brazilian GDP and 50% of Brazil's export volume. This sector's entrepreneurs, investors and government regulators are obliged to constantly identify technological trends capable of maintaining the enormous competitiveness of Brazilian agriculture.

Brazil produces about 250 million tons of grains each year that helps feed much of the world's population. It produces more than 400 products of animal and plant origin, with many different scales and sizes of production units, which are consumed internally and exported to more than 150 countries across all continents. The effects of this competence provide more affordable food for all populations, raise incomes and create jobs.

A study by the Brazilian Agricultural Research Company (Embrapa) identified megatrends for agribusiness over the next ten years, with a preponderance of digital technologies and AI. Topics such as changes in crop-livestock-forest integration, agroforestry, organic agriculture, biological nitrogen fixation, pasture recovery, forest management, irrigation optimization, biological control of pests and diseases and waste recycling require digital techniques to achieve success, especially regarding climate change, re-spatialization, risk management and productivity.³⁶

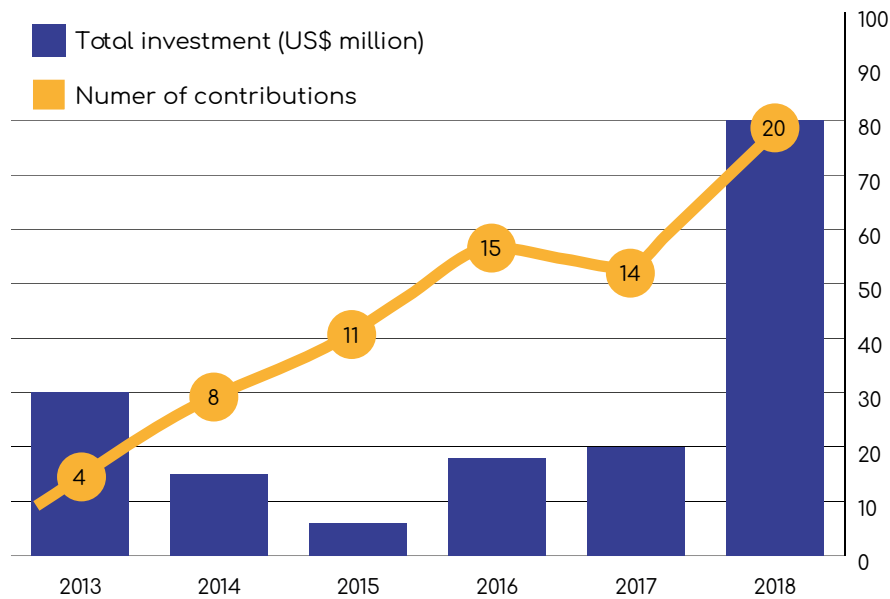
Brazilian agriculture has become a powerful global food production machine. Brazil is the world's second largest producer of food and all its agriculture is technology intensive, from planting techniques to irrigation, soil analysis, pest control, and seed improvement. Growing demands will further boost the production of agroenergy (biofuels and biogas) and wind and solar energy in the rural environment. By replacing fossil fuel sources, renewable energies will be linked to agricultural intensification and will be able to amplify regional employment and income opportunities.³⁷

Genetic improvement, biotechnology and bioinformatics are major points of emphasis in universities and agribusinesses. With the application of AI, Brazil has expanded and exhibited to the world advanced techniques of precision agriculture, logistics and storage. For decades Brazil has been providing a fertile field for innovation in agriculture. In 2019 alone, more than 1,125 startups were registered that develop state-of-the-art technologies for their client farmers and many are AI-

³⁶ Embrapa (2020). "Visão 2030: o futuro da agricultura brasileira". Brasília.

³⁷ O Brasil conta com um total de 236.879 hectares de terras agrícolas. Ver: <https://data.oecd.org/agrland/agricultural-land.htm>

Investments in AGTech startups in Brazil



Source: Radar AgTech

intensive, according to data from Radar AgTech (Embrapa), the largest mapping of the Brazilian ecosystem.

“AI has proven to be a strong ally to increase agribusiness productivity and sustainability. With AI, Brazil will contribute to increase by 70% the productivity of the major agricultural crops by 2050 and to increase the amount of organic carbon in agricultural soils and consequently reduce the global level of carbon dioxide concentration.” - Fábio Angelis, CEO of Agrorobotics

Agriculture is an area of strong intersection with the UK, where cooperation can be intensified with positive results for productivity and combating the effects of climate change. The reduction of greenhouse gas emissions, the reduction of deforestation rates, the increase of areas with intensive low-carbon agricultural systems and the recovery of degraded areas will be essential in the process of increasing the value of global agriculture.

The challenges of Brazilian agriculture offer particular potential for collaboration between universities, companies and governments. The emergence of new agritech companies is essential for the reason that the specific weight of Brazilian agriculture can model the agriculture of the future and its transformative effect for all countries. Given the projected population growth and expansion of global life expectancy³⁸, the challenge of meeting the demand for increased consumption of food, fiber and energy of more than 2 billion additional people on the planet by 2030 will require the application of technology and strong international cooperation. Vulnerabilities and uncertainties will not allow large agriculture sectors to think only of larger production volumes. It will be mandatory to

³⁸ A expectativa de vida é de 75.7 anos no Brasil e de 81.3 anos no Reino Unido (OECD). <https://data.oecd.org/brazil.htm> & <https://data.oecd.org/united-kingdom.htm> “Visão 2030: o futuro da agricultura brasileira”. Brasília.

produce with higher quality and lower cost, in an undegraded environment. These challenges will not be solved by the efforts of a single country.

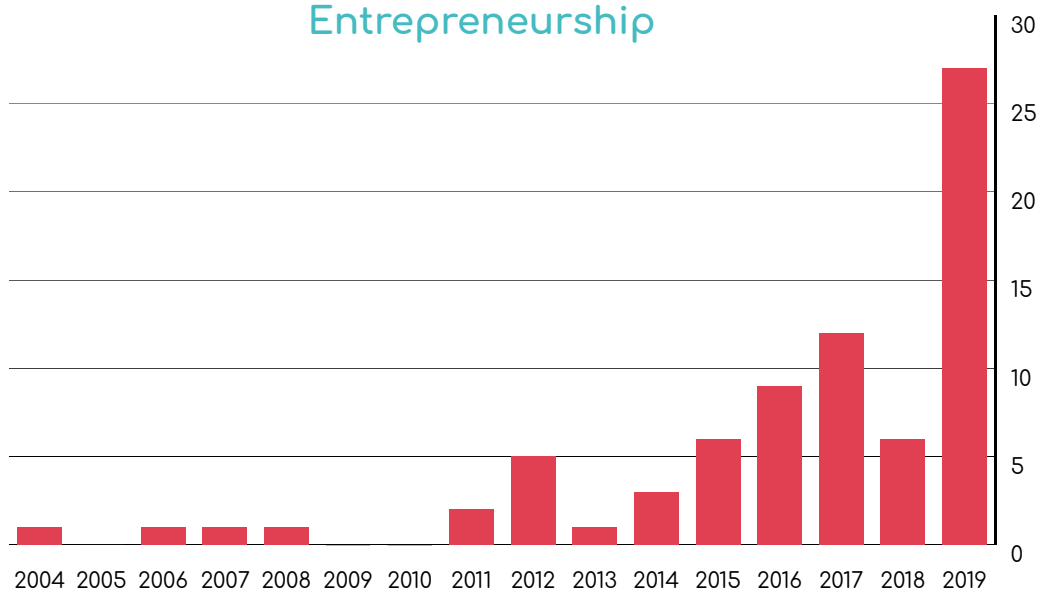
Embrapa's "Vision 2030: the future of Brazilian agriculture", studied megatrends for agribusiness over the next ten years. The study raises issues such as climate, spatial and socioeconomic changes, the need to add value to production chains to please the increasingly demanding consumer and good management to reduce the risks that generate annual losses of R\$ 11 billion – equivalent to 1% of the GDP of national agriculture.

This research highlights the importance of knowledge and the implementation of technological strategies in this sector. These needs were confirmed by another Embrapa study in partnership with the Sebrae, which interviewed 753 farmers regarding technology and agribusiness. About 84% of the farmers responded that they already use at least one technology in their production process; 70% use the internet and technology in activities related to farm production and 57.5% use social media to disseminate data or advertise products. The use of technology is the starting point to achieve the goal of digitizing agribusiness by 2030.

startups ecosystem

The existence of a dynamic startup ecosystem strongly contributes to sustained innovation, brings dynamism and efficiency to the productivity of industrial sectors, facilitates the dissemination of knowledge and generates greater opportunities for quality jobs. The interest of authorities, managers and legislators in encouraging entrepreneurship grows every year, as can be seen by the number of legislative bills to encourage entrepreneurship.

Legislative Bills Supporting Technological Entrepreneurship



Source: Felipe Matos and Vanderleia Radaelli (2020). "Startup ecosystem in Brazil". Brasília: Inter-american Development Bank, IDB.

A survey by the Getúlio Vargas Foundation indicated that Information Technologies receive the most investment and participation of the nearly 100 accelerator institutions across Brazil. Among the largest cities that host startups, São Paulo is the most prominent, followed by Florianópolis, Belo Horizonte, Rio de Janeiro, and Curitiba³⁹.

Data from Dealbook.co, a platform that collates investment information in the startups system in Brazil, show that as of 2020, 226 venture capital investors and entrepreneurship-focused equity funds such as Monashees, Kaszek, Redpoint, eBricks, Canary, Insight Ventures, Rocket Internet, Flybridge and Qualcomm were in operation.

In Brazil, angel investment has nearly doubled in five years, approaching more than US\$ 200 million in 2018 (Anjos do Brasil). According to data from the Kauffman Foundation, Brazil had about 300,000 angel investors in 2018, many of which are grouped into associations such as Anjos do Brasil, Gávea Angels, Latin American Angels Society, Harvard Angels, MIT Angels and others – among all Latin American countries, Brazil receives the most venture capital investments.

In recent years, large national and multinational companies have begun to build innovation hubs to support and strengthen contacts with young entrepreneurs. The most significant examples are the Cubo Space (Banco Itaú), Campus São Paulo (Google), InovaBra Habitat (Bradesco), District (Bosch), Pulse (Raizen), Onovolab (Ello) and Idexo (Totvs).

According to the Inter-American Development Bank (IDB), universities most active in supporting entrepreneurship are USP, followed by Unicamp, PUC-Rio de Janeiro, the Federal University of São Carlos, the Federal University of Ceará, and the Federal University of Minas Gerais.

The startup ecosystem has grown substantially in recent years, with the multiplication of support initiatives, available capital, the dissemination of entrepreneurial culture and the jump in the creation of unicorns. There is much to be done, starting with the improvement of the regulatory framework and the strengthening of initiatives for the education of a new digitally-savvy generation. The challenges are great, but the potential is immense and worthwhile.

The clearest illustration of this dynamic is seen in the rapid emergence of a large number of companies which are active in AI, as recorded in the survey conducted by District in partnership with KPMG (2020)⁴⁰.

According to that report, Brazil currently has 702 AI startups, the state of São Paulo alone hosts 51.9% of these companies. The Southeast region of Brazil accounts for 70.2% of startups, followed by the South (22.5%), Northeast (3.7%), Midwest (3.2%) and North (0.3%) regions. Of these startups, 479 develop solutions for specific industrial sectors and 223 have intersectoral operations. Health and Human Resources are

³⁹ Felipe Matos e Vanderleia Radaelli (2020). "Ecossistema de Startups no Brasil". Brasília: Banco Interamericano de Desenvolvimento, BID.

⁴⁰ District & KPMG . (2021). "Report 2021 -Artificial Intelligence". Andm: https://d335luupugsy2.cloudfront.net/cms%2Ffiles%2F65883%2F1612818997AI_Report-v6.pdf

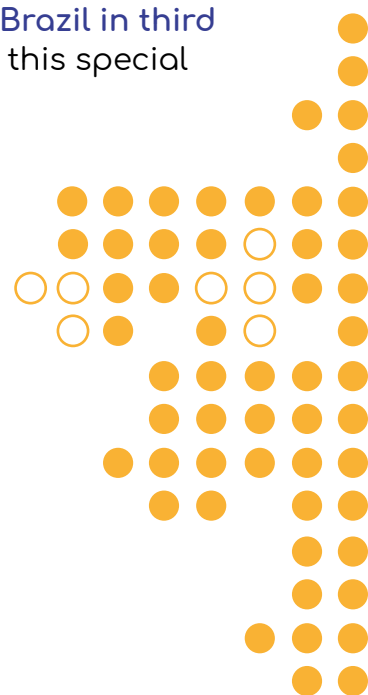
focal points of greater concentration for solutions, and Agriculture accounts for about 10% of the business. This mapping identified that 34% of startups offer AI services and 30.9% focus on analytics, data management and marketing. Chatbots are the specialties of 19.3% of startups and behavior prediction accounts for about 6.3%. The study also revealed that over the past 8 years, these startups have absorbed venture capital investments of the order of \$2.87 billion by 2020.

Brazil is currently ranked 17th in the number of startups dedicated exclusively to AI.⁴¹

Until 2019, despite the growth in the number of companies focused on AI, the Brazilian ecosystem had not yet registered startups with accelerated growth and exponential value appreciation. Although results vary due to different measurement methodologies, 2019 generated, for the first time, five companies with the title of unicorns - startups with market value above US\$ 1 billion. By 2020, that number had jumped to 16. According to CB Insights (2020), of the 449 unicorns in the world, 50% are in the United States and 25% in China.


From 2020, the world map of unicorns changed with the inclusion of Brazil in third position, alongside Germany when accounting for the growth rate of this special type of startup⁴².

In addition to an ecosystem that is constantly improving to better accommodate nascent companies, it is also important to note that Brazil has technology companies of the first magnitude. In addition to large global corporations with headquarters and operations in country, world-class Brazilian companies such as Totvs and Stefanini operate in an environment full of small companies and startups with significant growth and technological ambition.



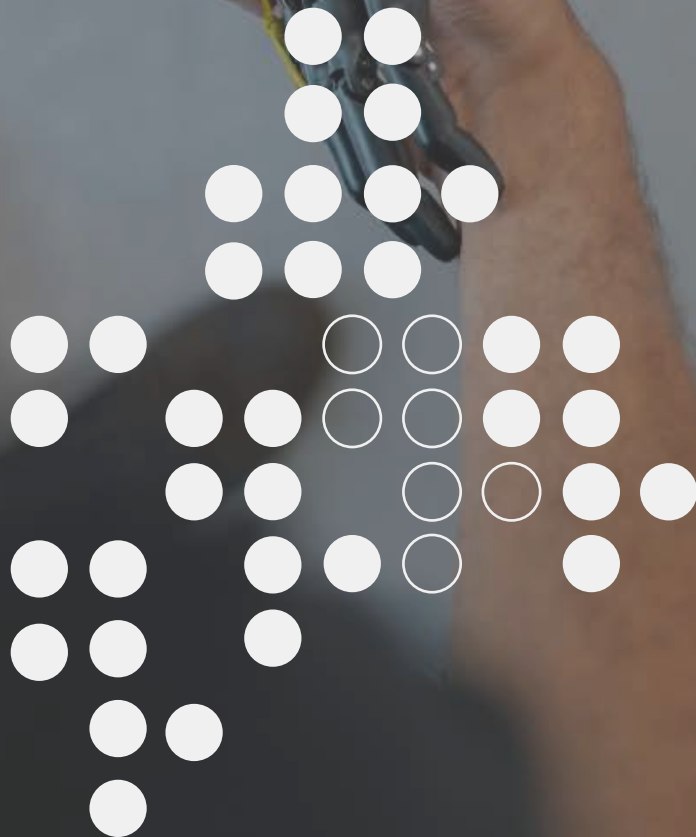
⁴¹ Cf. Asgard e Roland Berger (2019). "A Strategy for European AI Startups". Nesse mesmo estudo, o ecossistema do Reino Unido é avaliado como o mais forte de toda a Europa, seguido da Alemanha, França e Espanha.

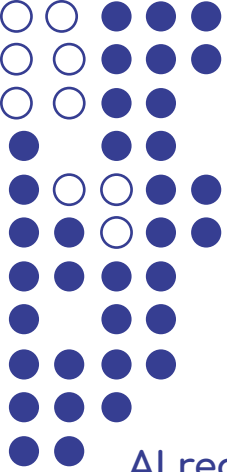
⁴² The Brazilian Unicorns as of January 2021 are: 99 (transport), Arco Educação (Education), C6 Bank (digital bank), Creditas (Crissaid), Ebanx (International Payments), Gympass (Activities Físicas), iFood (Logística), Loft (Real EstateMarket), Loggi (Logística), Madeira Madeira (Comércio), Nubank (Finanças), PagSeguro (Payments), Quinto Andar (Real estate), StonePagamentos (Finanças), Wildlife (Games), Vtex (Cloud).



8.

UK-BR: ways to intensify cooperation





This report has identified a range of points of contact, cooperation, learning and complementarity, and exposed the enormous extant potential to raise the level of AI cooperation between the UK and Brazil, particularly in the following areas:

AI regulation and governance

The United Kingdom and Brazil face a vast field of activity in the creation and improvement of guidelines, regulations and standards for the development and use of AI. The presence and active participation of its representatives in multilateral forums such as the OECD and GPAI help to strengthen the sharing of objectives and values, as well as encouraging joint research in AI.

academic cooperation

Academics from leading universities and research institutes in the UK and Brazil have collaborated for many years. The expansion of dedicated AI reference centers in Brazil provides increased scope to mobilise our shared expertise to solve complex problems facing companies, governments and civil society. The exchange of students and researchers and the multiplication of institutional cooperation agreements can be enhanced through programs such as the Turing Scheme in the United Kingdom and SPRINT in Brazil⁴³.

The new generation of Innovation-Oriented AI centers in Brazil, inspired by the experience of the Digital Catapult and the Alan Turing Institute, will prioritize international cooperation and joint work with private companies. The partnerships between these centres will be a valuable point of support for UK entrepreneurs to identify partners and investors.

The UK and Brazil have shared priorities for advancing applications of AI, especially in the areas of healthcare, environment and biodiversity, sustainability and clean growth, finance and education.

⁴³ <https://www.turing-scheme.org.uk/>

business opportunities

Brazil and the United Kingdom offer an attractive set of possibilities for growth and investment in technology companies. In addition to the continental dimensions of its market, Brazil is a reference country that remains the major gateway to the Latin American market, comprising more than 620 million people. Brazil is also a country with a stable legal and economic structure, which concentrates business expertise as a hub of global corporations, export-import trading companies, international consultancies, logistics specialists, investment funds, manufacturing, and service companies, all of which have been operating in the country for decades.

The receptivity of Brazilian users to new technologies is enormous. The strength of the internet, the flow of information, digital media, and the receptivity to chatbots form a set of assets that are not easily found in other countries. The financial and services sectors, agriculture and extractives offer particular opportunities for tech companies.

The range of incentives, programs and tools available to support companies and startups in both countries provides a welcoming and safe environment for AI investment. Not only because of the technological appeal, but also because both national systems of innovation are constantly improving and seeking to consolidate an institutional network of support and policies friendly to business and AI research.



acknowledgement

This report was made possible by the collaboration of Cindy Parker and Cristina Hori of the UK Embassy in Brazil and Luciana Mancini of the Brazilian Ministry of Foreign Affairs. The authors of this report would also like to thank the interviewed government authorities, professors, corporate representatives and other persons from Brazil and the United Kingdom for their valuable contributions.

Carlos Américo Pacheco - FAPESP - São Paulo State Research Support Foundation - CEO of the Technical-Administrative Council

Carlos Eduardo Pereira Embrapii - Brazilian Industrial Research and Innovation Company - Operations Director

Chris Moore (Dr) Department for International Trade, United Kingdom - Technology Specialist

Fábio Angelis - Agrorobotics - CEO

Fernando Martins (Dr.) - Intel Brazil (Former CEO)

Francesca Garcia - Digital Catapult, United Kingdom - Policy and Research Manager

Gianna Sagazio - CNI - National Confederation of Industry - Director of Innovation and executive coordinator of MEI - Business Mobilization for Innovation

Henrique Padial Ferri Holzhausen - Libbs - CIO

Jorge Almeida Guimarães - Embrapii - Brazilian Industrial Research and Innovation Company - President

José Gustavo Sampaio Gontijo - MCTI - Ministry of Science, Technology and Innovation - Director of the Department of Science, Technology and Digital Innovation

José Ricardo Roriz Coelho- FIESP - Federation of Industries of the State of São Paulo - Vice president

Luís Lamb - Secretariat of Innovation, Science and Technology of Rio Grande do Sul - State Secretary

Marcia Martini Bueno - Libbs - Director of Institutional Relations

Marcos Vinicius Souza - Secretariat of Economic Development of the State of São Paulo - Undersecretary of Science, Technology and Innovation

Newton Hamatsu - FINEP - Innovation and Research Funder - Superintendent of Innovation

Paulo César Rezende De Carvalho Alvim - MCTI - Ministry of Science, Technology and Innovation - Secretary of Entrepreneurship and Innovation

Rosa Maria Vicari - Full professor at the Institute of Informatics (INF) of the Federal University of Rio Grande do Sul (UFRGS) - Coordinator of the UNESCO Chair in Information and Communication Technologies in Education

research team

Glauco Arbix (Coordenador)

Professor Titular de Sociologia da Universidade de São Paulo (USP) e pesquisador do CEBRAP. Coordenador do Observatório de Inovação do Instituto de Estudos Avançados (USP) e da área de Humanidades do Center for Artificial Intelligence-USP-FAPESP-IBM (C4AI). Foi presidente do Instituto de Pesquisa Econômica Aplicada (IPEA) e da Agência Brasileira de Inovação (FINEP).

Fábio Gagliardi Cozman

Professor Titular da Escola Politécnica da USP e Diretor do Center for Artificial Intelligence-USP-FAPESP-IBM. Foi Chair da Conference on Uncertainty in AI e Area Chair da International Joint Conference on AI. Foi editor associado dos periódicos Artificial Intelligence, Journal of Artificial Intelligence Research e Journal of Approximate Reasoning. Foi coordenador do Comitê Especial em IA da Sociedade Brasileira de Computação, da qual recebeu o Prêmio de Mérito Científico em IA.

Marcelo Finger

Professor Titular de Ciência da Computação do Instituto de Matemática e Estatística da USP. PhD pelo Imperial College (London). Coordenador da área de Natural Language Processing do Center for Artificial Intelligence-USP-FAPESP-IBM. Editor do The Scientific World Journal e do Sao Paulo Journal of Mathematical Sciences. Foi premiado com a Armstrong Prize and Medal (1994) e Jabuti Prize (2007).

Rodrigo Brandão

Doutorando em Sociologia na USP e pesquisador do Center for Artificial Intelligence-USP-FAPESP-IBM. Foi especialista em relações institucionais na Companhia Siderúrgica Nacional (CSN) e coordenador-assistente de estudos e debates da Fundação Fernando Henrique Cardoso.

Hugo Neri Munhoz

Pesquisador do Center for Artificial Intelligence-USP-FAPESP-IBM e pós-doutorando no Departamento de Engenharia Mecatrônica e Sistemas Mecânicos da Escola Politécnica da USP. Professor visitante no departamento de Sociologia da Innsbruck Universität (Áustria) e membro do Editorial Board do The American Sociologist Journal.

Laura Simões Camargo

Graduanda de Ciências Sociais na USP e pesquisadora do CEBRAP



GREAT *for* **PARTNERSHIP**
BRITAIN & NORTHERN IRELAND

MINISTRY OF
FOREIGN AFFAIRS



PÁTRIA AMADA
BRASIL
BRAZILIAN GOVERNMENT



CEBRAP

centro brasileiro de análise e planejamento



**Center for
Artificial
Intelligence**

