PROLOGUE

Ingenuity and the entrepreneurial spirit have always driven mankind to seek improvement and to resolve problems as they arise. During the twentieth century, human intelligence enabled the development of technologies that opened up new horizons in our economic and social systems, fostering extraordinary advances in science, industry and services, in resource allocation, public management, governance and the welfare state.

One such technology is that of artificial intelligence (AI), which has impacted all areas of activity, throughout the world, catalysing research and innovation, and making the generation, storage and processing of 'Big Data' an economic sector in itself in the new scenario of digital and technological development. In consequence, a dramatic transformation is taking place in many sectors, including environmental protection; energy; industry; tourism; transport; mobility and logistics; food production; banking and insurance; retail commerce; construction; creative and cultural industries; and vital strategic sectors such as health, education and national security.

The Spanish Government is resolved to promote the development of AI and its integration into the productive fabric, the economy and society. This public leadership will play a crucial role in ensuring that technological development is always for the public benefit, helping safeguard our values and rights and the welfare state. Appropriate action in health, education, justice and social welfare, together with the provision of an effective system of public benefits, are fundamental to the national good and a hallmark of Spain's identity. Building on basic research and innovation, and using the results obtained to modernise our productive fabric, underpin key areas of public activity and enhance digital skills training programmes, AI can be an important vector of economic growth, creating a virtuous cycle of action and reaction between technology and our political, social, economic and industrial systems.

With the growing presence of AI throughout the productive economy, the inclusion of women at all levels of skills training, production, science and technology is an issue of the utmost importance. Technological advances must be employed as a means of eliminating the many gaps still apparent in our country, according to gender, age, urban vs. rural living, financial means and education.

The central question underlying the development and spread of AI is that of the ethical dimension. The widespread use and management of data through the application of algorithms and autonomous systems has multiple ethical and moral implications. In consequence, appropriate processes and control mechanisms must be employed to protect our values, principles and rights. Among other initiatives, the present Strategy includes the development of a Digital Rights Charter and the creation of mechanisms to supervise the ethics of AI, in order to facilitate consensus on a suitable framework for this technological development.

This National Strategy is not proposed as a definitive, closed document, of a merely administrative nature, but rather as a dynamic and flexible framework, open to contributions from the business world, the general population, social agents and other public administrations. The Government has undertaken this project from an inclusive perspective, seeking to integrate all elements of society, and thus achieve an inclusive, sustainable economy. It is also a shared commitment with our European partners, aimed at helping the EU become a leader in the deployment of inclusive, ethical, reliable and economically efficient AI.

Spain has made great progress and is well placed to become a leading voice, in Europe and throughout the world, in innovation and technological development. Its tightly-woven infrastructure, the leading role played in the rollout of 5G technology (crucial for big data development), the strength of the university system and capabilities in key areas such as high-performance computing, cybersecurity, AI itself and other digital-enabling technologies, provide a solid basis with which to address intense digitalisation and technological disruption.

These factors, together, represent a magnificent opportunity for us to put the digital transition into practice, focusing public actions on people's needs and interests, ensuring that none are left behind and safeguarding the fundamental rights and values on which European societies are based.

Pedro Sánchez Castejón
PRESIDENT OF THE GOVERNMENT
November 2020

INTRODUCTION

INTRODUCTION

WHAT IS ARTIFICIAL INTELLIGENCE?

Just as human intelligence is hard to define, no formal, universally-accepted definition has yet been established for Artificial Intelligence (AI). The European Commission recently proposed the following: "Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions."[1]

Although AI first appeared as an academic discipline in 1956, it subsequently underwent various cycles in which periods of high expectation alternated with others when less attention was paid to this topic. Initial systems were based on human programming and pre-set decision-making processes, but the recent conjunction of several crucial factors has produced an exponential leap in the capabilities and influence of AI, which is now expanding irreversibly within economic and social structures, via autonomous systems that are capable both of learning and of setting their own programmes for action, through the analysis of large volumes of data. In this respect, significant enabling factors include:

- **The enormous growth in the amount of data available**

- **Advances in the power and capacity of computing and storage systems.**

- **Successful research and development of new algorithms and machine learning methods.**

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[1] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118163/jrc118163_ai_watch._defining_artificial_intelligence_1.pdf

The great potential of AI rests in the fact that many such systems are able to solve complex problems, through the application of advanced programming techniques, without prior knowledge of the steps required and without receiving specific instructions, unlike conventional computer programs. Inputs to AI systems may take many forms (for example, cases or examples), and from these the system adjusts its internal models until a solution to the problem is found.

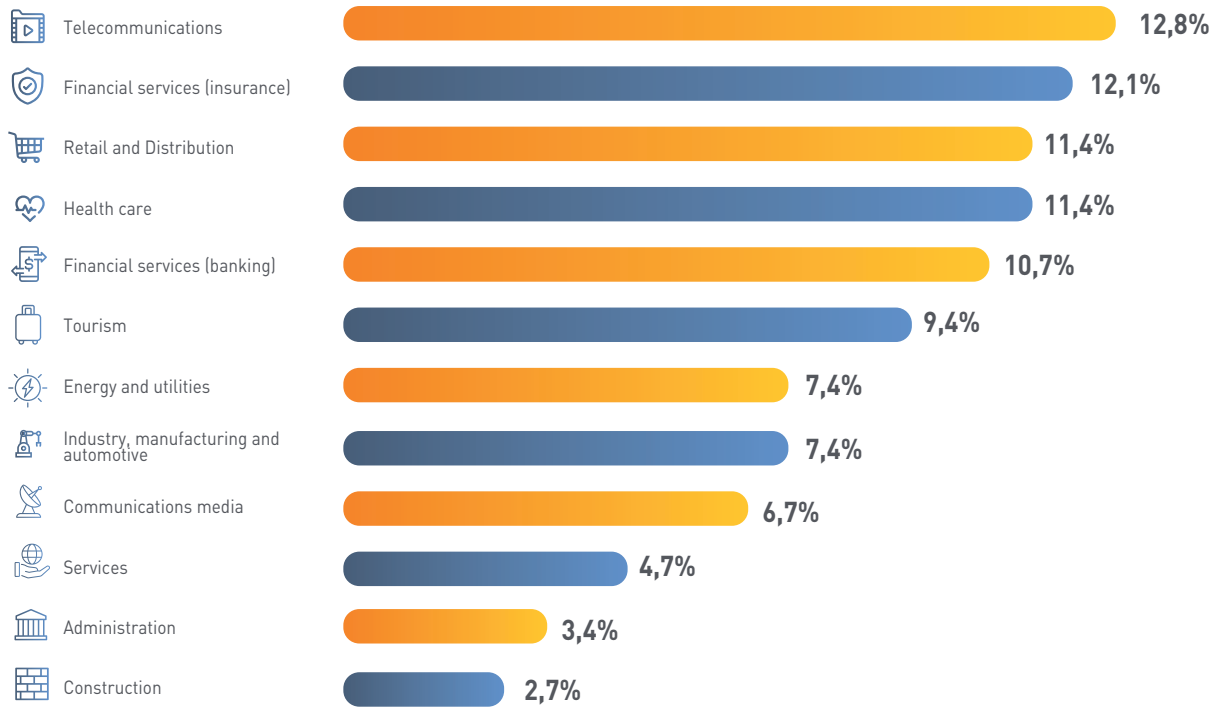## AREAS IN WHICH AI IS CURRENTLY BEING APPLIED

In addition to its presence in daily activities (Internet search engines, personal assistants, household appliances, e-commerce recommendations, the robotisation of computer or physical processes, etc.), as well as in multidisciplinary areas of research, AI has great potential in many areas of professional activity and of services: in health care, helping design new drugs, reducing production times and costs, preventing diagnostic errors, enhancing the prevention of common diseases and enabling personalised treatment; in the materials industries, creating new biomaterials for engineering applications, raising business productivity, streamlining administration, optimising resources, automating processes and facilitating the prediction of demand; in the financial sphere, making risk management systems more efficient; in education, facilitating the adaptation of learning to personal needs; in transport, mobility and logistics, improving management, efficiency and security; in terms of environmental impact, improving the management of energy networks and the thermal efficiency of buildings, mitigating the effects of climate change and predicting weather and climate patterns, among other applications. Moreover, in recent months, AI has played an important role in the response made to the COVID-19 pandemic, as described in Annex 2.

In short, AI has great transformative potential, from technological, economic, environmental and social standpoints, thanks to its intersectoral penetration, powerful impact, rapid growth and important contribution to improved competitiveness.

SECTORS WITH THE GREATEST EXPECTED AI IMPACT IN THE SHORT/MEDIUM TERM

Sector	Value
Telecommunications	12,8%
Financial services (insurance)	12,1%
Retail and Distribution	11,4%
Health care	11,4%
Financial services (banking)	10,7%
Tourism	9,4%
Energy and utilities	7,4%
Industry, manufacturing and automotive	7,4%
Communications media	6,7%
Services	4,7%
Administration	3,4%
Construction	2,7%

Source: AI in Spain: Current reality and perspectives (Realidad y perspectivas de la IA en España) (PWC & Microsoft, 2018)

CURRENT SITUATION OF AI IN SPAIN

Spain is favourably placed to address this technological and scienti(c revolution. It has the necessary high-quality infrastructure for the development and application of AI-related activities, having invested heavily in information and communication technologies (ICTs) and infrastructure, such as high-performance computing facilities capable of processing massive volumes of data. AAdvances in AI are further driven by the existence of excellent public and private R&D&I groups, the steady progress achieved in the digitalisation of government administration and Spanish corporate presence in key sectors (such as telecommunications, retail trade, distribution, health, mobility, construction, financial services, tourism and agri-food). The joint impact of these factors provides a solid foundation for the integration and rollout of AI in our country.

However, this process also poses significant challenges, including the need to:

- **Increase** the digital skills of the population, especially those of people in or at risk of social exclusion.

- **Accelerate** the digitalisation of small and medium-sized enterprises (SMEs).

- **Promote** the creation of data stores and facilitate access to them.

- **Improve** the efficiency and productivity of public services.

- **Stimulate** collaboration and increase public and private investment in R&D&I.

Consolidating and expanding the AI ecosystem in Spain is essential for the proper integration of the R&D&I, economic and industrial assets created by technological development. The effective implementation of AI will also optimise the application of human potential in economic activities and contribute to achieving synergies between the productive and social systems.

The inclusion and use of the Spanish language in AI should be promoted through the development of tools for this purpose, and their incorporation and application in a broad range of technologies and services. Good practices for the Spanish-language application of AI solutions should be developed and recommended.

Public authorities should inspire and lead these activities, to ensure that technological development benefits society and buttresses the social welfare system. In this respect, our healthcare, education, justice and dependency benefits structures are the cornerstone and the hallmark of Spanish identity. AI must contribute to consolidating our welfare state, providing the data and other aspects needed to promote innovation and technological development by and for society, thus creating a positive feedback loop between technology and our political, social, economic and industrial systems.

AI RESOURCES IN EUROPE
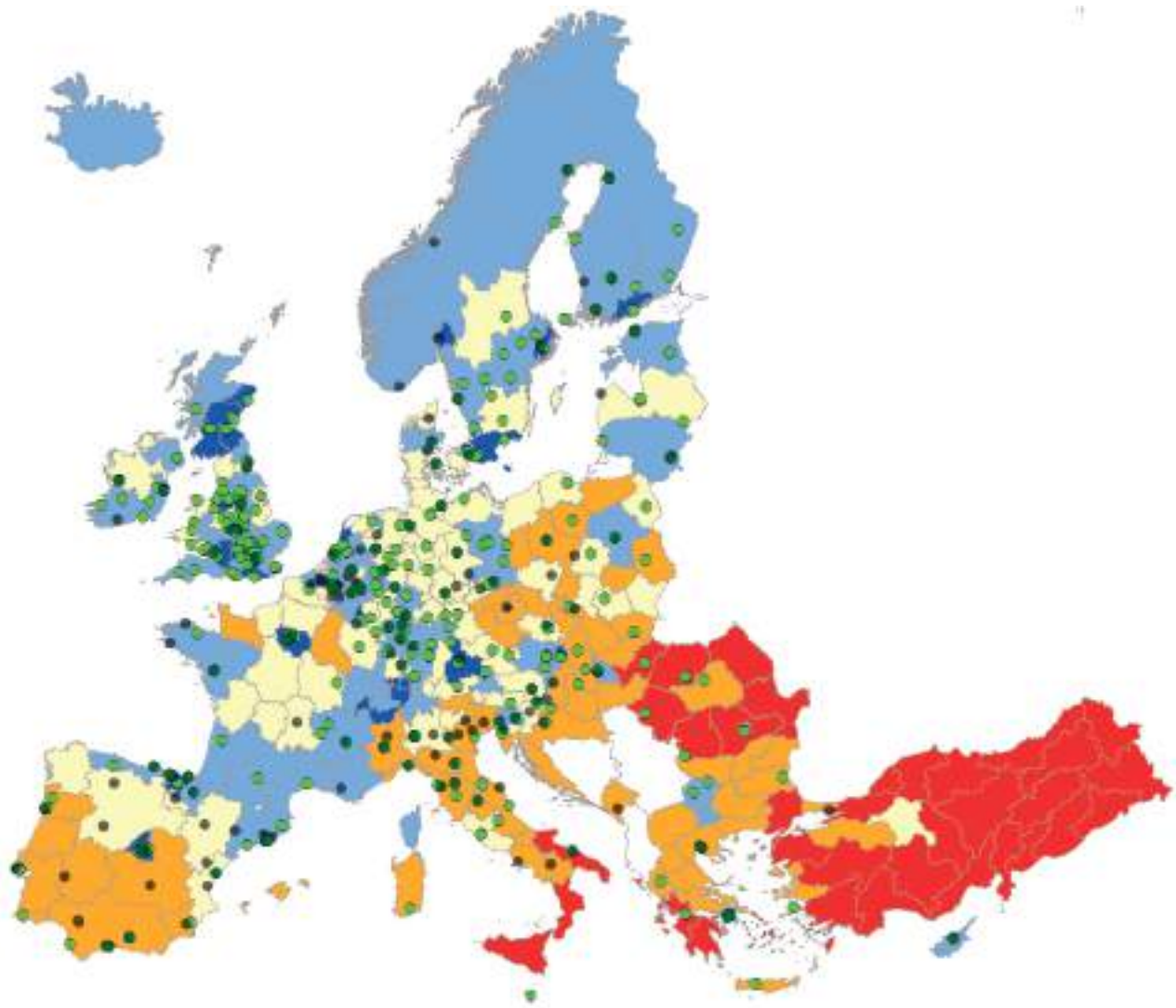
Digital Innovation Hubs - Digital Innovation Hubs
Al Study Topics - Al Study Topics
Human resources in science and technology (% share of economically active population)

< 28   28 - 38   38 - 46   46 - 54   > 54

Source: European Commission[2]
[2] https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool

WHY HAVE A NATIONAL STRATEGY FOR AI?

The above considerations underline the need to set in motion a National Strategy for Artificial Intelligence, to properly structure the actions taken by different administrations and to provide a reference framework to stimulate public and private sector involvement in this area. The promotion of AI is one of the main elements of **Spain's Digital 2025 Agenda,** presented in July 2020. Action Area 9 in this document focuses on Data Economy and Artificial Intelligence, based on preparatory work conducted for the Agenda for Change[3] (presented in February 2019); on programmes to support Digital Enabling Technologies[4]; and on the Spanish R&D&I Strategy for Artificial Intelligence (presented in March 2019). The Digital 2025 Agenda is a vital cross-cutting initiative to transform the productive fabric and to strengthen the Spanish economy.

However, the Strategy does not address AI merely as a field for scientific research and for boosting business innovation and industrial development. It has the potential to transform not just the economy but multiple aspects of society, including the operation of public services and the transparency of government administrations as well as address major societal challenges such as the gender gap, the digital gap or ecological transition.

To respond appropriately to the impact of accelerated technological change, an interdisciplinary approach should be taken, focusing on people and on the environment, and incorporating a broad range of perspectives, including computer engineering, technical engineering, mathematics, biology, neuroscience, sociology, psychology, economics, physics, earth and environmental sciences, law and the humanities. Only thus can we ensure that AI is employed within a framework that preserves our democratic values and maintains respect for individual and collective rights.

Various challenges must be faced in deploying advances in AI, such as raising awareness of the tasks to be addressed, supporting private investment in the field, making good use of AI capabilities to overcome economic, social and environmental problems, and optimising public management or governance. Moreover, Spain should seek to reinforce its position in European and international affairs. This point will be addressed in the future National Strategy for Technology and the Global Order.

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[3]http://www.mineco.gob.es/stfls/mineco/ministerio/ficheros/190208_agenda_del_cambio.pdf
[4]European Commission. Preparing for our future: Developing a common strategy for key enabling technologies in the EU. Communication of the European Commission COM (2012) 341 final. https://eacea.ec.europa.eu/sites/eacea-site/files/information_note_on_kets_blueprint.pdf

ALIGNMENT WITH EU POLICY

This National Strategy has been prepared to re)ect the shared commitment with our European partners to make the EU a leading player in this (eld. This commitment is included in the Digital Agenda for Europe[5], the AI for Europe Strategy[6] adopted in 2018, the AI Coordinated Plan on Artificial Intelligence[7] 2019-2027, the OECD document Measuring the digital transformation[8], the White Paper on Artificial Intelligence[9], published in February 2020, and the European policy document Artificial Intelligence[10]. The most significant points of these publications are as follows:

• **White Paper on Arti(cial Intelligence.** Emphasises the need to strengthen industrial and technological capacities, with appropriate regulatory changes, coordination and governance, to ensure these capacities are expanded in an ethical, reliable way, in line with EU standards. The corresponding security and civil liability framework must also be constructed. Capacities and talent should be strengthened to foster the adoption of AI in the market, especially by SMEs.

• **European policy document "Arti(cial Intelligence":** Proposes a development framework to address technological, security[11], protection[12], ethical, inclusion, legal and socio-economic issues, with the ultimate aim of promoting research and industrial capacity to make AI widely available. This framework focuses on the socio-economic changes arising from the use and implementation of AI, on the EU's coordination of research and initiatives in this field, on the creation and development of specialised talent and on guaranteeing protection[13] for the population and the provisions of the welfare state, focusing on the population's needs and on bolstering confidence in AI[14].

Additionally, and to jointly promote AI, the EU Member States signed a declaration of cooperation during "Digital Day 2018"[15]. This declaration was intended to consolidate European achievements and investment in AI and to establish the foundations for the Coordinated Plan on AI.

[5]https://www.europarl.europa.eu/factsheets/en/sheet/64/digital-agenda-for-europe
[6]http://www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/com/2018/0237/COM_COM(2018)0237_EN.pdf
[7]https://ec.europa.eu/digital-single-market/en/news/coordinated-plan-artificial-intelligence
[8]https://www.oecd-ilibrary.org/science-and-technology/measuring-the-digital-transformation_9789264311992-en
[9]https://ec.europa.eu/info/files/white-paper-artificial-intelligence-european-approach-excellence-and-trust_en
[10]https://ec.europa.eu/digital-single-market/en/artificial-intelligence
[11]https://ec.europa.eu/info/files/commission-report-safety-and-liability-implications-ai-internet-things-and-robotics_en
[12]https://ec.europa.eu/info/files/regulation-eu-2016-679-protection-natural-persons-regard-processing-personal-data-and-free-movement-such-data_en
[13]https://ec.europa.eu/info/files/regulation-eu-2016-679-protection-natural-persons-regard-processing-personal-data-and-free-movement-such-data_en
[14]https://ec.europa.eu/digital-single-market/en/european-ai-alliance
[15]https://ec.europa.eu/digital-single-market/en/news/eu-member-states-sign-cooperate-artificial-intelligence
[16]https://ec.europa.eu/digital-single-market/en/news/coordinated-plan-artificial-intelligence

In line with this approach, the European Commission indicated at its extraordinary meeting on 1-2 October 2020[17] that 20% of the Recovery and Resilience Facility would be available for the digital transition, and for SMEs in particular, for purposes such as fostering technology capabilities, developing capacities in strategic digital value chains, accelerating the rollout of very-high-capacity infrastructure (especially fibre optics and 5G), enhancing the EU's ability to protect itself against cyber threats, providing secure communication environments, especially through quantum encryption, and ensuring access to data for judicial and political ends.

This National Strategy has been prepared to re)ect the shared commitment with our European partners to make the EU a leading player in this (eld. This commitment is reflected in the Digital Agenda for Europe, the AI for Europe Strategy adopted in 2018, the Coordinated Plan on AI for 2019-2027, the 2020 Communication "Shaping Europe's digital future"[18] and the White Paper on Artificial Intelligence, published in February 2020.

The Strategy also incorporates the work coordinated by the Ministry of Science, Innovation and Universities, which has held various meetings with the private sector and social agents to analyse possible actions by government administrations in the development of AI and other enabling technologies. In this context, an analysis has been made of the main assets, vulnerabilities, opportunities and risks identified in the Spanish context, and an AI Capabilities Map was presented in October 2019[19]. This map is one of the goals set out in Priority 1 of the Spanish R&D&I Strategy for AI, which was published by the Ministry of Science, Innovation and Universities on 4 March 2019[20]. Such a map has been prepared by all EU Member States, in accordance with the Coordinated Plan on AI[21].

On the basis of these initiatives, the National Strategy for Artificial Intelligence presents a reference framework for the period 2020-2025 by which sectoral, state and regional strategies in this matter can be aligned with corresponding EU policies, thus promoting the transformation of the economic sectors involved, via public-private cooperation.

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[17]https://www.consilium.europa.eu/media/45932/021020-euco-final-conclusions-es.pdf
[18]https://mapa.estrategiaia.es/mapa
[19]http://www.ciencia.gob.es/stfls/MICINN/Ciencia/Ficheros/Estrategia_Inteligencia_Artificial_IDI.pdf
[20]http://www.ciencia.gob.es/stfls/MICINN/Ciencia/Ficheros/Estrategia_Inteligencia_Artificial_IDI.pdf
[21]https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52018DC0795&from=EN

GOALS
OF THE
STRATEGY

GOALS OF THE STRATEGY

Spain's National Strategy for Artificial Intelligence has seven strategic goals:

- **Scientific excellence and innovation in Artificial Intelligence.** Positioning Spain as a country committed to promoting scientific excellence and innovation in AI.

- **Projection of the Spanish language.** Leading the world in the development of technological tools and software for the dissemination and use of the Spanish language in AI applications.

- **Creation of qualified employment.** Promoting the creation of skilled jobs, fostering training and education, stimulating Spanish talent, and attracting global talent.

- **Transformation of the productive system.** Incorporating AI as a factor to improve the productivity of Spanish business, to increase the efficiency of public administration, and to drive sustainable and inclusive economic growth.

- **Trust environment in relation to Artificial Intelligence.** Generating an environment of trust in AI, its technological development, its regulatory

- **Humanistic values in Artificial Intelligence.** Driving the global debate on human-centred AI, focusing on seeking social welfare when making technological progress, and creating and participating in forums and dissemination activities to develop an ethical framework guaranteeing citizens' individual and collective rights.

- **Inclusive and sustainable Artificial Intelligence.** Strengthening inclusive and sustainable AI, as a transversal vector to address the major challenges facing our society; specifically to bridge the gender gap and the digital divide, and to support the ecological transition and territorial cohesion.

These Strategy aims are in line with the 2030 Agenda[21] and with the OECD Recommendation[22], that public action should incorporate economic, social and environmental considerations. The Strategy also addresses the need to design systems that are robust, secure and impartial, with AI applications that are reliable, explainable, transparent and inclusive. In addition, they must comply with fundamental rights and applicable regulations, respect basic principles and values, and take into account the collective aspirations of the population[23].

[21]http://www.exteriores.gob.es/Portal/es/SalaDePrensa/Multimedia/Publicaciones/Documents/PLAN%20DE%20ACCION%20PARA%20LA%20IMPLEMENTACION%20DE%20LA%20AGENDA%202030.pdf
[22]https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449
En 1997 el Consejo de Europa adoptó el "Convenio de Oviedo"
[23]https://www.boe.es/boe/dias/1999/10/20/pdfs/A36825-36830.pdf which declared that fundamental rights are the basic foundation guaranteeing the "primacy of human beings" in a context of technological change.
See also the "AI EthicGuide"https://ec.europa.eu/digital-single-market/en/news/draft-ethics-guidelines-trustworthy-ai published by the European Commission's High Level Expert Group on AI.

ACTION
PLAN

ACTION PLAN

To achieve the Strategy aims described above, six Strategy Lines have been de(ned, incorporating the priority actions to be carried out during the period 2020-2025 and defining specific targets for this period.

Strategy Pillar 1. Promote scienti(c research, technological development and innovation in AI

To strategically anticipate coming events, in an environment of increasingly rapid technological change, it is essential to generate new knowledge and ensure its effective transfer to the productive fabric and to the administrative sector. These tasks must be undertaken with a double focus: (i) on the one hand, considering the current interests and demands of companies and institutions that need to implement mature AI technologies, fundamentally to optimise resources and procedures based on the exploitation of large databases; (ii) on the other hand, it is also necessary for the Strategy to respond to medium to long-term interests, looking beyond the immediate horizon to focus on the generation of new and emerging techniques that will allow new businesses to develop and established ones to enter sectors not previously considered.

Strategy Pillar 2. Promote digital capabilities, empower national capabilities and attract global skills in the (eld of AI

With respect to AI, the technical capabilities of the active population (both the workforce in general and specialists) must be enhanced, in order to facilitate access to new, high-quality jobs and to overcome the challenges encountered in the future labour market. In addition to scientific-technical skills training, it will also be necessary to extend training in the social sciences to address the many significant aspects of AI from an interdisciplinary standpoint.

Strategy Pillar 3. Develop data platforms and technological infrastructures in support of AI

Digitalisation, access to large volumes of data, the development of general purpose AI platforms incorporating resources (data, corpora, lexicons, ontologies, models, etc.), algorithms and inference engines, together with supercomputing infrastructure or other high-performance, high-processing capacity mechanisms: all of these elements are essential for the development of AI, for its use and promotion by government administrations and for its low or zero-cost availability to innovative SMEs and researchers. Beyond investing in the generation of new data sets and data infrastructures, the efficient management and governance of data use must also be ensured, in accordance with principles of interoperability, integrity, reliability, quality and legality. At the same time, citizens' rights, privacy and confidentiality must be protected, as called for by European initiatives such as the European Open Source Cloud and by Spanish legislation on data protection.

Strategy Pillar 4. Incorporate AI into value chains to transform the economic fabric

Digitalisation, innovation and the incorporation of AI into value chains is a fundamental opportunity to change the pattern of economic growth in Spain, one in which human and technological capital may be expanded, reducing environmental impacts, raising productivity and enhancing the potential to grow intensively and sustainably, thus increasing well-being in society and generating high-quality employment.

Strategy Pillar 5. Enhance the use of AI in government administration and in national strategic missions

The relationship between AI and government administration is one of mutual benefit. On the one hand, AI heightens transparency and facilitates the communication of public activity in sectors such as health care, social services, the environment, energy, justice, transport, logistics, education, employment and security. At the same time, it provides a more accurate picture of our society and makes it possible to determine priorities for action, identifying areas with competitive advantages and those which are most disadvantaged. In turn, government activities foster the acceptance and use of AI by providing finance and promotion and by integrating AI into the administrative process. In the final instance, it is society at large that benefits from the introduction and application of AI, and so the citizenry should monitor government activities, exploit the proximity achieved and make use of AI applications that respond to individual circumstances.

Strategy Pillar 6. Establish an ethical and regulatory framework that reinforces the protection of individual and collective rights, in order to guarantee inclusion and social welfare.

The development and deployment of AI has great potential and raises expectations, but it may also create uncertainty due to its ethical, legal, social and economic implications. If Spain is to place itself at the political and social forefront of this technological revolution, an appropriate framework for action must be created. Moreover, we must consider whether the current rules and standards for coexistence will continue to be appropriate, whether the ethical and legal framework that has served us to date will still be sufficient, and what adjustments may be needed to protect individuals in a digital world. In all of these respects, ethical and democratic ideals must prevail over the development of AI. Furthermore, the action framework arising from these considerations will be complementary to the corresponding social and political debate and to the regulatory procedures that will be required for each case.

The Strategy, moreover, addresses major social challenges that must be overcome if AI is to be inclusive and sustainable, such as reducing gender and digital inequalities, reinforcing territorial cohesion and assuring the ecological transition.

Social Challenge 1: Reduce the gender gap in AI as concerns employment and leadership.

The first results obtained from the map of AI capabilities in Spain confirm the existence of a marked gender gap, due to inequality between women and men in scientific and social studies (i.e., Science, Technology, Engineering, the Arts and Mathematics – STEAM) as well as in employment and leadership in the field of AI. This imbalance is a major vulnerability in our economy and society, and so gender equality is one of the principal, and cross-cutting, aims of the Strategy. In fact, Spain already has a higher proportion of female researchers than the EU average[25](38.8% vs. 33.8%), according to INE and Eurostat data, which means the country is well positioned to further narrow the gender gap.

Social Challenge 2: Foster the ecological transition and reduce the carbon footprint.

In addition to the above, an ecological transition, spanning all sectors, must be undertaken to focus AI activities on the good of the planet, in two respects in particular: firstly, by promoting energy-efficient data storage and computing systems (both in the development of hardware and in employing more efficient processes for algorithm design and training, via approaches such as the systematic analysis of the energy consumption of the applications considered), while minimising its own environmental footprint. Secondly, by orienting AI and digital-enabling technologies to address global challenges, to support the implementation of the Paris Agreement on climate change[26], to achieve the UN Sustainable Development Goals, to make the European Green Deal a success and to drive the transition towards a circular economy, especially in the fields of agriculture, food and consumer electronics.

Social Challenge 3: Reinforce territorial cohesion.

Territorial cohesion can be defined as the existence of a consistent internal structure throughout the country. In the present context, this refers to the organisation, extension, development and coverage of digital infrastructures, in particular those related to the National Strategy for Ultrafast Networks[27], including broadband. Territorial governance and coordination between various levels of government (national, regional and local) can benefit from digitalisation and the development of AI.

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[24]de Science Technology Engineering Arts Mathematics
[25]https://www.ciencia.gob.es/stfls/MICINN/Ministerio/FICHEROS/EECTI-2021-2027.pdf
[26]https://www.consilium.europa.eu/es/policies/climate-change/paris-agreement/
[27]https://avancedigital.gob.es/planes-TIC/agenda-digital/DescargasAgendaDigital/Planes%20espec%C3%ADficos/Plan-ADpE-1_Redes-Ultrarrapidas.pdf

Greater cohesion, in conjunction with AI, will also contribute to territorial revitalisation and modernisation and help reverse the regressive dynamics that have been observed in some areas in recent years. Finally, territorial cohesion will facilitate the adoption of AI at all levels of the productive fabric, within agencies of government administration and throughout the services offered.

Social Challenge 4: Narrow the digital divide.

Digital literacy is the ability to locate, organise, understand, evaluate and analyse information using digital technology. Accordingly, it goes beyond merely learning to use the tools. Countries, companies and individuals are developing these skills at different rates, which is creating a new gap, termed the digital (or technological) divide. Certain groups, at risk of social exclusion or experiencing this situation, are especially vulnerable to the digital divide. If the problem is not addressed and overcome as a matter of urgency, the emergence of AI will be an additional factor weighing on the social exclusion that is suffered by many, further distancing them from society and employment. In Spain, for example, the younger population are especially well placed to adopt technological advances and profit from them. Great opportunities exist for them in the digitalisation of jobs and in the introduction of ICTs in the workplace. Further openings arise with the specific training needed for teachers[28].

Understanding the benefits of digital technology, accessing it, and using it to communicate, and perhaps even creating digital content; these are some of the skills that must be much more widely acquired to narrow the digital divide. Companies and other organisations must realise that ensuring an effective digital transformation is an issue of the highest priority in the drive to increase productivity and competitiveness in today's globalised world.

Annex 1 describes the relationship between the Strategy Lines and the objectives sought.

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[28]https://www.oecd.org/spain/Skills-Outlook-Spain-ES.pdf

STRATEGY LINE 1.

PROMOTE SCIENTIFIC RESEARCH, TECHNOLOGICAL DEVELOPMENT AND INNOVATION IN AI

STRATEGY LINE 1. PROMOTE SCIENTIFIC RESEARCH, TECHNOLOGICAL DEVELOPMENT AND INNOVATION IN AI

The National Strategy for AI necessarily emerged from the research conducted by the public and private sectors, through public-private and public-public collaboration, which expand knowledge of the (eld and facilitate new techniques, focuses and applications that can be transferred to the productive environment and/or the public sector, thus boosting innovation and technological change. However, in a rapidly-changing environment, research plans must be flexible and adaptable.

To generate an optimal environment and to establish mechanisms that will enhance innovative capabilities in AI, both in the public and in the private sector, the Strategy proposes the following five objectives for research and technological development:

1.   Promote high-level public research into AI, increasing funding for this purpose, broadening the scope of research and subsequent application, separating these efforts from market inertia, facilitating the development of options, and generating a diversified plan for innovation in AI, focused on both basic and applied research, in order to ensure excellence and short, medium and long-term relevance.

2.   Foster and exploit research synergies between universities and research centres, via inter-university cooperation networks, and with companies and government administrations.

3.   Create platforms for research cooperation and for the transfer of results between the public and private sectors. Furthermore, attract and retain research talent in Spain, reducing paperwork and processing times that would otherwise hamper this process. Foster the creation of public-private consortia for research projects, encouraging the participation of SMEs and startups in the sector in order to create a solid, expanding AI ecosystem in the country, underpinning the productive fabric.

4.   Promote the exploitation of synergies between AI research and that conducted in strategic areas such as health, education, energy, climate change, tourism, culture, language, security and agriculture, applying the action protocols established between the respective ministries and the Ministry of Science and Innovation, fostering collaboration between the different levels of administration (national, international and European) and sponsoring strategic missions in this respect.

5.   **Explore alternative investment mechanisms in public-private collaboration** (seed capital, venture capital, etc.) to ensure the availability of sufficient investment for Spanish research to be competitive and to facilitate the transfer of research results to industry and other activity sectors.

FRAMEWORK FOR THE DEVELOPMENT OF AI RESEARCH

Spanish research in AI technologies enjoys wide international recognition, in areas such as machine learning, heuristic optimisation, planning, automatic deduction, logic and reasoning, natural language processing, computer vision, robotics, multi-agent systems, recommendation systems, human-machine cooperation, modelling based on intelligent agents, and ontologies. The Spanish AI community has also made outstanding contributions to the development of innovative applications in services, in the energy field and in environmental sustainability, in strategic sectors (for example, health care and agriculture) and in areas where Spain has a particularly strong presence such as tourism and the creative industries[29].

In Spain, scientic research activity forms part of the Spanish Science, Technology and Innovation System, which includes research activity focused specifically on AI developments. This activity is carried out by public and private academic and scientific institutions, by associations and by organisations providing R&D&I support to the business world.

The development of scientic policy in Spain is regulated under the Science, Technology and Innovation Act (14/2011), which seeks to promote the generation of knowledge in all areas, to foster its disclosure and to facilitate its subsequent application to produce social or economic benefit, with a multiplier effect on actions aimed at sustainable development, via sectoral and cross-cutting policies. Research into AI opens up great opportunities for the generation of knowledge, technologies and innovations of a multidisciplinary and disruptive nature. In this respect, the combination of fundamental and applied research and experimental development also plays an invaluable role.

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[29]https://www.ciencia.gob.es/stfls/MICINN/Ciencia/Ficheros/Estrategia_Inteligencia_Artificial_IDI.pdf

With respect to the scientifc application of AI, specifc action will be taken in the framework of the National R&D&I Strategy set out by the Ministry of Science, under the following premises:

1   **AI technologies represent a great opportunity to develop priority sectors of the Spanish economy and society in a sustainable way.**

2   **The humanities and social sciences sectors are cross-cutting in nature and should be taken into account in all areas in which AI is applied.**

AI technologies may be implemented at different speeds according to the sector addressed, and depending on their strategic nature and degree of maturity and development. Accordingly, the research-innovation cycle should be strengthened, by rewarding excellence and seeking networking synergies in the initial phases (both in academic research and in the business world), whilst making use of mature technological solutions already employed in the productive fabric, and promoting startups, spinoffs and disruptive innovation. The outcomes of these endeavours might only become apparent in the medium term, but they are crucial to ensuring fruitful participation in the design of technological developments, to encouraging investment and to making Spain one of the countries creating the AI of tomorrow.

The universities must play an active role in supporting a Network of Excellence in AI. In conjunction with the research centres of public organisations, with those of European organisations operating in Spain, and those established to support technological innovation, university activity in this field should be focused on addressing hybrid/mixed lines of research[30]. Therefore, a network of excellence will be established, to mobilise and coordinate a critical mass of researchers, thus creating a pool of future PhDs, working in associated postgraduate programmes, organised as a mesh or within a federation in scalable structures enabling the constituent elements to form coordinated units that are larger and more competitive. These units, in the form of distributed structures, combining profiles of a purely technical nature with profiles from other disciplines, will adopt a broad-ranging approach and generate interdisciplinary relationships with other areas of knowledge, such as medicine or the analysis of social impact.

The current status of the AI ecosystem in Spain is reflected in the map of AI capacities in Spain, published in May 2019 by the Ministry of Science and Innovation.

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[30]Numerous international initiatives support this mixed/hybrid approach, including the Center for Human Nature, Artificial Intelligence and Neuroscience (www.chain.hokudai.ac.jp), the Centre for the Governance of AI (www.fhi.ox.ac.uk/govai), the Leverhulme Centre for the Future of Intelligence (lcfi.ac.uk/projects/kinds-of-intelligence), the Hybrid Intelligence Centre (www.hybrid-intelligence-centre.nl) and the Stanford Institute for Human-Centered Artificial Intelligence (hai.stanford.edu).

CREATION AND DEVELOPMENT OF INSTRUMENTS AND MECHANISMS TO TURBOCHARGE INNOVATION

AI is considered an outstanding area for innovation, a driving force of digitalisation and an essential component of the public sector, society, private companies, government and science. It makes invaluable contributions in all these sectors, for example by enhancing the diagnosis of diseases, reducing energy consumption, preventing traffic accidents, creating new services, improving health care and rehabilitation, rationalising industrial production, advancing the development of new pharmaceutical products and reducing processing times.

To narrow the gap between theory and implementation, this innovation environment must be promoted and accelerated by means of targeted public policies. In Europe, this question has been addressed with the creation of Digital Innovation Hubs (DIHs), or one-stop shops whereby companies (especially SMEs) and public administrations can access the services and facilities needed to achieve a successful digital transformation. In Spain, AI is being incorporated into many DIHs[31] (see Figure 1).

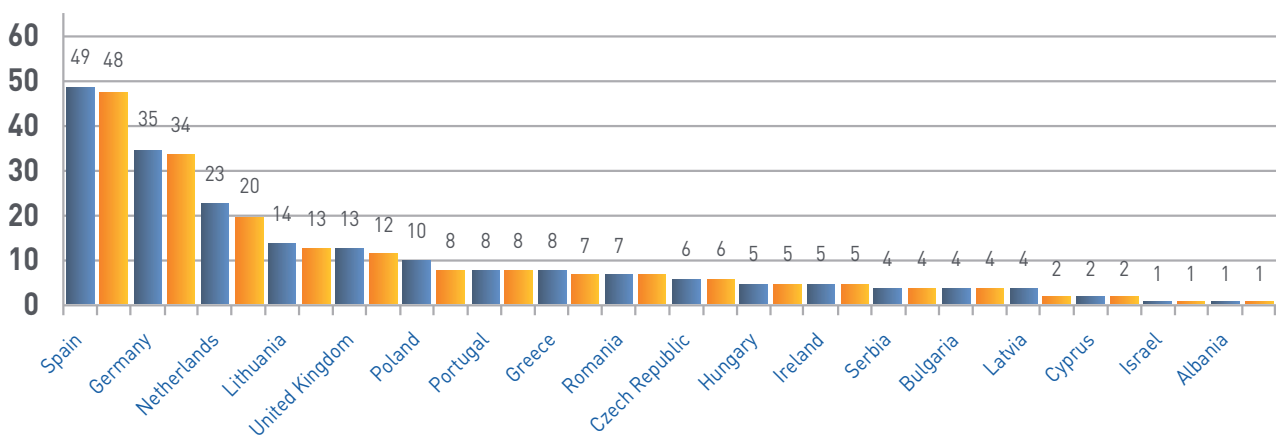## DIHs operational or under preparation in Europe

Figure 1. Source: JRC –European Commission

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[31] https://www.apte.org/parques-cientificos-tecnologicos-participan-28-digital-innovation-hubs

The recently-published "European Digital Innovation Hubs in Digital Europe Programme" describes the current context of these centres, within the 2021-2027 Digital Europe Programme[32]. This document highlights the four main functions of the European DIHs for which accreditation will begin in 2021: skills and training, pre-investment testing, investment support, and the creation of network and innovation ecosystems. This new strategy defines the technologies on which the different proposals should be based, among high-performance computing (HPC), cybersecurity, AI and digital skills. These are the main areas considered for the development and promotion of innovation and digital transformation in the period 2021-2027, within the framework of the Digital Europe Programme. The European DIHs will be reinforced, making them regional structures for the development of innovation and of strategies for the transfer of digital technologies. A number of DIHs (in Spain: 9-18) will be recommended for accreditation and financing (p. 30, Table 1). The first call for applications for accreditation of European DIHs is scheduled for January 2021, following the Spanish administration's pre-selection of candidates in October 2020.

DIHs are key elements for knowledge transfer, supporting the digital transformation and enabling the effective uptake of AI by public administrations, businesses (especially SMEs) and industry, facilitating access to knowledge, IT skills, cloud platforms, and testing, training and service facilities. This network of centres will also promote the optimal use of the industrial potential present in the R&D&I results obtained at regional, national and European levels. Moreover, these capabilities will be reinforced by the forthcoming Digital Europe and Horizon Europe programmes for 2021-2027. The European Commission has established strategic objectives and actions, to be implemented in collaboration with the Member States, to prioritise investment in R&D&I, including efforts to promote the mobility of researchers, to develop career and skills frameworks, to boost gender equality and to foster research excellence within the EU[33].

In Spain, these European initiatives are complemented by other programmes for scientific research cooperation, funded by different ministries and providing mechanisms for transferring the results of scientific research and facilitating the incorporation of AI within novel applications and technologies.

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[32]https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=70324
[33]https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1749

This ecosystem for the transfer and implementation of research findings is expected to foster the creation of new projects, startups or spinoffs from research centres, university research groups, public research bodies and university and non-university research institutes, providing co-financing and stabilisation assistance. Cooperation between spinoffs, SMEs, large companies, research centres and universities will also be promoted, to favour the transfer of existing knowledge, to create new lines and products of research and to stabilise the personnel specialised in R&D&I, in different environments and sectors.

In the (scal sphere, Article 35 of the Corporation Tax Act of 27 November (27/2014) states that tax deductions may be made for R&D and technological innovation activities, and Article 39.2 allows similar deductions to be made for R&D&I costs[34].

TARGETS FOR 2025

ACTION AREA 1.1. SUPPORT RESEARCH INTO AI

ACTION 1. Create a Spanish Network of Excellence in AI to conduct research and create training programmes at the forefront of knowledge in the disciplines of AI.

ACTION 2. Reinforce the system of pre-doctoral and post-doctoral research contracts and create programmes to attract senior researchers in AI.

ACTION 3. Make the scienti(c career path for AI research personnel more)exible to enhance scientific diversity and permeability between the public and private sectors and to foster knowledge transfer.

ACTION 4. Create new national centres for technological development in multidisciplinary fields, including neurotechnology, psychology, sociology and politics.

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[34]https://www.agenciatributaria.es/static_files/AEAT/Contenidos_Comunes/La_Agencia_Tributaria/Segmentos_Usuarios/Empresas_y_profesionales/Impuesto_sociedades/Novedades_Impuesto_Sociedades_publicadas_2014/Comparativa_Sociedades_dic.pdf

ACTION AREA 1.2. FACILITATE INNOVATION AND TECHNOLOGY TRANSFER IN AI

ACTION 5. **Establish a programme to assist companies that provide AI solutions and data,** to enable digitalisation, accelerate AI inclusion and promote the adoption of new technologies and the intensive use of data in production processes.

ACTION 6. **Strengthen the network of DIHs** specialised in AI, providing access to smart technology, big data and advanced computing capacity.

ACTION 7. **Create a programme of R&D&I missions** to address major social challenges.

A central element of this Strategy Line is the proposed Spanish Network of Excellence in AI, to promote research and knowledge generation in this field. To achieve these aims, advanced research and training programmes will be created in various areas of AI. Both short and long-term research programmes must be undertaken, to generate and foster emerging and/or disruptive techniques and to enter sectors not currently considered with respect to AI. In addition, interdisciplinarity and links with the private sector must be incorporated.

Organisationally, there will be a network structure based on the nodes of the Network of Excellence, thus forming an interdisciplinary AI community and providing resources for training, recruitment and talent retention, entrepreneurial support, visiting-researcher programmes and projects, according to criteria of excellence. In addition, appropriate policies will be designed for research and knowledge transfer, and for undertakings in sectors not currently addressed. Another area of interest is the exchange of personnel between public and private organisations, and the temporary incorporation of senior researchers in project development.

One of the main goals of this Network of Excellence is to motivate intellectuals to consider challenges in the field of AI as a possible route towards overcoming technical, social and scientific barriers. The Network will be equipped to answer scientific questions with great transformational potential. The results obtained will be published for unrestricted use and high-level training programmes and seminars will be offered. The primary benefit expected of this network is that it will enable Spanish initiatives to take the forefront in research work and thinking in the field of AI.

STRATEGY LINE 2.

PROMOTE DIGITAL CAPABILITIES, EMPOWER NATIONAL TALENT AND ATTRACT GLOBAL SKILLS IN THE FIELD OF AI

STRATEGY LINE 2. PROMOTE DIGITAL CAPABILITIES, EMPOWER NATIONAL TALENT AND ATTRACT GLOBAL SKILLS IN THE FIELD OF AI

One of the main pillars on which the digital transformation of our society must be sustained is the necessary education and training in digital skills of the entire population, throughout their lives. Specifically, for this National Strategy for AI to be successful, it is essential to ensure that students, teachers, public sector personnel, the workforce in general and society as a whole receive appropriate preparation for and training in AI, from an ethical, humanistic and gender perspective.

Some of the active employment policy measures presented in this Strategy form part of the National Plan for Digital Competences, such as training for the digital transformation, university-SME consortia and the acquisition of digital skills by the unemployed. These measures are intended to promote entrepreneurship

This approach means we must create a capable citizenry, equipped to understand the options and decisions of "smart" systems. Training in digital skills must be initiated in early childhood, and include training in computational thinking, in order to fashion a society that is well apprised of digital technologies, in which science, technology, engineering and mathematics (STEM) vocations are promoted and the gender gap is reduced. In vocational training and university education, greater effort is needed in AI to ensure that all involved acquire a solid foundation of computational thinking. We must also increase the technical training in AI provided to the working population, both for general users and for specialists, in order to facilitate access to new, high-quality jobs and to successfully address the challenges of the future job market. Furthermore, the inclusion of AI in the learning environment cannot and should not be restricted to the STEM areas, but also include humanistic components and the social sciences, in order to address all aspects pertaining to AI, from an interdisciplinary approach.

In addition to these educational efforts aimed at developing talent in AI, actions should be taken to attract expert teaching staff from abroad, taking into account the existence of severe international competition for personnel with these skills.

AI has great potential to improve the learning process and its outcomes. Furthermore, it can be used as a transversal learning method, spanning a range of subjects – scienti(c, the humanities, social science, etc. Finally, AI will enable us to modernise education and skills-training systems, providing a new opportunity to resolve challenges in education, both old and new, and promoting personalised learning.

In this field, AI training must be approached on the following fronts:

- **Promote vocational training** and establish technical training procedures, both in the private sector and in government administration, to complement short-term technological transitions in the labour market.

- **Update the AI and digitalisation content offered in vocational training and in university education** to adapt it to new needs and to new processes of knowledge generation in a wide range of subject areas (health, agronomy, aerospace, etc.) arising in the medium term. Spanish universities must seek to develop global leadership capabilities in order to become a benchmark in Spanish-language AI.

- **Lay the foundations for the understanding of computational, critical and creative thought** regarding the fundaments of AI and its outstanding questions, at all levels of education from early childhood, providing adequate long-term training for teachers. In this respect, the needs of students with special needs should also be addressed.

In the "Spain Can" plan for recovery, transformation and resilience, Key Policy 7, under the title "The impact on citizens of the new economy and employment policies" addresses the following skills-training areas:

- Retraining for workers temporarily laid off
- Training in the tourism sector (of strategic importance in Spain)
- Training to enable employment in strategic sectors of general interest.

These reskilling and upskilling programmes, preferably for persons in employment, will be publicly funded, by the central government, according to the productivity and competitiveness requirements of companies and the need to adapt to the digital transformation.

The above initiatives should be enriched by a cross-cutting, multidisciplinary approach, for example relating technical training with the humanistic, legal and social aspects involved, or using smart technologies to modernise education itself, or to assist efforts to reduce the gender gap, an issue that continues to be of the utmost importance.

Public-private collaboration is crucial to the success of these initiatives, together with measures to enhance the population's understanding of smart technologies, to ensure that citizens are aware of the challenges presented and of the real opportunities offered. The main business sectors are participating directly in the modernisation of vocational training programmes, and multiple collaborative initiatives have been undertaken to promote reskilling and upskilling. Another important consideration is the wide variety of collaboration instruments that have been established, together with European consortia and projects contracted directly from the Spanish Centre for Industrial Technological Development (CDTI).

The Government has launched various initiatives in this area[35], including an Action Plan aimed at reducing gender discrimination, promoting gender equality and narrowing the gender gap in science, promoting equality for persons with disabilities and combating social exclusion, etc. These actions will be applied in all areas of STEAM training and access to AI jobs. Other instruments that will be applied include scholarships, industrial doctorates, programmes for technical support personnel, post-doctoral contracts, seed capital reserves for startups, and support for women's participation in international AI technology programmes.

CURRENT SITUATION OF AI IN EARLY CHILDHOOD, PRIMARY AND SECONDARY EDUCATION

The percentage of schools that are strongly equipped with technological resources is now higher in Spain than the EU average[36]. According to the Connected Schools project, over 83% of Spanish schools have fast internet connections (>100Mb). With respect to their preparation in STEAM subject areas, the number of teachers in Spain who have taken courses on the pedagogical use of ICTs is also above the EU average (55-75% according to the teaching level considered), while in terms of their acquaintance with learning apps, the percentages are similar to the EU average.

However, levels of digital competence are slightly below the European average, with 43% of individuals aged 16-74 years lacking basic digital skills (vs. the EU-28 average of 42%). The Digital Economy and Society Index (DESI) for 2020 places Spain in 16th place in the EU-28 ranking in human capital[37]. According to another report, Spain is performing below the OECD average in the use of ICTs in schools and in mathematics training, which is associated with inadequate performance in analytical tasks that require the use of a computer to solve problems[38].

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[35] Such as the Women, Science and Innovation Observatory, the White Paper on Women in Technology and various measures adopted in the field of science, detailed in: https://www.lamoncloa.gob.es/consejodeministros/Paginas/enlaces/080219-enlaceagendacambio.aspx
http://www.mineco.gob.es/stfls/mineco/ministerio/ficheros/libreria/LibroBlancoFINAL.pdf, published by the Ministry of Economy, Industry and Competitiveness.
[36] According to the 2nd Survey of schools: ICT in education 2019 https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=57821 reaching 79% and 78% for levels ISCED2 and ISCED 3, respectively.
[37] https://administracionelectronica.gob.es/pae_Home/pae_OBSAE/Posicionamiento-Internacional/Comision_Europea_OBSAE/Indice-de-Economia-y-Sociedad-Digital-DESI-.html
[38] https://ec.europa.eu/digital-single-market/en/scoreboard/spain The 2015 OCDE report "Students, Computers, and Learning: Making the Connection"
https://www.oecd-ilibrary.org/education/students-computers-and-learning_9789264239555-en

From the above, it is clear that greater emphasis is needed on ICTs and AI technologies (mathematics and logic) from the early stages of the educational cycle, together with appropriate training for teaching staff. In response to this perceived need, the Spanish Computer Science Society (SCIE) and the Conference of Directors and Deans of Computer Engineering (CODDII) have drawn up a manifesto on the need to include Computer Science as a compulsory subject in the Spanish educational system, from primary education to high school[39]. Furthermore, the SCIE and the Royal Spanish Mathematical Society have presented a joint document entitled "Towards a new education in mathematics and computer science in secondary education[40]". Finally, the Ministry of Education and Vocational Training has published a study on the situation of Computational Thinking in education in Spain[41]. This study will provide the basis for a project to be implemented in collaboration with the Autonomous Communities to create a School of Computational Thinking and Artificial Intelligence[42].

THE GROWING PRESENCE OF AI IN VOCATIONAL TRAINING

Numerous studies have highlighted the need to reinforce the technological content of vocational training programmes at all levels, especially in promoting "medium-level skills" in technology, and to adapt it to the reality of the productive sectors, thus enhancing professional capacities and skills. In response, the Government has presented its first Strategic Plan for Vocational Training within the Education System 2019-2022[43], to promote the modernisation of vocational training and twin-track vocational training, and to harmonise levels of supply and demand for skills and qualifications. This Plan will be put into practice in coordination and cooperation with social agents and with public and private companies. The process of reviewing professional qualifications and degrees has already started, but much remains to be done to integrate AI capabilities into the vocational training system, in both technical and non-technical areas.

The fundamental aim of these reforms is to promote the creation of more career opportunities, such as computer analysis, software development and specialist computation, reflecting the importance of these occupations in the development of AI-related activities.

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[39]http://www.scie.es/wp-content/uploads/2018/07/informe-scie-coddii-2018.pdf
[40]https://www.rsme.es/wp-content/uploads/2020/06/Educacion-matematicas-e-informatica-secundaria.pdf
[41]http://code.intef.es/wp-content/uploads/2018/10/Ponencia-sobre-Pensamiento-Computacional.-Informe-Final.pdf
[42]https://intef.es/tecnologia-educativa/pensamiento-computacional/
[43]https://www.lamoncloa.gob.es/consejodeministros/referencias/documents/2019/refc20191122e_3.pdf

GRADUATE AND POST-GRADUATE EDUCATION AND THE DEVELOPMENT OF AI

In Spain, university training in AI is represented by several well-consolidated undergraduate and postgraduate programmes, at both Master's and Doctorate levels. Moreover, new AI-related Master's and Bachelor's degrees have recently been launched, and speci(c skills in AI are included in all computer science and computing degrees and in Master's degrees in computer technology[44]. However, in some respects the universities need to play a more active role in this context. On the one hand, the current shortage of ICT graduates and profiles, which many in the business and industrial world have warned against, means that non-computer studies must be reoriented towards these technologies[45]. Moreover, there must be more effective coordination between higher education and the world of work, making it possible to identify career paths that are in transition and for the universities to offer mechanisms for the reskilling of workers in employment, as has already been done in some university disciplines in which AI is combined with studies involving other sciences, business or the humanities. Indeed, there is a growing trend for degrees to combine AI with scientific subjects, the humanities, economics, etc. On the other hand, a lack of technological diversity persists in the educational opportunities offered in this field. To remedy this, the universities have a range of possible approaches, such as supporting the study and development of AI, in different fields of application. Although there exist programmes of this type (mainly at the Master's level), for example combining Law, Robotics or Biology and AI, it is important to place greater emphasis on such interdisciplinary studies in order to achieve a technologically richer ecosystem, with a greater diversity of perspectives.

Finally, and with the same ambition of supporting educational diversity, it is important that universities address the challenges presented by AI in their courses of a social and humanistic nature, since these questions must be present in the oversight of course design and implementation. Furthermore, analytical methods and methodological intervention should be co-defined, adding a new perspective to established technical considerations. This evolution will require supporting education in AI and adapting it to non-technical courses, thus making society better equipped to resolve the questions and challenges posed by AI, on the basis of diverse experiences and sources of knowledge.

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[44] https://www.boe.es/boe/dias/2009/08/04/pdfs/BOE-A-2009-12977.pdf
[45] According to the OECD, between 2011 and 2017, ICT employment in Spain grew by 2.2%, in comparison with 9% in Australia, the USA and the UK. The EU average in this respect (5.2%) more than doubles the Spanish figure. In general, fewer than 20% of Spanish companies have hired ICT experts, and this figure falls to 3% among companies with fewer than 10 workers (Source: INE).

The Government will promote the creation and consolidation of a community focused on cognitive science, which as yet is inexistent in Spain, but present in neighbouring countries. In such a community, the hybridisation of areas such as computer science, neuroscience or computational biology would facilitate the development of technological instruments based on the fundaments of human intelligence. In this mixed space focused on exploring the basic elements of a science of cognition and intelligence, neuroscientific, psychological, computational, biological and technological disciplines would interact on an equal basis. This focus would make it possible to define a new field of study, namely the Science and Engineering of Intelligence. However, to achieve this goal there must be structures for academic cooperation within these bounds, with institutional recognition and the promotion of interdisciplinary and interuniversity networks and forms of collaboration, so that a mixed-approach community can be structured and consolidated in Spain. In addition to this perspective, others in which AI is associated with disciplines such as philosophy, sociology, psychology and language studies will be strengthened, in order to enrich and diversify the AI ecosystem in Spain.

TRAINING AND ATTRACTING AI SKILLS IN GOVERNMENT ADMINISTRATION

Government administrations must also contribute to the development of AI capabilities, through training and reskilling plans provided by the State, the Autonomous Communities and local corporations. These training plans should provide public-sector staff with the knowledge required for AI-based solutions, at all levels, including executive positions, to be employed to improve the services offered. Accordingly, consideration will be given to the creation of Master's programmes in AI, to be supplied either in the public sector alone or in collaboration with private entities, and to establishing mechanisms enabling greater flexibility in attracting, retaining, selecting and planning personnel and in service provision. In the lawtech-legaltech (legal technology) sector, the training and research potential of the Centre for Legal Studies of the Ministry of Justice will be employed as appropriate, in accordance with the current model of co-governance.

In addition to the above, AI talent and skills must be attracted to enter government administration. Our society is aging and with it, our public sector. This process is aggravated by the currently scant appeal of the public sector as a source of employment, by a lack of knowledge about the role played by our institutions, and by the low value assigned to the functions carried out by their personnel. The successful implementation of information technologies in general, and of AI in particular, could revolutionise the production processes and working methods of the administration.

In this respect, it is essential to act proactively to reinforce the quality of our public services, and AI provides a unique means of doing so. Its successful implementation would require coordinated actions in all of the following areas, aimed at attracting human capital towards government administration, with each reinforcing the other:

1.   Attract skills and talent: Widespread ignorance of the role of the public sector and of the employment potential it offers is limiting government's access to skilled personnel. To remedy this situation, flexible contracts could be offered to university and research centre staff to enable their short-term or part-time employment within government facilities. Another possibility would be to create public-private consortia, bringing together researchers from the public sector and staff from SMEs and startups, to develop government-sponsored productive projects.

2.   Improve the image of public-sector employment: Among possible areas of attention in this respect, attention should be drawn to the role of the Administration in society as a fundamental support for public policies and services, in which the human factor is an essential component. The added value of AI would enhance the quality and operability of public services and their interaction with society, raising awareness and appreciation of the implementation of public policies.

3.   Boost the quality and accessibility of information on public employment: Access to employment is governed by the principles of equality, merit and ability. Public employment is stable and encourages career progression, both horizontal and vertical, and the continual acquisition of new skills. The Administration has pioneered access for persons with different skill sets and who present 33% disability or greater. In all employment offers by the Administration, special emphasis should be placed on recruiting persons combining technical capacities in subjects such as science, technology, engineering and mathematics (STEM) with skills and knowledge in humanistic components and the social sciences (STEAM), to promote a balanced approach to the diverse aspects of AI.
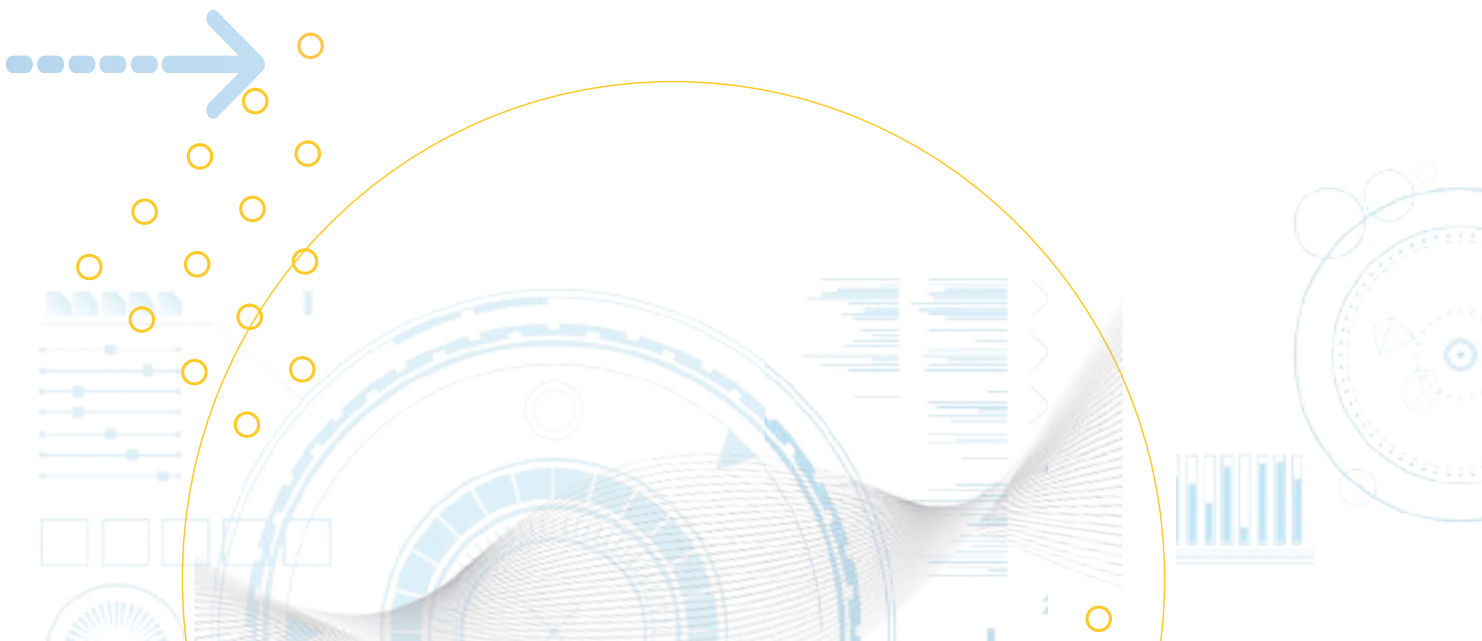
WORKPLACE TRAINING

Going beyond the education system, it is essential to promote training in the workplace to accompany technological transitions. In Spain, the current rate of unemployment among school leavers and graduates of vocational training courses is 16%, compared to 8% among university graduates. In view of the anticipated digitalisation of the economy, and assuming appropriate mechanisms for technical training in AI technologies, professional training in this area could be the best means of addressing the technology gap and improving employability. In this respect, the EU has published a Digital Education Action Plan, setting out the strategic priority of improving digital capacities, in basic and advanced digital education[46].

Finally, to ensure that this technology is guided by principles of collective bene(t, spaces for communication and debate should be fostered between the agents involved and civil society, in order to enhance public understanding of smart technologies and to make known the real challenges and opportunities. In this endeavour, special attention should be paid to the elderly, persons of foreign origin, families with limited resources and residents of rural areas, who may have fewer opportunities than others and might require special instruction in the use and understanding of these technological resources.

ATTRACTING AND TRAINING PERSONNEL WITH SPECIALIST AI SKILLS

Spain is strongly placed to attract AI talent, with two cities, Madrid and Barcelona, among the top ten in Europe for the establishment of startups. In addition, projects with outstanding capacities for innovation are being developed in Aragón, Valencia, Malaga, Granada, Bilbao, A Coruña and elsewhere. These projects are drawing investment by Spanish and foreign companies, attracted by the higher quality of life offered and by lower financial costs. Another relevant factor is the COVID-19 pandemic, which is displacing many workers towards less populated areas of the country and rural environments. The National Strategy for AI aims to consolidate Spain as a pole of attraction for AI talent and for the creation of R&D centres for international companies. To achieve these goals, however, there must be appropriate territorial cohesion, especially as concerns communications.

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[46] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

ACTION TARGETS FOR 2025

### ACTION TARGET 2.1 ‹ DEVELOP NATIONAL TALENT AND SKILLS IN AI

ACTION 8. Develop the National Plan for Digital Competence, introducing elements of computational thinking and AI into the school syllabus, modernising vocational training, developing university and post-university training, fostering occupational reskilling and digital training among the population as a whole, promoting vocations in the fields of science, technology, engineering, mathematics and the humanities (STEAM), with a special focus on reducing the gender gap, and establishing AI training and discussion events.

ACTION 9. Strengthen the provision of AI training among vocational and university students, expanding Doctorate and Master's studies and post-graduate courses, offering more positions for teaching and research personnel, and updating the content of degree programmes. Promote interdisciplinary and interuniversity structures for academic cooperation to consolidate a nationwide, broad-based academic community and to promote international exchanges.

ACTION TARGET 2.2 ‹ ATTRACT AND RETAIN GLOBAL TALENT IN THE FIELD OF AI

ACTION 10. Launch the "SpAIn Talent Hub" programme, in coordination with ICEX Invest in Spain, to attract both academic and professional talent in the field of AI, with special emphasis on attracting foreign investment (including the creation of company headquarters/facilities in Spain), on investments with a social impact and on promoting the incorporation of female entrepreneurs and women with talent.

ACTION 11. Launch a programme to support the **recognition of international qualications and accreditations** in order to attract international teachers of AI.
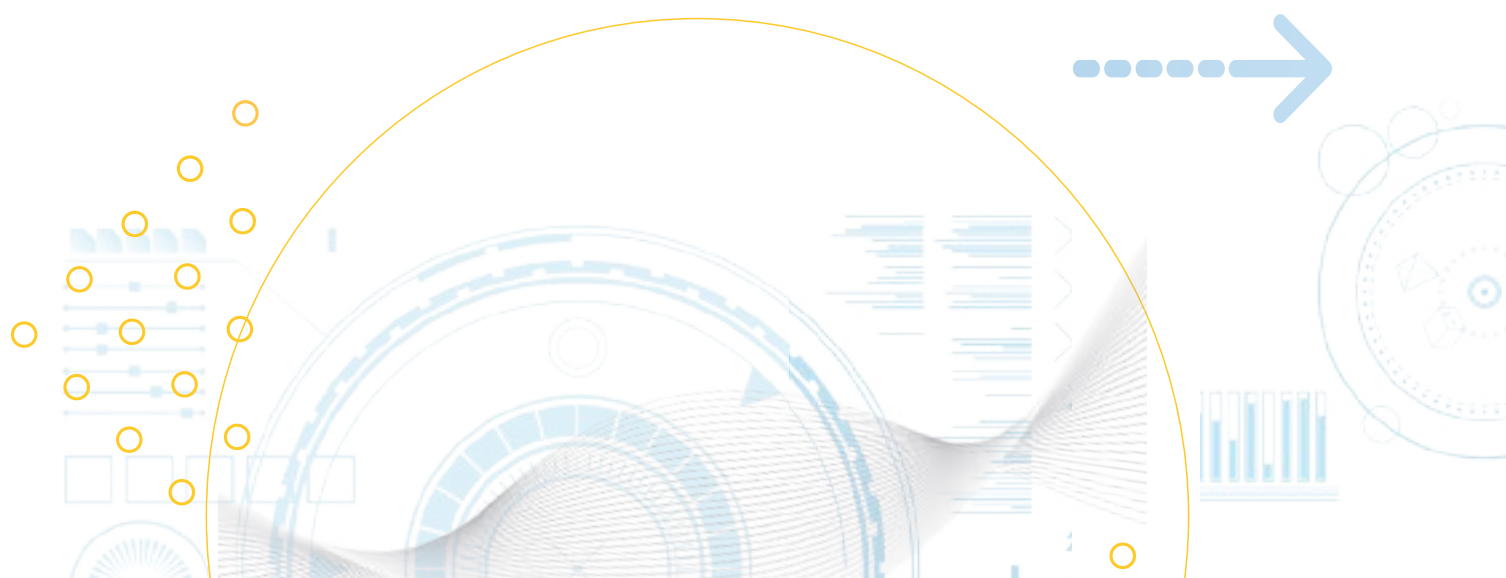
STRATEGY
LINE 3.

DEVELOP DATA PLATFORMS AND TECHNOLOGICAL INFRASTRUCTURE TO SUPPORT AI

STRATEGY LINE 3. DEVELOP DATA PLATFORMS AND TECHNOLOGICAL INFRASTRUCTURE TO SUPPORT AI

Digitalisation, availability and access to large volumes of data, and the existence of high-performance infrastructure and processing capacity are essential to the development of AI. In addition to investing in the generation of new datasets and infrastructure, the efficient management and proper use of data throughout its value chain must also be ensured, respecting the principles of integrity, reliability and quality, and protecting citizens' rights and privacy, as described in Strategy Line 6.

The data comprising these data platforms and infrastructure must be disaggregated by sex, age, nationality and geographic location, among other variables.

The actions described in this Strategy Line are intended to originate and develop solutions to three key issues regarding data platforms and AI technology infrastructure.

1.   Develop the regulatory framework for Open Data, to define a strategy to publish and enable access to public data, to facilitate the use and sharing of multilingual data among government administrations and other agencies, and to ensure the proper, safe use of the data.

2.   Promote actions regarding data platforms, models, algorithms, inference engines and cybersecurity to catalyse research and innovation aimed at improving the security, certification, efficiency and governance of open and closed data and of the AI system.

3.   Promote the specific development of AI technologies in the field of natural language processing, which represents a great opportunity for Spain to play a leading role in this area, in view of the growing importance of the Spanish language worldwide.

PUBLIC DATA PLATFORMS

With current AI technology, the ability to impact on the value chain depends mainly on the availability of large volumes of high-quality data and metadata. Moreover, the data must be accessible, complete, secure and managed in full compliance with regulations on data confidentiality.

To ensure the correct management of data in the public sphere, appropriate regulations will be established, a Data Office created and the role of its Chief Data Officer clearly defined. The Data Office will form part of the General State Administration and will coordinate the constituent administrations to guarantee the storage, access and consistent, secure treatment of multilingual data related to energy, agriculture, natural resources, infrastructure, science, industry, social security, employment, the administration of justice and health care, among other sectors. The Office will enhance the availability of data sets, making them available to improve administrative procedures and to enable

the private sector to safely develop AI-based solutions, products and services whilst applying best practices in terms of security and data quality[47].

Following recent initiatives, Spain is now a European reference in the (eld of open data[48]. The law on the reuse of public sector information[49], has resulted in important initiatives being taken to promote access to public data in Spain. A series of collaboration agreements between the General State Administration[50] and the public business entity Red.es[51] to promote the accessibility and reuse of public sector information has led to the adoption of a body of actions termed the APORTA Initiative (an open data initiative sponsored by the Spanish Government[52]). The Organic Law to Protect Personal Data and Guarantee Digital Rights[53] establishes new obligations for the public sector, such as the power to verify the authenticity of citizens' personal data and the designation of a Data Protection Office.

Furthermore, initiatives on open data and the reuse of public sector information are being applied locally and regionally, and within the context of the EU, in accordance with amended Community regulations in this respect[54]. The legislation regulates the use of data in publicly-funded research, including metadata, dynamic data and high-value data, introducing conditions on the reuse of such data and measures related to exclusive agreements.

An interdisciplinary Working Group on open data in the national public sector will be created to ensure the efficacy of the above actions and initiatives.

The private sector will be encouraged to develop accessible data storage facilities and to facilitate data sharing and/or publication, following the necessary technical preparation and definition of strategies in this respect. Companies will be encouraged to establish a data life cycle, based on collection, preparation, publication and maintenance. In addition, monitoring and supervision protocols will be defined for data sharing.

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[47] Royal Decree-Law 14/2019, of 31 October, adopting urgent measures for reasons of public security in matters of digital administration, public sector procurement and telecommunications.
[48] https://datos.gob.es/es/dashboard
[49] See Royal Decree 1495/2011, of 24 October, which developed Law 37/2007, of 16 November, on the reuse of public sector information, for the national public sector.
[50] Through the Secretary of State for Digital Advancement and the Secretary of State for the Civil Service.
[51] https://www.red.es/redes
[52] https://datos.gob.es/es
[53] https://www.boe.es/buscar/doc.php?id=BOE-A-2018-16673
[54] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=uriserv:OJ.L_.2019.172.01.0056.01.SPA

In the judicial field, institutional skills-training policies will be adopted. The Centre for Legal Studies, part of the Ministry of Justice, will play an important role within this Strategy Line, functioning as a Digital Intelligence Hub for the technological legal sector (lawtech-legaltech) and providing AI skills training within the public sector.

Regulatory measures will be adopted to reinforce commitments for the protection, coordinated management, openness and accessibility of information available to the public sector. Furthermore, in conjunction with the private sector, new value-added, data-driven services will be facilitated. In this respect, and in line with the proposed European Data Strategy[55] encouraging the creation of sectorial data pools, an action framework will be developed to implement data sharing models, as a means of encouraging innovation and experimentation, at the following levels:

- **G2B** (Government to Business)

- **G2G** (Government to Government)

- **G2C** (Government to Citizen)

- **C2G** (Citizen to Government)

- **G2G** (Business to Government)

- **G2C** (Business to Business)

The introduction of new, data-driven processes and services, in both the public and private spheres, will be assured by the use of secure environments, or sandboxes, with the support of the European Commission and the European Parliament. The main purpose of this approach is to test new AI applications in different areas, in comparison with the existing regulatory framework, in a process performed by participating entities and the regulatory authority. These sandboxes and data repositories may be exploited by government agencies, as users and catalysts of AI, and by the creators of and contributors to the data repositories, possibly as part of a network of Digital Innovation Hubs. They are expected to be particularly valuable for SMEs, both regionally and locally. In Spain, the General Secretariat for the Treasury and Financial Policy has promoted a Financial Sandbox law[56], to establish an appropriate legal environment in which financial innovations will be implemented efficiently and safely. Thus, government administrations and others will be able to safely investigate new formats for data use, such as the acquisition of information relevant to taxation, as an alternative to current information return systems.

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[55] https://ec.europa.eu/info/sites/info/files/communication-european-strategy-data-19feb2020_en.pdf
[56] https://www.lamoncloa.gob.es/consejodeministros/Paginas/enlaces/180220-enlace_financiero.aspx

Finally, the Data for Social Good project will be launched, to stimulate the use and good governance of public and private data, thus generating a social and public good. Open data, citizen-generated data and government-to-citizen data transactions will be used to streamline processes that produce a marked social and public impact, thus enhancing the quantity and quality of public participation in government. For example, combinations of open, public or citizen-generated data could be used to monitor environmental phenomena (from air quality to the mapping of invasive species), to study aspects of community health or to open up new lines of public and private research.

DATA-ENABLING PLATFORMS AND CYBERSECURITY

For AI to be a powerful driver of innovation and economic growth in our country, it is necessary to promote digital-enabling technologies such as connectivity infrastructure, big-data storage environments (cloud technology), cybersecurity, high-performance computing, the Internet of Things, AI at the edge, automation, process control and smart systems for the development of services, products and processes.

An important element within the framework of cloud computing technologies is the European Gaia-X initiative, an ambitious project to create an ef(cient, secure and sovereign European public-private data infrastructure. This platform will enable providers to offer cloud computing services, in full compliance with European quality and performance standards. Another initiative within this same framework is the European Open Science Cloud[57], intended to manage, analyse and reuse data for research, innovation and education. This virtual infrastructure will help develop and support open science and open innovation throughout Europe and beyond.

Spain has a favourable starting point in this regard, thanks to its rapid deployment of very-high-speed connectivity, providing a lever for digital transformation and the deployment of AI technologies. Spain already has the most extensive fibre optic network in Europe, available to more than 80% of the population[58]. With its 5G development plan, Spain is among the most advanced countries in the world in the development of next-generation networks. Among other benefits, this greatly facilitates the penetration of AI technologies, for the use of companies and citizens regardless of their geographic location and income. Also of note are the 5G pilot projects that have been approved[59] and the wide variety of situations that can benefit from this technology (for example, in medical diagnostics and real-time image analysis).

[57] https://www.csic.es/sites/default/files/22febrero2019%20EOSC%20Synergy_0.pdf
[58] Data according to the report "Broadband Coverage in Spain, as of June 2018".
https://avancedigital.gob.es/banda-ancha/cobertura/Documents/Cobertura-BA-2018.pdf
[59] https://www.red.es/redes/es/que-hacemos/pilotos-5g

In June 2019, after a coordinated international exercise, the EU decided to make a significant investment in pre-exascale supercomputing research infrastructure, to be performed on the supercomputer at the National Supercomputing Centre in Barcelona[60]. This decision places Spain on the European supercomputing map, consolidating it as a benchmark within the EU and making it a pole of attraction for basic research and technological development for the private sector. Support from EuroHPC (the European High Performance Computing joint undertaking) means that Spain will play a leading role in this area, which among other outcomes will facilitate the development of AI on the international stage.

Emerging applications, such as those used by autonomous vehicles, human-machine interactions and the Internet of Things, require the incorporation of advanced data analytics capabilities into these peripheral devices. For such applications, moreover, the data environment must be secure, ensuring the principles of confidentiality, integrity and availability are fully upheld.

To guarantee this data security, all agents involved – the Administration, the business world and private citizens – must be alert to the perils and opportunities present, and there must be effective coordination between all involved in protecting the network, including regional authorities, the national cybersecurity centres and the Spanish Institute of Cybersecurity (INCIBE), which is responsible for promoting companies' cybersecurity, together with these agencies' counterparts in Europe and elsewhere. INCIBE provides cybersecurity services and mechanisms to prevent or respond to information security incidents, together with programmes to promote the advancement of an information-security culture, via awareness-raising and specialised training. INCIBE also generates and shares research knowledge related to cybersecurity, generating and developing talent in the field, and provides a channel for coordination among national and international organisations[61].

NATURAL LANGUAGE PROCESSING TECHNOLOGIES

A basic component of AI infrastructure is the processing of natural language. In this area, Spain benefits from the presence of a large body of experts in technology and the use of Spanish in AI. In consequence, Spain has presented its Plan for the Promotion of Language Technologies[62], to promote the development of natural language processing, automatic translation and conversational systems, in Castilian Spanish and other co-official languages, thus contributing to the internationalisation of companies and institutions in this sector, expanding Spanish participation in international R&D&I in ICTs, and enhancing cooperation with the Ibero-American community.

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[60] https://www.bsc.es/es
[61] https://www.incibe.es/que-es-incibe/que-hacemos
[62] https://www.plantl.gob.es/tecnologias-lenguaje/PTL/Paginas/plan-impulso-tecnologias-lenguaje.aspx

In addition, the Royal Spanish Academy (RAE) has recently underwritten an agreement between the network of academies and the main operators of digital platforms, termed the LEIA (Spanish Language and Arti(cial Intelligence) Project[63], aimed at defending, projecting and making good use of the Spanish language in the digital universe, especially in the (eld of AI and related technologies.

The affiliated organisations undertake to use components and materials for the development and deployment of their conversational assistants, their text-based language processing machines, search engines, etc., enabling Spanish to be included as an available language in their products or services. In this respect, moreover, the signatories pledge to follow the RAE criteria on the good use of Spanish.

The significance and specificity of natural language in the Public and Legal Administrations ecosystem will also be taken into account, both in the provision of services to citizens and in the internal management of government.

ACTION TARGET 2025

ACTION TARGET 3.1 ‹ PROMOTE DATA PLATFORMS

ACTION 12. Create a **national body for data governance** (the Data Office), to be headed by a Chief Data Officer. Actively participate in initiatives to create secure data repositories in the EU and in coordinating AI applications in the Administration, supported by regulatory sandboxes.

ACTION 13. Create decentralised, accessible data pools and repositories, to facilitate the provision of value-added services based on data infrastructure and the construction of safe, innovative AI applications in a regulatory sandbox environment.

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[63] https://www.rae.es/noticias/la-rae-presenta-el-proyecto-lengua-espanola-e-inteligencia-artificial-leia-en-el-xvi

ACTION TARGET 3.2] PROVIDE ENABLING TECHNOLOGICAL INFRASTRUCTURES

ACTION 14. **Promote the National Plan for Language Technologies** and resource creation in the Spanish Language in AI (LEIA) initiative sponsored by the Spanish Royal Academy and the National Language Plan.

ACTION 15. Strengthen **strategic supercomputing capabilities,** promote the development of high performance computing, facilitate access to and use of existing supercomputing centres and introduce Communication and Quantum Computing and Edge Computing.

ACTION 16. Launch the **Data for Social Good Project,** based on the use of public and citizen-generated data to generate a positive collective return (citizen science, the contribution of evidence for public policies, etc.).

STRATEGY LINE 4.

INCORPORATE AI INTO VALUE CHAINS TO TRANSFORM THE ECONOMIC FABRIC

STRATEGY LINE 4. INCORPORATE AI INTO VALUE CHAINS TO TRANSFORM THE ECONOMIC FABRIC

The digitalisation of society and business will create contexts in which compiling, processing and analysing data is the only way to understand reality, create strategic value, optimise processes and, in short, prosper. Therefore, AI is emerging as a sector of activity that in itself may generate close to 14 trillion euros within the global economy in 2030 and double economic growth rates by 2035.
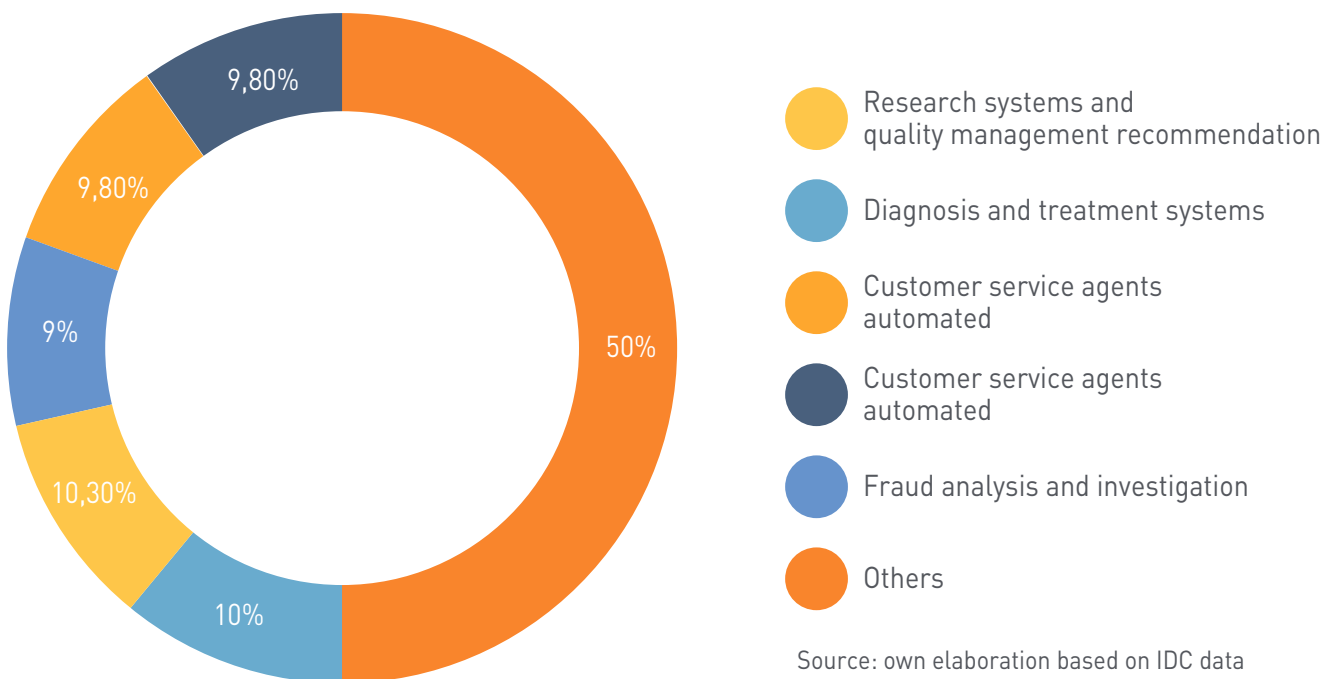

Artiﬁcial Intelligence Revenue, World Markets: 2016-2025
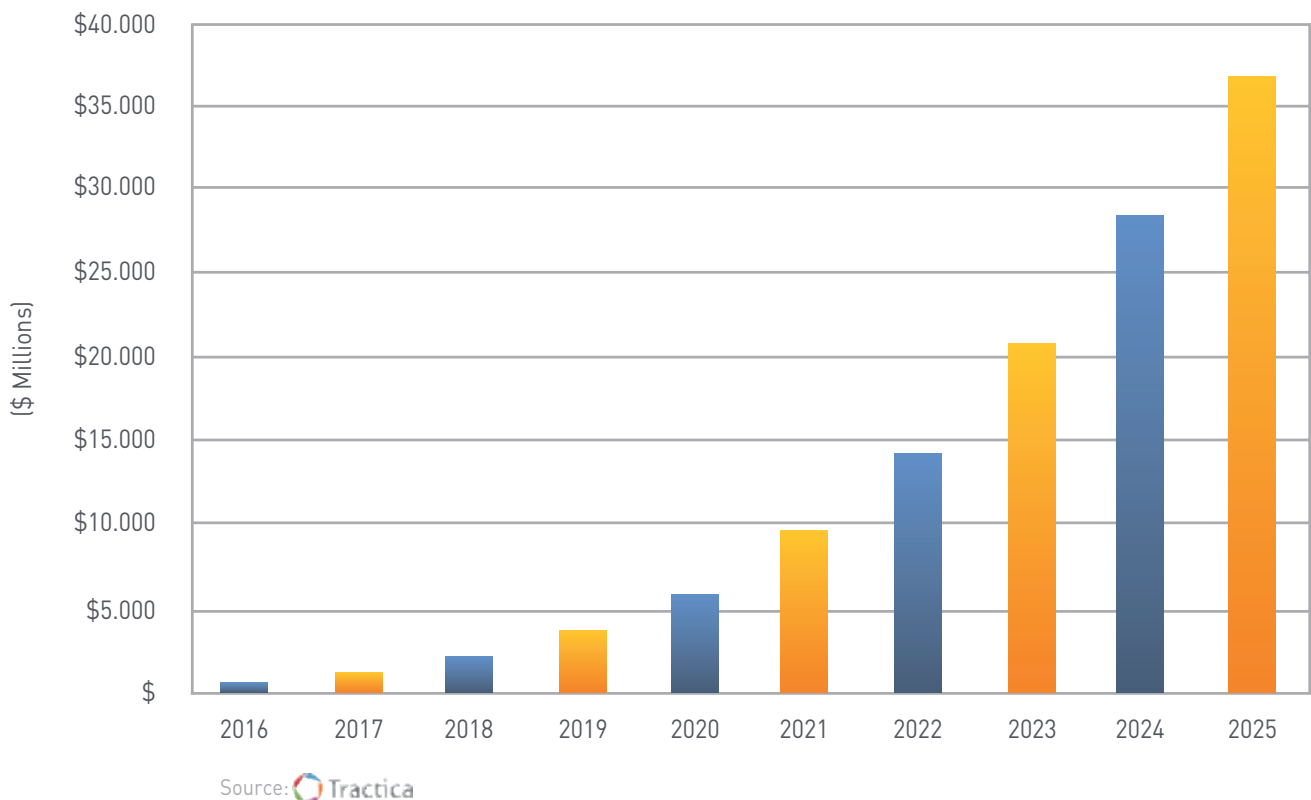
The market research firm Tractica forecasts that annual revenue generated by AI-based technologies will grow from $643.7 million in 2016 to $36.8 billion by 2025.

At present, half of all AI activities are concentrated in the following areas:

▪ **Automation of large-scale data processing,** reducing error margins and data processing times.

▪ **Diagnosis and processing of historical data:** increasing the speed and accuracy of diagnoses and enabling the early detection of anomalies.

▪ **Automated customer service agents (Chatbots):** Voice or text-driven conversational interfaces that allow the user to interact with the organisation's computer and operational systems, using natural language and with little or no human-human interaction.

▪ **Automatic threat prevention,** enabling response protocols to be triggered almost immediately.

▪ **Fraud investigation and analysis:** AI models of supervised or unsupervised learning, to reduce analysis time and margins of error in detecting risk or actual fraud in large volumes of transactions.

Examples of the most used use cases

- Research systems and quality management recommendation
- Diagnosis and treatment systems
- Customer service agents automated
- Customer service agents automated
- Fraud analysis and investigation
- Others

Source: own elaboration based on IDC data

THE CURRENT STATUS OF AI IN SPANISH COMPANIES

AI and Big Data are irregularly distributed in business activity sectors in Spain. In 2018, only 11.2% of SMEs and large companies and 2.3% of micro-companies used Big Data, and these firms were concentrated in a few specific sectors: information and communications (30.2% and 10.7%, respectively), transportation and storage (18.9% and 3.7%) and professional, scientific and technical activities (14.2% and 3.6%). These low rates of adoption mean there is ample room for improvement, in terms of benefiting from these technologies and creating business value.
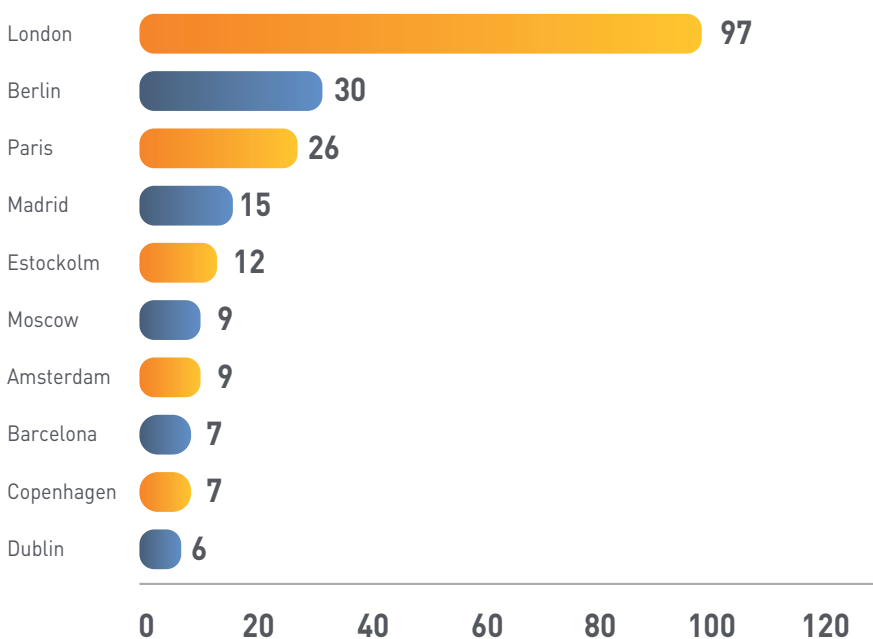
A wider understanding of this potential would encourage firms to assign adequate budgets for AI-based R&D activities and digital skills training, thus maximising investment returns.

Various sectors have been identified as presenting great potential for the adoption of AI, due to their size and importance in the Spanish production system. These sectors include tourism, health, agriculture, food and digital content, as well as other industries in which complementary technologies are being applied to AI, such as virtual and augmented reality, robotics in manufacturing, and the Internet of Things in Edge computing environments.

The impact of AI-based digital entrepreneurship

The disruptive technologies of the 21st century have largely been driven by companies created by entrepreneurs, and this SME segment should be supported in order to create AI-powered vertical lines of innovation.

AI startup hubs in the EU

Hub	Value
London	97
Berlin	30
Paris	26
Madrid	15
Estockolm	12
Moscow	9
Amsterdam	9
Barcelona	7
Copenhagen	7
Dublin	6

Based on data from Asgard Roland Berger

Spain is the fourth-largest AI market in Europe, and together with the United Kingdom, France and Germany it accounts for 60% of startups, laboratories and communities in the continent. Features of the AI market in Spain include its well advanced deployment of connectivity infrastructure, its buoyant research and innovation ecosystem, and a high level of human capital development, in terms of advanced technical qualifications.

Although Spain has a very active ecosystem of companies, with significant growth rates both in business creation and survival, the institutional and private funds available are insufficient to enable scalability, in contrast to other countries. Despite the notable development of financing instruments and the role of capital markets in the expansion of new companies (for example, through the Alternative Stock Market), an OECD report indicates that private equity investment in AI-focused startups in Spain from 2011 to mid-2018 was only 3% of the corresponding amount invested in the EU, well behind the figures for France (13%), Germany (14%) and the United Kingdom (55%).

These data show there remains ample room for improvement if Spain is to create an ecosystem of growth and innovation similar to that developed in other countries in the Single Market, and to lever its AI research capabilities to make Spanish companies industry leaders.

INITIATIVES TO PROMOTE AI IN ECONOMIC AND BUSINESS ACTIVITY

Spain has launched a series of initiatives to encourage the practical application of AI from R&D&I findings, including the Spanish Strategy for Science, Technology and Innovation 2021-2027, the State Plans for Scientific, Technical and Innovation Research, the recent Spanish Strategy for R&D&I in AI, the Technology and Innovation Strategy for Defence, the forthcoming Strategy for Safe, Sustainable and Connected Mobility, the National Integrated Energy and Climate Plan and the 4th National Strategy for Connected Industry. These action plans and programmes specify the instruments needed for AI technologies to be incorporated into applications and developments. Other programmes in this area include the Strategic Action on the Digital Economy and Society and the State Subprogramme to Promote Enabling Technologies (part of the State Plan for Scientific, Technical and Innovation Research 2017-2020). The latter programmes are specifically aimed at strengthening business competitiveness. Nevertheless, these programmes should also be re-dimensioned so that not only multinationals but also SMEs may benefit from these advances. The successful implementation of these programmes will stimulate innovation in the Spanish business world and help prevent a brain drain of Spanish talent to other countries.

The Autonomous Communities have developed local strategies for digitalisation, with initiatives in fields such as supercomputing, quantum computing, blockchains, AI and 5G.

One of the areas in which Spain has had most success is that of **Smart City** projects, which provide an ideal framework for the application of AI, where it has resolved challenges in economic, social and environmental fields, as well as in public management and governance. These projects are in line with the provisions of the National Plan for Smart Territories, the successor to the Smart Cities Plan, which have led to initiatives to improve digitalisation and services in local contexts, as envisaged at the Smart City Expo World Congress.

Spain is also a leading force in the aerospace sector, an industry where AI is increasingly being used for tasks such as analysing satellite data (for meteorological predictions, navigation, etc.), studying climate change, controlling human trafficking, detecting pandemics, urban planning, monitoring migrations and detecting industrial activities. In the "New Space" field that is opening up, Spain has proven its leadership capabilities in commercial cargo micro-launchers, and has the best geography in Europe for the commercialisation of space transport, an industry in which data and AI are the basis for its logistics operations.

FINANCIAL INSTRUMENTS TO SUPPORT THE PRIVATE SECTOR

To properly develop AI, digital entrepreneurship must be levered to transform, promote and accelerate the economy and society. Success in this area will help bring about a change in the country's economic model through the creation, consolidation and growth of companies, focusing on technological development, fostering talent and ensuring equality of opportunities for men and women. To achieve these goals, a series of measures are envisaged for application in the short, medium and long term to strategic sectors of the Spanish economy, such as mobility, the agri-food industry, health and tourism. In addition, legislation on startups will be enacted and a review will be conducted of public-sector financial support mechanisms.

In this (eld, too, the Government has created various programmes and instruments aimed primarily at SMEs. Notably, the Ministry of Science and Innovation has established the Innvierte programme (to be applied by the Centre for Industrial Technological Development), facilitating risk capital and seed capital, in collaboration with private investors. Direct subsidies for new companies are also provided, under the Neotec programme. Other instruments have been introduced under the National Strategy for AI (with participative loans, via the programmes Young Entrepreneurs, Entrepreneurs and Growth), by the Official Credit Institute (which together with the fund-of-funds Global FOND-ICO promotes the creation of privately-managed venture capital funds to invest in Spanish companies, at all stages of development) and by more sector-specific agencies such as the Institute for Diversification and Energy Saving (IDAE) (which in 2019 participated in innovative investment projects focused on the ecological transition) and the Spanish Meteorological Agency (AEMET).

Further action is needed to strengthen public (nancial support for private initiatives, in order to increase the impact of resources allocated to grants and to improve the return on the investments made via credits, venture capital, seed capital, industrial property instruments and other approaches to sharing the risks inherent to technological innovation, especially in the initial stages of business setup.

At different levels, government administrations have promoted technological centres and supported technological innovation in biotechnology, health, nanoscience and nanotechnologies, energy and climate change, telecommunications and the information society. In addition, support and guidance networks have been established, such as the 27 digital transformation offices that have recently been opened. Managed by Red.es, these offices provide information and training to SMEs to assist in the digitalisation of Spanish companies and the expansion of digital entrepreneurship.

To incorporate AI into the productive fabric, there must be effective national and regional coordination of the above policies, promoting synergies and avoiding the creation of closed technological environments. To this end, it is essential that companies collaborate and make use of technology as a tool for narrowing the gaps still present in terms of gender, age, urban vs. rural residence, economic capacity and level of education. Moreover, these instruments should be aligned and harmonised, and networks established to foster the diffusion and exchange of good practices. Streamlined mechanisms for intersectoral cooperation should also be introduced. In this context, a valuable role could be played by the Science, Technology and Innovation Information System (SECTI), composed of public and private coordinating agencies, finance and execution offices, and their relationships, structures, measures and actions to promote, develop and support R&D&I policy in Spain.

These national actions should be aligned with European Programmes that have AI-oriented funding, such as the H2020 R&D&I Framework Programme, the forthcoming Horizon Europe programme, the LIFE programme, the Digital Europe programme, the European Defence Industrial Development Programme and the future European Defence Fund. Other relevant areas, albeit at a lesser order of magnitude, include the projects developed by the European Defence Agency and by NATO. This international involvement means that Spain must ensure it has sufficient means to ensure a proactive presence, with active participation by public agencies (via SECTI) and the private sector.

Spain must also simplify and promote foreign direct investment and improve the regulatory framework to increase the return on investment. Therefore, we must support the ministries involved, promote the InvestInSpain programme and work towards eliminating regulatory, technical, fiscal, legal or other barriers to attracting skills and talent.

Given the importance of developments in this field, in Europe and worldwide, mechanisms should be established, addressing political, social, economic, security and sustainability issues, to ensure that Spain maintains its active role in the initiatives promoted by the EU, the OECD and international private forums (such as the World Economic Forum). In this respect, the UN Information and Communication Technologies Facility (UNICTF), located in Valencia, is an AI reference centre for the entire UN system. The development of AI, from programming the necessary algorithms to their real-world application, should comply with and contribute to the European Green Deal, which aims to make Europe the first climate-neutral continent, ensure a fair and inclusive transition, promote the intelligent use of resources for a clean, circular economy, reduce greenhouse gas emissions and pollution and restore biodiversity. Furthermore, the contribution of AI to the economy and growth must impose no ecological burden on the environment.

ACTION TARGETS FOR 2025

ACTION TARGET 4.1] HELP INTEGRATE AI INTO THE PRODUCTIVE FABRIC

ACTION 17. 17. Launch aid and support programmes for digital transformation and the incorporation of AI into production processes within existing value chains.

ACTION 18. Launch programmes to promote innovation in AI, as part of the Recovery, Transformation and Resilience Plan, as stipulated in the Spain, an Entrepreneurial Nation strategy and in the 2030 Industrial Policy Strategy. These programmes will be applied through Digital Innovation Hubs and other centres, the entrepreneurship and spinoff programmes offered by universities, the National Entrepreneurship Office and the territorial support network. In addition, an ecosystem of participation and mutual benefit will be created, involving companies in the activities carried out at specialised AI hubs.

ACTION 19. Launch the NextTech public-private venture capital fund to promote digital entrepreneurship and to foster the creation of highly innovative technology-based companies in the field of AI and its digital enabling technologies.

ACTION 20. 20.Develop the **National Programme for Green Algorithms** and promote the application of AI in the field of sustainability.

STRATEGY LINE 5.

ENHANCE THE USE OF AI IN GOVERNMENT ADMINISTRATION AND IN NATIONAL STRATEGIC MISSIONS

STRATEGY LINE 5. ENHANCE THE USE OF AI IN GOVERNMENT ADMINISTRATION AND IN NATIONAL STRATEGIC MISSIONS

The importance of the public sector in this technology is such that it is present in the AI strategies of many countries. Further proof is apparent in how the issue is addressed in international forums in which AI development frameworks are defined, such as the OECD, which has issued a specific report on the question: Hello, World: Artificial intelligence and its use in the public sector[64], and the AI Watch of the European Commission, which in its Artificial Intelligence for the Public Sector report analyses the use and impact of AI in public services.

The digitalisation of government administrations is one of the main "lever" policies set out in Spain's plan for Recovery, Transformation and Resilience. Indeed, the modernisation of public sector processes is expected to underpin and drive the economy and society in general. This will be achieved, firstly, by increasing productivity in both the public and the private sectors, and by enhancing the relationship between citizens and the administration. In addition, this modernisation will spur the development of new technological solutions and the innovation they generate within public management and procurement. Finally, it will foster the modernisation of skills and abilities throughout society.

In this context, the integration of AI will impact significantly on growth, by increasing productivity in the operation of public services, enhancing the citizen-administration interface, streamlining internal management, accelerating decision-making, supporting information management systems and aiding the definition and application of public policies. All of these benefits will accrue from the technological changes promoted by AI, affecting the productive and economic sectors, our relationships with others and how we view and understand the environment. Facing this transformation, government agencies cannot allow themselves to be left behind.

AI helps improve the transparency and disclosure of public activity, which ultimately benefits us all. It is our duty, as citizens, to monitor government activity, to understand it well and to be capable of using applications adapted to our needs; in short, to make good use of technological advances and thus improve our quality of life.

This is why it is necessary to consider the relationship between government administration and AI. Firstly, we describe the benefits that AI provides, after which we examine the government's role as a promoter of these technologies, and finally we highlight the benefits that citizens can obtain from this relationship.

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[64]https://www.oecd-ilibrary.org/docserver/726fd39d-en.pdf?expires=1583405945&id=id&accname=guest&checksum=925A586494022B78DD0241D09C4506BC

REFORM PF PUBLIC SERVICES

Artificial Intelligence

1 →

← 2

Public Administratipn

IMPACT OF IA

3 ↓
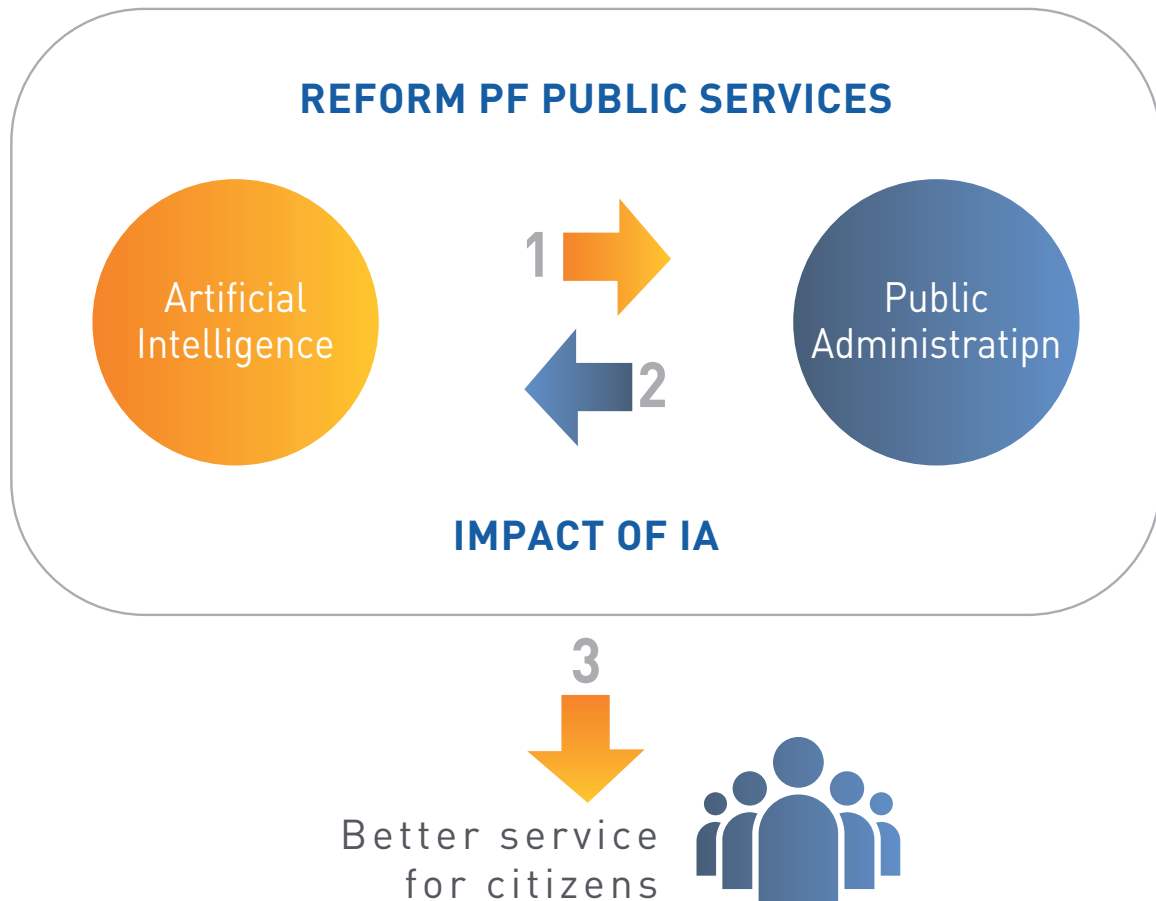
Better service for citizens

Figure 5. The introduction of AI into public administrations and its impact on citizens' services

THE IMPACT OF AI ON PUBLIC SECTOR REFORM

AI enables public agencies to become more effective and efficient, and to enhance their relations with society. Among the many benefits offered, AI enables government administration to:

- **Make decisions in a transparent way.** Information of public interest must be accessible, thus promoting open government and allowing citizens to monitor policymaking and implementation. To achieve this, the quality of the data provided and its accessibility will be improved and a data-focused culture fostered, using transparent, explainable algorithms to strengthen relationships between citizens and their government.

- **Create public data repositories** providing access under optimal conditions of security, legality, integrity, confidentiality and protection of the privacy of citizens. These repositories will facilitate the development of new applications and opportunities, both for the public sector (in health management, education, security, ecological transition, town planning, sustainable mobility, etc.) and for the private sector.

- **Reach evidence-based decisions and conduct informed policy evaluation.** For a public policy to achieve its objective, in justice, health, employment, or any other area, the decisions taken must be based on the most accurate, up-to-date knowledge available, thus ensuring public action is optimally effective and correctly oriented. Moreover, this should be done with full respect for privacy, the confidentiality of personal data and the principles of inclusion, accessibility and sustainability. Finally, this approach enables government agencies to take structured, reliable action in critical areas such as epidemiological prevention and responses to natural phenomena.

- **Increase the ef(ciency of administrative processes,** streamlining procedures, automating processes, incorporating the use of robots, enhancing interactions with citizens via virtual assistants or chatbots, strengthening security, combating fraud with models based on the detection of fraudulent patterns of behaviour, and in general, improving the quality of analytics-based public policies in order to determine optimal policies from simulations. Each of the ministries involved will implement programmes to integrate AI into its systems in order to improve data repositories and provide a better public service.

- **Avoid imbalances between rights and obligations** in the provision and use of data.

In this application of AI technologies to transform the Administration and its processes, potential areas of complementarity with the provisions of the Strategic Digital Administration Plan 2021-2024[65], will be identified, within the framework of the EU Structural Reform Support Programme[66], in order to obtain synergies with initiatives arising within the framework of these programmes.

Furthermore, and as in the United Kingdom[67], a guide will be published on the use of AI in the public sector, to ensure this technology is introduced in an orderly, interoperable manner, in compliance with ethical principles and current legislation and contributing to the development of trade and economic growth. The content of this guide will be determined in collaboration with the Autonomous Communities and with local corporations, through a **Sector Conference.**

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[65]https://administracionelectronica.gob.es/pae_Home/pae_Actualidad/pae_Noticias/Anio-2019/Octubre/Noticia-2019-09-30-Secretaria-General-Administracion-Digital-inicia-elaboracion-Plan-Estrategico-2021-2024.html
[66]https://ec.europa.eu/info/funding-tenders/funding-opportunities/funding-programmes/overview-funding-programmes/structural-reform-support-programme-srsp_es
[67]https://www.gov.uk/government/collections/a-guide-to-using-artificial-intelligence-in-the-public-sector

THE ADMINISTRATION AS A DRIVER OF AI DEVELOPMENT

The public sector has always played an inspirational role in driving the development, application and widespread adoption of new technologies, and must continue to do so throughout the process of AI adoption, funding research and innovation in the pre-rollout phases, promoting its development among users of new technologies, improving efficiency in the management and implementation of public policies, adopting innovative solutions and promoting the sector in a manner compatible with constitutional values.
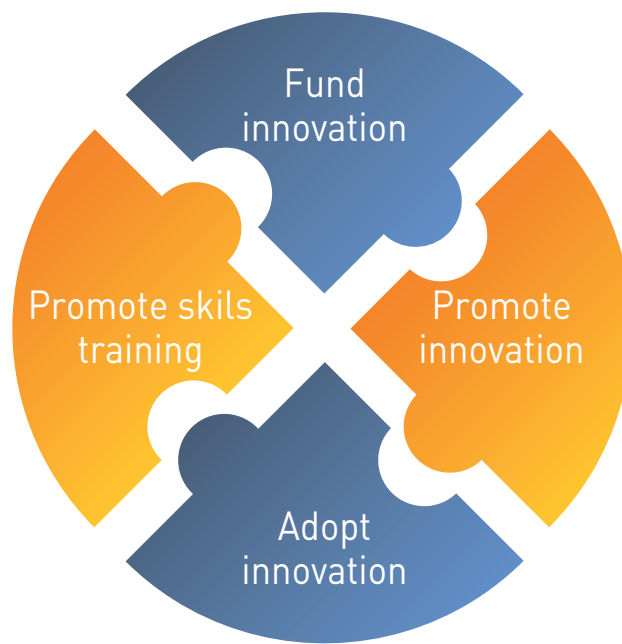

Figure 6. The role of the Administration in promoting the development of AI

Government administrations in Spain must strive to ensure that our country is not left behind in the adoption of technological advances such as AI, which will undoubtedly become a major driver of the global economy. To maximise access to the opportunities generated by AI, the following initiatives are proposed with respect to funding, public-private cooperation and inter-administration coordination:

▪ **Foster the introduction and adoption of AI through financial instruments** such as grants and subsidies, at national and supranational levels. This funding should be used to implement public and private projects that go beyond the possibilities of the relevant

▪ **Encourage public and private investment through mission-based programmes,** fostering innovation in socially important sectors such as sustainability and health care. Many public-private cooperation programmes will be located in the following areas, in which AI will doubtless become invaluable: safe, efficient and clean energy for the 21st century; sustainable and smart mobility; the revitalisation of the agro-food sector, keeping it large, sustainable and healthy; reinforcing and modernising Spanish industry; enabling a sustainable response to diseases and to the special needs of an aging population. These areas will all be addressed from a gender perspective.

▪ **Introduce innovative mechanisms of public procurement,** via the Innovative Public Procurement Programme referred to in Strategy Line 4 among the financial support instruments to be made available to innovative companies, in order to optimise the use of subsidies and public credits, and to enable universities to transfer their research outcomes to the market.

▪ **Commission technological solutions, thus promoting the development of new programmes and capacities by the private sector.** The public sector has numerous AI needs, in areas such as employment, health, justice and migration, and the call for these needs to be met will, in turn, stimulate innovation in AI. For this purpose, specific procurement instruments may be used, such as the innovation-focused association, by virtue of which a public agency identifies an objective or problem, inviting private companies to provide appropriate solutions. This approach will foster private innovation in areas where as yet no proven system or procedure exists. In this respect, too, the guidelines of the Digital Europe Programme will be taken into account, and the implementation of the White Paper on Artificial Intelligence will be monitored, with particular regard to the adoption of AI in the public sector.

▪ **Promote AI through other mechanisms, such as regulation, using controlled environments (sandboxes).** The present Strategy will be complemented by action programmes designed and implemented by the corresponding Ministries and sectors. In addition, public sector training in AI will be promoted, new technologies incorporated into employment selection processes, and administrative agencies restructured.

IMPROVE PUBLIC SERVICES

The actions described above will improve the services provided to citizens, with the use of mechanisms such as the Personal File (enabling citizens to access their administrative records online) and the One-Stop Register. Public service will also be improved with the growing implementation of AI, which will streamline procedures and automate tasks, making public services better targeted and more usable, accessible and personalised, for individuals and companies.

As noted above, the use of AI will transform the services offered by the Administration. Virtual robots and data processing tools will help optimise the use of time and resources, through the automation of routine tasks, resulting in improved service quality and reduced costs. By means of virtual robotics, personnel will be released from many repetitive tasks, alleviating workloads and allowing staff to focus on areas in which their input is essential, thus enhancing their value. Furthermore, the use of natural language processing technologies will improve the relationship between administrative offices and citizens, through the implementation of new forms of communication such as chatbots.

AI is making contributions to the public sector in many areas. For example, the mission-oriented approach is applicable to the provision of public services in activity sectors such as health and social services, environment and energy, justice, transportation and logistics, education, employment and security.

AI technology and tools are increasingly used by the Customs authorities, greatly facilitating trade and simplifying customs procedures related to securing the international logistics of goods, persons and means of transport, as well as performing protection and security functions. Strategic use is also being made of more advanced tools. For example in planning, monitoring and analysing Official State Aid, the Info@DS tool provides major benefits and increased reliability in data quality and usability.

Another important field in which AI is applied is that of health care, where it has been used to reinforce strategic projects. One area in which AI excels is the simplification of algorithms for the provision of health care, such as the triage of patients, a task of vital importance to the efficient operation of the health system.

The Plan for the Digital Transformation of Public Administrations, to be published soon, details the actions that will be implemented to incorporate AI into public sector processes.

ACTION TARGETS FOR 2025

ACTION TARGET 5.1. ENSURE OPTIMAL USE IS MADE OF AI

ACTION 21. **Incorporate AI into public administration** procedures to improve efficiency vis-à-vis citizens, industry, companies and society in general and eliminate administrative bottlenecks.

ACTION 22. **Launch an innovation laboratory (GobTechLab) to develop services and applications of AI in government administration.** Coordinate the AI programmes being applied in Ministries and public agencies to ensure standard programmes are used and solutions shared.

ACTION 23. **AI competencies in government administration.** Foster the use of AI in the Administration, in areas such as access to the civil service, staff training and job definitions.

ACTION 24. **Program "AI for data-based public management".** Use AI to obtain real knowledge of society, to achieve accurate macroeconomic forecasts and to determine public policies based on reliable, up-to-date information. Furthermore, use AI to improve employment policies and skills-training procedures.

ACTION TARGET 5.1. ENSURE OPTIMAL USE IS MADE OF AI

ACTION 25. **Promote national strategic missions in the field of public administration** where AI can have an impact to improve services to citizens (areas such as health, justice, employment, etc.).
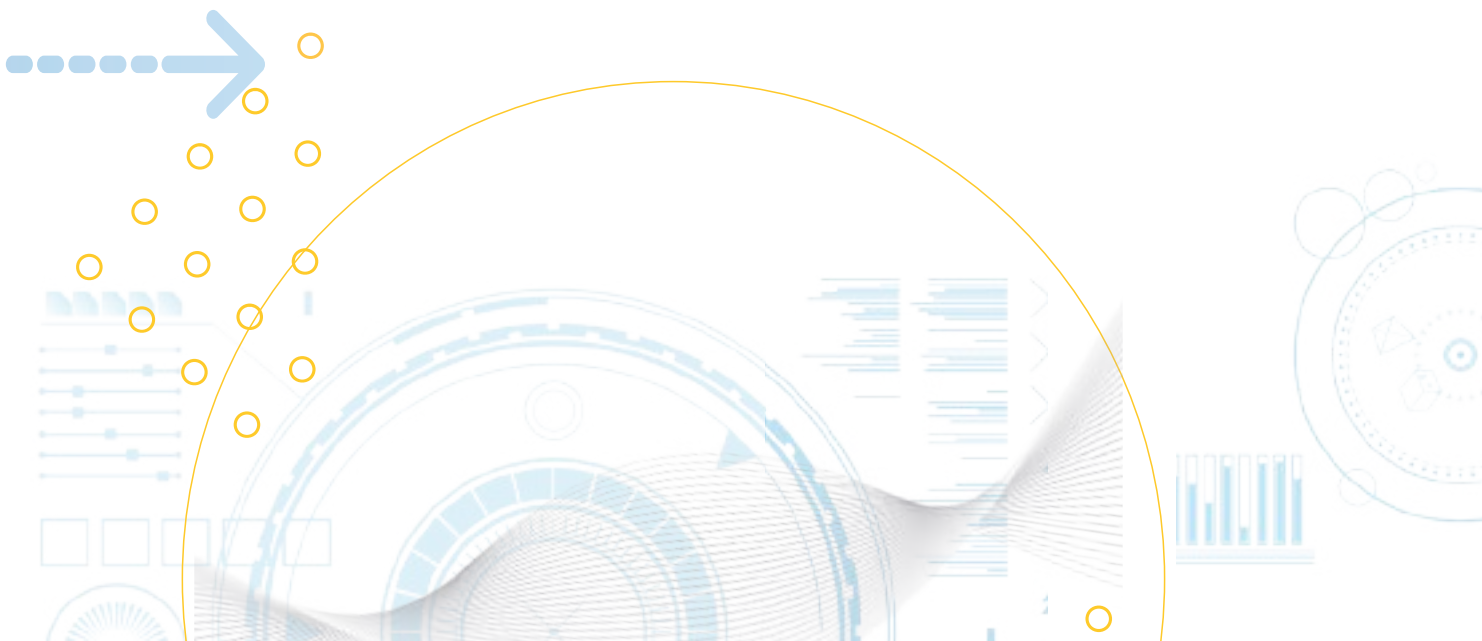
STRATEGY LINE 6.

ESTABLISH AN ETHICAL AND REGULATORY FRAMEWORK THAT REINFORCES THE PROTECTION OF INDIVIDUAL AND COLLECTIVE RIGHTS, IN ORDER TO GUARANTEE INCLUSION AND SOCIAL WELFARE.

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The potential impact of the development and deployment of AI raises expectations, but also uncertainty due to its ethical, legal, employment, social and economic implications. For Spain to exercise sovereign, effective control over this technological revolution, the appropriate framework for action must be created. The aim of the National Strategy for AI is to adapt our rules of coexistence to meet current needs, to ensure that our ethical and legal framework is appropriate and to determine what adjustments may be needed.

In promoting the adoption and use of AI, all democratic societies must ensure that values of social welfare and sustainability underpin its design, development and implementation, requiring the use of big data and advanced technologies in order to improve public services and generate collective benefits, as called for by the EU[68].

In this respect, actions to define and develop services are envisaged in three key areas affected by AI:

- **Legal.** Pre-existing fundamental rights must be protected, the necessary legal reforms identified, and action taken to address loopholes that may require additional regulation.

- **Socio-technological.** Action will be taken to establish methods, standards and processes with which to develop automated services.

- **Ethical.** It is essential to ensure that the use of AI is in accordance with society's fundamental values and is employed to achieve inclusion and to enhance the well-being of the population

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[68]https://www.euractiv.com/topics/gaia-x/

LEGAL FRAMEWORK FOR AI

To ensure that society can benefit from the enormous potential of this technology, AI must be developed in accordance with all applicable laws and with our Constitutional principles.

The EU is preparing specific legislation on AI to ensure that fundamental rights are respected, emphasising the importance of privacy and non-discrimination[69]. Spain will play an active part in European talks to define a balanced regulatory framework that ensures the protection of fundamental rights while fostering innovation and benefiting from the economies of scale offered by the internal market. This regulatory framework will allow us to gain global competitiveness and at the same time support European digital sovereignty.

Numerous initiatives and studies are being conducted throughout Europe to address questions such as gender issues, ethics and computational thinking in AI[70].

AI systems must respect fundamental rights, enable fair access and prevent discrimination, as well as all the rights enjoyed in the analogue world. Legislative and administrative reforms will also be required to ensure the acceptability and operability of the new technological scenario within a democratic framework. These reforms will be especially significant in the administration of justice, in view of the present model of co-governance in this sector and the importance of the interoperability and interconnection of systems and applications.

Spain will also participate in the forums of international organisations such as the Council of Europe and the OECD to advance a joint vision on AI that is reliable, ethical and respectful of fundamental rights, in order to ensure continuing progress in social welfare and in the quality of life and work.

QUALITY AND TECHNICAL IMPLEMENTATION

It is important that AI systems be transparent and auditable, so that their operation can readily be explained, because the tasks performed assist decision-making that may impact significantly on people's lives and on how society functions. Such is the case, for example, of medical applications or of autonomous vehicles. For this reason, the teams in charge of developing AI systems must be aware of the possible repercussions of their design decisions and be able to verify the quality of the systems developed so that, when appropriate, the appropriate modifications can be made to alleviate any undesirable effects.

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[69] Libro Blanco sobre Inteligencia Artificial: https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_es.pdf
[70] https://www.informatics-europe.org/publications.html

This Strategy Line includes two key actions aimed at reinforcing confidence in AI systems, together with standards to ensure their fair, inclusive and balanced development.

To properly supervise automated systems, they will be continually monitored, in a process going beyond certification. Moreover, in addition to the implementation of EU seal and certification schemes, a catalogue of supplementary measures for the supervision and evaluation of algorithmic systems will be developed.

This catalogue should facilitate the implementation of the fundamental ethical principles established by the international community[71] and will receive input from companies, individuals, social agents and all levels of government administration, to ensure the development of fair and appropriate AI systems:

- **Human supervision.** AI must be subject to continuous monitoring, and it must be readily understandable.

- **Governance of data and systems.** The data must not be used to harm society or to breach the fundamental rights of citizens. Data have personal implications and at the same time have the character of public good. The ethical and legal standards employed to establish the democratic balance between these two considerations must be carefully examined by the IA ethics committee and also in the corresponding process of legal review and reform.

- **Transparency (traceability).** The traceability of AI systems must be guaranteed. This means ensuring that the decisions taken by algorithmic systems can be audited, evaluated and explained by the persons ultimately responsible.

ETHICS AND VALUES

Ethical implications emerge throughout the AI development process. One such is the possible bias of AI algorithms, caused, for example, by their being trained with data that are not representative of the universe intended to be explored. The design and implementation of algorithms requires balancing technical quality and efficiency with the ability to identify and correct the ethical issues that may arise.

To ensure that the AI systems developed in Spain meet the highest standards, consultations will be held within the AI Advisory Council to determine appropriate measures for the development of AI, guided by the following ethical principles, among others.

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[71]https://www.coe.int/en/web/freedom-expression/committee-of-ministers-adopted-texts/-/asset_publisher/aDXmrol0vvsU/content/recommendation-cm-rec-20 20-1-of-the-committee-of-ministers-to-member-states-on-the-human-rights-impacts-of-algorithmic-systems?inheritRedirect=false&redirect=https%3A%2F%2 Fwww.coe.int%2Fen%2Fweb%2Ffreedom-expression%2Fcommittee-of-ministers-adopted-texts%3Fp_p_id%3D101_INSTANCE_aDXmrol0vvsU%26p_p_lifecycle %3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-1%26p_p_col_pos%3D1%26p_p_col_count%3D3

- **Inclusion and non-discrimination.** AI systems must consider the full range of human skills and requirements, and ensure accessibility.

- **Social welfare** AI must contribute to the common good, supporting the well-being and fundamental rights of human beings, and not diminish, limit or divert their autonomy.

- **Sustainability.** AI systems should be used to improve sustainability and ecological responsibility.

Furthermore, a wide-ranging consultation has been conducted and a Committee of Experts established to draw up a Digital Bill of Rights, in order to identify a set of fundamental principles to regulate the use of AI systems, both nationwide and regionally, ensuring the legislative and normative framework is appropriate to the novel circumstances arising in the digital field, particularly those related to the growing implementation of AI. This Bill of Rights will also reinforce Spain's presence in the world forums at which issues related to ethics and the protection of values and rights are addressed.

Digitalisation and the expansion of the knowledge society are expected to contribute to development in partner countries and to the implementation of the 2030 Agenda for Sustainable Development[72/73].

SOCIAL IMPACT AND RISK MANAGEMENT

This Strategy Line also includes various actions aimed at increasing public confidence in AI and analysing the impact of the use of algorithms, in different areas of society.

For society to trust AI and understand the implications of its use, it must have reliable information and appropriate skills. In general, citizens must be enabled to acquire basic digital skills, so that a digital society can be developed and maximum benefit obtained from it. Accordingly, the EU has defined a European Framework of digital skills for citizenship (the EU Science Hub). In addition, in view of the speed at which new technologies are being developed, it is essential to observe and study the long-term impact of algorithmic decision-making, compiling information and conducting studies that not only identify but also anticipate its effects.

For this reason, the present Strategy will encourage citizens to take part in the debate on the most significant aspects of AI and its governance, by promoting national and international forums for dialogue.

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[72] https://www.agenda2030.gob.es/
[73] https://www.agenda2030.gob.es/recursos/docs/AGENDA_ADDIS_ABEBA.pdf

These encounters will address fundamental issues, such as the role of ethics in AI systems and the impact of this technology on human rights and public freedoms. The Strategy also envisages that Spain will actively participate in the main international forums organised to debate and define a global framework for the development and use of AI, with special attention to the Global Partnership on Artificial Intelligence promoted by the OECD.

A register of automated systems within government administrations will be set up using the GobTechLab, documenting both existing and future automated systems. Among other tasks, the ethical and legal aspects of AI systems will be evaluated, in order to reinforce the legitimacy of automated government systems and to underpin trust in them. The ethical framework created must take into account the specific nature of the public-sector use of AI and address the questions it poses.

In addition to observing the effects of AI on the digital society, the Strategy also highlights the need to analyse its impact on democracy, society and the individual, calling for active participation and for international debate on the role of AI systems, which should be focused above all on the wellbeing and sustainability of our society.

CITIZEN PARTICIPATION FORUMS

Ethical re)ection must begin prior to regulation and continue in parallel with it. In this process, society delineates its sensitivity and establishes the social positions that will later be channelled via its institutions. For this reason, there is a clear relationship between ethical debate and forums for collective debate. Democratic society must be led to realise that in its government and supervision, questions of engineering design should also be addressed, to ensure that the developers of commercial products employ technologies aimed at improving public services and at providing collective and social benefits.

The nature of political debate, on the distribution of burdens and rewards during and following social transformation, can be understood more clearly by viewing AI as a form of infrastructure, not as a product. This infrastructure takes the form of standards and of automated processes that act as intermediaries in the interactions of citizens in areas such as health, agriculture, mobility, communication, social welfare, banking, electronic commerce and employment, structuring social relationships, practices and interactions within that context. Due to this collective dimension, it is essential to facilitate spaces for communication and debate among the agents involved.

For the above reasons, it is essential to promote national and international forums for dialogue, awareness and participation in the (eld of AI, to foster communication between government, science, social partners, the private sector and civil society. Acknowledging this necessity, the Government has strengthened its participation in relevant international forums and in Spain has launched the **Digital Future Society** forum, together with the Mobile World Capital, to promote debate and scientific exchange on the humanistic, legal and ethical dimensions of technological innovation, guaranteeing the protection of collective rights and values such as inclusion, plurality, social cohesion, sustainability and access to public services.

In this regard, it is essential to implement programmes fostering scientific-technological culture, with the support of the universities and with an interdisciplinary approach. In this task, we must all work together, jointly fashioning a conceptual and interpretive outlook that will enable us to understand the technological changes currently taking place, so that citizens may adopt a critical position in response to the social changes produced by technological advance.

ACTION TARGETS FOR 2025

ACTION TARGET 6.1 ‹ GENERATE CONFIDENCE IN AI

ACTION 26. Develop a **national AI seal of quality** and prepare a battery of supplementary measures to AI Certification.

ACTION 27. Implement **observatories for ethical and legal evaluation** of the algorithmic systems used in government administrations and of their impact, in order to strengthen legitimacy and foster public confidence in the automation of public administration systems.

ACTION 28. Develop a **Charter of Digital Rights** as a dynamic framework guaranteeing the protection of individual and collective rights in the digital sphere, both nationally and in the European context, inspiring the development of a global humanistic setting.

ACTION TARGET 6.2 ‹ GOVERNING AI

ACTION 29. Launch a **model of national governance of AI ethics** through the AI Advisory Council, in collaboration with the Digital Transformation Advisory Council.

ACTION 30. Establish **forums for dialogue, awareness-raising and national and international participation in the field of AI,** to foster communication between government, science, the private sector and civil society, including a plan of activities to enhance understanding and to underpin confidence in AI, as a framework for social technological innovation and for creating bottom-up democratic, participatory processes with the use of new technologies.

IV.
SUMMARY
OF MEASURES

IV. SUMMARY OF MEASURES

STRATEGIC	PILLAR

1.
FOSTER SCIENTIFIC RESEARCH, TECHNOLOGICAL DEVELOPMENT, AND INNOVATION IN AI

1. Spanish Network of Excellence in AI.

2. Strengthen the pre-/post-doctoral contract system for research in AI.

3. Increase the flexibility of the **scienti(c careers of AI research staff.**

4. Promote the **creation of new national multidisciplinary centres for technological development,** with special focus on neurotechnologies.

5. **Assistance programme for companies** providing AI and data solutions.

6. Strengthen the network of **Digital Innovation Hubs (DIH)** specialized in AI at investigation level.

7. Create the **R&D&i Missions Programme in AI** to address major social challenges.

2.
PROMOTE THE DEVELOPMENT OF DIGITAL SKILLS, BOOST NATIONAL TALENT, AND ATTRACT GLOBAL TALENT IN AI

8. Develop the **National Digital Skills Plan.**

9. Promote more **AI-focus training options** in vocational training and university education.

10. Implement the **"SpAIn Talent Hub"** Programme to attract international talent fostering female talent.

11. Launch an assistance programme for the **recognition of international diplomas and quali(cations for teachers** to attract international talent, especially women.

3.
DEVELOP DATA PLATFORMS AND TECHNOLOGICAL INFRASTRUCTURE TO SUPPORT AI

12. Creation of a **Data Of(ce** and appointment of a Chief Data Officer.

13. **Creation of shared sectorial and industrial data pools** and decentralized and accessible repositories

14. Promotion of the **National Language Technologies Plan.**

15. Strengthening of **Strategic Supercomputing Capabilities** (cloud, edge, quantum).

16. Implementation of the **Data for the Social Good Project.**

STRATEGIC | PILLAR

4.
INTEGRATE AI INTO VALUE CHAINS TO TRANSFORM THE ECONOMIC FABRIC

17. Implementation of subsidy programmes to companies to incorporate AI into the production processes of value chains.

18. Programmes to promote transfer of innovation in AI through Digital Innovation Hubs specialized in AI at industrial level.

19. Launch of the **NextTech fund** of public-private venture capital fund to promote digital entrepreneurship and scaling up companies in AI.

20. Development of the **National Green Algorithms Programme.**

5.
PROMOTE THE USE OF AI IN THE PUBLIC ADMINISTRATION AND IN NATIONAL STRATEGIC MISSIONS

21. Incorporate AI into the public administration to improve efficiency and eliminate administrative bottlenecks.a administrativos.

22. Launch an innovation laboratory to develop new services and AI applications in the public administration **(GobTechLab).**

23. Foster **AI skills in the public administration.**

24. **"AI for a data-driven public management" Programme.**

25. Promote **national strategic missions** based on AI in the sphere of the public administration (e.g. health, justice, and employment).

6.
ESTABLISH A FRAMEWORK THAT GUARANTEES THE PROTECTION OF INDIVIDUAL AND COLLECTIVE RIGHTS, INCLUSION AND SOCIAL WELFARE

26. Development of an **AI national seal of quality.**

27. Launch **observatories for ethical and legal evaluation** of the impact of algorithms.

28. Develop and foster the **Charter of Digital Rights.**

29. Implement an **ethics national governance model** in AI (AI Advisory Council).

30. Promote **national and international forums for AI-related** dialogue, awareness raising and participation.

V. GOVERNANCE
AND BUDGETS

V. GOVERNANCE AND BUDGETS

V.1. GOVERNANCE

In the governance model proposed for the development and execution of the Strategy, an inclusive approach is taken to the different levels of government administration and to the economic and social representatives involved. The State Secretariat for Digitalisation and Artificial Intelligence (SEDIA) will make use of the instruments of State available to coordinate and facilitate the introduction of AI into the productive fabric, taking into consideration the European and international initiatives adopted in this respect.

The potential impact of AI technologies on a complex, multidimensional environment such as ours requires a cross-sectional approach, incorporating a wide range of public policies. To be effective, an appropriate model of governance must include the joint input of various departments within the General State Administration, and be properly implemented by each of the Ministries concerned, coordinated by SEDIA. Furthermore, mechanisms must be created to ensure effective coordination with the Autonomous Communities and local corporations. Sectoral conferences and other forums of coordination will be constituted to prepare the nationwide implementation of the Strategy. Finally, Spain's position in European and international forums must be carefully specified, and efforts made to ensure all possible cooperation with the private sector, which will play a crucial role in the transition process.

This Strategy forms part of Spain's Digital 202Agenda and of the Recovery, Transformation and Resilience Plan. Public-private collaboration, which is vital to the application of this Strategy, will be promoted through the Sectoral Councils and Conferences, and in particular through the **Advisory Council for Arti(cial Intelligence** and the **Advisory Council for Digital Transformation,** with the participation of the main economic and social agents.

ADVISORY COUNCIL FOR AI

The Advisory Council for AI was constituted to advise and support the government in the (eld of AI through Order ETD/670/2020, of 8 July, to create and regulate the Advisory Council for Arti(cial Intelligence, and to provide independent advice and recommendations on the steps to be taken to ensure the safe and ethical use of AI.

This Advisory Council is composed of internationally-reputed Spanish experts and of scientists, economists and representatives of society, with a balanced gender presence.

Among its terms of reference, the Council is expected to develop and monitor the actions taken under the Strategy, to analyse the implications of technological change in the workplace, to consider fundamental rights, to endorse the (ght against discrimination and to defend the fair access and use of these technologies. Committees may be created to address specific aspects of AI, I areas such as ethical questions or industrial applications.

The Council will independently **monitor and evaluate** the questions considered, establishing prior criteria enabling it to reach significant conclusions and to establish the foundations for transitional and final evaluations of the social and economic impacts of AI in activity sectors, essential public services and society in general.

Among other functions, the Council will:

- **Evaluate** observations and comments on the Strategy for AI, to draw conclusions that will facilitate decisions on revised versions of the Strategy.

- **Promote** training plans and content proposals.

- **Advise** the government on questions of open data.

- **Evaluate** the impact of AI on industry, government administration and society.

PERIODIC REVIEW OF THE NATIONAL STRATEGY

This Strategy is intended to be responsive and)exible, in keeping with the rapidly-evolving technology it must address. To achieve this aim, channels of communication will be opened through which individuals and collectives may make the contributions they see fit.

The information compiled will be analysed by the Advisory Council for AI, and the conclusions drawn will provide points of reference for the next edition of the Strategy, in two years.

V.2. INVESTMENT IN THE RECOVERY, TRANSFORMATION AND RESILIENCE PLAN

Implementation of this Strategy will require signi(cant investment, both public and private, in the coming years. The State will invest 600 million euros during the period 2021-2023, to which the Next Tech fund would be added to promote entrepreneurship in enabling digital technologies. This boost, which could mobilize a private investment of around 3,300 million euros[74], will serve to catalyse the action of universities and companies, guiding priorities, generating synergies and covering areas where significant perceived risk or absence of markets might delay private initiatives.
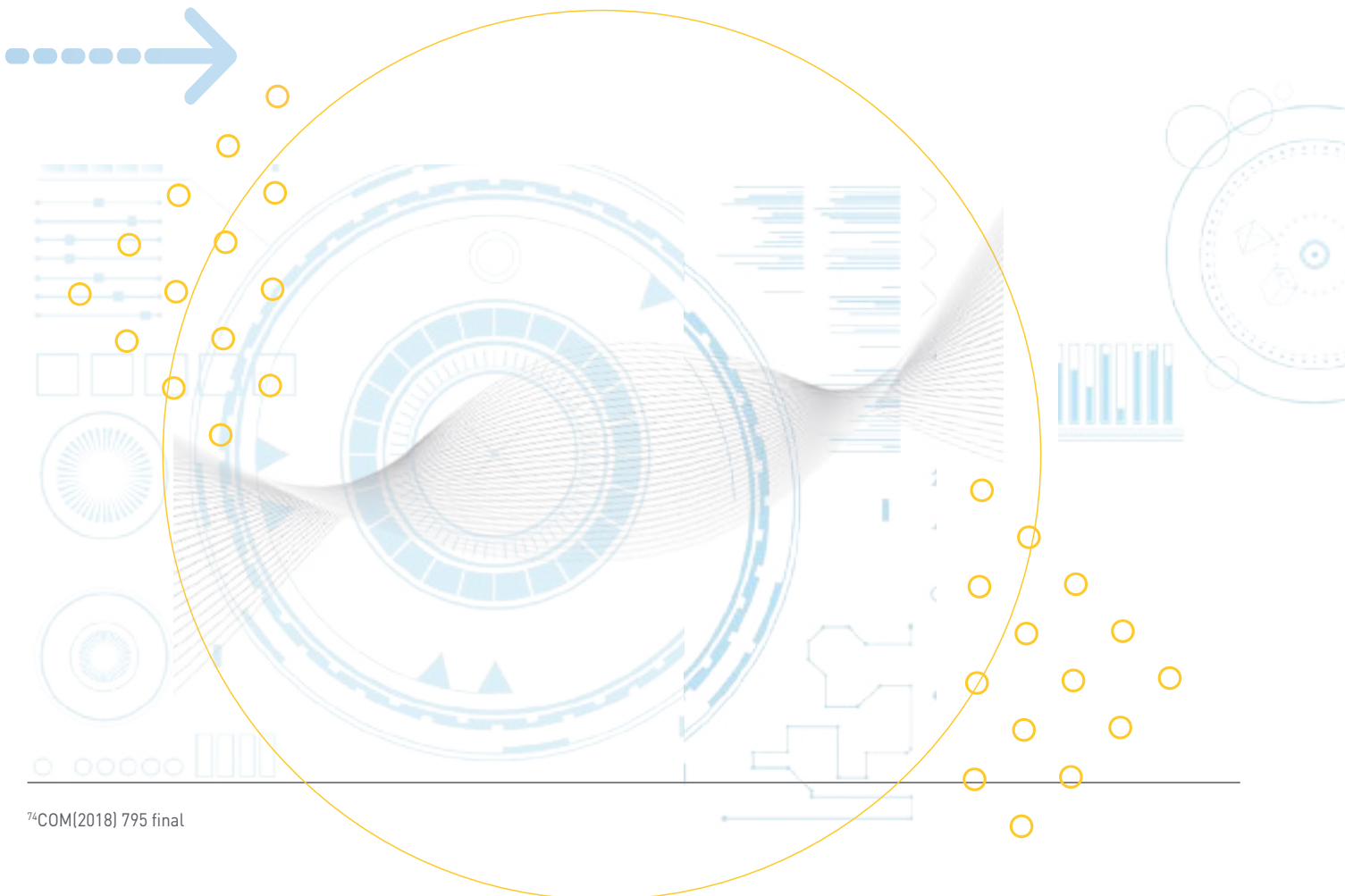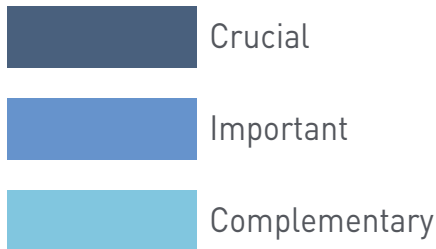
[74]COM(2018) 795 final

ANNEX 1:

RELATIONS BETWEEN STRATEGIC AIMS AND LINES OF ACTION

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Legend:
- Crucial
- Important
- Complementary

	Line 1	Line 2	Line 3	Line 4	Line 5	Line 6
A. Spain, a leader in AI science and innovation	Crucial	Important	Crucial	Complementary	Complementary	Important
B. Spanish-language AI	Important	Important	Crucial	Important	Important	Complementary
C. Workforce with AI skills and talent	Important	Crucial	Crucial	Crucial	Important	Important
D. AI, a factor for productivity and efficiency	Important	Important	Crucial	Important	Crucial	Important
E. Environment of confidence and regulation	Complementary	Important	Important	Important	Crucial	Crucial
F. Debate on ethics and human-centred technological development	Important	Important	Important	Important	Important	Crucial
G. Cross-cutting vectors: gender, digital, environmental, territorial.	Important	Important	Important	Important	Important	Important

Line 1. Promote **scientific research,** technological development and **innovation in AI.**
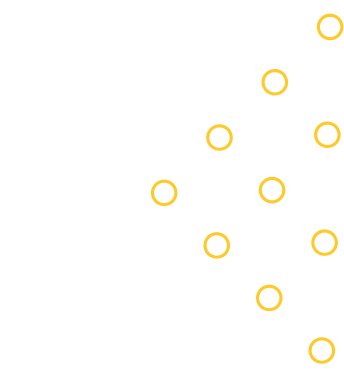
Line 2. Promote **digital capabilities,** empower **national talent** and **attract global skills in the field of AI.**

Line 3. Develop **data platforms** and technological infrastructures in support of AI.
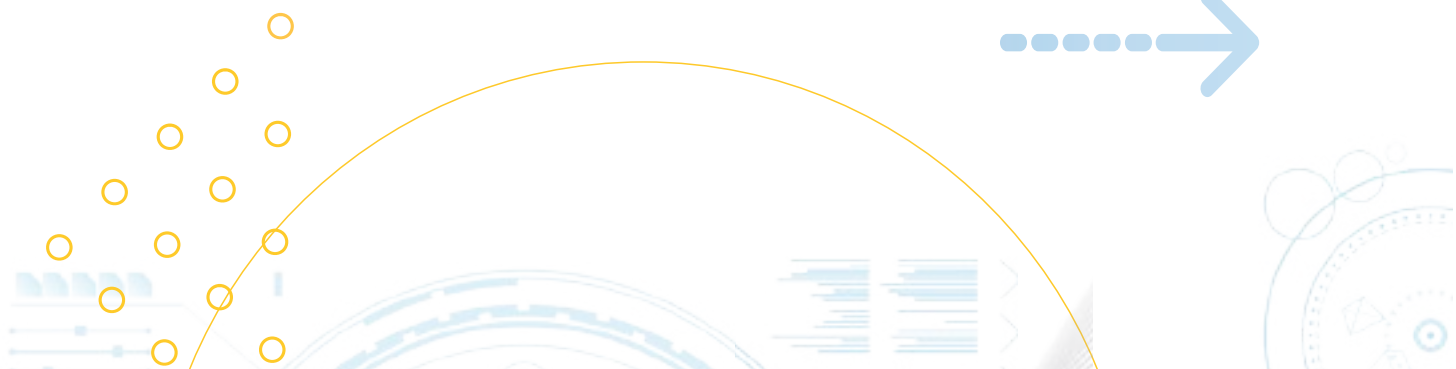
Line 4. Incorporate **AI** into **value chains** to transform the **economic fabric.**

Line 5. Enhance the **use of AI in government administration** and in **national strategic missions.**

Line 6. Establish an **ethical and regulatory framework** that reinforces the **protection of individual and collective rights,** in order to guarantee inclusion and social welfare.

RELATION BETWEEN LINES OF ACTION AND SOCIAL CHALLENGES (CROSS-CUTTING VECTORS)

Crucial

Important
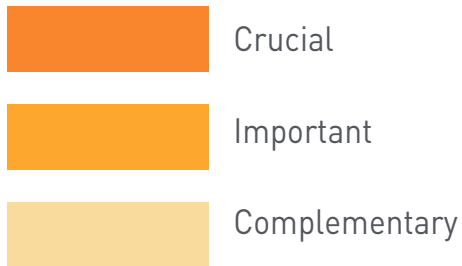
Complementary

	Line. 1	Line. 2	Line. 3	Line. 4	Line. 5	Line. 6
Gender gap	Important	Crucial	Complementary	Important	Complementary	Crucial
Ecological transition	Crucial	Important	Important	Important	Important	Important
Territorial cohesion	Crucial	Crucial	Important	Important	Important	Crucial
Digital literacy	Crucial	Crucial	Important	Crucial	Important	Crucial

Line 1. Promote **scientific research,** technological development and **innovation in AI.**

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ANNEX 2:

THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE RESPONSE TO THE COVID-19 PANDEMIC

ANNEX 2: THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE RESPONSE TO THE COVID-19 PANDEMIC

The world is facing a new disease, COVID-19, caused by a novel infectious agent, the SARS-COV-2 coronavirus, about which our knowledge is still very limited. This means that the development of treatments and vaccines, despite all possible efforts, is not fast and will take several months, at least. For this reason, health authorities must resort to other, non-pharmacological instruments to manage the epidemic, offering accurate information to citizens, imposing measures such as lockdowns and physical distancing, and trying to reduce infections, while strengthening health systems.

Artificial intelligence is playing an important role in the response to the crisis. It is being applied to develop new treatments and vaccines, to analyse different versions of the virus genome, to characterise the response of the immune system, to model the degree of severity of the disease and to manage health resources. Many smartphone apps have been developed to minimise human contact, to support self-diagnosis and to detect exposures with a risk of contagion. Moreover, predictive modelling and simulation systems are being used to support healthcare systems in making data-driven decisions.

In the coming months, AI will continue to be needed, for example to support a phased de-escalation. Although technology offers possible solutions to many problems, careful account must be taken of the possible consequences, ensuring that the rights and values of society are respected.

Although AI has been applied in numerous ways in response to this crisis, fully AI-based solutions have been limited. Modelling is difficult due to the scant data available on the new virus and the disease it provokes. Nevertheless, AI is proving of decisive assistance in advances in biomedical and clinical research (in areas such as vaccines, drugs, and the biology of the virus and of the immune response), although it is having less impact in patient management and epidemiological management.

Finally, it is very important to draw appropriate lessons from the main problems revealed in this crisis, in order to take corrective measures and prepare health systems (research, clinical medicine and public health care) so that in the future greater benefits can be obtained from the application of digital technology in general and of AI in particular to manage crises such as COVID-19. Among the future improvements needed, we should:

1. Provide mechanisms that ensure the compilation of high-quality, standardised data.

2. Consider all aspects of the use of AI systems (privacy, data security, accessibility, usability, etc.)

3.   Ensure that AI is applied only when really necessary and that it does not raise unrealistic expectations

4.   Devise methods for the formal evaluation and measurement of results after the application of AI systems.

5.   Increase cooperation, both internationally and between areas of knowledge (sciences, technologies, humanities, etc.) in the search for solutions to this type of crisis.

Since the outset of the COVID-19 crisis, Spain has established numerous contacts with agents in the digital technology sector, seeking to achieve a coordinated response to the problems posed by this unprecedented public health crisis, developing various initiatives and projects that use AI technologies and methods. These initiatives include:

1.   A conversation assistant (chatbot) in Spanish (Hispabot-Covid19) that provides the user with accurate information crawn from official sources..

2.   An AI-based self-diagnosis system, accessible both in mobile format and in web applications (Symptomatic Covid 19).

3.   A mobility study (Datacovid-19) based on mobile phone data collected by the National Institute of Statistics in collaboration with the main telecommunications companies, as well as a mobility study based on mobile phone data, conducted by the Ministry of Transport, Mobility and Urban Affairs. Both of these studies employ complementary approaches.

4.   A web portal to offer an integrated presence and a one-stop shop to access all the digital resources available in Spain to combat the pandemic.

5.   The notification, integration and analysis of data to support resource management and to facilitate the notification of residences for the elderly throughout Spain.

ABBREVIATIONS

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- **AEI.** Agencia Española de Investigación – Spanish Research Agency
- **AEMET.** Agencia Española de Meteorología – Spanish Meteorological Agency
- **AI.** Artificial intelligence
- **B2G.** Business to Government
- **B2B**. Business to Business
- **CDO**. Chief Data Officer.
- **CDTI.** Centro para el Desarrollo Tecnológico Industrial - Centre for Industrial Technological Development
- **CGD.** Citizen generated data
- **CODDII.** Conferencia de Directores y Decanos de Ingeniería Informática - Conference of Directors and Deans of Computer Engineering
- **DESI.** Digital Economy and Society Index
- **DIHs.** Digital Innovation Hubs
- **DLTs.** (Digital Ledger Technologies)
- **EDA.** European Defence Agency
- **EDF.** European Defence Fund
- **ENIA.** Estrategia Nacional de Inteligencia Artificial - National Strategy for Artificial Intelligence
- **EuroHPC.** European Consortium for High Performance Computing
- **G2B.** Government to Business
- **G2C.** Government to Citizen
- **G2G.** Government to Government
- **HPC.** High-performance computing
- **ICO.** Instituto de Crédito Oficial – Official Credit Institute
- **IDAE.** Instituto para la Diversificación y Ahorro de la Energía - Institute for Diversification and Energy Saving
- **INCIBE.** Instituto Nacional de Ciberseguridad - National Institute of Cybersecurity
- **JRC.** Joint Research Centre of the European Commission
- **LEIA.** Lengua Española e Inteligencia Artificial - Spanish Language and Artificial Intelligence
- **OECD**. Organization for Economic Cooperation and Development
- **R+D+I.** Research, Technological Development and Innovation
- **RAE.** Real Academia Española - Royal Spanish Academy
- **SCIE.** Spanish Computer Science Society
- **SECTI.** Sistema Español de Ciencia, Tecnología e Innovación - Spanish Science, Technology and Innovation System
- **SEDIA.** Secretaría de Estado de Digitalización e Inteligencia Artificial - Secretary of State for Digitalisation and Artificial Intelligence
- **SICTI.** Sistema de Información para la Ciencia, Tecnología e Innovación - Information System for Science, Technology and Innovation
- **STEM.** Science, Technology, Engineering and Mathematics
- **STEAM.** Science, Technology, Engineering, Arts and Mathematics
- **ICTs.** Information and Communication Technologies
- **UNICTF.** United Nations Information and Communications Technology Facility

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Acknowledgements

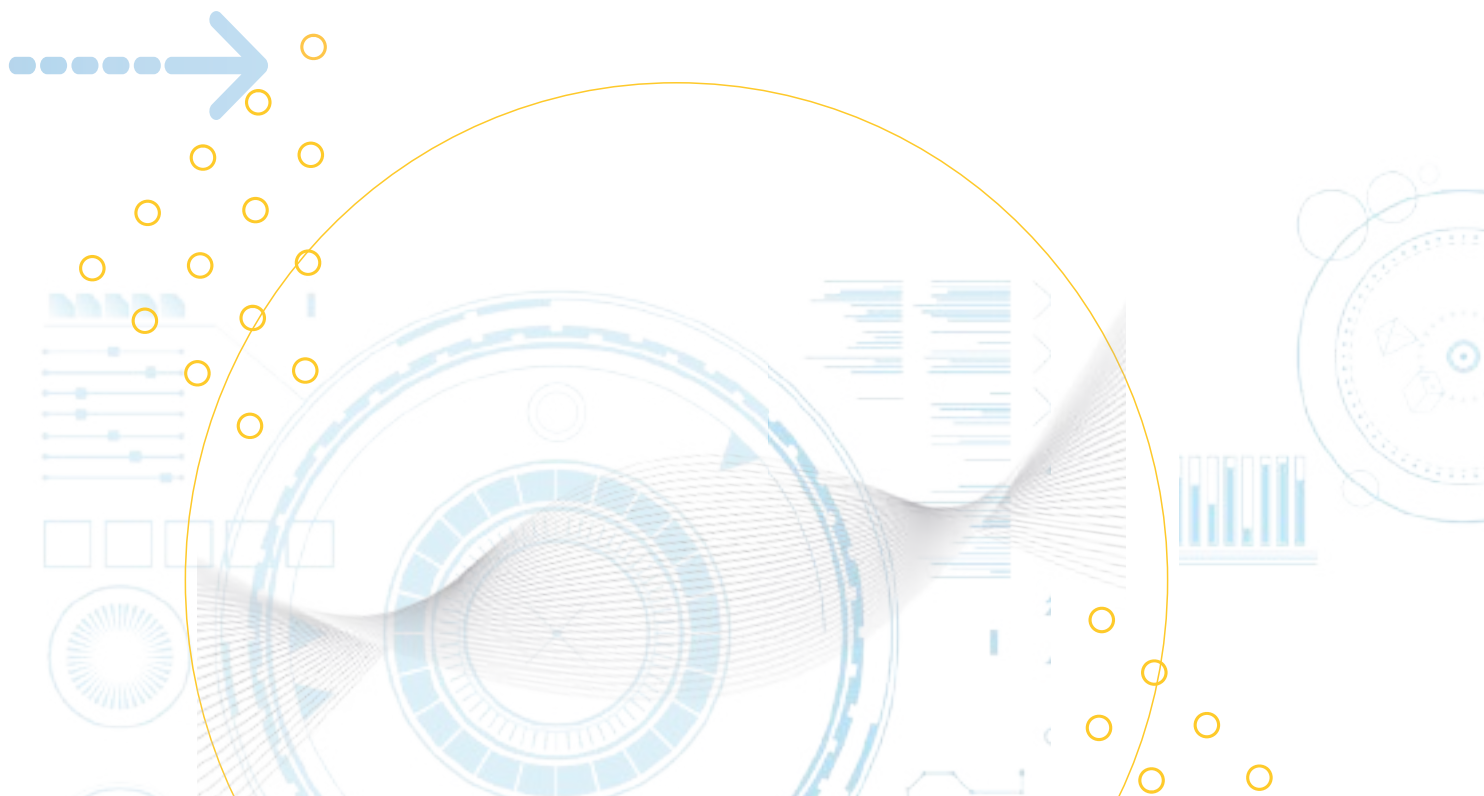## Secretary of State for Digitalization and Arti(cial Intelligence (SEDIA)

ENIA

NATIONAL ARTIFICIAL INTELLIGENCE ESTRATEGY

GOBIERNO DE ESPAÑA

VICEPRESIDENCIA TERCERA DEL GOBIERNO

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