



The European AI Landscape

Workshop Report

Disclaimer: This report represents solely the input gathered from the European AI Landscape Workshop in Brussels and has not been reviewed by the respective national authorities, nor does it represent the views of the European Commission.

EUROPEAN COMMISSION

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PART ONE

Introduction

Artificial Intelligence (AI) is expected to have enormous impact in addressing many of the greatest societal challenges that face us today, e.g. ageing, transport, and the environment. It is expected that it will help improve the quality of life of citizens both at home and at work. In addition, it will contribute greatly to increasing European industrial competitiveness across all sectors, including small and medium-sized enterprises and non-tech industries.

Europe has a leading edge in AI and robotics, as acknowledged by the excellent scientific standing of European researchers, including a number of worldwide AI experts originating from Europe. This strong expertise is also reflected in the level of investment in Europe from world leading companies, either in existing labs or companies, or in creating new major R&D labs in Europe. In addition, Europe has a vibrant start-up landscape.

However, these AI resources are scattered throughout Europe, and we must acknowledge that international competition is fierce. Therefore, in order to fully exploit the potential of AI for the benefit of the European economy and society and to guarantee Europe's leading position in AI, it is essential to join forces at the European level to capitalise on our strengths.

As a starting point, it is important to identify clearly Europe's current ecosystem and the opportunities that it creates. To that end, in January 2018 the European Commission in collaboration with EurAI, the European Artificial Intelligence Association, organised a workshop on the European AI landscape, considering academic, industry, and governmental initiatives, with a view to sharing information and strategies for AI across Europe. The workshop was attended by academics, researchers, and representatives of industry and governments from EU Member States and Associated Countries¹.

This report is an initial snapshot of the European AI landscape. It is a scoping document. It is not intended to be an exhaustive survey for any Member State.

We would like to acknowledge the high level of engagement from the many stakeholders within the European AI community and the depth of the discussion we had. We believe that there is an unprecedented level of promise in how the European Union wishes to support this community and see it succeed.

This is one of the first steps from which we hope to build a strong European AI community and pave the way to beneficial Europe-wide cooperation on AI.

¹ Association to Horizon 2020 takes place through the conclusion of an International Agreement. As of 1 January 2017, the following countries are [associated to Horizon 2020](#): Iceland, Norway, Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Montenegro, Serbia, Turkey, Israel, Moldova, Switzerland, Faroe Islands, Ukraine, Tunisia, Georgia, and Armenia.

National AI landscapes

Austria

Academic ecosystem

Austria hosts 17 institutes (university and non-university) with a research focus on robotics and AI.

Industrial ecosystem

There are 13 robotics companies based in Austria, and an estimated 7 900 robots (2015) in industry.

Governmental initiatives

In 2017, Austria established the [Robot Council](#) with the mandate to support the Federal Minister for Transport, Innovation and Technology in developing a comprehensive robotics and AI strategy. The timeframe is two years. The Council has members from various disciplines (e.g. social sciences, robotics, and information technology), including industry experts and organisations such as the [Austrian Chamber of Labour](#) and the [Austrian Federation of Industry](#). The aim is to identify and discuss current and future opportunities and challenges for Austria in the area of robotics, autonomous systems and AI. The process draws on a wide range of perspectives including technological, economic, socio-cultural, ethical and legal. The Robot Council will also provide policy advice.

Although no dedicated AI or robotics programme has been established yet, both areas – as enablers for various technologies or systems – have left a deep footprint in the main technology programmes in Austria: [Production of the future](#), [ICT of the Future](#), [ECSEL](#) and [Mobility of the Future](#). These programmes cover topics that range from predictive maintenance, collaborative robotics, formal verification tools, smart data management, ambient assisted living, and cognitive mechatronics to automation of knowledge processes and autonomous driving.

The new government proposed in January 2018 the establishment of an Ethics Council for Digitalisation, which will collaborate or merge with the Austrian Robot Council. Currently, digitalisation, robotics and AI are handled by different federal departments.

In 2015, the Austrian Society for Measurement, Automation, and Robotics Technology established the [National Robotics-Technology Platform \(GMAR\)](#). It serves as the main Austrian platform for technology transfer, bringing together all interested stakeholders. The platform was initiated and supported by the [Austrian Ministry of Transport, Innovation and Technology \(BMVIT\)](#).

GMAR aims to (1) promote networking and information exchanges among key players, (2) secure Austria's competitiveness in these industries, (3) promote robotics, automation, and AI technology, (4) provide advice to policy makers, and (5) connect internationally relevant communities.

Next steps

The Robot Council was to meet in March 2018 to identify the most critical opportunities and challenges and then present its first policy recommendations in a white paper.

Belgium

Academic ecosystem

The Benelux countries have a coordinating AI association ([BNVKI](#)) that covers over 20 different universities and institutes in Belgium, the Netherlands and Luxembourg. The original Belgian (founded 1982-1983) and Dutch (founded 1981) associations were independent. They merged in 1998. The Luxembourg groups (located primarily at the University of Luxembourg) joined in 2008. The association has a board comprising academics and industry representatives, covering all three countries. The mission is to bring together academic researchers involved in research in AI and other domains relevant to AI. The Benelux Artificial Intelligence Conference (BNAIC) takes place every year, and it includes awards for best presentation and best demonstration.

Seven universities have groups that focus mainly on AI (or a related topic): *Universiteit Gent, Université Catholique de Louvain-la-Neuve, Université de Liège, Katholieke Universiteit Leuven, Universiteit Antwerpen, Université Libre de Bruxelles, and Vrije Universiteit Brussel.*

There are many groups in Belgium focusing on topics related to machine learning (supervised and unsupervised learning, reinforcement learning, evolutionary and probabilistic learning, neural networks, etc.). Other topics include natural language processing, swarm intelligence, behavioural intelligence, vision and image processing, knowledge representation/reasoning, constraint processing, recommender systems, big data / data science, text mining, etc. In Belgium, AI has historically been part of a CS curriculum. Only Katholieke Universiteit Leuven offers a one-year Masters programme focusing on AI. According to a recent analysis in Analytics India Magazine², it is one of the leading Masters programmes in AI in the world.

Belgian researchers have identified a number of future trends in AI research, including in particular fair AI, understandable AI, robust/secure AI and scalable computing.

The [Royal Flemish Academy of Belgium for Science and the Arts](#) has launched an initiative aimed at highlighting the need for structural support for AI research. It will soon publish a document entitled 'AI: towards the 4th industrial revolution'.

Industrial ecosystem

Belgium has the most B2B (business-to-business) oriented ecosystem in Europe, with the share of B2B at 92% and B2C (business-to-consumer) at 8% (source: Sirris). Most of the companies in Belgium are SaaS (software as a service), or selling licences and offering something for free to make money through the premium versions.

Funding ecosystem

The main funding bodies for academia in Belgium are [FWO](#) (Flanders) and [FNRS](#) (Wallonia). Between 2011 and 2017 around 67 out of 241 AI-related applications (representing 2.3% of all applications) submitted to FNRS were funded, and 175 out of the 832 AI-related applications sent to FWO were also accepted. In the case of FWO, 33% of all ICT budget was spent on AI, whereas at FNRS it was only 12.5%. The funding scheme was not targeting AI specifically. AI topics compete with other ICT-related applications. FNRS spent approximately EUR 1.8 million per year in the period 2011-2017 and FWO approximately EUR 6.7 million per year. This funding does explicitly target AI research, but is part of general calls for projects.

Other funding vehicles in the Belgian ecosystem are [innoviris.brussels](#), non-profit [Sirris](#) and [imec.iStart](#).

[Team Up](#), a project by Innoviris, aims to foster academic and industry collaborations in AI and is successfully organising matchmaking events where people from different backgrounds team up to develop AI projects. So far, 35 expressions of interest have been received as a result of these sessions and 19 projects have been funded, for a total of EUR 12 million. Innoviris has also launched a call for academic prospective research, entitled 'Anticipate: AI'.

Governmental ecosystem

The Belgian Government has launched [Digital Minds for Belgium](#), a group comprising various industry representatives and intended to support the [Digital Agenda for Belgium](#). An initial SWOT analysis of the Belgian AI ecosystem was presented to the think tank Digital Minds.

² B. Gupta '[10 Leading Masters Programs on Artificial Intelligence from around the world](#)', Analytics India Magazine, 6 January 2017

Belgian academic AI SWOT

Strengths	Weaknesses
<ul style="list-style-type: none"> International excellence in research Skilled students and researchers Strong teaching in CS, AI and Data Science Variety of local funding opportunities Rich history in AI research Highly demanded AI master 	<ul style="list-style-type: none"> Fragmentation (research/teaching) Funding mostly small scale Insufficient structural support Only sporadic inter-university collaborations No long-term B2A/A2B actions Lack of computational thinking in high schools Relative little support in the W-B Federation Too much CS focus
<ul style="list-style-type: none"> Sufficient mind-power to make AI hub AI is an enabling technology for many domains (business AND academic) Strong business interest Long-term B2A and A2B collaborations possible Expand AI education to cognitive/social sciences (bachelor level?) Interest of general public Develop AI policies 	<ul style="list-style-type: none"> No actions Underestimation of AI importance for companies and policy Missing the EU AI train completely Regional segregation No improvement in W-B funding Companies go for expertise elsewhere Too much focus on hardware/IoT Top-down agenda
Opportunities	Threats

Recommendations

1. Dedicated funding for a Belgian AI platform.
2. A better balance needs to be found between long-term and short-term needs in terms of basic research, innovation and development.
3. A better long-term vision and strategy for Belgium is required.
4. Avoid focus on hardware/IoT (Internet of Things) alone; a focus on AI is required.
5. Programmes for fundamental AI research should be encouraged.

Czech Republic

Academic ecosystem

The Czech Republic hosts eight major academic research centres that focus on topics relevant to AI. These centres are distributed across the following universities: Czech Academy of Sciences, Charles University, Czech Technical University in Prague, Brno University of Technology, Masaryk University, University of West Bohemia, Technical University of Liberec, and Technical University of Ostrava. The research topics include pattern recognition and machine learning, computer vision, robotics and voice recognition.

[Strategy AV21](#), led by the Czech Academy of Sciences, supports interdisciplinary research between institutes and outside the academia. An AI-relevant project under this strategy is the research programme on [Hopes and Risks of the Digital Era](#), which draws on work from eight Czech universities (all members of the Czech Academy of Sciences) and six cooperating institutes.

The Czech Academy of Sciences hosts 53 interrelated research institutes.

Industrial ecosystem

Several international players have offices in the Czech Republic, including AVAST (web security), Siemens, Škoda Auto, and IBM.

Governmental strategies

The governmental body responsible for an AI strategy would be the [Research, Development and Innovation Council](#).

The [National Research, Development and Innovation Policy of the Czech Republic](#) (2016-2020) touches upon several areas concerning AI: digital economy (cybersecurity, data processing, IoT, AI), automotive (smart cars), aviation, and electrical engineering (Industry 4.0, smart buildings).

Next steps

Continuing the dialogue between academia and industry, strengthening the ecosystem

Denmark

Academic ecosystem

There are substantial long-term machine learning efforts at the Technical University of Denmark (DTU) and the University of Copenhagen (UCPH), as well as data science/AI curricula at all major universities.

The [SCIENCE AI Centre](#) has been established at the University of Copenhagen, where research activities are coordinated through one centre with more than 100 researchers coming from all AI-relevant disciplines. It offers researchers, students, start-ups, established corporations, and public institutions expert help in AI and infrastructure for performing AI. The SCIENCE AI Centre has three main aims: (1) coordinating and conducting research into AI and its applications, (2) coordinating teaching in AI across SCIENCE AI, and (3) acting as an interface for industry and public institutions using AI.

Denmark is home to the [Odense robotics cluster](#) and the [Odense Robotics Start-up Hub](#) hosted by the [Danish Technological Institute \(DTI\)](#), and participates in the EU-funded project [ROBOTT-NET](#), a Digital Innovation Hub that receives support through Horizon 2020 and is a shared infrastructure for sustainable optimisation of technology transfers throughout Europe. DTI also has a dedicated group on applying AI in robotics and SMART production.

Similar clusters might be beneficial for AI.

Governmental initiatives

One of the [Analyses of National Initiatives on Digitising European Industry](#) was 'Towards a Digital Growth Strategy – MADE', published in 2017, which identified AI as a major growth area.

Coordination is now taking place across sectors, through the 'Digital Growth Strategy' supported by the national initiative '[MADE \(Manufacturing Academy Denmark\)](#)' started in 2013. It is now reframed around Industry 4.0.

The [2018 Financial Act](#) identified certain actions concerning the establishment of digital hubs at universities (DTU, UCPH, CBS, and ITU) and a general digitalisation of universities.

The [Danish Society of Engineers](#) (IDA) has set up Siri commissions, to support the realisation of the potential of technology and knowledge, alongside growth panels and disruption panels.

Another noteworthy national effort is [Genome Denmark](#).

In Denmark's regions, there have been several smaller healthcare initiatives with half a billion euros put aside. So far, the funds have come mainly from public-private schemes and are used for research at hospitals.

Funding ecosystem

[Innovation Fund Denmark](#) has provided EUR 20 million as funding for big data. At the same time, a large amount of funding comes from private companies. For example, the [Novo Foundation](#), for their Big Data Challenge, provided around DKK 1 billion (approx. EUR 135 million) for big data research in healthcare.

Estonia

Governmental initiatives

Estonia started to think about AI when it began considering how it could integrate autonomous vehicles into the ecosystem. It initially looked at changing the legal system in order for fully self-driving cars to become a possibility, and at creating the ecosystem that would be suitable for developing such vehicles. As Estonia started to allow test driving for such vehicles (as [from 2 March 2017](#)), it concluded that instead of focusing on traffic laws it would be better to focus on a more general plan of AI laws, legal systems, systems of liability, accountability, data integrity and ethics.

Estonia is taking a very general approach concerning legal matters and AI. It is working on an approach that is not based on different sectors, but on figuring out AI issues such as liability in a holistic way. The reason is that, for questions such as the cybersecurity, enforcement and data ethics issues related to these algorithms, cross-sector approaches can minimise the time it otherwise takes to establish regulations for each individual sector (e.g. drones, IoT devices, etc.). With a holistic approach, Estonia can use these technologies more quickly, and hopes to reap the benefits faster. In addition, such an approach is also user-friendly, with fewer and simpler laws facilitating the end-user's engagement with these systems.

Estonia intends to co-author these laws together with the wider society, including ethical and legal experts. In September 2017, it started a [public debate and consultation](#) asking how the liability issues related to AI and AI-based systems could be addressed and resolved. The consultation leaders suggested four different scenarios to stimulate the debate.

Estonia is also setting up an AI task force that aims to bring together three elements: (1) legal aspects, (2) putting together an Estonian strategic plan identifying sectors where AI can bring strategic benefit, and (3) communicating realistically and increasing AI-related know-how.

Estonia will have a bill on general AI liability ready in March 2019.

By establishing a comprehensive liability framework and enabling the use of a variety of AI systems, Estonia hopes to attract new investors to the country.

Estonia will use a blockchain technology to address liability, enforce the legal system, and establish trust between users and producers of AI-based products. It is currently running a pilot that tests data integrity and cybersecurity of self-driving vehicles and IoT devices. The main innovation in this closed blockchain solution is that it is possible to detect a hack into an information system instantly. This is a drastic decrease from the time it currently takes, which is around seven months.

Next steps

Expanding the case studies

Finland

Governmental initiatives

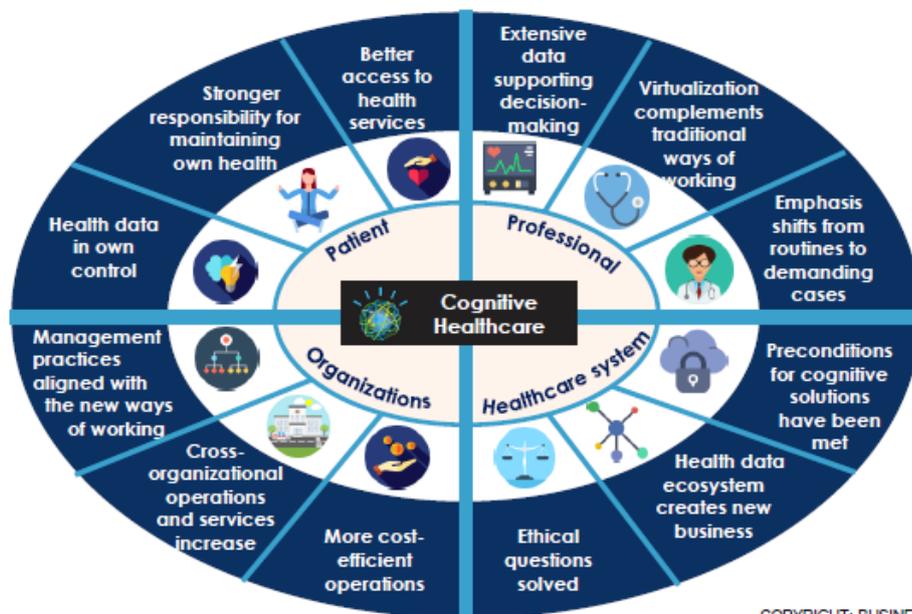
The government was to announce a new AI strategy in the first quarter of 2018. The relevant department within the government is the [Ministry of Economic Affairs and Employment of Finland](#).

General areas expected to be addressed in the near future are daily seamless usage of AI in public and private life, enhanced industrial competitiveness, AI for defence, and fuelling economic growth.

[Business Finland](#), the public funding agency of the Finnish Ministry of Employment and the Economy, plans to use AI for the biggest healthcare reform in the history of Finland. Finland is currently the first country to introduce secondary use of data in healthcare.

Cognitive Healthcare Vision

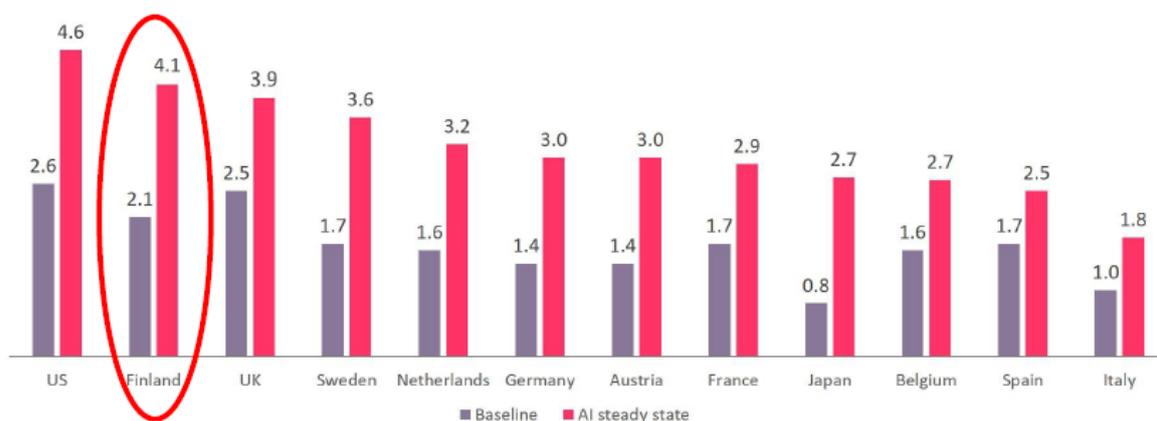
What Does Cognitive Healthcare Look Like in Finland in Five Years?



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According to Frontier Economics and Accenture, Finland is second most likely country to benefit from AI, after the United States.

Annual growth rates by 2035 of gross value added (a close approximation of GDP), comparing baseline growth by 2035 to an artificial intelligence scenario where AI has been absorbed into the economy



Finland places a lot of importance on the development of a platform economy, and has analysed several elements of society that would gain the most from these changes.

Next steps

The Finnish approach to AI has been described as being based on:

1. increasing the competitiveness of Finnish business;
2. leveraging data extensively in all sectors;
3. speeding and facilitating the use of AI;

4. securing top talent and attracting new talent;
5. courageous selections and investments;
6. building the best public services in the world with the help of AI;
7. creating new models for global collaboration;
8. positioning Finland as a role-model for the Age of AI.

Recommendations

1. The EU needs to fight back in the platform economy.
2. More activities to enhance inter-organisational boundary resources (e.g. legal standards, APIs - application programming interfaces, and SDKs - software developer kits) are needed in the EU.
3. We need an Open Data market in the EU with good legislation and technical standards; this also applies to international companies collecting data within the EU.
4. States should actively purchase solutions in sectors such as health, energy, transport, education, and food from European companies, thus boosting R&D.
5. People have to be able to manage and control easily how their personal data (e.g. electronic health records) are used between several parties and how they provide additional value for the user. This can further be supported via automated data anonymisation technology. The EU should also actively encourage public and private organisations to open their data in all sectors of life, not just industry.
6. The EU needs to drive ethical standards for AI solutions.
7. EU countries should use digitalisation to remove superfluous bureaucratic structures.

France

Governmental initiatives

France published the [France IA](#) strategy in 2017. Subsequently, the new Prime Minister asked mathematician and Member of Parliament Cédric Villani to produce an in-depth report entitled [Mission Villani](#), which was published on 29 March 2018. *Mission Villani* built on the France IA strategy, but sought to deepen and extend the grounds covered in the report, with a view to drawing up an ambitious and innovative industrial, economic, and societal policy.

Mission Villani had four key objectives: (1) studying all actions that need to be taken to enable France and Europe to be at the forefront of the AI economy without leaving anyone behind, (2) drawing up a benchmark of the global best practices regarding the applications of AI technologies in public policies, (3) identifying the applications that could be deployed within the public sphere and (4) opening up a crucial public debate on the impacts of AI (including the labour market and ethics).

The main lines of the [Villani Report](#), as published on 29 March 2018, are: (1) developing an aggressive data policy, (2) targeting four strategic sectors, (3) boosting the potential of French research, (4) planning for the impact of AI on labour, (5) making AI more environmentally friendly, (6) opening up the black boxes of AI, and (7) ensuring that AI supports inclusivity and diversity.

All areas were addressed, but priority was given to healthcare, the environment, transport, and defence. For each of these sectors, new public authorities will be established to act as drivers for fostering and developing ecosystems, organising dedicated AI innovation challenges, and adapting the legal, regulatory, and organisational frameworks.

Mission Villani also focused on sectors of general interest that are still in the experimental phase, such as inclusion and education.

Below are several large areas of interest, alongside relevant considerations.

1. Data: access to big data is a major concern for France and Europe, and a key competitive advantage in the global competition.

Explorations in this area could consider, for example, accelerating open public data policy around several use cases, notably in the priority sectors mentioned above, organising access to data of general interest currently held by private actors, and considering mechanisms for voluntary data sharing between companies.

2. Labour: AI will transform labour, with far-reaching implications for training and education.

Mission Villani recommended investigating the impact of AI on jobs through dedicated prospective studies and experiments for jobs with high risk of automation. The intention is to develop new training methods in terms of structure and curriculum and new ways of financing vocational training that take value transfer related to digitisation into account.

3. Research: a focus on brain drain from the French ecosystem and competitive investment in talent.

One recommendation is the establishment of a network of independent but coordinating Interdisciplinary Institutes for Artificial Intelligence.

4. Ecology: creating sustainable AI for a sustainable ecological economy, by exploring AI for renewable energy, improvements in energy management, farming and biodiversity, but also for chip development and other advances toward a more frugal AI.

Germany

Academic ecosystem

Within the [German Informatics Society](#), the [Section for AI \(FBKI\)](#) hosts all activities related to AI. There are ten special interest groups covering topics such as computational intelligence, knowledge representation and reasoning, deduction systems, and declarative languages. FBKI has around 1 000 members, and hosts [annual conferences on AI](#) and interdisciplinary meetings.

Across universities, there are about 90 Chairs for AI, including at the Saarland Informatics Campus and the Karlsruhe Institute of Technology. Germany hosts a variety of research centres and institutes: (1) the [German Research Centre for AI \(DFKI\)](#), (2) the [Max-Planck-Institutes for Intelligent Systems, and Informatics](#), (3) the [Fraunhofer Institute for Intelligent Analysis and Information Systems](#), including the [Fraunhofer Big Data Alliance](#), and (4) the AI research centre [Cyber Valley](#) funded by the federal state Baden-Württemberg.

Industrial ecosystem

Several large corporations such as Siemens, BMW, Bosch, SAP, and Telekom are investing in Germany in the use of AI for various applications. In addition, a variety of spinoffs like AgroLinks and SemVox employ around 100 people each. There are more than [80 AI-focused](#) start-ups currently established in Germany.

Funding ecosystem

With an annual budget of more than EUR 3 billion, the [German Research Foundation](#) (DFG) is the main source of funding for basic research in AI in Germany.

In the past thirty years (1988-2018), applied AI has been funded continuously by the [Federal Ministry of Education and Research \(Bundesministerium für Bildung und Forschung - BMBF\)](#), for a total of EUR 215 million. Current annual investment in AI is EUR 40-50 million. Between 1988 and 2017, [DFKI](#) received EUR 200 million from BMBF. There is additional funding allocated to universities and other research centres by the government.

BMBF and the [Federal Ministry of the Economy and Energy \(*Bundesministerium für Wirtschaft und Energie - BMWi*\)](#) are currently funding a selection of Industry 4.0 projects such as Mixed Reality Production 4.0, for a total of EUR 550 million since 2013.

Venture capital firm [ASGARD](#) actively funds AI companies in several application domains (healthcare, image and speech recognition, process automation, etc.) in Germany.

Governmental initiatives

BMWi is currently conducting a survey on the [Potential of AI for Industry](#) (PAICE).

In 2017, BMBF launched its government aid campaign in the field of machine learning. The aim of the government action is to improve training and professional education in machine learning, to support basic research and to create internationally visible machine learning competence centres.

The [Platform Learning Systems](#) is an expert platform for AI, funded by BMBF, aiming to: (1) shape AI for the benefit of people, (2) exploit AI to its full economic potential, (3) focus on technological, economic and societal challenges (improving quality of life, work performance, etc.), and (4) produce recommendations, roadmaps and use cases. This platform is supported by experts from science, business and society, and runs from 2017 to 2022.

Germany pursues ambitious goals for the use of AI for intelligent networked production in cyber-physical systems. Recent examples of BMBF projects for applied AI in Industry 4.0 are [InVerSiV](#) (2015-2017), [HySociaTea](#), and [Hybr-IT](#) (2016-2019). The expert platform for Industry 4.0, [Platform Industry 4.0](#), will develop a consistent comprehensive understanding of Industry 4.0 and a reliable framework. This includes: (1) recommendations for actions, (2) example applications of practical digitisation of manufacturing, (3) thematic working groups on standards, innovation, security, law and business, work and education, and (4) a reference architecture (RAMI4) aligned with the [IIRA of the Industrial Internet Consortium](#).

The programme [Smart Services World II](#) aims to address areas where digitalisation could have an impact for the economy. It has funding of EUR 50 million from BMWi (2017-2021).

The [Automated and Networked Driving](#) project is funded by BMBF, for a total of EUR 100 million since 2015. It addresses intelligent mobility concepts. AI technologies are regarded as a key enabler of autonomous driving, and this was the basis for launching several projects and initiatives related to this research area in Germany.

Germany also conducts basic research on quantum technologies through [QUTEGA](#), funded by BMBF.

Ireland

Academic ecosystem

Ireland draws on over two decades of AI research with a variety of centres focused on different areas of AI, e.g. [Insight](#) (AI and data analytics), [Connect](#) (networking services and security), [ICHEC](#) (accuracy, scalability; 6th global NVIDIA CUDA research centre), [Tyndall](#) (integrated ICT hardware and systems), [ADAPT](#) (digital content, pioneering intelligent behaviour), and [CeADAR](#) (data analytics).

The focus areas of these research centres include recommender systems, constraint programming, case-based reasoning, and machine learning. Ireland is leading in the ACM recommender systems community.

The [AI Association of Ireland](#) (AIAI) has around 330 members and puts the emphasis on a strong engagement between the academic community, industry, and start-ups.

Ireland announced in January 2018 a national Masters programme in AI, defined 100% by industry and delivered by multiple tertiary education institutions across the country. A total amount of EUR 3.5 million has been invested into this Masters course.

Industry ecosystem and academic collaborations

[Insight and UTRC](#): UTRC is one of 80 funding industrial partners of the Insight Research Centre, home to 450 personnel and dealing with key research topics in artificial intelligence, data analytics, machine learning, human-machine interaction, and optimisation.

Samsung has invested about EUR 4 million with the [University College Dublin](#).

[Adapt and Intel](#): in collaboration with Intel, the Adapt Centre's machine learning experts have developed a tool that suggests multilingual keywords to improve global discoverability.

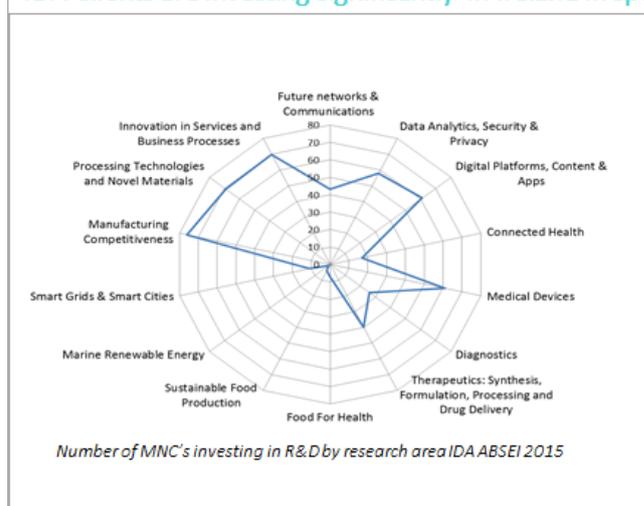
[Huawei](#), a global ICT leader, announced a new research partnership with Trinity College Dublin as part of its growing R&D footprint in Ireland. At an event at Trinity, Guo Ping, Huawei's Deputy Chairman and Rotating CEO, also announced the expansion of the company's R&D operation.

Over the past 3 years, companies have invested EUR 3 billion in in-house R&D.

Funding ecosystem

The Irish government spends, through the [Irish Economic Development Agency](#) (IDA), [Enterprise Ireland](#), and Science Foundation Ireland, over EUR 700 million on R&D annually. Enterprise Ireland funds Irish companies and is the largest VC fund in Europe.

IDA Clients are investing significantly in Ireland in specific Research Areas



- + Manufacturing Competitiveness
- + Processing Technologies and Novel Materials
- + Innovation in Services and Business Processes

- + Data Analytics, Security & Privacy
- + Digital Platforms, Content & Apps

- + Medical Devices
- + Diagnostics
- + Therapeutics, Synthesis, Formulation, Processing and Drug Delivery

Tech Ireland tracked EUR 580 million in 2017 spent by venture capital firms on AI companies, of which EUR 256 million was directly spent on AI and related technologies (www.techireland.org).

Governmental strategies

The [Irish Economic Development Agency](#) (IDA) and [Enterprise Ireland](#) have drawn up the [AI Island](#) strategy, with the main focus on AI and robotics. To begin, they audited the country's ecosystems and organised a workshop in 2017, bringing together industry, academia, trade unions, the military, and civil society. Resulting from this, Ireland has set up a national Masters programme in AI that is 100% industry-driven (launch in 2018) and shorter courses for skills delivered nationally, e.g. Coursera, Udacity, and Udemy. They will continue with targeted investment in AI and in Irish SMEs.

Furthermore, Ireland is a leader in access to open data (www.europeandataportal.eu) that prioritises research for AI.

Israel

Academic ecosystem

AI research in Israel has been firmly established since the 1980s, and there are currently quite a few AI research groups and labs at Israeli universities. Several universities have distinct strengths in particular subfields of AI, such as Bar-Ilan University, Ben-Gurion University of the Negev, the Technion, Tel Aviv University, and the Hebrew University. Some of the areas covered by these universities are cyber security, machine learning, robotics, human-machine collaboration, e-learning and education.

A lot of AI research in Israel, particularly in applied work that implements AI algorithms in real world settings, occurs in engineering departments rather than in computer science departments. There is a rich culture of cooperation between Israeli companies and academia in AI research. Universities in Israel strongly rely on the transfer of technology and knowledge from labs to industry for profit. Each university in Israel has a development company that was built to protect and commercialise the intellectual property of the universities. These companies actively recruit academics to collaborate with industry and share data.

Industrial ecosystem

Israel is host to R&D centres from IBM, Intel, and Microsoft, which work in close connection with the local academic institutions. In addition, General Motors' Israeli Research Lab serves as a major centre for developing technologies for autonomous connected vehicles.

Israel has a strong high tech sector that can provide a good basis for AI companies to succeed. Furthermore, it has an active start-up landscape, e.g. [MobilEye](#), [VoyagerLabs](#), and [Percepto](#).

The largest areas of the AI industry in Israel are marketing, financial technology, and healthcare³. The area with the highest growth rate is cyber security, which is receiving significant funding incentives from the government following the newly formed National Cyber Security Authority, which is responsible for protecting the civilian cyber space.⁴ Another area is transport (e.g. route positioning systems and autonomous vehicles).⁵

Funding ecosystem

The Israeli government has several grant funding schemes for promoting collaboration and knowledge transfer between academia and industry, such as [Magnet](#) and [Magneton](#).

The [Israeli Science Foundation](#) has a rich history of funding AI projects in academia that provide researchers with a high degree of freedom in their research compared to other countries.⁶

Several accelerators, such as [mindcet](#) and [minducate](#), support tech start-ups.

The [Ministry of Defence](#) has a yearly call for grant proposals that sometimes includes an AI focus.⁷

Challenges

1. Stronger collaborations between academia and industry.
2. Issues with government regulations inhibiting the growth of applications such as ridesharing.
3. The need for larger universities to keep up with the demand for skilled software engineers.

³ <https://www.vccafe.com/2017/09/11/israels-machine-intelligence-startup-landscape-2017/>

⁴ https://www.gov.il/en/Departments/israel_national_cyber_directorate

⁵ <https://www.israel21c.org/17-israeli-companies-pioneering-artificial-intelligence/>

⁶ <https://www.isf.org.il/>

⁷ http://www.mod.gov.il/Departments/Pages/Research_and_Development_Agency_Mafaat.aspx

Italy

Academic ecosystem

The Italian Association for AI ([Associazione Italiana per l'Intelligenza Artificiale](#) - AI*IA) aims to bring the Italian AI community together. It has over 900 members, including around 500 members from academia and the rest from private companies. Areas of research covered by AI*IA include machine learning, deep learning, robotics, knowledge representation, natural language processing and multi-agent systems. The association places a strong emphasis on networking within the country, and on collaboration beyond the constraints of individual laboratories.

AI*IA has also been working on projects concerning AI and society, for almost 5 years. In the context of those projects, it has hosted several open meetings to engage with students, the media and diverse institutions hoping to change negative perceptions of AI and to tackle perceived problematic trends. It is also working on an active AI roadmap for social topics such as inequality, democracy, and well-being.

Italy and AI*IA are working to participate in the international AI ecosystem and attract resources (including funding), in order to contribute to the national and international economy, and to govern the research and development of AI towards new, more responsible and sustainable solutions, beneficial to the planet, to people and to science.

Notable ecosystem

In Italy, the government, the [Agency for Digital Italy](#) (AGID), the academia, and AI*IA, alongside industry, e.g. [AI Labs](#), collaborate to develop the Italian AI community and ecosystem.

Industrial ecosystem

The Italian AI ecosystem covers the whole spectrum of AI technologies and applications, with over 100 start-ups, various industries, and more than 20 universities and research centres. The majority of the industrial initiatives focus on the delivery of machine learning-related services and natural language processing technologies, with growing interest in technologically intensive areas, including robotics, machine vision, and human-computer interaction. Other spinoffs are well positioned in niche markets, such as educational services, recruitment, and knowledge-based systems.

Italian AI ecosystem, by area



If you want your company to be listed or removed please write to segretario@aixia.it, updated 16/3/2018, 102 companies

www.aixia.it 

Governmental initiatives

The [Agency for Digital Italy](#) (AGID) created the [AI task force – Artificial Intelligence at the service of the citizen](#) in 2017. The task force includes 30 direct members and around 450 community members from academia and the public and private sectors. Its main aim is to tackle public administration problems.

In March 2018, AGID released a [white paper](#) on 'AI at the service of citizens', after a month-long consultation on the original draft. Some of the challenges discussed in the white paper are ethics, the role of data, preventing inequality, and measuring the impact of AI.

AGID's work also involves setting up pilot projects, drawing up recommendations for the public administration, and improving the public administration's AI capacities.

In addition, Italy has an [Observatory on Artificial Intelligence](#) that aims to analyse AI-related public conversations on social networks through technology.

Italy is also the coordinator of the Thematic Group on Emerging Technologies (AI & Blockchain) of the OECD Working Party of Senior Digital Government Officials (E-Leaders). They will map the state of the art and draft guidelines on the use of AI and blockchain technology in the public sector.

Next steps

The Agency for Digital Italy and the AI task force are planning to take several imminent next steps: open innovation calls to promote innovative procurement to integrate AI solutions in public services, setting up pilot projects to accelerate the use of AI in the public sector, and creating synergies with research institutions to promote the development of AI solutions for the public administration through research and education.

Luxembourg

Academic ecosystem

Luxembourg has one university, the University of Luxembourg, with around 100 people in the computer science and communications research unit. A quarter of them work in AI-relevant research areas (e.g. [Interdisciplinary Lab for Intelligent and Adaptive Systems](#)). The topics covered include machine learning, robotics, drones, data mining, and data visualisation.

The University's [Interdisciplinary Centre for Security, Reliability and Trust](#) (SnT) currently runs two relevant projects: TUNE (Testing the untestable), which uses AI for software testing, and AGNOSTICS (Actively Enhanced Cognition based framework for design of complex systems), which examines disruptive cognitive radio systems. Another interesting development is the recent creation of the 360 lab at SnT, which does research related to autonomous driving platforms and smart mobility (<https://360lab.uni.lu/>).

In addition, Luxembourg is strong in bringing AI to finance (mainly RegTech, i.e. regulatory technology) and smart cities through the [Luxembourg Institute for Science and Technology](#) (LIST). LIST covers three facets associated with the performance of organisations: business analytics, Infrachain protection, and human-machine interaction.

Governmental initiatives

The [Digital Luxembourg Initiative \(Digital Letzebuerg\)](#) demonstrates that there is strong government support for digitalisation, particularly infrastructure, e-skills, digital public services, innovation ecosystem, and data regulation. In this context, an AI action plan will be published in spring 2018, with concrete steps supporting the AI ecosystem in Luxembourg. Digital Luxembourg's infrastructure group has recently organised a conference for the local data centre ecosystem in order to talk about new opportunities related to machine learning services and new resource demands for data centre providers.

[ICT Luxembourg](#), an IT industry trade organisation, will also focus on AI and will publish white papers on different topics in order to stimulate the debate among the actors involved and showcase

concrete business opportunities related to AI. [Luxinnovation](#), the innovation agency supported by the government, is equally active in the AI domain and its activities also include advising start-ups and other companies on funding opportunities and mapping the national AI ecosystem.

Luxembourg's heavy engagement in the EuroHPC initiative and the construction of a national HPC infrastructure and competence centre will provide a strong basis for fostering AI services that are accessible to SMEs.

Industrial ecosystem

Luxembourg hosts several AI start-ups, e.g. Aiva, LuxAI, and BlackSwan. In addition, bigger industrial players like Goodyear or SES, the global satellite provider, are also active in AI-related research and development.

Next steps

LIST's [FEDER](#) project aims to create a Data Analytics Platform (DAP), with EUR 6.5 million in funding between 2016 and 2019, and will deliver further research projects. Digital Luxembourg will publish a concise AI action plan that will present ideas to the ecosystem, e.g. on ethical aspects, funding opportunities, research opportunities, and data economy aspects.

Netherlands

Academic ecosystem

The Benelux countries have a coordinating AI association ([BNVKI](#)) that covers over 20 different universities and institutes between the three countries. The association represents on average 150 researchers (PhDs, postdoctoral researchers, and professors). The original Belgian (founded 1982-1983) and Dutch (founded 1981) associations were independent. They merged in 1998. The Luxembourg groups (located primarily at the University of Luxembourg) joined in 2008. The association has a board comprising academics and industry representatives, aiming to cover all three countries. The mission is to bring together researchers from academia involved in AI research and other domains relevant to AI. The Benelux Artificial Intelligence Conference (BNAIC) takes place each year, and includes awards given for best presentation and best demonstration⁸.

A large number of universities in the Netherlands have research groups that focus on AI or related topics: Delft University of Technology, Eindhoven University of Technology, Leiden University, Maastricht University, Radboud University Nijmegen, Tilburg University, University of Amsterdam, University of Groningen, University of Twente, Utrecht University, and VU University Amsterdam. A detailed overview can be found [here](#). The topics studied include computer vision, knowledge representation, various forms of machine learning, natural language processing, planning/search, and robotics.

Since 2017, BNVKI has been collaborating with the [ICT-Research Platform Netherlands](#) (IPN). At the initiative of the BNVKI board, a Special Interest Group (SIG) on AI has been created, comprising researchers from each of the 12 IPN institutes (i.e. the 11 universities mentioned above and the [CWI](#)), which are representative of the AI community in the Netherlands. Having the status of a special member of the IPN, the main objective of the SIG is to help shape the national research agenda on artificial intelligence in the Netherlands. This is being done by drawing up an overview of the Dutch research groups and companies that are active in the field, formulating a vision on future developments, and communicating with national scientific and governmental organisations. The SIG is currently working on a National AI Manifesto in which three focus areas are identified in order to shape the research agenda for the coming decade:

1. socially-aware AI: AI that is able to interpret, reason about, and influence human behaviour, resulting in intelligent systems that interact, collaborate and coordinate their behaviour with human beings;

⁸ See also the section on Belgium.

2. explainable AI: AI that is able to explain to its users in an intuitive, human-understandable manner how and why its underlying algorithms produced the AI's behaviour;
3. responsible AI: AI that is able to take into account moral, societal and legal values, while efficiently processing the abundance of (sensory) information available worldwide.

The Netherlands has a long tradition in AI-specific education, both at Bachelor and at Masters level. According to a recent [analysis](#) by Analytics India Magazine, 4 out of the 10 leading Masters programmes in artificial intelligence in the world are Dutch.

Industrial ecosystem

In recent years, the number of companies investing in AI and big data analysis has increased rapidly. These include large international companies as well as smaller niche companies. The areas addressed include banking, big data, consultancy, energy, gaming, smart city, and robotics. Big hubs can be found in the areas around Amsterdam and Eindhoven.

Funding ecosystem

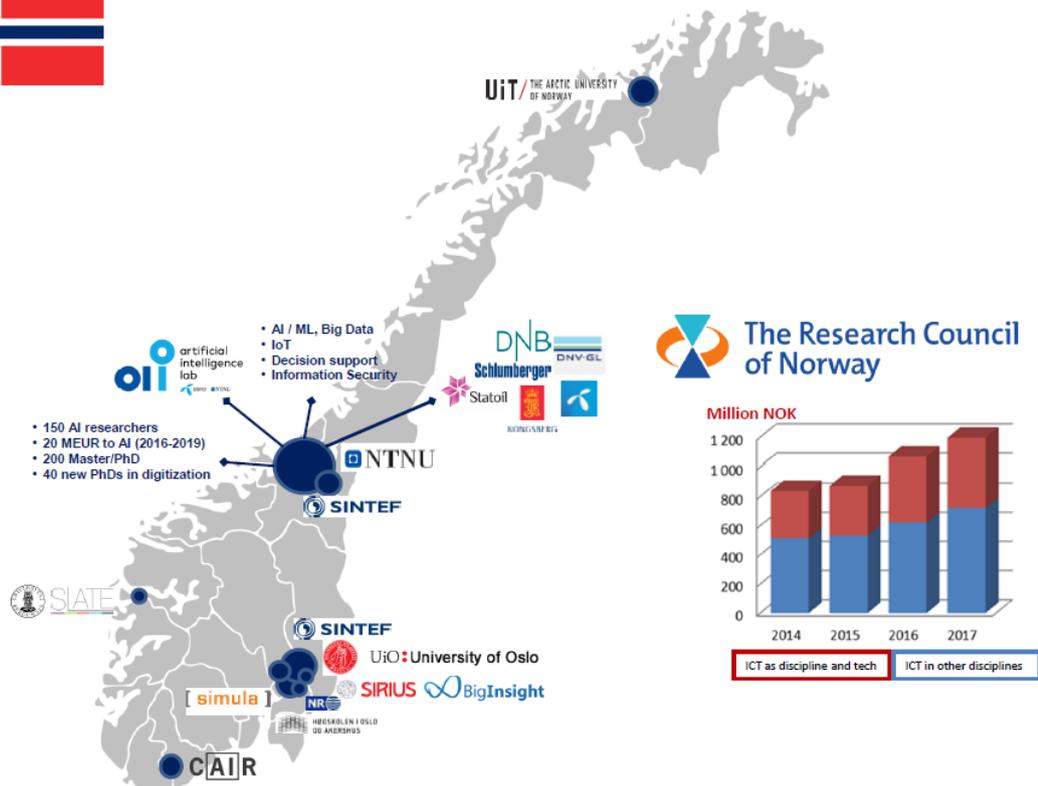
The main funding body for academia in the Netherlands is the Netherlands Organisation for Scientific Research ([NWO](#)). Since 2002, NWO has funded 119 research projects containing the term 'artificial intelligence' and 142 research projects containing the term 'machine learning'. In 2015, a [programme](#) on 'Natural Artificial Intelligence' was launched, which has funded five projects. More recently, the National Research Agenda has issued a [call](#) that focuses on explainable and safe AI.

Recommendations

1. Dedicated funding for a Dutch AI platform.
2. A better long-term vision and strategy for the Netherlands is required.

Norway

Academic ecosystem



Academia and industry also closely collaborate on the [Telenor-NTNU AI Lab](#), as described in the next section.

Industrial ecosystem



Norway, a country traditionally associated with oil, benefits from a trust-driven and collaborative cluster model tradition surrounding oil excavation, which it regards as key to building an equally strong AI ecosystem. The nation has a flat work structure, which facilitates fast decision-making processes. Furthermore, it has a high quality health data registry since the 1980s, and technologically advanced oil, maritime, energy, telco, and aquaculture industries that serve as a unique AI test-bed environment.

This environment is supported by activities in commercial applications of AI and pilot phases throughout Norway. Norway is also strong on security research.

An example of a large industry and academia research collaboration is the [Telenor-NTNU AI Lab](#). Telenor is a Norwegian, mostly government-owned, multinational telecommunications company. The AI Lab trains doctoral and Masters students, grants access to real-life data sets and problems, and hosts lab-affiliated events. In this way, the AI Lab aims to build AI competence, attract a larger number of companies to Norway, and retain and attract AI talent.

Telenor expects that concrete AI applications can be developed through the facilitation of data deployment. To that end, Telenor launched the [Start IoT programme](#), to set up an exploratory network providing free access to start-ups and students who are trialling their IoT projects. Start IoT tries to find novel ways of gathering data through IoT, hosts research and educational programmes, and supports rapid and low-cost prototyping of IoT.

Governmental initiatives

The Norwegian government has a strong focus on digitisation and a commitment to responsible business and ethical AI.

The Ministry of Local Government and Regional Development ([Kommunal-og moderniseringsdepartementet](#)) issued the [Digital Agenda for Norway](#) in 2016 (updated for 2018-2020). It focuses on three key areas: (1) user-centric focus and efficient public administration, (2) innovation and economic growth, and (3) digital inclusion (investment in new jobs).

In addition, Norway is concerned with topics such as automation and the future of work, handling of data (including security concerns), and autonomous transport testing (legal framework).

Norway has just passed a law allowing pilot projects for automated cars and buses.

Portugal

Academic ecosystem

The Portuguese Association for Artificial Intelligence ([APPIA](#)) aims to promote research and teaching in and dissemination of AI as a scientific domain. Beyond hosting conferences on AI, APPIA has an advanced school on AI (EAIA) that focuses on specific topics. APPIA also plans to set up a school on general AI in collaboration with the Spanish AI association.

Portuguese research groups	Agents and Systems Multi-Agent DI/FCUL LIACC/UP ALGORITMI/Uminho INESC-ID	Computational Creativity CISUC/DEI/UC	Extraction of Knowledge and Data Mining LIAAD, FEP/UP CISUC/DEI/UC
	Machine Learning LIAAD, FEP/UP AIlab, CISUC/DEI/UC LIACC/UP ALGORITMI/Uminho	Logics for AI and Knowledge Representation Centria/DI/FCT/UNL DI/UEvora ALGORITMI/Uminho	Information Retrieval/Text Mining/Web Mining DI/UEvora LIAAD, FEP/UP
	Ambient Intelligence ALGORITMI/Uminho	Decision Support Systems GECAD/ISEP/IPP	Logic Programming DCC/FC/UP Centria/DI/FCT/UNL DI/UEvora ALGORITMI/Uminho
	Adaptive and Evolutionary Computation ECOS/CISUC/UC DI/FCUL, LabMag INESC-ID ALGORITMI/Uminho	Language Processing / Natural Language HTL/CITI/DI/FCT/UNL DI/UEvora ALGORITMI/Uminho	Autonomous Systems and Robotics ISR/IST/UTL IEETA/UA LIACC/UP
		Constraint Programming FCT/UNL DCC/FC/UP	

Industrial ecosystem

In Portugal, 72% of companies are in the tertiary sector, with several Portuguese start-ups outside that sector, e.g. Talk Desk (call centres), Heartgenetics (medicine), Movvo (trade), and Loqr (security). Other examples of AI-specific companies in Portugal are SISCOG - Sistemas Cognitivos and Interprolog Consulting.

Funding ecosystem

Due to the recent financial crisis in Portugal, there are no significant funds available for research and development (R&D) on AI technologies. The European Commission, through Horizon 2020, is funding several R&D projects. The [Fundo Europeu de Desenvolvimento Regional \(FEDER\)](#), an EU fund in collaboration with Portugal, is also providing regional grants under the [Portugal 2020](#) initiative.

Several national agencies in Portugal promote R&D, including: (1) [Portuguese National Funding Agency for Science, Research and Technology \(FCT\)](#), (2) [National Agency for Innovation \(ANI\)](#), (3) [Regional Coordination and Development Commission for each region \(CCDR regional\)](#), and (4) [Agency for Competitiveness and Innovation \(IAPMEI\)](#).

Academic and governmental initiatives

The Portuguese Association for AI creates links between the academic community and other relevant actors, e.g. government. They have several ongoing initiatives concerning AI.

The national strategies in relation to APPIA are the following: (1) administrative modernisation together with the Portuguese government, (2) establishing a centre linking all major AI centres in Portugal, and (3) a scholarship programme entitled New Talents in AI that aims to attract talent to AI at university level stemming from the [Fundacao Calouste Gulbenkian](#).

Romania

Academic ecosystem

The main AI association in Romania is the [Romanian Association for Artificial Intelligence \(Asociația Română Pentru Inteligență Artificială - ARIA\)](#). It comprises eight universities and twelve companies, and has over 150 members in total. ARIA is carrying out several national and international projects, such as establishing an overview of the AI landscape in Romania, summer schools, and AI competitions.

Over thirteen Romanian universities and research institutes work on AI-related topics, including the Polytechnic University of Bucharest, the Research Institute for AI (part of the Romanian Academy), the Technical University of Cluj-Napoca, the University of Bucharest, the National Research Institute for Informatics, and the Technical University of Iași. Topics addressed by researchers include machine learning, multi-agent systems, applications for social and assistive robots, natural language processing, corpora building, computer vision, and virtual reality.

The following is a selection of ongoing projects relevant to AI within the Romanian academic ecosystem:

1. [CoRoLa](#) is a reference electronic corpus of the contemporary Romanian language, including hundreds of millions of word forms, and written and spoken texts. The project is led by RIAI and ITI Iași.
2. [CAMI](#) works on an artificially intelligent ecosystem for self-management and sustainable quality of life under the European Active and Assisted Living Programme 2015-2018, with UPB as coordinator.
3. [UP Drive](#) is a project that researches automated urban parking and driving. It is funded under Horizon 2020, with the Technical University of Cluj-Napoca as partner.
4. [ROBIN](#) is a project that develops cognitive systems for personal robots and autonomous vehicles, coordinated by UPB.

Industrial ecosystem

Romania is host to over 30 start-ups and small AI and AI-related companies that work in a wide range of domains, such as computer vision, natural language processing, conversational agents/personal assistants, and applied deep learning techniques.

Funding ecosystem

There are several accelerators and hubs based in Bucharest and Cluj-Napoca. While [Spherik Accelerator](#), [TechAngels Accelerator](#), [Innovation Labs](#), and [Tech Hub Bucharest](#) all support start-ups, there are no specific AI-focused accelerators.

National initiatives

The [Romanian Association for Smart City and Mobility](#) is supporting initiatives in over twenty cities in Romania, with deployment under the [Alba Iulia Smart Cities](#) initiative and in the [Cluj IT cluster](#) (nine projects in areas such as smart parking and digital access to public services).

Governmental initiatives

[National Research, Development & Innovation programme 2016-2020](#). The priorities mentioned in the programme are information and communication technologies, space and security, and big data and AI.

Recommendations

1. More national funding support for AI research in academia.
2. Enhanced collaboration with companies and technological transfer on AI-related development.

3. More places to grow skills and perform networking within industry.
4. Improved dissemination of AI university research (people in start-ups/companies are not completely aware of existing research).
5. A national initiative providing strong support for AI and technology transfer of AI research in companies.
6. A boost for AI in industry and other economic sectors from the government.

Spain

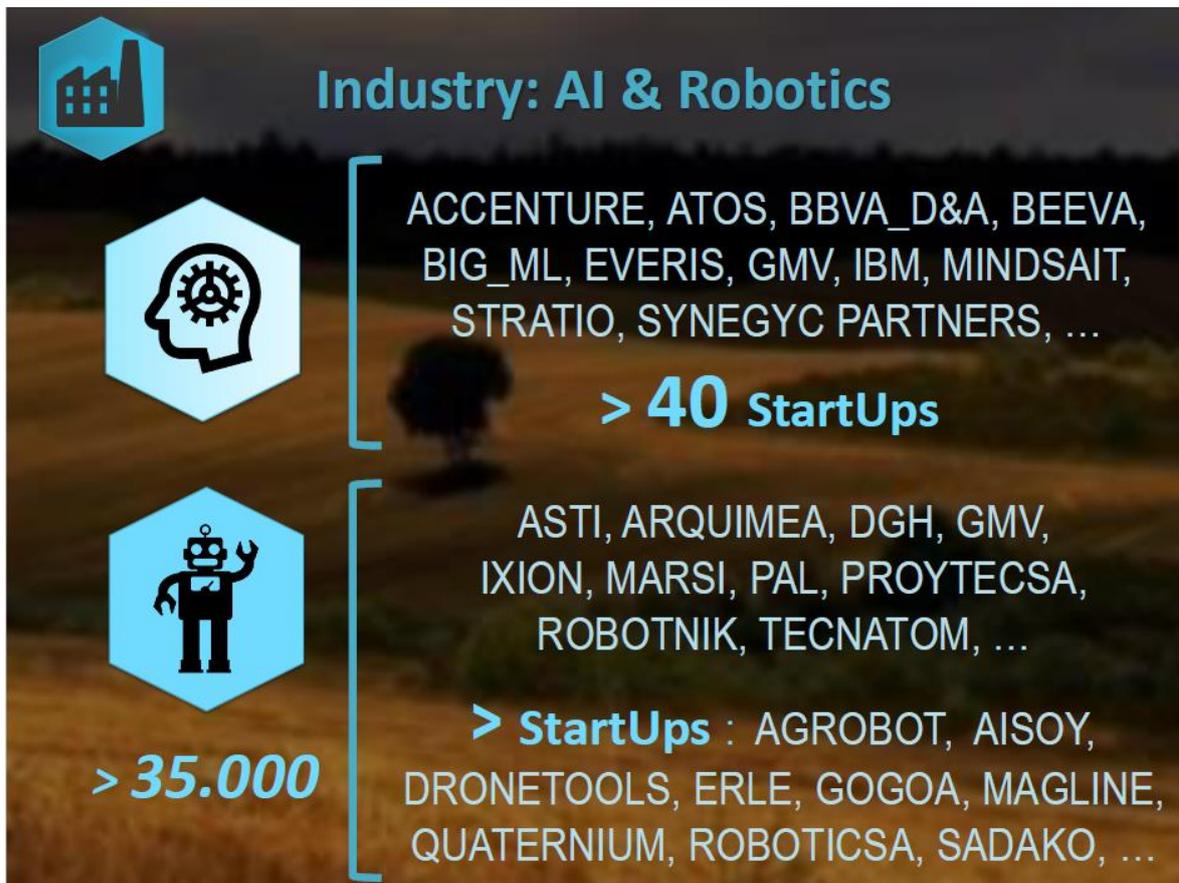
Academic ecosystem

Spain has several AI research groups, and most universities with computer science or engineering programmes host such groups.

Particular strengths of the academic community in Spain are, for example, multi-agent systems, machine learning, optimisation and metaheuristics, and planning and fuzzy logic. The latter has a long research tradition in Spain. In robotics research there are a variety of groups with focus on vision, service-, soft & collaborative robotics, medical, agriculture and aerial/underwater robotics.

In addition, a variety of AI associations such as [AEIPA \(Spanish AI Association\)](#) and [ACIA \(Catalan AI Association\)](#), as well as robotics groups such as [AER \(Spanish Robotics and Automation Association\)](#), [HISPAROB \(Spanish Platform on Robotics\)](#) and [SEIDROB \(Spanish Society for R&D in Robotics\)](#), are active in Spain.

Industrial ecosystem



Funding ecosystem

The [Centre for the Development of Industrial Technology](#) (CDTI), a public organisation under authority of the [Ministry of Science and Innovation](#), funds AI and robotics on a yearly basis up to

about 30% of the total, and the [Ministry of Energy, Tourism and the Digital Agenda](#) (MINETAD) funds around 22%.

Considerable funding is raised from funding schemes, such as the European Commission's programmes, and venture capital firms like the [Spanish Venture Capital & Private Equity Association](#) (ASCRI).

Collaborations between academia and industry are funded privately. For example, Universidad Politécnica de Madrid (UPM) and Accenture are collaborating on the creation of [AI.nnovation Space](#), a new AI centre funded with EUR 6 million by Accenture.

Governmental initiatives

Spain has a [National R&D and Innovation Plan \(2017-2020\)](#). It focuses on four core areas: (1) talent, (2) science, (3) industry, and (4) social challenges, alongside several strategic actions such as digital society, language technology, and Industry 4.0.

Under the [Plan de Impulso de las Tecnologías del Lenguaje](#), EUR 90 million will be invested in digital society and language technology between 2016 and 2021. The investment will focus on areas related to infrastructure, public administration, industry, and lighthouse projects.

Since 2016, EUR 170 million has been invested in the Industry 4.0 project [Industria Conectada 4.0](#) under the National R&D and Innovation Plan. Industry 4.0 focuses on skills, cooperation, industrial adoption, and digital technologies (robotics, AI, cloud, cybersecurity, big data).

Spain has published a [white paper on robotics](#).

Next steps

A Digital Strategy for Spain is being drawn up. It will address five areas: (1) ecosystems 4.0, (2) data, (3) citizens, (4) regulation, and (5) infrastructure.

In addition, a white paper on AI and big data will be drafted by ten experts, and is expected in July 2018.

Sweden

Academic ecosystem

In Sweden, AI is a natural part of computer science. There are at least nineteen universities that conduct research relevant to AI, e.g. research on knowledge representation and reasoning, planning, constraint programming, and machine learning.

The [Swedish AI Society](#) (SAIS) has around 100 members from academia and from the public and private sectors. They promote research and application of AI with a focus on areas such as machine learning, explainable AI, autonomous systems, robotics, and cognitive computing. SAIS will host the [27th International Joint Conference on Artificial Intelligence jointly with the 23rd European Conference in Artificial intelligence \(IJCAI-ECAI\)](#) on 13-19 July 2018, in Stockholm.

Industry and academia collaborate closely, for example in the area of autonomous systems and robotics through the [Wallenberg AI, Autonomous Systems and Software Program \(WASP\)](#). The Agency for Innovation (Vinnova) is also funding several collaborative projects between industry and academia, lately with a focus on healthcare.

The Research Institutes of Sweden is currently setting up an AI centre ([RISE AI](#)), with an initial turnover of SEK 50 million (approx. EUR 4.9 million) per year in R&D, over 4 start-ups, more than 50 experts and around 30 active industrial collaborations (e.g. Nokia, Ericsson, ABB, and H&M).

Notable ecosystem

The [Nordic AI Institute](#) (NAII) aims to transform healthcare and is based on collaboration between Denmark, Sweden, Norway, Finland, and Iceland.

Regional initiatives

The Knowledge Foundation is funding the creation of a [smart specialisation area](#) in the Örebro region. They are doing it in three phases. First, Örebro University will provide insights and knowledge. Second, a testbed infrastructure called AI.MEE will promote early testing of prototypes and fast tracking of products to market for companies in a vast application area. The third phase will be SMARTER, a competence development programme providing courses in AI and machine learning, and tools such as ROS, for free to working professionals.

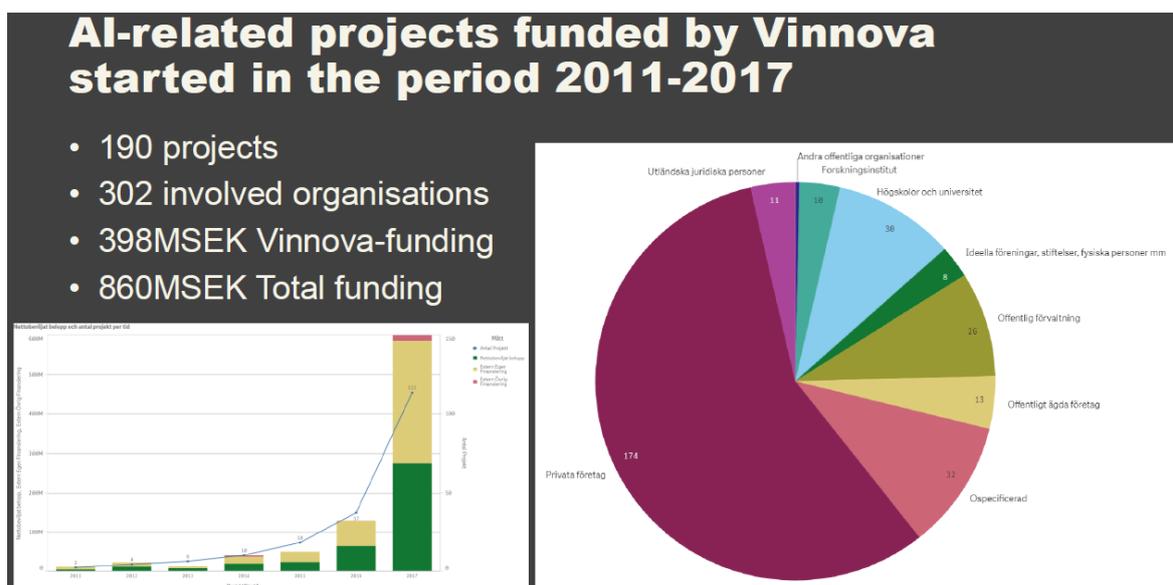
In healthcare, the [Analytic Imaging Diagnostic Arena \(AIDA\)](#) is a national area under the Strategic Innovation Programme [Medtech4Health](#), a joint initiative by Vinnova, Formas, and the Swedish Energy Agency. AIDA aims to bridge the gap between AI research and clinical routine.

Other notable research efforts in Sweden are SSF Smart Systems, SSF Big Data, Vinnova AI in healthcare, KK BigData (Blekinge TU), KK CAISR (Halmstad U), KK IoTaP (Malmö U), KK Semantic Robots (Örebro U), and the [Wallenberg AI, Autonomous Systems and Software program \(WASP\)](#).

WASP is a ten-year research programme, sponsored by a private foundation with more than EUR 300 million in funding. It is developing a recruitment programme with internationally competitive offers. It offers industrial PhDs and is currently hosting 120 PHD students, with 50 PhD students being employed by industry. The programme was extended in 2017 with more than EUR 100 million for AI, and is led by Professor Danica Kragic. There are two tracks: (1) AI/ML: machine learning, deep learning, and explainable AI, and (2) AI/Math: theoretical questions related to AI in a wider sense.

Governmental initiatives

[Vinnova](#), Sweden's Innovation Agency, has funded 190 projects in the past 6 years.



Vinnova is currently compiling an overview of the AI landscape in Sweden. It has been tasked by the government with analysing how AI and machine learning can be used in industry, the public sector, and society, and what benefits can be gained from addressing current bottlenecks. This includes a survey of the skills and competences currently available through education and training.

The final report will be published by the end of April 2018.

The project is part of the [National Plan for Smart Industry](#) – a strategy for new industrialisation for Sweden.

Key recommendations

1. Ensure that Sweden has adequate scientific and technical knowledge within the country.
2. Make Sweden a country that welcomes and supports the testing and evaluation of AI technologies at all levels.
3. Establish a national AI research agenda for a coordinated large-scale long-term research effort.
4. Ensure that Sweden has the best lifelong competence development opportunities in the world.

Switzerland

Academic landscape

With only 8.5 million inhabitants, Switzerland has the world's highest proportion of peer-reviewed scientific publications relative to its population.

Switzerland is host to a variety of highly recognised labs at universities and joint research institutes relevant to AI research, such as those at ETH- Zurich (Autonomous Systems Lab and Max Planck ETHC Centre for Learning Systems), IDSIA research institute (Swiss AI Lab), IDIAP Research Institute, *École Polytechnique Fédérale de Lausanne* (Artificial Intelligence Laboratory - LIA), and the University of Zurich (Department of Informatics - Artificial Intelligence Lab).

Industrial ecosystem

Switzerland has the highest number of AI companies per capita in Europe⁹.

With its broad AI start-up landscape, Switzerland has a small but very sustainable AI Cluster throughout all Swiss regions.

Switzerland is a country with a high share of SMEs with a strong export-orientated business model. New cutting-edge technologies like AI ensure them their global position.

Switzerland serves as a base for various global giants. Google Research is based in Zurich, IBM has opened its first European branch of research in Switzerland, and Disney has chosen Switzerland for one of the only two worldwide Disney Research Labs.

⁹ Asgard Capital Verwaltung '[The European Artificial Intelligence Landscape: More than 400 AI companies built in Europe](#)', 31 July 2017



Governmental strategy

The Digital Switzerland strategy provides the guidelines for government action and indicates where and how the authorities, academia, the private sector, civil society and politics must work together to shape the transformation process for the benefit of everyone in Switzerland.

Switzerland is in a very good position regarding telecommunications infrastructure and the use of information and communications technology. The Action Plan is an integral part of the Digital Switzerland strategy. It outlines the measures that the Federal Administration envisages in order to make a tangible contribution to achieving the Digital Switzerland strategy's goals.

The strategy has a [Digital Switzerland Coordination Group](#) and an Information Society Business Office. The interdepartmental Digital Switzerland Coordination Group will coordinate the implementation work and the networking of Federal Administration stakeholders, with increased interdisciplinary cooperation within the Federal Administration.

In addition, in July 2017 the Federal Office of Communications launched the [digitaldialog.swiss](#) website to encourage a joint commitment to the strategy. The aim is to open up public debate about questions such as ethics in AI, but also to bring society closer together to collaborate on this topic.

Non-governmental initiatives

[SwissCognitive](#): the 'Global AI Hub' and a leading point of reference in finding answers to all questions that arise around artificial intelligence. It enables Swiss companies to become pioneers in the field of artificial intelligence. Cognitive computing should become a key industry. SwissCognitive is a private sector platform, but it covers all parties involved in the ecosystem (suppliers, customers, investors, universities, research, NGOs, and political actors).

[Mindfire](#): decoding the mind for humankind. Mindfire brings together the greatest minds on earth so as to unlock the underlying principles of human intelligence.

[Swiss Group for Artificial Intelligence and Cognitive Sciences \(SGAICO\)](#): brings together researchers, practitioners, and other parties interested in AI and cognitive sciences.

[Digital.Swiss](#): an informational platform to showcase the country's digital performance in the form of a scorecard.

United Kingdom

Academic ecosystem

The United Kingdom is host to several AI Societies, such as [AISB](#) and [BCS SGAI](#). AISB is a broker between academia and industry. Its mission is to foster interdisciplinary studies in AI and related fields, through cooperation and communication between the groups involved.

BCS SGAI is the British Computer Society Specialist Group on AI, which aims to foster achievement, capacity and awareness in both business and research in AI.

One of the leading institutes in this field in the UK is the [Alan Turing Institute](#), which is the national institute for data science. It comprises eleven universities and one research council. The Alan Turing Institute's mission is to change the world for the better through data science research.

Governmental initiatives

The UK government has increased financial support for several future industries, such as AI, Internet of Things, and electric vehicles. With GBP 75 million available for investment in AI, it is the least funded major future technology in the government's portfolio.

The [UK Science & Innovation Network](#) and the [Department for International Trade](#) are working, together with [Digital Catapult](#), on several international innovation initiatives. Most recently, they have exchanged ideas with a delegation from Canada (January 2018). They hope to: (1) increase understanding and knowledge of foreign AI ecosystems, (2) increase awareness of the UK AI strategies and capabilities, and (3) strengthen and foster partnerships between the UK and foreign organisations.

Professor Dame Wendy Hall and Jérôme Pesenti have published an independent report entitled [Growing the Artificial Intelligence Industry in the UK](#), containing several key recommendations. They include (1) the development of data trusts, to improve trust and ease around sharing data, (2) establishing 200 more PhD places in AI at UK universities, (3) greater diversity in the AI workforce, (4) a programme to support public sector use of AI, and (5) an AI Council to promote growth and coordination in the sector.

In reference to the independent report for the UK government on Growing the Artificial Intelligence Industry in the UK, BSI, Nesta and TechUK convened a workshop to discuss suggested needs for standards-like activities. The discussions revealed three areas where standards might be useful: (1) general AI process, (2) procurement, and (3) the medical use of AI.

Ideas for Standards

Developed at the Artificial Intelligence/Machine Learning standards development workshop (October 2017)

1 AI Process
Specification for Artificial Intelligence/Machine Learning.

2 Procurement
Specification for the evaluation of Artificial Intelligence/Machine Learning Systems and software

3 Medical imaging diagnosis
Process for evaluation of images for an AI agent – aid for medical imaging diagnosis

Other potential standards that could be developed:

i GDPR - Additional guidance to aid organisations to do AI best practice in line with the requirements of GDPR

ii Additional guidance to aid organisations with Data Protection Impact Assessment (DPIA)

iii Standard agreements for procuring AI/ML

iv Risk management in the context of using AI/ML

v Buying/trading data

vi Training AI/ML models

vii Test for the quality of an AI/ML system

viii Ethical consideration in AI/ML systems

ix Communication with data subjects on third-parties around AI/ML

x Methods for addressing governance, safety and the minimisation of risks

xi Measurement of bias in systems

xii AI/ML specific data anonymisation methods

xiii Standard on AI/ML methodologies and relative merits

Digital Catapult is active across the country with the aim of encouraging small and medium-sized enterprises to gain an overview of available technology, accelerating the practical application of digital innovation, and connecting academia with businesses.

The UK government had called for evidence on major AI issues in a House of Lords Select Committee on AI. The [final report](#) was published on 16 April 2018. Since 2017, Parliament is informed of current issues through an All Party Parliamentary Group on AI (APPG-AI).

Next steps

The UK plans to establish a [Centre for Data Ethics and Innovation](#) that will work with government, regulators and industry to lay foundations for AI adoption.

The Nuffield Foundation was planning an independent Convention on Data Ethics and Artificial Intelligence, in order to tackle the ethical and social issues arising from data use, AI, and associated technologies. On 28 March 2018, the Foundation announced the new £5 million Ada Lovelace Institute to examine profound ethical and social issues arising from the use of data, algorithms, and AI.

European overviews

In addition to the presentations describing the national landscapes in the participating countries, the workshop also included presentations surveying the overall European AI landscape.

The strongest AI regions within the EU are the UK, Germany and France. The top 10 AI start-up hubs within the EU are London, Berlin, Paris, Madrid, Stockholm, Amsterdam, Copenhagen, Barcelona, and Dublin.

European AI start-ups raised EUR 3.6 billion in 2017, almost three times more than in 2016. The top 5 industries they operate in are FinTech, HealthTech, MadTech (marketing, advertising and technology), business intelligence, and automotive. They focus mostly on B2B (business-to-business), which represents 76% compared to 24% for B2C (business-to-consumer).

Some of the most active AI investors in Europe are Amadeus Capital Partners (UK), BpiFrance (FR), Kima Ventures (FR), LocalGlobe (UK), the European Commission, Balderton Capital (UK), Holtzbrinck Ventures (DE), Enterprise Ireland (IE), High-Tech Gründerfonds (DE), and Sunstone Capital (DK).

TAKE AWAYS from the presentations

1. All participating countries emphasised the importance of a unified EU-wide AI approach in order to remain globally competitive.
2. The majority of countries mentioned distributed but cooperative AI clusters across Europe as a suitable next step. Smaller initiatives are already laying the groundwork (Nordic AI Artificial Intelligence Institute, Benelux Association for Artificial Intelligence, ROBOT-NET, etc.).
3. There are considerable differences between EU countries in terms of governmental initiatives and funding. Overall, most of the investment in AI technology seems to come from industry and private funds.
4. Several countries mentioned a need to discuss realistic future scenarios, and found debates surrounding dystopian applications of AI, e.g. killer robots, to be hindering beneficial AI development.
5. There are vast differences in public acceptance, usage, and uptake of ICT technologies across European countries.
6. Overall, Europe has a very strong academic landscape concerning AI and AI-related research.
7. Academia across Europe actively counteracts fragmentation between different AI-related disciplines and uses opportunities to cross-pollinate with industry and government.
8. The migration of academics and students to the US and China is a concern in most EU Member States. Almost all new initiatives surrounding AI involve activities related to talent creation, talent attraction, and talent retention at educational, training, and university level.
9. Most countries view limited access to open data as a hurdle to AI development and several countries are working on suitable solutions.
10. One country specifically mentioned AI as a technology for defence applications, but there are significant concerns within the AI community regarding the development of lethal autonomous weapons systems with a view that these should be banned from development.
11. One country directly addressed our duty to future generations to develop AI in a beneficial and sustainable manner.
12. One country acknowledged the possibility of AI as an existential risk but found this consideration less relevant for imminent developments in AI.

PART TWO

Discussion

Following the national presentations, Professor Barry O'Sullivan (Insight Centre for Data Analytics and University College Cork, Ireland) hosted a discussion under the Chatham House Rule¹⁰. The discussion aimed to examine and address the most serious bottlenecks within the European AI ecosystem.

Summarised below are some of the most relevant considerations.

Start-ups

The European Commission focuses a lot on research, but only a small percentage of SMEs are university spin-offs. In order to provide better support for the European ecosystem, there is a need for increased investment in start-ups. This includes: (1) finding better mechanisms to support young entrepreneurs, (2) highlighting the opportunities available within their own country, and (3) combating hesitation among investors surrounding the less conservative innovation ideas.

Supporting young people

One of the lessons learnt from countries that successfully attract young people is that the need for a diverse network and meaningful connectivity features in academic establishment decisions. Europe could support universities in their aim of collaborating with industry and hold open discussions on Europe's industrial and economic culture. Europe could also encourage large-scale innovation and moonshot projects in the field of AI.

In addition, Europe needs to find ways of raising the level of competence of those who are already working for established companies in the field. While improved education is a suitable measure, it will not change the status quo immediately.

Talent

As highlighted in the national presentations, Europe has a very strong academic ecosystem.

However, the European market is relatively conservative and many young people who wish to innovate leave for different markets. Europe needs to provide strong support for these people and their endeavours to innovate.

In addition, Europe is facing a global 'war' for tech talent with industry offering high salaries for highly qualified expertise. Europe could tackle this in three ways: (1) a coordinated European approach to the issue, (2) improving the ease with which people can contribute and progress within their own country, and increasing the attractiveness of that prospect, and (3) making it easier for non-EU people to work in Europe, in order to compete with the US and China. There is also a lack of research engineers in Europe to support the development of the platform/systems building aspects of research. This bottleneck could be addressed by the funding bodies in each Member State.

Concerning (2), it was suggested that European bureaucracy may affect young people to the extent that they prefer to leave for the US. For example, in Silicon Valley it only takes a couple of days to set up a company whereas in France it can take up to six months.

Nevertheless, Silicon Valley is becoming very expensive and many companies are looking to invest elsewhere, sometimes internationally. Europe could seize this opportunity and bring a large number of researchers back to Europe.

¹⁰ 'When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.' See [Chatham House Rule](#).

Awareness of opportunities

There appears to be a lack of awareness in industry as to the opportunities that AI can offer to companies in various sectors. Smaller companies often cannot invest time and money in AI research and, therefore, lose out on potentially higher productivity and increased revenue, as well as on innovation opportunities. Some proposed solutions included: (1) building awareness of the benefits of AI within industry, (2) supporting students by illustrating use cases for research and possible monetisation, (3) supporting smaller companies in their understanding of how they can leverage these new technologies in their businesses, and (4) providing them with information on the products and tools available to them. The latter could, for example, be achieved through digital coaches for industry.

In addition, AI needs to be made accessible for all of society, and an open Europe-wide multi-stakeholder dialogue needs to be established, where citizens can voice concerns and gain information about AI-based technologies.

Stronger infrastructure

There is a need for a wide-reaching European AI framework that all EU Member States could follow. The rationale is that if there were such a coordinated framework that consolidates findings from European leadership, EU Member States could speed up execution, save time in the long run, and remain competitive as a whole.

Data

Europe needs to explore better ways of sharing data, benchmarking data, and supporting access to open data. This includes establishing a strong pan-European data infrastructure that enables researchers to access data across national borders. Companies within Europe will need to implement the General Data Protection Regulation (GDPR) and ensure compliance.

Funding

In several individual EU Member States there is a lack of funding to support research in AI. For Europe to be competitive, an increase in funding is needed in order to forge a strong basis for fundamental research from which companies across Europe could benefit in the coming years.

Fragmentation

Europe needs a multi-national, pan-European, perspective and approach towards AI. There is a strong need to pull together existing strategies in a succinct way that will help grow the ecosystem across Europe without duplicating efforts.

If Europe does not combat fragmentation, there is a real risk of weakening the whole European ecosystem. Established dialogues need to gain momentum in terms of a collaborative effort.

Immediate next steps proposed

1. Establishment of a European hackathon and/or innovation forum encouraging entrepreneurship.
2. Consideration of the establishment of a European research centre for AI modelled on institutions such as CERN.
3. Incentivising stronger inter-governmental collaboration to combat fragmentation across Europe.
4. Investment and creation of a pan-European data infrastructure that makes high quality data sets available to European researchers and companies, beyond the existing Open Data Portals.
5. Support to facilitate and incentivise collaboration using European computational infrastructure and pooling existing resources and capabilities.
6. Increased support for working groups/focus sessions and summer schools to train and educate technical researchers (including on ethical concerns surrounding AI and the development of responsible AI).
7. Designing mechanisms to re-skill and up-skill the wider population in the use of AI tools and methods.
8. An increase in Europe-wide and national research funding for current and potential future AI systems, their novel properties and large-scale/wide-reaching impacts, such as safety.
9. Support for explicit studies concerning the integration of AI into society that address and propose novel approaches to increase the societal benefit derived from technical advances.
10. Developing incentives and forums to promote stronger interactions between European industry, SMEs and the general public to host large EU AI and robotics conferences (e.g. IJCAI) and showcase European talent and successful projects.

PART THREE

Presenters

Name	Organisation	Country
BANI, Marco	Agenzia per l'Italia Digitale	Italy
BONNET, Yann	French Digital Council	France
CESTA, Amedeo	CNR - Italian National Research Council	Italy
CIOCIOLA, Massimo	AI Labs	Italy
FINNEGAN, Ken	IDA Ireland	Ireland
FITZE, Andy	SwissCognitive	Switzerland
FLOREA, Adina Magda	University POLITEHNICA of Bucharest	Romania
GAL, Kobi	The Israeli Association for Artificial Intelligence (IAAI)	Israel
GUILLOUD, Géraud	Luxinnovation	Luxembourg
HAINDL, Michal	The Czech Academy of Sciences	Czech Republic
HEINTZ, Fredrik	Swedish AI Society	Sweden
HIJAZI, Younis	LUXCOR	Luxembourg
KLUSCH, Matthias	German Society for Informatics (GI)	Germany
KOESZEGI, Sabine	Vienna University of Technology	Austria
LE FEVRE, Enzo Maria	Agency for Digital Italy	Italy
LENAERTS, Tom	Benelux Association for Artificial Intelligence (BNVKI-AIABN)	Belgium
MARTINKENAITE, Ieva	Telenor	Norway
MESEGUER, Pedro	CSIC	Spain
MOHOUT, Omar	Sirris	Belgium
MUESSNER, Rainer	Federal Ministry of Education and Research	Germany
MÜLLER, Bertie	AISB (Society for the Study of Artificial Intelligence and Simulation of Behaviour)	United Kingdom
NIELSEN, Mads	University of Copenhagen, Department of Computer Science	Denmark
NOVAIS, Paulo	APPIA - Associação Portuguesa Para a Inteligência Artificial	Portugal
O'SULLIVAN, Barry	University College Cork	Ireland
PELAYO, Enrique	CDTI	Spain
RIGUZZI, Fabrizio	Italian Association for Artificial Intelligence	Italy
SCHOENAUER, Marc	INRIA - Saclay Branch	France
SIVONEN, Pekka	Business Finland	Finland
STEIGER, Dalith	SwissCognitive	Switzerland

Attendance list

Name	Organisation	Country
ACKERMAN, Nathanael	Hub France IA	France
AILISTO, Heikki	VTT Technical Research Centre of Finland Ltd.	Finland
ANGELIS, Georgo	Eindhoven University of Technology (TU/e)	Netherlands
BANI, Marco	Agenzia per l'Italia Digitale	Italy
BARACSI, Krisztina	Telenor	Norway
BELVISI, Barbara	HUB France IA	France
BONNET, Yann	French Digital Council	France
BORÄLV, Erik	VINNOVA	Sweden
CESTA, Amedeo	CNR - Italian National Research Council	Italy
CIOCIOLA, Massimo	AI Labs	Italy
DAFOE, Allan	Yale University / University of Oxford	USA
DE LAMA, Nuria	ATOS Spain	Spain
DORMOY, Jean-Luc	France Hub IA	France
FINNEGAN, Ken	IDA Ireland	Ireland
FITZE, Andy	SwissCognitive	Switzerland
FLOREA, Adina Magda	University POLITEHNICA of Bucharest	Romania
FREDONIE, Julien	Infosys Innovation Fabrik	Germany
GAL, Kobi	The Israeli Association for Artificial Intelligence (IAAI)	Israel
GARCIA ROBLES, Ana	Big data value Association (BDVA)	Belgium
GINDT, Max	Ministry of State - Media and Communications Service	Luxembourg
GUILLOUD, Géraud	Luxinnovation	Luxembourg
HAINDL, Michal	The Czech Academy of Sciences	Czech Republic
HEINTZ, Fredrik	Swedish AI Society	Sweden
HIJAZI, Younis	LUXCOR	Luxembourg
HUBLET, Laurent	Belgian Federal Government	Belgium
KLUSCH, Matthias	German Society for Informatics (GI)	Germany
KOESZEGI, Sabine	Vienna University of Technology	Austria
LAKEMEYER, Gerhard	RWTH Aachen University	Germany
LE FEVRE, Enzo Maria	Agency for Digital Italy	Italy
LENAERTS, Tom	Benelux Association for Artificial Intelligence (BNVKI-AIABN)	Belgium
MARTINKENAITE, Ieva	Telenor	Norway
MESEGUER, Pedro	CSIC	Spain
MOHOUT, Omar	Sirris	Belgium
MUESSNER, Rainer	Federal Ministry of Education and Research	Germany

MÜLLER, Bertie	AISB (Society for the Study of Artificial Intelligence and Simulation of Behaviour)	United Kingdom
NIELSEN, Kurt	Danish Technological Institute	Denmark
NIELSEN, Mads	University of Copenhagen, Department of Computer Science	Denmark
NOVAIS, Paulo	APPIA - Associação Portuguesa Para a Inteligência Artificial	Portugal
O'SULLIVAN, Barry	University College Cork	Ireland
PELAYO, Enrique	CDTI	Spain
RIGUZZI, Fabrizio	Italian Association for Artificial Intelligence	Italy
SANTAELLA, Juan	Ministerio de Energía, Turismo y Agenda Digital	Spain
SCHOENAUER, Marc	INRIA - Saclay Branch	France
SIVONEN, Pekka	Business Finland	Finland
SORICI, Alexandru	Romanian Association for Artificial Intelligence	Romania
STEIGER, Dalith	SwissCognitive	Switzerland
SWIRTUN, Linda	Vinnova	Sweden
THALHAMMER, Alexandra	SwissCognitive	Switzerland
VAN IMPE, Philippe	DigitYser	Belgium
VERMASSEN, Erwin	ERTICO	Belgium
WESTERHEIDE, Fabian	Asgard - Human Venture Capital for Artificial Intelligence	Germany