The Federal Government

Artificial Intelligence Strategy of the German Federal Government
AI Made in Germany

Artificial Intelligence Strategy of the German Federal Government

2020 Update

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Content

Summary

With the update of the Artificial Intelligence Strategy, the Federal Government is focusing its measures with regard to current developments in the field of artificial intelligence (AI) since the strategy was adopted in November 2018. The update aims to strengthen Germany as an internationally competitive centre of AI research, development and application. This entails further establishing and expanding AI ecosystems[1] in Germany and Europe to strengthen the application of AI on a broad scale and at the same time to promote the visibility of outstanding initiatives and structures. Responsible and public good-oriented development and application of AI systems should be made an integral part and thus a trademark of an "AI Made in Europe"..In addition to this, the update puts pandemic control, sustainability - in particular environmental and climate protection - and international and European networking at the heart of new initiatives.

Achieving this entails

- training, attracting and retaining more **AI specialists** in Germany,
- establishing powerful and internationally visible **research structures** and, in particular, providing internationally competitive cutting-edge AI and computing infrastructures,
- establishing AI ecosystems with an international reach, based on excellent research and **transfer structures**, in order to foster research results **being applied** in business practice, especially in the SME sector or Mittelstand, and to boost start-up dynamics,
- bolstering the underlying conditions for innovative and human-centric AI applications in Germany and Europe by establishing and expanding the quality infrastructure into a system for safe, secure and trustworthy AI on the basis of an appropriate **regulatory framework**; and
- supporting **civil society networking** and its involvement in the development and use of AI that serves the common good.

[1] AI ecosystems are not meant here in the sense of a natural ecosystem.

Introduction

Artificial intelligence (AI)[2] is a key technology which harbours great potential for additional economic growth and productivity gains - in Germany, Europe and worldwide. To promote and use this potential, the Federal Government developed a framework for action and adopted far-reaching measures in its Artificial Intelligence Strategy (AI Strategy). These measures help shape a holistic policy for responsible research, development and application of AI in Germany for the good of citizens and the environment. The Federal Government is basing this on a broad societal dialogue designed to enable societal actors to also contribute to shaping AI, and on active policy-making.

The guiding principle behind the AI Strategy is a European AI ecosystem for innovation that enhances the competitiveness of European research, business and industry, promotes a wide range of different uses of AI in all areas of society in the interest of citizens and is rooted in common European rules and values. When it comes to the development and use of AI, we will put the benefits for people, the common good, the environment and the climate at the fore. The AI ecosystem consists of actors of different sizes across different sectors, connected across national borders, and enables everyone to participate. This includes not just science, research and business and industry, but also civil society as a whole. The AI ecosystem is designed to significantly enhance the appeal of Germany and Europe as an internationally competitive centre of research and business. Germany and Europe have the potential to create the world's largest data space for machinery, operational and mobility data. Furthermore, the AI ecosystem will be based on a secure and sovereign data infrastructure, thus ensuring competitiveness. The aim is also to give citizens the skills to be able to deal with AI applications confidently in all manner of situations.

Two years have passed since the publication of the AI Strategy in November 2018 (Chapter Progress to date). Much has happened during this time (Chapter Situation in 2020). With the update of the AI Strategy, the Federal Government is responding to these developments and supplementing them with further measures (Chapter AI Strategy priorities). Here, current developments in response to the COVID 19 pandemic and sustainability issues, in particular environmental and climate protection and European and international networking, play a major role. The update also sets out concrete steps for implementing the AI Strategy (Chapter Next steps in the implementation of the AI Strategy).

The present report is the product of seven thematic expert forums that were held with experts from the fields of business and industry, science, politics and society in the scope of updating the AI Strategy. The main subjects of the expert forums were research, transfer, Industry 4.0, mobility, healthcare and long-term care, environmental and climate protection and the regulatory framework for the human-centric use of AI at work and in society. In the expert forums, the experts were called upon to provide feedback on the progress made in implementing the AI Strategy to date, to highlight new developments and make recommendations for action.

[2] For the definition see www.ki-strategie-deutschland.de.

Key dates of the German Government's AI Strategy

- **15 November 2018**: Cabinet adopts the AI Strategy. The website www.ki-strategie-deutschland.de presents the strategy, measures and current developments.
- **15 November 2019:** A year after the strategy was first published, the Federal Government publishes an interim report providing information on individual measures to implement the strategy.
- **June 2020:** With its Future Package, the government coalition decides to increase the planned expenditure of 3 billion euros for the promotion of AI by an additional 2 billion euros to a total of 5 billion euros by 2025.
- **December 2020:** With its **updated AI Strategy,** the Federal Government responds to new developments in the field of AI and hones, strengthens and supplements its measures to foster AI in Germany and Europe.

Progress to date

Since the publication of the AI Strategy, numerous initiatives and measures to foster AI have been implemented and many more have been initiated. A year after the publication of the strategy, the Federal Government published an interim report providing information on individual measures to implement the AI Strategy.

The experts in the **expert forums for updating the AI Strategy** have stressed that, as an enabling technology, AI needs to be used more commonly in the broadest range of fields of application than it has been to date. This entails dovetailing and strengthening the relevant actors and initiatives and promoting the establishment and expansion of AI ecosystems. The expert forums for updating the AI Strategy also indicated that the AI Strategy needed to hone in on the key areas outlined below.

AI research has been established in Germany for a long time now and is well positioned: Studies have found that Germany ranks fifth internationally in terms of the number of scientific publications on AI in recent years[3]. At the same time, the studies point to very dynamic growth in AI research throughout the world, which must prompt Germany to expand its research capacities if it is to keep up with international developments. To durably enhance Germany's appeal as a centre of AI research, it will be key to establish visible research structures in the field of AI, as will broadly embedding AI in the German research landscape. The establishment of a National Research Consortium for AI has already laid the foundation for an internationally prestigious research network that has a great development potential, particularly through the connection of various research areas.

[3] According to the 2018 report "Artificial Intelligence: How knowledge is created, transferred and used" by scientific publisher Elsevier, Germany ranks fifth internationally in terms of its number of scientific publications, behind China, the US, Japan and UK. In the AI Index 2019, Germany ranks fifth worldwide in terms of the number of scientific publications on AI.

Alongside companies, universities and research institutions are also competing internationally for highly trained **AI specialists and AI experts.** Government talent promotion schemes specifically targeting AI experts exist internationally. A recent study also demonstrates the demand for AI workers: 30 % of the businesses using AI in Germany had vacancies in the field of AI in 2019. Out of these, they were able to fill 47 % of the positions as planned, but 11 % were filled either late or not with the preferred staff, and 43 % of the positions remained vacant. In light of this, strengthening AI expertise in Germany is of paramount importance for the German Federal Government. This encompasses a wide range of measures: from attracting leading AI experts from abroad, promoting young scientists at Germany's universities, initial and continuing education and training of workers all the way to empowering innovative regional small and medium-sized enterprises (SMEs) and embedding basic knowledge in broad sections of society. These measures need to be bolstered further and, in the interests of sustained effectiveness, established and expanded over an extended period of time. In addition to making Germany an attractive location for experts of international renown, there needs to be more targeted action to foster national talent.

In the context of its AI Strategy, the Federal Government has already actively promoted the **transfer** of findings from AI research to the economy as well as the **use** of AI across the breadth of SME sector and "Mittelstand". To remove barriers to the market and further cement trust and confidence in technologies, the Federal Government has expanded its information and advisory services for SMEs further and improved the business environment for start-ups. In cooperation with science and business communities with special emphasis on SMEs, this has allowed the Federal Government to boost Germany's position as an international centre of AI innovation. The use of AI in the fields of mobility, health, environment and agriculture were particular priorities here. A recent study[4] shows that to date only around six per cent of the companies surveyed use AI, though. With the update of the AI strategy, the Federal Government is therefore strengthening and expanding measures aimed at further reducing barriers to transfer and expanding support services.

AI-based products and services need to be as safe to use as any other product. The underlying conditions in place also play an important role in the development and use of AI. Legal certainty and incentives for the development and deployment of secure and trustworthy AI can reduce reservations and uncertainties among users and provide investment security for companies. The Federal Government is therefore advocating and working towards a suitable **regulatory framework**, adapted to reflect AI-specific issues if and where appropriate, within which the existing quality infrastructure is expanded and, if necessary, developed further. By setting clear rules, standards, the fundamental rights of citizens can be protected, trust in AI can be strengthened, sustainable deployment of AI as well as innovation and competition can be promoted. The implementation of the Federal Government's AI Strategy to date has contributed to harness the innovative thrust associated with the development of AI for the benefit of the economy, science and society It has also led to the successful initiation of a more objective and factual discussion on the opportunities and risks harboured by AI, digital sovereignty and ethical aspects. The Federal Government has also established new structures for monitoring the impact of AI on work and society. The Federal Government will use this momentum to further promote sustainable and responsible development and application of **AI for the good of citizens** and to

[4] Federal Ministry for Economic Affairs and Energy (2020) Einsatz von KI in der deutschen Wirtschaft (Use of AI in the German Economy)

shape it together with them. This also goes hand in hand with greater promotion, involvement and networking of civil society projects and initiatives.

Monitoring the AI landscape

To record trends and developments in the German, European and international AI landscape and to then align and evaluate the implementation measures in the AI Strategy accordingly, the Federal Government compiles indicators. These currently include indicators on the use of AI in the economy, in higher education and teaching, as well as on the number of AI publications in international comparison and on society's perception of AI. The indicators are constantly being further developed and supplemented by indicators from other areas.

A study published in spring 2020 on the "Use of Artificial Intelligence in the German Economy" provides the first overview of the current state of use of AI in companies. Indicators are used to show in which sectors, to what extent and with what aims and objectives AI was used in 2019. The study is part of a comprehensive research assignment on digitalisation commissioned by the Federal Government, for an initial period of three years.[5] There will continue to be more study reports on the use of AI in businesses in the future in the scope of the research project in order to assess the development and possible needs in the area of the use of AI in the economy.

Furthermore, the Federal Government's Observatory for Artificial Intelligence in Work and Society (AI Observatory) will develop indicators that specifically record and evaluate the use of AI in work and society. The AI Observatory organised a workshop for this purpose in May 2020 with experts from business, science, politics, social partners and civil society organisations to discuss the potential and challenges in developing suitable AI indicators for the area of work and society and to start brainstorming on first concrete indicators. These indicators will now be further developed with these experts. The first indicators on AI in work and society are scheduled to be published on the AI Observatory website in 2021.

The Plattform Lernende Systeme also continuously analyses the use of AI in different areas in its working groups and discusses the opportunities, challenges and general conditions for the development and responsible use of learning systems. It uses these findings to develop scenarios, recommendations, policy options or roadmaps. The platform also produces a Map on AI showing current uses and projects, research institutions and transfer activities.

Situation in 2020

Since November 2018, when the Federal Government's Artificial Intelligence Strategy was first adopted, there have been a number of developments at both national and European and international level. The Covid-19 pandemic in particular has presented people, our communities

[5] The project entitled "Measuring the degree of digitalisation of the German economy" is being conducted by a project consortium consisting of the ZEW - Leibniz-Zentrum für Europäische Wirtschaftsforschung GmbH Mannheim (consortium leader), the Institut der deutschen Wirtschaft Köln e.V., the Institut der deutschen Wirtschaft Köln Consult GmbH, the Forschungsinstitut für Rationalisierung e.V. at the RWTH Aachen University and the Deutsches Institut für Wirtschaftsforschung e.V.

and the economy with major and new challenges. The potential AI harbours for finding answers to these challenges must be harnessed. AI can assist in the management of pandemics, for example in pandemic forecasting, monitoring and modelling the course of the epidemic or the effectiveness of different measures, and in research, inter alia in developing vaccines. At the same time, AI technologies' use cases have increased in many places due to side effects of the pandemic, for example through the increased use of purchase offers in online shops, the increasing use of AI-based cybersecurity in the economy and to combat AI-based disinformation and personalised phishing attacks by diffuse actors.

To strengthen Germany in the fight against the COVID-19 pandemic and to lay the foundations for Germany's competitiveness during and after the pandemic, the Federal Government has significantly stepped up its commitment to future technologies like AI once again. The economic stimulus and future package will increase the Federal Government's investments in AI from three to five billion euros by 2025. These funds are to be used in particular to modernise the supercomputer infrastructure and increase computing capacities through new supercomputers, to promote the systematic digital provision of data from previously inaccessible data pools, to sustainably bolster AI centres of excellence and dovetail them with regional economy in application hubs, and to establish AI ecosystems of international appeal in order to lay the foundations for a European AI network and the competitiveness of AI "Made in Europe".

In November 2019, the Federal Government published key points of a data strategy. Within the framework of a broad public consultation and a host of expert discussions, the Federal Government is now developing a data strategy aiming inter alia to increase the provision and use of data for all stakeholders responsibly and in compliance with data protection regulations. Data-driven innovations should thus be promoted. The data strategy will address the issues of data availability and -infrastructures.

But even before the current pandemic and associated issues and questions arose, there had already been AI-specific developments in many areas:

In **Germany**, the Commission of Experts on Competition Law 4.0 presented its report on "A New Competition Framework for the Digital Economy" in 2019. The Competition and Digitalisation Act[6] adopted by the Cabinet on 9 September 2020 addresses several of the Commission's recommendations and implements them where this is essential to ensure functioning competition, for instance when it comes to improving access to data. The Study Commission on Artificial Intelligence - Social Responsibility and Economic, Social and Ecological Potential of the 19th German Bundestag presented its final report with specific recommendations for action in October 2020, on which the German Bundestag concluded its deliberations on 5 November. On 23 October 2019, the Data Ethics Commission presented a report containing 75 recommendations for action on the use of data and algorithmic systems (including AI systems). In 2019, the German Advisory Council on Global Environmental Change (Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen) also prepared its main report entitled "Towards our Common Digital Future" and two additional papers providing extensive analysis of the links between digitalisation and sustainability and listing recommendations for

[6] Tenth Act amending the Act against Restraints of Competition for a focused, proactive and digital competition law 4.0

action and research in specific policy areas. Various industry associations have also published recommendations for action for the policy towards AI.

In December 2018, the **European Commission** published a Coordinated Plan on Artificial Intelligence with proposals for specific measures for the European Union (EU) to be implemented through programmes from both the current and future Multiannual Financial Framework (Horizon 2020, Digital Europe and Horizon Europe). Member States are also called upon to make additional investments in this vein. On 8 April 2019, the *High-Level Expert Group on Artificial Intelligence* set up by the Commission published "Ethics Guidelines for Trustworthy AI" and on 26 June 2019 "Policy and Investment Recommendations for Trustworthy AI". Building on these, on 19 February 2020 the Commission presented its "White Paper on Artificial Intelligence - A European approach to excellence and trust". The White Paper sets out policy measures and options on the one hand to promote the use of AI in the European Single market and on the other hand to address associated risks. It was accompanied by the publication of a "Report on the safety and liability implications of Artificial Intelligence, the Internet of Things and robotics". The Federal Government also participated in the associated consultation procedure in the form of a statement. In June 2020, the **European Parliament** established a Special Committee on Artificial Intelligence in a Digital Age. It also published recommendations on a framework of ethical aspects of artificial intelligence, robotics and related technologies and recommendations on a civil liability regime for artificial intelligence in October 2020.

The Organisation for Economic Co-operation and Development (OECD) adopted the first recommendation on **internationally** agreed AI Principles on 22 May 2019. They include principles for responsible stewardship of trustworthy AI and policy and cooperation recommendations. The G20 countries also adopted identical principles in June 2019. Furthermore, the OECD has opened the AI Policy Observatory and put in place an extensive AI Programme on Work, Innovation, Productivity and Skills, which Germany is supporting significantly. On 15 June 2020, at the initiative of Canada and France, the Global Partnership on AI (GPAI) was launched, of which Germany is also a founding member. This long-term international multi-stakeholder initiative bringing together leading and independent experts from the fields of science, business and civil society from a broad range of different countries aims to support the responsible use of AI and complement the work of the OECD. The first multi-stakeholder conference is scheduled for the end of 2020. At the level of the **Council of Europe**, the new Ad hoc Committee on Artificial Intelligence (CAHAI) began its work in November 2019. During its two-year mandate, it will examine the feasibility and possible elements of a legal framework for the development, design and use of AI based on the Council of Europe's legal standards in the area of human rights, democracy and the rule of law, in the scope of a broad-based stakeholder dialogue. The Federal Government is actively supporting the CAHAI's work.

Study Commission on Artificial Intelligence - Social Responsibility and Economic, Social and Ecological Potential

The Study Commission on Artificial Intelligence - Social Responsibility and Economic, Social and Ecological Potential established by the 19th German Bundestag studied AI's impact on our lives (and how we live together), the German economy and the future world of work and explored the opportunities and challenges AI presents for society, government and economy. Based on this, the Study Commission then identified the need for action by the state. The

Federal Government followed the work of the AI Study Commission closely and is including relevant input from the Study Commission's work in the updated AI Strategy in all fields of action.

AI Strategy priorities

The rapid pace of technological development and the changing economic, social and political conditions mean that the AI Strategy initiatives are also being constantly further developed. The Federal Government is liaising closely with the scientific community, business and industry and society as well as the Länder, the EU and other national and international actors to this end.

The update of the Federal Government's measures outlined below is divided into the following priorities pursued by the strategy: minds (technical expertise), research, transfer and application, the regulatory framework and society. The issues of pandemic control, environmental and climate protection, and European and international networking in particular take centre stage in the initiatives.

With this update, the Federal Government is working to ensure that technology benefits humans and that the further development and use of AI is aligned with the Sustainable Development Goals (SDGs[7]), which it has committed to in the scope of the United Nations (UN) Sustainable Development Agenda. It is also working to ensure that all stakeholders in the field of AI honour their individual responsibility to respect human rights. International networking with developing and emerging countries also plays an important role here, in order to enable these countries to participate in the use of AI technologies and to develop AI applications for sustainable economic, ecological and social development.

Furthermore, the Federal Government will work to encourage that the technology is designed to be both energy and resource-efficient and is used as an instrument for environmental conservation. Direct and indirect environmental impacts will also be taken into account in all of this, so as to include rebound effects and shifting of environmental problems.

Many measures to foster and apply AI are already being implemented and their financial impacts are baked into the current financial budget. In addition to the funds originally earmarked, an additional 2 billion euros is available from the Federal Government's "Package for the Future" and an overall concept for the allocation of these funds is in the process of being drafted. Any additional funding needs to implement the strategy will require direct, complete and permanent counter-financing.

[7] On 25 September 2015, the 193 member states of the United Nations adopted the Sustainable Development Agenda containing 17 Sustainable Development Goals (SDGs)

Minds

The highly competitive labour market for AI experts presents businesses, universities and research institutions alike with major challenges in the search for qualified candidates for vacancies in the field of AI. Germany is vying for highly qualified AI experts in research and development with other countries and numerous global companies in particular[8]. Above all, it is becoming increasingly difficult to establish AI research at locations that do not already have an AI focus. Therefore, it is of vital importance to the Federal Government to secure more specialists through university courses and education and training and to create an attractive working and research environment for scientists.

Attractive working conditions in Germany as a centre of science and research

In concert with the Länder and the business community, the Federal Government wants to sustainably secure internationally outstanding specialist expertise in Germany as a centre of science and research and, in this context, reaffirms its goal of providing funding for the establishment of 100 new professorships in AI at German universities. One example is the new Alexander von Humboldt Professorship in AI for internationally renowned researchers. Further AI professorships are planned at the centres of excellence for AI research. Here, the tight-knit research network between the centres will ensure particularly attractive conditions for researchers from Germany and abroad. Together with the Länder, the Federal Government is also supporting the creation of AI professorships in the scope of the Tenure Track Programme and the Excellence Strategy.

Establishing AI professorships at universities of applied sciences is a move designed to involve SMEs in particular and promote greater implementation of AI at SMEs. In addition to this, a dedicated DAAD (German Academic Exchange Service) programme for Master students and doctoral candidates is to be set up to attract young international researchers to selected programmes and, through incentives for top-level AI research, will have a powerful and enduring appeal in Germany. Furthermore, AI challenges are to be held that promote application-oriented AI innovation and lead to high international visibility through the dynamism this unleashes. In this context, a German “AI - made in Germany” Award with international reach is to be established. It will be ensured that the Federal Government’s measures can dovetail powerful action by the Länder.

In light of the tight labour market situation and to open up career paths for future generations of excellent scientists as well, the funding of new AI professorships is designed to cover a period of multiple years. Above and beyond this, the Federal Government will stress the importance of attractive conditions in Germany as a centre of science and research in its talks with the Länder and will advocate improved salary structures for AI professorships.

The Federal Government will also focus especially on encouraging young researchers, starting by targeting doctoral students and outstanding Master students to highlight the attractive prospects available in the research system, as they are the professors of tomorrow. Researchers at the nexus between AI and other disciplines will be supported in particular. In coordination with its funding bodies, the German Research Foundation (DFG) is supporting interdisciplinary

[8] The 2019 Global Talent Report shows a net drain of AI experts with doctorates.

AI research groups and young researcher groups in the scope of the renowned Emmy Noether Programme, thus opening up career paths for young researchers.

Bolstering AI expertise

Making Germany a globally leading location for AI research, development and application requires a broad and highly trained specialist workforce.

The Federal Government will therefore be working with the Länder to strengthen the academic qualifications of students with AI expertise and to improve the quality and performance of higher education through the responsible use of AI. The Federal Government will continue to foster innovation in higher education through AI and big data, such as the AI-supported development of university courses or design of learning settings. The idea behind this is not just to promote research in this field but to set in motion the transfer to the regular operation at the universities, too. Thus, projects within specific priority subjects will be devoted, for instance, to the AI-supported and automatic setting of exam tasks or learning paths, AI-supported feedback on learning processes or AI-supported assistants for analysing, planning or organising studies.

To sustainably secure AI skills and expertise in Germany, it is also important to encourage young people to develop a passion for STEM subjects, so science, technology, engineering and mathematics, and the career prospects building on these. The Federal Government is pursuing this goal with the STEM Action Plan, *inter alia* through nationally funded STEM clusters and the communication campaign #mintmagie (STEM magic). The Federal Government wants to encourage women in particular to discover STEM careers, and in turn increase the share of female students studying STEM subjects. The Federal Government is also working to counter the current shortage of specialists by doubling down on eliminating discrimination against qualified women.

When it comes to securing enough skilled labour to meet demand in the field of AI, the Federal Government believes in a sectoral approach in order to find tailored solutions. Education and training curricula are being adapted. In addition to school and vocational and higher education, the focus is also on skills development and continuing training at companies for the development and use of AI. AI expertise is also being developed in public administration.

With its "National Skills Strategy" the Federal Government is already implementing a broadly targeted set of instruments to promote the skills of the workforce in times of demographic, digital and ecological change. In the future, the spotlight will increasingly be on both AI-specific skills and AI-supported applications.

The Federal Government will provide more targeted support for health-related AI research and development with a view to retaining scientific AI expertise in the German healthcare system, too. Here, it will also support the integration of AI modules in education and training in the fields of healthcare and long-term care.

In the mobility sector, the Federal Government is planning a package of measures entitled "AI for innovative mobility solutions", which inter alia is designed to contribute to securing the next generation of experts and AI skills development in the area of mobility research.

Furthermore, the Federal Government will be partnering with the Plattform Lernende Systeme to develop initiatives to prepare and showcase helpful use cases in detail to serve as best practice examples, creating incentives for other businesses, too.

Beyond this, the Federal Government is fostering the establishment and development of technical AI expertise in the Global South to effectively meet the high demand that exists globally. Here, it is effectively supporting countries in dealing with changes in local labour markets.

Research

The Federal Government has been promoting and funding AI research in Germany for over 30 years now. As a result, Germany is well positioned internationally: German AI researchers are cooperating with the most prestigious research institutes worldwide and publishing their work in the most prestigious journals[9]. This foundation needs to be cemented and expanded further to secure and strengthen the technological sovereignty of Germany and Europe.

Strengthening national research structures

To further strengthen Germany's position as a centre of research, the Federal Government will continue to actively push forward the expansion of the six existing centres of excellence for AI research and linking these at regional, national and international level. The aim is to establish a research and teaching network at German universities that pools different types of AI expertise locally, fosters innovation with local businesses in the regions and in association with application hubs, and is reputed at international level as a prestigious network, too. The plan is to dovetail the existing centres at the universities in Berlin, Dresden/Leipzig, Dortmund/St. Augustin, Munich and Tübingen and the German Research Centre for Artificial Intelligence with other application hubs to be established to form a network of at least twelve centres and hubs. In this context, there are also plans to establish additional innovation centres for smart mobility. Subject to an excellent scientific evaluation, the Federal Government and the Länder will fund the five university centres of excellence permanently. The rising use of AI is predominantly attributable to the increased availability of large computing capacities which enable the use of AI applications in practice. AI research in Germany also needs to have access to modern and high-performing computing infrastructures. The Federal Government is making an important contribution to this by expanding the centres of excellence for AI research and by promoting High Performance Computing (HPC): To build suitable computing capacities throughout Germany, the Federal Government will work with the different Länder to accelerate the expansion of the Gauss Centre for Supercomputing to Exascale capability in addition to developing the National Supercomputing Centre (NHR), especially taking into account future peak demand for AI applications and for analysing large data volumes. Particular attention will be paid to energy and resource efficiency as well as possibilities for industrial use. A connection to GAIA-X and the mobility data space is planned here to create a new and trustworthy bridge to use by business and industry, for instance Industry 4.0.

The ever-faster acceleration of technological developments is also impacting research and the translation of its findings into practice. The Federal Government is responding to these

[9] The 2019 AI Index ranks Germany fifth worldwide in terms of the number of scientific publications on AI.

developments, for instance, with the Agency for Breakthrough Innovations, which is a new flexible and rapid government funding instrument also encompassing the field of AI. The Federal Government is also creating new agility in research funding with initiatives such as the "Energy-efficient AI system" pilot innovation competition.

Beyond this, the Federal Government has set up the Agency for Innovation in Cyber Security (Cyber Agency), which will commission research projects - including on AI topics - to meet Germany's domestic and external security needs in cyberspace. The Federal Government aims to use the Cyber Agency to help Germany achieve greater technological sovereignty in the field of cyber security. Additionally, in its capacity as a research and development service provider for all federal security authorities, the Central Office for Information Technology in the Security Sector (ZITiS) is working on expanding capabilities and skills relating to AI. As such, the Cyber Agency and ZITiS are a cornerstone of the Federal Government's work to protect citizens, public administration and business and industry in cyberspace.

European and international research cooperation

The Federal Government will continue to foster the internationalisation of AI research and aims to develop a globally leading European AI network under the master brand "AI made in Europe". The EU is the largest AI think tank in the world. The Federal Government will also support the European Commission with partial funding to expand existing excellent structures and to pool existing expertise in a European AI network with international reach and provide substantial funding true to the maxim of "strengthening strengths". The Federal Government aims to bolster European networking and to mobilise European expertise across the board so that the EU can assert and establish itself as the world's leading pacemaker (AI made in Europe) and trailblazer - particularly when it comes to establishing clear ethical guidelines, in basic and applied research in the medium and long term.

Beyond this, a special priority for the Federal Government will be cooperation with France, Canada and Japan. In particular, it will continue to advance the networking between German AI centres of excellence and French AI institutes in the form of a joint Franco-German AI research and innovation network, at the same time always taking care to ensure that other European countries can join this. The objective is to establish a pan-European AI network aligned with the AI strategy of the European Commission, which will decentrally implement the transfer of AI applications from research to practice and promote the systematic further development of expertise in science and research, business and society. The Federal Government is also backing the EUREKA clusters' synchronised call for funding for AI.

For cooperation projects with other third countries, the Federal Government will ensure that they serve German and European interests and that common European values are upheld, including human rights and security interests.

Interdisciplinary research and sustainable utilisation

The application of AI methods harbours innovative potential for a very wide range of different scientific fields, for example in the fields of energy, mobility, climate, the environment and recycling, bioeconomy, physics, biology, biotechnology and medicine as well as in materials development, materials research and in production processes. Here, AI is understood as an "enabling technology", whose deployment will enable the scientific fields in question to reach new heights and achieve new results. This is why it is particularly important to further bolster the interdisciplinary nature of AI research and to combine AI expertise with sector-specific

specialist knowledge. For this reason, the Federal Government will be especially supporting the linking of and exchange between computer science and applied mathematics and other disciplines, including in the setting of national and international research infrastructures. The Federal Government's funding of AI research and development is generally geared towards applications and solutions. The selection of the AI processes used or to be further developed is based on traits specific to the domain or problem. Both symbolic and learning processes and combinations thereof are considered alike.

In future funding programmes in particular, the Federal Government will create cross-project incentives for a sustainable utilisation of results, for instance by making algorithms available in open-source form, by disclosing the prepared project data, for instance as open AI training data, or by researchers liaising closely on best practices as well as on any setbacks and problems encountered. For quality assurance purposes, the Federal Government will also pay particular attention to the traceability and verifiability of research findings when assessing or evaluating projects.

In its research funding for AI methodology, the Federal Government will place new emphasis on improving existing simulation models for the synthetic generation of realistic and representative data for especially relevant areas of application and on the interaction between AI and complex systems. By intensively funding applied research at universities of applied sciences, their role as an innovation driver in the different regions will be bolstered.

AI research for healthcare and long-term care

The Federal Government will supplement the Medical Informatics Initiative with a further four-year funding phase and roll out the solutions and use cases at other healthcare facilities. This will mean patients treated outside university hospitals will also be able to benefit from developments. Setting up *digital health progress hubs* will allow the approach developed at university hospitals for data-supported digital medicine to be tested in mainstream patient care, promoting the use of AI in particular. The focus here will initially be on defined areas of application, such as cancer and infectious diseases. The Federal Government will also be deploying structural measures to improve patient care and research through data exchange and digital solutions in the event of a pandemic, whilst at the same time ensuring the protection of personal data.

The Federal Government will further strengthen the science-based quality criteria for medical study designs (for instance for using external data sets) and bolster research funding on specific AI challenges in healthcare. Furthermore, it intends to further develop the quality infrastructure in university medicine and fund it so that standardised, high-quality, health-relevant data is available quickly and widely for AI-driven health research. The Federal Government will also support the use of AI in pharmaceuticals research, in modelling epidemic dynamics and in the research and development of medical technology solutions for digital healthcare.

In the scope of the *Long-term Care Innovations 2030* initiative, the Federal Government is currently exploring the use of AI systems with regard to needs, application scenarios, underlying and success conditions for research and development. This has led to a new funding priority in the area of interactive technologies promoting health and quality of life, through which we will tap into the opportunities harboured by digitalisation and AI in long-term care in a way that is tailored to needs.

AI research to protect the environment and climate

The Federal Government will systematically identify the potential harboured by AI to promote a sustainable, and in particular environmentally and climate-friendly way of living and doing business and harness it by funding and promoting AI-based instruments to solve specific challenges for sustainable development. AI can make a key contribution to achieving the goals set out in the European Green Deal and the Sustainable Development Goals laid down in the United Nations' Sustainable Development Agenda. There are concrete opportunities in the application fields of renewable energies and energy systems, energy efficiency, resource conservation and recycling, water protection and water management, immission control and health, nature conservation and mobility, for instance. For the National Bioeconomy Strategy, too, which is executing the establishment of a sustainable biobased economy, AI has tremendous potential for optimising and further developing both the primary production of biomass and its use in a wide range of production and process engineering processes.

The Federal Government will continue and expand the successfully launched funding initiative *AI Flagship Projects for the Environment, Climate, Nature and Resources (KI-Leuchttürme)* and further develop it, focussing on funding AI innovations for climate protection and the resource efficiency of AI applications. As part of this, it will bolster the links between SMEs, start-ups and public-interest actors and research so as to promote the transfer and application of research findings across the breadth of the economy and society. In research on climate change, climate protection and climate adaptation, the Federal Government will also harness the potential harboured by linking AI and high-performance computing and continue to promote the use of AI in satellite earth observation to develop innovative applications for sustainable business and industry. The computationally intensive analysis of complex climate and environmental data makes it possible to identify relevant environmental changes early on and to take action to counter them.

To promote the use of AI in fields of application of special ecological and social significance, the Federal Government plans to provide funding for the establishment of an application hub in the field of recycling and the circular economy. The aim and objective of the hub's research and development work is to use AI-supported recycling-friendly product design, smart sensors and tracking technologies for collection, sorting and recycling to increase the use of recyclates, to use plastics longer and more efficiently and to avoid plastic being released into the environment. The hub is designed to boost Germany's innovativeness in the important markets for environmental and sustainability technologies and to secure the technological leadership of German businesses in the recycling sector.

Making AI environmentally sound

The Federal Government will continue to systematically expand its funding of research into linking digitalisation and ecological sustainability goals. The aim is to advance energy-and resource-saving information and communication technology (green ICT) and to use smart digital solutions to promote better climate and resource protection and sustainability (digital green tech). For the use of computationally intensive AI methods, optimised microelectronics are essential in adequately tackling the requirements relating to energy efficiency and computing power. This is why the intention is to provide funding for investments in the dynamic research field of AI electronics at universities. Measures to develop specific AI hardware will ensure that what are typically very resource-intensive AI applications can be used in various challenging application areas, such as autonomous driving, whilst at the same time significantly

reducing energy and resource use. To advance the environmentally and climate-friendly use of AI applications, the Federal Government will develop a concept for environmental impact assessment of AI and step up its funding for research on the environmental impacts of AI, in particular commissioning the collection of empirical data and a systematic analysis of the CO_2-saving potential of AI, duly taking into account possible negative effects (such as rebound effects).

AI research in the field of aerospace

In aviation, AI is creating new application possibilities in adaptive manufacturing and entire manufacturing networks (smart factory), new market models for the maintenance and repair of complex aircraft systems, but also new ways to reduce the environmental footprint of aircraft. Data platforms are an important foundation for effectively integrating machine learning and pattern recognition into operational processes. To fully tap the potential of these systems for safety-critical applications in aviation, new approaches are being developed to be able to track and understand how decisions are made within learning algorithms. One of the most promising applications is in urban air mobility, the pilotless flying of the future. This makes it crucial for AI systems for aviation-relevant applications to be specially protected against cyber attacks. Researchers are already working on this at full steam, too.

Satellites generate earth observation information, which is highly relevant, for instance when it comes to commodity price trends, observing and monitoring the impacts of climate change and emergency preparedness. To analyse and evaluate this information in interaction with other geospatial information as well as citizen science and social media data and transform it into valuable geospatial information, the Federal Government will provide funding for the development of new specific AI techniques. Integrating relevant user domain expertise into specific AI analysis procedures to evaluate earth observation data is an essential part of this. Open-source products and services will also support the implementation of earth observation-specific procedures at companies.

Increased funding for satellite earth observation can encourage environmentally friendly developments in the areas of urban development, transport and mobility, and make it possible to monitor, verify and better manage the sustainable use of natural resources in areas like agriculture and forestry, raw material extraction, water and energy management.

AI research for mobility

AI and self-learning systems are of central importance to the mobility of the future. They help to improve road safety and design transport systems to be sustainable. AI-supported logistics systems optimise capacities, effectively relieving the environment of unnecessary empty transport traffic. The Federal Government will be taking targeted action to shore up this development with innovation centres for smart mobility.

Automated driving is a pillar of Germany's competitiveness. The Federal Government will therefore further expand its funding of applied research, development and testing of complex autonomous driving scenarios. As such, it is supporting the establishment of interconnected European test fields and regulatory sandboxes for testing new, AI-based technologies in practice across different transport modes, particularly with a view to resource-efficient and climate-neutral mobility. In addition to issues relating to environmental impacts, data and consumer protection issues also have to be duly taken into account.

AI in agriculture

Digitalisation and AI are playing an increasingly important role in the area of food and agriculture. The Federal Government has therefore initiated a number of research projects on this. These include digital trial fields in agriculture, which show how digital and AI technologies can be optimally deployed to protect the environment, improve animal welfare and biodiversity, and facilitate work. They are also contact points for interested practitioners and support the transfer of knowledge and information. The use of AI in the primary production of biomass means they will also advance the implementation of the National Bioeconomy Strategy.

Transfer and application

The Federal Government's measures to increase the transfer of AI knowledge into application serve to maintain the competitiveness of the German and European economy and expand it through the broad application of innovative technologies.

Implementation in the economy

Catering especially to start-ups, the funding programme EXIST established for science start-ups is making an important contribution by supporting the transfer from research to the market. Here, a new focus on AI backed up by different individual measures is designed to increase the proportion of AI-based spin-offs. The international start-up funding programme German Accelerator will also make a significant contribution to competitiveness in the start-up sector thanks to its existing networks in Germany and its presence at the most important AI hubs worldwide (inter alia Silicon Valley, Boston for life sciences and Singapore in Asia). It serves to increase the share of AI-related high-tech start-ups and supports AI-based business models in growing faster internationally.

Although there is considerable potential for efficiency gains and growth for businesses of all sizes, there is a need for political action mainly impart AI skills to SMEs. A study published by the Federal Government at the end of March 2020 shows that only six per cent of all companies surveyed use AI. Out of these, around four per cent use AI in products or services, generating sales of almost 60 billion euros in 2019 as a result. This equates to around one per cent of the turnover of all companies and about eight per cent of the turnover of companies using AI. The Federal Government will continue to remove obstacles to transfer and use of AI and expand support services in order to increase the use of AI in companies. This will entail inter alia information and skills development schemes on digitisation for businesses, in particular the successful AI trainer programme at the Mittelstand 4.0 Centres of Excellence, are being expanded and brought even further into the area. One key factor to bringing more AI into economic applications is joining forces with multipliers, so train-the-trainer programmes for multipliers at chambers and business associations are being supported and initiated by the Mittelstand 4.0 Centres of Excellence. This will enable businesses which could potentially use AI to be targeted more intensively and specific AI concepts to be developed by qualified advisors and consultants. Here, it is important that this knowledge also reaches decision-makers.

The Federal Government will also promote closer links to AI research centres in order to translate current research into practice even faster.

The Federal Government will develop measures to raise awareness of the energy and resource consumption of AI. The development of a digital EMAS platform will support businesses in mapping their environmental impacts digitally so that it is much easier for them to use the environmental management system. At the same time, the new platform is designed to reduce the administrative and auditing workload at the enforcement authorities and registries involved in the scheme.

The boom in innovative mobility concepts driven by digitisation and AI methods, such as the linking of different mobility services or in the field of unmanned aviation, opens up a wide range of new prospects for products and use. The Federal Government will further expand its funding for the technological development of innovative mobility concepts based on AI applications like this. The overarching policy areas of urban mobility, rural connectivity and public acceptance are the priorities here. The measures form part of the implementation of the "Digitalisation and Artificial Intelligence in Mobility" action plan.

The Federal Government is specifically promoting the adaptation and further development of AI as a key aerospace technology. The high degree of autonomy of robotic systems required for applications in space leads to the development of miniaturised and energy-efficient AI. A new field of application is the collaborative robotic between man and machine in space systems. Adaptations of current technologies such as digital twin and business information management for use in space travel use AI to boost cost efficiency, quality and reliability. These developments then translate into an economic and competitive advantage through transfer to other industries and sectors of the economy.

Networking and international cooperation

With GAIA-X, the Federal Government is promoting the development of a high-performance, competitive, secure and trustworthy federated data infrastructure to accelerate the birth of an innovative digital ecosystem. Different working groups are working intensively on the technological implementation to achieve this. The International Data Space (IDS) is closely involved in the GAIA-X process, helping inter alia with the development of a scalable and secure reference architecture. In addition to this, on the user side numerous businesses are participating in GAIA-X, contributing the requirements the project needs to meet from the user perspective. This entails developing numerous use cases, for instance in the area of Industry 4.0, with the support of the Federal Government. To shore this up, the Federal Government will be actively promoting networking and matchmaking schemes to bring start-ups, SMEs and large companies together more.

Given the special significance of data for innovative mobility applications, the Federal Government is taking targeted action to advance the establishment of a mobility data space. The process' objective is a secure European mobility data space bringing together private and public mobility providers, initiatives of the Länder, local government and the Federal Government. This will create a sustainable mobility data ecosystem for the development of innovative AI applications.

With an annual AI transfer conference and AI theme days for different fields of application, the Federal Government will bring together various initiatives and institutions dedicated to transferring AI into practice. The conference will allow the actors involved to network, enable the exchange of ideas and proposals and trigger fresh joint impetus.

The Federal Government will create internationalisation opportunities for businesses, for instance by exploring and developing market access in and with interesting target countries in order to bolster international cooperation.

In the US, especially in the Bay Area, important topics of the future such as AI, robotics and digital platforms are being shaped on an unprecedented scale worldwide. Access to this ecosystem is a key part of empowering the relevant federal ministries to shape and master the challenges of the digital transformation. For this reason, a contact point is to be set up in Silicon Valley as a networking centre above all for ministries, institutions and individuals from Germany. To successfully develop and shape AI, national measures tend not to be sufficient. For this reason the Federal Government will continue to closely dovetail its activities with the measures of the EU and other international actors. At EU level, the Federal Government is advocating that common framework conditions be put in place in the scope of a European health data space for the EU-wide secondary use of health data in compliance with data protection regulations. It is fostering close cooperation inter alia with the European Commission's research institute *AI Watch* and the OECD's AI Observatory. Furthermore, the Federal Government is supporting the OECD programme *Artificial Intelligence in Work, Innovation, Productivity and Skills* (AI-WIPS), whose results and findings will make a major contribution to shaping the global AI debate. The Federal Government is advocating and working towards international standards and guidelines for the use of AI and is one of the actors shaping the international dialogue on this issue. The Federal Government is involved *inter alia* in the work of the Ad-hoc Committee on Artificial Intelligence (CAHAI) established by the Council of Europe. The Federal Government is also backing the establishment of international and multilateral structures in this field, such as the *Global Partnership on Artificial Intelligence* (GPAI).

In developing and emerging countries, AI also offers new ways to overcome obstacles and attain the SDGs set out in Agenda 2030. The Federal Government is strenghtening local AI capacity building and better access to open AI training data.

In addition to this, the Federal Government is supporting the development of suitable political and regulatory frameworks for AI in the Global South, such as the African governmental alliance "Smart Africa", which is developing regulatory recommendations on AI for 30 African member countries. Here, the Federal Government is championing principles such as respect for human rights, data protection and other European and international premises such as transparency and traceability of decision-making.

Norms, standardisation and test spaces for innovations

Technical norms and standards facilitate economic processes, can enfold court-proof presumption effects related to quality and foster the transfer of technology. Here, the Federal Government is supporting the presentation of the current status of norms and standardisation nationally and internationally and identifying and structuring future standardisation needs. The German standardisation institute Deutsche Institut für Normung e.V. (DIN) and the German Commission for Electrical, Electronic and Information Technologies in DIN and VDE (DKE) have worked with business leaders, trade associations and leading scientists to compile a comprehensive standardisation roadmap for AI, including ethical issues, on behalf of the Federal Government and presented this at the 2020 Digital Summit. This forms the basis for a subsequent implementation programme, which, building on the roadmap, is to initiate specific standardisation projects, address certification issues for learning systems and initiate the rapid

transferability of the findings gained into international standards and test criteria. Key topics here are inter alia safety and security, robustness, transparency and non-discrimination in AI systems.

In combination with metrology, accreditation, conformity assessment, market surveillance and environmental audits, rules, norms and standards form the quality infrastructure - the backbone of the "Made in Germany" brand. The quality infrastructure is thus an essential key to guaranteeing our economic success and trust and confidence in products and services. The Federal Government will promote the further development and bolstering of the national and European quality infrastructure in terms of the use and treatment of AI methods, in turn supporting market access, especially for SMEs in Europe and worldwide. Data quality assurance, for instance through benchmark tests, reference data, establishing and curating training data pools and setting up test data sets for validating algorithms, must also be ensured to enable the trustworthy application of AI methods. The involvement of users should also be considered.

Testing in regulatory sandboxes ("*Reallabore*") is important for the transfer of innovation and for the further development of the legal framework in order to strengthen innovation capacity in the field of AI. A major priority in the further implementation of the cross-cutting strategy on regulatory sandboxes as test spaces for innovation and regulation is to draw up specific proposals for strengthening the legal scope for testing in regulatory sandboxes on the basis of ongoing expert opinions (for instance on general experimentation clauses or on tools for wording experimentation clauses). At the same time, regulatory sandboxes are supported by established networking and information services such as the Network of Regulatory Sandboxes, the Handbook for Regulatory Sandboxes and the Regulatory Sandboxes Innovation Prize, which will be continued and further developed to reflect new requirements arising from the field of practice. One extensive example of the implementation of regulatory sandbox approach is the Reallabor digitale Mobilität Hamburg.

The Federal Government is supporting practical applications and digital test fields for the innovation cluster of AI in logistics by expanding and further developing its funding instrument. The aim is to create a "logistics flagship" in Germany as a centre of business to compete in the data and platform economy.

AI in healthcare and long-term care

AI applications are becoming increasingly important in healthcare and long-term care. For this reason, the Federal Government is laying the foundations for data-supported and quality-assured healthcare and nursing and is piloting the first applications in everyday care. To learn more about the specific benefits AI harbours for healthcare, the Federal Government will be supporting numerous projects. Up to and including 2024, these projects will study the use of decision-support and expert systems and smart sensors in care-related use scenarios with high clinical relevance, paving the way for trustworthy and safe use. This also includes innovative forms of data use and use cases for AI in managing pandemics. In both the funded pilot projects and subsequent AI applications in healthcare and long-term care, existing data protection regulations will be respected.

AI in the world of work

The new Observatory for Artificial Intelligence in Work and Society (AI Observatory) studies the impacts of AI on work and society, observes trends and develops possible solutions and recommendations for a human-centric AI design that serves the common good. A broad group

from the scientific community, businesses, trade unions and civil society is involved in the work of the AI Observatory. As part of the AI Observatory, the Federal Government is developing indicators for AI monitoring in the field of work and society to review the implementation of the AI Strategy. The AI Observatory also studies the interaction between humans and AI at the workplace for a safe and human-centric use of AI-based applications, for which the AI Observatory will submit proposals.

In order to support businesses in introducing human-centric AI, the model of Hubs for the Future (Zukunftszentren) initially set up in eastern Germany is now being rolled out throughout Germany. These are designed *inter alia* to enable businesses and their employees to structure and shape the digital transformation, especially when it comes to AI. The aim is to make the knowledge about how AI-based systems work available in a way that is tailored to the business' use case to be able to design introduction and application processes in the framework of social partnerships between labour and management or in a participatory way and to impart the requisite skills.

Funding for company-based learning and experimentation spaces will be expanded. Experimentation spaces enable businesses or public administrations and their employees to work together to develop and test solutions for a human-centric introduction and implementation of AI processes in operational practice in a creative process; the process will be accompanied by research

AI in public administration

AI offers huge potential not just for businesses but also for public administration. Using AI here is an opportunity not only to provide information and services in a more targeted, tailored and more easily accessible way within the administration and for the business and scientific communities, but also to support the goal of a climate-neutral federal administration by 2030. The Federal Government will be exploring to what extent AI can be used to improve general (information) security and the performance of communication and information systems, to stop potential cyber attacks and as a possible basis for future security architectures in public administration. AI could, for instance, be applied through the use of (semi) automated procedures or AI-based services to detect attacks on public administration communication networks.

In some areas of the administration's remits involving ever-higher data volumes, for instance earth observation/remote sensing, further developing automated data analysis procedures with AI methods is a necessary prerequisite for harnessing the potential for the federal administration's work, *inter alia* in disaster control, to be exploited at all. The AI methods developed above all by researchers in recent years need to be transposed onto the specific tasks of the federal authorities and adapted if necessary.

It is hugely important to continue to apply high standards for the introduction and use of AI and to ensure that AI is non-discriminatory and transparent, complies with existing rules governing the protection of personal data, information security requirements and upholds citizens' trust and confidence. Traceability ("Nachvollziehbarkeit") and verifiability of decisions as well as transparency, fairness and non-discrimination, safety and security and participation are key to creating trust in the use of AI in public administration. Individual opt-out possibilities also have the potential to contribute to this - depending on the use case.

The AI Observatory is working on questions relating to the human-centric design, introduction and use of AI that serves society as a whole in suitable processes labour and social administration and offering support to interested authorities.

In public procurement processes, the Federal Government will increasingly opt for innovative AI solutions, harnessing public-sector demand and public tenders as a steering tool. It will continue to develop the Centre of Excellence for Innovative Procurement (KOINNO) in order to permanently bolster the orientation towards innovation in public procurement in a way that is subject and technology neutral. It will also promote the exchange of best practices in public administration. To support public authorities, the Federal Government will define standard processes for decision-making, purchasing, implementation and operation of AI applications in public administration. Open-source solutions will also be increasingly considered in procurement. The Federal Government itself can support start-ups and SMEs with AI solutions by giving greater consideration to these in public contracts in compliance with the requirements under budgetary and public procurement law.

In combination with AI applications, the systematic provision, compilation, modelling and evaluation of environment-related mass data can identify changes and patterns and leverage efficiency potentials , for instance in the area of climate impact assessment, ecosystem analysis or the analysis of mobility and energy consumption behaviour. To this end, the Federal Government will set up an “Application Lab for AI and Big Data” with the aim of developing data-based applications to attain the Sustainable Development Goals and strengthen the cooperation between the Federal Government and the Länder on AI applications in the environmental sector.

AI offers potential for security authorities to counter hybrid threats to preserve territorial integrity and protect the population. In the context of policing, the use of AI is an important strategic aspect of domestic security. For instance, it can help to significantly enhance existing capabilities and make police work more targeted and effective. It can also relieve the psychological strain on police officers, for instance if AI is used to identify child pornography. In each specific use case, though, it must be examined whether and how AI can be deployed in a policing context in compliance with fundamental rights.

The Federal Armed Forces (Bundeswehr) are examining the possibility of using AI first to fulfil the core mission of its armed forces and to gain informational, decision-making and effectiveness superiority, and second to optimise administrative and logistical processes and in the predictive maintenance of complex systems. AI is also used to support specialist personnel in the context of civil-military early crisis detection across different remits in the analysis of mass data and to make projections for deployments. AI is an integral part of major defence projects, which are also being implemented in a European context, contributing to maintaining and fostering European technological excellence. One example is the Next Generation Weapon System (NGWS) project launched jointly with France and Spain, which is interconnected with airborne platforms of the Future Combat Air System (FCAS). In terms of national and international technological developments in the armaments sector, AI serves to ensure the capabilities required for national and allied defence in the future. Developing the possibilities to deploy AI, in particular for the protection of national security and for military purposes, is carried out within the remits and responsibilities of the respective ministries and departments. Without prejudice to this, AI technologies and AI applications of security relevance are embedded in the AI Strategy.

Regulatory framework

In addition to fostering competitiveness and innovation in the European Union, one of the Federal Government's stated aims is the responsible development and use of AI for the benefit of society as a whole. Whilst the multifaceted and ever-growing range of possible uses of AI harbours major economic, social and individual potential benefits, it can also entail risks. To counteract these effectively, specific requirements need to be set for the development and use of AI systems and the framework for responsible development and use of these systems for the benefit of the common good needs to be aligned accordingly.

Underlying conditions for safe and trustworthy AI applications

The regulatory framework includes laws, subordinate acts and technical standards and The detailed framework must include in particular a level of transparency and traceability that adequately reflects the risks and, if necessary, an appropriate control structure and verifiability of AI applications and their results. Standardisation and norms can contribute to accelerating development processes, legal certainty for companies and to building people's trust and confidence in this technology. In areas where the use of AI entails huge innovation potential, regulation must be careful to encourage rather than hamper innovation.

The Federal Government welcomes the approach proposed by the European Commission in the White Paper on Artificial Intelligence of reviewing the EU's existing legal framework to determine whether existing legislation duly reflects the risks and requirements of AI applications and can be effectively enforced or whether and what amendments or new legislation may be necessary. Here, the question to be answered is whether the current legal framework on product safety and product liability is sufficient for AI systems embedded in products or whether new provisions need to be created, also when it comes to the issue of legal certainty. In particular, the Federal Government believes it makes sense in the interest of principle-based regulation to draft central principles for trustworthy AI which are harmonised across the EU. In addition to this, the Federal Government is actively supporting the processes and initiatives that have already been launched at the level of the EU and the Council of Europe in this regard.

As the COVID 19 pandemic has highlighted, the regulatory framework needs to be sufficiently flexible to allow innovation to be accelerated when it is a matter of averting major harm to the Community. The "Report on the safety and liability implications of Artificial Intelligence, the Internet of Things and robotics" published with the European Commission's White Paper on AI clarifies the requirements to be met for safe AI. This poses new challenges to the regulatory framework, which in the single market for products is currently shaped by the New Legislative Framework (NLF) - and here in particular to the quality infrastructure consisting of metrology, norms and standardisation, accreditation, conformity assessment and market surveillance. The task is to further develop the existing structures into systems for safe and trustworthy AI.

Need for regulation in work settings and for product safety

To meet these requirements, it is necessary first of all to review the existing technical, regulatory and structural conditions and to adapt or create new ones where these are necessary or currently insufficient. This includes rolling out and further developing a quality infrastructure and empowering and enabling those acting within it, as well as incentives for innovations for safe

and trustworthy AI applications. This entails developing the relevant institutional competencies and capacities, particularly in the fields of occupational health and safety and product safety.

The use of AI presents new challenges in regulatory areas such as employee data protection and co-determination, but also for the social partners. The use of AI at businesses and companies can mean larger amounts of personal data being processed. Here, the opportunities of using AI must be weighed up against the risks of additional data processing. On employee data protection, the Coalition Agreement of the governing coalition states that the optionality clause in the EU General Data Protection Regulation should be used and the possible creation of a separate Act on employee data protection examined.

The use of AI-based products and services also gives rise to changed, and in some cases new requirements for evidencing functional safety. Established safety requirements from the areas of machine safety and occupational health and safety regarding mental and physical hazards must not be weakened taking into account human-machine interaction. The regulatory framework varies a great deal from area to area, making it necessary to incorporate standards as well as any potential regulations early on in the development of AI applications so as to accelerate the subsequent approval process and in turn market access.

Security, robustness and sustainability of AI

A great deal of attention needs to be paid to the aspect of information security. The Federal Government will work towards IT security standards for AI systems (for instance in the area of critical infrastructures), which will vary in accordance with the respective use purpose. Ensuring the confidentiality, integrity and availability of certain AI systems over their entire life cycle is key here. When developing AI systems, the detection of attacks therefore also needs to be included in any risk assessments.

When using AI, effective protection against discrimination, manipulation or any other misuse needs to be ensured. The more social diversity is reflected in the teams developing AI applications – including above and beyond gender aspects - the more likely it is that bias and discrimination can be prevented from the very outset. The Federal Government will champion these principles at national, European and international level.

The major potential harboured by “AI made in Europe” should be fully leveraged for the Green Deal. To enable the environmental administration to use AI in a legally compliant way quickly and to effectively support the goal of “sustainable AI” as an important component of sustainable digitalisation, environmental law is being examined to see whether modifications might make sense.

Society

AI has long since arrived in people’s everyday lives. Trust in AI is growing[10], but parts of the population still need more information and have reservations or concerns. The Federal Government will provide help to promote the human-centric introduction and application of

[10] Statista (2019): Germans’ confidence in AI is growing: The proportion of Germans who say “I can imagine communicating with artificial intelligence” rose from 58% in 2018 to 83% in 2019.

this technology. This entails strengthening the societal dialogue and opportunities for citizens to have a say, and using new forms of effective participation, for instance for users or civil society. The concerns and interests of people with disabilities must also be duly taken into account. This should create an overarching common understanding among all stakeholders and enable viable solutions.

The opportunity to have a say and help shape developments has a major role to play in the development, introduction and use of AI. The earlier the groups or institutions directly or indirectly impacted are involved, the better they can feed their knowledge, experience and needs into the process, helping to ensure that the positive potential of AI is fully harnessed. With this in mind, the Federal Government is pooling its infrastructures and funding programmes in the field of AI use that serves the common good and is driving forward the development of an ecosystem for AI for the good of society. This includes the *Civic Innovation Platform* project to connect civil society players from all sections of society. The platform enables them to publish their ideas and find potential project partners from civil society, educational institutions, science and research, public administration, SMEs, AI developers and start-ups. Additionally, the Federal Government is developing a *Civic Data Lab* to prepare data sets shared and provided by various civil society actors and access and exchange structures, and *Civic Tech Labs for Green* for the participatory development and provision of green tech tools.

AI in the cultural and media sector is far more than just a subject of artistic debate. In many cases, AI is also used in the production of art and media content. Humans and AI can collaborate creatively. Furthermore, AI makes a valuable contribution at many cultural institutions in the processing of large amounts of data, in collection activities (for instance of museums, libraries and archives), in curating or in conveying cultural knowledge. So the Federal Government will continue to advance the development of AI applications in different cultural and media contexts.

AI skills for all

Every citizen in Germany should be well informed about the importance of AI and the opportunities and challenges it presents to do away with prejudices and demystify AI. This also means that, when discussing risks, areas should be more clearly delineated where certain risks cannot occur if, for instance industrial AI where no personal data is being used. First, there is a need to strengthen digital skills for dealing with AI related to everyday life, and second, the potential of AI applications should be used to empower citizens, for instance to design and shape teaching and learning processes. The Federal Government is patron of the free online course "Elements of AI", aimed at the full breadth of the population whose objective is to make the mechanisms of AI and its possible uses more comprehensible to as many people as possible - including those without prior knowledge.

To limit the energy and resources AI systems need, a *Sustainable AI* brand is being developed in a participatory process and requirements and incentives developed. The prerequisites for this are expanding the database on energy and resource needs, improving the transparency of energy and resource needs and ecological requirements for the use of AI including the AI infrastructure. The *Sustainable AI* brand makes it possible to pool German solutions around the principles of "Sustainability by Design" and "Ethics by Design" and share them internationally - for instance for resource-efficient AI as well as economically more sustainable and socially more balanced AI.

Annex

Next steps in the implementation of the AI Strategy

The Federal Government will take the following measures in the coming years to continue to implement the AI Strategy:

Minds

- Expanding the efforts to promote and fund attractive working and research conditions for young researchers at universities of applied sciences
- Holding AI challenges and establishing a German award for "AI made in Germany"
- Launching further initiatives to promote young researchers, including with the German Academic Exchange Service (DAAD)
- Promoting and funding innovation in digital higher education through the vehicles of artificial intelligence and big data
- Promoting and funding measures for the training of future academic staff by implementing AI in the curriculum content and measures to improve the quality and performance of higher education through the use of AI (in partnership with the Länder)
- Developing a new AI-supported online portal for continuing vocational training
- Launching the INVITE (Digital Platform for Continuing Vocational Training) innovation competition projects for the design of an innovative, user-oriented and coherent digital continuing education and training area
- In its consultations with the Länder, working towards establishing improved salary structures for AI professors
- AI education programmes for young women by experts from regional innovation systems and clusters

Research

- Developing a globally leading European AI network under the master brand "AI - made in Europe"
- Accelerated expansion of the Gauss Centre for Supercomputing to Exascale capability and accompanying measures in high-performance computing
- Developing a HPC infrastructure tailored to needs in the scope of joint federal-Länder funding for national high-performance computing for nationwide use by university students and staff
- Expanding research and development by the German Aerospace Centre (DLR) for safe and secure AI systems in infrastructures of systemic economic relevance

- Launching a new funding initiative for research and development in the field of AI-based assistance systems for medical care and epidemiological prediction
- Initiating a new measure to promote and fund research and development of AI systems for long-term care
- Expanding the "computational life sciences" funding measure focussing on "AI for digital infection epidemiology"
- Expanding the "AI in earth observation" funding measure focussing on innovative applications for sustainable ways of doing business
- Intensifying research into the use of trustworthy AI for civil security
- Launching a funding measure on learning manufacturing technology - use of artificial intelligence in production
- Launching a funding measure for the generation of synthetic data
- Launching a new research funding initiative for reliable and trustworthy AI
- Intensifying AI use in the scope of the Quantitative Early Crisis Detection and Information Management (PREVIEW) project at the Federal Foreign Office
- Establishing *Digital Health ProgressHubs* to promote data-supported digital medicine with a focus on defined use fields (for instance cancers, infectiology)
- Launching projects from the *Artificial Intelligence for IT Security* and *Artificial Intelligence in Communication Networks* funding measures
- Launching start-up projects from the *StartUpSecure* funding initiative which contribute to the security of AI-based business models and products
- Launching projects from the funding measures for the pilot innovation competition "Energy-efficient AI system", *Future-proof special processors and development platforms* (ZUSE) and investments in universities to tap into new research fields for new AI electronics
- Intensifying cooperation between public administration and research on regulatory impact assessments relating to tax impacts with AI
- Launching the projects from the AI funding measures in agriculture, the food chain, health food and rural areas in the scope of research projects
- Research and application of AI systems in the context of digital trial fields in agriculture
- Strengthening research on the safety and security and robustness of AI systems
- Developing methodology and testing tools to test the properties of AI systems
- Putting in place innovation centres for AI and self-learning systems in the field of mobility
- Expanding applied research, development and testing on complex autonomous driving scenarios using connected European test fields and living labs
- Expanding and further developing the funding initiative *AI Flagship Projects for the Environment, Climate, Nature and Resources (KI-Leuchttürme)* with the priorities AI innovations for climate protection and "resource-efficient AI"
- Intensifying research on the environmental impacts of AI, including a systematic analysis of AI's CO_2-saving potential
- Implementing a "resource-efficient AI" initiative as the target system for the resource and energy efficiency of AI systems
- Setting up a mobility data space for a sustainable mobility data ecosystem linking private and public mobility service providers

Transfer and application

- Establishing a new AI focus within the current EXIST funding programme for science start-ups with several individual measures
- Implementing a targeted funding programme for AI-based start-ups within the international German Accelerator Programme
- Developing application centres (including virtual ones) which actively link the Mittelstand 4.0 Centres of Excellence with the AI research centres and involve SMEs in research at an early stage
- Expanding the AI trainer programme at the Mittelstand 4.0 Centres of Excellence by funding train-the-trainer programmes and through targeted cooperation with multipliers
- Establishing a contact and service point as a networking centre in Silicon Valley, above all for ministries, institutions and individuals from Germany
- Establishing a high-performance, efficient and competitive, secure and trustworthy federated data infrastructure through Project GAIA-X
- Promoting and funding use cases for SMEs (for instance in the area of Industry 4.0) and agriculture on the basis of GAIA-X
- Promoting and funding innovative mobility concepts based on AI focussing on urban mobility, connecting rural areas and public acceptance
- Measures to raise awareness and promote the exchange of best practices on the energy and resources used by AI
- Developing a digital EMAS platform
- Evaluating and testing AI technologies in federal IT projects, for instance in the scope of the IT measures chatbot and service consolidation analytics
- Establishing an annual AI transfer conference to link initiatives and institutions dedicated to translating AI into practice
- Funding AI to tackle epidemic crises with an innovation competition
- Launching a new initiative to promote collaborative research and development projects between German and Canadian industry and research for the use of AI in the context of Industry 4.0
- Expanding funding for the research, development and use of artificial intelligence methods at SMEs
- Establishing additional sectoral and domain-specific AI application hubs, including in the field of recycling and the circular economy
- Strengthening the promotion of the dissemination of AI technology using established innovation structures
- Promoting AI in basic research for the exploration of the universe and matter at large research infrastructures
- Using and further developing AI methods in mathematical modelling, simulation and optimisation
- Transdisciplinary application and transfer of AI methods in data-intensive systems research in physics, earth system research and systems biology

- Promoting AI in aerospace as a key technology and its transfer to other sectors such as car manufacturing and modern mobility, shipbuilding, agriculture and long-term care sectors
- AI-based analysis in remote sensing - processing and analysing remote sensing information for the needs of the federal administration using AI
- Creating global public goods and implementation capacities in the field of AI together with partner governments from the Global South
- Continuing the interdisciplinary innovation award for living labs
- Strengthening the legal scope for testing innovations in regulatory sandboxes: Developing specific proposals on how to strengthen the legal scope for regulatory sandboxes and translate the results into general law, based on a number of ongoing expert opinions (for instance on general experimentation clauses, on tools for wording experimentation clauses and on international regulatory sandbox approaches)
- Netzwerk Reallabore (regulatory sandboxes): further developing and expanding the living labs network's services in 2020 on the basis of a survey of network members
- Developing an AI in logistics innovation cluster to strengthen the "logistics flagship" (Leuchtturm Logistik) in Germany as an attractive place to do business and to compete in the data and platform economy
- Funding and promoting learning and experimental spaces for AI
- Further developing the Centre of Excellence for Innovative Procurement (KOINNO) to increase the proportion of innovations procured in the total volume of public procurement in Germany
- Establishing an "AI and Big Data Application Laboratory" for the systematic use of AI methods to improve environmental monitoring (*inter alia* on the basis of in-situ, sensor and remote sensing data) to then develop environmentally relevant measures and to support the environmental administrations at federal and Länder level with their enforcement activities
- Expanding the AI Observatory focussing on the development of a system of indicators to monitor developments and trends of AI at work and in society, dealing with questions of the human-centric introduction and use of AI, especially in labour and social administrations and the exploration and design of human-machine interaction
- Supporting and developing the GPAI
- Expanding the "Zukunftszentren-Ost" (Hubs for the Future East) into a federal programme "Zukunftszentren KI" (Hubs for the Future AI) for future centres in western Germany and Berlin as well
- Studies on the use of AI to improve the security and performance of communication and information systems in public administration (network infrastructures and digital radio of security authorities and organisations)
- Piloting AI applications in the energy sector under the auspices of the Future Energy Lab at the German Energy Agency
- Funding of projects until 2023 under the funding priority: "Digital innovations for the improvement of patient-centred care in the health sector".
- Implementation of the AI Strategy in the field of policing

Regulatory framework

- Assisting the European Commission's announced proposal for an AI legal act by examining whether existing legislation adequately addresses the risks and requirements of AI applications and enables effective enforcement
- Feasibility study including possible elements of an international legal framework for the development, design and application of AI
- Developing a system for occupational health and safety
- Initiating a dialogue and exchange platform on the quality infrastructure for artificial intelligence, in particular in the areas of healthcare and autonomous systems, to include the regulatory framework at an early stage for faster approval procedures. Examining human rights aspects and defining possible red lines.
- Implementing the roadmap defined in the AI standardisation roadmap: developing test criteria on the basis of established and future test technologies to test the robustness, safety and security, reliability, integrity, transparency, explainability, interpretability and non-discrimination of (hybrid) AI systems
- Creating a legally certain regulatory framework for AI actors in science and research, at businesses and start-ups, as well as for the general public and public administration
- Mapping where changes are needed in labour and social law and other areas of law (for instance, environmental law) triggered by AI and reviewing possible proposals in response to this
- Establishing a network of think tanks and international standardisation and regulatory forums and technical standard-setting bodies relevant to global AI governance as part of the "International AI Governance" project by the Federal Foreign Office in partnership with the Stiftung Neue Verantwortung e. V.
- Establishing a central body for the certification/conformity assessment of any AI systems used by the security authorities to perform public security tasks

Society

- Developing an ecosystem for AI that serves the common good, including launching the *Civic Innovation Platform* project, the Civic Data Lab and the Civic Tech Labs for Green
- Funding AI applications to support consumers in their everyday lives (known as "consumer enabling technologies")
- Funding and expanding AI projects for the preservation, development, accessibility, networking and communication of cultural programmes
- Developing AI skills in categorising and verifying media content to ensure diversity of opinion