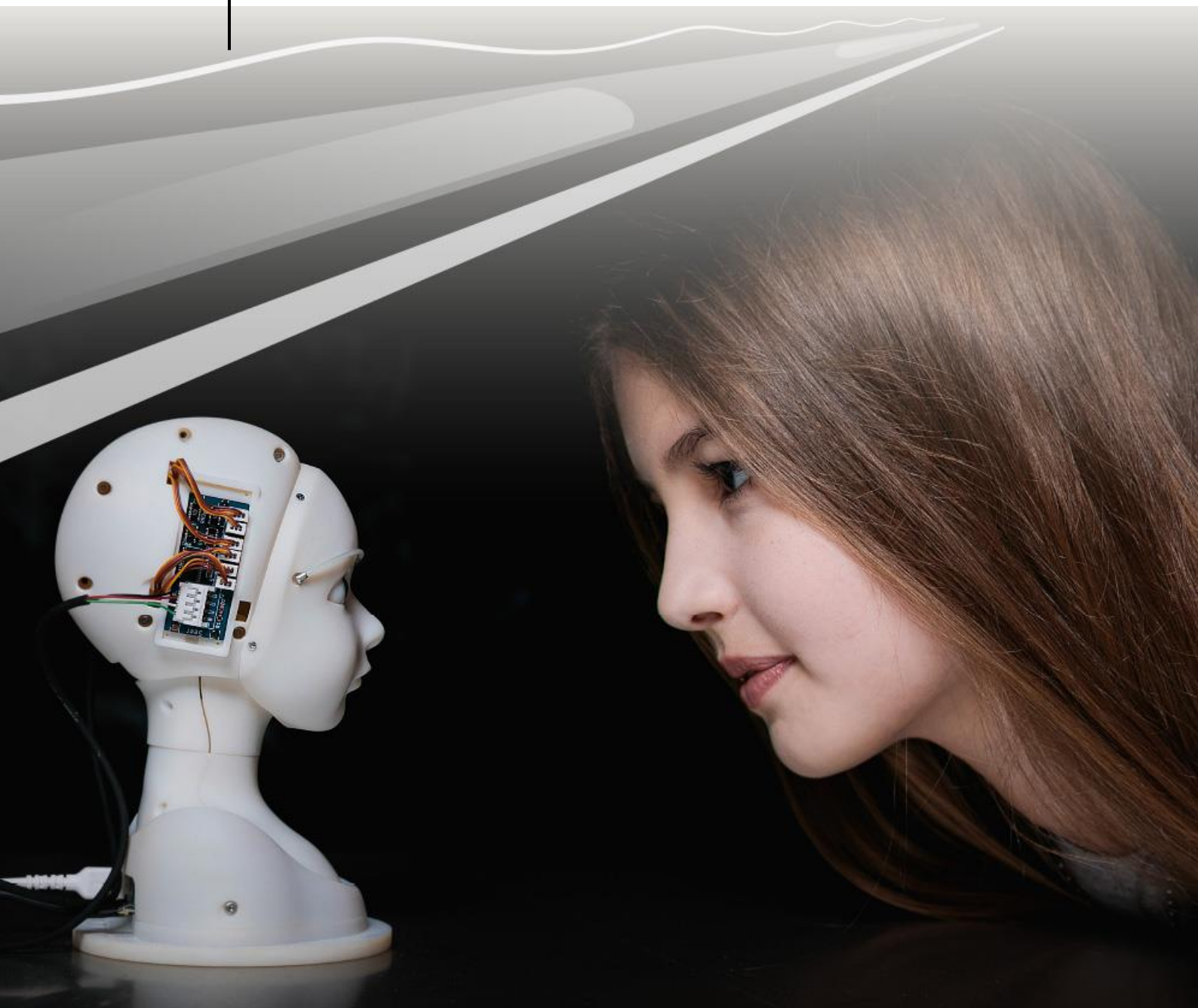
Norwegian Ministry
of Local Government
and Modernisation

Strategy

National Strategy for Artificial Intelligence



Foreword

It is difficult to predict the future, but we know that Norway will be affected by the age wave, climate change and increasing globalisation, and that in the coming years we must work smarter and more efficiently to remain competitive and maintain the same level of welfare. Digitalisation and new technologies are the key to achieving this, and artificial intelligence will be a vital component.

Artificial intelligence represents vast opportunities for us as individuals, for business and industry, and for the public sector. If used optimally, technology can contribute to achieving the Sustainable Development Goals – not just in Norway, but globally.

There are many good examples of AI in use in Norway, and in the coming years we will likely see many more, especially in business and industry and the public sector. While the United States and China have come far with consumer-oriented applications, our strength lies in the fact that our industry, business and public sector are more technologically advanced and digitalised than in most other countries. Norway is world-leading in the process industry, green shipping, aquaculture and petroleum activities. We have one of the most digitalised public sectors in the world. We must continue to build on these advantages in our development and use of artificial intelligence.

Norway enjoys a high level of trust and some fundamental values that permeate our society. We respect human rights and privacy, and the precautionary principle also applies in the world of technology. This is something we perhaps take for granted in Norway, but leading the way in developing human-friendly and trustworthy artificial intelligence may prove a vital competitive advantage in today's global competition.

There is no denying the fact that AI also presents some difficult questions. Who is responsible for the consequences of a decision that is made by AI? What happens when autonomous systems make decisions which we disagree with and which, in a worst-case scenario, cause harm? And how do we make sure that the technology does not intentionally or unintentionally perpetuate and reinforce discrimination and prejudice? When faced with dilemmas like these, it can be beneficial to have some fundamental principles to turn to for guidance: transparency, explainability and cautious testing. These principles must also be applied when we develop and use solutions built on artificial intelligence.

While working on this strategy I have had opportunities to meet people who work on artificial intelligence in academia, business and industry, and the public sector. I have had meetings with employer and employee organisations who see that artificial intelligence will impact the labour market in the time ahead. An overview of most of these meetings is available at www.regjeringen.no/ki-strategi, along with all the written input I received. I would like to thank everyone who shared their engagement and insights.

I hope this strategy can serve as a framework for both public and private entities seeking to develop and use artificial intelligence. Together we will explore the potential that lies in this exciting technology!

Nikolai Astrup
Minister of Digitalisation

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«Progress», Akinori Goto (JP)
Photo: Ars Electronica/Design society

Artificial intelligence will not only enable us to perform tasks in increasingly better ways; it will also enable us to perform them in completely new ways. The Government wants Norway to take the lead in developing and using AI that respects individuals' rights and freedoms.

Introduction and summary

Artificial intelligence (AI) represents vast opportunities for us as individuals and for society at large. AI can lead to new, more effective business models in business and to effective, user-centric services in the public sector.

Norway is well positioned for succeeding with artificial intelligence. We have:

- a high level of public trust in both the business and public sectors
- a population and business sector that are digitally competent
- An excellent infrastructure and high-quality registry data that span over many decades
- well developed e-governance and public agencies that have come a long way with digitalisation and that have the capacity and expertise to experiment with new technologies
- tripartite cooperation between employers, unions and government, which facilitates cooperation when restructuring is necessary

Technology will not only enable us to perform tasks in increasingly better ways; it will also enable us to perform them in completely new ways. But development and use of AI can also present challenges.

Norwegian society is characterised by trust and respect for fundamental values such as human rights and privacy. The Government wants Norway to lead the way in

developing and using AI with respect for individual rights and freedoms. This can become a key advantage in today's global competition.

The Government believes that:

- artificial intelligence that is developed and used in Norway should be built on ethical principles and respect human rights and democracy
- research, development and use of artificial intelligence in Norway should promote responsible and trustworthy AI
- development and use of AI in Norway should safeguard the integrity and privacy of the individual
- cyber security should be built into the development, operation and administration of systems that use AI
- supervisory authorities should oversee that AI systems in their areas of supervision are operated in accordance with the principles for responsible and trustworthy use of AI

A good basis for artificial intelligence

The Government will facilitate world-class AI infrastructure in Norway in the form of digitalisation-friendly regulations, good language resources, fast and robust communication networks, and sufficient computing power. It will facilitate data sharing within and across industries and sectors.

Data

Data represents an important starting point for developing and using AI. Today vast amounts of information are generated from many different sources. AI and machine learning can use this data to give us important insights.

Access to high-quality datasets is decisive for exploiting the potential of AI. The Government will facilitate data sharing in both the public and private sectors and between sectors.

Regulations

The Government will evaluate whether there are regulations that hamper appropriate and desired use of artificial intelligence in the public and private sectors. Requirements will be set for transparency and accountability in new systems for public administration in which AI is used. The Government is positive towards establishing regulatory sandboxes in areas where this is called for. Such initiatives already exist in connection with autonomous transport. The Government will also establish an advisory community and regulatory sandbox in the area of data protection.

Language

Language technologies such as speech recognition and language comprehension represent an important component of AI. To enable Norwegian citizens to participate in increasingly advanced services in their own language, it is decisive to have good language resources in both language forms and in Sami. The Government will facilitate the collection of and access to language resources.

Communication networks and computing power

Development and use of AI requires a sound communication infrastructure and access to computing power. The work on communication infrastructure, and on 5G networks in particular, is a priority area for the Government. Access to sufficient computing power will be secured through the use of national and international resources for high-performance computing.

Developing and leveraging artificial intelligence

Norway will invest in AI in areas where we have distinct advantages, such as health, seas and oceans, public administration, energy and mobility.

The Government wants Norwegian organisations to be attractive cooperation partners for leading business and research communities in AI. Norway will continue to pursue its investment in basic and applied ICT research. Policy instruments that stimulate investment in strong research communities, such as the Research Council of Norway's centre schemes, will be central to AI investments.

Artificial intelligence will have a dominant place in Horizon Europe, the EU's next framework programme for research and innovation. Moreover, the EU has proposed the establishment of a comprehensive digitalisation programme, Digital Europe Programme (DEP), for the period 2021–2027. The programme will focus on initiatives in high-performance computing and artificial intelligence. The Government has signed a non-binding declaration of intent to participate in Horizon Europe and will consider Norway's participation in DEP from 2021.

Norway will have advanced skills, including in basic ICT research and AI research, in order to understand and benefit from changes in technological developments. This requires good study programmes that coincide with the needs of different sectors for advanced skills in artificial intelligence and in basic subjects such as statistics, mathematics and information technology.

AI and related topics such as ethics and data protection associated with applications of AI will also be important in areas such as law and other professional programmes. Institutions of higher education ought to evaluate how topics with relevance to artificial intelligence can be integrated into their programmes in areas that will be affected by artificial intelligence in the coming years.

Technological development will lead to changes in the labour market, and the pace of change is likely to accelerate. Opportunities for upskilling and reskilling – both in the workplace and in the form of study programmes – will therefore be increasingly important as applications of AI become more widespread in the labour market. The Government will present a white paper on a skills reform, and has already begun work on flexible further educational programmes both for digital skills and for employees who must adapt their skills as a result of digitalisation and the green shift.

Enhancing innovation capacity using artificial intelligence

The Government wants Norway to exploit the innovative potential of artificial intelligence. Norway can take a leading position in applying artificial intelligence, particularly in areas where we already have the necessary prerequisites and strong

research and business communities, such as health, oil and gas, energy, the maritime and marine industries and the public sector.

The Government will consider how industrial policy instruments can best be designed to support the potential value creation and use of AI in the business sector.

Public agencies ought to actively explore the potential of artificial intelligence, and increased interaction between the public sector and the business sector should promote innovation and value creation. The public sector ought to actively explore opportunities in the market in connection with procurements, and innovative public procurements should be used where appropriate. To facilitate innovative solutions, the agencies ought to focus on tasks that need to be performed rather than on concrete products or services.

Responsible and trustworthy artificial intelligence

Development and use of AI can also present challenges. This particularly applies to AI that builds on personal data. There is therefore a need for continuous discussion about what is responsible and desirable development and about what can be done to prevent adverse development.

The Government wants Norway to lead the way in developing and using AI with respect for individual rights and freedoms. In Norway, artificial intelligence will be based on ethical principles, respect for privacy and data protection and good cyber security. Norway will continue to participate in European and international forums to promote responsible and trustworthy use of artificial intelligence.

About the strategy

The National Strategy for Artificial Intelligence is intended for the civilian sector – both private and public, and does not cover the defence sector. The strategy focuses on specifying what is meant by artificial intelligence and on describing some areas where it will be important for Norway to exploit the opportunities offered by AI.

Artificial intelligence is an area that is constantly evolving. For this reason, no specific time period is applied to the strategy. There will be a need to adjust and evaluate the strategy at appropriate intervals, in line with technological and social developments.

This strategy must also be viewed in connection with other important work by the Government, such as the digitalisation strategy for the public sector[1], a new public administration act[2], a review of the system of business-oriented policy instruments[3], the skills reform for lifelong learning (*Lære hele livet*), health data regulation[4], and several other small- and large-scale initiatives that are discussed in the strategy.

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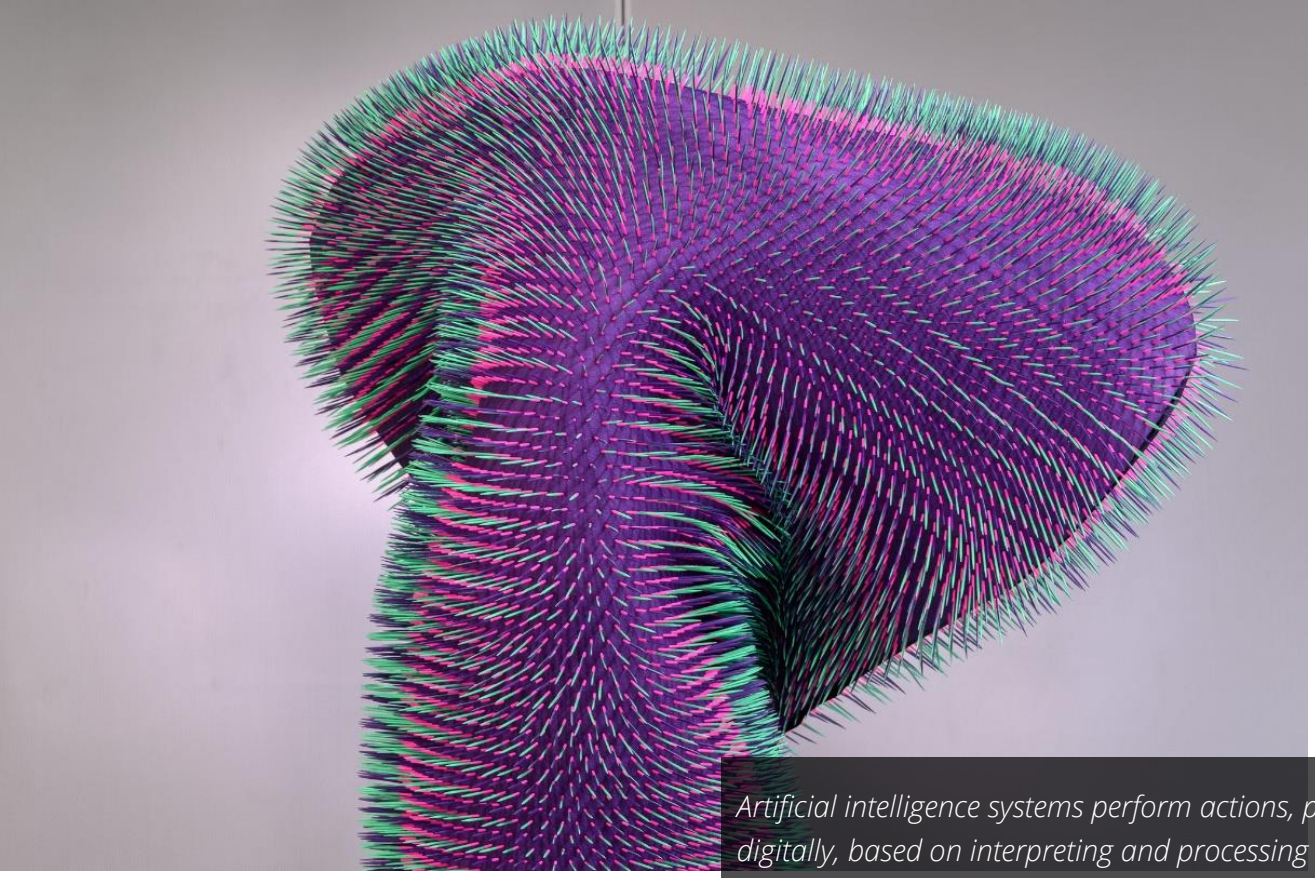
[1] Ministry of Local Government and Modernisation (2019): *One digital public sector.* Digital strategy for the public sector 2019–2025

[2] NOU 2019: 5 *Ny forvaltningslov –Lov om saksbehandlingen i offentlig forvaltning (forvaltningsloven)* [Official Norwegian Report on a new Public Administration Act]

[3] Information on this work is available (in Norwegian) at: www.regjeringen.no/vmg

[4] Information on follow-up of the work of the Health Data Commission is available (in Norwegian) at: www.regjeringen.no/no/dokument/dep/hod/sak1/helsedatautvalget/id2595894/ and Helse- og omsorgsdepartementet (2019): *Høring – tilgjengeliggjøring av helsedata (endringer i helseregisterloven m.m.).* [Ministry for Health and Care Services (2019): Public hearing on making health data available and amending the Health Register Act]



«Doing nothing with AI», Emanuel Gollob (AT)
Photo: Ars Electronica

Artificial intelligence systems perform actions, physically or digitally, based on interpreting and processing structured or unstructured data, to achieve a given goal.

1 What is AI?

1.1 Definition

Definitions of artificial intelligence (AI) vary considerably, and often change in line with what is technologically possible. This strategy takes the definition proposed by the European Commission's High-Level Expert Group on Artificial Intelligence[5] as its starting point, and defines AI as:

> *Artificial intelligence systems perform actions, physically or digitally, based on interpreting and processing structured or unstructured data, to achieve a given goal. Such systems can also adapt their behaviour by analysing and taking into account how their environment is affected by their previous actions.*

As a scientific discipline, artificial intelligence embraces various approaches and technologies, such as machine learning (including, for example, deep learning and reinforcement learning), machine reasoning (including planning, searching and optimisation), and certain methodologies in robotics (such as control, sensors. and integration with other technologies in cyber physical systems).

[5] High-Level Expert Group on Artificial Intelligence set up by the European Commission (2019): *A definition of AI: Main capabilities and scientific disciplines*

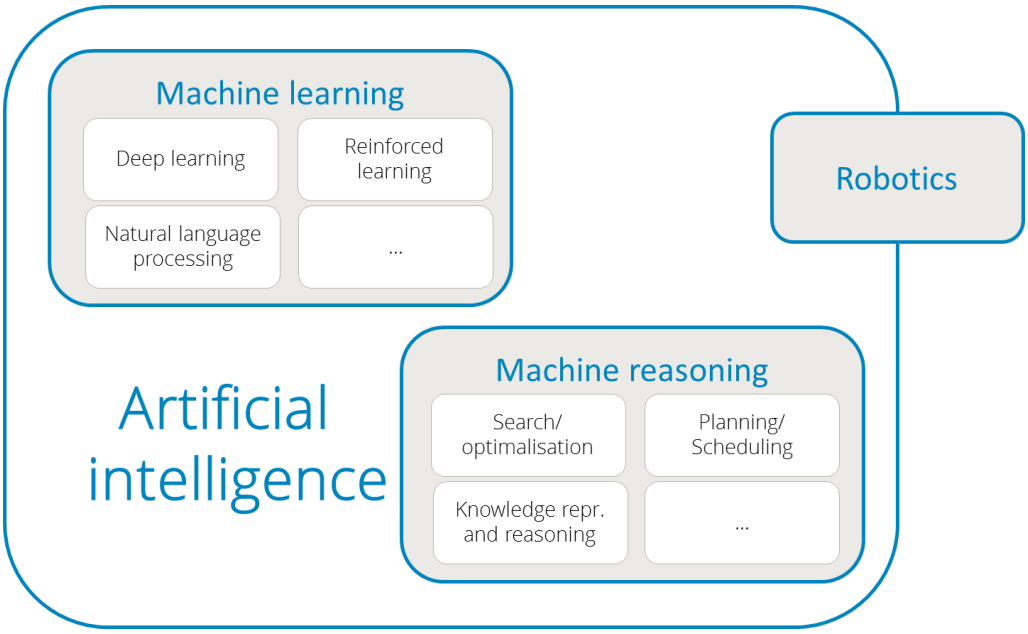


Figure 1: Simplified overview of AI's sub-disciplines

Source: Independent High-Level Expert Group on Artificial Intelligence set up by the European Commission (2019): A definition of AI: Main capabilities and disciplines.

'Strong' and 'weak' artificial intelligence

We are still a long way from a form of artificial intelligence that resembles human intelligence, or artificial general intelligence (AGI). Artificial general intelligence is often referred to as 'strong AI' while other forms are referred to as 'weak AI' or 'narrow AI'.

This does not mean that AI systems that are designed for a specific 'narrow' area cannot be powerful or effective, but they more often refer to specific systems designed to perform a single task, such as image processing or pattern recognition, for specific purposes. Nor is it the case that AI developed in parallel in many specific areas, or research on 'weak AI', necessarily brings us closer to artificial general intelligence.

Our definition embraces both 'strong' and 'weak' artificial intelligence.

Rule-based systems for automation

A rule-based IT system is often built on rule types such as 'IF x happens, THEN do Y'. Such rules can be organised in complex decision trees. Rule-based automation systems can be used to model regulations, business rules or experience-based practice (exercise of discretion). Many of the systems used for automated administrative processing in the public sector are rule-based. Our definition of artificial intelligence covers some of these systems, depending on factors such as the complexity of the rule set.

1.2 How does artificial intelligence work?

A system based on artificial intelligence can either interpret data from devices such as sensors, cameras, microphones or pressure gauges or can be fed input data from other information sources. The system analyses the data, makes decisions and performs actions. Both the need for data and the fact that it is the system that makes decisions and performs actions raise ethical issues that are discussed in chapter 5.

Some types of systems have a feedback loop which enables the artificial intelligence to learn either from its own experiences or from direct feedback from users or operators.

The artificial intelligence system is usually embedded as a component within a larger system. Tasks are often performed digitally, as part of an IT system, but AI systems can also be part of a physical solution, such as a robot.

Examples of current practical applications of AI are:

- Computer vision/identification of objects in images: can be used for purposes such as facial recognition or for identifying cancerous tumours.
- Pattern recognition or anomaly detection: can be used to, for example, expose bank or insurance fraud or to detect data security breaches.
- Natural language processing (NLP): can be used to sort and categorise documents and information, and to extract relevant elements from vast datasets.
- Robotics: can be used to develop autonomous vehicles such as cars, ships and drones.

Development in some areas has progressed rapidly, and we are already seeing systems being used in practice. Development and testing in other areas can take longer to achieve reliable results.

Machine learning

Today when we hear about systems being based on artificial intelligence, they are usually based on machine learning. Unlike rule-based systems, where rules are defined by humans and are often based on expert experience, business logic or regulations, the concept of machine learning covers a range of different technologies where the rules are deduced from the data on which the system is trained.

In AI systems developed by machine learning, the machine learning algorithms build mathematical models based on example data or training data. These models are then used to make decisions.

Machine learning algorithms usually learn in three different ways:

- *Supervised learning*: the algorithm is trained with a dataset where both input data and output data are given. In other words, the algorithm is fed both the 'task' and the 'solution' and uses them to build the model. This will make it capable of making a decision based on input data.
- *Non-supervised learning*: the algorithm is fed only a dataset without a 'solution' and must find patterns in the dataset which then can be used to make decisions about new input data. Deep learning algorithms can be trained using non-supervised learning.
- *Reinforcement learning*: the algorithm builds its model based on non-supervised learning but receives feedback from the user or operator on whether the decision it proposes is good or bad. The feedback is fed into the system and contributes to improving the model.

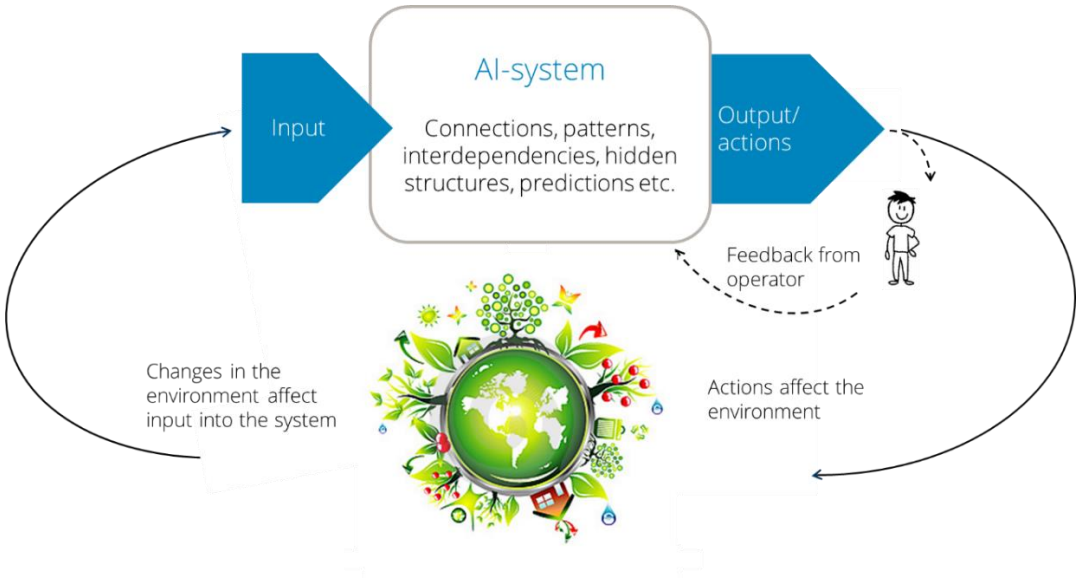


Figure 2: The interrelationship between an AI system, its operator and environments.

Deep learning is a subcategory of machine learning. Today deep learning is an important component in widely used solutions such as image processing, computer vision, speech recognition and natural language processing. Other areas of application are: pharmaceutical development, recommendation systems (for music, films, etc.), medical imaging processing, personalised medicine, and anomaly detection in a range of areas. The most widely used deep learning frameworks have been developed by Google (TensorFlow) and Facebook (PyTorch).

Some deep learning algorithms are like a 'black box', where one has no access to the model that can explain why a given input value produces a given outcome. This is discussed in more detail in chapter 5.

«Data urns», Daniel Huber (AT)
Photo: Ars Electronica

The Government will facilitate world-class AI infrastructure in Norway in the form of digitalisation-friendly regulations, good language resources, fast and robust communication networks, and sufficient computing power. It will facilitate data sharing within and across industries and sectors.

2 A good basis for AI

2.1 Data and data management

Data represents an important starting point for AI. Today vast datasets are generated from many different sources. AI and machine learning can use this data to give us important insights. Access to high-quality datasets is decisive for exploiting the potential of AI. The Government's goal is to facilitate sharing of data from the public sector so that business and industry, academia and civil society can use this data in new ways.

Data can be regarded as a renewable resource. Sharing data with others does not mean that one is left with less data. In fact, the value of data can increase when shared because it can be combined with other types of data that can offer new insights or be used by organisations with the expertise to use the data in new and innovative ways.

Open public data

In principle, all information that is lawfully published on public websites can also be made accessible as open data. Data containing personal data that is exempt from public disclosure or that is subject to confidentiality must not, however, be made accessible unless specific reasons apply for doing so. Weather data from the Norwegian Meteorological Institute and traffic information from the Norwegian Public Roads Administration are examples of open data from the public sector.

Personal data

The issues related to sharing and using data are closely connected to the type of data involved. A decisive dividing line is drawn between use of personal data and use of

data that cannot be traced back to individuals, such as weather data. Use of personal data for developing AI raises a number of issues that must be addressed before such data can be shared or used.

Data sharing principles

Principles for sharing open public data

No statutory obligation currently requires public sector data to be made accessible for use by others, but the goal is for data that can be made openly accessible to be shared so that it can be used by others (what we refer to as 'reuse').

Report to the Storting no. 27 (2015–2016*) Digital agenda for Norway: ICT for a simpler everyday life and increased productivity* highlighted five sectors where reuse of open public data is regarded to be of particular economic value: culture, research and education, government expenditure, transport and communications, and maps and property (geodata). Specific strategies have been developed for data sharing in these areas. Furthermore, the Norwegian Government Agency for Financial Management (DFØ) has developed a system for publishing data pertaining to public expenditure.

The Freedom of Information Act regulates how public data should be made available for reuse. Since 2012, the Digitalisation Circular has required government agencies which establish new or upgrade existing professional systems or digital services to make data from these services accessible in machine-readable formats. The agency should arrange for data to be accessible in the long term, with integrity, authenticity, usability and reliability intact.

The Nordic countries share many interests and values with respect to artificial intelligence. The Nordic countries therefore cooperate through the Nordic Council of Ministers in several areas related to AI. One of these areas concerns data. A working group has been formed to identify datasets that can be exchanged between Nordic countries and create added value for Nordic enterprises – public and private alike – while still respecting the ethical aspects and the trust and values particular to the Nordic countries.

One important measure in the digitalisation strategy for the public sector[6] is to establish a national resource centre for data sharing in the Norwegian Digitalisation Agency. The centre is intended to serve as a knowledge hub, and one of its tasks will be to increase awareness about the value of sharing data.

Principles for data sharing between public-sector agencies

The aim is to ensure that citizens and businesses do not have to provide identical information to multiple public bodies.[7] Updated and quality-assured information that is shared across public administrations is a prerequisite for implementing the once-only principle, and is important for developing better, more coherent public services.

In Norway we hold some information in central registries, such as the National Population Register and the Central Coordinating Register for Legal Entities, but a lot of information exists outside such registries. To facilitate sharing of this data between

[6] Ministry of Local Government and Modernisation (2019): *One digital public sector.* Digital strategy for the public sector 2019–2025

[7] Report to the Storting no. 27 (2015–2016) *Digital agenda for Norway: ICT for a simpler everyday life and increased productivity*

public agencies, the Brønnøysund Register Centre and the Norwegian Digitalisation Agency have established a national data directory to provide an overview of the types of data held by various public agencies, how they are related, and what they mean. This catalogue will also provide information on whether data may be shared and on what terms.

The Digitalisation Circular requires agencies to publish data that can be shared with others in the National Data Directory and on data.norge.no.

Principles for publicly funded research data

Research that is publicly funded should benefit everyone. It is therefore important that the data behind research results also be made accessible to as many as possible; to other researchers as well as to public administration and the business sector. Better access to research data can boost innovation and value creation by enabling actors outside research communities to find new areas of application. It can also contribute to smarter service development in the public sector, opportunities for new business activities, and new jobs.

There is no doubt that far more research datasets can be made accessible, along with pertinent protocols, methods, models, software and source codes. Such access must be safeguarded by sound data protection practices and give due consideration to security, intellectual property rights and business secrets. However, the vast and growing amount of research data means that not all data can be archived and maintained for the same long periods. The costs of making datasets genuinely reusable must be weighed against the benefit to research communities and society.

The Government has announced a strategy on access to and sharing of research data.[8] The strategy sets out three basic principles for publicly funded research data in Norway:

- Research data must be as open as possible, and as closed as necessary.
- Research data should be managed and curated to take full advantage of its potential value.
- Decisions concerning the archiving and curation of research data must be made within the research community.

Framework for data sharing in the industry sector

In Germany, a framework for sharing data in the industry sector, International Data Spaces, was established in connection with the Industry 4.0 initiative. The initiative has been expanded to industry sectors in other countries, and in Norway SINTEF has enabled Norwegian companies to use the framework. The framework offers a common infrastructure for the secure storage of industry data. The framework offers companies control of their own data while enabling them to share it if they wish to do so.

Sources: Fraunhofer institut, SINTEF

[8] Ministry of Education and Research (2012): *National strategy on access to and sharing of research data*

Principles for data sharing in the business sector

In principle, companies own their own data, and it is up to each company to decide how it wants to use its data within the parameters of data protection regulations. Few industries and businesses are aware of the value of data sharing. Many companies have a poor overview of their own data, and therefore have neither categorised it nor assessed its potential benefit to themselves or to other organisations.[9]

Norway has some examples of voluntary data sharing within the private sector and between businesses and the public sector:

- *The oil and gas industry:* In 1995 the Norwegian Petroleum Directorate and the oil companies operating in the Norwegian continental shelf established the Diskos National Data Repository (Diskos). Diskos is a national data repository of information related to exploration and extraction from the Norwegian shelf. The data is directly accessible online to members of the Diskos joint venture. The idea behind Diskos is that the oil companies should all cooperate on storing exploration data and compete in interpreting it.[10]
- *Geodata:* Norway Digital is a broad cooperation programme between agencies that are responsible for obtaining geospatial information and/or that are large users of such information. The cooperation partners comprise municipalities, counties, national agencies and private enterprises such as telecom and power companies.[11] Geonorge.no is a national website that has been created for weather data and other geospatial information in Norway under the Norway Digital partnership.

The authorities are generally hesitant about *requiring* private enterprises to share data. The Government's position is that private enterprises with a mutual interest in sharing data should do so on their own initiative. Nonetheless, this can prove difficult to achieve in practice.

The Government has set out the following principles for sharing data from the business sector:[12]

- Voluntary data sharing is preferable, particularly between parties with a mutual interest in sharing data.
- The authorities can facilitate the sharing of data where the enterprises themselves don't see the value in sharing if sharing such data would enhance public benefit.
- Data sharing may be imposed if necessary; for example for reasons of public interest.
- Data must be shared in such a way that individuals and businesses retain control of their own data. Privacy and business interests must be safeguarded.

[9] Veritas Technologies LLC (2015): The Databerg Report: See what others don't

[10] Ministry of Petroleum and Energy (2015): *DISKOS 20 years of service for petroleum geology*.

[11] www.geonorge.no/en/

[12] The principles are inspired by: Dutch Ministry of Economic Affairs and Climate Policy (2019): *Dutch vision on data sharing between businesses*

Some activities in the business sector are performed for the public sector or under permits or licences granted by public authorities. Public agencies have taken little advantage of opportunities to set requirements for data access or sharing in connection with entering into contracts or awarding licences. The Government will therefore consider whether the public sector can contribute to making more datasets from the business sector accessible by setting requirements for data sharing in conjunction with entering into public contracts wherever appropriate. The Government will also consider evaluating requirements to make data publicly accessible in licensing areas where such access is considered to be of particular benefit to society.

Methods of sharing data

A variety of methods are available that can make it simpler and safer to share data between different stakeholders:

Data lakes

A data lake is a central repository for storing data, such as a cloud service. The data can be stored as is, in its original format, and can be a combination of structured and unstructured data. The data need not be structured or labelled. The data lake can then be used to retrieve data for machine learning or for other analyses.

Data trusts

A data trust is a legal structure where a trusted third party is responsible for the data to be shared. The third party decides which data should be shared with whom, in compliance with the purpose for which the data trust was set up.

Anonymisation interface

An anonymisation interface allows various analyses to be carried out on register data containing personal data from multiple data sources without being able to identify individuals. The Remote Access Infrastructure for Register Data (RAIRD) is a cooperation project between the Norwegian Social Science Data Services and Statistics Norway on such an anonymisation interface. The information model for RAIRD is openly accessible and can be used by anyone.[13]

Synthetic data

Synthetic data can in many cases be an alternative to identifiable data or anonymised data. If synthetic datasets can be produced with the same features as the original dataset, they can be used to train algorithms or be used as test data. This means that even datasets which normally would be considered sensitive could be made openly accessible for use in research and innovation.

Common open application programming interfaces

An application programming interface (API) makes it possible to search directly in a data source to retrieve the desired data. This is a prerequisite for being able to use data in real time. The Digitalisation Circular establishes that public agencies must make appropriate information available in machine-readable and preferably standardised formats, ideally using APIs.

[13] RAIRD Information Model RIM v1_0 accessible at https://statswiki.unece.org/display/gsim/RAIRD+Information+Model+RIM+v1_0

Generation of synthetic test data for the National Registry

The Norwegian Tax Administration is in the process of developing a solution in which machine learning is used to generate rich synthetic test data in a dedicated test environment for the National Registry. The synthetic National Registry will offer synthetic test subjects in addition to simulating events. The objective is to allow enterprises that use information from the National Registry to test their integrations without using authentic personal data in the tests. Initially the synthetic National Registry will be made available to all parties wishing to test integration with the National Registry. Eventually it will be available to everyone who needs National Registry data for testing purposes.

Source: Norwegian Tax Administration

White paper on the data-driven economy

The Government will prepare a white paper on data sharing and the data-driven economy. The white paper will discuss important issues such as data ownership, incentives for sharing data, and possibilities for equitable sharing of the economic gains from a global digital data economy. Other important issues are data protection, secure data sharing, and ethical use of data. The white paper will also discuss issues relating to competence in data science and data sharing, and to infrastructure for data capture and sharing.

In connection with the work on preparing the white paper, the Minister of Digitalisation will appoint an expert group to examine the prerequisites and terms for sharing data within and from the business sector.

The Government will

- present a white paper on the data-driven economy and innovation
- establish a resource centre for data sharing, with expertise in the relationship between law, technology, business and administrative processes
- establish a set of principles for extracting and managing data from central registries, and a common API catalogue to promote better utilisation of basic data by providing an overview of data interfaces (APIs)
- consider policy instruments that can make it easier for industry sectors to share data and that simultaneously safeguard privacy and data protection, security, and business interests
- give guidance to public agencies on how they can ensure access to data when entering into contracts by, for example, proposing standard clauses
- consider which areas it may be in the public interest to require that data from the business sector be made accessible, and examine whether requirements for data access in connection with licences might be a suitable policy instrument in this regard

2.2 Language data and language resources

Language technology in the form of, for example, speech recognition and language comprehension, represents a key component in AI. Natural language processing (NLP) involves registering natural language (text/audio) and understanding the meaning and context. Natural language generation (NLG) involves producing text based on data. These technologies combined are important in the development of virtual assistants and in analyses based on unstructured data.

To make systems like these accessible in written Norwegian and Sami and in dialects, the technology must be adapted to these languages and to local conditions. This requires language resources.

Språkbanken, a service provided by the National Library of Norway, makes language data available for developing language technology in Norwegian. The National Library of Norway and the Language Council of Norway will cooperate by coordinating their efforts to further develop the resources held in Språkbanken. They also have a responsibility to make sure that the public sector as buyer, and developer communities in both the public and private sectors, be informed about and request these language resources.

The Sami languages are particularly vulnerable. Language technology and language technology resources in Sami are important for contributing to future development and use of the language and eventually for developing services in Sami based on artificial intelligence. Divvun and Giellatekno, the research group for Saami language technology at the Arctic University of Norway, are both developing different language technology tools for Sami. The Government will return to the issue of Sami language data and language resources in a white paper on Sami language, culture and society. The main topic of the white paper will be digitalisation.

One of the challenges in the work on facilitating language technology in Norwegian and Sami is obtaining sufficient amounts of language data within different domains, such as medicine, ICT and transport. There is a need for both written and oral data that

Analysis and classification of unstructured data in the MFA

Every year, the Ministry of Foreign Affairs (MFA) receives between 5,000 and 6,000 reports from Norwegian embassies, delegations, etc. Previously it was extremely difficult to navigate all this information. Since the MFA adopted machine learning and processing of natural language to analyse and classify the content of these documents, it has been possible to find almost all relevant information on a given subject matter. The solution is also used to extract key information in reports and prepare summaries.

In the work on developing this solution, the MFA cooperated with the University of Oslo, which provided solutions for categorising the Norwegian language. The plan is to gradually expand the solution with information from archives and external research reports.

Source: Ministry of Foreign Affairs

covers dialects and pronunciation variations. Examples of useful resources include multilingual terminology lists, area-specific texts and speech recordings or parallel texts in different languages. The linguistic structures in text produced by the public sector constitute valuable data for language technology research and development. It is important to facilitate reuse for these purposes.

There is reason to believe that the public sector possesses far more data that could be used in developing language technology than it realises. The Government will therefore promote awareness of language data and language resources in the public sector by, among other things, addressing such data specifically in the Digitalisation Circular.

The Ministry of Local Government and Modernisation has strengthened its information management community in the Norwegian Digitalisation Agency to facilitate closer cooperation with the National Library and the Language Council of Norway on forming strategies to ensure that public language resources can be used for language technology purposes. This can entail providing guidance on what can be regarded as language resources and ensuring deposits of language resources for Språkbanken.

Language technology aids

Tuva is an aid for dictating text (speech recognition) and navigating a PC using voice control. The product was developed by Max Manus in 2017 and is provided to people with permanent disabilities. The solution uses AI and builds on resources from Språkbanken. The dataset developed specially for this system is now openly accessible to other developers in Språkbanken.

eTranslation is a machine translation service developed by the EU that can be used by the public sector in the EEA area. The functionality for Norwegian is built on translations by the Unit for EEA Translation Services in the MFA, translations by Semantix for public agencies and from standards translated by Standard Norway. Språkbanken makes the datasets accessible to developers and researchers.

Source: Ministry of Culture

The Government will

- make a recommendation in the Digitalisation Circular that text produced by the public sector be made available for language technology purposes and deposited in Språkbanken at the National Library and the national term bank.
- formulate standard clauses for use in public-sector contracts in order to give the public sector rights to the language resources produced by translation services and other language-related services
- present a white paper on language
- continue cooperating with the University of Oslo on plain and digitalisation-friendly legal language
- present a white paper on Sami language, culture and society that focuses on digitalization

2.3 Regulations

Norway has a tradition for modernising its regulatory environment to meet new technological developments, starting with the eRegulation project[14] in 2000. The aim is to make laws and regulations as technology-neutral as possible so that they can be applied even when new technologies and digitalisation change our society and the way we live.

At the same time, we often see that regulation is called for when new technologies give rise to problematic applications. We have seen examples of this with artificial intelligence in connection with electoral manipulation in social media and 'deep fakes'. However, it is challenging – and often inexpedient – to regulate a technology that is still in an early phase. Regulating too early can have unintended consequences on developments, disrupt the market and reduce the potential for innovation. Moreover, any technology will often have both positive and negative applications. The same underlying technology used to produce deep fakes can also be used to, for example, create synthetic data, a technology that helps protect personal data.

Digitalisation-friendly regulations

The Government is concerned that regulations reflect the opportunities and challenges that come with new technology, including artificial intelligence. It also wants regulations to be digitalisation friendly. Regulations ought to facilitate fully and partly automated administrative proceedings and not contain unnecessary discretionary provisions.15 Regulations that are suitable for automated administrative proceedings ought to be worded in such a way that they can be read by a machine and used in systems that use AI.

There is a need to consider whether there are areas where regulations impose inexpedient and adverse limitations on the development and use of artificial intelligence. Among other things, there is a need to review laws that apply to some public agencies to see how the regulations can better facilitate sharing and using data and developing and using artificial intelligence.

Such a process will require thoroughly reviewing sector-specific regulations and drawing on cross-sectoral expertise so that consideration is given to society's needs, the individual's right to privacy, and the technological possibilities. This work must be viewed in connection with the regulatory review aimed at removing barriers to digitalisation and innovation, as discussed in the Government's digital strategy for the public sector.

Areas that create particular challenges:

Interoperability

The fact that different sector-specific regulations use the same concepts in different ways can present challenges. *Income*, for example, does not mean the same in the Norwegian Tax Administration as it does in the Norwegian Labour and Welfare

[14] Ot.prp. nr. 108 (2000-2001) *Om lov om endringer i diverse lover for å fjerne hindringer for elektronisk kommunikasjon* [Draft resolution and bill to amend various acts in order to remove obstacles for electronic communication]

[15] Ministry of Local Government and Modernisation (2019): *One digital public sector*. Digital strategy for the public sector 2019–2025

Administration (NAV), and the concept of *co-habitant* is defined in a variety of ways in different regulations. The Government aims to achieve semantic interoperability in its legislation to make it easier to be read by machines and used for artificial intelligence. If concepts do not have the same meaning, it is important to have information on this to prevent the system from producing misleading results.

Personal data: consent and statutory authority

Data containing personal data is covered by the Personal Data Act. The principle of purpose limitation means that the purpose for processing personal data must be clearly stated and established when the data is collected. This is fundamental to ensuring that individuals have control of their data and can make informed choices about consenting to data processing. Development and use of artificial intelligence often require different types of personal data; data which in some cases was originally collected for other purposes. Moreover, processing of data – such as health data – may be subject to other regulations, such as the Health Registries Act.

The most widespread way of gaining lawful access to personal data for use in AI is *consent*. Consent is often obtained by the users' approving an end user agreement and consenting to data processing when they want to use a service. The agreement should state, among other things, how the entity will use the data collected and with whom it may be shared. It must also be possible to withdraw consent, and some services allow end users to administer how their personal data is used in more detail.

The public sector often collects and processes personal data without the explicit consent of the user. In such cases, collection is based on a *statutory provision* that provides legal basis to collect and use data on citizens for specific purposes. Norway currently has no common system whereby citizens can see what information is collected and administered by the public sector, though solutions have been established in some important areas, such as helsenorge.no. Here users can, for example, administer which healthcare personnel may access their summary care record and clinical documents; withdraw their consent to be registered in certain health registries; and grant power of attorney to family members.

Datasets that are based on consent will in most cases be incomplete or contain selection bias that may influence the outcome of any analyses performed on the data. This is an important reason for having central registries where registration is statutory and mandatory.

When personal data is collected pursuant to a statutory provision, opportunities to use the data for purposes other than the original purpose are limited unless the new use is also permitted by a statutory provision. This means that public agencies have little scope to use the data they collect to perform analyses on their own activities using AI beyond the statutory authority provided for the relevant dataset. The Government wants to expand the scope for public agencies to use their data to develop and use AI.

Regulatory challenges in the health area

There may be a need to develop regulatory frameworks in some health-related areas before testing of methods based on AI takes place. Other areas are already safeguarded under existing regulations. For example, algorithms used in medical equipment software, such as surgical robots or software for enhancing or processing images in diagnostic imaging instruments, are subject to regulation of medical

equipment. The Norwegian Medicines Agency provides guidance and supervises compliance with regulations governing such equipment in the Norwegian market.

Development and use of tools based on artificial intelligence are dependent on information from sources beyond individual patients who receive health care in specific cases. Use of data for primary care (patient treatment) and use of patient data for research purposes (secondary care) are currently regulated differently. The current regulations provide no clear legal basis for using health data pertaining to one patient to provide healthcare to the next patient unless the patient gives consent. However, exemption from the duty of confidentiality may be granted to use patient data for research purposes. Artificial intelligence challenges the distinction between research purposes and patient treatment because there is often a need to include patient data from research projects when AI-based tools developed in a research project are to be used to provide patient treatment. Exemption from the duty of confidentiality will no longer apply in such cases, and the use of personal data will no longer be legally permitted.

In July 2019 the Ministry of Health and Care Services distributed a proposal for consultation regarding access to health data and other health-related data in health registries.[16] The proposal concerns access to health data for use in statistics, health analyses, research, quality improvement, planning, management and emergency preparedness in order to promote health, prevent disease and injury, and provide better health and care services.

The Ministry of Health and Care Services is also considering amendments to regulations governing access to health data in connection with teaching and quality assurance. This work includes reviewing permission to use health data in decision support tools. Moreover, the Norwegian Directorate of Health, the Directorate of eHealth and the Norwegian Medicines Agency have, in consultation with the regional health authorities, been tasked with identifying the opportunities and challenges posed by artificial intelligence and what adaptations in regulatory conditions at national level night be needed.

In the long term, more tasks which today are performed by healthcare personnel may be performed by autonomous systems and artificial intelligence. Relevant examples

Health analysis platform

The Government will establish a health analysis platform, a national system for making health data accessible for research purposes and for other, secondary uses. The platform will allow more advanced analysis of Norwegian health data and will form the basis for new types of medical and health research. Among other things, it will allow health data to be used more actively in developing medicines and medical technology.

Source: Norwegian Directorate of eHealth

16 Helse- og omsorgsdepartementet (2019): *Høring – tilgjengeliggjøring av helsedata (endringer i helseregisterloven m.m.)* [Ministry of Health and Care Services (2019): Public hearing on making health data available and amending the Health Register Act]

span from automatic generation of patient records, patient logistics and fleet management of the ambulance service to autonomous surgical robots. Although the scope of automation and autonomous tools will expand in the health sector, health personnel will still be responsible for ensuring proper provision of healthcare.

Regulatory sandboxes

Regulatory sandboxes are first and foremost a policy instrument for promoting responsible innovation. A regulatory sandbox is intended to give enterprises opportunities to test new technologies and/or business models within specific parameters. In this strategy the concept is used to refer to:

- legislative amendments that allow trials, for example subject to application, usually within a limited geographical area or time period
- more comprehensive measures in areas where close monitoring and supervision is needed, usually by the relevant supervisory authority

The concept of regulatory sandboxes is best known in the financial sector, where supervisory authorities in several countries have given enterprises opportunities to test specific products, technologies or services on a limited number of customers for a limited time period and under close monitoring. In December 2019 the Norwegian financial supervisory authority (Finanstilsynet) established a regulatory sandbox for financial technology (fintech). The purpose of the sandbox is to expand Finanstilsynet's understanding of new technological solutions in financial markets, while at the same time expanding innovation enterprises' understanding of regulatory requirements and how they are applied to new business models, products and services.

However, it makes little sense to talk about one regulatory sandbox for AI. AI solutions do not represent a homogeneous group of services, and are subject to a broad spectrum of regulations and regulatory authorities, depending on their purpose and functionality.

The Government has already established regulatory sandboxes in the area of transportation, in the form of legislative amendments that allow testing activities. An act has been introduced allowing pilot projects on autonomous vehicles. The act entered into force on 1 January 2018.[17] The Norwegian maritime authorities established the first test bed for autonomous vessels as early as 2016. A further two test beds have since been approved.[18] In 2019 the Storting adopted a new Harbours and Fairways Act[19] which, subject to application, permits autonomous coastal shipping. Such permission allows sailing in specific fairways subject to compulsory pilotage or in areas where no pilotage services are provided.

[17] LOV-2017-12-15-112 Lov om utprøving av selvkjørende kjøretøy [Act relating to testing self-driving vehicles]

[18] Sjøfartsdirektoratet (2017): *Horten blir testområde for autonome skip* [Norwegian Maritime Authority (2017): *Horten to be test bed for autonomous ships*]. www.sdir.no/en/

[19] LOV-2019-06-21-70 Lov om havner og farvann (havne- og farvannsloven) §25 [Act relating to Harbours and Fairways, section 25]

Investment in autonomous ships

The Norwegian shipping industry is at the forefront of developing and exploiting new technologies. Norway will have the world's first commercially operated autonomous ship: Yara Birkeland. On commission from Yara, the Kongsberg Group is supplying equipment for the world's first electric, zero-emissions, autonomous container ship. The ship will transport fertiliser from Yara's factory on Herøya to the ports of Brevik and Larvik. The ship, which is due to be delivered in 2020, will gradually move from manned operation to fully autonomous operation with remote monitoring in 2022. The ship will replace a substantial volume of road haulage (estimated at 40,000 truck journeys annually), emit fewer greenhouse gas emissions, improve local air quality and produce less noise.

In addition, NorgesGruppen (ASKO) has received funds from ENOVA (NOK 119 million) to establish an autonomous transport chain across the Oslo fjord, between Moss and Holmestrand. Two sea drones will then replace 150 daily (approximately 50,000 annual) truck journeys between Østfold and Vestfold. These all-electric, autonomous transport ferries are scheduled for commission in 2024.

Sources: Norwegian Maritime Authority/Yara and Enova

Where pilot projects depart from applicable laws and regulations, they can be conducted with statutory authority in special laws, as in the examples mentioned, or in the Pilot Schemes in Public Administration Act. Under the Pilot Schemes, public administration can apply to the Ministry of Local Government and Modernisation to depart from laws and regulations in order to test new ways of organising their activities or performing their tasks for a period of up to four years. In the white paper on innovation in the public sector we will consider whether the Pilot Schemes allows sufficient scope to test new solutions based on AI.

The Government will establish a regulatory sandbox for data protection under the remit of the Norwegian Data Protection Authority. This will fulfil several purposes:

- Enterprises can gain a better understanding of the regulatory requirements placed on data protection and reduce the time from development and testing to actually rolling out AI solutions to the market. Systems that are rolled out after being developed in the sandbox can serve as leading examples, and can help other enterprises that are interested in developing similar systems.
- The authorities can gain a better understanding of new technological solutions and more easily identify potential risks and problems at an early stage so that guidance material can be produced to clarify how the regulations should be applied.
- The authorities and industries can identify sectors with a need for their own industry standards.
- Individuals and society as a whole will benefit from new and innovative solutions being developed within responsible parameters.

The Information Commissioner's Office's regulatory sandbox

The Information Commissioner's Office (ICO) in the UK is testing a regulatory sandbox designed to support development of products and services that are innovative and widely beneficial. Organisations can have the way they use personal data in their systems reviewed and assessed. ICO can provide some comfort from enforcement action during the testing and development phases of their systems. ICO wants to work on products and services that are at the cutting edge of development and that operate in areas where there is genuine uncertainty about how regulations should be interpreted.

Following an open application process, the ICO selected 10 organisations of varying types and sizes and from different sectors to be provided with free, professional guidance from ICO staff. One of the successful applicants is Heathrow Airport's project to assess whether facial recognition technology can be used for checking in, security checks, self-service bag drops, etc. to create a frictionless journey through the airport. Another project selected comes from TrustElevate, which is developing a model using AI for age-checking children and young people under 16 in connection with accessing social media.

Source: The Norwegian Data Protection Authority

The Government is positive towards developing new regulatory sandboxes in different areas. Responsibility for such regulatory sandboxes ought to lie with the communities best qualified to test new systems. In some areas, such as further development of smart cities and autonomous transport systems, it may be natural for this responsibility to lie with local and regional authorities or other professional communities.

Public Administration Act and Archival Act

The reports published by the Law Commission on the Archival Act[20] and by the Law Commission on the Public Administration Act[21] will both have a bearing on public-sector administrative proceedings and on the use of AI in public administration.

Administrative proceedings in the public sector are highly regulated, though some degree of discretionary assessment may be exercised in the process. This means that a system does not have to be either manual or automated. It can have solutions where only exceptional cases are processed manually or have processes where an executive officer must examine certain points in order to make an assessment, but where the rest of the process is automated and rule-based. Many public-sector administrative proceedings are already automated. There are case management systems with integrated application dialogue providing possibilities to make automated decisions immediately.

[20] NOU 2019: 9 *Fra kalveskinn til datasjø – Ny lov om samfunnsdokumentasjon og arkiver* [Official Norwegian Report on a new Archival Act]

[21] NOU 2019: 5 *Ny forvaltningslov – Lov om saksbehandlingen i offentlig forvaltning (forvaltningsloven)*. [Official Norwegian Report on a new Public Administration Act]

A feature common to all of the current automated case management systems is that they are rule-based. The regulations are programmed into the solution, making it possible to give reasons for the decisions made. The Public Administration Act requires grounds to be given for all individual decisions. This obligation to state grounds is important for safeguarding citizens' opportunities to verify and check decisions made concerning them.

NOU 2019: 5 Ny forvaltningslov [New Public Administration Administration Act]

The Law Commission on the Public Administration Act was appointed in 2015 and submitted its report in the spring of 2019. A central element in the commission's mandate was 'to draft an act that facilitates and builds on the fact that most administrative proceedings are performed, or will be performed, digitally'.

The commission points out that automated decision-making can generate substantial efficiency gains, particularly where case volumes are large. Automation can also promote equal treatment, given that everyone who, according to the system criteria is in the same situation, is automatically treated equally. Automation enables consistent implementation of regulations and can prevent unequal practice. Automated administrative proceedings can also enhance implementation of rights and obligations; for example, by automatically making decisions that grant benefits when the conditions are met. This can particularly benefit the most disadvantaged in society. More consistent implementation of obligations can lead to higher levels of compliance and to a perception among citizens that most people contribute their share, which in turn can help build trust.

Wherever there is a need to exercise discretion, rule-based systems can filter out cases or checkpoints for manual assessment. The commission points out that machine learning can offer new possibilities for automating assessment criteria.

The majority of the commission proposes that statutory authority be provided in the regulations to allow administrative bodies in specific areas to make decisions using fully automated administrative proceedings. Decisions with a low impact on individuals may be made without providing statutory authority in regulations. The commission also proposes that the administrative body must document the legal content of automated decision-making systems. Such information should be made public unless otherwise provided by laws or regulations or if special considerations dictate otherwise.

The Law Commission on the Public Administration Act sees the difficulty in implementing cohesive services without sharing data across agencies. The absence of authority to share information can make it difficult to organise the public administration system appropriately, and prevents full automation of administrative proceedings in areas that lend themselves to this. The commission therefore proposes that authority be given to share confidential information with other administrative bodies on a need-to-know basis. This constitutes a broader application than current laws.

Source: NOU 2019: 5 *Ny forvaltningslov - Lov om saksbehandlingen i offentlig forvaltning (forvaltningsloven)*

There is huge potential to increase the use of artificial intelligence in public-sector administrative proceedings in the form of both rule-based systems and machine learning. The Law Commission on the Public Administration Act emphasizes that automation can promote equal treatment and consistent implementation of regulations. Nonetheless, when case management systems containing AI elements are implemented, the algorithm's judgement must be at least as sound and as trustworthy as the human discretion it replaces. To ensure this, we need systems that are transparent and explainable.

In its report, the Law Commission on the Archival Act is concerned that efforts be made to ensure that AI-driven processes and decisions be documented and that the documentation be protected in ways that render it authentic and usable. Existing archiving procedures, archiving systems and archiving institutions in the public sector are currently not equipped to address this challenge. The commission therefore recommends that consideration be given to how archiving functionality can be built into the administrative processes and to identify any specific aspects resulting from the use of artificial intelligence.

Artificial intelligence can also be used to achieve better, more efficient classification and sorting of information and thereby simplify and improve record-keeping and archiving practices in the future.

The Government will

- review and assess regulations that hamper appropriate and desired use of artificial intelligence in the public and private sectors
- set requirements for transparency and accountability in new public administration systems in which AI is part of the solution
- establish an advisory body and a regulatory sandbox in the area of privacy and data protection
- be receptive to requests from public and private enterprises to establish more regulatory sandboxes
- establish a health analysis platform to streamline and simplify access to health data for research and analysis and simultaneously strengthen privacy and data protection
- facilitate more active use of health data for testing the effects and safety of medicines and medical technology

2.4 Infrastructure: networks and computing power

Deployment of the electronic communication networks

The electronic communication networks, and the mobile communication networks in particular, constitute a cornerstone in the digital transformation of society. Norway has a well-developed fourth-generation (4G) mobile network with excellent coverage. There are plans to deploy a nationwide 5G network in the Norwegian mobile market by 2023.[22] This will be important for leveraging the opportunities that lie in 5G technology and 5G networks, not least as an underlying technology for the Internet of Things (IoT).

The Internet of Things is a term often used to refer to the ever increasing amount of sensors connected to the internet. It can cover everything from mobile phones and private smart home solutions to sensors in waste handling equipment and devices for measuring, air and water quality, noise levels, and so on. The data can be used in predictive maintenance, decision processes and development of new business models. IoT solutions are already deployed in today's 4G networks, but because 5G is faster than 4G and can handle much larger datasets and detect weaker signals, it will play a significant role in the development of IoT. Increased capacity is particularly important in densely populated areas.

5G infrastructure will therefore be important for implementing a full-scale realisation of IoT with a capacity that cannot be delivered by today's technology. This will open the way for completely new applications in different sectors of society, such as transport, health and care, and smart cities.

The mobile networks will be a vital enabling technology for AI, due not only to their role as a communication infrastructure but also to the vast amount of communication data generated by producing the services. Anonymised metadata from the mobile networks can be used as an input factor in systems that use AI for data analysis, improving decision-making bases, and controlling processes. Such data is already commercially available from mobile network operators (Telenor, Telia and Ice). Use of such data is regulated in a range of regulations, both sectoral laws and the Personal Data Act. The Government will monitor developments in this area and consider how to facilitate increasing use of this data.

In the transport sector, deployment of the electronic communication networks, expansion of IoT technology and access to anonymised metadata from communication will represent key elements in leveraging the opportunities that lie in AI, such as:

- self-driving and autonomous cars, buses, trucks, drones, trains and ships
- intelligent traffic management, controlling and influencing behaviour in traffic
- early warning of the need to replace and maintain infrastructure
- prediction of travel behaviour
- more advanced route optimisation

[22] Telia (2019): *Telia skal bygge ut et nasjonal 5G-nett i løpet av 2023* [Telia to deploy a national 5G network by the end of 2023]. Press release, 8 October 2019

Transport and communication infrastructure is also a key element in the development of smart cities and municipalities. Smart city solutions such as adapted health services, smart energy supply, and control of buildings with solutions that use big data and AI will depend on fast and robust electronic communication networks.

The Government wants to accelerate the pace of further broadband deployment. The draft legislation on broadband deployment includes measures to facilitate the common use of existing physical infrastructure; measures to ensure that developers of mobile and broadband networks receive information on, and can participate in, ongoing and planned building and construction projects; and measures to ensure that developers receive information on existing physical infrastructure. The new act will require new buildings and buildings that undergo renovation to be made ready to connect to high-speed networks.

The Government will present a white paper on electronic communication.

High-performance computing (HPC)

Datasets in many areas of research and public administration are growing rapidly. Calculations and data-driven research have become important work methods in research, in addition to experiments and theory development. This creates a growing need not only for storing and accessing data, but also for the computing power to process this data. Scientific calculations make it possible to analyse and identify new theoretical relationships in the vast datasets generated by, for example, genetic sequencing, satellite observations or research vessels.

Many research projects that process large datasets can use local resources or buy capacity from one of the large cloud service providers. If the chosen provider stores and processes data in compliance with the General Data Protection Regulation, most unclassified data can be processed in its cloud services. Use of cloud services from large commercial players like Google, Amazon and Microsoft offer more capacity (for storage and computing power) and various commercially available analytical tools.

However, these are insufficient for processing large datasets or data requiring large-scale parallel calculations. Situations like these call for larger computing resources, which are more cost-effective to establish at national or international level. UNINETT AS develops and operates Norway's high-speed research and education network. UNINETT'S subsidiary, UNINETT Sigma2, is responsible for procuring, operating and maintaining national resources for high-performance computing and data storage in Norway.

For some research areas, such as astrophysics and marine research, the datasets are so large and require such high computing speeds that our national resources lack the necessary capacity. We are dependent on cooperation and on buying capacity in international consortia. Such high-performance computing centres can have up to 100 times more capacity than national resources.

In 2017 the European Commission took the initiative to establish the European High-Performance Computing Joint Undertaking (EuroPHC), which is jointly funded by the European Commission and national contributions. From 2021 Norway's participation in EuroPHC will still depend on Norway's participation in the Horizon Europe framework programme and the Digital Europe Programme (DEP). UNINETT Sigma2 is

HPC produces vital knowledge about major societal challenges

Life cycle assessments and material flow analyses are key elements for gaining an overall picture of the environmental impacts of different products from cradle to grave. Such analyses demand large datasets and immense computing power. Combining data from the oceans with atmospheric measurements will provide a better data source for climate modelling. Climate models require increasingly higher resolution in time and space, and thereby more calculations, if they are to provide the necessary local insights into how climate change will affect the risk of floods, land slides and extreme weather.

Similarly, modelling of space weather will be essential for avoiding paralysis of critical infrastructure by severe solar storms.

Health research has been revolutionised in recent years by genetic sequencing and advanced algorithms, which in turn have opened the door to personalised medicine and new advanced forms of treatment. These methods generate vast amounts of sensitive data that must be analysed by high-performance computers and must be stored in highly secure environments.

Source: Ministry of Education and Research

Norway's national competence centre for high-performance computing in the EuroHPC partnership.

Some areas require high levels of cyber security while simultaneously allowing the data to be processed efficiently. Relevant examples are high-resolution MR images, DNA data, videos of patients and other sensitive data. Solutions for storing and processing such data are provided through the Service for Sensitive Data (TSD), among others, which is operated and developed through collaboration between the University of Oslo and UNINETT Sigma2.

Norwegian data centres as a resource for AI

Cloud services are fundamental for enabling enterprises to exploit the potential of AI technology. Cloud services provide them with access to computing power and frameworks for machine learning which they lack locally.

Many factors are driving the increase in datasets, among them IoT and the possibility to perform more and increasingly advanced analyses on complex data sources. This increases the demand for storage and processing capacity 'in the cloud', which in turn increases the need to establish more data centres.

The Government wants Norway to be perceived as an attractive host country for data centres and other data-based industry. A data centre strategy was announced in 2018.[23] Several measures laid out in the strategy, such as reduced electricity supply costs for data centres, removal of the 'machinery tax' and a more straightforward site zoning process for data centres, have made Norway even more attractive to the data centre industry. Clean energy, good communications infrastructure and political and

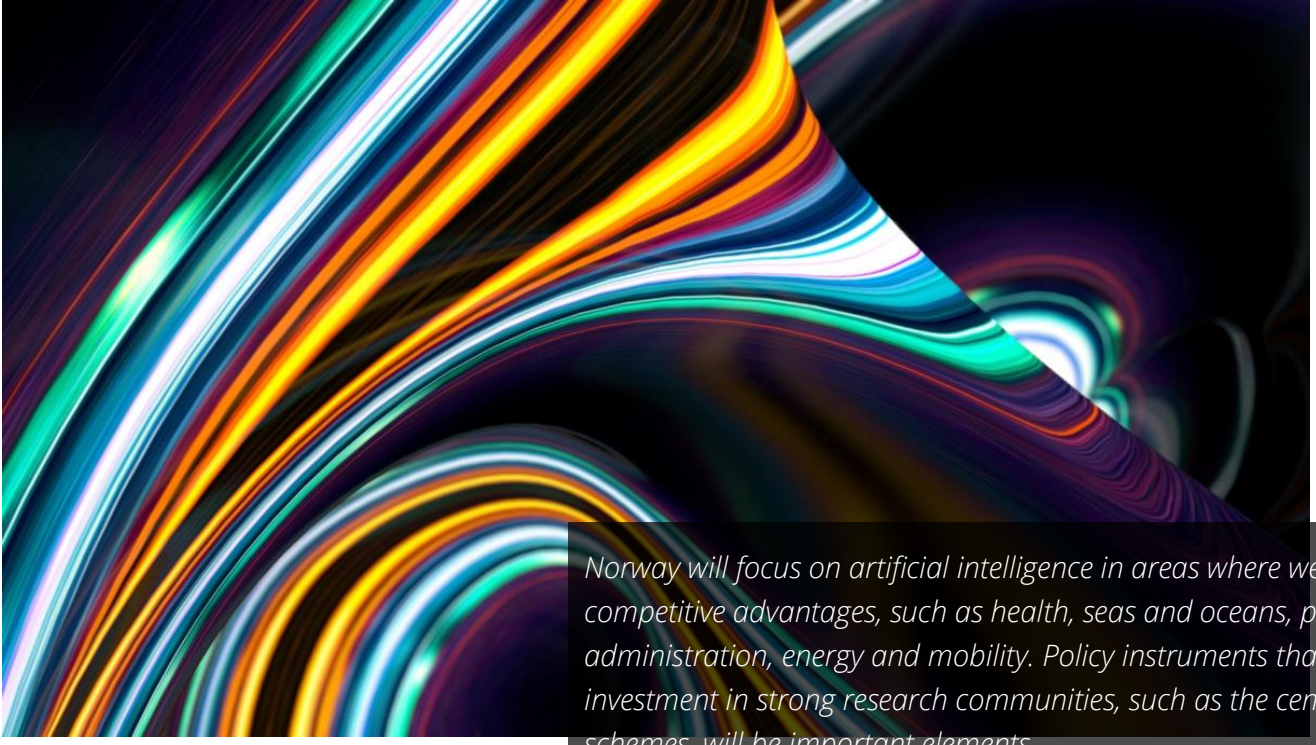
[23] Ministry of Trade, Industry and Fisheries (2018): *Powered by Nature – Norway as a data centre nation.* Strategy

geological stability are other important arguments for choosing Norway as a host country for data centres.

The number of data centres established in Norway has grown in recent years. Many Norwegian data centres have major international customers, and several large international cloud service providers have opted to establish their own data centres in Norway. We are also witnessing a trend whereby customers – including international companies – are moving tasks that require large amounts of computing power to Norwegian data centres because they can offer scalable capacity based on renewable energy. This is a positive trend from a business perspective, and provides Norway's business and public sectors with a wider choice of suppliers. It is particularly important for enterprises with stringent latency requirements or that process data subject to national storage and processing requirements.

The Government will

- consider how to facilitate increased use of anonymised metadata from the mobile networks
- present a bill on broadband deployment that will contribute to accelerating the pace of deployment of high-speed networks in Norway
- facilitate the rapid rollout of 5G
- present a white paper on electronic communication
- consider further participation in EuroHPC in connection with Horizon Europe and the Digital Europe Programme (DEP)
- establish a marketplace for cloud services which will, among other things, guide public agencies on procuring cloud services, with particular focus on security
- follow up the data centre strategy *Powered by Nature Strategy: Norway as a data centre nation*



«Inside Me», Dimitry Zakharov (RU)
Photo: Ars Electronica

Norway will focus on artificial intelligence in areas where we have competitive advantages, such as health, seas and oceans, public administration, energy and mobility. Policy instruments that stimulate investment in strong research communities, such as the centre schemes, will be important elements.

The Government wants Norwegian research communities to be attractive partners for leading AI enterprises and research communities through continued investment in basic and applied ICT research, good study programmes and competence building in AI through courses and further education programmes at all levels.

3 Developing and leveraging AI

Norway will have advanced expertise in basic ICT research and AI research in order to understand and benefit from changes in technological developments. Norwegian communities will be attractive cooperation partners for leading business and research communities.

Norway will invest in research and development in artificial intelligence within the long-term priority areas in the Government's long-term plan for research and higher education: seas and oceans, environment, environmentally friendly energy, health, public administration and civil protection.

The EU framework programmes for research and innovation represents important arenas for cooperation and an important source of funding for Norwegian enterprises and institutions. In the future, too, the aim is for national policy instruments to stimulate participation in and qualification for any European programmes Norway chooses to join.

The EU framework programmes also open the door to cooperation with countries on other continents. Norway has entered into bilateral government agreements with selected countries to strengthen cooperation with strong research nations. The aim is to promote cooperation in priority areas, including AI.

The Government's goal is that investments in artificial intelligence within research, research-based innovation and development should be concentrated on strong

research communities where cooperation between academia and industry is central, such as in the centres of excellence and the centres for research-based innovation.

Higher education programmes should correspond to needs for advanced expertise in artificial intelligence and for competence in basic subjects such as statistics, mathematics and information technology in the different sectors.

Overviews of courses and further education programmes in artificial intelligence will be readily available. Digital skills, digital judgement and technology literacy will be given prominence already at primary and lower secondary school level. A basic introduction to what artificial intelligence means and what it deals with will be made available to the general population.

3.1 Research and higher education

Research

There has been solid growth in research and development in ICT in recent years, with a nominal increase from NOK 8 billion in 2007 to NOK 18 billion in 2017. Industry accounts for the largest share of R&D investment in ICT, and most of this comprises development activities. More recently, however (2015–2017), the strongest growth has been in the university and university college sector.[24]

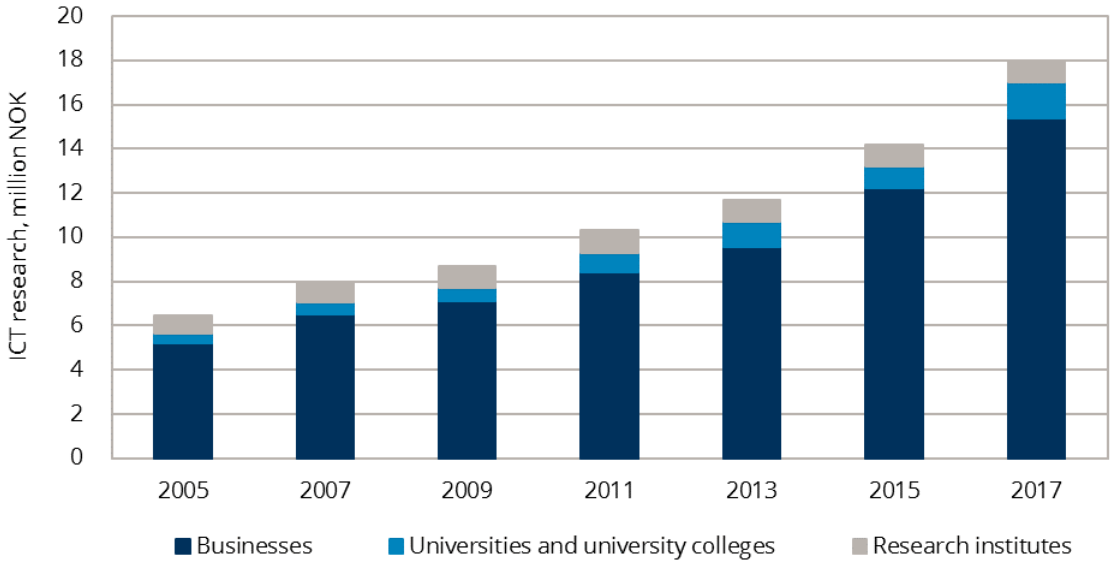


Figure 3: Consumption of ICT R&D
Source: Statistics Norway and NIFO, R&D statistics. Research Council of Norway (2019): *Report on science and technology indicators for Norway*

In 2018 the Government allocated a total of NOK 9.9 billion to the Research Council of Norway, approximately NOK 1.4 billion of which was allocated to research, innovation and advanced applications of ICT. The Research Council of Norway has no programmes dealing specifically with AI, but AI has been one of several priorities in the IKTPLUSS initiative. Calculations from 2019 show that over 40 per cent of the Research

[24] Research Council of Norway (2019): *Report on science and technology indicators for Norway*

Council of Norway's allocations to ICT was awarded to projects in AI, robotics and information management (big data). This represents almost NOK 400 million.

Between 2015 and 2019 allocations to these research areas totalled approximately NOK 1.3 billion, of which almost NOK 400 million was allocated to research infrastructure while over NOK 240 million was allocated to innovation projects in the industrial sector. AI, robotics and information management are also the ICT technology areas that grew most between 2015 and 2019 (see Figure 4). Other important ICT-related R&D areas are data protection, security and vulnerability.

The investment in AI is heavily influenced by the challenges and opportunities that lie in applications, and projects that combine good AI research with advanced applications stand a strong chance of winning the competition for funding.

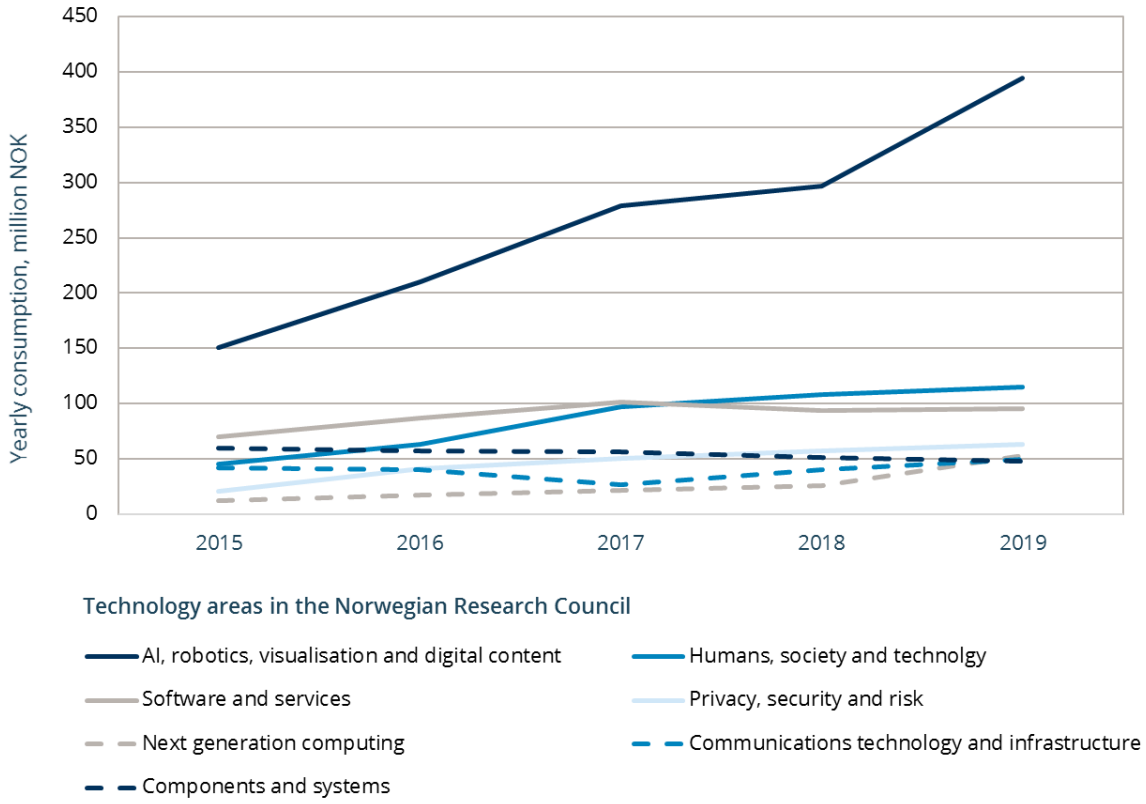


Figure 4: R&D expenditure for different technology areas in the Research Council of Norway. Recorded expenditure of funds allocated by the Research Council of Norway 2015–2018 and budgeted figures for 2019.

Source: Research Council of Norway

The Research Council of Norway's centre schemes

The centre schemes are intended to support the best research communities and drive pioneering research and ground-breaking innovation or to strengthen priority areas. The centres for research-based innovation and the centres of excellence are two examples of such schemes. The overarching objectives of the centres for research-based innovation are to enhance innovative ability and increase value creation in the Norwegian business sector through long-term research.

Norwegian AI Research Consortium (NORA)

In 2018 a consortium was set up aimed at strengthening Norwegian research and education in artificial intelligence, machine learning, robotics and related disciplines. The consortium comprises Norwegian universities and research institutions engaged in research and education in artificial intelligence: the University of Agder, the Arctic University of Norway, OsloMet, the University of Bergen, the Norwegian University of Life Sciences, Simula Research Laboratory AS, the University of Stavanger, NORCE and the University of Oslo.

Source: nora.ai

BigInsight – Statistics for the knowledge economy and Sirius – Centre for Scalable Data Access are centres for research-based innovation that focus on AI-relevant technologies (big data and data analysis). The Research Council of Norway is now witnessing a trend whereby most centres for research-based innovation have one or more activities related to artificial intelligence. Sirius is affiliated with the BigMed project, to which the Research Council of Norway has allocated NOK 60 million for personalised medicine and use of large-scale data analysis in healthcare.

Industrial PhD scheme

Under the industrial PhD scheme, companies are granted funding from the Research Council of Norway to allow an employee undertake a PhD project in an area that is relevant to the company's activities. The scheme enables companies to enhance their long-term research competence and innovation ability and to strengthen their collaborative relationship with academia.

The scheme is a good alternative for companies in need of targeted research activities but with no possibility or capacity to initiate large-scale R&D projects. Figures from the Research Council of Norway show that artificial intelligence is the area of knowledge in ICT showing the strongest growth in the industrial PhD scheme.

The Government's ambition for Norwegian AI research

The Government considers Norway to be well placed to succeed with human-friendly and trustworthy artificial intelligence, and with artificial intelligence in industrial applications. Norway has a technologically advanced industry with the ability and will to adopt new solutions. Although large countries such as the United States and China have resources with which neither Norway nor Europe can compete, there are areas where Norway and Europe have competitive advantages, such as certain industrial applications of AI and trustworthy AI that takes data protection and ethical considerations into account.

To ensure that Norway remains internationally competitive in areas where we have comparative advantages, it is important that AI research is integrated with investments in these areas.

As a small country, Norway does not have the capability to build knowledge and expertise to high international standards across the full spectrum of AI. Nevertheless, the quality and scope of our national expertise must be sufficient to exploit the technologies and innovations that emerge internationally. Another goal must be to

leverage our position as a nation with a digitally advanced population and business sector in order to take the lead in applying AI, not least in industry. Our national standard. Artificial intelligence falls under one of the five long-term priorities in the Government's long-term plan for research and higher education: enabling and industrial technologies. The Government is increasing allocations to this priority area through, among other things, the Technology Initiative escalation plan, which is one of the stated measures in the long-term plan.

Private investments in AI research

Wallenberg AI, Autonomous Systems and Software Program (WASP)

Wallenberg AI, Autonomous Systems and Software Program (WASP) is a Swedish research institution funded by the Knut and Alice Wallenberg Foundation. WASP cooperates with Sweden's five leading ICT universities. WASP focuses on two areas in AI: the main focus area covers machine learning, deep learning and next-generation AI (explainable AI) and the other focus area is the mathematical foundations of AI.

WASP also aims to recruit outstanding international researchers and to enhance competence in Sweden and in Swedish industry by training at least 400 new PhD candidates, of which at least 100 should be industrial PhD candidates. WASP has a budget of SEK 3 billion up to and including 2026.

Norwegian Open AI Lab

The Telenor-NTNU AI Lab was established at the Norwegian University of Science and Technology (NTNU) in 2017 after Telenor donated approximately NOK 50 million. The donation was made to help boost research, innovation and education in artificial intelligence, machine learning, big data analysis and IoT in Norway. In 2018 several business partners were included in the cooperation project, and the research centre changed its name to the Norwegian Open AI Lab. The new partners – DNB, DNV GL, Equinor and Kongsberg – have donated funds towards general research at NTNU and to research where AI is a central component. The contributions from industry are donated primarily to fund researcher positions and professorships but also physical facilities and equipment that can be used by both researchers and students.

These types of donations from industry strengthen relationships between the partner companies and the university. The connection to industry forms a better platform for exploiting the opportunities that lie in artificial intelligence. This form of cooperation will, among other things, give students and researchers opportunities to work on authentic problems and datasets from industry, contributing to innovation and moving the frontier of AI research forward. Cooperation is continually being expanded to include new cooperation partners from research and industry.

Sources: www.wasp-sweden.org and Norwegian Open AI Lab

It is also important that Norwegian research communities take full advantage of the opportunities offered by the EU framework programme, and that we leverage the research and study programmes in artificial intelligence must hold a high international opportunities that lie in our bilateral research and technology agreements with strong academic communities in leading research nations worldwide. Norway must be a trustworthy and attractive partner in international cooperation, networks and consortia dealing with research and education in artificial intelligence.

A key research policy objective is to stimulate private investment in research.[25] This includes stimulating private individuals and organisations to make donations to research. There are general policy instruments to support this: under the gift reinforcement programme, donations of at least NOK 3 million made to long-term, basic research can trigger a gift reinforcement from the state worth 25 per cent of the donated amount. This programme is administered by the Research Council of Norway. The Norwegian Tax Administration has a scheme under which deductions from taxable income may be granted for monetary donations made towards scientific research conducted by pre-approved organisations.

Participation in EU programmes

Norway has actively participated in the EU's framework programmes for research and innovation for many decades. The Government is concerned that the Research Council of Norway's policy instruments be designed in such a way that they stimulate and qualify for participation in the EU programmes. Artificial intelligence and high-performance computing are areas where we are dependent on international cooperation.

AI is included in several calls for proposals in Horizon 2020, and will have an even more prominent place in the next EU framework programme, Horizon Europe. Investment in innovation will also be strengthened compared with the current period.

The EU has proposed establishing a comprehensive digitalisation programme, Digital Europe Programme (DEP), for the period 2021–2027. This is the first time the EU has proposed a programme dedicated specifically to digitalisation.

The programme has a proposed budget of EUR 9.2 billion divided into five main areas: high-performance computing, artificial intelligence, cyber security, digital transformation and interoperability, and advanced digital skills. DEP is a core element in the European Commission's efforts in digital transformation The programme targets areas where individual countries alone lack the necessary resources to succeed. The resources in the programme will be used in areas where they are expected to be most effective, such as health, justice, consumer protection and public administration. The programme also aims to help small and medium-sized enterprises to adapt to changes brought about by digitalisation and artificial intelligence.

Norway has made a non-binding declaration of intent to participate in the next programme period for the research and innovation framework programme, Horizon Europe. This will give us the opportunity to participate in the strategic planning process on content and design. The Government is considering Norway’s possible participation in DEP.

[25] Report to the Storting no. 4 (2018–2019) *Long-term Plan for Research and Higher Education* and the Granavolden platform of 17 January 2019

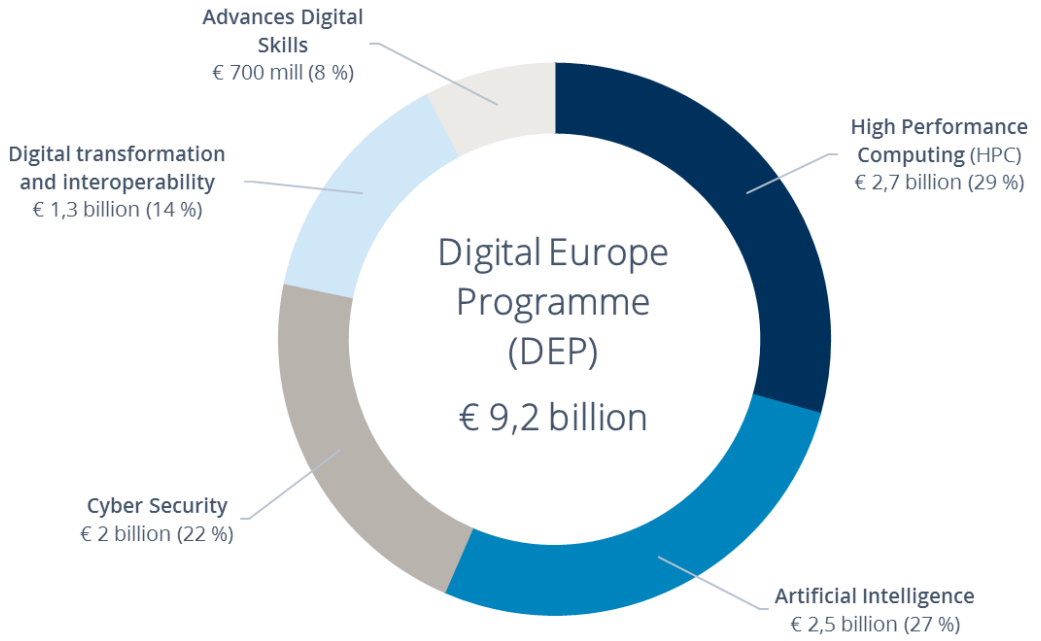


Figure 5: Priority areas in DEP
Source: European Commission 2018

The Government will also facilitate participation by the business sector in the European Commission's research, innovation and development programmes. This will give access to leading knowledge communities and markets. The Research Council of Norway and Innovation Norway have policy instruments for encouraging Norwegian actors to participate in EU programmes and for providing guidance.

The Research Council of Norway has taken the initiative to form a national network for artificial intelligence. The objective is to promote Norway's priorities and interests in the strategy work that takes place in the EU and that this will lead to greater participation by Norway in Horizon 2020 and Horizon Europe. The network will coordinate input from Norwegian research communities and give strategic advice to the Research Council of Norway's focus areas. An important task for the network is to organise meeting places to promote contact, cooperation and knowledge dissemination between the research communities and increased involvement by the business and public sectors. The network was established in the spring of 2019 and brings Norway's leading AI communities together.

Higher education

The universities and university colleges have a high degree of autonomy. They are responsible for following up the national sectoral goals for the university and university college sector, one of which is to facilitate good access to education. The institutions have responsibility for designing the study programmes. The Government can use various means to signal which areas it wants the institutions to give priority to; for example, by allocating resources to study places earmarked for certain subject areas, such as nursing or cyber security. Since 2015 the Government has given particular priority to ICT-related programmes. Increased allocations to these programmes allow almost 1,600 more students admission to ICT-related studies every year.

Subjects that can be classified as artificial intelligence make up several study programmes, but most of these subjects fall within information technology and cybernetics/robotics. In these programmes – at both bachelor and master level – students may, to varying extents, choose courses in AI or decide to specialise by both choosing AI-relevant subjects and writing their bachelor or master's thesis in that subject area. Subjects that typically make up these types of study programmes are: algorithms, machine learning, computer vision, deep learning and big data analysis.

Some educational institutions also offer dedicated programmes in AI, but up to now these programmes could offer relatively few study places. Since 2018, however, we see that a growing number of educational institutions are offering separate programmes in AI at both bachelor and master level. Institutions already offering such programmes are expanding the number of study places. More than 350 new study places dedicated to AI, robotics and data science are planned from 2020, compared to 2017.

More than 400 master degree candidates with a clear AI profile are estimated to have graduated between 2016 and 2019. These were candidates from study programmes dedicated to AI and candidates whose choice of course and thesis define them as 'AI candidates'.[26] The majority of these students graduated from the University of Oslo and NTNU. In addition, just over 300 bachelor candidates graduate every year with AI profiles. Some of them pursue master programmes in the same subject area.

Informal learning arenas: Eik idéverksted

Eik idéverksted is a makerspace for technological innovation. The makerspace is a cooperation project between the Norwegian University of Life Sciences (NMBU), Inkubator Ås, the Savings Bank Foundation DNB and the SpareBank 1 Foundation. Eik idéverksted offers a range of courses, workshops, seminars and projects to students and employees at NMBU. The aim is to serve as an active meeting place that is open to the academic, student, local and business communities.

Many of the students who participate in Eik idéverksted learn to use AI tools at quite advanced levels, even though they do not necessarily have the same in-depth knowledge and academic background as students taking formal courses in AI. AI is becoming increasingly accessible because companies like Google and Facebook offer low-threshold tools in areas such as image processing, natural language processing, prediction, and so on.

Sources: Norwegian University of Life Sciences (NMBU), eikide.org

[26] Student data on, among other things, the number of students and the number of candidates which the institutions report to the *Database for Statistics on Higher Education* are not tagged to such a level of detail as to enable retrieval of reliable figures on programmes in AI. To gain a picture of the current situation, the Ministry of Local Government and Modernisation therefore asked a sample of educational institutions to count the number of candidates who graduated from study programmes in AI and the number of candidates with an 'AI profile'.

The enquiry regarding the numbers of study places and graduated candidates in AI was sent to all the universities as well as to Østfold University College, Western Norway University of Applied Sciences, Inland Norway University of Applied Sciences, and Kristiania University College. All of them submitted reports. As well as reporting the number of study places and the number of candidates who took examinations at bachelor, master and PhD levels in AI, they also reported on new study programmes in AI and on increases in the number of study places in existing AI programmes. The institutions may have used different definitions of what constitutes an 'AI profile' or an 'AI programme' and thus which candidates were counted.

Development of study programmes in AI

The Faculty of Mathematics and Natural Sciences at the University of Oslo hosts a centre of excellence, the Centre for Computing in Science Education (CSSE), which makes an important contribution to further developing study programmes in AI.

The faculty, through CCSE and the Centre for Teaching and Learning in Science and Technology (KURT), offers comprehensive continuing education to schoolteachers in order to integrate programming into school subjects. This is done through the ProFag programming course for schoolteachers. What subjects are taught in schools is also a key factor in raising the level of higher education in artificial intelligence, including machine learning, robotics and data science.

Source: University of Oslo

The number of PhD degrees in topics that can be defined as artificial intelligence is also steadily growing. Moreover, methods from artificial intelligence are increasingly used as tools by PhD candidates and researchers in other areas.

As well as seeking candidates with specific training in AI and data science, business and industry is also interested in candidates with sound knowledge in information technology, mathematics and statistics. Candidates like these will possess the necessary prerequisites for understanding and learning more about AI, either through formal education or through training in the workplace.

Need for interdisciplinarity

Knowledge of artificial intelligence, and related fields such as ethics and data protection associated with AI applications, will be important in study programmes oriented towards the educational sector, health, crime prevention, law and several other fields. For example, an introductory course in artificial intelligence has been established at the University of Bergen, in which students of medicine and bioengineering learn about how AI can be used in clinical practice. One of the aims is to promote interdisciplinary cooperation between physicians and engineers. The universities of Bergen and Oslo also offer courses in artificial intelligence and machine learning oriented towards social scientists.

Institutions of higher education ought to evaluate how topics with relevance to artificial intelligence can be integrated into their programmes in areas that will be changed by artificial intelligence in the coming years.

Need for knowledge about study programmes with relevance to artificial intelligence

During the work on preparing this strategy, it has become clear that official statistics on higher education are not sufficiently detailed to provide reliable information about the scope of the different study programmes needed to succeed with artificial intelligence in Norway. This knowledge base must therefore be strengthened. The EU is also working on models that can produce better knowledge on this issue, based on official statistics and databases that already exist. Norway is engaged in this work, and will evaluate whether new measurements can be based on these models.

The Government will

- strengthen basic ICT research through the Research Council of Norway
- complete implementation of the Technology Initiative escalation plan laid out in Report to the Storting no. 4 (2018–2019) *Long-term plan for research and higher education 2019–2028*
- consider Norwegian participation in relevant EU programmes in the next programme period
- take an initiative to encourage research cooperation with the private sector, inspired by the Wallenberg AI, Autonomous Systems and Software Program (WASP) in Sweden
- set clear expectations for educational institutions to design and adapt their study programmes in AI to meet anticipated needs in the labour market and to integrate AI into established study programmes where relevant
- establish a knowledge base that makes it possible to monitor trends in study places and candidates in AI

3.2 Skills

The Government wants digital skills and technology literacy to be given more prominence already at primary and lower secondary school level. Under The Curriculum Renewal[27], natural science will be made a more exploratory and practical subject already at primary school level, with a distinct technology element that also includes programming. Programming will be introduced in more subjects; among other things, programming and computational thinking skills will be included in the new mathematics subject.

The new curricula will come into effect in 2020. It will take a long time before the children starting school in the autumn of 2020 complete their education and are ready to start work or take further studies, perhaps in technology or artificial intelligence. In the meantime there will be a need to manage the new skill requirements expected of today's adult population in both their private and working lives.

Courses and further education programmes

An analysis from 2015 estimated a high probability that 33 per cent of jobs in Norway would be automated over the next 20 years. These figures have subsequently been modified, and a 2018 report from the Organisation for Economic Co-operation and Development (OECD)[28] estimated that only 6 per cent of jobs in Norway were at risk of automation. This figure is the lowest of all OECD member countries. It also emerged that Norwegian employees – both those with and those without higher education – were among those who receive most training in the workplace.

NAV's Horizon Scan[29] deals with the most important societal trends that will affect the future labour market. It shows that the pace of change in the labour market will accelerate. OECD estimates that every fourth job will undergo major changes. Technological developments will likely lead to many new jobs, but will just as likely lead to employees having to change jobs, change the formal relationship they have with employers, and update their skills more often. Opportunities for continuing and further education – both in the workplace and through study programmes – will therefore become increasingly important. Development and use of artificial intelligence make up part of this picture.

Like elsewhere, technological developments in artificial intelligence are bringing about changes in many jobs; some work tasks will disappear, while tasks that require other skill types will emerge. Meanwhile, ever fewer jobs will require little or no formal skills. The Government considers it important that people who already have jobs be given opportunities to take courses and further education. In 2020 the Government will present a white paper on a skills reform for lifelong learning (*Lære hele livet*). The objectives of the skills reform are that no one should be left behind and that more employees should remain longer in their jobs.

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[27] The Curriculum Renewal refers to the work on renewing all the curricula in primary and lower secondary education and in upper secondary education. The new curricula will come into effect at the start of the school year in 2020

[28] Nedelkoska, L. and Quintini, G. (2018): *Automation, skills use and training*, OECD Social, Employment and Migration Working Papers, No. 202, OECD Publishing, Paris

[29] NAV (2019): *NAV's Horizon Scan 2019 – Developments, trends and consequences towards 2030.* Report 1 2019

AI for everyone: Elements of AI

Elements of AI is a series of free online courses in artificial intelligence. The course series was developed in the spring of 2018 by the Finnish company Reaktor, its Norwegian sister company Feed and the University of Helsinki. The aim of the course is to teach as many as possible about what AI is, what it can and cannot be used for, and how to start using methods based on AI. The course combines theory with practical exercises, and requires no prior knowledge.

Elements of AI has quickly become extremely popular, and ranks top in several overviews of massive open online courses (MOOCs). Eighteen months after it was launched, more than 230,000 people had registered to take the course, of which 15 to 20 per cent have completed all the modules.

The course has attracted much larger proportions of female students (40%) and students aged over 45 (30%) than is normally the case for ICT courses. In Sweden and Finland the proportion of female students taking the course is more than 50 per cent. Since Elements of AI was launched, the University of Helsinki, which is the host university, has seen increases in the number of ordinary applicants to ICT programmes and in the proportion of female applicants.

A key factor in motivating people to complete the course is the #AIChallenge. The #AIChallenge encourages companies and public agencies to commit to supporting their employees to complete Elements of AI. By the autumn of 2019 more than 450 Finnish and Swedish organisations had taken up the challenge, among them Telia, Nokia, Systembolaget, Nordea, Bonnier, Swedish Tax Agency, the Finnish Ministry of Economic Affairs and Employment and Volvo.

Elements of AI will be launched in Norwegian in cooperation with the Norwegian University of Science and Technology in 2020

Source: Feed/Reaktor

Employers must ensure that their employees possess the necessary skills. This includes assessing the need for continuing and further education. Individual employees must also take responsibility for their own skills development in a labour market with ever increasing skill requirements. Nonetheless, some skill needs may not be met, and the public sector ought to find new ways of addressing these.

To help enterprises meet new skill needs that arise, the Government has established a range of schemes that support the development and operation of flexible further education programmes. Several programmes in digital skills have already been established as a result of cooperation between universities, university colleges or tertiary vocational colleges and the labour market. The idea is to enable people to undertake this type of further education while they are employed.

From 2020 the Government will reinforce these efforts through a new Skills Programme and through increased allocations to a competition-based scheme administered by the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Diku). The target group for the programmes

developed with funding from these schemes comprises employees who need new skills due to restructuring needs created by digitalisation and the green shift.

Workplace training

Norway has positive experiences of restructuring in the labour market due to various changes.[30] Norwegian employees are good at adapting, and cooperation between employee organisations, employer organisations and the authorities is good. This may be one of the reasons why Norwegian employee organisations tend to seek dialogue on how employees and employers can work together to meet the challenges rather than focus their concerns on the potential consequences of AI for jobs and changing work tasks.

Several large enterprises have launched their own further education programmes in AI and data analysis. For example, DNB bank has offered its employees opportunities to train as data scientists in order to meet the bank's need for competence in this area.

The Government is also cooperating with the social partners on an industry programme for the municipal care sector and an industry programme for industry and construction. The costs of the industry programmes are shared among the state, which pays for developing and operating the programmes; the enterprises, which invest their own resources; and the employees, who invest some of their free time. The industry programmes will also be included in the Skills Programme in 2020, and work on the programmes will be strengthened and further developed in cooperation between the partners.

Norwegian State Educational Loan Fund: testing AI as a training measure

When the Norwegian State Educational Loan Fund (Lånekassen) was introducing a new collaboration platform in 2017, it wanted to find out whether an AI chatbot could make training users of the platform more effective. Lånekassen decided to use a technology supplied by the Norwegian company Boost.ai, a market leader in conversational AI. Because testing the chatbot involved *all* Lånekassen employees, they all gained insight into what a chatbot is and how it is trained.

After two weeks, Lånekassen's employees had performed close to 1,500 chats with the robot. The system made an important contribution to the launch of the collaboration platform, as well as illustrating how use of AI created an opportunity to involve a whole organisation. This measure is an example of successful public–private cooperation on using new technology and modern development methodology. The test project has also provided experience transfer for other public agencies such as Vy, NAV and the Norwegian Government Agency for Financial Management (DFØ).

Source: Lånekassen (2017): *Sluttrapport fra konseptutreding av muligheter for effektivisering ved bruk av kunstig intelligens* [Norwegian State Educational Loan Fund (2017): Final report from the concept study of the rationalisation potential of AI]

[30] NAV (2019): *NAV's Horizon Scan 2019 – Developments, trends and consequences towards 2030*. Report 1 2019

Student projects as a measure to access new skills and for recruitment

The Norwegian Tax Administration has in recent years hosted summer projects using AI, such as Pattern Recognition in Cryptocurrency and AI-assisted Tax Returns. The objective of these projects is to test new technologies. Participants are recruited from technology study programmes in AI, machine learning, programming and statistical methods, among others. The projects not only provide the Norwegian Tax Administration with an opportunity to conduct interesting pilot projects in relevant areas; they also give the agency the chance to present itself as a potential workplace for students who will be highly sought-after in the labour market once they graduate.

Source: Norwegian Tax Administration

The Government will

- make Elements of AI available in Norwegian through the Norwegian University of Science and Technology, and initiate the #AIChallenge in Norway
- consider a digital platform for continuing and further education programmes
- support development of flexible further education programmes so that universities and university colleges can apply for funding to develop programmes in AI
- prepare a strategy for digital competence in the public sector

«Aerial biped», Azumi Maekawa (JP) and Shunji Yamanaka (JP)
Photo: Ars Electronica

The Government wants Norway to take a leading position in exploiting the innovation potential in applying artificial intelligence. The Government will evaluate how industrial policy instruments can best be designed to support potential value creation and use of AI in the business sector.

Public agencies ought to actively explore the potential of the technology, and increased interaction between the public sector and the business sector should promote innovation and value creation.

4 Enhancing innovation capacity using AI

Norway can take a leading position in applying artificial intelligence, particularly in areas where we already have the necessary prerequisites and strong business and research communities, such as health, oil and gas, energy, the maritime and marine industries and the public sector.

The foundation we lay in the form of access to good infrastructure, data sharing, research and competence building will also provide a good starting point for increased innovation and value creation for small but technologically advanced companies.

The largest public agencies already serve as a driving force in AI by actively exploring the potential that lies in this technology. Sharing of best practice across sectors and enterprises will be facilitated.

Increased interaction and cooperation between the public and business sectors, and between research communities and the business sector, are vital to unlocking the innovative potential of applying artificial intelligence in the form of both established and new models of cooperation.

The public sector ought to actively explore opportunities in the market in connection with procurements, and innovative public procurements should be used wherever appropriate. To facilitate innovative solutions, agencies ought to focus on the tasks that need to be performed rather than on specific products or services.

4.1 Industrial policy instruments

The authorities play an important role in facilitating business development, also with regard to AI. However, the business sector also has a responsibility to develop and adopt technologies that can create better, more profitable services or more efficient operations.

The underlying assumption is that companies and enterprises invest less in research and development than what is profitable for society as a whole. As part of Norway's research and innovation system, public authorities therefore facilitate innovation through grants and other schemes administered by the system of policy instruments for research and innovation. Several policy instruments currently available promote research in, and development, testing and commercialisation of, artificial intelligence.

Support for the early phase, where more emphasis is placed on research and research-based innovation, is usually provided through the *Research Council of Norway.*

Innovation Norway has a responsibility to promote innovation, value creation and growth in business and industry through, among other things, financial contributions and expertise. In recent years Innovation Norway has arranged the Tech City Executive Accelerator (TEA) initiative for companies oriented towards AI and the Internet of Things. The aim is to make executives in expanding Norwegian companies aware of the opportunities for leveraging AI and the Internet of Things. TEA is based in London.

The Industrial Development Corporation of Norway (SIVA) facilitates innovation through infrastructure such as business gardens, incubators and initiatives such as the Norwegian Catapult scheme. *Investinor* is a state-owned venture investment company whose purpose is to improve access to capital in the early-stage market (the market for investment capital for companies in the process of developing new products or processes). *Export credit and guarantee schemes* should help Norwegian businesses enhance their competitiveness in the international market.

Innovation project: Machine learning in seismology

Earth Science Analytics AS leads an industry innovation project that receives funding via the Research Council of Norway's PETROMAKS 2 programme Machine Learning in Geoscience. The project shows how digitalisation and artificial intelligence are in the process of transforming the seismic industry.

Today geologists spend around 70 per cent of their time on seismic interpretation. Artificial intelligence could automate some parts of the interpretation process. This would make retrieving relevant information from seismic data far easier and more efficient. The technology can also be combined with tools for analysing well data. This will help the oil companies make better decisions based on large amounts of reliable data.

Source: Ministry of Petroleum and Energy

Digital21

Digital21 is a strategy developed by and for businesses. The goal has been to make recommendations to the authorities on how businesses can better develop and benefit from competence, technology, research and development in order to succeed in digitalisation. An important message in the strategy is that Norway cannot be best at everything, and should therefore give priority to the technology areas where Norwegian business and industry can profit most. Digital21 highlights artificial intelligence, big data, the Internet of Things and autonomous systems as particularly important technologies for Norway in the time ahead.

Source: digital21.no

Some countries have introduced grant schemes for businesses that start up AI projects. In Sweden, for example, Vinnova has established a scheme to which companies and public enterprises can apply for grants of up to SEK 500,000 to start up their first AI project. Norway has no schemes specifically for R&D in AI; instead we have a broader scheme, SkatteFUNN, through which Norwegian companies can apply for tax deductions on R&D costs. SkatteFUNN is a rights-based scheme with simple application processes and reporting requirements.

Forskerpool [Researcher Pool] is a scheme affiliated to SkatteFUNN to which businesses can apply for up to 50 hours of assistance from a researcher to develop an idea or get feedback on a problem. This scheme may be particularly relevant for SMEs, which often lack this type of in-house expertise. In AI, where there is a shortage of personnel with advanced skills, schemes like these where resources are shared can help more companies gain access to the expertise they need to start their projects or pilots.

Business clusters represent a policy instrument that can be suitable for promoting business development in AI. Innovation Norway, the Research Council of Norway, and Siva currently fund a cluster programme. The business community takes on the roles of leading and coordinating the business clusters, but research institutions and public agencies are often members.

Cluster for applied AI

In Halden, eSmart Systems, the Institute for Energy Technology (IFE), Østfold University College and the research and innovation company Smart Innovation Norway have taken the initiative to develop a new cluster, the Cluster for Applied AI. The ambition is to create an optimal platform for developing Norwegian companies' international competitiveness and sustainable social development through applied AI. The purpose of the cluster is to create new jobs and sustainable development based on rapid development and application of AI. Key focus areas will be technological development, commercialisation, ethics, security and accessibility. The cluster will facilitate the sharing of data, infrastructure and other technologies that its members would otherwise be unable to invest in.

Source: Smart Innovation Norway

DigitalNorway

DigitalNorway is a non-profit organisation whose mission is to make it easier for Norwegian businesses to succeed with digitalisation. DigitalNorway cooperates with research and educational institutions, business clusters and several of Norway's best competence and innovation communities. Among other things, the organisation provides tools for companies that want to make the transition from idea to product or service, and networks for sharing knowledge and experiences.

The Conversion Engine service helps companies build their in-house expertise in digitalisation and advanced production. Together with Smart Innovation Norway, NCE iKuben and NCE Kongsberg Innovasjon, DigitalNorway leads the work on the Conversion Engine for digitalisation while NCE Raufoss has corresponding responsibility for manufacturing/advanced production. The aim is to help small and medium-sized enterprises throughout the country succeed in their digital transformation. Innovation Norway supports the programme.

Source: DigitalNorway

There are also good examples of the business sector launching its own initiatives. Measures such as the AI Village in Trondheim, where several companies have joined forces to leverage synergies and create a stronger community, are good examples of how cooperation within the business sector can produce positive effects.

Review of the system of policy instruments

In 2018 the Government launched a comprehensive review of the system of business policy instruments.[31] The purpose is for Norway to derive maximum value creation and economically sustainable jobs within sustainable parameters from the resources that are channelled through the system of policy instruments.

EU policy instruments for AI targeting SMEs: digital innovation hubs

Digital innovation hubs (DIHs) is a policy instrument that was launched by the European Commission in 2016 to help small and medium-sized enterprises (SMEs) to digitalise faster. The first generation of DIHs was created under Horizon 2020. Four Norwegian digital innovation hubs have been set up, affiliated with GCE NODE in Agder, SINTEF, Oslo Cancer Cluster and Digital Norway, all of which are active enablers for SMEs.

In the transition to the new EU programmes for 2021–2027, a new generation of larger and more binding DIHs will be introduced. These will be one-stop shops, and will cover an ecosystem (national and international) that can offer expertise and competence and contribute to enabling SMEs in particular to participate in the digital shift and leverage the potential of artificial intelligence. Funding for the projects to be implemented will come from the Digital Europe Programme, among others.

The DIH programme and Norway's catapult scheme share some common features. The Government has established Norwegian Catapult, a scheme that gives Norwegian

[31] Updated information on the review of the system of business-oriented policy instruments is available (in Norwegian) at www.regjeringen.no/vmg

industry access to test facilities in order to enhance innovation and value creation. NOK 125 million was allocated to the scheme in the 2019 national budget. Siva has given priority to further developing the catapult scheme in 2019, in cooperation with Innovation Norway and the Research Council of Norway.

In Norway the clusters will be key participants in the digital innovation hubs that are set up. One important task for the system of policy instruments will be to further develop complementarity between the digital innovation hubs, the cluster programme and the catapult scheme.

Intellectual property rights

Protecting intellectual property rights is important for ensuring that the AI market develops in the right way. Any uncertainty about ownership of the various elements that make up solutions based on AI (data, development framework, pre-trained algorithms, etc.), how they are licensed or how access to the solutions is paid for, will have negative impacts.

The Government wants Norwegian companies to make informed and competent decisions regarding protection, use and enforcement of their intellectual assets and rights, and to have a professional and conscious approach to the way they handle the rights of others. There is a wish that Norwegian companies secure the increased market access and value creation which professional protection and use of copyright law can afford them. Protecting their ownership rights can be particularly decisive in connection with internationalisation.

The Ministry of Trade, Industry and Fisheries has begun mapping competence levels and needs in the area of intellectual property rights in Norwegian industry, and will assess whether the guidance offered on the system of policy instruments is adequate.

Public agencies can find it particularly difficult to know how to deal with rights when development of an AI-based solution is conducted through cooperation between the public sector and a private company: for example, how should a public agency handle ownership and user rights in a partnership where a commercial party develops and trains algorithms using the public agency's data? This type of issue will likely arise in the future, and perhaps especially so in connection with using health data for commercial purposes.

One important exception here, of course, is open data, which may freely be used by both commercial and public actors, pursuant to the Norwegian Licence for Open Government Data (NLOD) or under a Creative Commons licence.

Google DeepMind and the National Health Service (NHS) in the UK

In the UK the National Health Service (Moorfields Eye Hospital NHS Trust) has cooperated with Google DeepMind on developing an algorithm that can identify eye diseases based on images of the eye. The agreement makes DeepMind the owner of the final system but entitles Moorfields to the right to use it free of charge for a given number of years after it is approved for clinical use.

Source: Moorfields Eye Hospital NHS Trust

Standardisation

Norway can contribute to ensuring that artificial intelligence develops in the desired direction by exerting influence on international standards related to AI. Such influence is exerted by participating in international standardisation activities and by chairing working groups in areas that are important for us. At global level, AI activities are conducted in the standardisation organisations ISO and EIC and at European level in CEN and CENELEC. It is most often the large companies that take an active part in standardisation activities. The threshold for participating in this type of activity can be high for many SMEs for various reasons, such as travel costs or the time involved.

Standard Norway has created a mirror committee (SN/K 586 Kunstig Intelligens) to follow up international standardisation activities in AI. The committee is composed of representatives from research, business and industry, national authorities and various interest organisations.

The Government will

- work towards enabling the digital innovation hubs to help SMEs get started on applying AI
- engage in dialogue with Digital Norway on how it can enable SMEs to take more advantage of the potential of AI
- promote the work on international standardisation activities related to AI, particularly with regard to stimulating SMEs to participate in these activities
- develop guidelines, including proposals for standard agreement clauses, on how public agencies should deal with ownership rights when cooperating with the business sector on developing artificial intelligence

4.2 AI-based innovation in the public sector

The Government believes there is vast potential for the public sector to rationalise and create better services through digitalisation. Artificial intelligence is one aspect of this. In the future the public sector will use artificial intelligence to deliver more targeted and user-adapted services, enhance the social benefit of its own activities, rationalise operations and work processes, and reduce risk.

Artificial intelligence in the public sector can contribute to:

- more relevant advice and services to citizens in different life situations
- better decision-making support for public-sector employees
- rationalising processes and optimising resource utilisation
- improving the quality of processes and services by automatically detecting possible deviations
- predicting trends based on data from both agencies and their environments
- processing natural language for sorting and categorising, and for translating between different languages and language forms

Use of AI in the public sector is still in an early phase, however. A survey[32] shows that many agencies are still in the planning or testing phase, where they try to find out what AI can be used for. Some agencies have begun testing through proofs of concepts. The survey shows that more than half of the agencies regards organisational culture, legal and regulatory issues, and data protection and security as the major challenges with respect to AI. Lack of competence is highlighted as another challenge.

For example, agencies can find it difficult to assess which areas are suitable for AI. One area that raises several dilemmas is the use of AI for control purposes. Such controls can involve, for example, identifying individuals who *may be* violating regulations (that is to say where an algorithm identifies a high probability for this). For applications like these, consideration must be given to rule of law and protection against self-incrimination for individuals subjected to regulatory checks. The risk and consequences of false positives – i.e., of someone being wrongly identified and of the undue hardship this would impose on them – must be part of a data protection impact assessment, which must be included when a solution is under evaluation.

Such assessments related to the use of AI in public administration can prove challenging, particularly if the agency lacks the relevant in-house expertise. Uncertainty over regulations for processing personal data, relevance to the Public Administration Act or assessments of when it is acceptable to use AI may make agencies unduly reticent. This may deprive the public sector of important opportunities to improve its services or rationalise its processes. The Government will therefore ask the Norwegian Digitalisation Agency to prepare guidance on this matter, in cooperation with the Norwegian Data Protection Authority.

[32] Broomfield, Heather and Reutter, Lisa (2019): *Kunstig intelligens/data science: En kartlegging av status, utfordringer og behov i norsk offentlig sektor* Første resultater. [Artifical intelligence/data science: A mapping of status, challenges and needs in Norway's public sector. Initial results]. September 2019

Projects using AI in public administration

The Government wants public agencies to facilitate experimenting with artificial intelligence to gain knowledge about and experience in the technology. Trial projects or pilots in AI within organisations will provide valuable experience that can be used when evaluating large-scale projects and can enhance understanding of the technology at all levels in the organisation.

Artificial intelligence is one of many important tools for developing sustainable public administration in both central government and the municipal sector. Cooperation and experience exchange across agencies will contribute to strengthening insights into and experiences of artificial intelligence, and experiences gained by the large agencies, which often have their own IT and analysis units, can help smaller agencies get started on AI projects.

The municipal sector is in a unique position when it comes to potential cooperation, because all municipalities will in principle provide the same services to their inhabitants and hold datasets covering the same areas. The possibility to share best practice and to cooperate on procurements and training measures may therefore be particularly important for the municipalities. Cooperation on data, algorithms and competence in AI may also create possibilities to see interrelationships across sectors.

Examples of projects using AI in the public sector

Several public agencies have conducted projects in which they have used artificial intelligence:

Artificial intelligence in residence verification

The Norwegian State Educational Loan Fund (Lånekassen) has conducted a project using artificial intelligence to select students for residence verification. In 2018 Lånekassen's residential verification process covered 25,000 students, of which 15,000 were selected using artificial intelligence (machine learning) and 10,000 were selected randomly (control group). The results showed that the selection made using machine learning was twice as effective at identifying students who had not documented previously submitted residence information compared to the control group.

Automatic posting of invoices

Customers of The Norwegian Government Agency for Financial Management (DFØ) spend considerable time and resources on posting incoming invoices due to uncertainty about the correct posting. In some cases this can lead to invoices being paid after the due date and can create extra costs for the agency in the form of interest and charges. DFØ is currently testing solutions from two companies, one of which involves an accounting robot that uses AI to propose the correct posting. The model is trained using historical data before making a prediction of the posting based on a combination of historical data and information obtained from the actual invoice.

Sources: Norwegian State Educational Loan Fund and Norwegian Government Agency for Financial Management

The Government will therefore ask the Norwegian Digitalisation Agency to facilitate cooperation in AI with a view to, for example, establishing common user journeys and sharing of best practice.

Public-private partnerships

Norway's public sector procures goods and services worth more than NOK 500 billion annually. These procurements can be used to promote innovation and use of new technologies. A study conducted by Menon[33] shows that most public procurement processes are conducted without any dialogue with suppliers and without encouraging suppliers to supply systems that are radically new and innovative. The companies report that young, innovative companies in particular find it difficult to know what they need to do to win contracts.

An innovation partnership is a procurement procedure that facilitates product and service development through cooperation between buyers and developers/suppliers. Innovation partnerships are used for procuring solutions that are not currently available in the market. Preliminary experiences show that startups and technology companies win assignments in innovation partnerships more easily than in other public tendering processes.

One of the measures in the Government's digital strategy[34] is to establish a programme for increased interaction between the public sector and start-up companies, modelled on similar programmes in the United States and the United Kingdom. Such a programme would also benefit companies whose activities are based on artificial intelligence.

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[33] Menon Economics (2017): *Midtveisevaluering av nasjonalt program for leverandørutvikling* [Midway evaluation of the National Programme for Supplier Development]

[34] Ministry of Local Government and Modernisation (2017): *One digital public sector.* Digital strategy for the public sector 2019–2025

The Government will

- develop guidance on responsible use of artificial intelligence in public administration
- facilitate cooperation and exchange of experience and best practice for AI in both central and municipal administration
- establish a new programme for interaction between startups and the public sector
- present a white paper on innovation in the public sector

«Ghosthouse», h.o. (INT)
Photo: Ars Electronica/Martin Hieslmair

The Government wants Norway to lead the way in developing and using AI with respect for individual rights and freedoms. In Norway, artificial intelligence will be based on ethical principles, respect for privacy and data protection, and good cyber security.

5 Trustworthy AI

Norway is known for the high level of trust citizens have in each other and in public and private institutions. The Government wants to maintain and strengthen this trust at the same time as artificial intelligence is adopted in new and innovative ways.

The Government believes that:

- artificial intelligence that is developed and used in Norway should be built on ethical principles and respect human rights and democracy
- research, development and use of artificial intelligence in Norway should promote responsible and trustworthy AI
- development and use of AI in Norway should safeguard the integrity and privacy of the individual
- cyber security should be built into the development, operation and administration of AI solutions
- supervisory authorities should oversee that AI systems in their areas of supervision are operated in accordance with the principles for responsible and trustworthy use of AI

5.1 Issues related to artificial intelligence

Developing and using artificial intelligence can create challenges and raise many complex questions. This particularly applies to AI that builds on personal data.

Big data versus data minimisation

A certain amount of data is needed to develop and use artificial intelligence. At the same time, one of the key principles of data protection is data minimisation, which requires the amount of personal data collected to be limited to what is necessary for fulfilling the purpose for collecting it. Consequently, the need for large datasets can conflict with the principle of data minimisation. Although enterprises planning to implement a project based on AI will want to obtain as much data as possible, the starting point must be to select a relevant sample and a dataset that is sufficiently large.

They can also consider whether there are other more privacy-friendly methods of gaining access to the personal data it needs, such as anonymised data, synthetic datasets or various encryption methods. The Norwegian Data Protection Authority has published a guide on artificial intelligence and privacy which covers this and other issues.[35]

Data quality

It is not only the amount of data that is important for artificial intelligence; the quality and structure of the data must also be good. Any errors in the data can have an impact on the analyses performed. Moreover, there must be metadata describing the content of the different data fields. A good start is for individual organisations to put their own house in order[36], meaning that they gain an overview of what data they manage, what the data means, what it is used for, what processes it is used in, and whether legal authority exists for sharing it.

One challenge to quality that particularly applies to artificial intelligence is what is known as selection bias. Selection bias occurs if we have datasets which only contain information about part of the relevant source data. If an algorithm that is meant to recognize images of dogs is only trained using images of dogs playing with balls, the algorithm may reason that a dog cannot be a dog if no ball appears in the image. Similarly, it is problematic if an algorithm meant for facial recognition is trained on images of faces from a single ethnic group.

Bias can occur for other reasons; for example, a training dataset for supervised learning may contain bias resulting from human misjudgements or historical bias in the source data (on account of, for example, the conventional view of men as holders of certain types of positions, or if the data contains more images of women than men by a kitchen sink). Artificial intelligence can also be influenced by who defines the problems.

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[35] Norwegian Data Protection Authority (2018): *Artificial intelligence and privacy.* www.datatilsynet.no/en/regulations-and-tools/reports-on-specific-subjects/ai-and-privacy/

[36] Difi (2018): *Veileder for orden i eget hus* [Guide to putting one's own house in order].

Lack of transparency

One challenge with artificial intelligence is the lack of transparency in some solutions based on deep learning. Some deep learning algorithms can be likened to a 'black box', where one has no access to the model that can explain why a given input value produces a given outcome. Most systems based on AI are not black boxes, however, and render it possible to understand and document how decisions are made. In areas where explainability is important, an alternative approach to deep learning might be more appropriate.

At the same time, much research is being conducted in the field of 'explainable AI', which aims to make black box algorithms explainable. This is not the same as publishing the code behind an algorithm or allowing full access to full datasets, because such an approach may breach intellectual property rights and data protection laws. Instead, explainable AI can analyse what data had significance for the outcome and what significance the different elements had, and thereby explain the logic behind the outcome.

Autonomy

Finally, the fact that artificial intelligence is characterised by autonomy, and that it can make decisions and initiate actions without human beings being involved, presents a challenge. Although the degree of autonomy will vary, it nonetheless raises questions about responsibility for the consequences of such decisions and how such autonomy can be limited. The initial discussions on ethics for artificial intelligence originated in these issues.[37]

5.2 Ethical principles for artificial intelligence

In its Global Risk Report 2017, the World Economic Forum characterises artificial intelligence as one of the emerging technologies with the greatest potential benefits but also the greatest risks. There is therefore a need to continuously discuss what is responsible and desirable development and what we can do to prevent undesirable development.

The European Commission set up an expert group which has drawn up ethical guidelines for trustworthy use of artificial intelligence.[38] The guidelines are based on the Charter of Fundamental Rights of the EU and on international human rights law. The purpose of the guidelines is to promote responsible and sustainable development and use of artificial intelligence in Europe.

For development and use of AI to be defined as trustworthy, the European Commission's high-level expert group believes that it must be *lawful*, *ethical* and *robust*. On this basis, the expert group has proposed seven principles for ethical and responsible development of artificial intelligence. The Government will adopt these principles as its basis for responsible development and use of artificial intelligence in Norway.

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[37] See for example Isaac Asimov's three laws of robotics. Asimov, Isaac (1950): 'Runaround'. *I, Robot* (The Isaac Asimov Collection edition.). New York City: Doubleday

[38] Independent High-Level Expert Group on Artificial Intelligence set up by the European Commission (2019): *Ethics Guidelines for Trustworthy AI*

The principles largely address artificial intelligence that builds on data from or that affects humans, but they are also relevant for industrial use of AI built on data that does not constitute personal data.

Satisfying all seven principles simultaneously can prove challenging. Tensions may arise that create a need to make trade-offs. Such trade-offs should be addressed in a rational and methodological manner. Where no ethically acceptable trade-offs can be identified, the development and use of the AI solution should not proceed in its current form.

All decisions made regarding trade-offs must be reasoned and documented. If unjust adverse impacts occur in a solution built on AI, mechanisms should be in place to ensure that such impacts can be reported. Particular attention should be paid to vulnerable persons or groups, such as children.

1) AI-based solutions must respect human autonomy and control

The development and use of artificial intelligence must foster a democratic and fair society by strengthening and promoting the fundamental freedoms and rights of the individual. Individuals must have the right not to be subject to automated processing when the decision made by the system significantly affects them. Individuals must be included in decision-making processes to assure quality and give feedback at all stages in the process ('human-in-the-loop').

2) AI-based systems must be safe and technically robust

AI must be built on technically robust systems that prevent harm and ensure that the systems behave as intended. The risk of unintentional and unexpected harm must be minimised. Technical robustness is also important for a system's accuracy, reliability and reproducibility.

3) AI must take privacy and data protection into account

Artificial intelligence built on personal data or on data that affects humans must respect the data protection regulations and the data protection principles in the General Data Protection Regulation.

4) AI-based systems must be transparent

Decisions made by systems built on artificial intelligence must be traceable, explainable and transparent. This means that individuals or legal persons must have an opportunity to gain insight into how a decision that affects them was made. Traceability facilitates auditability as well as explainability. Transparency is achieved by, among other things, informing the data subject of the processing. Transparency is also about computer systems not pretending to be human beings; human beings must have the right to know if they are interacting with an AI system.

5) AI systems must facilitate inclusion, diversity and equal treatment

When developing and using AI, it is especially important to ensure that AI contribute to inclusion and equality, and that discrimination be avoided. Datasets that are used to train AI systems can contain historical bias, be incomplete or incorrect. Identifiable and discriminatory bias should, if possible, be removed in the collection phase. Selection bias can be counteracted by putting in place oversight processes to analyse and correct the system’s decisions in light of the purpose.

6) AI must benefit society and the environment

Artificial intelligence must be developed with consideration for society and the environment, and must have no adverse effects on institutions, democracy or society at large.

7) Accountability

The requirement of accountability complements the other requirements, and entails the introduction of mechanisms to ensure accountability for solutions built on AI and for their outcomes, both before and after the solutions are implemented. All AI systems must be auditable.

The Government wants public debate on the ethical use of artificial intelligence and on what applications of artificial intelligence we want to adopt in Norway. Norway has a number of bodies whose mandate is to invite public debate on technology and ethics, such as the Norwegian Data Protection Authority, the Norwegian Board of Technology, and the Norwegian National Committees for Research Ethics.

Privacy by design and ethics

Algorithms can be controlled by facilitating access or audit, but it is more appropriate for developers as well as users to build privacy and ethical considerations into systems from the outset. Such a mindset has already been established with regard to privacy. Privacy by design is a key requirement in the General Data Protection Regulation, and means that consideration must be given to privacy in all phases of development of a system or solution. This is so as to ensure that information systems meet the requirements of the Personal Data Act and safeguard the rights of the individual.

Likewise, ethical considerations should be built into algorithms during development. Among other things, it will be important to assess whether an algorithm may lead to discrimination and whether it is sufficiently robust to withstand manipulation. Ethical evaluations may also call for considering potential environmental impacts and whether a system contributes to achieving the UN Sustainable Development Goals.

Work on privacy by design and ethics require those who work on solutions based on AI to possess or acquire the necessary competence. Higher education institutions ought to evaluate how privacy and ethics can be integrated into their programmes in, for example, information technology and data science.

Artificial intelligence and research ethics

The act relating to the organisation of work on ethics and integrity in research (*Lov om organisering av forskningsetisk arbeid*) imposes a duty of care on researchers and research institutions to ensure that all research be conducted in accordance with recognised standards for research ethics. Research institutions have a responsibility to ensure that candidates and employees receive training in recognised standards for research ethics and that everyone conducting or participating in research be familiar with them. The National Committee for Research Ethics in Science and Technology recently submitted a report on research ethics in which it proposes nine principles for AI research in three areas:[39]

[39] Den nasjonale forskningsetiske komité for naturvitenskap og teknologi (2019): *Forskningsetisk betenkning om kunstig intelligens*

A) *Responsibility for development and use of autonomous systems*:
Research in AI must safeguard human dignity, assign responsibility, be explainable, and promote informed public debate.

B) *Social implications and responsible research:*
Research in AI must acknowledge uncertainties and ensure broad involvement.

C) *Big data*:
Research in AI must protect privacy and the interests of individuals, ensure reproducibility and quality, and promote equal access to data.

Challenges for consumers

Use of AI offers many advantages to consumers, such as the development of an ever increasing range of new services that simplify everyday life. But it also presents challenges with respect to privacy, transparency and consumer rights. Consumers are particularly vulnerable when AI is used to develop personalised services and targeted marketing based on collecting and processing consumers' personal data. There is growing concern internationally that businesses are failing to take consumers' privacy seriously enough.

A survey from Consumers International[40] shows that consumers appreciate what AI technology can do; it gives them independence, entertainment and motivation in new and interesting ways. But the survey also shows that consumers are unsure about how their personal data is used and who is behind the data processing. They seek more clarity and control.

When services and marketing are made increasingly personalised, consumers risk being subjected to discriminatory treatment and arbitrary non-transparent decisions such as price discrimination. Moreover, personalised marketing and other commercial practices developed using AI can manipulate and mislead consumers into making decisions that are not in their interests.

AI affects many aspects of consumer's social life and will encompass different sectors of society. The use of AI raises legal issues under various sectoral legislation, particularly in competition, privacy and data protection, and consumer protection. It is therefore important that the relevant supervisory authorities cooperate on this issue. They should develop competence and information, and participate in international forums such as the Digital Clearinghouse, the European forum for consumer, competition and data protection enforcement bodies. In the white paper on the consumer of the future[41] , the Government announced that it will create a similar cooperation forum at national level: Digital Clearinghouse Norway.

Regulation of artificial intelligence in the consumer sector

Norway has a tradition of strong consumer protection laws. Efforts are being made in Norway and the EU to provide consumers with strong and enforceable rights that are adapted to digital life. As part of these efforts, the EU has adopted a number of regulatory acts that will strengthen consumer rights online, such as the proposed package of measures called the New Deal for Consumers. While these regulatory acts

[40] Consumer International (2019): *Artificial intelligence: Consumer experiences in new Technology*

[41] Meld. St. 25 (2018-2019) *Framtidas forbrukar – grøn, smart og digital*. [Report to the Storting no. 25 (2018-2019 Consumer of the future – green, smart and digital]

do not specifically address AI, the European Commission has stressed that AI will be one of the key areas in the time ahead.[42] Norwegian authorities have been closely monitoring the EU's work on modernisation of consumer rights and will continue to do so.

International cooperation on ethical and trustworthy AI

Norway is engaged in an array of international forums that work on strategies and guidelines for ethical and trustworthy artificial intelligence, among them the UN, EU, OECD and the Nordic Council of Ministers.

United Nations

Norway participates in processes, activities and discussions across the UN system dealing with applications of AI. Thematic areas in which AI is given attention span from eliminating hunger, combating climate change and efforts to promote good health for all to discussing disarmament and international security.[43]

European Union

Norway, represented by the Ministry of Local Government and Modernisation, has participated in EU activities related to AI from the start, and was involved in, among other things, preparing the European Commission's Coordinated Plan on Artificial Intelligence from December 2018.[44] The EU is working towards human-centric and trusted AI. Norway participates in this work and sits on the steering group that is developing a coordinated approach to AI together with the European Commission and the member countries.

The European Commission is expected to submit a legislative proposal on AI regulation in 2020. A new regulatory framework for AI is expected to build on the ethical principles for developing and using AI published by the EU's high-level expert group in April 2019, on which the Government has based its ethical principles for AI. Norway will be actively involved in the work carried out on any future regulatory framework for AI.

OECD

The Organisation for Economic Co-operation and Development (OECD) is working on AI and has published several reports on the topic. Norway, represented by the Ministry of Local Government and Modernisation, has participated in OECD's work on preparing a recommendation on artificial intelligence.[45] This was finally approved on 22 May 2019.

The recommendation identifies key values for trustworthy AI, namely: inclusive growth, sustainable development and well-being; human-centred values and fairness; transparency and explainability; robustness, security and safety; and accountability. In addition, OECD makes recommendations pertaining to R&D in AI, fostering a digital ecosystem for AI and shaping public policy on AI. The importance of building human capacity and preparing for labour market transformation is also highlighted.

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[42] European Commission (2018) *Communication from the commission to the European Parliament, the Council and the European Economic and Social Committee – A new deal for consumers*

[43] In 2018 the International Telecommunication Union (ITU) published a summary of UN activities on AI: handle.itu.int/11.1002/pub/8120d5d5-en

[44] European Commission (2018): *Coordinated Plan on Artificial Intelligence (COM(2018) 795 final)*

[45] OECD (2019): *Recommendation of the Council on Artificial Intelligence, OECD/LEGAL/0449*

Furthermore, the OECD points out the importance of international cooperation for ensuring ethical and trustworthy AI.

Council of Europe

The Council of Europe is concerned with the potential impacts of AI on human rights. The European Court of Human Rights (ECHR) has as of 2019 not yet heard any cases in which artificial intelligence has been the central issue, though it has touched on the topic in some contexts. In the autumn of 2019 the Council of Europe set up an ad-hoc committee to examine the opportunities and risks posed by AI in respect of human rights. Norway, represented by the Ministry of Justice and Public Security, participates in this work.

Nordic Council of Ministers and Nordic–Baltic cooperation

Nordic cooperation on digitalisation will promote the Nordic and Baltic countries as a cohesive and integrated digital region. Through binding cooperation and projects, the Nordic countries will find solutions to problems encountered by citizens and businesses, promote innovative technologies and services, and make it easier to develop new services for individuals and businesses throughout the region. Nordic–Baltic agreements have been signed on closer cooperation on 5G, AI and data exchange.

The Government will

- encourage development and use of artificial intelligence in Norway to be based on ethical principles and to respect human rights and democracy
- encourage industry and interest organisations to establish their own industry standards or labelling or certification schemes based on the principles for responsible use of artificial intelligence
- encourage the educational institutions to consider how privacy and ethics can be given a central place in their programmes in artificial intelligence
- expect the supervisory authorities to have the competence and authority to supervise artificial intelligence systems within their areas of supervision in order to, among other things, ensure compliance with the principles for responsible and trustworthy artificial intelligence
- establish a cooperation forum for consumer, competition and data protection enforcement bodies: Digital Clearinghouse Norway
- continue to participate in European and international forums, including the EU's work towards creating a regulatory framework to promote responsible and trustworthy use of artificial intelligence and towards modernising consumer rights in light of digital developments
- stimulate public debate on the ethical use of artificial intelligence

5.3 Security

To ensure a well-functioning digital society, we must minimise the risk of being affected by adverse cyber incidents. The Government therefore considers cyber security to be a priority area.

In January 2019 the Government presented a national strategy for cyber security[46] and a national strategy for cyber security competence.[47] The strategy defines goals for five priority areas:

- Norwegian companies shall digitalise in a secure and trustworthy manner, and improve their capability to protect themselves against cyber incidents.
- Critical societal functions shall be supported by robust and reliable digital infrastructure.
- Enhanced cyber security competence shall be aligned with the needs of society.
- Norwegian society shall improve its capability to detect and manage cyber attacks.
- The police shall enhance its capability to combat cyber crime.

The Ministry of Justice and Public Security and the Ministry of Defence have overarching responsibility for following up the National Cyber Security Strategy for Norway. The individual ministries are responsible for ensuring that the strategy's priorities and measures be followed up in their respective sectors.

Cyber security and artificial intelligence have two aspects: security in solutions based on artificial intelligence, and solutions based on artificial intelligence for enhanced cyber security. The competence needs in these areas will largely overlap. There is also a need for in-depth specialisation in security architecture for protecting AI systems, and for specialisation in algorithms/big data for using AI to protect IT systems and society.

Security in AI-based systems

Implementing an AI system entails applying conventional technologies such as sensors, communication networks, data centres, big data and software. An AI system will inherit vulnerabilities from these technologies and will also introduce new vulnerabilities as part of the new AI-based solution. In this respect, AI systems are no different from conventional IT or from conventional methods of working on cyber security.

As with other IT systems, a structured, holistic approach to cyber security is needed before an AI system is deployed. The Norwegian National Security Authority's basic principles for cyber security provide all Norwegian organisations with a good starting point for identifying what they should consider in their security activities, regardless of size, maturity and competence.

[46] Ministries (2019): *National Cyber Security Strategy*

[47] Ministry of Justice and Public Security (2019): *National Strategy for Cyber Security Competence*

Artificial intelligence in law enforcement

The Norwegian Police University College and NTNU in Gjøvik are cooperating on a project that examines the use of different forms of artificial intelligence for analysing big data, aimed at detecting, preventing and investigating economic crime. The objective of the Ars Forensica project is to produce new knowledge that can improve prevention, investigation and prosecution of incidents without compromising privacy and the rule of law. Some examples of the research challenges are:

i) vast amounts of electronic data that need to be analysed
ii) fragments of evidence that are hidden in chaotic environments
iii) varying quality in digital trails, and possibilities to plant/distort digital trails
iv) dynamic environments and continually changing situations/contexts
v) lack of knowledge, and
vi) decisions characterised by uncertainty and conjecture

The project is funded by the Research Council of Norway's IKTPLUSS programme.

Sources: NTNU/Ars Forensica

For many organisations, AI as a service will be provided by external parties with the necessary competence and computing power. This can create challenges in terms of transparency, integrity, accountability and traceability. This must be taken into account when procuring the service. Both the Norwegian Digitalisation Agency and the Norwegian National Security Authority have issued guidance material on security in connection with outsourcing and procuring cloud services.

An AI-based IT system must be trustworthy as well as robust, secure, safe and accurate. Depending on the system's purpose, error or manipulation can in some cases have significantly more far-reaching consequences for an AI system than for a conventional IT system. This must be taken into account when performing a risk assessment of such systems.

Protection of digital infrastructure

The existing early warning system for digital infrastructure has been used to detect targeted cyber attacks for almost 20 years. The Norwegian National Security Authority is now developing new sensor technology that will build on and eventually replace the sensors used in the existing early warning sensors. A new platform will be developed to use artificial intelligence and machine learning on the data collected. The platform will enable automatic analysis of any malware detected as well as automatic sharing of results.

Source: Norwegian National Security Authority

Use of AI for enhanced cyber security

Systems built on artificial intelligence are becoming increasingly widespread, and will be one of the prerequisites for the success of Norway's future digitalisation efforts. This also applies to organisations engaged in security activities and in cyber security in particular.

Most security organisations regard the use of AI systems as necessary for identifying threats and threat agents, and for being able to withstand and manage cyber attacks. AI-based cyber security solutions contribute to faster detection and management of incidents and to more precise and detailed analysis.

Machine learning and data-driven technology can also help prevent vulnerabilities in software development. Simula researches technologies aimed at helping software developers predict vulnerability in source code during development and thereby prevent security holes which subsequently could be exploited by threat agents.

Regjeringen vil

- develop Norway's capacity to detect and respond to cyber attacks using AI
- develop the Norwegian National Security Authority as a tool for guidance, problem solving and cooperation, with the aim of building its expertise in securing AI systems and in using AI for enhanced cyber security

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