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Leading the way into the age of artificial intelligence

Final report of Finland's Artificial Intelligence Programme 2019

Ministry of Economic Affairs
and Employment of Finland

Leading the way into the age of artificial intelligence

Final report of Finland's Artificial Intelligence Programme 2019

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Abstract

Artificial intelligence has been identified as one of the most important technologies of our time. It can create new economic growth and thereby promote wellbeing. Access to more efficient and inexpensive computing capacity, growth of the volume of data available to artificial intelligence, and the development of algorithms have resulted in the acceleration of AI development and utilisation.

A growing number of countries have recognised the opportunities provided by artificial intelligence and have prepared a national artificial intelligence strategy. In 2017, Finland was among the first countries to launch an Artificial Intelligence Programme. The objective of the programme was to make Finland a leader in the application of artificial intelligence.

In this report, the Programme's steering group and secretariat comment on the progress made during the programme, and give recommendations for the future. These are examined in the context of case studies from the business world and views offered by a panel of AI professionals.

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Tiivistelmä

Tekoälyyn on viitattu yhtenä aikamme tärkeimmistä teknologioista. Tekoäly voi luoda uutta talouskasvua ja tätä kautta edistää hyvinvointia. Laskentakapasiteetin tehostuminen ja halventuminen, tekoälyn hyödynnettävissä olevan datan määrän kasvu sekä algoritmien kehittyminen ovat johtaneet tekoälyn kehittämisen ja hyödyntämisen kiihtymiseen.

Yhä useammat maat ovat tiedostaneet tekoälyn mahdollisuudet ja laatineet kansallisen tekoälystrategian. Suomen Tekoälyohjelma käynnistettiin ensimmäisten joukossa 2017. Sen tavoitteena on viedä Suomi tekoälyn soveltamisen kärkimaiden joukkoon.

Tässä raportissa ohjelman ohjausryhmä ja sihteeristö raportoivat edistystä ohjelman aikana ja antavat suosituksia tulevaan. Yritysten esimerkit tekoälyn hyödyntämisestä sekä kansainvälisen tekoälyn asiantuntijapaneelin ajatukset tuovat kontekstia.

Työ- ja elinkeinoministeriön yhdyshenkilö: Innovaatio ja yritysrahoitusosasto, ylijohtaja Ilona Lundström, puh. +358 029 504 7186

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Artificiell intelligens anses vara en av vår tids viktigaste teknologier. Artificiell intelligens kan skapa ny ekonomisk tillväxt och på så sätt främja välfärden. Att processorkapaciteten blir effektivare och billigare, att mängden data som kan utnyttjas av artificiell intelligens ökar och att algoritmer utvecklas har lett till att utvecklingen och utnyttjandet av artificiell intelligens blir snabbare.

Allt flera länder har blivit medvetna om möjligheterna med artificiell intelligens och utarbetat en nationell strategi för artificiell intelligens. Finlands program för artificiell intelligens inleddes 2017 och var ett av de första programmen. Målet med programmet är att Finland ska vara en föregångare när det gäller tillämpning av artificiell intelligens.

I denna rapport redogör programmets styrgrupp och sekretariat för vilka framsteg som gjorts medan programmet pågått och ger rekommendationer inför framtiden. Företagens exempel när det gäller utnyttjande av artificiell intelligens samt de tankar som framförts av den internationella expertpanelen för artificiell intelligens utgör grund för arbetet.

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Contents

PREFACE: FINLAND LEADING THE WAY INTO THE AGE OF ARTIFICIAL INTELLIGENCE

The introduction and use of artificial intelligence offer huge potential for society and the economy and can act as a major force for change. Artificial intelligence can help us to solve global problems, create wellbeing and boost economic growth, while at the same time creating new ethics challenges at different levels of society. Our actions and our choices will determine whether artificial intelligence can live up to its potential and how we can minimise its potential risks. We must make active decisions on how to develop artificial intelligence technologies and how to apply them and we should not hesitate when implementing the decisions. We should aim at a human-centric and trust-generating way of applying artificial intelligence in different sectors.

The Government of Prime Minister Juha Sipilä made artificial intelligence as one of its key projects . Minister of Economic Affairs Mika Lintilä launched the Artificial Intelligence Programme in May 2017. In October of the same year, we presented the first eight key actions for making Finland one of the leaders in the application of artificial intelligence. This work was later supplemented with separate analyses and recommendations for measures on the future of work, ethics and security. It is now time to review the situation: What has been achieved? What has been learned? What should we do next?

It is clear that we should do many things without delay and also speed up the pioneering projects so that we can learn how to apply artificial intelligence in the way we want. At the same time, we should also initiate long-term changes and ensure that the development process encompassing the business world and

society at large will continue. We should also make Finnish society ready for the next development wave of artificial intelligence.

The publication of this report marks the move from setting up the programme to the next stage in which the lessons learned should be extensively incorporated into everyday work. The Finnish companies taking part in the work have emphasised that the building artificial intelligence capabilities should not aim at creating separate artificial intelligence units in organisations but to provide all those involved in the daily work, from the management groups down, with more expertise and understanding. This is also true at the level of society. This report, which is based on the lessons learned in the programme work, describes how artificial intelligence expertise can be incorporated into daily work and daily life.

The Artificial Intelligence Programme has shown the way for development in Finland but at the same time we are also making our experiences available internationally. Finland is one of the first countries in Europe to launch a national artificial intelligence programme. We have been doing this work at the right time and the fact that the concept 'Finland's age of artificial intelligence' has been built on practical work and the actors' own needs makes the Artificial Intelligence Programme interesting in global scale. Finland has been one of the first countries to prepare a national artificial intelligence strategy but we have also accumulated a great deal of experience of how the legislation and companies' own action impact the process or what it means to be a pioneer.

During the writing of this report and the summing up of the programme results, we have once again been impressed by the effectiveness and power of online action. The Artificial Intelligence Programme itself set in motion a broad range of different issues, which created the core network. However, at the same time, a great deal was already happening. By building a network of networks operating model summing up the situation and bringing together all key artificial intelligence activities, we were able to produce the overall picture essential for the work. This overall picture helped us to establish links with other AI parties and to identify gaps in the work taking place at national level. Irrespective of the nature of the next steps at national level, we believe that maintaining this overall AI picture and identifying the new

measures important at each moment of time on its basis are key to ensuring that Finland can remain at the forefront of artificial intelligence development.

Special thanks go to the steering group of the Artificial Intelligence Programme, the chairs of the five sub-groups, the secretaries supporting them (who also worked as members of the core team) and the more than 100 experts participating in the work of the sub-groups. Without a strongly committed core team of the Ministry of Economic Affairs and Employment, it would have been impossible for us to remain on top of things. In addition to a large number of projects, pilots and concrete achievements, we can also be particularly proud of the network created for the programme. This provides a good basis for us as we are proceeding to the next stage on our way towards the age of artificial intelligence.

Pekka Ala-Pietilä   Ilona Lundström
Programme Chair   Programme Deputy Chair

Key proposals for action

In May 2017, the Minister of Economic Affairs Mika Lintilä stated his goal of turning Finland into a leading country in the application of artificial intelligence and appointed a steering group to prepare a proposal for an Artificial Intelligence Programme for Finland. The report describes the results achieved during the programme period and provides a basis for the next stage, which will be the responsibility of the next Government and the network involved in the programme work. The aim is to prepare Finland for the age of artificial intelligence and make it into a nation that is competitive and able to attract talent, has the most relevantly educated population and where citizens are well-informed and independent.

The programme and its networks have taken Finland towards the age of artificial intelligence through the following 11 key actions:

1. Enhance business competitiveness through the use of AI
2. Effectively utilise data in all sectors
3. Ensure that AI can be adopted more quickly and easily
4. Ensure top-level expertise and attract top experts
5. Make bold decisions and investments
6. Build the world's best public services
7. Establish new models for collaboration
8. Make Finland a forerunner in the age of artificial intelligence
9. Prepare for artificial intelligence to change the nature of work
10. Steer AI development into a trust-based, human-centric direction
11. Prepare for security challenges

It is essential to establish close cooperation between public and private sectors in the work to promote digitalisation of business operations and the use of AI as

we are building a competitive Finland able to attract talent. This allows us to find effective ways to boost innovation inputs, build workable cooperation models, develop incentive-oriented regulation, enhance business competence and promote talent in a broad range of sectors.

In order to make Finland into the most relevantly educated nation, we need a lifelong learning reform. This allows us to meet the substantial continuing education needs arising with the age of artificial intelligence by relying on such factors as the changes in the education system and the division of responsibilities arising from the updating of professional skills. At the same time, artificial intelligence and digitalisation should be extensively incorporated into a broad range of different educational programmes.

Strong inputs by the public sector in the development of services enabled by artificial intelligence and technological advances in general are required to allow well-informed and independent citizens to influence developments. This will also contribute to private-sector services and the renewal of the public-sector service structure. At the same time, there should also be an active discussion between different societal actors on how artificial intelligence can be applied in a human-centric and trust-generating manner for the benefit of well-informed and independent citizens.

The following key measures should be introduced during the next 12 months:

Clarify the **rules of how data is used**, from the perspective of companies, society and users. Provide support for the use of data by means of legislation, agreements and self-regulation of industries.

Support the development of **significant testbeds** and international cooperation. Integrate the operations as part of the Finnish Digital Innovation Hub network.

Recognise the **business potential of different types of ecosystems and the B2B market** and develop solutions for using data in them.

Continue **AI accelerator style operations** based on the lessons learned and seek opportunities to expand the operations.

Ensure Finland's ability to **secure major strategic investments** in AI and RDI investments in competences.

On the basis of the experiences gained, create an **extensive provision of online courses for those in working life**, which would provide an opportunity for the adult population to supplement and renew their competences.

Explore whether **every Finn in working age could be provided with a learning voucher or account**, which would create a well-functioning adult education market in Finland.

Ensure human-centric **introduction of artificial intelligence and the implementation of ethical principles in the public sector** through the AuroraAI project.

Encourage companies and public-sector actors to introduce **ethical self-regulation** and to share best practices.

Introduce the digital economy, founded on artificial intelligence, data and platform economy, as one of the key themes of **Finland's EU Presidency**.

Monitor how the implementation of the Artificial Intelligence Programme's objectives is advancing. The responsibility for the monitoring should belong to a **monitoring group with representatives from both the private and public sectors** or a broader cooperation forum promoting the digitalisation of business.

1   Artificial intelligence is advancing at full speed

Finland launched its Artificial Intelligence Programme nearly two years ago in May 2017, when the Minister of Economic Affairs Mika Lintilä announced that Finland aims to become a world leader in the application of artificial intelligence and in new ways of work. During the past two years, artificial intelligence has become one of the most intensely debated topics in Finland and in the rest of the world. In this section, we examine how artificial intelligence is defined and who are affected by it. We also review the attitudes towards artificial intelligence in different countries and in international organisations. The implementation of the Artificial Intelligence Programme is detailed in section 3 (Eleven key actions ushering Finland into the age of artificial intelligence).

Background to artificial intelligence

There has been a great deal of discussion about artificial intelligence over the past few years. More effective and lower-cost computing capacity, vast increases in the amount of data that can be used by AI, and more advanced AI algorithms have all led to more intensive use of artificial intelligence. In fact, we are experiencing a new spring of artificial intelligence. Artificial intelligence has been referred to as one of the most important technologies of this century. It has been one of the most talked topics at business forums and has been at the centre of public debate.

Artificial intelligence is not a single technology as it covers a number of different methods, technologies, applications and schools of research. Artificial intelligence

and AI methods, technologies and applications are part of the wider phenomenon of digitalisation. In the Artificial Intelligence Programme, artificial intelligence is defined as follows:

Artificial intelligence means devices, software and systems that are able to learn and make decisions in almost the same manner as humans. Artificial intelligence allows machines, devices, software, systems and services to function in a sensible way according to the task and situation at hand.

In the project *Artificial intelligence and its capability assessment*[1] carried out as part of the Government's analysis, assessment and research activities, it was emphasised that artificial intelligence is connected with many different branches of science: philosophy, cognitive science, linguistics, neuroscience, mathematics, physics, engineering sciences and computer science. In addition to technological development, artificial intelligence also impacts individuals and all areas of society. In that respect, it is examined from the perspective of moral issues, ethics, values and policies as well as social sciences, law, economics, and business sciences. The use and application of AI technologies can also be examined in a broad range of different sectors, such as medicine, trade, industries, police work and warfare.

The branches of science connected with artificial intelligence, the sectors using it and the moral issues, ethics, values and policies steering its development are shown in Figure 1.

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1   Ailisto et al. (2018) Artificial intelligence and its capability assessment. Publications of the Government's analysis, assessment and research activities 46/2018.
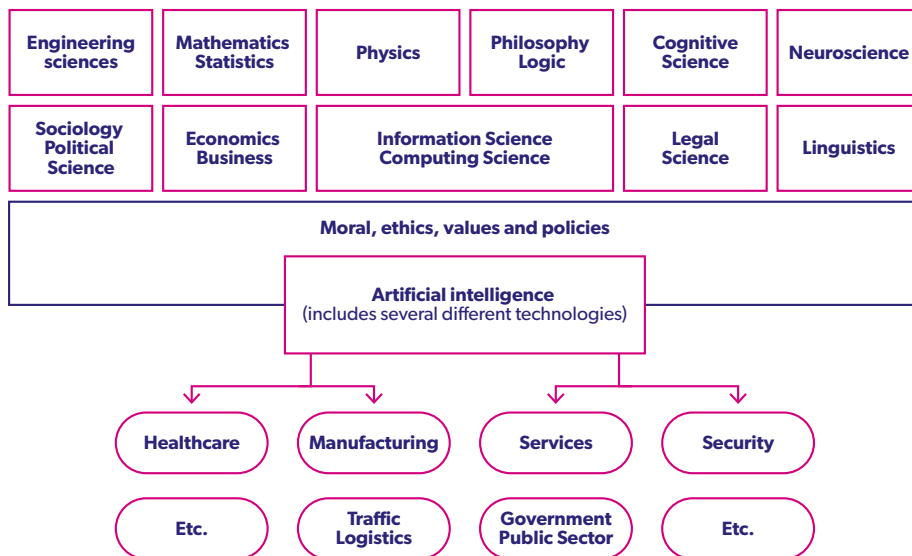
Figure 1: Branches of science connected with artificial intelligence and the sectors using it (Ailisto et al. (2018) Artificial intelligence and its capability assessment Publications of the Government's analysis, assessment and research activities 46/2018

Thus, artificial intelligence is relevant to a broad range of different branches of science, sectors of society and policies. It is also relevant to us as citizens and employees. A great deal has been written about the topic in newspapers and magazines, books on AI have been published and training in AI issues has been provided. Events for companies and professionals working in different sectors are also held, such as the monthly AI Monday, which is jointly arranged by a number of AI actors.

Unlike many other technology-related topics, artificial intelligence has also aroused keen interest among the public at large and policy makers. In two successive years, leaders of Finland's largest political parties have taken part in the panel discussion on artificial intelligence arranged by the Finnish Information Society Development Centre and held at the Information Society Academy. Ministers of Prime Minister Juha Sipilä's Government have discussed artificial intelligence at numerous strategy sessions.

It is characteristic of our time that there is enthusiastic debate on certain new technologies and people are very optimistic about their potential. AI experts may be irritated by the vague concepts presented in the debate and the non-professional approach to the issue. It is, however, important that people with only limited knowledge of the technology can also take part in the discussion. A good example of this is the project of *Omnia AI Lab* in which 100 senior citizens are trained as AI mentors.

It is essential to make people more aware of AI and at the same time raise the level of the debate on artificial intelligence, its potential, the challenges ahead and the choices that must be made at societal level. Initiating an extensive discussion, providing information and making conclusions have also been the aims of the Artificial Intelligence Programme.

We have also noted with pleasure that artificial intelligence is already part of day-to-day activities in an increasing number of companies. According to the SME barometer carried out during 2018, about 8% of all SMEs are already using or testing artificial intelligence and another 24% are examining the matter. In strongly growth-oriented SMEs, the figures are twice as high.

Finland's Artificial Intelligence Accelerator project lists 15 Finnish companies that generate most of their turnover from artificial intelligence. Artificial intelligence is also at the core of operations in many other companies and organisations and in this publication, eight of them are presented in case reports.[2]

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2   The cases are as follows: KONE p.11, Cargotec p.13, Ultimate.ai p.16, Teqmine Analytics p.18, K-Group p.29, Fiva p.30, Neuro Event Labs p.91, Avaintec. p.92.

CASE KONE: PREDICTIVE MAINTENANCE

As world cities and population are growing, more advanced technology is required each year so that moving in cities would be easy and safe. Public transport and other traffic, lifts and escalators must function smoothly so that large masses of people can move from one place to another without problems.

The Finnish company **KONE**, established way back in 1910, is one of the world's largest companies in the lift and escalator sector and it has more than 1.3 million pieces of equipment in its maintenance portfolio around the globe. KONE wants to make human mobility easier; it uses a broad range of different artificial intelligence applications to ensure a smooth and seamless flow of people. With artificial intelligence, it is possible to predict and identify potential defects in lifts already before they appear.

The company has developed KONE 24/7 Connected Services, an AI-based setup for predictive maintenance of lifts and escalators. In 24/7 Connected Services, the pieces of equipment in the company's maintenance portfolio are connected to the IBM Watson IoT Platform in which artificial intelligence helps to predict defects before they occur.

The lifts and escalators send data and the sensors installed in them measure specific matters and supply data on real-world phenomena. Using the data, the artificial intelligence application continuously learns how to deal with new situations and this helps the company to become more proactive as it becomes more familiar with different types of lifts and their maintenance needs. The service is used in the maintenance of new and old lifts.

The AI-based service has allowed KONE to make its products safer and the maintenance processes more transparent. The customers now know in advance how their equipment might be affected by defects and how they should be prepared for them in their maintenance budgets. Artificial intelligence has also made lifts smarter: lifts using the technology are able to communicate their maintenance needs so that the mechanics know what will happen before anything happens. As a result, malfunctions have become less common and the repairs can be carried out more quickly.

Last year, a hospital using the system sent KONE 25% fewer service request than in 2017. In other words, the predictive maintenance service has substantially reduced the number of malfunctions.

KONE plans to link nearly all lifts and escalators in its maintenance portfolio to artificial intelligence. The company is continuously investing in new technologies in such areas as data collection and processing as well as artificial intelligence.

KONE believes that the correct use of data will play a major role in the future: actors who can best use their data in the design and supply of services and products will have an advantage over their competitors.

KONE

A company operating in the lift and escalator sector
Domicile: Helsinki
More than 57,000 employees
Established: 1910
Turnover in 2018: EUR 9.1 billion

KONE is one of the world's largest manufacturers of lifts and escalators. The company, which was established in 1910, also provides maintenance services for its equipment, which account for almost half of its turnover. KONE has invested in technologies ensuring easier and more effective maintenance and it uses artificial intelligence is such areas as predictive maintenance.

CASE CARGOTEC: WORKING TO MAKE MARITIME FREIGHT TRANSPORT EASIER

The world's population is growing, cities are becoming larger and energy consumption is increasing. We already know this. However, amid all this, global logistics and container traffic as part of it play a major role.

Surprisingly enough, there is plenty of room for efficiency improvements in global container traffic and many of the processes are based on communications between humans. For example, if there are unexpected changes to the arrival times of container ships due to weather, the information may not be automatically relayed to the cargo handlers waiting at the port and they are thus unable to change their plans. Or it may not be relayed to the lorry drivers who are waiting for the containers so that they could transport it further.

Cargotec has tackled this problem with the help of AI-based solutions. In container traffic, it is essential to ensure seamless cooperation between shipping companies, logistics companies and port operators. A more transparent value chain and quicker reactions to changes would mean less confusion, less wastage and shorter waiting times. Reducing the emissions generated by the equipment is also essential.

Energy modelling and fuel guarantee are the models currently in use. Cargotec supplies mobile machinery for lifting and moving containers at ports and terminals. When designing the equipment, Cargotec uses technical solutions maximising energy-efficiency and minimising emissions because fuel costs are a major cost item for operators who are increasingly committed to environmentally friendly and low-emission operations.

Cargotec has developed a machine learning algorithm that can forecast fuel or electricity consumption in each customer's operations with a high degree of accuracy. Each customer is asked a few essential questions allowing it to receive an accurate forecast of its own future consumption. The forecast helps the customer to acquire the equipment best suited to its needs and to accurately predict the costs arising from the operations. A concrete picture of the future emissions is also produced.

Telemetry data collected from a broad range of different equipment provides the basis for the machine learning algorithm. Customers use their equipment around the world in different conditions in a wide variety of different tasks. The algorithm learns to understand how different types of equipment operate and how operating conditions impact fuel consumption and emissions. The model is so accurate that Cargotec grants a fuel guarantee, in which it promises to provide customers with a financial compensation if the consumption exceeds the promised guarantee levels.

More AI-based technologies and solutions for different fields will be introduced in the future. The equipment will become more autonomous and security solutions are assuming an increasingly important role. Artificial intelligence is playing a key role in this process.

Cargotec

Cargotec
Domicile: Helsinki
Personnel: 12,000
Established: 2006
Turnover in 2018: EUR 3.3 billion

Cargotec is an example of an industrial company that uses artificial intelligence. Global maritime traffic and especially container traffic are growth industries and their processes are largely based on communications between humans. In practice, only the introduction of artificial intelligence has made improvements in them possible. The fuel guarantee granted by Cargotec is an example of the use of artificial intelligence. In this arrangement, AI-based solutions provide accurate estimates of the amounts of fuel consumed.

Artificial intelligence is conquering the world

The opportunities offered by artificial intelligence have been globally recognised. More and more countries have incorporated artificial intelligence as a key factor in their competitiveness strategies or prepared a national strategy for artificial intelligence.

The CIFAR research institute, which took part in the preparation of the Canadian strategy for artificial intelligence, has examined in its report the state of EU's AI strategy and the national AI strategies of 17 countries at the end of 2018. In addition to the countries reviewed in the report, many other countries have also launched artificial intelligence work. According to the report, artificial intelligence has become a key theme in national strategies more rapidly than any other of the recent technologies.

In half of the strategies, funding for the measures have also been proposed, while the rest were documents providing more general guidance for political decision-making in the future. The priority in national AI strategies is on developing industries and enhancing national competitiveness as well as on research and access to expertise. Ethics and data policy are present in many of the strategies, while at the same time, future of work and use of artificial intelligence in government and public services are less often mentioned. The strategies of China, India and Russia are examples of extensive strategies, while France, Germany and the United Kingdom are examples of major European countries with extensive AI strategies. Such countries as Estonia and the Czech Republic are also preparing AI strategies.

In April 2018, the European Commission presented its own AI initiative in which the aim is to increase private and public investments, prepare for societal and economic changes and provide an ethical and legal framework for the development and application of artificial intelligence. The initiative was made more detailed through a coordinated action plan jointly prepared by the Commission and the EU Member States in December 2018. The plan is extensive and it contains infrastructure investments, measures to improve data accessibility, investments in research and application, development of ethical principles and international cooperation. Funding for the AI activities comes from the Horizon Europe and Digital Europe programmes.

In their own national AI strategies, major powers emphasise the economic and societal impacts of artificial intelligence but also the international competitive setting and the strengthening of their own political and military position. In the United States, companies play a major role in the development of artificial intelligence, whereas in China, the efforts are led by the state and in the EU, the priority is on citizens' fundamental rights and ethical issues. This has also been described as the 'third way' of developing artificial intelligence. However, in the AI initiative presented by President Trump in early 2019, the emphasis is also on the development of artificial intelligence so that societal trust can be ensured. For example, measures will be taken to ensure more effective opening of public sector data resources for the use of artificial intelligence in such ways that protection of privacy, civil liberties and protection of confidential information will be ensured in accordance with national values.

The ethical issues associated with the use of artificial intelligence and robotics are common features in many of the international AI initiatives (such as those of the UN, the OECD, the EU, Nordic Countries and the Baltic States). In many of the initiatives, existing regulation is used as a basis for the regulation of artificial intelligence. In the initiative of the United States, the federal government is urged to coordinate the development of technical standards and steer the development of administrative standards. Accountability and security issues concerning artificial intelligence have also been discussed at international forums and in national strategies. The European Commission is examining product safety and liability issues from the perspective of legislation.

CASE ULTIMATE.AI: BETTER CUSTOMER SERVICE WITH ARTIFICIAL INTELLIGENCE

Customer service is one of the largest business sectors in the world and it employs millions of people. However, studies have shown that customer service is among the most stressful sectors of the world because the pace of work is hectic and customers have become more and more demanding.

In fact, many companies have developed AI-based solutions, such as chatbots, to ease the workload of their customer service personnel. However, chatbot solutions are not yet sufficiently advanced so that they could replace customer service staff or provide customer-friendly service. The founders of ultimate.ai noticed these challenges in artificial intelligence and customer service in 2016 and decided to start solving customer service problems with their own application.

Ultimate.ai is making customer service more effective using deep-learning artificial intelligence. This is a tool that helps a company's customer service personnel during chats or email discussions. The software understands the customer's questions and provides ready-made alternatives for answers, which the customer service employees can process and use during the customer service situation.

The method is based on deep-learning algorithms, which means that it is completely independent of such factors as the language of the customer service data. Unlike ordinary statistical methods in which ordinary algorithms must be taught the language structure, a deep-learning algorithm learns the structure when it is provided with customer service data. In other words, the algorithm can be provided

with data in any language because it can learn and process a new language quickly and accurately.

The company has collected more than one million euros in capital funding from German-based Holzbrinck Ventures and Finnish-based Maki Ventures. The customers of ultimate.ai include such large companies as Zalando, ADAC and Finnair.

Its aim is to become a smart layer in a CRM system. The company wants to create an artificial intelligence application that can understand system text data, automate work and provide companies with an overview of the problems affecting their customer service.

The company's long-term vision is to teach machines how humans discuss (to encourage artificial intelligence to learn from humans and to produce human-like discussion). When we have reached the stage where artificial intelligence understands and takes part in such discussions, the potential for using AI is even larger.

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ultimate.ai

Customer-service AI-startup
Domicile: Helsinki & Berlin
Personnel: 20
Established: 2016
Turnover in 2018: EUR 0.26 million

Ultimate.ai is a startup providing solutions for more effective customer service. Its AI-based tool assists customer service personnel in chats and other similar situations. The software understands the customer's questions and provides ready-made alternatives for answers, which the customer service employees can process and use. The tool has already helped a number of large companies, such as Zalando and Finnair, to streamline their customer-service processes.

CASE TEQMINE ANALYTICS: ARTIFICIAL INTELLIGENCE AS A TOOL ENHANCING INNOVATION

Patents are the world's most important source of information on scientific and technological inventions. There are more than 110 million patents in the world and about three million new patents are added to this total every year. However, the information contained in the patents is difficult to interpret and access. Furthermore, it would be nearly impossible to review millions of patents manually.

Until now, the common practice in innovation projects has been that a patent expert has been asked to give an opinion on whether the new idea is practicable or might somebody else already have invented it. However, there is now a disruptive and a more agile solution, which is based on artificial intelligence.

Teqmine Analytics is a Helsinki-based AI startup, established in 2013, that wants to promote human inventiveness and help people to make better and more effective decisions on innovations. Teqmine Analytics is offering a solution that goes through millions of patents with the help of artificial intelligence. Researchers and investors can put questions to the AI application (such as "Is the idea already patented?" or "Has somebody else already invented it?").

The basic idea is to help inventors to make better inventions but the aim is also to help investors and strategy directors to make better technology-related decisions.

The patent analysis performed by the application is based on machine learning that can automatically check the uniqueness of a new patent application against the patents contained in a database of about 25 million patents. The artificial intelligence application learns more by going through about 100,000 new patents each month. It helps to reduce the need for extra meetings and speeds up inventors' work. The innovation has allowed companies to reduce the use of outside experts, which in turn has led to quicker decision-making.

Teqmine Analytics already has customers around the globe, from China to Silicon Valley. In Finland, its AI application is used by such customers as Wärtsilä, the University of Turku, VTT and the Finnish Patent and Registration Office. The company's turnover is increasing by leaps and bounds because the application is in huge demand.

In the long term, the aim is to build an AI application that can act as an equal partner in all research and development teams of the world. The requirement is that humans can trust artificial intelligence.

High-intelligence products can only be added to the internet, if the users feel that they are in full control of what they are doing in the internet. For this reason, exceptionally strong privacy protection and information security arrangements are built into the application. The system works on the company's own private servers. Unlike a number of free services, Teqmine Analytics does not collect information or sell it to third parties.

The company realises that there is a global need for new inventions: scientific and technological creativity is critical to ensuring the future of humankind and life of Earth. For this reason, the company wants to make the service available to all people in some form and not only to those who can afford to pay for it.

Teqmine Analytics

Teqmine Analytics
An AI startup specialising in patent information analysis
Domicile: Helsinki
Personnel: 3
Established: 2013
Turnover in 2018: EUR 0.25 million

Teqmine Analytics is a Finnish AI startup, which has developed an AI platform for analysing patent and technology information. The aim of the company is to help researchers and inventors to innovate more effectively. There are more than 110 million patents in the world and they are the key sources of information in the development of new science and technology. Teqmine Analytics helps researchers, inventors and investors to use AI to interpret and understand the information contained in the patents and to communicate on it easily and effectively.

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2 International AI experts: Towards the third wave of artificial intelligence

Where is AI going and what opportunities does the development create for Finland? Nine distinguished international experts were asked to give their answers to these questions. Coming from different backgrounds, they are well placed to analyse extensively the future perspectives of artificial intelligence. This section is based on the interviews with the experts and reflecting their views.

INTERNATIONAL EXPERTS

- **Christian Guttmann**, Vice President, Global Head of Artificial Intelligence & Data Science, Tieto, Executive Director, Nordic Artificial Intelligence Institute, Sweden. Professor (adj. assoc.), University of New South Wales, Australia. Senior Researcher, Karolinska Institute, Sweden

- **Gesche Joost**, Professor for Design Research at the Berlin University of the Arts, Head of the Design Research Lab, Germany

- **Doina Precup**, Research Team Leader, DeepMind and Associate Professor, McGill University, Canada

- **Michele Sebag**, Professor, Deputy director of Laboratoire de Recherche en Informatique, Head of A O team, CNRS, France

- **John Shawe-Taylor**, Professor, Head of Department of Computer Science, University College London, UK

- **Jim Spohrer**, Director, Cognitive OpenTech at IBM, California, USA

- **Masashi Sugiyama**, Director of RIKEN Center for Advanced Intelligence Project, Japan and Professor for Machine learning and statistical data analysis at the Department of Complexity Science and Engineering, the University of Tokyo, Japan.

- **Volker Tresp**, Professor for Machine learning at the Ludwig Maximilian University of Munich and Distinguished Research Scientist at Siemens, Germany

- **Harri Valpola**, Founder and CEO, Curious AI, Finland

The interviews were conducted and the summary based on them compiled by:

- **Samuel Kaski**, Academy Professor at Aalto University, Director of the Finnish Center for Artificial Intelligence (FCAI)

- **Heikki Ailisto**, Research Professor at VTT Technical Research Centre of Finland

- **Arho Suominen**, Senior Scientist at VTT Technical Research Centre of Finland

Over the past few years, the biggest successes in AI have been achieved in machine learning and especially in deep neural networks. Huge amounts of data, good development tools and the computing power that is increasing each year have boosted the development. Large companies, such as Facebook, Google, Amazon, Alibaba, Baidu and Tencent make effective use of AI technologies and they are also investing heavily in AI research.

Dividing the development of AI into waves helps us better understand the phenomenon. John Launchbury from DARPA proposes division into three waves: 1) handcrafted knowledge; 2) statistical learning; and 3) contextual adaptation. The first wave is also called the symbolic or classic artificial intelligence because it was at the core of the AI research from the 1960s to the 1980s. Statistical learning is now the dominant technology and it is taking place by means of machine learning and deep neural networks. The third wave is expected to emerge in the 2020s.

According to the nine experts, machine learning and, in particular, deep neural networks will also be the most important AI technology in the foreseeable future (in the coming years). The most popular methods, which involve what is called supervised machine learning, require a large amount of high-quality training material accompanied by correct answers (labeled data). Using such material, the methods also learn to produce answers to new inputs. Consumer sector actors, such as retail, digital entertainment and social media companies, have access to a large amount of data suitable for training purposes and this partially explains why they are leaders in AI applications.

If you want to teach neural networks to identify a cat in a picture, there is a fairly large number of pictures available in which the word 'cat' is connected with the picture as metadata. This is, however, not the case in all applications. For example, the measurement data saved from industrial processes has not always been supplemented with metadata. This is also often the case with healthcare data. A sufficient amount of data may be available but it is not accompanied by classification data. At the same time, producing metadata manually during the measurement process or afterwards requires substantial resources. The data may also be of poor quality or unreliable. For example, in an industrial plant, the sensor may be defective or the sensor placed on the patient's skin in a hospital may momentarily get detached and give a wrong reading.

In other words, there are many industries that do not have access to high-quality data masses supplemented with metadata. This restricts the use of existing AI technologies. Recent advances in machine learning have provided partial solutions to the problem in the form of transfer learning, reinforcement learning and simulated training data. One and few shot learning as well as weakly supervised learning are also potential solutions. Many experts believe that weak supervision or unsupervised learning may offer partial solutions to the challenges posed by data-based learning.

> ""In five years we may have AI that can do basic commonsense reasoning, and there are leaderboards to track the progress." – Jim Spohrer

HOW CAN THE PROGRESS BE MEASURED?

We must be able to monitor and measure advances in AI technologies and in their performance. Scientific publications tell us how much is invested in research content, while the investments made by companies provide an indication of the economic inputs into artificial intelligence. Methodological performance can be monitored with tests on standardised databases and leaderboards connected with them. The leaderboards tell how the results are evolving and which of the research teams is at the top.

Experts are predicting that there will be a technological revolution when the existing machine learning methods reach their limits. The pendulum may swing back from data-oriented methods to symbolic methods. The third wave of artificial intelligence will combine unsupervised learning with the methods of symbolic artificial intelligence, such as reasoning, semantic representation, logic and search techniques.

Finland may get a head start in the third wave of artificial intelligence because we have a strong research tradition in unsupervised learning. By strengthening existing top expertise and by investing in domains important to Finland, we can enhance our position in the global AI competition. It should also be noted that funding should also be channelled to information technology and computer science research taking place outside the core of artificial intelligence. This is because we can never be sure where the next breakthrough takes place.

> *"The third wave of AI will combine current statistical and symbolic methods with unsupervised learning." – Harri Valpola*

One interesting aspect is the level of automation and independence of the AI systems. An AI-based system can perform routine work tasks automatically, it can help humans in their tasks or it may even function independently. A car is a good example of the advances in assisting systems, which may result in an autonomous vehicle functioning without human guidance. New cars already have driver-assist systems, ranging from lane assists to automatic emergency braking. Autonomous vehicles are already being tested in road traffic in many countries.

The car example can be transferred to many other areas of life. An AI system can provide humans with assistance in a broad range of different situations and in some situations it may replace humans. The desirability of full automation depends on a number of practical issues, such as the risks involved in the task. At the same time, it is also a philosophical issue. We must have an open discussion on technological advances. Do we want a situation where AI only serves as an assistant to humans? In what tasks should AI systems act independently?

> *"Even if Google DeepMind's Alpha Go is able to beat humans at Go, the system does not have the experience that it is playing a game in the way that a human does." – John Shawe-Taylor*

In the future, we will see AI systems that are much more aware of their environment and are able to adapt to change. This will inevitably lead to systems that are much more like humans and are able to adjust to changes around them.

User-friendliness, ease of use and ease of understanding are crucial factors in AI solutions. Users expect more from a 'smart' technology than from a traditional information technology. This means that it is also expected to behave in a reasonable manner. If the interaction between a system and humans is deemed as problematic, the system will not be taken into use.

There has been a great deal of research on the interaction between humans and computers in Finland and such research has also been carried out as part of AI research. Therefore, we will benefit if more emphasis is placed on interactive skills in the future.

Artificial intelligence application in the industrial and service sectors

AI technologies are most commonly used in sectors that have access to large and useful data resources. In addition to consumer business and large digital companies, the **health and wellbeing sector** has also been mentioned as an obvious user of artificial intelligence. There has been particularly rapid progress in the field

of medical imaging in which doctors can diagnose findings with the help of AI methods. In the future, AI methods will also be used in the predicting of patients' condition, estimating of drug response or in the planning of clinical trials.

Robots and intelligent aids will assume an increasingly important role in care tasks where human presence and empathy are not essential. Lifting patients and assisting their mobility are two examples of this.

The introduction of AI and robotics in healthcare also depends on sectoral regulation and the attitudes among professionals, doctors and nurses towards the new technology. Equipment manufacturers and service providers in the sector must ensure that the new technology will earn the trust of both professionals and patients.

Partial AI-based automation of healthcare processes frees the healthcare professionals from office routines to patient and care work. However, healthcare is not the only sector where routine processes can be automated using AI-based solutions.

Manufacturing and processing industries will also introduce AI technologies. Processing industries are understandably cautious with regard to the new technology because introducing new technologies requires detailed plans and the changes are not made overnight. Companies have optimised their production for decades, the lifecycle for investments in manufacturing plants may be several decades and industrial operations are subject to strict safety and environmental regulations.

Small subcontracting companies in manufacturing industries have a specific problem that AI technologies may help to solve. When a company's employees are ageing and retiring, tacit knowledge is disappearing. The sector does not attract young people. In fact, the disappearance of small companies at the base of the supply chain may threaten the existence of entire industrial sectors in Finland and in many other countries, such as Japan. Application of AI technologies may help to solve the problem in three ways: 1) automation will reduce the need for workforce; 2) AI may help in the collection of tacit knowledge; and 3) a new technology makes the sector more interesting for young people.

AI technologies are also changing the **logistics and transport sector as well as agriculture** where sensors, drones and artificial intelligence are providing opportunities for precision farming.

It is also believed that AI will substantially change **education, training and teaching**. As in healthcare, the pace of change will greatly depend on regulation and stakeholders' attitudes. In **creative fields**, AI technologies supplement and support existing processes but they are also opening up new opportunities.

Impacts of artificial intelligence on business operations

The speed of introducing AI varies between sectors. There are open source tools available that companies can use for testing the potential of AI in general and machine learning methods in particular. However, there is a long way from tests to actual use. The introduction of AI requires substantial inputs into the development of technological capabilities, into the interaction between users and the technology as well as into the creation of business models. An AI solution can only be made operational if it is compatible with existing processes and operating practices as well as the business model of the organisation.

> *"If 100 companies are trying it and it might be that only 10 of them have a practical business model at this point in time." – Volker Tresp*

In many cases, enhancing operational efficiency is the first stage in the application of AI technologies. This may mean more efficient use of workforce in the care of the aged, reducing the proportion of unsellable products in retail sales or higher fuel efficiency in maritime transport. Substantial savings or productivity improvements can be achieved. These improvements are company-internal in nature.

> *"Industries that already struggle can't really be saved by sprinkling some AI on top of it, instead we need to go where the new opportunities are." – Christian Guttmann*

In the experts' view, AI technologies provide a basis for disruptive changes that have a greater impact than improvements in operational efficiency. AI technologies can help to create entirely new business models that do not only have an impact on individual organisations but may also have a wider effect on business ecosystems. For this reason, it is important to stimulate AI-based business operations, for example by expanding cooperation between different sectors and companies of different sizes. The cooperation networks may be on a regional basis but they should also have an international dimension. At the same time, the cooperation networks also help to create attractive environments for talent. For example, the ability to choose any of the jobs offered by a large number of companies is an attractive prospect for foreign AI experts. Experts moving between companies transfer knowledge through ̈cross-pollination' and at the same time, they also help to build the success of all companies in the operating environment.

Even though large global companies dominating the consumer business are already making extensive use of AI, the technology is only now gaining a foothold in **business to business operations (B2B)**. In these sectors, there is often less training material for using AI available and for this reason, they need new AI systems requiring less training material. This can open up significant opportunities for Finland because we have particularly strong research and technology expertise in this area and strong traditions in B2B operations.

Artificial intelligence as a factor renewing society and democracy

At the moment, the focus in the AI debate in Finland and elsewhere in Europe is on ethical issues: protection of privacy, accountability for the errors made by AI systems and the traceability and transparency of algorithm-based decision-making. The members of the expert panel consider these issues important but difficult and add that they can only be solved through international cooperation.

Does the focusing on ethical AI issues slow down progress in Europe, while at the same time China is going full speed ahead with the development and introduction of AI solutions? According to the expert panel, we must find a balance between the

protection of privacy and the other rights of the citizens on the one hand, and the benefits generated by artificial intelligence on the other.

> *"Europe should find a balance between privacy and using AI technology."*
> *– Gesche Joost*

Should the focus be on the more practical issue of trust? Do we trust the organisations and people producing the AI-based services? Do we trust the technology solutions offered to us?

In practice, deep neural networks are black boxes. This has been criticised and it has been demanded that the algorithms should be transparent. But is this really needed and is it even possible? We can compare this with the functioning of the 4G mobile phone network. Do we actually understand how the calls are transmitted between continents? Even if we did not understand it, it is not necessarily a problem because we trust the data communications system and the parties operating it. Here too, it is a question of trust rather than transparency.

> *"We should be talking about trusting AI just as much as ethics in AI, it is a much productive approach." – Christian Guttmann*

Extensive introduction of AI technologies has an impact on employment, income and (in the longer term) the tax base. It is believed that in the next few years, the automation enabled by AI will mainly have an impact on jobs containing mainly routine tasks. Experts are of the view that countries like Finland that have a high overall level of education will not significantly suffer from the unemployment caused by the introduction of AI solutions in the coming years. It is also essential to support the creation of new jobs rather than protect the disappearing ones.

In the long term (in 20 to 50 years), AI may reach the performance level of humans or even exceed our capabilities in most tasks. As a result, extensive labour participation is no longer required to supply products and services. If paid work as a source of livelihood will become less common, the tax base will erode. This means that we need new means of livelihood and new sources of tax revenue.

"AI could facilitate civilized discussion about societal and political issues, it could be the agora of modern time." – Michele Sebag

There has been a great deal of debate about the role of AI technologies in societal influencing and decision-making. Even though external influencing of voters has given negative publicity to AI and analytics, especially in connection with the 2016 US presidential elections, AI technologies can also be used in a positive manner. Artificial intelligence can be used to collect citizens' opinions, identify hostile influencing attempts in social media and develop defences against hybrid threats. Robots and intelligent devices can extend the independent living of elderly people. Drones can serve remote regions and AI-based 'trainers' can advise employees how to work more effectively in teams or they may even help to find solutions to problems in family lives.

China is emerging as an AI power - what will Finland and the EU do?

China is investing heavily in AI technology and its aim is to be the world's number one in this sector by the year 2030. US companies are still leaders in the development of AI technology and AI-based business but in relative terms, China is investing more in these fields. Access to huge amounts of data gives China a competitive edge. This is a major advantage as long as AI technologies based on a large supply of teaching material dominate AI development. In a centrally governed country, even radical AI-based solutions can be implemented without regulatory or civil rights considerations.

"China is investing hugely, but it is also wooing talent to come to China. We do not fully appreciate that." – Gesche Joost

Even though the matter has attracted little attention in Finland and elsewhere in Europe, there is a fierce competition going on between companies and academic institutions in China, the USA and the rest of the world for top AI talent. If we fail to react to the situation early enough, Finland and the rest of Europe will soon start suffering from brain drain.

Finland should focus on its strengths so that it can retain and attract top talent. Highly motivated research groups focusing on emerging sectors, such as unsupervised learning, a vibrant startup field and close cooperation between research institutions and companies are Finland's strengths. The Finnish Center for Artificial Intelligence (FCAI) is playing a major role in the boosting of these strengths. Finland also provides families with a safe and clean environment and companies with a predictable legislative and taxation system. These strengths should be marketed in Finland and the rest of the world.

The European Union and its Member States have initiated measures in AI research and development and Finland has been one of the countries driving these efforts. The EU Member States should combine forces to harmonise AI research, development and regulation. By doing that, they can provide companies with a competitive operating environment.

Recommendations of the international expert panel for Finland

1. **Retain talent**
   Competition for skilled experts is fierce. Sufficient action has not been taken in Europe and Finland to deal with this issue. Finland needs to not only retain current talent but also to attract more highly skilled artificial intelligence specialists to Finland. This also applies to future talent, in other words students.
2. **Invest in B2B activities**
   Artificial intelligence is only making its way to the B2B markets. Finland is well equipped to succeed in these markets, provided it invests in its strengths, which include AI technologies for industrial solutions such as unsupervised learning and hybrid approaches, and a strong focus on industrial B2B business. This development stage provides a good fit with Finland's industry base and offers significant potential for the Finnish society and economy.
3. **Respect the principles of democracy and freedom**
   An approach must be identified in Finland and in Europe that respects

the principles of Western democracy and freedom while at the same time permitting businesses, consumers and public services to benefit from AI-based technologies. Solutions based on artificial intelligence should be seen as a way of reinventing society and increasing citizens' participation in decision-making and democratic processes.

4. **Artificial intelligence is more than a technology**

   It is important to bear in mind that technology only provides tools for implementing new business models and better public services. Before any solutions can be implemented, user acceptance is required.

5. **Embrace the free mobility of data**

   How useful artificial intelligence is depends largely on the availability of data. Bringing in meaningful data from multiple sources will improve the results dramatically. Therefore, we should break down silos within and between businesses and public services whenever possible and permit the free mobility of data.

CASE K-GROUP: ARTIFICIAL INTELLIGENCE KNOWS BETTER THAN YOU WHAT YOU WOULD LIKE TO EAT

For many years, the customer loyalty schemes of grocery stores have known everything about their customers. Based on the purchasing data, it is easy to make conclusions about the customers' buying behaviour. We also know that people usually buy more or less the same things every time when they go to a grocery store.

A few years ago, the K-Group decided to use this data as a basis for a much more intelligent system that would offer recipe recommendations and, in this way, make people's lives easier. The system was introduced in 2017. In its simplest form, the system works so that when you login and enter the word 'milk' into the search field, your favourite milk (based on your purchasing history) automatically appears on the screen.

However, the system was soon made smarter and the search function was expanded to cover recipe recommendations. Using the search results as a basis, the system concludes what recipes are used by people with different food purchasing habits and automatically recommends these to new users.

From the start of this year, the system was made even smarter and it now also covers shopping lists. In practice, when you login, you can now get the shopping list for

the following week by pressing a single key. The artificial intelligence application determines the content of the shopping basket on your behalf and it bases its choices on your previous shopping lists. In other words, it does not only recommend products that you have already bought but also concludes what you might want to eat the next week. As you make more purchases and shopping lists, the system will learn more about your habits and will also recommend new products.

In the end, the artificial intelligence application may become a better expert in your preferences and you no longer need to spend time on thinking what to buy next.

The K-Group has collected data on its customers' food purchases for many years, which means that when recommending purchases and recipes, the artificial intelligence application is on a fairly solid basis. The data is available in large amounts and it is of high quality.

At the same time, however, it has been more difficult to teach artificial intelligence to differentiate between personal preferences and seasonal variations. In other words, even if you loved Christmas pastries, you probably do want to get a recommendation to buy them in June. Accessibility and quality of the data as well as the adequacy of the data mass computing capacity have been the key challenges and only in the past few years has progress been achieved in these areas so that relevant recommendations can be given.

The next aim is to make the recipe and shopping list recommendations into a workable package that would revolutionise grocery shopping. You would only need to press a few keys to select and purchase the items. In this way:

The system asks you whether you would like to make a casserole and vegetable pasta next week. You answer is yes, after which the system suggests products for your shopping list. You accept the products after which the system asks whether you want to buy the products. You approve the list and pay the products, which will be delivered to your home address a short time later.

This may already become a reality in one year's time.

The recipe recommendations of the K-Group are an example of the development of digital services. This is a factor strongly impacting our daily life: we spend a great deal of time on grocery shopping and on thinking what we would like to eat. This means that artificial intelligence may revolutionise our daily lives by minimising the time spent on that activity and by learning to determine on our behalf what we have eaten and what we should eat next.

CASE FIVA: MAKING ROUTINE WORK EASIER WITH ARTIFICIAL INTELLIGENCE

In spring 2018, the Financial Supervisory Authority (Fiva) launched a pilot project, in which the aim was to substantially reduce the amount of manual and routine work.

After analysing the potential of robotics and artificial intelligence, Fiva implemented the first pilot project in investment service notifications. The task in which it was decided to test the robot requires a great deal of effort and time when done by humans and there is also substantial potential for human error. In this task, information is entered into a database, which means that theoretically, a robot could be programmed to perform the same work. The information concerns the investment services offered by European companies and the authorities use notifications to exchange information.

The robot processing the investment service notifications was also taught to process emails. The robot reads the email attachments and based on their contents, it can create new companies in the supervision register or update the change information contained in the notifications. It also enters dozens of different types of licence and service information into the register. As part of the process, the robot sends emails to other units in the organisation requesting registration information and enters this information into the register.

Encouraged by the excellent results of the first pilot, Fiva decided to carry out a second pilot in fund notification, which is slightly different from the first project. Fund notification documents involve substantially more variation than the documents in the first pilot, which means that the task could not have been managed by a robot alone. For this reason, an AI application that is able to process free-form text using statistical context recognition was developed to assist the robot. A simple AI algorithm is able to make a distinction between these different types of document. The artificial intelligence application is able to process documents in Finnish, Swedish and English. In addition to classifying documents, it is also able to pick specific information irrespective of where it is located in the document. The AI-assisted robot for fund notifications was introduced in February 2019.

The results from the use of the robot and the AI-assisted robot have been overwhelmingly positive. The fact that European supervisors do not fully observe the jointly agreed notification procedures has been the main source of additional work in the pilot projects. It is clear that the software robots achieve optimum results when all data is of uniform type, free of errors and seamless.

As the robots used in the pilot projects have been taught to imitate the work of humans, it has been asked many times during the project which systems the robot

should be able to access and what IDs and access rights it should be provided. Policy decisions on these issues have been reached during the project. For example, it has been agreed that users are able to check the notifications processed by the robot and that the robot sends all emails with its own name.

As a result, the work of the experts at Fiva has become more meaningful and most importantly, the robot and the AI have reduced work backlog. The robots also perform tasks in which humans make substantially more errors, which means that the number of errors has also decreased. Fiva will decide on the future action after the recently started second pilot has been completed.

The Financial Supervisory Authority is an example of a government agency that uses artificial intelligence. The Financial Supervisory Authority is a financial and insurance supervisory agency, which does not always have adequate resources for its tasks. Robotics and artificial intelligence have eased the situation and their use has also led to a sharp fall in the number of human errors. The Financial Supervisory Authority supervises the operations of banks, insurance and pension insurance companies, other actors in the insurance sector, investment firms, fund management companies and the Helsinki Stock Exchange. The supervised entities provide 95% of the funding for the operations and the remaining five per cent comes from the Bank of Finland.

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3 Eleven key actions ushering Finland into the age of artificial intelligence

Enhancing the competitiveness of the Finnish trade and industry with digitalisation has been one of the one of the key projects of Prime Minister Juha Sipilä's Government. On 18 May 2017, the Minister of Economic Affairs Mika Lintilä stated his goal of turning Finland into a leading country in the application of artificial intelligence and set up a steering group to prepare a proposal for a Finnish Artificial Intelligence Programme. The steering group's term of office was set to end at the same time as the term of Prime Minister Sipilä's Government.

The background, timetable and goals of the Artificial Intelligence Programme

How to usher Finland into the age of artificial intelligence? The steering group chaired by Pekka Ala-Pietilä, consisting of representatives of the public and private sectors and research operators, highlighted three challenges:

1. How can we make sure that the opportunities provided by artificial intelligence are best utilised to safeguard economic growth and the competitiveness of business?
2. How can we make sure that the public sector will be able to utilise the opportunities provided by artificial intelligence in its own operations and thereby efficiently produce good public services?
3. How can we make sure that the structures of society will adjust to the changes brought on by artificial intelligence, and that going forward, Finland will be able to provide a well-functioning society and wellbeing to its citizens?
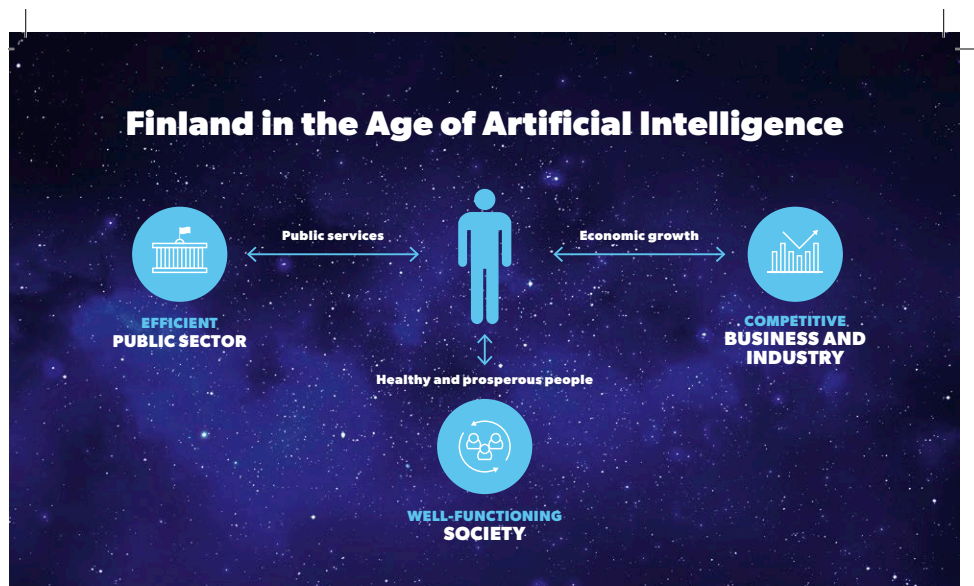
Figure 2: The three main themes of the Artificial Intelligence Programme: efficient public sector, proactive society and competitive business sector

Artificial intelligence is considered one of the most significant technologies of our time, which is believed to revolutionise transport, industry, healthcare and working life. However, artificial intelligence alone is often not enough to produce benefits – it also needs a great deal of other technologies, as well as data resources. New operating models, investments and novel competences and societal dialogue are also needed. In other words, steering Finland into the age of artificial intelligence requires very wide-ranging actions.

An extensive group of influencers and experts from different sectors of society, including business and industry, took part in formulating the Artificial Intelligence Programme. The approach adopted could be called a network of networks; the idea was to quickly and flexibly include many different interest groups in the preparation work.

In addition to the appointed steering group and a secretariat supporting its activities, there were four sub-groups assigned to participate in the compilation and implementation of the programme. They are chaired by Mika Vehviläinen (Expertise and innovations), Kimmo Alkio (Data and platform economy), Osmo Soininvaara (Transformation of society and work) and Meeri Haataja (Ethics).

Additionally, the group tasked with monitoring the Government programme's digitalisation objective and the public administration's ICT development (DigiNYT), established earlier, led by Olli-Pekka Heinonen contributed to the portion of the report concerning the public sector.

Steering group

Chair: Pekka Ala-Pietilä (Huhtamäki)
Deputy chair: Ilona Lundström (Ministry of Economic Affairs and Employment)
Ilkka Kivimäki (equity investor)
Jyrki Nurmi (Valmet Automotive)
Merja Fischer (Finnish Leadership Academy)
Jukka Ryhänen (Combient)
Sonja Ängeslevä (Zynga)
Samuel Kaski (Aalto University)
Antti Vasara (VTT Technical Research Centre of Finland Oy)
Taina Kulmala (Prime Minister's Office)

Mika Lintilä
Minister of Economic Affairs

Secretariat

Kalle Kantola (VTT Technical Research Centre of Finland)
Mika Klemettinen (Business Finland)
Olli Koski (Ministry of Economic Affairs and Employment)
Aleksi Kopponen (Ministry of Finance)
Jussi Nissilä (Ministry of Economic Affairs and Employment)
Maikki Sipinen (Ministry of Economic Affairs and Employment)

Expertise and innovations
Chair:
Mika Vehviläinen
(Cargotec)

Data and platform economy
Chair:
Kimmo Alkio
(Tieto)

Transformation of society and work
Chair:
Osmo Soininvaara

Ethics
Chair:
Meeri Haataja
(Saidot.ai)

DigiNYT
Chair:
Olli-Pekka Heinonen
(Finnish National Agency for Education)

Figure 3: The organisation structure of the Artificial Intelligence Programme.

The steering group published its first interim report, *Finland's Age of Artificial Intelligence*, on 23 October 2017. The report examined the significance of artificial intelligence for Finland's wellbeing, revised the programme objectives, and made recommendations for action. The report presented eight key actions for taking Finland towards the age of artificial intelligence:

1. Enhance business competitiveness through the use of AI
2. Effectively utilise data in all sectors
3. Ensure AI can be adopted more quickly and easily
4. Ensure top-level expertise and attract top experts
5. Make bold decisions and investments
6. Build the world's best public services

7. Establish new models for collaboration
8. Make Finland a forerunner in the age of artificial intelligence

Furthermore, the report raised some follow-up questions related to the ethics and security of artificial intelligence, which have been scrutinised during the programme period.

A subgroup working under the steering group published its report Work in the age of artificial intelligence addressing the transformation of work and the labour market on 20 June 2018. Issues related to ethics were covered in the Work in the age of artificial intelligence report, and by the Ethics group set up in spring 2018. The network involved in the programme also discussed matters related to security, and initiated measures aimed at promoting digital security competence and business. As a result of these activities, three new key actions were created:

9.   Prepare for artificial intelligence to change the nature of work
10. Steer AI development into a trust-based, human-centred direction
11. Prepare for security challenges

In the following, we will examine the actions taken and lessons learned during the programme period, as well as make recommendations for further measures through these 11 key actions. **The listed actions represent both the actions initiated by the AI Finland programme and actions already being carried out independently of the programme. Therefore, the list gives an overall picture of the key events in the AI sector in Finland.**

Key action 1: Enhance business competitiveness through the use of AI

Actions taken

- The programme brought together 15 enterprise-driven ecosystems from various sectors, where application of artificial intelligence played a major role.
- The ecosystems' work was supported in multiple ways. The application of AI was accelerated, for example, by means of peer learning and sharing of best practices and concrete solutions.
- The ecosystems were also offered expert assistance, access to networks and support for applying for funding.
- The blog series on the Tekoalyaika.fi website shared understanding and information about the business impacts of the application of artificial intelligence in different companies and its benefits using concrete examples.
- The measures aimed at increasing the understanding of corporate management of the opportunities offered by artificial intelligence included the establishment of an artificial intelligence growth group, and special programme for top executives of companies in connection with AI Forrum, the European Ministerial Conference on Artificial Intelligence.

Key lessons learned

- In organisations, the challenge is not so much in technologies or access to technologies. Instead, the organisations struggle with understanding the business potential of artificial intelligence and the shortage of AI specialists.
- Enterprises usually see AI as part of a larger digitalisation project. This is also due to the fact that to fully exploit artificial intelligence, organisations also need to develop other basic digital abilities.
- An ecosystem-based approach is often an effective way of applying AI, particularly in extensive projects. In the application process, it is essential to ensure an appropriate team composition, efficient forms of cooperation, trust and sufficient resources.

- Pilots and agile test environments play an important role in finding new areas of application in particular. With a view to success, it is of critical importance to generate efficient cooperation between those with substance matter expertise and those with AI expertise.
- Companies still suspicious about AI typically have limited knowledge of the potential and limitations of AI. Restrictions are also often posed by the resources available – such as specialists, data and technological readiness.
- In the public sector, the Public Procurement Act set limits to co-development. The legal restrictions and ethical questions to application should be largely examined on a case-by-case basis. Here, well-functioning cooperation between the private and public sectors becomes emphasised.

Recommendations

- Continue the activities of the steering group with management and experts from the public and private sectors aimed particularly at eliminating obstacles to application of AI (e.g. legislation) and increasing the understanding of the potential for applying AI.
- Target substantial, long-term funding for a research and innovation funding programme on AI with rules that enable international cooperation and encourage top researchers and companies to collaborate closely with each other.
- Support the development of significant test environments and testbeds, and international cooperation. Integrate the operations as part of the Finnish Digital Innovation Hub network.
- The Public Procurement Act should be reviewed in such a manner that it would enable effective public-private co-development. In addition, public sector operators should be secured sufficient resources and incentives to engage in such development.

From the perspective of Finnish business and economy, it is of critical importance that companies efficiently exploit the potential of AI in their own business operations and are capable of seizing the opportunities created by the market changes generated by AI. For example, the Finnish export industry created 46% of the added value of our GDP and provides employment to about 1.1 million Finns, directly and indirectly. Therefore, it is obvious how critical it is that these sectors

keeps up with the development to be able to gain the competitive advantage given by AI. At the same time, we should ensure that we are capable of taking advantage of totally new business opportunities as well.

The level at which various sectors and organisations use AI varies. In general, we could say that companies that have made the most progress in the digitalisation of their business activities have also made the most advances in the application of AI. This is generally the case also in the Finnish B2B sector, where AI is already being extensively used in such operations as predictive condition monitoring and automation and robotics solutions. The most rapidly growing trend is the use of different AI solutions that support humans, for example, in healthcare and, increasingly, in the industrial sector as well.

To fully exploit artificial intelligence, organisations need to have sufficient basic digital skills and competences. Therefore, AI is usually seen as part of a larger digitalisation project, which does help in the scaling up of AI applications in important areas of operation. The benefits provided by AI also increase when it is applied to more demanding processes. Forerunner companies apply AI to their key business functions, through which they seek a major competitive advantage. Enterprises are also seeking solutions that would speed up the application of AI, such as agile piloting. Areas where the use of AI is increasing rapidly include automation of customer service processes and business support processes.

The benefits of AI often lie at the systemic level, or complex overall solutions, the implementation of which requires collaboration between various operators. Artificial intelligence enables, for example, increasing the autonomy of vehicles, but the biggest benefits are reaped at the systemic level (e.g. shared transport solutions, reduced need for parking spaces and optimised traffic control). Similarly, for example, an industrial robot using AI eventually benefits the whole production and logistics chain, as it allows more flexible, competitive and productive arrangement of the chain.

At the same time, the challenges posed by the visions to be realised with the help of AI are not found so much in the solutions related to individual devices, but at the systemic level. Amendments are needed in the legislation, as well as investments and contracts on the sharing of benefits. Challenges can be tackled with

ecosystem-based innovation activity, when organisations develop common goals in collaboration with each other and share resources, competences and knowledge. Innovation activity based on ecosystems and close collaboration is a special national strength for Finland, and we have a traditionally low threshold to engage in cooperation between organisations. Ecosystems applying these principles also help Finland succeed in international competition.

Enterprise-driven ecosystems helped the sharing of information

In the Artificial Intelligence Programme, companies were provided support through enterprise-driven ecosystems in particular. The programme admitted 15 ecosystems[3], in whose development work AI plays a major role. The ecosystems involved operated in the fields of healthcare, energy, process industry, manufacturing industry, transport, built environment, service business and logistics. In total, people from more than 100 organisations participated in the programme.

The ecosystems also effectively implemented goals included in the national roadmap of platform economy by promoting data sharing practices and creation of new business models. The objective was to bring together companies that had already made progress in the application of AI, so that they could share concrete examples and competence between the ecosystems. The work highlighted that the challenges, limitations and solution models in the application of AI are largely the same regardless of the area of application. The participants considered the peer support meaningful and found functional solution models for challenges related to such matters as use of data, teaching of AI, reliability and performance optimisation. Naturally, legislation, ethical guidelines and standards, for example, pose application area-specific restrictions.

Alongside peer learning, the ecosystems were also provided external expertise. Another aim was to generate an up-to-date snapshot of the latest AI news nationally and internationally. The competences and experiences of the ecosystems

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3 Open customer-centred ecosystem, CleverHealth Network, Communication network operations, Connected Intelligence, Corridor as a service, Digital design and manufacturing excellence, Digital Fiber, Intelligent Industry Ecosystem, Intelligent Packaging, OneSea - Autonomous Maritime Ecosystem, OuluHealth ecosystem, Research alliance for Autonomous systems, Smart building ecosystem, Smart Otaniemi, Reboot IoT Factory

were also used, as applicable, for the preparation of national and international strategies. This was done to ensure that the opinions of the operators within the field become visible in such strategies.

Public operators face additional challenges compared to the private sector

The ecosystem work revealed that public operators have their own additional challenges compared to the private sector. For example, one factor slowing down the cooperation between public healthcare and private companies is the lack of funding for investments typical of healthcare organisations.

When applying AI, the cooperation between healthcare experts and technology specialists is of critical importance. The challenge here is that the time required by such development work is often away from patient work, which functions as the basis for measuring the performance of public healthcare providers. Therefore, the situation does not necessarily encourage people to participate in long-term development work, even though the potential benefits gained from such development might be significant.

In addition to this, special attention needs to be paid to the rights to the outcomes of co-development, to avoid the situation in which the healthcare provider is forced to buy again the jointly created product, in the development in which it has also made its own investments. Under the current Act on Public Procurement, healthcare providers may also need to subject the solution generated through co-development to tendering. It might accelerate the development done by public operators if solutions could be found to the challenges described above.

It is clear that there are still a lot of companies in Finland that are suspicious about AI and its use. Probably the biggest reason of this is their limited knowledge of the concrete potential and limitations related to the application of AI. Other reasons include the shortage of specialists and high-quality data, as well as limited technical resources (in relation to either AI technologies or enabling technologies). The readiness of customers to use AI applications also puts limits on their increased use. This is a challenge leader companies and experts of the ecosystems set out to solve in their blog articles. They often gave concrete examples of the application

of AI and the benefits this had brought. The objective was to clear misconceptions related to AI and to encourage companies at the early stages of applying AI to really seize the opportunities it can provide.

Key action 2: Effectively utilise data in all sectors

Actions taken

- An information policy report was prepared under the lead of the Ministry of Finance, and the final outcome 'Ethical information policy in the age of artificial intelligence' was submitted to Parliament in December 2018.
- Promotion of the utilisation of data modelled after MyData activities, including the establishment of MyData Global, the introduction of the act on the secondary use of social welfare and healthcare data to Parliament, Sitra's IHAN work and the work on AuroraAI national artificial intelligence programme coordinated by the Ministry of Finance.
- Different network of networks' data lake trials and test environments (sandboxes), with such examples as the use of social welfare and healthcare data in Espoo and the HUS diabetes trial.

Key lessons learned

- Finland has potential for acting as a global pioneer in the area of human-centred, ethical data economy in the middle ground between the enterprise-driven U.S. model and the administration-driven Chinese model. At the same time, however, it is important to find a sensible balance from the perspectives of individuals, society and companies, enabling also wellbeing and growth.
- Data generates added value to individuals and society only when it is put to use. In understanding the value of data and in its indirect use, the secondary use of data for research purposes is an important step, but also primary use in, for example, services should be enabled within the limits of jointly agreed and ethically sustainable rules.
- It is not possible to enact a separate law enabling the use of MyData for every useful public administration data resource. This calls for a

'sandbox', which allows the development of, for example, the AuroraAI network, while the sandbox also supports the development of regulation concerning the portability of personal data owned by public administration at the level of general legislation, and implementation of procurement and tendering processes.

- The amount of data is not always an end in itself – some areas of application may not even have that much data available in the first place. There might be an opportunity for Finland to become a pioneer also in the field of Small Data (cf. Big Data), where it is possible to use artificial intelligence even with a small amount of data.

- In the exploitation of data, the B2B market still remains to be conquered, whereas the B2C sector has become the playing field of global giants. In the business sector operations, Finland should invest in the B2B market which is about twice as large as the B2C market.

Recommendations

- Clarify the rules of how data is used from the perspectives of companies, society and users. Provide support for the use of data by means of legislation, agreements and self-regulation of industries.

- Create sandbox environments to support the exploitation of data, and the development and procurement of services that create added value. In the longer run, the sandbox operations should be aimed at developing the portability of personal data owned by public administration at the level of general legislation.

- Develop Small Data AI solutions at the forefront of global development.

- Recognise the potential of the B2B market and develop solutions for using data in the market.

- Enable secondary use of data in various sectors in a large scale. Clarify the paths of primary use of data, taking account of the ethical questions, so that the Finnish data resources could be harnessed to generate added value for society, individuals and companies.

- Take account of the information policy report and the viewpoints presented therein when drafting future laws.

Data has become the world's most valuable resource, but when the existing operating models are applied, it primarily benefits a few giant corporations that collect the data from their service users. The entry into force of the EU General Data Protection Regulation (GDPR) in May 2018 strengthened the rights of the individual and harmonised the EU regulation related to processing of personal data. However, the impacts of GDPR on the future European operating environment are only finding their concrete form, and, as yet, there is no joint concept or interoperable open ecosystem for the exchange of personal data based on consumer consent.

Finland is in a position to become a global trendsetter and a forerunner within EU in the creation of fair, consumer-oriented principles. This requires a visionary approach and a joint EU-level roadmap, as well as technical proof of functional exchange of data. When making interpretations of the General Data Protection Regulation, it must also be taken into account that, while protecting the privacy of the individual, on one hand, too strict interpretations must not endanger the realisation of the fundamental rights (e.g. right to wellbeing and health, and sufficient social welfare and healthcare services) of others. Combination of data creates new services and innovations that enhance wellbeing and running of everyday chores, thus strengthening fundamental human rights.

'Small Data', which may offer new opportunities for applying AI within the B2B field in particular, is an interesting area of development and, at the same time, an opportunity for Finland.

Information policy report

Key questions of the Artificial Intelligence Programme related to the use of data and AI have been addressed in the Government report *Eettistä tietopolitiikkaa tekoälyn aikakaudella (in Finnish; Ethical information policy in the age of artificial intelligence)*, prepared under the Ministry of Finance, where the Artificial Intelligence Programme was involved as part of the network of networks cooperation.

The report initiated by Prime Minister Sipilä's Government in its strategy meeting on 29 January 2018 was submitted to Parliament in December 2018. At the same time, it marked the launch of a new policy sector, the information policy. The Government's information policy report constitutes the knowledge basis and a policy, upon which a roadmap with prioritised actions can be built in the future.

Ethical information policy refers to policy measures applied to promoting good management and efficient use of information. Information policy is used for boosting, for example, the gathering, combining and sharing of information, and information disclosure and storage, and for enhancing data protection and information security in a manner that respects human rights and freedoms. The objective of information policy is to promote and enhance the refining and use of data for the common good, and to identify and prevent misuse of information. Information policies are also needed for ensuring competence and for regulations issues..
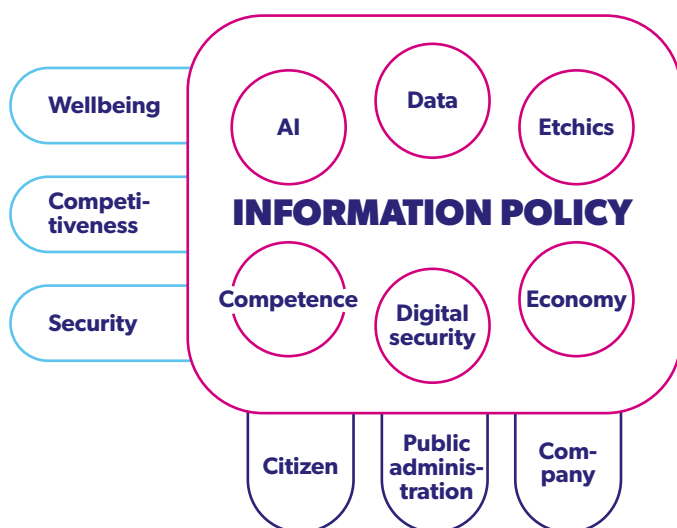
Figure 4: Key dimensions of information policy [Source: The report Eettistä tietopolitiikkaa tekoälyn aikakaudella (in Finnish; Ethical information policy in the age of artificial intelligence, p. 5)

In the report, information policy is studied not only from the viewpoint of information management, but also from the perspectives of the conditions for the use of information, value basis, ethical principles and financial impacts. AI is expected to open major opportunities for the analysis and use of information, but at the same time it poses totally novel challenges for information policy. In the report, the information policy is examined from the viewpoint of societal actors and, on the other hand, the perspectives of security, wellbeing and national competitiveness, without forgetting the citizens either. The report contains a large

number of general and detailed recommendations relating to such issues as data and AI.

Regulatory MyData sandbox to simplify the use of personal information

MyData refers to mechanisms for human-driven management and use of personal data, which give people the rights to their own personal data. The starting point is that people can themselves use, manage and consent others to access data collected on them, including purchase history, mobility, financial and health information. Human-driven data management is used for creating interoperability and for minimising the emergence of vendor lock-in as the platforms using data develop. The model reconciles the rights of the individual and high data protection requirements with the promotion of the accessibility of data and business operations. One of the key measures in reconciling the use of data related to individuals and data protection is to strengthen the individuals' status, rights and opportunities to manage their personal data.

The data collected by the public sector enables the development of many kinds of services for supporting citizens in different life situations. To enable the use of such data, the need to develop regulation concerning the use of personal information has emerged. A regulatory MyData sandbox environment for evaluating and piloting the opportunities for secondary use of personal data owned by public sector organizations in a restricted environment. It is based on the voluntary involvement of citizens, and it is being prepared across sectoral boundaries with an aim to enable legislative amendments required for novel needs for the use of information.

In the field of finance technology, the term 'sandbox' is widely used to refer to the development and testing of regulation and technologies side by side in restricted environments. Agile development of regulation can also be applied in other areas than finance technology.

Finland would need a sandbox allowing the development of regulation that would enable transfer and secondary use of personal information held by the public administration, when consented by the person concerned. This kind of sandbox would be a critical enabler of the development of, for example, the AuroraAI network (see Key action 6) built around life events and quick development of AI

serving the public interest. At the same time, it would support the development of other MyData services as well.

The EU's General Data Protection Regulation (GDPR), article 20, gives people a new right to data portability either for their own use or to have the personal data transmitted directly from one controller to another. Data portability plays a central role in the development of data-based services in a human-centred manner.

However, the article is binding only when the gathering and processing of data is originally based on the consent given by the person him- or herself or on a contract. The regulation lists a total of six grounds for the processing of personal information: consent, a contract, a legal obligation, protection of vital interests, exercise of official authority and legitimate interests pursued by the controller. In the public sector, there is a lot of processing of personal data based on regulations or exercise of official authority that the obligation of the data portability does not apply to, and, regarding which, the portability cannot be enabled by consent if the purpose of use is not related to compliance with a legal obligation of the authority concerned. Therefore, in addition to failing to obligate the public administration to enable data portability, GDPR does not give public organisations the possibility to offer such an opportunity either.

A concrete example of the need of a sandbox operating in this manner is the Koski service. The Koski service, maintained by the Finnish National Agency for Education, is currently being built into a data repository of people's lifelong learning that brings all information concerning people's studies into one system instead of keeping them in separate registers. A special act has been enacted for the Koski service under which people can give their consent for disclosing their personal information from the register to secondary uses. With a view to enabling the development of new civic services, it is of critical importance that Finland examine the need for and prepare effective legal solutions across sectoral boundaries for enabling similar use of human-centred information.

ACT ON THE NATIONAL REGISTERS OF EDUCATION RECORDS, QUALIFICATIONS AND DEGREES

Section 29 Disclosure of information with the help of the service

A person, whose information has been recorded in a register or data resource referred to under this act, may give in the service his or her individualized consent for the disclosure of information held in the register or data resource to an authority or some other party, and cancel the consent he or she has given. Information shall be disclosed in electronic format with the help of a disclosure service of education records, qualifications and degrees based on consent given by the person concerned.

The purpose of the proposed sandbox environment is 1) to enable the implementation of MyData trials of the public sector in a restricted environment based on voluntary involvement and consents of citizens; 2) to investigate whether new technology provides any useful opportunities for citizens to utilise the data collected by the public sector significant enough to mandate expansion of the legal obligations of authorities or to enable secondary use of such data for external users by, for example, the consent of citizens; 3) to prepare agile implementation of potential legal amendments across administrative boundaries.

Helsinki University Central Hospital (HUCS) is working on a first-level sandbox platform where cooperation partners may develop new solutions in collaboration with healthcare professionals. The sandbox will be tested in a project aimed at simplifying the treatment of diabetes in families with children in particular. The system under construction is an open interface solution, where the fluctuations in a child's blood glucose level are monitored with the help of an AI-based device. This way, the device would help the parents in the monitoring of the child's insulin levels and the anticipation of treatment. The most essential part of the project is the consent for the use of patient data and safe transfer of information. The project complies with the MyData philosophy and the consent is based on the IHAN® concept. HUCS is implementing the project in collaboration with its partners (CGI, Tieto, VRK, Patria, Nightscout, Elisa and Nokia).

In 2017–2018, Tieto and the City of Espoo carried out a successful trial which showed that advanced data analytics will be highly useful in the planning of healthcare services and the anticipation of the wellbeing of people. In Espoo, like in many other towns as well, the data on local citizens is siloed. In other words, data on an individual is dispersed into information systems of various sectors and services, but there is no transfer of information between them. In such a case, it is impossible to see the customer as an entity.

In this even internationally significant trial, the objective was to gain information on whether AI would enable identification of groups of customers needing specific services earlier than is possible today. Tieto and the City of Espoo processed a huge mass of data that consisted of 520,000 people who had used the services of the City of Espoo between 2002 and 2016, and more than 37 million customer contacts. The data processing was conducted following extremely strict information security practices: any identifying data, such as the name, personal identity code and address, were encrypted in the data search phase. Furthermore, secure connections were used for any transmission of data. The City of Espoo's social welfare and healthcare services data was brought to Tieto's data pool, where it was combined in such a manner that the customers and their use of services could be seen as an entity.

The results of the project were encouraging. The data was used, for example, for developing a risk prediction model with the help of which it is possible to predict someone's likelihood of becoming a customer of child protection services within five years. A total of 280 factors were used for prediction purposes. None of the factors is a risk in itself, but occurrence of various factors at the same time may constitute a risk. For the first time, the trial also enabled family-specific examination of customer paths, since the city information systems are usually built around individuals. The trial clearly showed that exploitation of data and AI have a significant role to play in healthcare and the prediction of the wellbeing of people, and, in the future, more investments should be made on such matters.

Finland to lead the development of digital human rights and fair data economy

Finland has clear thought leadership in the development of the principles, operating models, information architectures and technical solutions of human-centred data economy. Here, the MyData approach plays a key role. In international comparison, the Finnish MyData work is advanced particularly as regards the development of interoperability between operators and data ecosystems functioning in a fair manner (as opposed to 'winner-takes-all' models). The Finnish MyData development has attracted a lot of positive attention in the world, and, for example, the European Commission has highlighted it as part of the preparation work of its data economy communication.

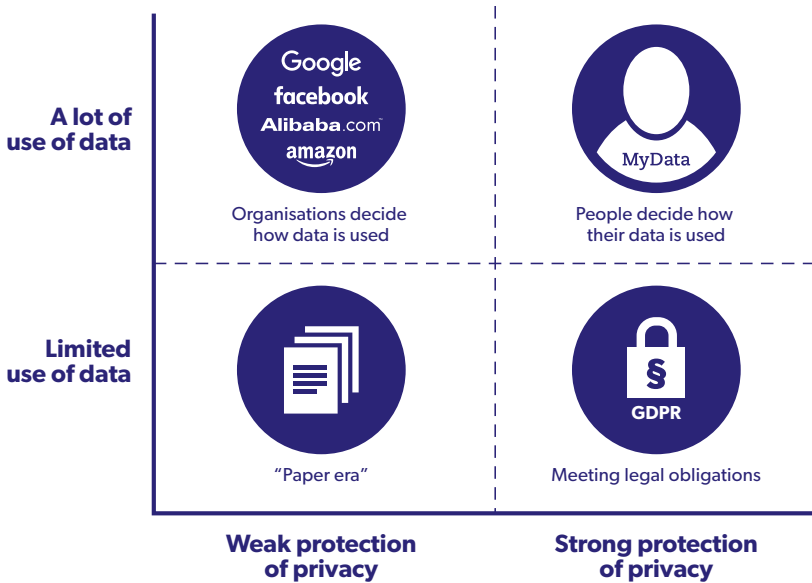**Figure 5:** MyData would enable smooth exploitation of personal information in a manner that maximises the benefits and minimises the deterioration of the protection of privacy. (Kuva Poikola & al. 2018)[4]

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4   Poikola & al. (2018) MyData - johdatus ihmiskeskeiseen henkilötiedon hyödyntämiseen [My Data – Introduction to human-centred use of personal data]. Ministry of Transport and Communications, Other publications 3/2018..

MyData Global, the service operator and consent practices related to secondary use of social welfare and healthcare data, and Sitra's IHAN work are examples of practical promotion and application of MyData principles.

To support international dissemination of MyData principles and cooperation, MyData Global – presumably the first international NGO created in Finland – was established at the end of 2018. More than 400 members, both organisations and private citizens, from 40 countries have already joined the organisation.

Furthermore, the though leadership in the areas of the management of personal information and human-driven data economy that we called for above requires active networking and internationalisation in such arenas as EU-level cooperation projects and international standardisation and technology forums.
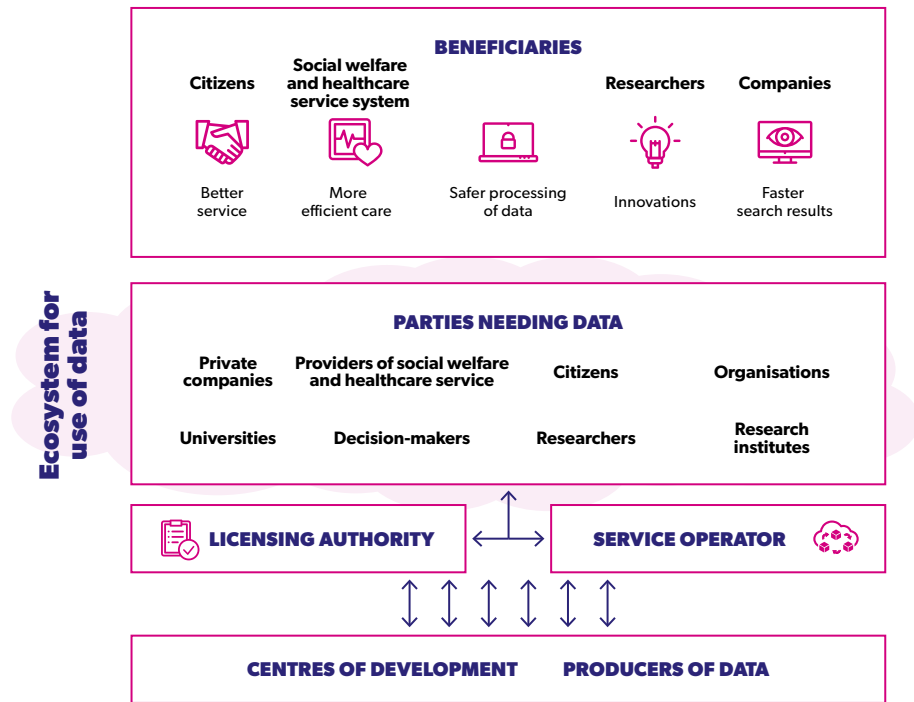

Figure 6: A concept for a service operator and licensing authority in connection with the secondary use of social welfare and healthcare data. (Source: Sitra)

The IHAN® project to promote a fair data economy, built upon Sitra's ISAACUS work that began in 2018, has taken as its starting point the regional and standardization work of the EU at CEN-CENELEC. In three years, the project will create cross-border ground rules and solutions for fair exchange and exploitation of data. The technical work related to IHAN operating model has been initiated, resulting in the CEN Workshop Agreement (CWA) document. During 2019, new service and business concepts using personal data will be piloted with Finnish and European pioneer companies in various sectors. These pilots will be based on genuine business operations, and they will create new service innovations by exploiting personal information at the consent given by people.
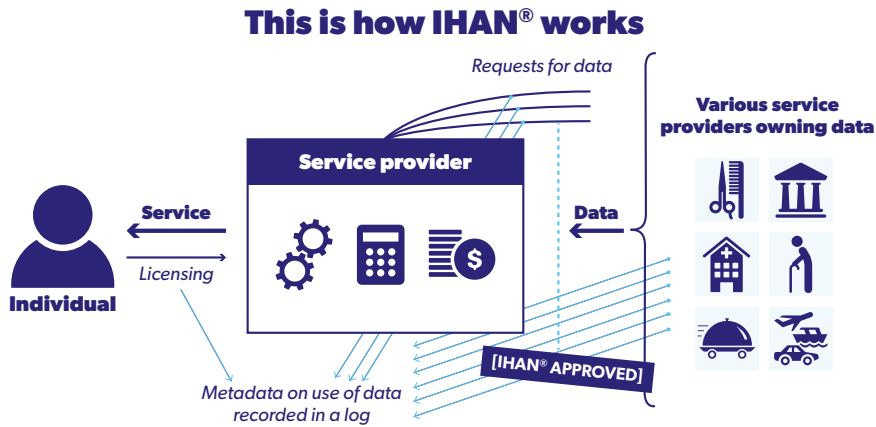
Figure 7: IHAN concept operating model. (Source: Sitra)

Even something small can be big – a new spearhead for Finland from Small Data?

The currently prevailing AI paradigm is focused on the processing of masses of data particularly with the help of deep neural networks. This paradigm is especially useful in solving consumer business issues of internet giants (e.g. Google, Facebook and Amazon), and often application of AI is connected to data: "AI feeds on data" or "data is the fuel for AI".

AI methods developed for consumer business that require a lot of data are not an efficient solution to many problems in the industry, companies or organisations, where it is not easy to find the same problem recurring all over the world. AI using smaller amounts of data is by no means complete yet, but its development is well under way. For Finland, this offers an important opportunity for two reasons: 1) the Finnish business operations strongly rely on B2B business, and 2) the Finnish AI research is on top of the world specifically in the development of AI suited for the processing of small data and solving issues related to B2B business. The Finnish Center for Artificial Intelligence (FCAI) is a good example of this. In other words, we have a need and a home market for this kind of AI, and potential to develop significant technology exports in this sub-area. According to McKinsey, the added value created by AI in the B2B is double the size of B2C markets. And the AI revolution of the B2B market is just starting.

Key action 3: Ensure AI can be adopted more quickly and easily
Actions taken

- The launch of Business Finland's AI Business programme (AI and platform economy) at the beginning of 2018. The programme activities have included disseminating AI knowledge regionally in Finland in collaboration with the Federation of Finnish Enterprises and supporting the establishment of local AI Hubs even outside big growth centres.
- The planning of Finland's Artificial Intelligence Accelerator concept and the launch of the project in August 2018.
- The preparation of the Finnish Center for Artificial Intelligence (FCAI) by Aalto University, the University of Helsinki and VTT in 2018 and its launch at the beginning of 2019 to promote both AI research, and use and application of AI in companies and elsewhere in society.
- The development and publication of the AI index in Finland's Digital Barometer 2018 report (Digibarometri 2018) in June 2018 as self-assessment tool for companies. In autumn 2018, an electronic version of the AI index was also published.

Key lessons learned

- In Finland, the business sector is divided into a small group of forerunners and a large number of companies, which are only taking their first steps in using both data and AI.
- Finnish organisations are making vast amounts of small AI experiments, but there are challenges in taking them to production. Finland's Artificial Intelligence Accelerator was established to facilitate this dimension, but it cannot be scaled up to the challenges of the whole Finnish business sector on its own.
- Artificial intelligence does interest companies: Business Finland's AI Business was the programme that allocated the most innovation funding in 2018 (more on the subject under Key action 5).
- Low-threshold AI trials call for test environments for shared use, which could receive investments from various sources of funding and funding instruments (e.g. Business Finland, Academy of Finland and companies) and where different AI algorithms could be tested on versatile data resources.

Recommendations

- Continue Finland's Artificial Intelligence Accelerator style operations based on the lessons learned and seek opportunities to expand the operations.
- Encourage companies to generate their own AI snapshots and to define their goals with the help of such self-assessment tools as the AI index, share experiences of the use of AI between companies and take advantage of the lessons learned from Finland's Artificial Intelligence Accelerator pilots.
- Maintain a list of top artificial intelligence companies in Finland (Finnish AI Landscape) and expand it to other areas of Finnish top competences.
- Expand strategic cooperation and joint investment capacity between Business Finland, the Academy of Finland and companies to test environments for shared use.

In terms of understanding and exploiting the potential of AI, the Finnish business sector is divided into forerunners and the rearguard. The Artificial Intelligence

Programme has identified methods by which AI understanding could be disseminated to a larger group of people, thereby lowering the threshold to adoption of AI through good examples and best practices. Good examples include Finland's Artificial Intelligence Accelerator (FAIA) established under the Technology Industries of Finland and operating in collaboration with the Kasvuryhmä (Growth Collective Finland) of SMEs, and the artificial intelligence index developed to support self-assessment in companies, published in connection with the Finnish Digital Barometer. In addition to these, Business Finland's AI Business programme (see Key action 5) that supports AI and platform economy projects through innovation funding has promoted the establishment of local AI Hubs in Tampere and Turku and disseminated AI and platform economy knowledge in smaller localities together with the Federation of Finnish Enterprises.

Finland's Artificial Intelligence Accelerator to boost the use of artificial intelligence

As a result of the work of the sub-group set up under the Data and platform economy working group of the Artificial Intelligence Programme, Finland's Artificial Intelligence Accelerator was established in August 2018. The key idea is to accelerate the use of artificial intelligence. Technology Industries of Finland is responsible for the operation of the accelerator. One of the models used for the activities is Kasvuryhmä (Growth Collective Finland), established in 2015, where the business operations of the companies involved have grown significantly. Currently, the accelerator cooperates with Kasvuryhmä.

Finnish organisations make vast amounts of small AI experiments, but there are challenges in taking them to production. Finland's Artificial Intelligence Accelerator (FAIA) offers organisations a platform for rapid and continuous learning and enhances their ability to adopt AI applications to large-scale use. The various functions of the accelerator provide information on how certain technologies can be utilised, how their application should be launched and what kind of partners should be included in the projects. The experiences of Finland's Artificial Intelligence Accelerator produce information that benefits the whole Finnish business sector.

With its operations Finland's Artificial Intelligence Accelerator answers to the following questions:

- How to take AI to production? – Accelerator period
  – Each accelerator period is built around limited batches of use cases, where organisations applying AI take AI applications to production together with service providers, startups and researchers. Each batch works together for six months, operating in three-week sprints that heavily rely on peer support and peer pressure. The companies are not working on one and the same challenge, which gives people in the group a more extensive understanding of the application of AI – and a major competitive advantage – through sharing of knowledge and experiences than they would gain from their own AI project only.
- With whom should you start off? – Finland's AI Landscape list
  – Finland's Artificial Intelligence Accelerator maintains a list of top artificial intelligence (AI) companies in Finland. The list gives companies hints on who they should collaborate with to take their AI applications to practice. The list is updated on a quarterly basis with a external jury acting as curator, based on such criteria as focus on AI and international growth potential, turnover and funding collected. Suggestions can be made on which new companies to add on the list.
- What should be taken into account when adopting different AI technologies? – AI Playbook
  – The lessons learned and the challenges faced by all use case batches – in other words, the understanding of how certain technologies can be used, how they should be applied to practice and how ethical modes of operation are taken into account through the dissemination of good practices – are shared in public, which allows other organisations to apply these lessons to their own operations. The examples of use case batches thus benefit others, giving organisations more courage to take AI applications to production.

The first use case batch of Finland's Artificial Intelligence Accelerator began in October 2018. The group aims to promote large-scale deployment of Finnish-language speech technologies (i.e. speech recognition and speech production). The participants in the first batch were Elisa Oyj, Alma Media Corporation, S Group and

the technology providers Curious.ai, Speechgrinder, Inscripta and Ääni Company. Each company has its own goals in the project: One wishes to develop its customer service to enable keeping its voice-operated customer service open even outside of official office hours. Another one wishes to develop new business models, such as procurement of services by speech. The third one wants to make the everyday life of its employees easier by offering new tools that use and understand speech. The applications and final products of the companies will be presented to the public at the AI Monday event in May 2019. At the same time, Finland's Artificial Intelligence Accelerator will publish its first AI Playbook guidelines. The guidelines will provide practical examples of the areas of application for speech technology and compile the lessons learned by the use case batch into a single document.

The next two use case batches of FAIA began their operation in March 2019, and their themes are transparent recommendation systems and smart contracts.

The batch that works on transparent recommendation aims to build a transparent and portable recommendation engine platform, where it would be possible for all parties involved to affect channel-specific recommendations. A substantial share of the existing recommendation engines is built upon simple collaborative filtering methods. The value chain of recommendation is thus biased, since recommendations are given almost exclusively on the channel owner's terms. Service providers have hardly any opportunity to affect the content of recommendations. Recommendations are not transparent to the final user, so the user does not understand or know why a certain matter is recommended to him or her. There is very seldom an opportunity to select or adjust one's preference data, and since the preference data is built per channel, the users need to start the process all over again every time they switch channels.

Different contracts and their manual revision take up a substantial share of the working hours of experts. Finland's Artificial Intelligence Accelerator's aim is to create an artificial intelligence system based on the terms and conditions of purchase contracts specified by the organisation itself that a) analyses and revises contracts; b) adds specific clauses agreed in advance to contacts; c) rewrites the contents of contacts in accordance with the words and clauses agreed in advance; and d) creates a finalised draft of the final content of the contract.

The longer-term goal of FAIA is to find a scalable operating model that supports the Finnish business sector and the growth of companies, taking advantage of AI.

Introducing the artificial intelligence index as self-assessment tool for companies

One of the basic requirements in accelerating the use of artificial intelligence is that the company understands itself what kind of matters should be taken into account regarding AI, how far the development of AI has advanced and what are the goals of using AI. To support the self-assessment of companies, the Artificial Intelligence Programme working group developed an AI index table (Table 1), which was published in the Digital Barometer of 2018.

Tabell 1. The AI index includes key elements with a view to application of AI. To succeed, companies do not need to be on level four in every column of the table.

	Information	Technology	Internally	Products and services	Competence	AI as resource
AI awareness Level 1	Materials have been juridicially validated (e.g. privacy or user right) for AI model use in an appropriate manner.	Traditional analytics and data management tools exist and are in use.	The potential of AI has been identified as part of processes.	Identified, clear need for applying AI, business potential charted.	Individual/scattered AI resources or ecosystem partnership strategy created.	The role of AI as an element of production has been acknowledged.
Assisting AI Level 2	The necessary part of data is in structured format, enabling the use of AI in individual areas.	Separate AI tools, such as classification using machine learning, chat bots etc. For implementation of individual use cases as batch run type processes.	AI used to enhance automation, but only in individual use cases.	Use case roadmap has been created, and implementation of individual use cases for AI has been initiated.	AI experts in a centralised team, translators creating a bridge between the team and business operations.	AI functions in simple tasks in collaboration with humans.
Integrated AI Level 3	Data and its management have been built and designed for AI, integrated into business processes.	Real-time AI models available for individual use cases in certain areas of business operations.	AI is used extensively in the company's internal processes.	AI is part of products and services, some of which could not have been possible to produce without AI.	A networked AI team that collaborates with other stakeholders (colleagues, customers, partners etc.) and reports to the company management.	AI technology functions in a self-repairing and self-teaching manner.
AI part of identity Level 4	Comprehensive data ecosystem including external and internal information updated in real time.	AI is utilised seamlessly as part of all business operations. AI is interactive and operates in real time.	Man-machine cooperation has been planned, and machine assists people in their everyday work.	AI has been successfully scaled up into business operations, AI has created value (e.g. sales, cost savings, new business operation areas).	Active development and contribution to industry and/or science in the application of AI.	AI is part of the brand and its role in the eyes of customers and partners is the same as the people have.

SOURCE: Finland's Artifical Intelligence Accelerator

The first columns of the table include the technological enablers related to the application potential of AI, or data/information and technology. The next columns describe the use of AI in the company's internal processes as well as its products and services. One obstacle to applying AI is the availability of AI competence in the company. This does not mean data science specialists and data engineering experts only, but the company also needs competence for creating a potential corporate AI strategy. Is the company well aware of what is possible using AI and what isn't, and what it should invest in? Does the company even need an AI strategy?

To get the companies started, a web-based tool was also created that different organisations can use to generate a comparable situational picture and recommendations for applying AI. The tool is based on a survey conducted by Finland's Artificial Intelligence Accelerator and the AI index. The survey revealed that, in organisations, the challenge is not so much in technologies or access to technologies. Instead, the organisations struggle with understanding the business potential of artificial intelligence and the shortage of AI specialists. With the help of an online tool, the organisation can easily and rapidly map its readiness to exploit the potential offered by AI. The web tool is free of charge and available for use for all organisations at the address https://ai.digimaturity.vtt.fi/. The tool offers six dimensions for the comparison of AI maturity, including Strategy and Management, Competence and Cooperation, and Technology.

Before the AI index table was drawn up, interviews were conducted in three companies. The table was evaluated by circulating it for comment in different organisations and in nine different company interviews. To test the table, the companies selected to the interview were ones known for having made major advances on their path towards digitalisation or even in the utilisation of AI. Therefore, the companies do not represent the whole Finnish business sector in a broad sense. The interviewed companies were Cargotec, Elisa, Kemppi, Kone, Nokia, Tieto, Vaisala, Valmet Automotive and Wärtsilä.

Different versions of the AI index were used during the round of interviews. Furthermore, towards the end of 2018, the final tool modified on the basis of the lessons learned from the interviews was published for general use. Table 2 shows Elisa's AI index with the help of colour codes. As we have gained good experiences, we can also encourage other companies to evaluate the index and use it.

Tabell 2. A colour-coded AI index was drawn up for each company. This table shows Elisa's AI maturity.

Colour codes: Yes Under way No

	Information	Technology	Internally	Products and services	Competence	AI as resource
AI awareness **Level 1**	Materials have been juridicially validated (e.g. privacy or user right) for AI model use in an appropriate manner.	Traditional analytics and data management tools exist and are in use.	The potential of AI has been identified as part of processes.	Identified, clear need for applying AI, business potential charted.	Individual/scattered AI resources or ecosystem partnership strategy created.	The role of AI as an element of production has been acknowledged.
Assisting AI **Level 2**	The necessary part of data is in structured format, enabling the use of AI in individual areas.	Separate AI tools, such as classification using machine learning, chat bots etc. For implementation of individual use cases as batch run type processes.	AI used to enhance automation, but only in individual use cases.	Use case roadmap has been created, and implementation of individual use cases for AI has been initiated.	AI experts in a centralised team, translators creating a bridge between the team and business operations.	AI functions in simple tasks in collaboration with humans.
Integrated AI **Level 3**	Data and its management have been built and designed for AI, integrated into business processes.	Real-time AI models available for individual use cases in certain areas of business operations..	AI is used extensively in the company's internal processes.	AI is part of products and services, some of which could not have been possible to produce without AI.	A networked AI team that collaborates with other stakeholders (colleagues, customers, partners etc.) and reports to the company management.	AI technology functions in a self-repairing and self-teaching manner.
AI part of identity **Level 4**	Comprehensive data ecosystem including external and internal information updated in real time.	AI is utilised seamlessly as part of all business operations. AI is interactive and operates in real time.	Man-machine cooperation has been planned, and machine assists people in their everyday work.	AI has been successfully scaled up into business operations, AI has created value (e.g. sales, cost savings, new business operation areas).	Active development and contribution to industry and/or science in the application of AI.	AI is part of the brand and its role in the eyes of customers and partners is the same as the people have.

SOURCE: Finland's Artifical Intelligence Accelerator

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LEADING THE WAY INTO THE ERA OF ARTIFICIAL INTELLIGENCE
FINAL REPORT OF FINLAND'S ARTIFICIAL INTELLIGENCE PROGRAMME 2019

Key action 4: Ensure top-level expertise and attract top experts

Actions taken

- The competence needs for AI and provision of AI education and training on various levels of education were analysed together with operators within the sector. Some actions are currently being taken to develop the education and training, for example, by the Ministry of Education and Culture.
- The University of Helsinki and the technology company Reaktor created a free online course *Elements of AI* open for anyone. The course was very popular, and a continuation course and various language versions of the course were created later.
- To enhance research and attract top specialists, support was given for the creation of the Finnish Center for Artificial Intelligence (FCAI).
- To attract talents, the Finnish Government launched the *Talent Boost – International talents boosting growth* action plan, a joint cross-sectoral programme for the Government. As part of the programme, a 'Finnish Startup Permit' was created to attract startups coming from outside the EU and to support the growth of business.
- Universities of applied sciences were promoting a Master of Artificial Intelligence degree concept. Some companies have also developed their own training methods for provision of further training to specialists. In addition, an extensive report on recommendations concerning the transformation of work and need for education and training to promote the further training of those in the working life was drawn up.

Key lessons learned

- Finland has high-quality education and training to offer to those wishing to become experts in AI (e.g. data processing and mathematical fields).
- The application of AI in different fields is not yet sufficiently taken account of in education and training. It is important to take it into attention at all levels of education, as applicable. In Finland, there are many ways by which new contents can be efficiently introduced to teaching, such as the network of tutor teachers to enhance the competences of teachers in basic

and upper secondary education. Access to online courses and joint course offering is an important opportunity.

- There is high-level competence in Finland, but the number of specialists is limited, and the limited research resources force organisations to make drastic choices in their research work. Therefore, active international cooperation and close cooperation with other fields of research are needed for ensuring the scope and effectiveness of research. This goal has been promoted by the AIPSE programme of the Academy of Finland.

- International cooperation becomes emphasised in both building of competence and the availability of experts. Attracting talents requires determined joint efforts, where the cooperation between the public and private sectors plays an important role.

- The international competition for skilled experts is fierce. Finland must have at least equally attractive places of study and workplaces for AI experts as the other countries competing over talents.

- Finland must be capable of keeping the experts trained or doing their research here by offering them a globally competitive operating environment. The retraining of those in working life is a challenge that needs to be addressed by different measures and mechanisms. In this respect, the key measure is making the management of various organisations increasingly aware of the changes brought about by AI so as to generate necessary flexibility and investments to new training methods.

Recommendations

- On the basis of experiences gained, create an extensive provision of online courses to those in working life, thus providing an opportunity for the adult population to supplement and renew their competences.

- Open up the courses and education programmes of universities and universities of applied sciences to anyone who wants to participate. Ensure the flexibility of study modules so that it is possible for people to collect an entity meeting one's own needs from the course offering of various educational institutions and to complete it in a flexible manner.

- Take account of the opportunities to use AI and its impacts on various work tasks in vocational education and training as well, to enable creating solid foundations for applying it in working life.

- Develop mechanisms, both nationally and internationally, to enable flexible mobility of persons between companies and research.
- The Finnish AI expertise must be made internationally visible by means of research, competence and business – and this also requires contributions from ministries, financiers and researchers.
- In addition to flagship funding of the Academy of Finland, the competence hub created around FCAI needs also other kind of support if we want to generate a spillover effect of competence to society in general.
- To give boost for raising the level of top expertise, it is important to create a national development and innovation strategy for the exploitation of AI technologies. In the research sector, this means long-term investments and engagement of both those implementing the work and those funding it.
- In the training of top experts, we should invest in systematic international partnerships with the top educational institutions and research institutes of the world. This could take place in doctoral training, for instance.
- Continued investments also need to be made to attracting talents from outside Finland and keeping Finnish talents in Finland. To enhance the operations and focus the measures, we should be able to describe what kind of talents we need.

One critical competition as regards the development and application of AI is the one over talents. To ensure the availability of the education needed and top experts, a Competence and innovations sub-group was established under the Artificial Intelligence Programme. The review of the current situation clearly highlighted that Finland has high-quality education for those wishing to become experts in AI (e.g. data processing and mathematical fields), but fields applying AI are not taken into account to a sufficient extent in education. In these fields, the impact of AI would become visible faster than on others. Therefore, the working group outlined that with a view to reaching the targets, the most important measures are to ensure the availability of versatile education, to invest in new teaching methods (such as massive open online courses, MOOCs) and to attract top talents to Finland. In addition, it is of critical importance that the management of organisations understands the transformation brought about by AI and the relevant competence needs.

The Ministry of Education and Culture is continuously developing the Finnish education system as an entity and has also been active in the development of AI education and training. One efficient training mechanism is the 'tutor teacher network' used in basic and upper secondary education. The idea of the tutor network is to efficiently disseminate new information through peer training of teachers. Other matters considered in the course of the development work include methods for supporting lifelong learning as well as the question how AI and digitalisation could be used in teaching. AI enables better observation of individual differences in learning and assists learning, thus making it possible to provide good and tailored teaching to a larger group of people.

Versatile education programmes

At the very beginning of the Artificial Intelligence Programme, the University of Helsinki and Reaktor created the *Elements of AI* online course, which brought the basics of AI at the reach of every Finn. The course attracted a lot of attention, and more than 100,000 people took the course within a few months. The course was also acknowledged internationally, and versions of it have been made available in English and in Swedish. A continuation course was also prepared, as well as a further course on the ethics of AI. The course has also been marketed abroad.

An important step towards training and attracting top talents is the establishment of the Finnish Center of Artificial Intelligence (FCAI) and the flagship funding it was granted by the Academy of Finland, and particularly the allocation of funding of host organisations and cooperation partners to the operations of FCAI that was the requirement for getting the flagship funding. Through FCAI, the Finnish leading-edge research can form one hub in the international competence network. Other key features in the operation of FCAI include demanding challenges in the application of AI and close corporate collaboration. In addition to sufficient resources, interesting challenges in particular and close research cooperation have been seen as key elements for attracting top talents.

Workforce skill requirements are influenced by changes in the demand for labour in the labour market. The demand for experts is expected to increase dramatically in tasks where AI or its application is developed. This is a requirement that cannot be responded through the normal educational path alone, but it calls for different measures and mechanisms by which the competences of those in working life can be efficiently enhanced. A major share of people's skills is based on on-the-job learning, and, therefore, employers' responsibility for upskilling will grow. Companies are actively seeking ways to train their employees either in-house or together with other companies. For example, in autumn 2018, the first further training course in machine learning was implemented for industrial employees. The training was arranged by DIMECC together with Futurice and Centres for Economic Development, Transport and the Environment (ELY Centres). The study entity included a versatile offering of subjects from machine learning algorithms to ethics, and from planning and management of an AI project to application of AI to a company's business activities. Universities of applied sciences have also begun to take concrete steps to promote the further training opportunities of those in working life; Metropolia, for example, has been advancing its Master of Artificial Intelligence education.

Immigration and international mobility are needed in addition to training

With a view to increasing the number of versatile AI experts, immigration and international mobility also play a bigger role than before. Furthermore, it is important that Finland also remains interesting to those international-level talents that have been trained or are doing research here. The immigration of top talents strengthens and internationalises the Finnish innovation activities and supports international investments. For this reason, several measures have been taken to attract foreign experts to Finland and speed up their entry to practical work. The Finnish Government launched the T*alent Boost – International talents boosting growth* action plan, a joint cross-sectoral programme for the Government. The aim of the Talent Boost is to strengthen the action for attracting international talents to Finland, to channel the expertise of international talents already in Finland to support the growth, internationalisation and innovation activities of Finnish companies, and to increase the openness, hospitality and attractiveness of the Finnish labour market. In support of the action plan, a study was conducted on

good practices for integrating the competences of international immigrants into the Finnish innovation economy, the internationalisation of companies in particular. Denmark, the Netherlands, Austria and Canada[5] were used as points of comparison.

A 'Finnish Startup Permit' was established in Finland to attract startups coming from outside the EU and to support the growth of business. The permit accelerates the immigration of entrepreneurs who have a business idea or business plan with major prospects of growth. The criteria for getting the permit include a business plan, sufficient skills background and funding. The assessment of whether the company meets the criteria is made by Business Finland. In addition, in order to get a two-year permit, the applicant must also meet the normal criteria for a residence permit. Business Finland has also developed a more comprehensive Startup Kit service package aimed at providing support for attracting international startups to Finland and for their integration. The Finnish Startup Permit is included in the kit.

Some operators have also seen business opportunities in the training of new talents. As an example, we could mention *Integrify*, which trains talented immigrants into programmers and helps those who have completed the training to find jobs matching their training. By providing an intense and practical top-level programming training of six months, the company strives to respond to the global shortage of programmers and address the challenge related to the integration of immigrants. In 2018, more than 60 people attended the training and 80% of those who completed the training are now working in junior programmer positions. The first courses focused on frontend technologies. In 2019, Integrify will expand its training offering to AI and machine learning programmers.

Investments need to be made in leading-edge research

The level of top expertise cannot be raised without leading-edge research. The national survey of AI competence[6] emphasised the importance of international scientific research. As expected, U.S. universities have a strong representation on

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5   see Immigrants in the Innovation Economy – Lessons from Austria, Canada, Denmark and the Netherlands

6   The overall view of artificial intelligence and Finnish competence in the sector

this sector. Of European operators, the ETH Zurich and the University of Oxford are close to the top, when using the average normalized citation score of publications as indicator. However, different fields of research differ substantially from each other both in terms of citation scores and changes in them. Different countries also have different focus areas in their research in the various lines of AI research. For example, India has risen as the third country after the U.S. and China in the number of AI publications particularly as a result of its research efforts in the fields of machine learning and perception, and data analysis.

The high quality of Finnish AI competence and research becomes visible when the indicators are set in proportion to the Finnish population. Measured by the number of publications, as expected, the biggest universities in Finland in 2008–2017 were Aalto University, the University of Helsinki and the University of Oulu (Digital Barometer 2017). Due to the limited resources, international cooperation plays an important role in Finnish research, which shows as a relatively high number of international joint publications. Typical of AI research is also the strong status of applied research. In Finland, the cooperation between companies and universities is also at a higher than average level, although it does not reach the level of top countries (Israel, Switzerland and the US).

Generally speaking, we could say that Finland has been investing in AI research for a long time, which currently constitutes a very strong competitive advantage, and the research sector as a whole is in a relatively good condition. Thanks to the strong foundations, it is possible for us to compete in the field with countries that invest major amounts of money in research, but it does require additional investments. Therefore, it goes without saying that long-term investments need to be made in AI research at an internationally competitive level. For example, the flagship funding targeted to FCAI by the Academy of Finland (EUR 8 million) is far from sufficient in international competition. Therefore, national investments need to be increased, thus enabling cooperation with the various stakeholders and companies doing leading-edge research.

Key action 5: Make bold decisions and investments

Actions taken

- Business Finland's targeted innovation funding for AI and the data and platform economy. Capital loan funding for Growth Engines was targeted for the operations of new kind of platform companies using data. In 2018, the AI Business programme was the biggest programme run by Business Finland.
- Investments were made to leading-edge research, reform of learning, and data management and computational infrastructure.
- Central government agencies were encouraged to promote productivity by means of AI and robotics.

Key lessons learned

- Finnish investments can be globally noteworthy, when they are targeted to strategically selected areas.
- The operating conditions, such as high level of digitalisation and high-quality data, must be in order to allow making of investments in AI. It is not expedient to separate AI investments into an area of their own, but the development is advanced in a comprehensive manner.
- In a global scale, any investments made by Finland are small. Another challenge is that the investments are fragmented, and they are difficult to gather into parallel, long-term entities with a strategic impact.

Recommendations

- Ensure that the existing funding channels and systems respond to the needs of the development, application of artificial intelligence as well as growth, and strengthen them if necessary.
- Ensure our ability to secure major strategic investments and RDI investments in competences.
- Maintain the cooperation between the public and private sectors and a functional dialogue regarding investments.
- Ensure that the provision of capital funding for AI by Business Finland continues as a permanent instrument.

If we want to promote the development, application and deployment of AI, and enhance competitiveness and wellbeing through them, we also need to make investments in artificial intelligence. In Finland, we cannot be real forerunners before the volumes of investments are at a notable level. Both private and public sector investments are important, and one of them can be used for leveraging the other. Thought leadership needs to be supported by actions as well. We can promote matters that we consider important, such as democracy or environmental affairs, only if relevant investments are in place.

AI requires, for example, high level of digitalisation and availability of appropriate, high-quality data. In many sectors investments are still used for making this groundwork, and, therefore, for the time being they lack the readiness to make direct investments in AI.

It is the public sector and lawmaker's task to remove obstacles, and to create space and opportunities for investments and growth. We have to ensure that the necessary funding tools are in place. It is not expedient to separate AI investments into an area of their own, but the development needs to be advanced in a comprehensive manner. The objective is that AI is made part of the existing funding channels and systems.

At the same time, Finland must ensure that we have the capacity to make bigger strategic investments, when necessary, and to pool resources. It is not realistic for us to compete with absolute investment volumes with actors like China or the US. Still, Finland's limited resources and investments can be noteworthy, when targeted to strategically selected areas. To accelerate investments in AI and maximise the impacts, companies and the state should make investments along the same lines. International AI investments targeted to Finland must also be promoted.

Making active investments to artificial intelligence

In this chapter we present AI investments in our knowledge and already implemented investments as examples to demonstrate different types of investments. In total, Finland's overall investments are significantly higher, consisting of the leveraging effect of the public sector funding, funding provided by companies and investments targeted to Finland.

There has been a high demand for AI funding provided by Business Finland. In 2018, with public funding amounting to EUR 34 million and a total of 115 projects, the AI Business programme, focusing on AI and the platform economy, was Business Finland's biggest programme. The programme, launched at the beginning of 2018, has been reserved an authorisation to allocate EUR 100 million over a four-year period, as well as an authorisation to grant EUR 60 million of capital loan for the first two years to be allocated through competitive biddings on Growth Engines. Growth Engine funding has been granted to five platform companies with an aim to boost the development of new business ecosystems and growth in Finland. Each of the entities that have been granted funding aim at generating business, exports or investments in Finland amounting to more than one billion euros. Data, AI and smart analytics play a central role in the platform companies granted funding. They operate in such sectors as data-based built environment and smart mobility services.

With its new business model, State Business Development Company Vake Oy, to begin its operations in 2019, is a European forerunner. Vake offers a totally new kind of partner option for both private and public operators to achieve long-term effectiveness through cooperation. Vake has chosen to launch its operations focusing particularly on the artificial intelligence theme. In its planning, the new operator is prepared to invest up to EUR 100 million to AI funding schemes and projects each year, provided that suitable operations can be identified and implemented. Vake will invest in solving AI bottlenecks and harnessing Finland's existing strengths. One of the key objectives of Vake is to have globally leading centres of excellence built in Finland around these strengths.

The software company RELEX Solutions from Helsinki received a minority investment of EUR 175 million from the venture capital firm Technology Crossover Ventures (TCV) at the beginning of 2019. The American TCV is one of the world's largest providers of capital for growth-stage companies in the technology industry and its earlier investments include such companies as Airbnb, Facebook, Netflix and Spotify. The system developed by RELEX uses AI to help stores optimise and automate their production chains and reduce waste, for instance. In 2017, the company's turnover was EUR 26.4 million and in 2019 RELEX is aiming at a turnover of EUR 60 million. Business Finland was already involved in the company's startup phase and has provided funding for RELEX's research and development work and internationalisation.

In 2018, the Academy of Finland granted EUR 17.8 million for leading-edge research linked with AI systems and applications.[7] The flagship decisions made at the beginning of 2019 granted the cancer research flagship applying AI techniques EUR 11 million. The Finnish Center for Artificial Intelligence (FCAI) was granted EUR 8.3 million in flagship funding for 2019–2022. This is seed funding for FCAI activities, which is estimated to amount to a total of EUR 250 over the next eight years when the flagship funding is combined with the funding provided for the flagships by host organisations and other organisations involved. In 2018, the Technology Industries of Finland Centennial Foundation and Jane and Aatos Erkko Foundation provided a total of EUR 3.2 million for seven research projects aiming to solve issues affecting the future of humankind. Researchers use the funding for such projects as developing tools for the use of AI, enhancing medical imaging and seeking more efficient solutions for monitoring water quality. FCAI was granted a million euros of the total sum[8].

In 2018, the Government decided to invest four million euros to acquisition of AI and AI research equipment for Finnish researchers and innovation operators. The development programme for research infrastructures and services in data

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7   The project is included in the results if its key words or abstract contain one or more of the following terms: "artificial intelligence", "deep learning", "machine learning", "neural network". This includes both projects that develop AI techniques and projects that apply them with such intensity that a term or more of the ones mentioned above are recorded in their abstract or list of key words.

8   Researchers will put artificial intelligence to work: foundations are pledging EUR 3.2 million for an AI toolbox, application of AI and more empathetic technologies

management and computing run by the Ministry of Education and Culture will invest a total of EUR 37 million on data management and computing infrastructures and related services between 2017 and 2021.

The supplementary budget of 2018 allocated EUR 10 million for short-term education and training aimed at completing a part of a qualification or a smaller skills entity. In June 2018, the Department of Computer Science of the University of Helsinki made its first-year studies open for everyone, free of charge. The Ministry of Education and Culture awarded a grant of EUR 1.5 million for the pilot project that will continue until 2020.

In 2018, one million euros was invested in the preliminary study pilots and project planning on the AuroraAI national AI programme (see Key action 6). Furthermore, central government agencies were encouraged to simplify and automate their processes and to boost productivity by means of robotics, AI or other emerging technologies with the help of special funding of EUR 6 million in 2018[9]. The total funding allocated for the Artificial intelligence research entity of the Finnish Government analysis, assessment and research activities in 2018 amounted to EUR 670,000. The five research projects focused on, for example, the opportunities and challenges of using AI in the national regulatory environment, the requirements for the development of information infrastructure, the mapping of national AI competence, and the societal acceptability and ethics of the regulation and use of robotics and AI. The AI-themed open application process of the Prime Minister's Office organised in 2018 sought small-scale pilots that would enhance everyday wellbeing. Each of the 21 pilots selected received EUR 3 000–5 000 to support the implementation.

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9   Boosting productivity by means of robotics, AI or other emerging technologies

Key action 6: Build the world's best public services

Actions taken

- The preliminary study on the AuroraAI national artificial intelligence programme was launched, laying foundations for the transition of the Finnish society towards the age of artificial intelligence in a human-centred and ethically sustainable manner.
- The preliminary study identified what kind of changes life-events based thinking means from the perspectives of, for example, the operation of organisations, and management and leadership.
- The first trial version of a decentralized and open AuroraAI network, enabling mutual interaction of smart applications and services provided by various service providers, was created.
- A coaching programme for the management and management-level operators was created to promote a transfer to a human-centred management model that supports collaboration.
- Special legal issues were investigated, and foundations laid for the ethical set of codes of the AuroraAI network.
- A development and implementation plan was drawn up for 2019–2023 with an extensive network of operators.

Key lessons learned

- The human-centred operating principle must serve as the starting point for all service operations.
- Open networking across sectoral boundaries changes the whole field of operations and generates new added value for everyone. It is our future way of operating, enabling joint commitment even to difficult changes and reforms.
- Phenomenon-based and wicked problems cannot be solved from separate silos.
- The capability of employees to work with data analytics and AI must be enhanced.
- The existing legislation on the use, sharing and combining of personal information on people is very challenging.

- The entity is too complex to lend itself to being transformed into an open blockchain system to serve as an incentive and reward mechanism for the AuroraAI network.

Recommendations

- Launch the creation of a human-centred service ecosystem together with citizens and companies around chosen life events and business-related events (the AuroraAI programme).
- Enhance the implementation by setting up a team for supporting the operational change.

The world's best public administration enables a human-centred, proactive society, where people learn to understand their own wellbeing, and where services seek their way to people in a timely, information secured and ethically sustainable manner. The starting point of a human-centred society is the comprehensive wellbeing of citizens, companies and society. The human-centred approach finds its concrete form in life-events based thinking, which guides the operations of organisations, and the planning and implementation of services. This approach will create the best possible conditions for individuals to support their own wellbeing and the wellbeing of their loved ones in different life situations. The implementation of a human-centred society was prepared in the preliminary study project on the AuroraAI programme, set up by the Ministry of Finance, between 15 September 2018 and 28 February 2019.

The objective of the preliminary study was to produce for organisations providing services for various events in people's lives a description of a service entity that would enable mutual interaction between smart services. The first trial version of the AuroraAI network was built during the project. At the same time, the aim was to identify what kind of changes implementation based on life-events-based thinking means for, for example, the provision and management of services. For the consumers of these services, the aim of AuroraAI is to enable seamless and smoothly functioning service paths in different life situations and for different life events. Various methods for implementing the objectives were studied during the preliminary study based on the life event pilots launched in spring 2018: 1) moving to a place of study, 2) gaining a foothold in working life through competence

development, and 3) the wellbeing of children and parents in changing family relationships. The preliminary study was carried out using an open networking approach which involved experts of various fields from local government, counties, the third sector, companies, agencies and ministries.
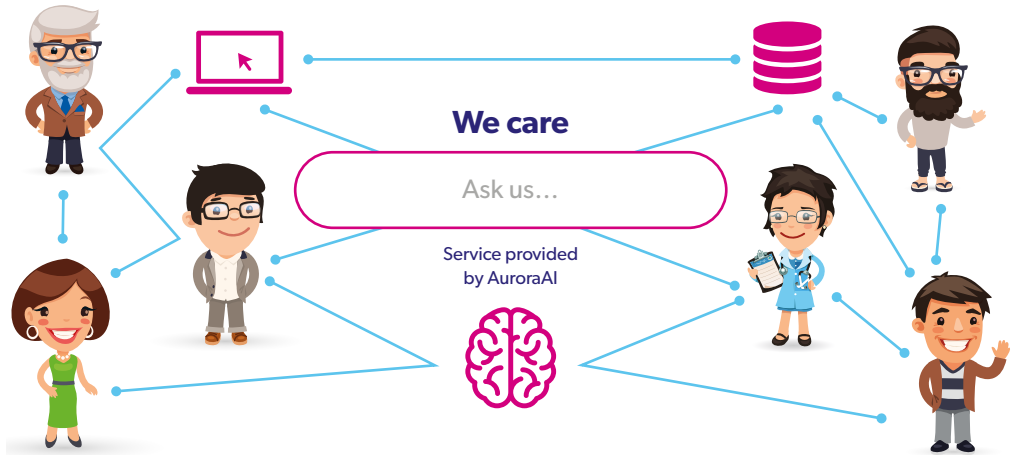

Figure 8: The AuroraAI concept of a human-centred, proactive society, where services seek their way to people in a timely, information secured and ethically sustainable manner.

Finding solutions to such societal challenges as the sustainability gap in the state economy, the ageing of the population and the social exclusion of young people call for understanding and snapshots of people's genuine needs and wellbeing status across administrative boundaries. Generating a snapshot requires that data, data analytics and other AI applications are used in new ways. Based on information, services could be targeted effectively, which would turn the service chains smooth, tailored and effective from the perspective of citizens. At the same time, services could be targeted effectively from the viewpoint of state economy as well, and misuse and overuse of resources and disruptive demand for services could be eradicated.
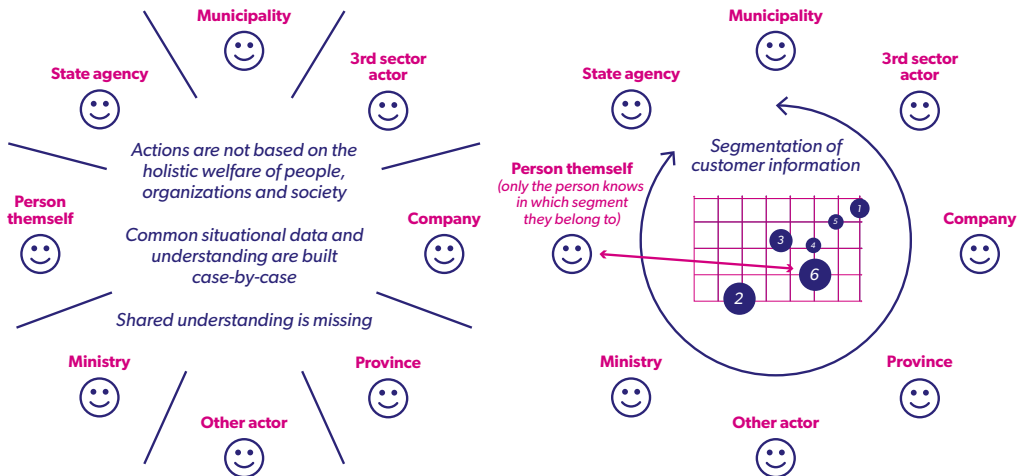
Figure 9: A shared snapshot of a person's situation eliminates running from one service point to another, bringing substantial improvements to the efficiency of organisations.

In practice, the AuroraAI programme creates a platform which various organisations from different sectors can join to create value for people in different life events. AuroraAI is speeding up the establishment of an ecosystem serving the needs of citizens and the trade and industry, where smart services function seamlessly in a human-centred, interactive and ethically sustainable manner. The precondition for the development of a trust-based society relying on information is that people feel being part of it. However, the building of trust requires transparency, accountability and reliability. Trust can be maintained by taking care of clear information management responsibilities and the understandability, information security and protection of digital products and services throughout their service lives. The ethical set of codes drafted in the preliminary study phase defines common ethical principles for the AuroraAI network, and it serves as a basis for formulating and deploying the ethical operating methods of the network.

The key benefits of the AuroraAI network are:

- Running from one service point to another is reduced drastically or even eliminated.
- Citizens are provided smoother functioning, better timed and more precisely targeted service entities.

- Citizens are provided with a novel way of taking care of their own comprehensive wellbeing.
- Service providers are given a capability to form customer-centred and dynamically evolving service chains in collaboration with other operators.
- Management based on a snapshot of the wellbeing of citizens will become stronger.

The next steps in the implementation of the AuroraAI programme:

1. **Identifying the essential life events and business-based events.** Asking directly from citizens and companies what are the key life events that should be made human-centred and the business-based events that should be made smoother.
2. **Form human-centred service ecosystems.** Public administration organisations are asked to make proposals for creating human-centred service ecosystems and operations with the help of smart applications and AI. The applications are linked together using the AuroraAI network to provide services for people in a human-centred, information secured and ethically sustainable manner.
3. **Establishing a support team for change in operations.** The objective of the team is to support the organisations implementing a change in their operations by means of coaching, creating snapshots that develop with time to support management, and assisting in creation of rules for ecosystem operations (e.g. data economy, technologies, judicial aspects, rights, obligations, powers and responsibilities) together with the ecosystem operators. The goal is a collaborative, reliable, reciprocal and viable ecosystem of operators, which enables a human-centred, proactive society.

What should be done next?

It is recommended that the Government introduce the AuroraAI service model to boost the effectiveness of services, to make service chains smoother in accordance with the life-events-based approach and to enable the use of data in the service offering. The model takes advantage of a decentralized and open network consisting of smart applications, which, on the other hand, enables

mutual interaction of various services and creation of seamless service chains in an information secured and ethically sustainable manner.

With the help of AuroraAI service model, organisations from various sectors of society generate a snapshot of wellbeing to support human-centred operations, go through the coaching programme supporting a change in operations, and integrate their operations and smart services as part of the service market, being formed around the selected life events and business-based events. The change in operations and utilisation of new technologies enable building the services from the viewpoints of citizens, companies and the community instead of allowing the development to begin from the needs of authorities.

Key action 7: Establish new models for collaboration

Actions taken

- Operating models that supported multivoiced discussion and culture of experimentation were used in the organisation of the Artificial Intelligence Programme's own activities. The programme has been operating as a network of networks, to which specialists from various sectors and organisations have been invited as needed.
- The Ecosystem Forum, operating under the Prime Minister's Office and the Prime Minister's State Secretary, has invited stakeholders from within and outside of administration to jointly identify digitalisation bottlenecks and solutions.
- The operating models of peer learning and cooperation between actors struggling with the same challenges have been used both in the sub-groups of the Artificial Intelligence Programme and in different projects, such as Finland's Artificial Intelligence Accelerator launched by the Technology Industries of Finland.

Key lessons learned

- To bring about an extensive change in society, it is of vital importance to establish an overall picture of the objectives, opportunities and obstacles,

as well as the measures needed. A network of networks enables the maintenance of such situational awareness. However, it is important not to try to overcontrol the activities of the different parts of the network – instead, they should be encouraged to independent activity.

• Keeping up with the technological change and international competition requires that we must boldly give up the old operating models and structures developed for the needs of an industrial society. With the help of new models and experiments, we will be able to create systemic change at an accelerated pace.

Recommendations

• Monitor how the implementation of the Artificial Intelligence Programme's objectives is advancing. The responsibility for such monitoring should belong to a monitoring group with representatives from both the private and public sectors that functions in the same manner as the DigiNYT group or a more extensive cooperation forum promoting the digitalisation of business.

• Continue the testing of new operating models particularly in cross-administrative and cross-sectoral cooperation.

The Artificial Intelligence Programme is a network of networks

In the Artificial Intelligence Programme, we have called for new cooperation models for private-public partnerships, but also for cooperation done within the public and private sectors. Broad application and use of AI require multivoiced discussion, identification of opportunities and obstacles, and rapid and experimental activities, often requiring joint efforts between various sectors. It is also important to involve individual people in the discussion and activities.

The AI Programme itself has been organised with this perspective in mind. Representatives of the private and public sectors and research institutes, employers and employees, individual experts and influential people were invited

to the steering group and its sub-groups. It has been important to formulate the objectives and the progress strategy together, to initiate practical measures quickly and to strive to learn from action taken in the spirit of the culture of experimentation, with the help of joint broad dialogue.

- The Competence and innovations sub-group has brought together a total of 15 enterprise-driven ecosystems to promote enterprise-driven innovations using AI, and exploitation of AI in various sectors and companies.
- The Data and platform economy sub-group has collected experts from all sectors to consider how the accumulation and use of data resources could be facilitated.
- The Transformation of society and work sub-group has brought together experts in working life and economy as well as representatives of employers and employees to examine how work and the labour market will come to change and what kind of needs for change this will cause for competences and legislation.
- The Ethics sub-group has assembled AI adapters and researchers to establish a common understanding of the multidimensional ethical aspects of AI and to create concrete mechanisms and operating models.
- The DigiNYT group has been bringing together experts and professionals in the digitalisation of the public sector since 2013. Last year, the focus was on the AuroraAI programme.

The parties that have been involved in the operations have actively seized the challenges and set to work, taking advantage of their own networks. Without the network of networks operating model, it is unlikely that the AI Programme could have initiated and taken forward such a large number of different measures. Furthermore, the perspective of the programme would certainly have been narrower and the situational awareness weaker.

Ecosystem Forum supporting public-sector innovation activities

Cooperation between different sectors and an ecosystem approach has also been applied in the Ecosystem Forum, operating under the Prime Minister's State Secretary. It has been tasked with identifying digitalisation bottlenecks and

solutions in collaboration with authorities, business representatives and researchers. The ecosystem has invited different stakeholders to work together about a dozen times over the past two years and offered a channel for raising different issues also at a political level.

In the Prime Minister's Office, the trial, which lasted for the final years of the government term, was considered good compared to the traditional and slow preparation of matters through committee work and by writing reports. Therefore, it is recommended that a similar operating model emphasising collaboration and free innovation be used also in the future to enhance innovation in the public sector, to support preparation of policies and decisions, and to have them implemented.[10]

Cooperation between companies

Peer learning and cooperation between actors struggling with the same challenges has also been important. The cooperation between the company ecosystems of the Artificial Intelligence Programme's Innovations and competence sub-group is a good example of this. Another good example is the operation of Finland's Artificial Intelligence Accelerator, generated by the activities of the Data and the platform economy sub-group, where companies strive to find solutions to challenges of applying AI together. Companies cooperate with each other regardless of the fact that some operators may also be their potential competitors, since they understand that cooperation leads to better results for everyone. For example, the Finnish gaming industry is a forerunner in this kind of operating model that combines competition and cooperation, and the culture of collaboration and learning resulting from this has been considered the key of the industry's success.

Adopting cooperation models that enable rapid clock frequency

By testing new operating models, we have learned that the societal changes brought about by AI and digitalisation in general are so extensive and multidimensional that the best way of anticipating and understanding them is

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10   Recommendations of the project to develop strategic government policy-making, Finnish Government publication series 2019:2

broad cooperation and discussion across sectoral and organisational boundaries. Collaboration between various actors is also needed for seizing the opportunities and finding functional solutions. We need an overall picture of the objectives, opportunities and obstacles, as well as the measures needed.

A network of networks is an example of an operating model that enables the maintenance of such situational awareness. However, it is important not to try to overcontrol the activities of the different parts of the network – instead, they should be encouraged to independent action.

We have to work together, rapidly and doing trials – in other words, at a faster clock frequency than before. Finland's small size, the trust between the actors and uniform culture enable the establishment and adoption of an agile operating culture. We can create competitive edge compared to global operators only by pulling together and acting in a smarter way than our competitors.

When necessary, we must boldly give up the old operating models and structures developed for the needs of an industrial society and develop new models to be able to generate systemic change at a faster pace. Therefore, it is important that we continue experimentation with new operating models particularly in cross-administrative and cross-sectoral cooperation and boldly give up any outdated operating models, as necessary. We must aim for speed, and establishment of situational awareness and common will in the cooperation between different stakeholder. It is also essential to enable learning through action with the help of such instruments as a sandbox.

The opportunities and changes brought about by AI are only just beginning, and there is still a lot to do for Finland to become a leader in the application of artificial intelligence. It is important to continue the work initiated by the Artificial Intelligence Programme in such a manner that we monitor the progress towards the objectives, enable learning from our experiences and adapt our actions as necessary. At minimum, this could mean setting up a monitoring group with representatives from the private and public sectors that functions in a similar manner as the DigiNYT group either as a separate organ or as part of a wider cooperation forum promoting digitalisation in business life.

Key action 8: Make Finland a forerunner in the age of artificial intelligence

Actions taken

- Finland has been among the first EU countries to draw up a national artificial intelligence programme.
- Holding a forerunner role, Finland has actively contributed to AI in the European Union and EU institutions. In addition, Finland has been visible in the lead of the *High-Level Expert Group on Artificial Intelligence* set up by the European Commission. *The group is preparing*, for example, ethics guidelines for trustworthy AI for Europe.
- The European ministerial AI conference, *AI Forum 2018*, held in October 2018, also brought visibility for Finland.
- The web-based civic AI education serves as an international model example. The AuroraAI programme has also made Finland known as the developer of AI solutions for the public sector, and the development of MyData made in Finland is considered to be trendsetting.

Key lessons learned

- We must take care of the high standard of AI research, but the AI programme's clear emphasis on the application of AI is considered a good choice for a small country.
- There are good spearhead initiatives in Finland, but often we can make best progress by engaging in international cooperation and learning from others.

Recommendations

- Influence the EU's strategic priorities in digitalisation and AI.
- Introduce the digital economy, founded on artificial intelligence, data and platform economy, as one of the key themes of the Finnish Presidency of the Council of the EU.
- Enhance AI cooperation with countries leading the AI development outside Europe and with our European counterparts on a bilateral basis as well.

In 2019, Finland will have a special opportunity to influence the development of EU policies as the holder of the Presidency of the Council of the EU in collaboration with the three-Presidency team. In accordance with the priorities of the Finnish Presidency of the Council of the EU, the goal is to enable sustainable growth of Europe with the help of efficient functioning of the Single Market and rapidly developing digital economy. European competitiveness, Single Market, industrial policy and innovation are supported by digitalisation that creates preconditions for growth on the global market. Boosting the digital economy is of vital importance for growth both in Europe and in Finland. Digitality is part of Europe's strategic autonomy, which requires building of AI, cybersecurity and digital competences.

Finland has been holding a forerunner role and has actively contributed to AI in the European Union. Finland has been among the first EU countries to draw up a national AI programme. In addition to Finland, France, Sweden, the United Kingdom and Germany already have their own targeted AI strategies. Some countries, like Denmark and the Netherlands, have included measures related to AI as part of more extensive digitalisation strategies. Finland has been an active member in a working group of Member States working on a common coordinated EU-level action plan on AI of the Commission and Member States.

Led by Janne Känkänen, the chair of the EU High Level Working Group on Competitiveness and Growth, the group processed the coordinated action plan on AI published by the Commission in January 2019 and discussed the impacts of AI on the industrial competitiveness for the European Union. AI is an inseparable part of industrial policy in Europe, and EU Member States – including Finland – have placed great emphasis on the availability of data, data protection, building of digital information and skills, and trust in AI. Creating a competitive edge at the EU level is essential, ethical principles are important, and the trust of both citizens and companies towards AI needs enhancement.

The Ministry of Economic Affairs and Employment organised an important European ministerial AI conference, AI Forum, led by Minister of Economic Affairs Mika Lintilä, in October 2018. The conference, held in collaboration with the European Commission, brought together European ministers, business leaders and AI experts to discuss the future of AI in Europe. The conference was hosted by Minister Lintilä, Vice-President of the European Commission Jyrki Katainen

and European Commissioner for Digital Economy and Society Mariya Gabriel. The discussions examined, for example, how Europe's strengths in the use of AI differ from those of other regions, such as China and the US. Political leaders from a total of 22 countries in Europe and the neighbouring regions were represented in the conference. Aalto University, VTT and the Technology Industries of Finland were also involved in the organisation of the conference.

Pekka Ala-Pietilä, who acts as chair of the Finnish Artificial Intelligence Programme, was selected to head the European Commission's High-Level Expert Group on Artificial Intelligence (AI HLEG). The ethics guidelines for trustworthy AI prepared by the group will be published in April 2019. The AI HLEG will also put forward operational policy recommendations on investments and regulatory framework. Meeri Haataja, chair of the Ethics sub-group of the Finnish AI Programme, has been appointed chair of the global Institute of Electrical and Electronics Engineers Standards Association (IEEE)'s Ethics Certification Program for Autonomous and Intelligent Systems (ECPAIS) aimed at creating an ethics certification process for artificial intelligence.

In addition to the close EU cooperation, boosted by the approaching Finnish Presidency of the Council of the EU, Finland has also been actively involved in the AI work of OECD, as well as in Nordic cooperation. In addition, Finland has been sharing views about artificial intelligence bilaterally. In August 2018, Prime Minister Juha Sipilä and President of the French Republic Emmanuel Macron agreed on French-Finnish Joint Statement for Cooperation on Artificial Intelligence in Helsinki. In the joint statement of Finland and France, the EU Member States are urged to take a more systematic approach to the opportunities brought about by artificial intelligence and to respond to citizens' concerns relating to the ethical questions linked to artificial intelligence, for instance.

Key action 9: Prepare for artificial intelligence to change the nature of work

Actions taken

- The sub-group on the Transformation of society and work, with economists and other leading researchers, senior public officials and experts from labour market organisations as members, published in June 2018 the report Work in the age of artificial intelligence. The report examined four main themes: (1) the effects of artificial intelligence on general economic and employment trends; (2) the transformation of work and the labour market; (3) reforms on education and skills maintenance; and (4) ethics.[11]

Key lessons learned:

- Since, in Finland, there are relatively few jobs containing routine and repetitive tasks, the number of jobs replaced by AI will probably be relatively small. However, we must be prepared for quick disappearance of jobs in certain sectors.
- AI is expected to worsen the skills mismatch, so the level of education must be raised. Furthermore, there should be jobs that people could enter without special skills.
- Artificial intelligence is support intelligence, and often certain tasks are best performed by the combination of a man and machine. AI may empower, for example, nurses to take over some of the tasks currently performed by physicians.
- Even though AI may not eliminate a large number of jobs, it will change the nature of work in almost any job. The need for continuous further training for the personnel is obvious. There are many alternatives for organising and funding the training.
- Use of AI may significantly enhance the efficiency of employment services. For example, the AI software of employment services could suggest a job that is a better match with an employee's new competence to those in employment as well.

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11 The issue of ethics is examined more closely under Key action 10.

Recommendations:

- Target innovation funding at innovations that generate new type of production, thus creating new tasks and jobs.
- With a view to promoting lifelong learning, we should explore the opportunity of granting every Finn in working age a learning voucher or account, which would create a well-functioning demand-based adult education market in Finland.
- Improve the current social security system and ensure smoother transitions with more predictable consequences between different roles in the labour market, including studies and unemployment.

Economy and work of artificial intelligence

Artificial intelligence can be aptly compared to electricity, because, just like electricity, AI is making its way to almost every aspect of life and developing in ways we know nothing about as yet. 150 years ago, people could imagine only a small share of the uses to which electricity lends itself. The general notion is that the productivity growth and creative destruction that slowed down in the 2000s will begin to pick up speed with the deployment of AI.

Ideas of to what extent artificial intelligence will do away with current jobs vary greatly. In Finland, the impacts are estimated to be smaller than in many other countries, since here we have relatively few jobs containing routine and repetitive tasks. In 2015, approx. 9% of Finnish jobs were tailored jobs containing routine tasks which lend themselves to automation easily, whereas in Germany the corresponding figure was approx. 30%. The Nordic welfare state will facilitate adaptation to the changes.

So far, automation has mainly reduced simple, basic tasks which do not require much competence, and replaced them with tasks that require a higher level of competence. Even though the population's level of education has risen, it has not risen as fast as the level of demand in many jobs. This has created a skills mismatch: there is shortage of highly educated specialists, while those with a low education

level cannot find jobs. AI is expected to worsen the skills mismatch even further. The situation calls for raising the education level. No-one should be left relying on basic education alone, and there should be more highly educated people in Finland than there are now.

In certain professional groups, AI may mean painful job losses. When, for example, automated cash registers begin to function reliably, the technology used is cheap to replicate. It may significantly reduce the number of jobs in retail trade within a short period of time.

AI will also rationalise work performed by those with an academic education. Google searches have already changed the work of journalists and researchers. As a tool used by lawyers, AI reduces the amount of routine work, and increases the value of and demand for work requiring creative thinking.

In research and innovation policy, it is recommended that rather than accelerating automation development, funding should increasingly be targeted to innovations that generate new types of production, as they also create new tasks and jobs. For example, organisational and social innovations needed for the successful utilisation of new technologies should be supported.

Artificial intelligence is support intelligence

Even though the level of demand in human work is generally expected to increase, development will also happen in the opposite direction. Navigators make the taxi driver's work easier. AI may turn some work tasks performed by humans easy and eliminate the protection that vocational skills give to an employee in the labour market, as anyone can learn the task quickly.

In the healthcare sector, AI creates pressure to change the division of labour between healthcare professionals. According to certain studies, AI and human physicians are currently at about the same level in making diagnoses, but a "centaur", a combination of a machine and physician, is absolutely the best. On the other hand, assisted by AI, nurses could manage a substantial share of the work tasks currently allocated to physicians, which would allow physicians to focus on

more demanding tasks and encounters with patient. This could reduce the overall healthcare expenditure, while simultaneously improving the level of treatment.

AI will also make its way to the patients' mobile phones, whether we want it or not. It would be advisable for the public healthcare to make AI programs that propose diagnoses generally available, because other actors will make such applications in any case. Self-tracking of personal health has become very popular. This generates mass data that could be very valuable to the healthcare sector. For example, in the treatment of diabetes, connecting the results of blood glucose measurements made at home to a physician's computer program would facilitate extending invitations to control appointment to those who are not doing well, while reducing unnecessary appointments for others.

Continuous learning

AI will change the nature of work in almost any job. Many skills become useless and new ones are needed. Workplaces that are developing into learning work environments are in best positioned for the future.

There has been talk about the need of lifelong learning for decades – now it is becoming a necessity. The need of continuous further training for employees is obvious. A lifelong learning reform is needed to ensure that learning continues throughout working life. This is the most far-reaching recommendation made by the working group.

There are many alternatives for organising and funding the training. The natural way of arranging such training would be in close connection with the workplace, in which case it would be paid by the employer. The problem is that when employers make the decision on the contents of training, they lay more emphasis on the company's own needs than on the needs of the employees from the perspective of labour market competence, or in a situation, where they lose their jobs.

Employees should be given a subjective right to a paid week of study once a year on average, when the employer would cover the salary expenses. The views differ on whether the contents of training should be paid by the employer or the state. The key point is on how much emphasis is laid on the employer's interests, when

making decisions on the contents of training. The working group suggests making a study on the possibility of granting every Finn in working age a learning voucher or account. That would create a well-functioning demand-based adult education market in Finland. The training should provide miniqualifications, "driving licences", that indicate the matters learned. This would give status for the training and simplify the use of AI programs in employment services.

The reform requires careful preparation that takes account of different interest groups. The implementation should be carried out in phases, enabling the making of impact studies.

Advancing on a career path

To ease the skills mismatch, there should be jobs that people could enter without special skills. This could be promoted by taxation that favours low-wage jobs and the service sector or by paying subsidies used extensively in Sweden, for example. Another method would be promoting the advancement of employees to more demanding roles, freeing up their earlier jobs that require less competence.

Use of AI may significantly enhance the efficiency of employment services. In such a case, the competence data on labour force should include not only the actual qualification data, but also information on the driving licences mentioned above and the work career. For example, the AI software of employment services could suggest a job that is a better match with an employee's new competence to those in employment as well.

The role of self-employment through enterprising has also become stronger with the platform economy and digitalisation development. Several working groups have considered the possibility of creating a new category of so-called light entrepreneurs between employees and entrepreneurs. The line between employees and entrepreneurs is sometimes blurred, but replacing one boundary with three others would not necessary make things any easier – there might emerge new groups falling between the cracks. Instead, the current social security system should be improved, providing for smoother transitions with more predictable consequences between different roles in the labour market, including studies and unemployment.

Key action 10: Steer AI development into a trust-based, human-centred direction

Actions taken

- Discussion on AI ethics and a renewal of operating models in Finnish organisations were launched. More than 66 companies have already joined the AI ethics challenge.
- The use of AI in public sector activities was examined from the viewpoints of ethics and societal acceptability.
- Foundations were created for the development of legality and ethics practices in the public administration's ecosystem-based AuroraAI service model.
- International AI ethics cooperation was promoted in Europe as part of the Commission working group of EU Member States and as part of the High-Level Expert Group on Artificial Intelligence and, globally, through ethics certification, for instance.
- In spring 2019, a continuation course, open for everyone, focusing on the theme of ethics will be published for the Elements of AI online course. The course will enhance the understanding of citizens of the ethical viewpoints of AI, and their own rights and responsibilities in the digital world.

Key lessons learned

- The key role will be taken up by finding a balance between the utilisation of new technologies and ethics. The ethics of AI must not be seen as a factor posing limitations on the activities only, but also as a factor that creates something new, and provides increasing synergies and opportunities.
- By clear sector-specific rules, we create a predictable operating environment that enables the use of human-centred AI. Thereby, we can build trust.
- The ethics of AI is a topical theme already demanding our attention; ethical decisions are being made at Finnish companies and organisations all the time.
- Sufficient understanding of AI and the ways in which AI affects our society are becoming a new civic skill.

- The deployment of AI has raised issues and concerns relating to human rights and the prerequisites of the realisation of democracy. We must ensure that, as society, we take care of the equality of citizens in the age of AI as well.

Recommendations

- Make Finland an international testbed for AI ethics implementation.
- Establish a national ethics council for technology.
- Involve citizens and develop their competences and prerequisites to assess AI.
- Encourage ecosystems and sectors to self-regulation and sharing of good practices.
- Increase interdisciplinary long-term research on the societal impacts of AI.
- Continue the international cooperation related to ethical application of AI, disseminate good practices and lead the way in ethical discussion.

Finland is known for its high level of citizen trust; according to a European study, more than four out of five Finns trust their fellow citizens. No other EU country ranks higher in the level of citizen trust than this. Key factors contributing to the atmosphere of trust include the fact that people generally consider public institutions, such as the judicial system, the police and the healthcare and wellbeing services, as being fair, as well as, for example, the high level of civic activity. It is a privilege to step into the age of artificial intelligence from such an exceptional setting. At the same time, it practically obliges us to an active approach, understanding of the prerequisites of trust in the age of artificial intelligence, and agile implementation both nationally and as part of the international community.

The importance of AI ethics has been acknowledged worldwide, and ethics issues have been extensively addressed by national AI programmes, research institutions and international organisations alike. For example, the EU, the UN, the OECD, the international technology organisation IEEE, and many research institutes, such as AI Now and MIT Media Lab, have made statements on the matter. Within the EU, France has raised ethics among the highest priorities of its national AI programme. The cross-cutting issue in the considerations of various stakeholders is ensuring the implementation of our values, human rights and democracy in a society, where the

norms are built into AI systems and automated decisions are made on the basis of these value choices.

Lively debate on the ethics of artificial intelligence

The debate has largely taken place on the level of principles, touching upon such themes as transparency, non-discrimination and accountability issues. In Europe, the debate has been meritoriously outlined by the EU Commission's High Level Expert Group on AI in the form of Draft ethics guidelines for trustworthy AI. This provides an excellent basis for national application. The draft guidelines were given some encouraging feedback in the consultation workshop the AI Programme held on the matter in Helsinki in January 2019. The Commission working group will publish the ethical guidelines in April 2019.

The international discussion on AI ethics is in many ways characterised by confrontation. Ethics has become a counterforce for innovation, and the debate is coloured by different threat scenarios. Within a short time, AI ethics has also attracted the attention of business executives both in Finland and in the world. The Ethics subgroup of the AI Programme set as its goal to challenge these confrontations and to raise the accountability of AI on the agenda of all companies developing and using AI in Finland. In October 2018, the group launched the AI ethics challenge for companies. The challenge brought together companies interested in ethical application of AI and published materials to make it easier for organisations to set out about formulating their own ethical principles.

More than 66 Finnish companies and organisations of different sizes from various sectors seized the challenge (see Annex 2 to the report). Slightly over one quarter later, the companies were asked how the ethics challenge had affected their operations. All companies that responded to the survey reported having started to create their own ethical principles since they had taken up the challenge, and many had also plans about applying the ethical principles to their operations outside Finland. The ethics challenge has hence had impact on international operations as well.

The AI ethics has been a rising theme in public debate as well. The issue has been discussed in the media, literature and events touching on the subject, and it has

become clear that the ethical aspects of AI are always included in the discussion about the future of AI as well. The themes political parties have chosen for their parliamentary election campaigns also touch on AI and its impacts. However, the debate is very expert-centric; the civil society should be allowed to participate in the discussion about the ethics of AI and its societal impacts in an increasing extent.

Universities and universities of applied sciences have organised courses (or course modules) on ethics, with the emphasis of research ethics and professional ethics. For example, in the Bachelor's Programme in Computer Science of the University of Helsinki, professional ethics is already highlighted on the first course of the first academic year. The range of studies in the Universities of Turku and Tampere include such courses as ethics of information technology and AI, and the philosophy of AI. Many universities and educational institutions have included ethical issues in their technological courses. The command of the basics of the ethics of technology must be integrated into technical training in various levels of education to an increasing extent. First and foremost, investments should be made in increasing the diversity and the utilisation of extensive multi-disciplinary competence for the development of AI. Universities and other institutes of higher education play an important role in strengthening such cooperation.

The varied impacts of the deployment of AI from the viewpoints of citizens and the whole society are an essential area of research. We need mechanisms for supporting strong discussion between disciplines. The Finnish Center of Artificial Intelligence (FCAI) has promoted interdisciplinary cooperation by setting up a broad-based group of experts from such fields as social sciences, theology, philosophy and technical sciences, to examine the questions of AI ethics and its societal dimensions. This kind of multi-disciplinary discussion and research data supporting it are important with a view to understanding and interpreting the broad societal impacts of AI in the future as well.

As regards public services, multi-disciplinary discussion on the issue has taken place in connection with the AuroraAI programme (in closer detail: Key action 6). AuroraAI has been laying foundations for practices required by legality and ethics in an ecosystem-based environment. During the work, foundations were laid for the network's ethical guidelines. It was also recognised that there was need for a judicial framework, ethical design practices and transparency, examination

of the responsibilities and monitoring of administration, and the continuous involvement of the citizens and civic society as part of the development of AI in the administrative sector and in ethical analysis.

Artificial intelligence, human rights and democracy

The deployment of AI has raised issues and concerns relating to human rights and the realisation of democracy. Such discussion was conducted, for example, in the European ministerial AI conference, AI Forum 2018, arranged by the Ministry of Economic Affairs and Employment and the European Commission in October 2018, and in the Governing the Game Changer conference organised by the Council of Europe and the Finnish Ministry of Justice in February 2019. It is essential that we ensure the realisation of our basic values in the future as well, and the work related to this goal is fostered in dialogue with NGOs, the business world and international networks.

AI is produced in ecosystems, and ensuring compliance with ethical practices can seldom be controlled by an individual organisation. Services are provided to citizens with the help of AI applications the production of which requires complex global value chains. This environment emphasises not only the importance of common practices, but also the increasing role of citizens. Some of the responsibility for the ethical assessment of AI will be borne by citizens themselves. Sufficient understanding of the ways in which AI applications steer our thinking, feelings and choices will become a key civic skill in the age of artificial intelligence. Sufficient access to information in relation to applications with wide impacts on citizens must be ensured in the public sector in particular.

Uncertainty about the application of legislation and ethical principles to the development and deployment of AI slows down the use of AI in Finland. With clear rules, we create a predictable operating environment that supports the trust of citizens on technology and serves as a basis of AI-related growth. In other words, AI ethics generates economic growth by making the environment easier to anticipate and by providing new business opportunities. The AI ethics must not be seen as a factor posing limitations on the activities only, but also as a factor that creates something new, and provides increasing opportunities.

The key role will be taken up by the ability to find a balance between the utilisation of new technologies and ethics. Our innovations must be based on the understanding of our common values and the ability to create sustainable competitiveness that keeps up people's trust. Innovations and ethics should be fostered in close collaboration, recognising also our limited capacities; we cannot fully predict the future, we are making our way towards it, learning by doing.

Make Finland an international testbed for AI ethics implementation

Here and now, Finland has every opportunity to function as an international testbed for AI ethics implementation. Factors in our favour include not only the exceptionally high level of citizen trust, but also the size of our country enabling agile operations and a business sector interested in applying AI. We will make it possible for Finland to act as a testbed, when we ensure that the ethical viewpoints are examined at all levels of activities, from citizens to the public sector and all the way to business ecosystems.

As the adoption of AI proceeds in our society, it is important to appoint a ministry in charge for the ethical analysis of the impacts of AI and creation of operating conditions for AI for the future government terms. The Ethics working group recommends appointing a national council on the ethics of technology to take charge of this mission and to coordinate a multidisciplinary national group of experts. The key task of the council would be to promote the use of AI in a manner that boosts Finland's competitiveness in the long run and respects the basic values and human rights, and fosters the prerequisites of citizen agency across administrative boundaries.

Ethical viewpoints must be taken into account when investigating potential needs for reinterpretation or amendments related to the application of existing laws. Ethical viewpoints must also be taken into account when assessing whether we need new regulation that will clarify the operating environment in relation to secondary use of information, for instance. Mechanisms for identifying future needs of regulation should be created in dialogue with the community engaged in the development of AI in various sectors.

The increasing use of AI and automated decision-making in public services raises also major ethical issues and challenges relating to, for example, transparency and supervision. Finland should promote the establishment of cross-sectoral practices and invest in fostering the competences and involvement of citizens and the civic society in the assessment of the acceptability of public AI services. Transparency must be enabled in a way that takes account of the competences of the person doing the assessment.

When promoting ethical practices and making agreements on them, it is important to recognise the importance of ecosystems. It is recommended that industrial associations take on increasing responsibility for the promotion and supervision of the implementation of self-regulation related to AI ethics. Through the ethics challenge, the AI Programme brought together 66 companies that made a commitment to develop ethical AI principles. This network should be retained as a foundation for the creation of a network for the sharing of best AI ethics practices and exchange of information.

We also need more interdisciplinary long-term research on the interaction of AI and society, supporting the autonomy of research and the critical voice. The key element in such research must be the application of a multidisciplinary approach that combines the viewpoints of, for example, humanities and social sciences with those of science and technology. We create new mechanisms for increasing the diversity of the scientific community and dialogue between disciplines, and steer the responsible development of Finland's age of artificial intelligence in a continuous dialogue with the scientific community.

Finland should actively continue the European and international cooperation concerning the ethical aspects of artificial intelligence, information exchange relevant to this theme and the dissemination of good practices, as well as serve as a forerunner in ethical discussion and implementation.

Key 11: Prepare for security challenges

Actions taken

- AI and the expanding digitalisation are rendering the field of security increasingly demanding. The Security Committee is currently in the process of updating the national cybersecurity strategy with a view to developing comprehensive state security. The National Emergency Supply Agency has launched the Kyber2020 programme to enhance the Finnish security of supply.

- The societal importance of digital security is becoming emphasised, which opens up opportunities for companies investing in it and providing relevant services. In collaboration with four partners, the Ministry of Economic Affairs and Employment launched a project, which resulted in the publication of the Growth from digital security roadmap aimed at the development of competence and business related to digital security.

- Business Finland launched the Digital Trust programme to foster innovation activities and internationalisation of companies within the sector. Finland has also been involved in European-level cooperation aimed at establishing a European Cybersecurity Network and a Competence Centre.

Key lessons learned

- AI can be used for enhancing digital security, and identification and prevention of misconduct, but the same technologies are also available to criminals and hostile parties. Preparations for preventing misconduct must be made already in design stages, while also making investments in raising the level of competence among the users.

- The risks related to AI security can be divided into three categories: malicious use of AI, influencing AI systems with malicious intent and fallible AI. To minimise the risks, we need new tools for both the evaluation and auditing of the operation of AI systems.

- Investments in raising the level of competence, the development of the business activities of companies operating in the sector, and boosting the RDI activities directly enhance the security in society and open up new opportunities for growth.

Recommendations

- Enhance our foresight capacity and identification of risks as part of cybersecurity.
- Take account of the threats and opportunities brought by AI for comprehensive security in actions to be initiated based on the national cybersecurity strategy.
- Support the development of the ecosystem of digital security and the relevant competences and RDI activities, and join both national and international networks.

Even though the efforts to develop AI have continued for decades, the development of AI and the societal changes generated by it are just beginning. However, it is clear that, from the viewpoint of societal security, the development and deployment of AI will bring up changes, new threats and opportunities.

Artificial intelligence has a role to play in comprehensive global security. China and the US are both striving for the forerunner status in AI, and gaining an economic competitive advantage is only part of the game. AI applications may also give an advantage in warfare, whether talking about autonomous war machines, or dissemination of disinformation or countermeasures against it. Therefore, it is important that even here in Finland we can trust the digital systems we are using under any circumstances. This underscores the importance of the autonomy of the European technology strategy. We must also have the capacity needed for building and maintaining reliable systems, so, in addition to actual technologies, it is also important that we develop our self-sufficiency in competences related to digital technologies and their security.

The increasing use of AI applications will also bring more day-to-day changes to security. If we are incapable of reforming the structures of our society in an agile manner, the age of artificial intelligence may give rise to unemployment and, consequently, societal unrest in Finland, Europe and the neighbouring regions. Autonomous vehicles may significantly reduce the number of traffic accidents, but, for example, if misused, AI-controlled drones may cause an air crash.

With the comprehensive digitalisation of our society, we are becoming increasingly dependent on digital technologies and AI-based systems, which is further

exacerbated by the interdependence of systems on each other's operations and data. Power outages, failures in the communications networks or other malfunctions in digital systems caused intentionally or unintentionally may cripple or stop the operation of organisations, sectors or, in the worst-case scenario, the whole society. Therefore, maintaining the reliability of societal operation and improving the security of supply in case of disturbance or emergency are key objectives for the age of artificial intelligence.

The AI Programme network and partners have studied the question of security in an increasingly digitalised society in various ways. The Security Committee, which assists the Government in the development of comprehensive State security, is taking part in the updating of the national cybersecurity strategy, which will serve as a basis for launching a development programme for implementing the strategy. The National Emergency Supply Agency, on the other hand, is implementing the Kyber 2020 programme aimed at helping companies and public operators to counter cyber threats and to recover from damages. These measures will help us update the situation picture of national security and enhance the preparedness of society to continue its operations in the age of artificial intelligence.

As the importance of digital security increases, we must make more investments in competence and development of talents within the sector. This will also open new business opportunities in the emerging sector. The Ministry of Economic Affairs and Employment launched a project exploring the growth opportunities provided by digital security, as a result of which the Growth from digital security roadmap was published. Business Finland, on the other hand, launched the Digital Trust programme to foster innovation activities and internationalisation of companies within the sector. Finland has also been involved in European-level cooperation aimed at establishing a European Cybersecurity Network and a Competence Centre.

Risks related to the security of artificial intelligence[12]

AI is currently being used in almost all sectors of life and industry. With the expanding use, the matters related to digital security and comprehensive security

12 Reference is made here to material written by Antti Karjalehto and Risto Lehtinen from DIMECC Ltd. on artificial intelligence and cyber security.

are taking a more central role. We are just beginning to understand what kind of impacts AI has and will have on the security of societies. The constantly accelerating technological development is making foresight necessary but challenging.

The growth of computation efficiency and capacity has enabled the development of more efficient AI-based operating models and solutions for the purposes of, for example, the anticipation and identification of cyber threats and crime. AI can also be used for identification and prevention of more conventional crimes or other kinds of misconduct.

AI creates new opportunities, but it also enables misconduct, because criminals and hostile parties have access to the same capacities as the rest of society. Therefore, the designers of AI must ensure security and prepare for misconduct already in design phases (security by design). Investments must also be made in user training, and users must have an understanding of the functioning and limitations of AI applications.

The risks related to AI security can be divided into three categories: 1) malicious use of AI; 2) influencing AI systems with malicious intent and 3) fallible AI. In malicious use of AI, AI has been programmed to influence people or other systems with an aim to promote a specific objective, such as influencing the voting behaviour. An information system that uses AI techniques may have vulnerabilities that expose it to malicious influencing. Several successful attacks have been made against AI systems; for example, software that identifies traffic signs could be successfully deceived. If the data used for developing or updating an AI system has been biased or harmful, this may reflect on such AI functions as classification functions and decision-making. Understanding the data used is of utmost importance when developing AI systems. It is also important to prevent malicious manipulation of data used for the training of AI.

The security issues related to the use of AI methods should be taken into account both in system design and deployment. A developing and complex operating environment makes this task particularly challenging, and new solutions are needed for the design work and securing the use of systems. We need new tools for both the evaluation and auditing of the operation of AI systems.

Finland is also in an excellent position to become a forerunner of digital security in the age of artificial intelligence, since we have high-standard basic infrastructure, good educational and RDI systems, and companies providing excellent AI, cybersecurity and other digital services. It is important to note that investments in raising the level of competence, the development of business activities of companies operating in the sector, and boosting the RDI activities directly enhance the security of society, while opening up new opportunities for growth.

The security toolbox for the age of artificial intelligence

In the age of artificial intelligence, security requires different prioritisations from society, where better understanding of the issue, multidisciplinary research and raising the foresight competence play the key roles. The development programme to be initiated based on the national cybersecurity strategy should take account of the threats and opportunities brought by AI to comprehensive security. The changes generated by the age of artificial intelligence must also be taken into account when developing the security of supply.

In addition to actions directly related to security, we must also take care of a sufficient capability to respond to the changes in the digital security of the age of artificial intelligence. We should enhance our self-sufficiency in digital technologies and their security by investing in training within the sector, the wellbeing of the business sector and attracting talents working in the sector.

The state should invest in RDI activities within the sector, support the development of a digital security ecosystem consisting of cybersecurity companies and, more comprehensively, companies engaged in digital business, and seek new cooperation opportunities between the public sector, companies and RDI operators both in Finland and at the European level.

We need a toolbox with methods for analysing, auditing and protecting the information security level of AI systems. To develop the toolbox – and the understanding of the subject in general – we encourage operators within the sector to launch RDI projects that combine AI and information security aspects, as well as research aimed at improving the reliability of AI techniques.

CASE NEURO EVENT LABS: BETTER DIAGNOSIS OF EPILEPSY

Traditionally, epilepsy has been a complex illness to diagnose and treat. The illness may manifest itself in the form of approximately 60 different types of seizures, and each patient displays them in a very individual manner. Furthermore, the seizures often occur during the night.

This has led to a situation where the treatment is largely based on the patient's own account of the symptoms. This is problematic, because the seizure diaries held by patients are very unreliable, and generally speaking the patients remember, on average, less than 10 per cent of the seizures they have had during the night. Unreliable and inaccurate data about the patient's seizures has led to a weak understanding of the number of seizures and, therefore, into major insufficiencies in the treatment.

Neuro Event Labs is a health-sector company from Tampere, which set out to find better ways to monitor the seizures patients have. The first prototype in 2016 tested remote monitoring, or a device that can be placed in the same room with the patient either at home or in hospital conditions. A camera using machine vision monitors the patient and learns from his or her movements and symptoms, which indicate a beginning seizure in a particular patient. The system notices even the slightest changes in, for example, the patient's breathing or movements, which have been impossible to detect earlier.

Remote monitoring of epilepsy seizures is based on the use of quantitative data in a manner not enabled by earlier technologies. The patient may personally remember having had, say, two seizures over a one-month period, even though the real number may be several dozens. With AI, they can all be verified. Precise monitoring of the seizures and the ability to learn to recognize individual symptoms of patients significantly enhance the diagnosis of the illness.

The development of the system has advanced quite a lot from the first phase. In the first version, there were challenges related to night-time disturbances: for example, if the patient got up at night or something dropped from the bedside table, the remote monitoring system could interpret the situation falsely. This reduces the quality of data. However, when correct algorithms are used, the device learns away from making false interpretations. The ability to learn makes it artificial intelligence: for example, there are major differences between individuals in the deviant movements, changes in breathing and other abnormal behaviours.

Similarly, from correct interpretations the device learns more accuracy and speed: the first signs of seizure displayed by patients are often similar – such as the way

they move their heads or open their mouths – and the device recognises the onset of a seizure at a very early stage. The system produces data for a physician who now gets precise information on the actual number and severity of seizures over a longer monitoring period. The physician can also examine afterwards a specific seizure in addition to the summary provided by the system.

The biggest challenge in the diagnosis and treatment of epilepsy has been specifically the identification and the individual nature of seizures, particularly at night-time. Remote monitoring provides data over a longer period of both night-time and day-time seizures, which have a significant effect on the patient's day-time energy level. When seizures are easier to recognise and monitor, with the help of the data provided, the physician in charge of care can plan an individual care path for a patient with increased precision and speed.

This will help boost the patient's general energy level, allowing, for example, many people suffering from the severe type of the illness to return to working life.

Neuro Event Labs

Health-sector startup
Domicile: Tampere
Employees: 25
Established in 2015
Turnover in 2018: EUR 0.5 million

Neuro Event Labs is an example of a health-sector company that uses artificial intelligence. The sector is important for Finland and it has large export potential. There are 65 million epilepsy patients in the world touched by the problem of insufficient diagnosis. Remote monitoring of epilepsy seizures may potentially help a large share of them to get better treatment and at an increasingly early stage of their illness. The system has been in use at several university hospitals in Finland since 2017. It is also being used in Belgium, the United Kingdom, Denmark, Sweden, Norway and the US.

CASE AVAINTEC: MORE EFFICIENT HEALTHCARE WITH ARTIFICIAL INTELLIGENCE

The customer and patient data and treatment processes in social welfare and healthcare continuously produce large amounts of data. In spite of the volumes of data, we still cannot or do not know how to use it properly. Where AI is an everyday phenomenon in many other data-intensive sectors, such as financing and marketing,

its exploitation in social welfare and healthcare is just starting. The main problems in the sector is the inconsistency of information, professional skills and resources. Furthermore, the several systems in use make data-based decision-making slow and complicated.

If AI was used in a proper manner, the operation of social welfare and healthcare and individual processes could be enhanced. There are vast existing reserves of data in the sector, the use of which for the purposes of description of effectiveness or predictive analytics could be implemented with quite simple browsing algorithms.

Avaintec, a Finnish company providing digital social welfare and healthcare solutions, noticed this and established its own AI unit DataChief three years ago to fulfil this gap in the market. DataChief offers a data analytics tool, and AI and machine learning solutions for social welfare and healthcare organisations. Avaintec has created the algorithms it uses in cooperation with the University of Lappeenranta. They can be used for implementing different data analyses and AI solutions.

The company is developing various AI-based solutions. One of them is a component that helps to analyse the log data recorded on the browsing of patient data. The healthcare sector conducts regular monitoring of log data to ensure that there is a care relationship between the patient and the professional at the moment the patient data is being browsed. However, monitoring of the log data requires a lot of manual work, in addition to automatic deductions. To simplify the work, Avaintec is developing in collaboration with the South Ostrobothnia Hospital District and Neotide an AI component making it possible to improve and develop the monitoring of log data, and reduce the resources needed for the monitoring.

Avaintec is developing another component with the South Karelia Social and Health Care District (Eksote) with an aim to predict the weakening of the state of health of old people in home care. AI examines the patient and customer information and predicts when the functional ability or general state of health of an elderly person is about to weaken or collapse. The component will enable targeting timely treatment to customers and simplifying the work of professionals. For the elderly, on the other hand, it enables living at home and maintaining one's functioning capacity for as long as possible.

The third example of Avaintec's AI projects is the application being developed in collaboration with the Lapland Hospital District and the Northern Ostrobothnia Hospital District with an aim to increase the efficiency of healthcare and reduce unnecessary trips to a hospital. The application enables remote paediatric emergency care: when a child gets sick, the application asks a set of precisely formulated questions on the patient's state of health. The risk assessment calculations made of

the test and, in the future, artificial intelligence give a proposal of measures to be taken based on the responses given and the information collected into the database in advance. Acute cases requiring an emergency evaluation are steered to a hospital, whereas in less severe cases the application encourages to wait. In addition, the patients are given a chance to contact an on-duty nurse.

At the moment, DataChief's market areas include Finland and China. The AI research centre established in China collaborates with a local hospital and the South Karelia Social and Health Care District. This helps in bringing together the professionals of social welfare and healthcare, data analysts and programmers. In Finland, the customers include the South Ostrobothnia and Lapland Hospital Districts.

At the moment, DataChief reduces the amount of manual work and provides more accurate information in support of decision-making. The next phase is to develop AI that recognises potential problems and bottlenecks in the customer and patient's functioning capacity earlier and more accurately than before, allows the personnel to work in a more autonomous manner, and includes the family members and other people close to the patient into the care process.

Avaintec

An enterprise providing digital healthcare solutions
Domicile: Helsinki, offices also in Hangzhou and Chengdu, China and in Warsaw, Poland.
Employees: 70
Established: 1997
Turnover in 2018: EUR 5.1 million

Avaintec is a 22-year-old company, helping organisations to enhance and develop their operations with the help of digital solutions. Avaintec has developed such solutions as electronic archives and signatures. The company established its own AI unit DataChief three years ago. DataChief offers data analytics tools, and AI and machine learning solutions for healthcare organisations.

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4 A vision for Finland in the age of artificial intelligence in 2025

The Artificial Intelligence Programme launched in May 2017 marked the start of the preparations for the age of artificial intelligence in Finland. The programme has been intensive and as described in the sections above, a great deal has been achieved during the past two years. The extensive network of experts, influential figures, entrepreneurs and organisations can take most of the credit for this. In addition to the work carried out by the network, a large number of other parties have also engaged in discussions, contributed to the AI knowledge base, expanded the AI vision, taken concrete action and launched pilot projects. The enthusiasm spurred by artificial intelligence has given rise to a real movement in Finland.

The first steps in the Artificial Intelligence Programme were taken between May and October 2017 when we studied artificial intelligence as a phenomenon, its potential and the challenges arising from it, set the objectives for the work and laid out the first measures for the programme. This was the first stage in the national artificial intelligence endeavour. In the period between October 2017 and today, we have launched a broad range of different measures and made every effort to learn from our past work and the work done by others. This was the second stage in the national artificial intelligence endeavour. The current Artificial Intelligence Programme will be concluded at the end of the term of Prime Minister Juha Sipilä's Government in spring 2019 but it is essential that the work now in progress will continue and new measures are launched so that we can take Finland further on the path towards the age of artificial intelligence. This is the third stage in the artificial intelligence endeavour and ensuring that it will become a reality will be the task of the next Government and the network involved in the programme work. We must preserve the information that has already been created, keep the contacts

that have been established and ensure that the movement will not lose any of its dynamism.

We have been lucky in terms of the timing of the project. If the Artificial Intelligence Programme had been launched earlier, we may not have known enough about the potential of AI or possessed the necessary enthusiasm. If we had started later, we would have found ourselves in the group of countries that have started to see the opportunities AI provides more recently. Now we are at the forefront and we have the possibility to make use of our position and the dynamics created by the movement in the way we want.

The steering group of the Artificial Intelligence Programme has produced a vision of Finland in the age of artificial intelligence in 2025, a vision of a country that is competitive and able to attract talent and has the most relevantly educated population consisting of well-informed and independent citizens.

Finland, a competitive country that is able to attract talent

In 2025, Finland can be exceptionally competitive and exceptionally well placed to attract talent. This will bring economic wellbeing to all of us.

Artificial intelligence is extensively used in all sectors to enhance the core competitiveness of companies. Artificial intelligence has helped to create easy-to-use and correctly timed services, made business operations more effective and efficient, and, above all, provided a basis for new operating practices and business models.

This has allowed Finland's basic manufacturing industries to find new opportunities for growth, especially in the rapidly changing B2B service markets as the inputs into new AI methods requiring less teaching material have produced results. Strong new B2C business ecosystems have also arisen in Finland because consumers increasingly prefer services supporting human-centric use of personal data to the offerings of global internet giants.

Finnish companies are already interested in artificial intelligence and this has produced results by the year 2025. Companies have enhanced their expertise levels in all areas of operations and every leader understands what AI means for their own business. Companies of all sizes have invested in their digital capabilities and are testing services and operating practices enabled by the new technology. Companies are collecting their own data but they have also built operating practices for use of company-to-company data.

In 2025, in the age of artificial intelligence, Finland is a trusted and safe digital economy pioneer. A balance between the interests of individuals, companies and society has been found in the use of the new technology, which also means that AI is used in an innovative and ethically sustainable manner. An advanced regulatory environment encourages parties to test and introduce new operating practices. By constructing a strong and distinctive digital economy, Finland is at the forefront of European development and is also exporting its model to the rest of the world.

This success story has been built by experts born in Finland and experts that have moved to Finland. The latter group has chosen Finland because of its stability, high quality public services, nature and dynamic working life. Centres of excellence comprising companies, higher education institutions and research institutes play a key role in the efforts to attract top talent to our country. Moreover, Finland is not selected as a place of work because of one company only. The actors involved are working in close cooperation with each other because everybody knows that the world can only be conquered as a joint effort.

Close cooperation between public and private sectors in the work to promote digitalisation of business operations and the use of AI has been the key factor in the building of an attractive and competitive Finland. The ability to engage in a productive dialogue and to take a long-term perspective has allowed Finns to find workable ways to boost innovation inputs, build effective cooperation models, develop incentive-oriented regulation, enhance business competence and promote talent. In addition to public and private sectors, experts in a broad range of different fields as well as civil society actors take part in the discussion on how to achieve sustainable growth.

The most relevantly educated nation

In 2025, in the age of artificial intelligence, Finland can also be the most relevantly educated nation, which will provide us with protection against the wind of technological change.

There is broad understanding in Finland that with technological advances and with the introduction of new technologies, society at large, the way of doing business and, consequently, the way of doing work, are also changing. This understanding has helped to make Finland a winner in the age of artificial intelligence. In 2025, Finland is a country where more work and jobs have been created than what the change has eliminated.

The work becomes more meaningful when AI- based systems take care of routine tasks. As work is performed more efficiently, we have more leisure time, which we can spend with other people or we can devote the time to our hobbies or civil society activities. AI applications help us to find jobs that can better meet our needs and in which we can make better use of our skills, which in turn will enhance wellbeing at work.

There are relatively few routine tasks in Finland that are completely replaced with artificial intelligence and the job descriptions of different professions have been developed so that there is very little unemployment as a result. To the extent that people have lost their jobs, society has been able provide the unemployed with a safety net and train them into new professions.

The educational level of the population has risen in all areas. The number of Finns with only basic education is decreasing and an increasing number of people obtain a higher education degree. The Finnish education system is better resourced and it also makes effective use of digital tools and the opportunities created by artificial intelligence. Education is more efficient and produces better results.

Understanding of artificial intelligence and new technologies has become a new civic skill, allowing Finland to make full use of the opportunities opening up in the age of artificial intelligence. Education in artificial intelligence is offered not only as part of computer science and in mathematical fields but also in applied and

creative fields because artificial intelligence and digitalisation in general have been incorporated as themes in most degree programmes.

In addition to degree education, a broader range of continuing education offerings is also available and it is jointly funded by individuals, employers and the public sector in different ways. Lifelong learning is reality and it does not need to mean long absences from paid work because combining work and studies has been made easy. Individuals understand that they are also responsible for learning new things.

In 2025, in Finland of the age of artificial intelligence, it is considered important that already at basic educational level, individuals are adequately familiarised with technologies. The aim is to ensure that everybody knows how to live in a digitalised society and is able to influence the way in which it develops.

The lifelong learning reform has been the key factor in the building of the most relevantly educated nation. It has allowed the education providers to respond effectively to the substantial continuing education needs arising with the age of artificial intelligence. With the changes in the educational system, it has become possible to provide the working-age adult population with broader and better opportunities for lifelong learning so that the employees, employers and the public sector jointly bear the responsibility for keeping the skills of the workforce up to date. At the same time, by extensively incorporating artificial intelligence and digitalisation into a broad range of different educational sectors, the nation can be better prepared for society and working life in the age of artificial intelligence.

Well-informed and independent citizens

In 2025, in Finland of the age of artificial intelligence, citizens are well-informed and independent, which means a better and more active life for all of us.

Technology already provides a basis for new solutions and changes and thus the key question is how we would like to develop our society with the help of

technology. In 2025, in Finland of the age of artificial intelligence, technologies have been developed and introduced so that they support the work and capabilities of individual citizens and professionals. We have autonomous and automatic systems, which are incorporated into such areas as traffic. However, in most cases, artificial intelligence acts as support intelligence and its task is not to replace humans or to make decisions on their behalf but to help them to do things better.

In 2025, in Finland of the age of artificial intelligence, citizens trust AI-based systems and believe that artificial intelligence will enhance security. The age of artificial intelligence has not eroded people's trust in society or to each other and Finland remains a trust-based society.

Artificial intelligence has been harnessed to produce anticipatory and human-centric services in the public and private sectors. Services are more clearly focused in accordance with the needs, which makes them more effective. The new service structure has thus enhanced citizens' wellbeing and reduced unhappiness. By doing this, it has helped to strengthen social stability and the functioning of the democratic society.

In Finland of 2025, technological advances have not led to the exclusion of groups with less developed technological skills as artificial intelligence helps services to reach those who need them, making them easier to use. Jointly built rules and regulation updated in accordance with the age of artificial intelligence will ensure that AI-based systems work in an open and transparent manner.

Citizens have a say in what information they want to disclose and to whom, and in this way, they can also influence the type and quality of the services that they get. Individuals are not passive consumers of technology as they are actively engaged in the discussion on the development and application of artificial intelligence and other technologies. The participation also has a genuine impact on the way in which our future is built.

The strong inputs by the public sector in the development of services enabled by artificial intelligence and technological advances in general have been the key factor in the process of empowering well-informed and independent citizens. This

has also contributed to the development of private-sector services and the renewal of the public-sector service structure. At the same time, there has been an active discussion on applying artificial intelligence in a manner supporting well-informed and independent citizens, and the higher-education community, the private and public sectors, civil society and individual citizens have taken part in this discussion.

APPENDICES

APPENDIX 1 Persons and parties taking part in the Artificial Intelligence Programme

Programme Steering Group

- Pekka Ala-Pietilä, Huhtamäki
- Ilona Lundström, Ministry of Economic Affairs and Employment
- Merja Fischer, Leadership Akatemia
- Samuel Kaski, Aalto University
- Ilkka Kivimäki, equity investor
- Taina Kulmala, Prime Minister's Office
- Jyrki Nurmi, Valmet Automotive
- Jukka Ryhänen, Combient
- Antti Vasara, VTT Technical Research Centre of Finland
- Sonja Ängeslevä, Zynga

Secretariat of the Artificial Intelligence Programme

- Kalle Kantola, VTT Technical Research Centre of Finland
- Mika Klemettinen, Business Finland
- Aleksi Kopponen, Ministry of Finance
- Olli Koski, Ministry of Economic Affairs and Employment
- Lasse Laitinen, Ministry of Economic Affairs and Employment
- Jussi Nissilä, Ministry of Economic Affairs and Employment
- Maikki Sipinen, Ministry of Economic Affairs and Employment

The following persons have also taken part in the preparation of the report:

- Nina Alatalo, Ministry of Economic Affairs and Employment
- Antti Eskola, Ministry of Economic Affairs and Employment

Artificial Intelligence Programme, sub-groups
Transformation of society and work

Chair:

- Osmo Soininvaara, Aalto University

Members:

- Tuomo Alasoini, Finnish Institute of Occupational Health
- Juha Antila, Central Organisation of Finnish Trade Unions SAK
- Merja Fischer, Leadership Akatemia
- Tuulia Hakola-Uusitalo, Ministry of Finance
- Niilo Hakonen, KT Local Government Employers
- Lauri Ihalainen, Parliament of Finland
- Seija Ilmakunnas, Labour Institute for Economic Research
- Anu Järvensivu, University of Jyväskylä
- Antti Koivula, Finnish Institute of Occupational Health
- Mikko Kosonen, Finnish Innovation Fund Sitra
- Mika Kuismanen, Federation of Finnish Enterprises
- Taina Kulmala, Prime Minister's Office
- Leila Kurki, Finnish Confederation of Professionals STTK
- Ville Kyrki, Aalto University
- Anita Lehikoinen, Ministry of Education and Culture
- Mika Maliranta, Research Institute of the Finnish Economy
- Susanna Siitonen, Ministry of Economic Affairs and Employment
- Penna Urrila, Confederation of Finnish Industries EK
- Vesa Vuorenkoski, Confederation of Unions for Professional and Managerial Staff in Finland

Facilitators

- Kai Husso, Ministry of Economic Affairs and Employment
- Olli Koski, Ministry of Economic Affairs and Employment

Ethics

Chair:
- Meeri Haataja, Saidot

Members:
- Patrik Floreen, FCAI
- Charlotta Grönqvist, City of Porvoo
- Saara Hyvönen, Dain Studios
- Antti Kauppinen, University of Helsinki
- Maija-Riitta Ollila, Pro Sophia
- Minna Pihlajamäki, Terveystalo
- Samuli Savo, Stora Enso
- Juho Vaiste, Turku AI Society
- Minna Vakkilainen, Kesko

Facilitator
- Maikki Sipinen, Ministry of Economic Affairs and Employment

The members of the FCAI have also commented on the report.

Data and platform economy

Chair:
- Kimmo Alkio, Tieto

Members:
- Pekka Ala-Pietilä, Huhtamäki
- Meeri Haataja, Saidot
- Hannu Hämäläinen, Finnish Innovation Fund Sitra
- Ari Järvelä, Tieto
- Topi Järvinen, PwC
- Samuel Kaski, Aalto University
- Outi Keski-Äijö, Business Finland
- Johannes Koponen, Demos Helsinki
- Pekka Lehtovuori, CSC
- Leena Niemistö, Pihlajalinna
- Jussi Nissilä, Ministry of Economic Affairs and Employment
- Harri Nummela, OP
- Ville Peltola, Technology Industries of Finland
- Kimmo Pentikäinen, Elisa
- Susanna Pirttikangas, University of Oulu
- Antti Poikola, Technology Industries of Finland
- Taru Rastas, Ministry of Transport and Communications
- Jukka Ryhänen, Combient
- Jukka-Pekka Salmenkaita, Elisa
- Manu Setälä, Business Finland
- Pekka Sivonen, Business Finland
- Sasu Tarkoma, University of Helsinki
- Tuomo Tuikka, VTT Technical Research Centre of Finland
- Alexander Törnroth, Technology Industries of Finland
- Harri Valpola, Curious AI
- Antti Vasara, VTT Technical Research Centre of Finland Ltd
- Jukka Viitanen, ResoluteHQ

Facilitator
- Mika Klemettinen, Business Finland

Expertise and innovations

Chair:
- Mika Vehviläinen, Cargotec

Members:
- Minna Aila, Nokia
- Timo Ali-Vehmas, Nokia
- Sauli Eloranta, Rolls-Royce
- Merja Fischer, Leadership Akatemia
- Riikka Heikinheimo, Confederation of Finnish Industries EK
- Erja Heikkinen, Ministry of Education and Culture
- Visa Honkanen, HUS
- Pasi Julkunen, Sandvik
- Antti Karjaluoto, DIMECC
- Samuel Kaski, Aalto University
- Ilkka Kivimäki, equity investor
- Leo Kärkkäinen, Nokia Bell-Labs
- Lars Maura, Siemens
- Jukka Merenluoto, DIMECC
- Heikki Mäkijärvi, Telia Ventures
- Anita Lehikoinen, Ministry of Education and Culture
- Juha Pankakoski, Konecranes
- Maritta Perälä-Heape, University of Oulu
- Milla Saaristenperä, Kone
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- Simo Säynevirta, ABB

Facilitator
- Kalle Kantola, VTT Technical Research Centre of Finland

AuroraAI network

Coordination

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- Niko Ruostetsaari, Ministry of Finance

Members:

- • The work has been carried out in extensive networks. For more information, visit https://vm.fi/AuroraAI

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- Mikael Grannas, Municipality of Sipoo
- Martti Hetemäki, Ministry of Finance
- Otto Juote, Prime Minister's Office
- Riku Jylhänkangas, Ministry of Finance
- Anna-Maija Karjalainen, Ministry of Finance
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- Janne Kerkelä, Prime Minister's Office
- Mikko Kosonen, Finnish Innovation Fund Sitra
- Mirjami Laitinen, Ministry of Finance
- Timo Laitinen, State Treasury
- Katri-Leena Launis, Social Insurance Institution of Finland Kela
- Heikki Mannila, Academy of Finland
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- Ville Peltola, Technology Industries of Finland
- Petri Peltonen, Ministry of Economic Affairs and Employment
- Päivi Sillanaukee, Ministry of Social Affairs and Health
- Pekka Soini, Business Finland
- Pekka Timonen, Ministry of Justice
- Tuomas Vanhanen, Ministry of Finance
- Janne Viskari, Population Register Centre

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- Aleksi Kopponen, Ministry of Finance
- Niko Ruostetsaari, Ministry of Finance

International experts interviewed for the report

- Christian Guttmann
  Vice President, Global Head of Artificial Intelligence & Data Science, Tieto, Executive Director, Nordic Artificial Intelligence Institute, Sweden. Professor (adj. assoc.), University of New South Wales, Australia. Senior Researcher, Karolinska Institute, Sweden
- Gesche Joost,
  Professor for Design Research at the Berlin University of the Arts, Head of the Design Research Lab, Germany
- Doina Precup,
  Research Team Leader, DeepMind and Associate Professor, McGill University, Canada
- Michele Sebag,
  professori, Ranska (Deputy director of Laboratoire de Recherche en Informatique, Head of A O team, CNRS. France)
- John Shawe-Taylor,
  Professor, Head of Department of Computer Science, University College London, UK
- Jim Spohrer,
  tutkimusjohtaja, IBM, Yhdysvallat (Dr. Jim Spohrer, Director, Cognitive OpenTech at IBM. California, USA)
- Masashi Sugiyama,
  Director of RIKEN Center for Advanced Intelligence Project, Japan and Professor for Machine learning and statistical data analysis at the Department of Complexity Science and Engineering, the University of Tokyo, Japan
- Volker Tresp,
  Professor for Machine learning at the Ludwig Maximilian University of Munich and Distinguished Research Scientist at Siemens
- Harri Valpola, Founder and CEO, Curious AI, Finland

APPENDIX 2 Organisations that have accepted the AI ethics challenge

- 8-bit-sheep
- Accenture
- Ahlstrom-Munksjö Oyj
- ASML, Direct Selling Association of Finland
- Avaus
- Barona Oy
- Basement AI
- Be Customer Smart Oy
- BearingPoint
- Berner Oy
- Bilot Consulting Oy
- Business Finland Oy
- Cargotec Oyj
- CGI Suomi Ltd
- CHAOS Architects Oy
- Curious AI
- DAIN Studios
- Dazzle Oy
- Digia Oyj
- DNA Oyj
- Elisa
- Enterlot
- City of Espoo
- Fortum
- Fourkind
- Futurice
- Headai
- Health Innovation Academy Oy
- Helsinki Intelligence Oy
- iloom Oy
- Inbot
- Social Insurance Institution of Finland Kela
- Kiinteistömaailma Oy
- K-Group

- Kunnan Taitoa Oy
- Microsoft Finland
- Neste
- Nixu Oyj
- OP Group
- Primeo Oy
- PwC Suomi Oy
- Reaktor
- Saidot
- Sanoma Oyj
- SAP SE
- Selko Technologies Oy
- Siili Solutions Oyj
- Solidabis Oy
- Solita Oy
- Stora Enso Oyj
- Success Clinic Oy
- Systeemityöyhdistys Sytyke Ry
- Technology Industries of Finland
- Telia Finland Oyj
- Terveystalo
- Tieto
- Top Data Science
- Valmennuskeskus Public
- Valohai
- Finnish Tax Administration
- Vincit
- Wunder
- VTT
- Population Register Centre
- Wärtsilä Corporation
- YEEA Work Oy
- YIT Oyj

(Situation on 11.3.2019)

https://www.tekoalyaika.fi/en/background/ethics/

Leading the way into the era of artificial intelligence
Final report of the Artificial Intelligence Programme

The "Leading the way into the era of artificial intelligence" report picks up from where the previous report, "Finland's Age of Artificial Intelligence", published in autumn 2017, left off. It listed eight key actions for taking Finland successfully into the age of artificial intelligence. This report explains what has been done since then to promote widespread and extensive utilisation of artificial intelligence, what were the lessons learned, and which steps should be taken in the future. Three new key actions have been introduced that cover the future of work, ethics and security.