POLICY BRIEF
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GOVERNMENT'S ANALYSIS, ASSESSMENT AND RESEARCH ACTIVITIES

Perspectives into topical issues in society and ways to support political decision making

Tools for Artificial Intelligence Discussion

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Artificial intelligence enables machines, software, systems and services to act reasonably according to their task and situation.

This Policy Brief

- Calls for a deeper and more specific AI discussion instead of hype-talk
- Claims that instead of using a general term such as AI, more explicit terms such as machine learning or data analytics should be used
- Proposes that in all governmental policy discussions and reports on AI, the 10-subfield structure elaborated in this report should be followed

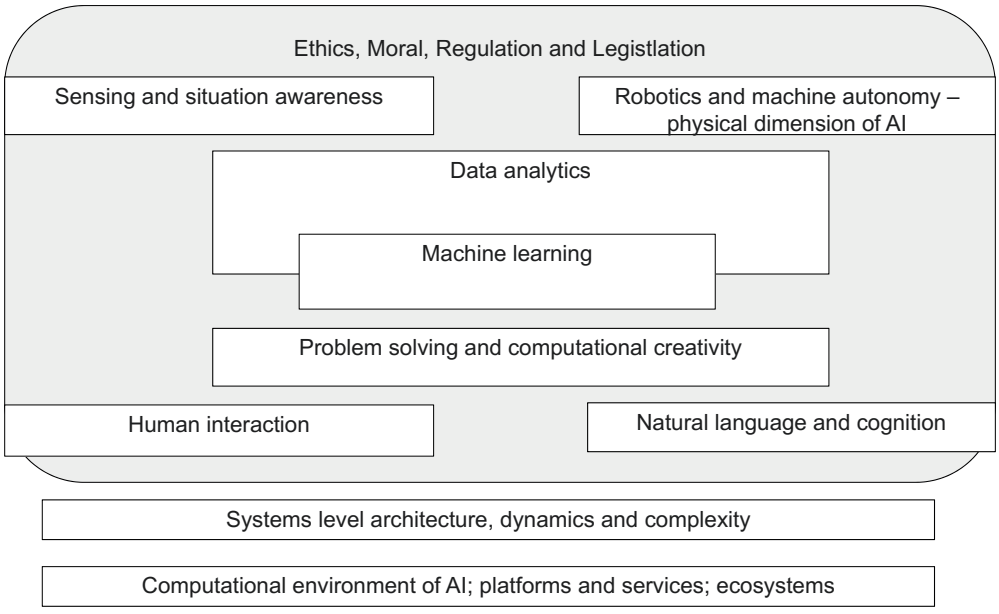

Figure AI divided into ten subfields

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AI BEHIND THE HYPE

Artificial intelligence (AI) is seen to be a crucial driver of technological and economic progress. It is even regarded as the key to world dominance in the future. Many political leaders have set a goal for their country to become a leader in AI. Therefore, it is easy to understand why there is much discussion and even hype around artificial intelligence.

However, the discussion is often confusing and ambiguous. This is because AI is a multidimensional and complex collection of technologies, and we lack a generally accepted description and taxonomy of the field, so even the basic concepts are often understood differently. The Government of Finland set out to create such description and taxonomy in order to enable shared understanding and meaningful public discussion. This Policy Brief is one result of that effort.

Why is there so much talk about AI? Yes, it is partly due to hype around the topic. Actually, the use of AI technology has made great progress, and it is becoming economically useful, which is because of three reasons:

1. Substantially more data are available for "teaching" AI
2. Reasonably priced computing power is now available to run the algorithms
3. Free, easy-to-use tools have become available for AI developers

AI in context

Artificial intelligence does not exist in isolation. As a scientific discipline, AI has its roots in information and computing sciences, mathematics, logic, statistics, and engineering. It also has connections to many other fields. AI technologies are used in most industries and domains, and significant benefits are expected. The discussion about AI and the regulations governing its use also relate to morals, ethics, and values.

The relationship of AI to other research disciplines, society, and domains using AI technologies is depicted in Figure 1.

Discussion on AI needs structure: division into 10 subfields

AI is not one monolithic unit, but a collection of technologies and applications using those technologies. Dividing AI into ***ten subfields*** helps in understanding. Subfields 1–6 concern AI research and core technologies, while 7–10 are other subfields that are relevant to AI.

1. Data analytics
2. Sensing and situation awareness
3. Natural language and cognition
4. Human interaction
5. Problem-solving and computational creativity

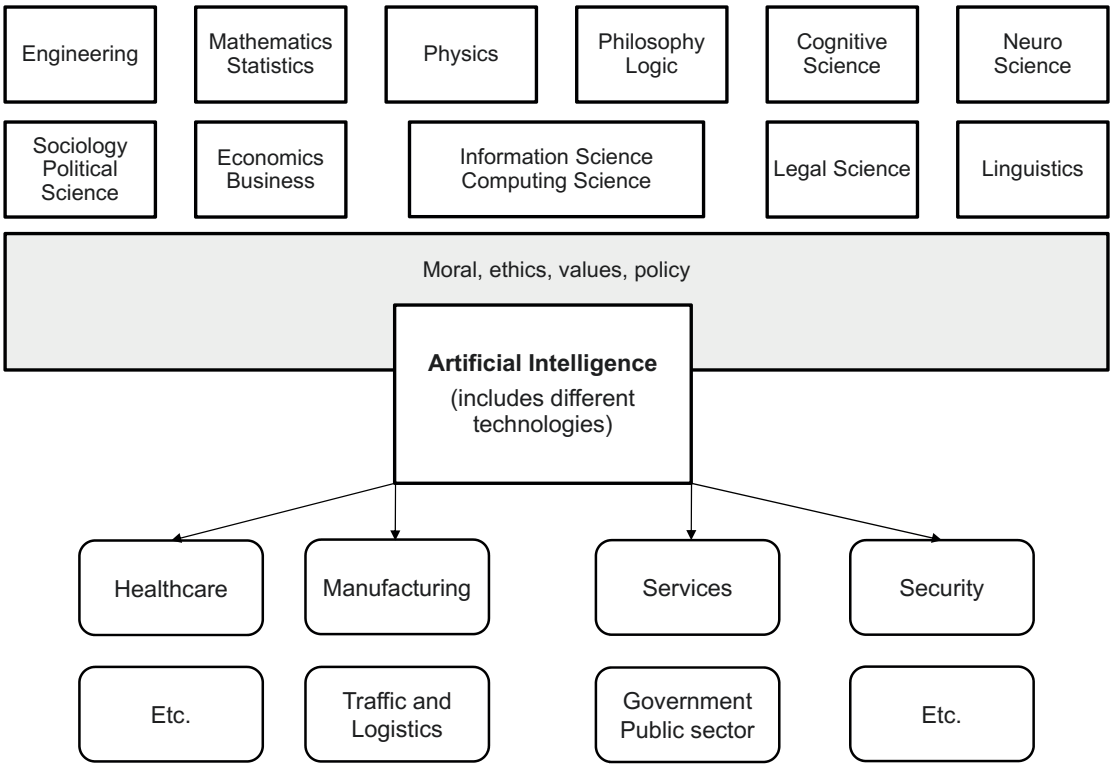

Figure 1. AI and related fields of science

6. Machine learning
7. System-level architecture, dynamics and complexity
8. Computational environment of AI; platforms and services; ecosystems
9. Robotics and machine autonomy – physical dimension of AI
10. Ethics, morals, regulation and legislation

A report published in June 2018 (Ailisto et al., 2018) describes the 10 subfields in detail.

We propose that AI discussion should follow the 10-subfield structure in all governmental policy discussions and reports. This approach would enable a shared understanding of the basic concepts and lead to a discussion that is more meaningful.

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Another viewpoint to AI: maturity level

The expectations – and fears – regarding AI are great. Unfortunately, the current discussion does not make a distinction between what we have now (i.e., “narrow AI”), what the researchers are studying (i.e., “general AI”), and what futurists and sci-fi writers envision (i.e., “super AI”). We try to make this distinction in Figure 2 by describing the characteristics of the three maturity levels of AI.

NARROW (WEAK) AI	GENERAL (STRONG) AI	SUPER AI
Goal-oriented AI is very good, e.g., in recognizing faces in images, and totally useless in everything else.	General AI has understanding of meaning, and it can do human-like common sense reasoning.	AI superseding human intellect in all respects. Related to the concept of the singularity. Popular in sci-fi.

Figure 2. The levels of AI: narrow, general and super

Ethics and moral questions of AI

There are several ethical and moral questions related to the use of AI. The World Economic Forum (WEF) has made a list of nine of the most important questions below:

The Top 9 ***ethical issues*** in AI according to the World Economic Forum (WEF, 2016):

1. Unemployment. What happens when there are no more jobs available?
2. Inequality. How do we distribute the wealth that is created by machines?
3. Humanity. How do machines affect our behavior and interaction?
4. Artificial stupidity. How can we guard against mistakes?
5. Racist robots. How do we eliminate AI bias?
6. Security. How do we keep AI safe from adversaries?
7. Evil genii How do we protect against unintended consequences?
8. Singularity. How do we stay in control of a complex, intelligent system?
9. Robot rights. How do we define the humane treatment of AI?

Perhaps the most provocative question related to society and ethics is whether AI will make the majority of people unemployed and thus cause a massive inequality gap (questions 1 and 2 in the list by WEF). Not necessarily so, claims recent research by MIT professor Erik Brynjolfsson (Brynjolfsson et al., 2018) as well as a ***report by consultancy firm McKinsey***

The giants rule AI and our data – is that OK?

It appears that the AI technology market is dominated by a few giant players: IBM, Google, Microsoft and Intel from the US and Baidu, Alibaba, and Tencent (“BAT”) from China. There is a feeling of déjà vu since the same situation exists in the digital platform economy – few companies dominate the market and basically have monopolies in their specific fields. It appears that the economic laws in the data economy will inevitably lead to either monopolies or oligopolies. The situation has downsides regarding competition, market entry and privacy.

But is there an alternative? Yes, there is, claim Finnish researchers in a ***recent report*** (Digibarometri 2017, pp. 31–37, Nikander et al., 2018). They suggest that we should rethink the nature of data ownership and force (by regulation) the digital giants to open the data in their possession to third-party firms in order to boost competition. Additionally, the customer’s ability to walk away – with their data – from one service provider to another should be made a real option.

(McKinsey Global Institute, 2017). They suggest that it is not that whole jobs will be eliminated by AI-driven automation but instead that certain tasks within the jobs will be done by robots and software. We should be talking about redesigning jobs.

Another important question concerns the fairness, transparency, openness, safety and security of AI algorithms, which are related to points 4–7 in the WEF list. There is a growing pressure towards subjecting the algorithms to an auditing process similar to those used with new drugs or airplanes (***Digibarometri 2017***). France will be demanding more transparency for AI algorithms, and Kathy O'Neil suggests that "In setting up an AI strategy for Europe, algorithmic accountability or responsibility should be a key element" (O'Neil, 2016). The problem is that a deep neural network is essentially a black box, since comprehending the workings of its millions of internal parameters is almost impossible.

Look into Machine Learning – the technology behind the AI boom

Machine learning algorithms are used to predict or estimate something. For example, they can be used to predict the probability of a bank customer to diligently make her loan payments when knowing her background data. The predictions that are made by the algorithm are based much information that has been gathered from previous customer cases.

Machine learning algorithms differ from traditional algorithms in one essential aspect. When working with a traditional algorithm, the programmer who is writing the software code explicitly codes the rules by which the probability of paying back the loan is computed, whereas the *machine learning algorithm learns automatically from the data* it is fed. The task of the human is to choose a suitable algorithm and tune its features for the task in question. Self-learning models are the next thing to be studied and implemented by many firms across different industries.

Machine learning algorithms can adjust to changes in their environment by changing their internal parameters. For example, if in our case increasing wages would decrease the problems with the loan payments, the algorithm would take this into account after some time with accumulating new data.

We must keep in mind that once a machine learning algorithm has been taught with training data, it is typically useful for one certain task only.

The most interesting machine learning method today is called *deep learning* or, more accurately, deep neural networks (Lecun et al., 2015). A neural network tries (coarsely) to mimic how the human brain processes data at the lowest level. Neural networks can be implemented with digital computers. "Deep" here refers to neural networks with millions of *input nodes* and large numbers of *processing layers, each also having large numbers of nodes*. Since processing power and access to data for learning has grown exponentially for some time, deep neural networks have become feasible.

It is amazing what seemingly intelligent things, machine learning algorithms, can do without the faintest understanding of the meaning of the data that they are processing.

Proposed actions

Based on this study, we propose the following.

- We should have a more analytical and explicit discussion about AI;
- We should usually avoid the general term “AI” and decompose it into explicit terms, such as machine learning and data analytics;
- All governmental policy discussions and reports on AI should follow the *10-subfield structure*.

References and further reading

Ailisto, H. – Heikkilä, E. – Helaakoski, H. – Neuvonen, A. – Seppälä, T. (2018). Tekoälyn kokonaiskuva ja osaamiskartoitus (in Finnish). Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja, 46/2018. http://urn.fi/URN:ISBN:978-952-287-549-5

Brynjolfsson, E. – Mitchell, T. – Rock, D. (2018). What Can Machines Learn, and What Does It Mean for Occupations and the Economy? AEA Papers and Proceedings, 108: pp. 43–47.

Mattila, J. – Pajarinen, M. – Rouvinen, P. – Seppälä, T. (2017). Tekoälyn voitto? (in Finnish). In Digibarometri 2017, pp. 15, Taloustieto Oy, Helsinki. https://www.etla.fi/wp-content/uploads/Digibarometri-2017.pdf

Lecun, Y. – Bengio, Y. – Hinton, G. (2015). Deep learning. Nature, 521(7553), pp. 436–444.

McKinsey Global Institute (2017). A Future That Works: Automation, Employment and Productivity. https://www.mckinsey.com/mgi/overview/2017-in-review/automation-and-the-future-of-work/a-future-that-works-automation-employment-and-productivity

Nikander, P. – Mattila, J. – Seppälä, T. (2018). Kehittymättömät datamarkkinat johtavat Internetin keskittymiseen (in Finnish). In Digibarometri 2018, pp. 31–37, Taloustieto Oy, Helsinki. https://www.etla.fi/wp-content/uploads/Digibarometri-2018.pdf

O'Neil, C. (2016). Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy, Crown.

WEF (2016). Top 9 ethical issues in artificial intelligence. https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence (fetched 26.7.2018).

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Overall view and national competence study on AI is part of the implementation of the 2018 Government plan for analysis, assessment and research.

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