

FCAI

**Finnish
Center for
Artificial
Intelligence**

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Aalto University



UNIVERSITY OF HELSINKI



What is Artificial Intelligence?

- Most “definitions” are hopelessly circular:
 - “Field of study which tries to make computers smart”
 - “Theory and development of computer systems able to perform tasks that require intelligence.”
- **Artificial:** AI systems are **computer programs or machines**, built by people.
- **Intelligence?**
 - We cannot properly define intelligence, but **learning** and **reasoning** seem to be central concepts
 - **Machine learning, pattern recognition, data analytics, data mining, computational statistics, signal processing, constraint reasoning, logic, planning, combinatorial optimization,...**
 - **We need systems that not only learn, or not only plan, but can both learn and plan.**

Why is AI so successful?

Recent breakthroughs in AI largely due to advances in machine learning, methods that learn from data, made possible by:

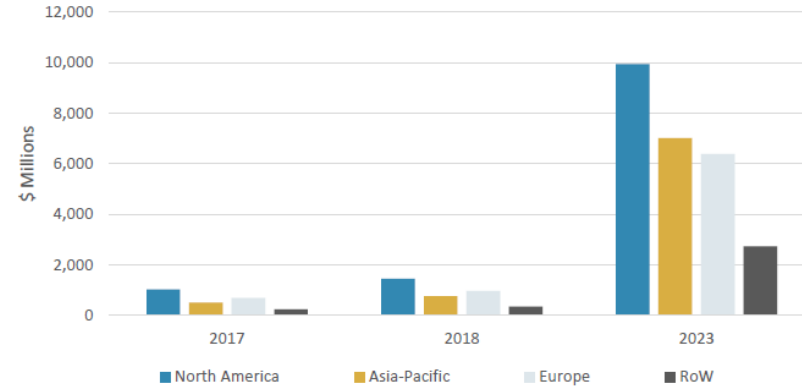
- Increased computing capacity (GPU etc.)
- Larger data sets (ImageNet, web-scale text data etc.)
- Easy-to-use software, backed up by web-scale companies (TensorFlow etc.)
- Some algorithmic improvements (especially in deep neural networks)
- By “lowering the bar” and focusing on clever applications of “narrow AI” (e.g. not translating novels, but food menus or tweets)

AI: Huge Potential, But Not Mature

- Disruptive economic and societal transformations
- Short gap between AI research and products
- Tough global competition of the new economy: the division to leaders and followers is taking place now
- **AI is not ready:** currently popular AI methods have shortcomings that need to be solved before more wide-spread utilization

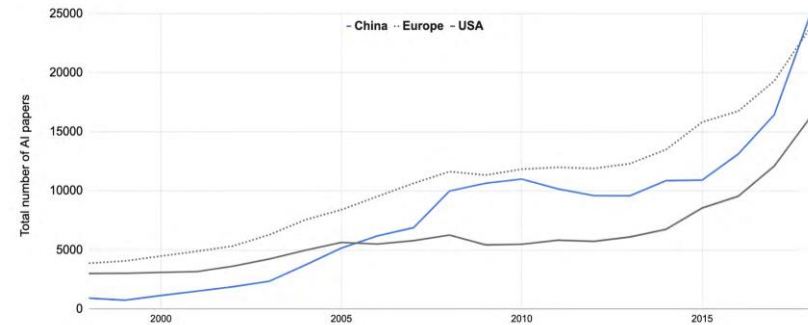
Global Artificial Intelligence Market, by Region, 2017-2023
(\$ Millions)

BCC Research



Annual Number of AI Papers on Scopus

Source : Elsevier, 2019.





Ben Haden/Getty

From 'Jeopardy' to poker to reading comprehension, robots have managed to beat humans in all of these contests in the past decade

Aaron Holmes 11/16/2019 2:00 PM

When IBM's Deep Blue chess machine defeated world chess champion Garry Kasparov in 1997, the world responded with surprise and angst at how far computers had come: "Be Afraid," read a Weekly Standard headline reacting to the news.

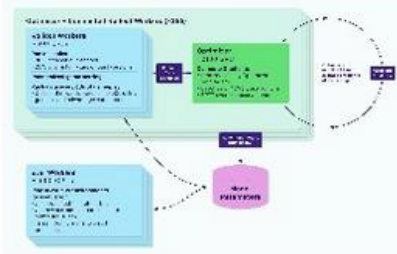
Artificial intelligence has since made advancements that were unthinkable just 20 years ago — in the past decade alone, robots have achieved dominance over humans in games far more complex than chess.

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RL conquers new territory: OpenAI Five improves even further

► OpenAI's Dota2 playing bot now has a 99.4% win rate over >7,000 online games with >15,000 live players.

- **August 2017:** A single player bot beats a top global Dota2 player in a simplified 1v1 match.
- **August 2018:** A team of bots, OpenAI Five, lost 2 games in a restricted 5v5 best of 3 match in *The Internationals*.
- **April 2019:** OpenAI Five wins 2 back-to-back games vs. the world champion Dota2 team in a live streamed event. Over the 4 day online tournament (*Arena*), 15,019 total players challenged OpenAI Five to 7,257 Competitive games of which the bot team won 99.4%.
- **System design:** Each bot is a single-layer, 4,096-unit LSTM that reads the game state and is trained through self-play RL (80% against itself and 20% against older versions of itself). Bots report their experience in batches and gradient optimisation is run and averaged globally.

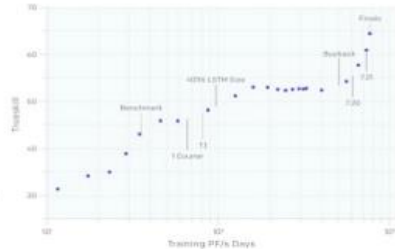


stateof.ai 2019

RL conquers new territory: OpenAI Five improves even further

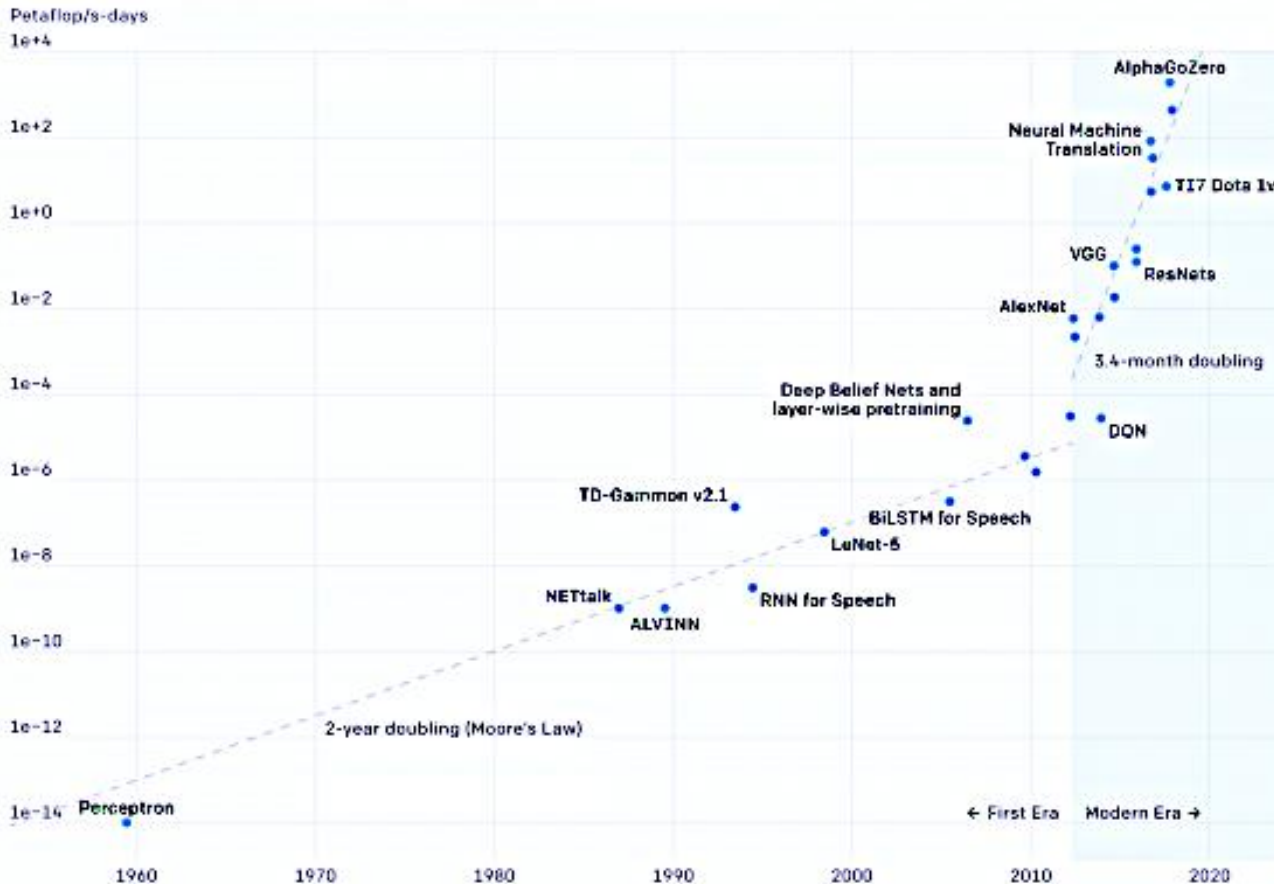
► Compute was the gatekeeper to the competitive performance of OpenAI Five.

- Compared to the August 2018 version of OpenAI Five, April's version is trained with **8x more compute**.
- The current version has consumed **800 petaflop/s-days** and experienced about **45,000 years of Dota self-play over 10 realtime months**.
- As of *The International* in 2018 where the bots lost 2 games in a best of 3 match, total training experience summed to 10,000 years over 1.5 realtime months. This equates to **250 years of simulated experience per day** on average.



stateof.ai 2019

Two Distinct Eras of Compute Usage in Training AI Systems



K. Hao: The computing power needed to train AI is now rising seven times faster than ever before. MIT Technology Review, Nov. 11, 2019.



Only huge firms such as Facebook can house the number of processors that machine learning requires. Photograph: Jim Thompson/Quanta Services/eyewire

Can the planet really afford the exorbitant power demands of machine learning?

John Naughton

There is, alas, no such thing as a free lunch. This simple and obvious truth is invariably forgotten whenever irrational exuberance teams up with digital technology in the latest quest to "change the world". A case in point was the bitcoin frenzy, where one could apparently become insanely rich by "mining" for the elusive coins. All you needed was to get a computer to solve a complicated mathematical puzzle and – lo! – you

could earn one bitcoin, which at the height of the frenzy was worth \$19,783.06. All you had to do was buy a mining kit (or three) from Amazon, plug it in and become part of the crypto future.

The only problem was that mining became progressively more difficult the closer we got to the maximum number of bitcoins set by the scheme and so more and more computing power was required. Which meant that increasing amounts of electrical power were needed to drive the kit. Exactly how much is difficult to calculate, but one estimate published in July by the Judge Business

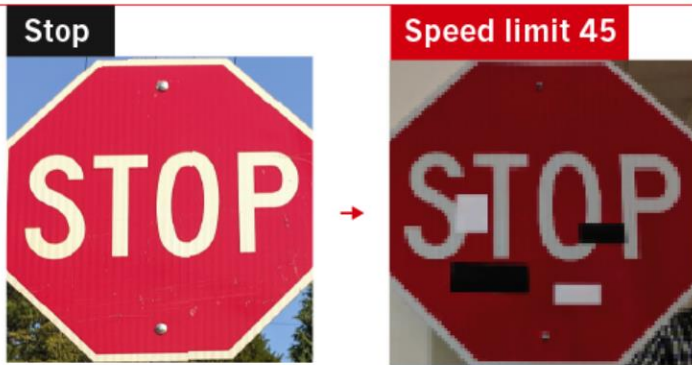
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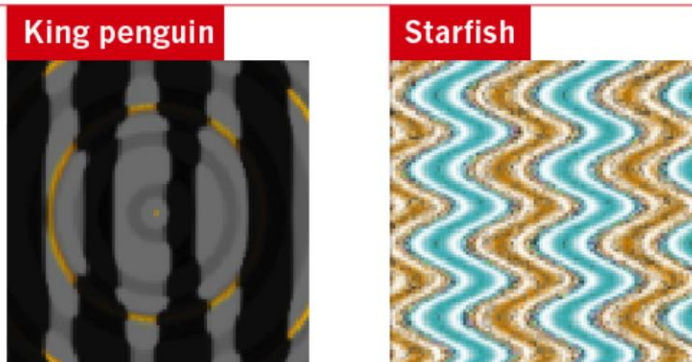
FOOLING THE AI

Deep neural networks (DNNs) are brilliant at image recognition — but they can be easily hacked.

These stickers made an artificial-intelligence system read this stop sign as 'speed limit 45'.



Scientists have evolved images that look like abstract patterns — but which DNNs see as familiar objects.

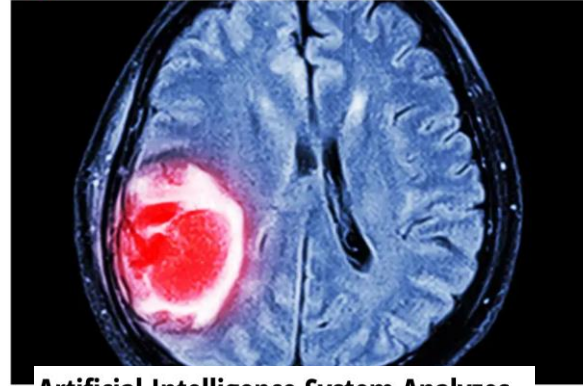


AI matches humans at diagnosing brain cancer from tumour biopsy images



HEALTH 8 January 2020

By Gege Li



Artificial Intelligence System Analyzes Chest X-Rays in 10 Seconds

The artificial intelligence model was able to rapidly identify findings in chest x-rays of patients with pneumonia.



Source: Thinkstock

By Jessica Kent



News Network

For Journalists

Mayo Clinic Radio

By Ethan Grove

Augmented human intelligence is changing health care for the better, experts say

November 26, 2018



#SCIENCE

Uber self-driving car in fatal crash did not recognize that pedestrians jaywalk

🔥 Euronews - By Phil McCausland with NBC News Tech and Science News

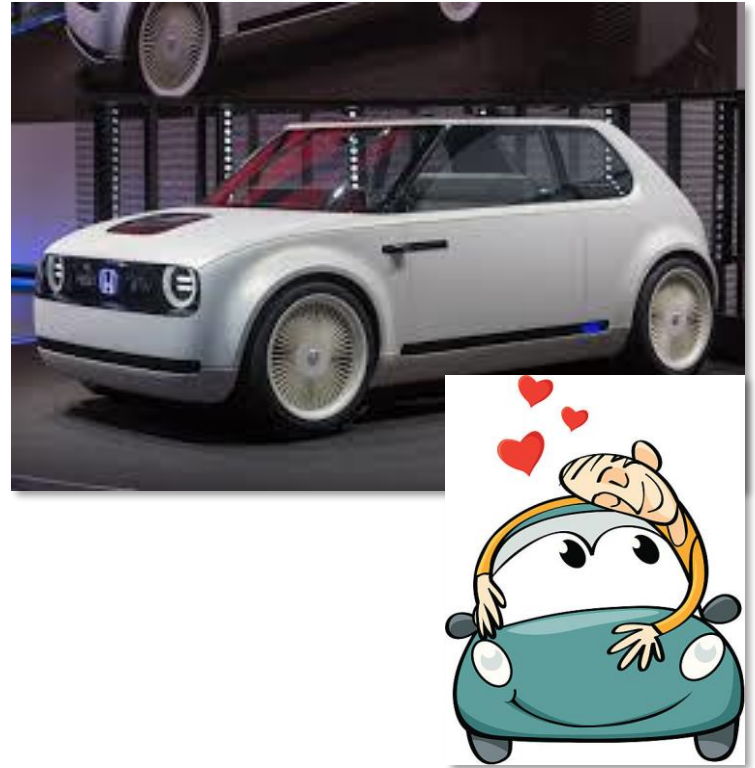
A self-driving Uber car that struck and killed an Arizona woman was not able to recognize that pedestrians jaywalk, the National Traffic Safety Board revealed in documents released earlier this week. Herzberg,

(Most) AI today



FCAI

AI tomorrow

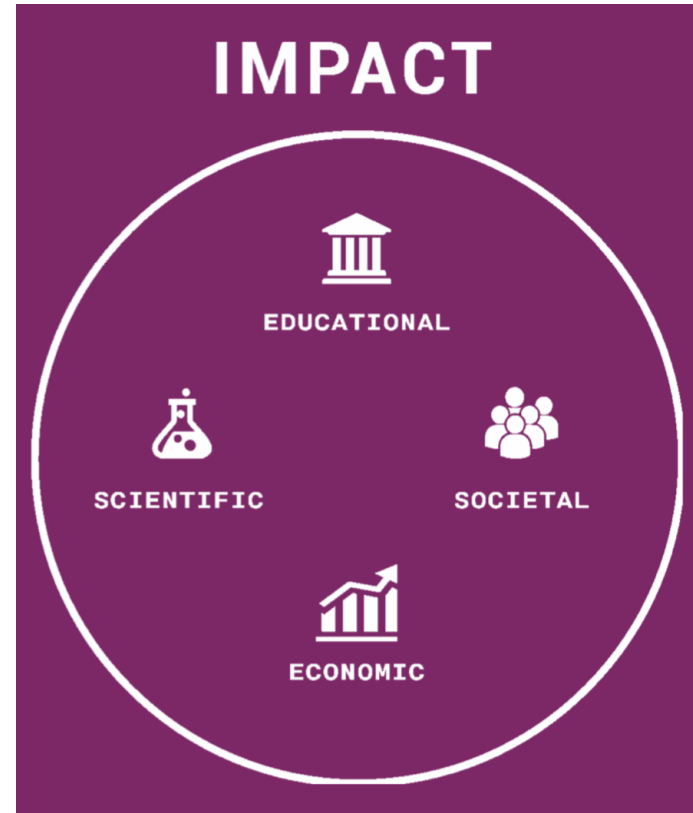


fcai.fi

FCAI: The Finnish Flagship on AI

- “The Flagship Programme is an instrument that promotes **excellent research** and versatile **impact** arising therefrom.
- Through this one-time instrument, the Academy of Finland has decided to fund six Flagships in the 8-year period of 2019-2026
- One of the six Flagships is **the Finnish Center for Artificial Intelligence (FCAI)**
- The total budget of FCAI is 250 M€ for the next 8 years.

FCAI



FCAI: CONTINUING THE LONG-TERM FINNISH AI STRATEGY

Based on strong investments in foundations of AI over decades

1980's
Neural networks

1995–99
First AoF CoE on Neural Networks (Aalto)
1999
HIIT founded as joint institute between UH and Aalto

2000–05
Neural Networks CoE (Aalto)
2002–07
From Data to Knowledge CoE (UH)
2006–11
Adaptive Informatics CoE (Aalto)
2008–13
Algorithmic Data Analysis CoE (UH)

2012–17 Computational Inference CoE (Aalto/UH)
2014
Profi 1 UH: Large Data & Life-Science Informatics
Aalto: ICT & Digitalization
2015
Profi 2 UH: Digital Humanities
2016
Profi 3 UH: Data Science
Aalto: Data Science and Analytics, Digital Technology Ecosystems
2017
The national Finnish AI Strategy

2019-2026: AI Flagship

- 1. Make Finland a leader in development and application of AI,** generating wealth and prosperity for the country as a whole.
- 2. Recruit experts** with skills and capabilities to employ the latest AI methodologies
- 3. Support analytic data-based decision making** using AI methods.

Aalto, University of Helsinki & VTT: Building national and international ecosystems

FCAI AS AN AI COMPETENCE HUB

Helsinki is the leading AI hub in the Nordics

- producing almost 90% of top-level AI output in Finland
- on par with many global top-20 universities known for their AI output:

	H-index	Citations	AI output	Ranking
FCAI	32	5800	164	56 (UH)
UCL (UK)	31	6100	117	16
Cornell (US)	38	8200	140	14
Stanford (US)	47	7000	337	2

H-index/citations: Median for AI faculty

AI output: Publications in top-level AI forums in 2014-2017

Ranking: Shanghai University Ranking 2017

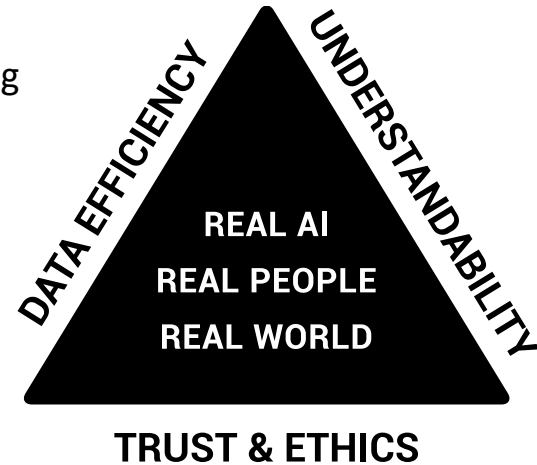
This result is supported by an independent bibliometric study (Ailisto et al., 2018), which indicates that the total AI output volume of FCAI (as determined by Scopus, based on years 2008-2017), is around 75% of the output of the country of Finland, and is among the top 10 in Europe, and is growing faster than the competition.

FCAI AND THE EUROPEAN TRUSTWORTHY AI



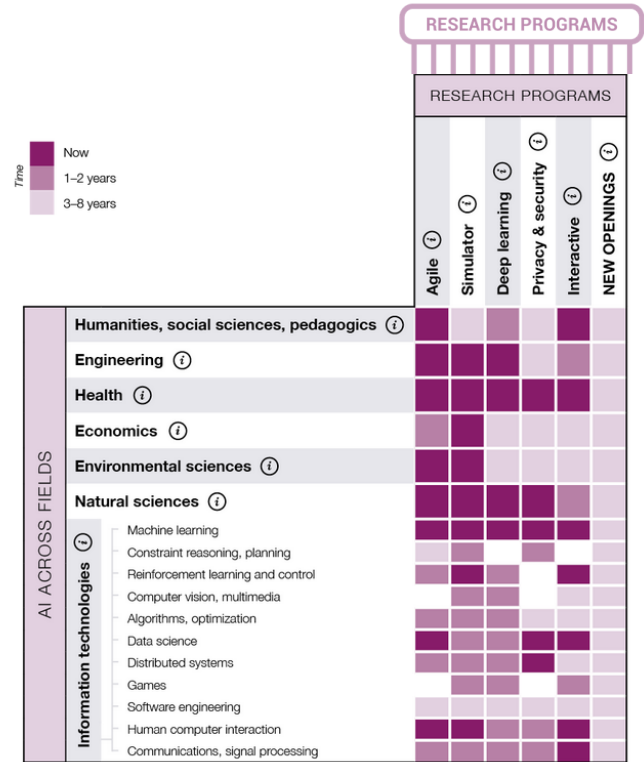
FCAI RESEARCH FOCUS

- 1. Data efficiency.** Most of the value in big data is in the enormous number of small questions it could answer. At this resolution **data becomes small and a scarce resource.**
 - ✓ We will **make AI applicable to a significantly wider scope of questions** by several means: data-efficiency, prior knowledge, (privacy-preserving) sharing and fusion of data.
- 2. Trust and ethics.** Many AI techniques cannot be trusted because they are vulnerable to manipulation and information stealing, and reliability is not known.
 - ✓ We will develop the required privacy-preserving, secure and resilient AI. **Societal trust** stemming from dependable AI **enables wide applicability.**
- 3. Understanding and Interaction.**
 - ✓ We will give AI the capability to understand the user, which enables for making AI understandable. Outcome: AIs that are able to **augment human capabilities.**



CURRENT FCAI RESEARCH PROGRAMS

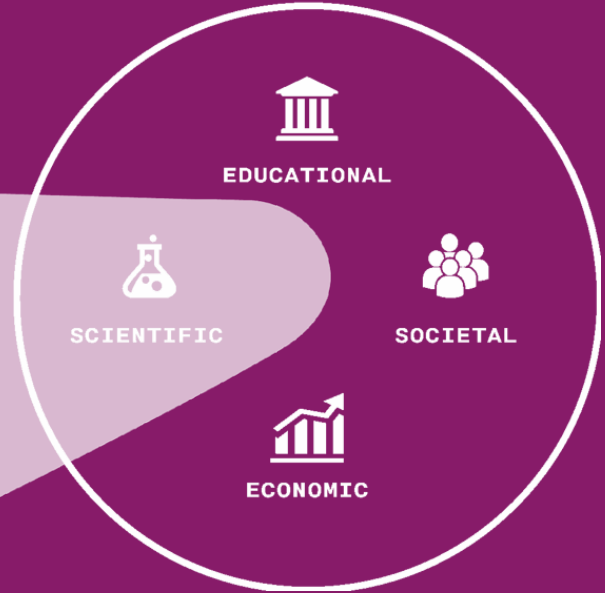
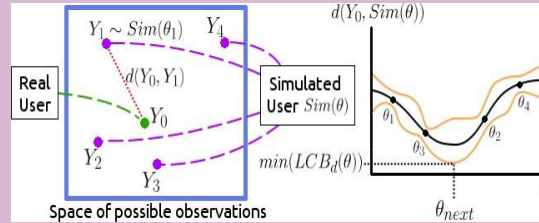
- **Agile probabilistic AI**, *Coord: Prof. Aki Vehtari*
explainable, verifiable, uncertainty-aware, and reliable tools for data analysis and developing models.
- **Simulator based inference**, *Coord: Prof. Jukka Corander*
enables the use of established knowledge, e.g. models of human physiology, psychology, disease evolution, processes etc. Including these models helps the AI to learn and generalize faster and better when using the smaller data sets. The models are efficient and their reasoning is interpretable.
- **Next-generation deep learning**, *Coord: Prof. Arno Solin*
boosts the already ongoing success of deep learning in data analysis by providing AI methods that can cope with less training data while still sustaining the full power of deep learning, especially in combination with simulator-based inference.
- **Privacy & Security**, *Coord: Prof. Antti Honkela*
provides AI solutions, which preserve the privacy of data as well as the security and privacy of the developed AI systems.
- **Interactive AI**, *Coord: Prof. Antti Oulasvirta*
ensures the context sensitive natural interaction between the AI solutions and the users.
- **Autonomous AI**, *Coord: Prof. Ville Kyrki*
- **AI and Society**, *Coord: Prof. Petri Ylikoski*
- **+New openings in works**



AI research programs (columns) and the disciplines linked to them (AI Across Fields rows), with expansion plan in colors: currently in operation (dark purple), starting in 1-2 years (middle purple), and in planning (light purple). Examples of on-going work and initiatives are being linked to from the matrix (work in progress).

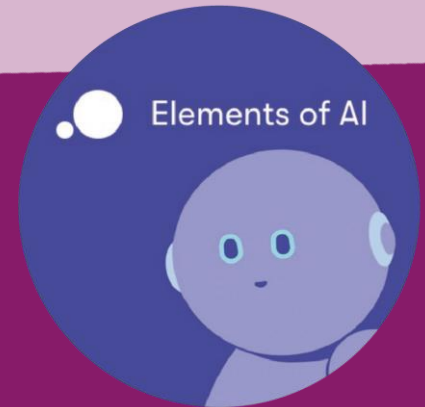
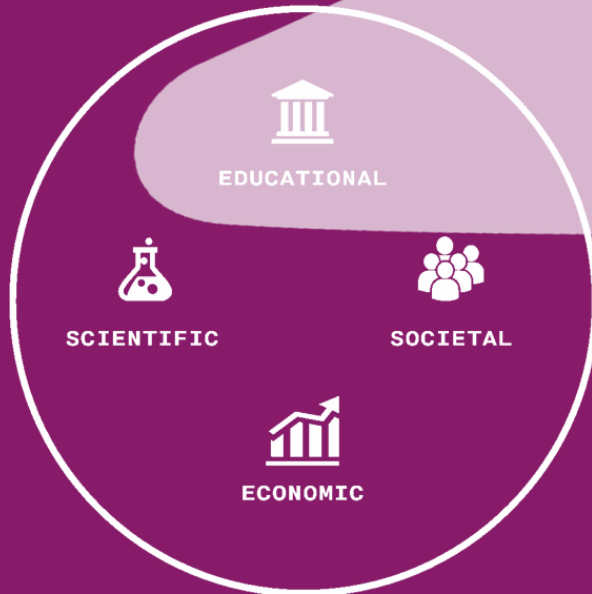
SCIENTIFIC IMPACT

- NEW SCIENTIFIC RESULTS
- RESEARCH PROGRAMS
- HIGHLIGHTS
- ATTRACTIVITY OF FCAI



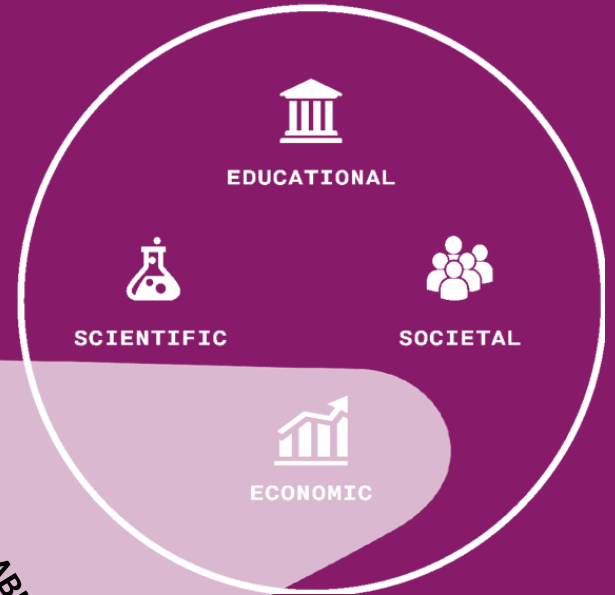
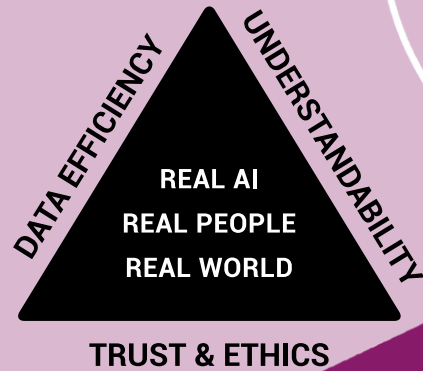
EDUCATIONAL IMPACT

- PROVISION OF AI PROFESSIONALS
- EDUCATION OF PROFESSIONALS IN INDUSTRY AND PUBLIC SECTOR ABOUT AI; SUPPORTING CHANGE OF WORK
- INCREASING THE GENERAL PUBLIC'S UNDERSTANDING OF AI



ECONOMIC IMPACT

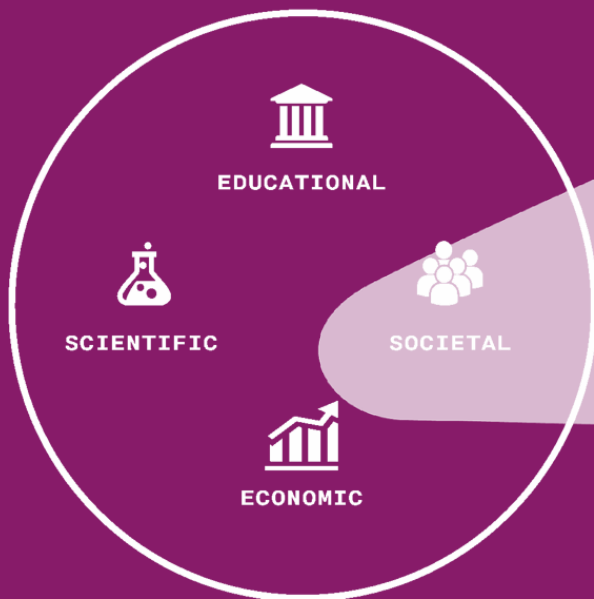
- ACCELERATING RENEWAL OF EXISTING BUSINESS AND PUBLIC SECTOR BY BRINGING FCAI RESEARCH RESULTS TO PRACTICE
- GENERATING NEW AI-DRIVEN BUSINESS
- CREATION OF AN FCAI ECOSYSTEM



SOCIETAL IMPACT

 Tekoälyaika

FINLAND WANTS
TO BE A LEADING
COUNTRY IN AI

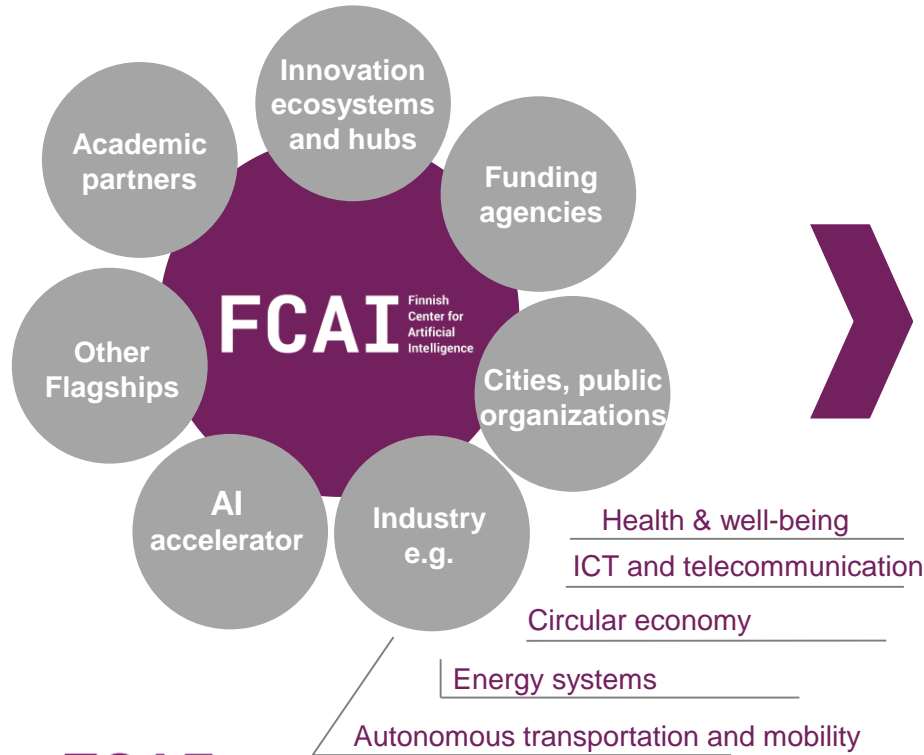


- PROMOTING EFFECTIVE AND ETHICAL APPLICATION OF AI IN SOCIETY
- SUPPORTING GOVERNMENTAL DECISION-MAKING

ADDED VALUE IN NATIONAL ECOSYSTEMS

FCAI collaboration

Added value



STRATEGIC PARTNERS

European Laboratory for Learning and Intelligent Systems



NSF Science and Technology Center for Science of Information (USA)



Alan Turing Institute (UK)



Japan



Partnership program



FCAI

Finnish
Center for
Artificial
Intelligence

REAL AI FOR REAL PEOPLE IN THE REAL WORLD

The logo for Aalto University, featuring a stylized white letter 'A' with two quotation marks to its upper right.

Aalto University



UNIVERSITY OF HELSINKI

The logo for VTT, consisting of the letters 'VTT' in a bold, white, sans-serif font.