

EAISI: the Eindhoven AI Systems Institute

AI Systems for the Real World

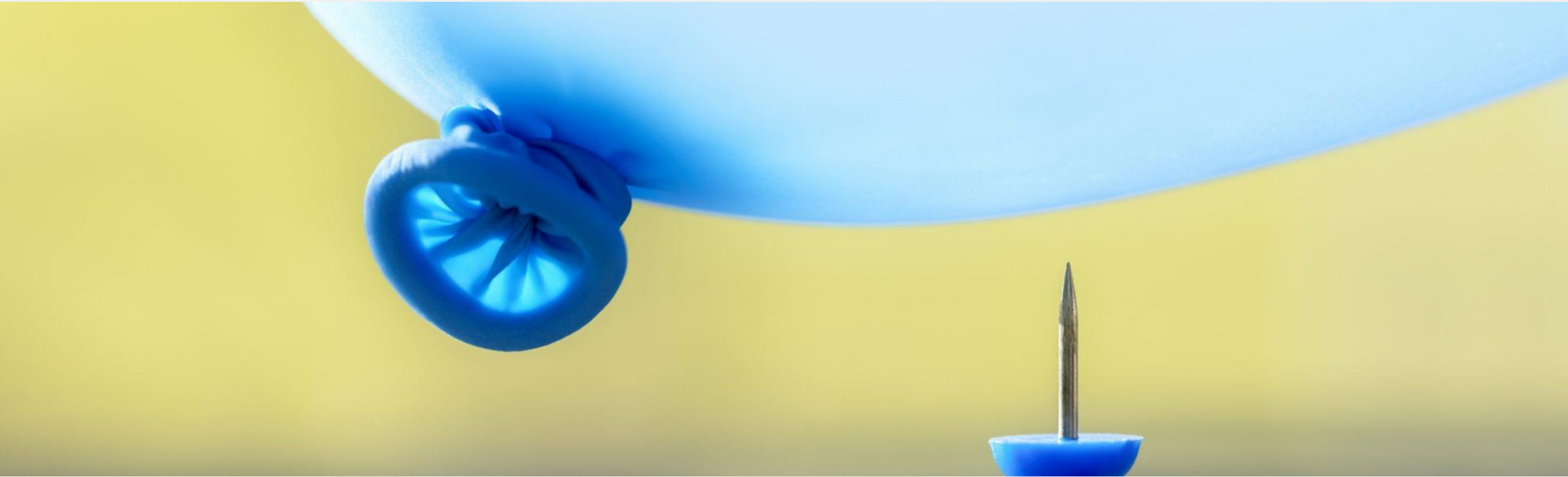
The Future of Systems Engineering, Georgo Angelis TU/e Fellow, November 11th 2020
g.z.angelis@tue.nl with contributions from colleagues Ton Peijnenburg and Albert van Breemen

Artificial Intelligence is like a Swiss army knife ...



... it can be applied to many different applications/areas, including machine vision, logistics, planning, robotics, predictive maintenance, sales, ...

Artificial Intelligence is not a silver bullet.....



... The Curse of Inflated Expectations leads to the idea that someone has already invented the silver bullet; now all you have to do is load and fire it.

<https://expertsystem.com/matching-inflated-expectations-with-ai/>

Artificial Intelligence for real life.....

... A data scientist without application domain knowledge



...An application engineer without machine learning knowledge

Positioning

opportunity & challenges

Research Agenda

programmes & moonshots

Collaboration and Valorisation

student teams & consortia & AIE Lab

TU/e EAISI Targets for 2024, 100MEUR/5yrs

Research	<ul style="list-style-type: none">➤ Appoint 50 new AI related professor positions on top of current 150➤ Have 20% of our AI related publications in the top 5% of scientific journals
Education	<ul style="list-style-type: none">➤ 25% of TU/e graduates to be AI specialists or AI 'enabled' engineers (>300 BSc, >300 MSc, >300 professional education students per year)➤ Systems Engineering / Thinking embedded in curriculum (PdEng, Msc,..)
Acquisition	<ul style="list-style-type: none">➤ Acquire an additional, external annual research budget of 30M€ on top of our own investment of 20M€
Positioning	<ul style="list-style-type: none">➤ Build a dedicated AI lab in the center of the TU/e campus➤ Regular (> weekly) appearance in (inter)national press outings➤ Contribute to a flourishing AI ecosystem in Brainport Eindhoven, building on the High-Tech Systems knowledge base
Valorisation	<ul style="list-style-type: none">➤ Set-up collaborations (i.e. consortia) and facilitate Student teams / start-ups that enrich the ecosystem with AI driven or enabled propositions.

High Tech prepares for AI

Consumer 'database'-driven AI



Google

Uses ML to predict traffic density based on anonymous mobile phone position data.

<https://ai.google/>



Netflix

Uses ML as part of their movie recommender system.

<https://www.wired.co.uk/article/how-do-netflixs-algorithms-work-machine-learning-helps-to-predict-what-viewers-will-like>



Facebook

Uses ML-based algorithms to detect and recognize faces in photo's.

<https://research.fb.com/category/machine-learning/>



Apple

Developed speech recognition service Siri with ML.

<https://machinelearning.apple.com/>



Spotify

Uses ML for recommending new music.

<https://www.oreilly.com/ideas/machine-learning-at-spotify-you-are-what-you-stream>



Paypal

Uses ML to detect and combat fraud

<https://www.paypal-engineering.com/tag/machine-learning/>

Industrial 'sensor data'-driven AI



General Electric

Uses ML develop Digital Twins to understand, predict and optimize performance of assets.

<https://www.ge.com/digital/predix/digital-twin>



Tesla

Uses ML to develop autonomous driving cars.

<https://www.youtube.com/watch?v=2aVc84mGJfE>



Siemens

Uses AI a.o. for Industry 4.0, medical and traffic optimization applications

<https://www.siemens.com/global/en/home/company/innovation/pictures-of-the-future/artificial-intelligence.html>



PTC

Applies AR and ML for maintenance.

<https://www.ptc.com/en>



SemioticsLab

Dutch startup using ML for predictive maintenance.

<https://www.semioticslabs.com/nl/>



Freenome

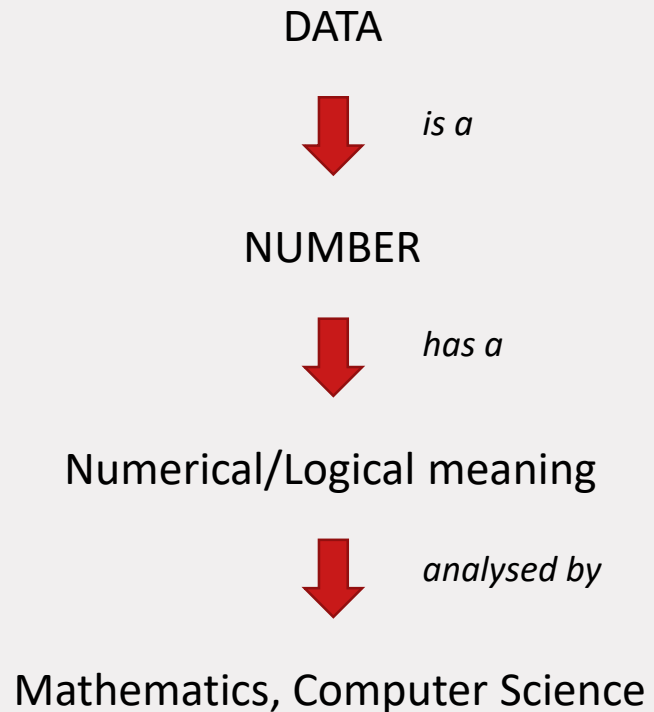
Startup using AI for early cancer detection.

<https://www.freenome.com/>

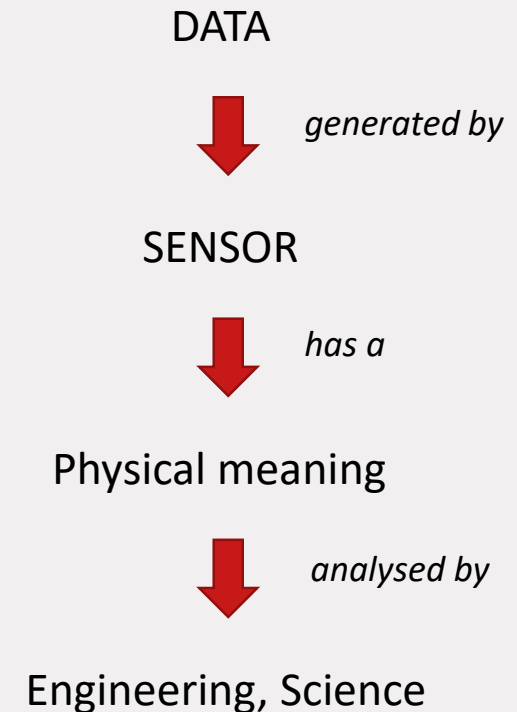
2nd wave of AI applications

High Tech prepares for AI

Data Science

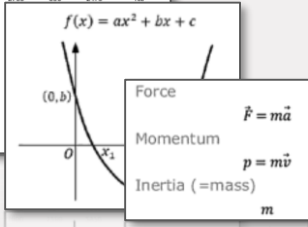


AI (in) Engineering

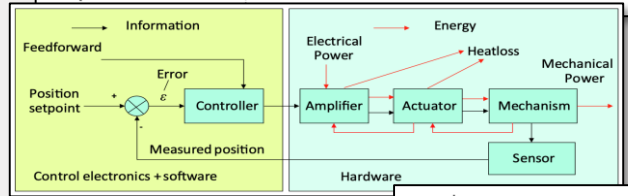
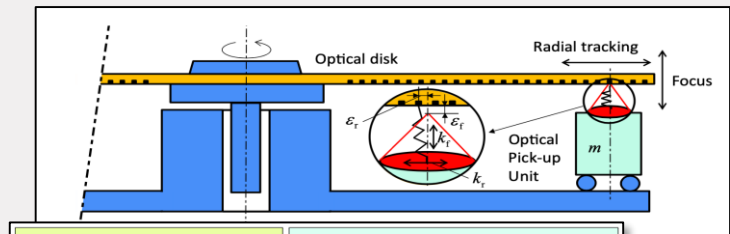
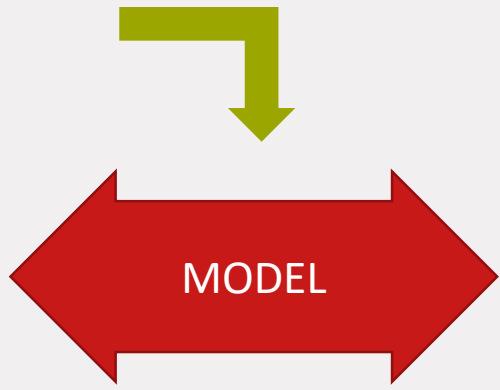


Designing high tech systems

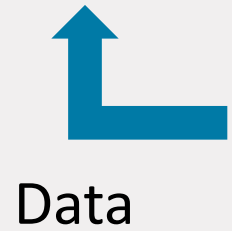
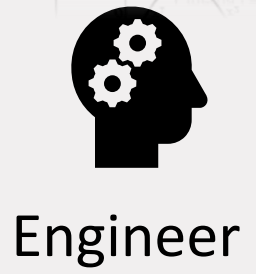
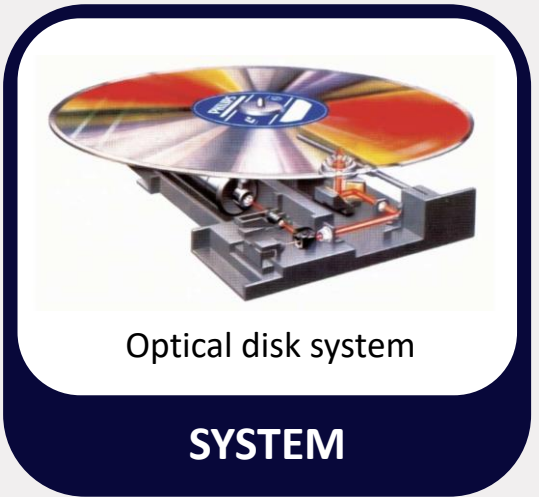
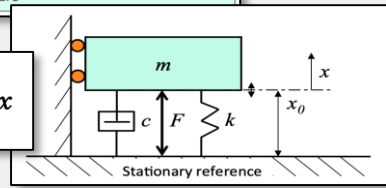
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Cerium	58				
Chlorine	17				
Chromium	24				
Cobalt	27				
Copper	29				
Europium	62				
Fluorine	9				
Gadolinium	64				
Germanium	32				
Gold	79				
Hydrogen	1				
Iodine	53				
Iron	26				
Krypton	36				
Lithium	3				
Neon	10				
Nickel	28				
Niobium	41				
Oxygen	8				
Palladium	46				
Phosphorus	15				
Platinum	78				
Plutonium	94				
Polonium	84				
Praseodymium	59				
Protactinium	91				
Radium	88				
Rhenium	75				
Rhodium	45				
Rubidium	37				
Ruthenium	44				
Samarium	60				
Selenium	34				
Silver	47				
Sodium	11				
Sulfur	16				
Tantalum	73				
Tellurium	52				
Thallium	81				
Thorium	90				
Thulium	61				
Tin	50				
Titanium	22				
Tungsten	74				
Uranium	92				
Vanadium	23				
Xenon	54				
Zinc	30				
Zirconium	40				



First principles



$$F(t) = m \frac{d^2x}{dt^2} + c \frac{dx}{dt} + kx$$



Source: 'The Design of High Performance Mechatronics', R.M. Schmidt et al, 2014

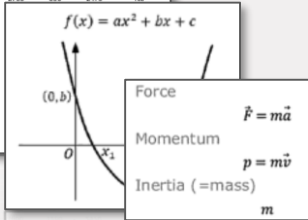
Growing design challenges

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Bromine	35				
Cadmium	48				
Cesium	55				
Chlorine	17				
Chromium	24				
Cobalt	27				
Copper	29				
Curium	96				
Dubnium	105				
Dysprosium	69				
Einsteinium	88				
Erbium	68				
Eurobium	67				
Fermium	100				
Ferrous	26				
Francium	87				
Gadolinium	64				
Gallium	31				
Germanium	32				
Gold	79				
Hafnium	72				
Hassium	108				
Helium	2				
Holmium	65				
Hydrogen	1				
Indium	49				
Iodine	53				
Iridium	77				
Itanium	22				
Lead	82				
Lithium	3				
Lutetium	71				
Lawrencium	103				
Lanthanum	57				
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Lanthanum	629				

Growing design challenges

Complexer models and bigger data needed to deal with challenges

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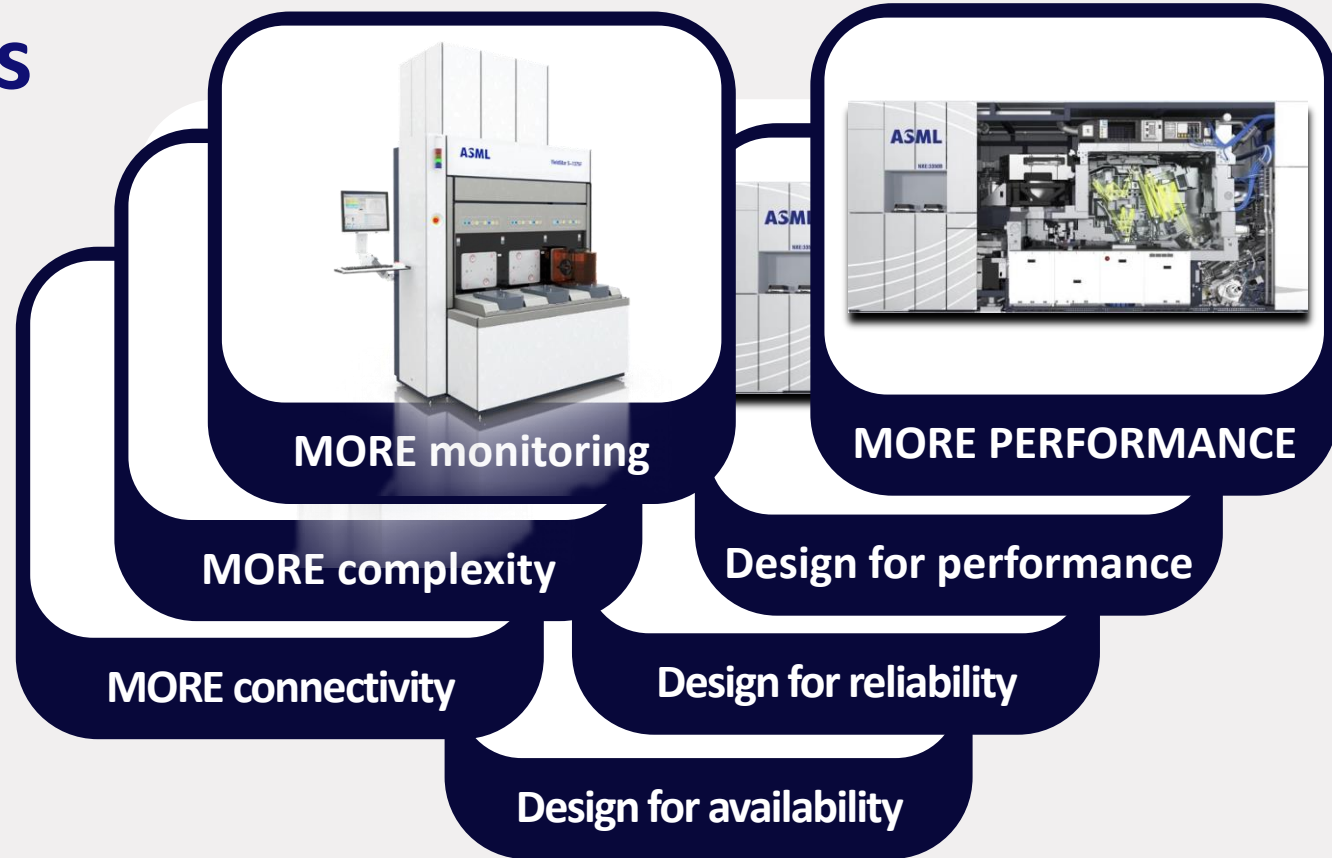


First principles



BIGGER Data

Engineer



How do I guarantee performance? How to use prior knowledge? How to understand the outcome and avoid bias? Why should we sacrifice interpretability to get the most accurate model?

Growing design challenges

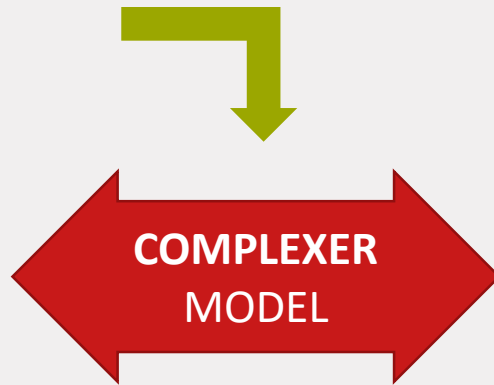
Artificial Intelligence is a technology platform to deal with bigger datasets and complex models

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Lithium	3				
Lutetium	71				
Mercury	80				
Magnesium	12				
Manganese	25				
Meitnerium	109				
Mendelevium	101				
Neon	10				
Nickel	28				
Niobium	41				
Oxygen	8				
Osmium	76				
Palladium	46				
Protactinium	91				
Radium	88				
Rhenium	75				
Rhodium	45				
Rubidium	37				
Ruthenium	44				
Samarium	62				
Selenium	34				
Silicon	14				
Silver	47				
Sodium	11				
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$f(x) = ax^2 + bx + c$

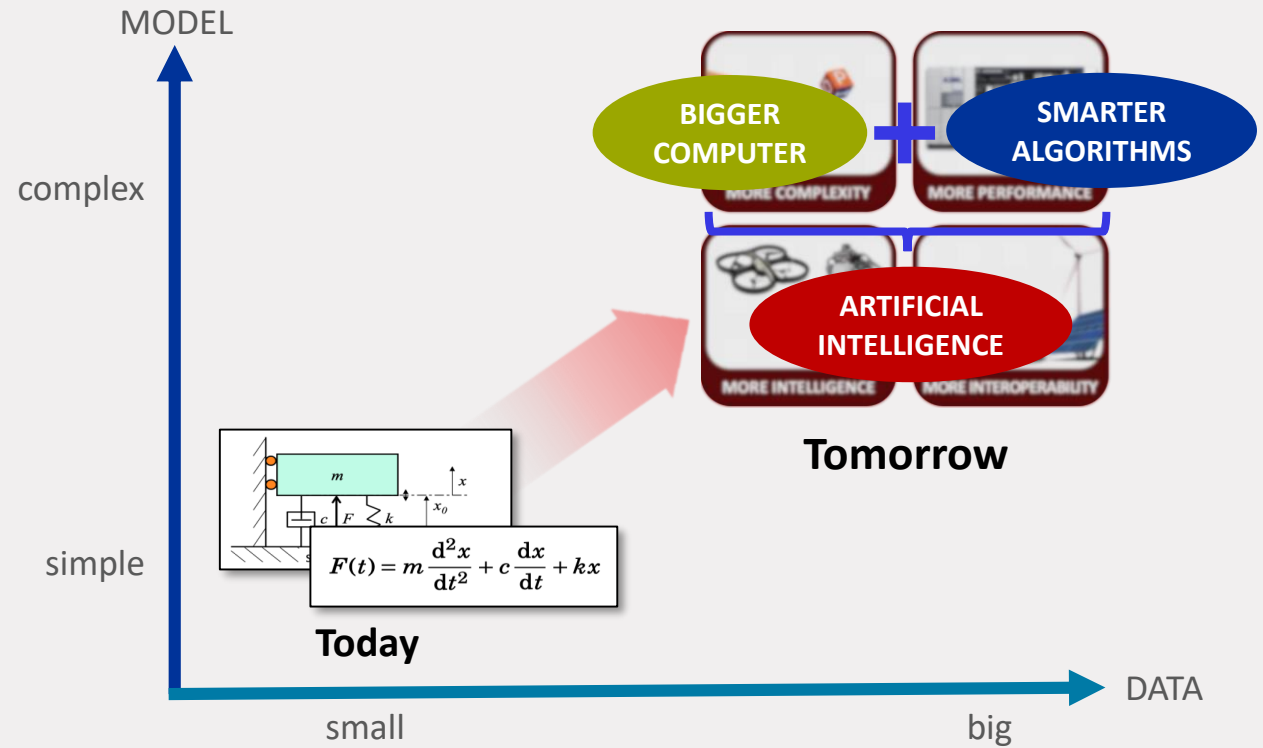
Force $\vec{F} = m\vec{a}$
 Momentum $p = m\vec{v}$
 Inertia (=mass) m

First principles



BIGGER Data

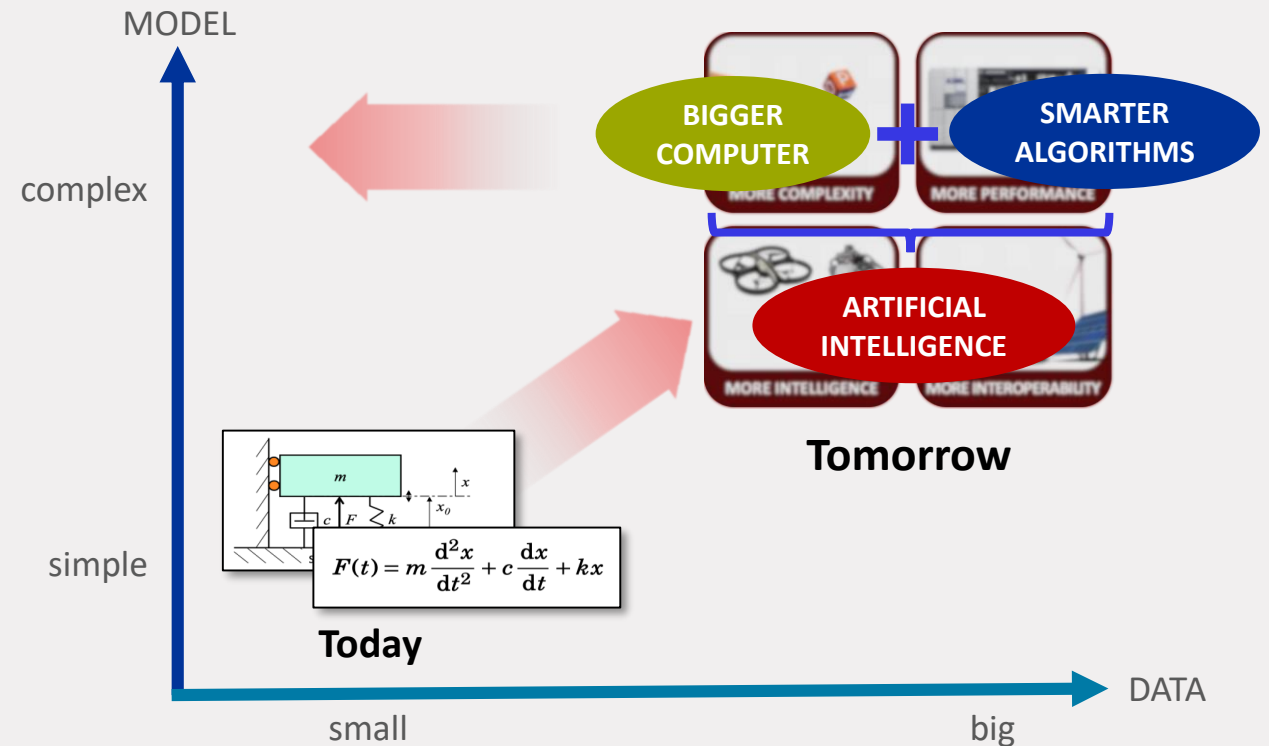
Engineer



Growing design (and research) challenges

There is a **gap** between the world of **engineering** and **data science** that can be bridged by:

- Combining first principle techniques with machine learning
- Making (black-box) models explainable
- Democratizing AI (complex AI technology stack and diversity of algorithms)
- Improve transfer learning (from virtual to real environment, from application 2 application, hyperparameters: from art to science)
- Applicability (since 2012, compute used in AI doubles every 3.4 month, compared to Moore's Law having a 2-year doubling period)
- Reusability, scalability and safety of AI



Which of the following AI adoption barriers do you consider the most important/relevant for your business?

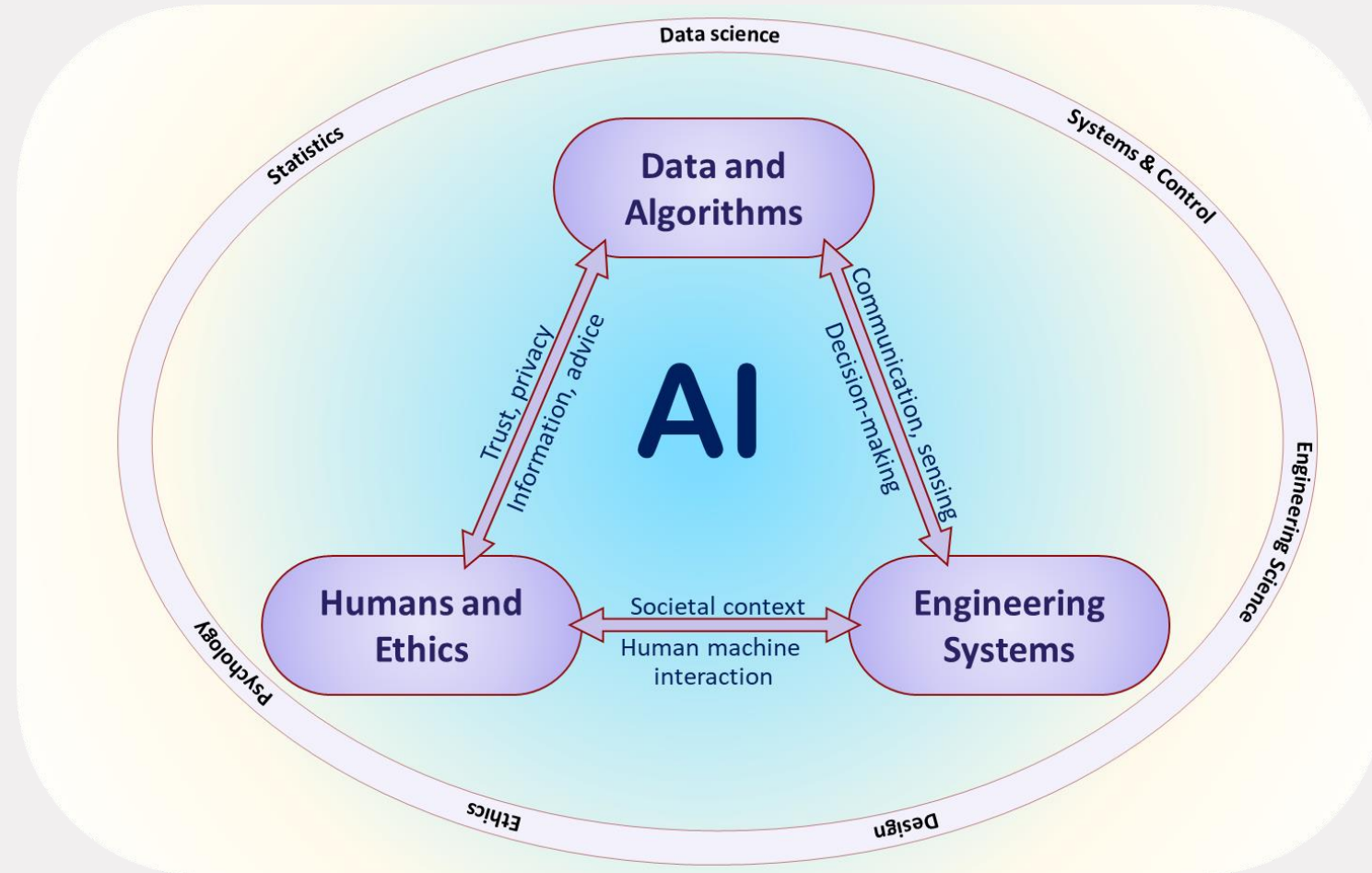
1. Complex AI technology stack and diversity of algorithms
2. Compute resources
3. Transfer results from simulated to real world
4. Transfer academic (research) results to practice
5. Reusability, scalability and safety of AI
6. Hyperparameter tuning, Blackbox models
7. Combine AI with engineering approaches
8. Fast innovation pace
9. Finding talent



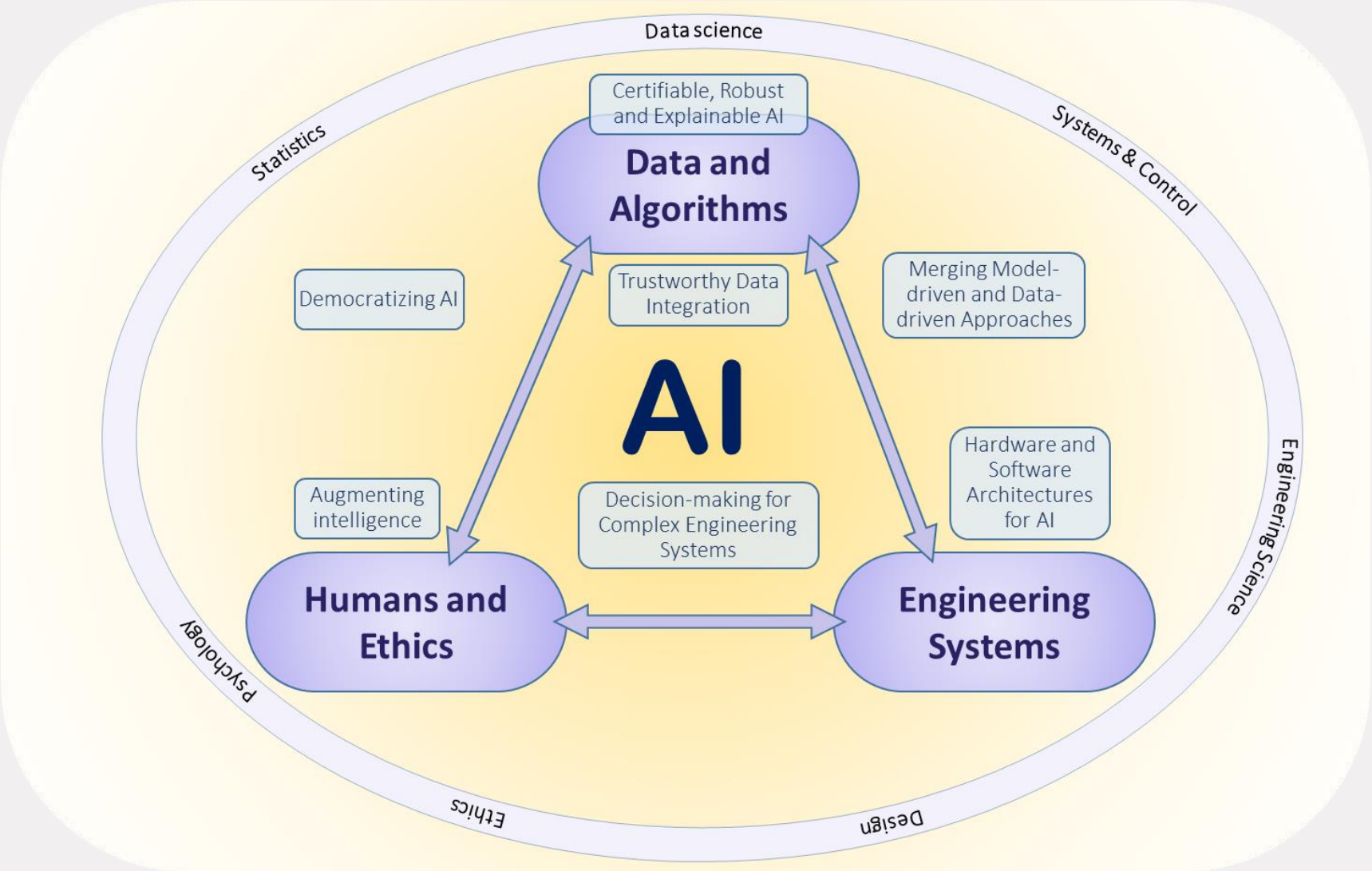
EAISI Focus

AI for the real world

With AI moving from *Data-only* to *Data-Human-Machine*, we aim to use our traditional strengths in the research domains *Data Science*, *Humans and Ethics*, and *Engineering Systems* to significantly leverage the huge potential of the next generation AI



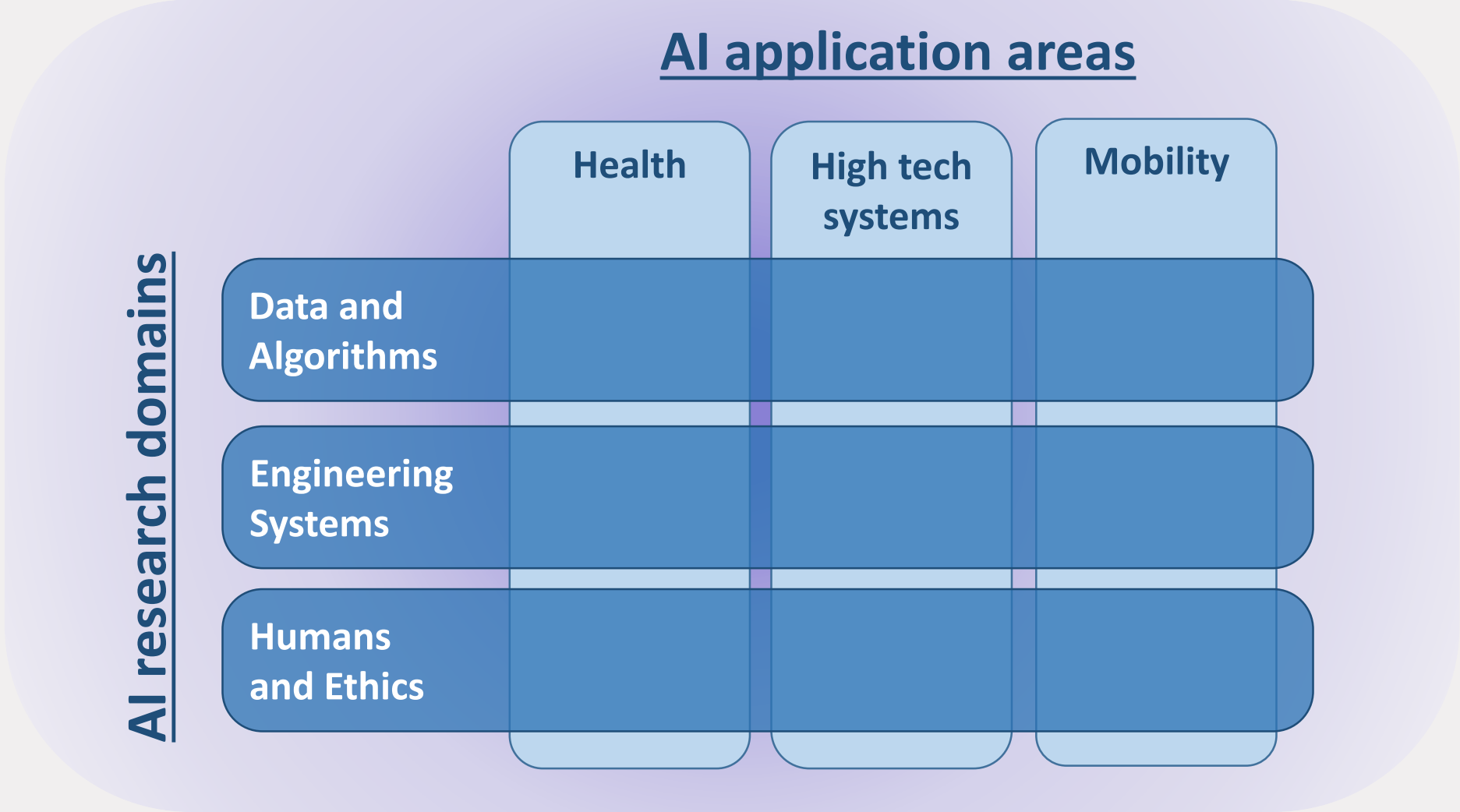
EAISI Research Domains and Program Lines



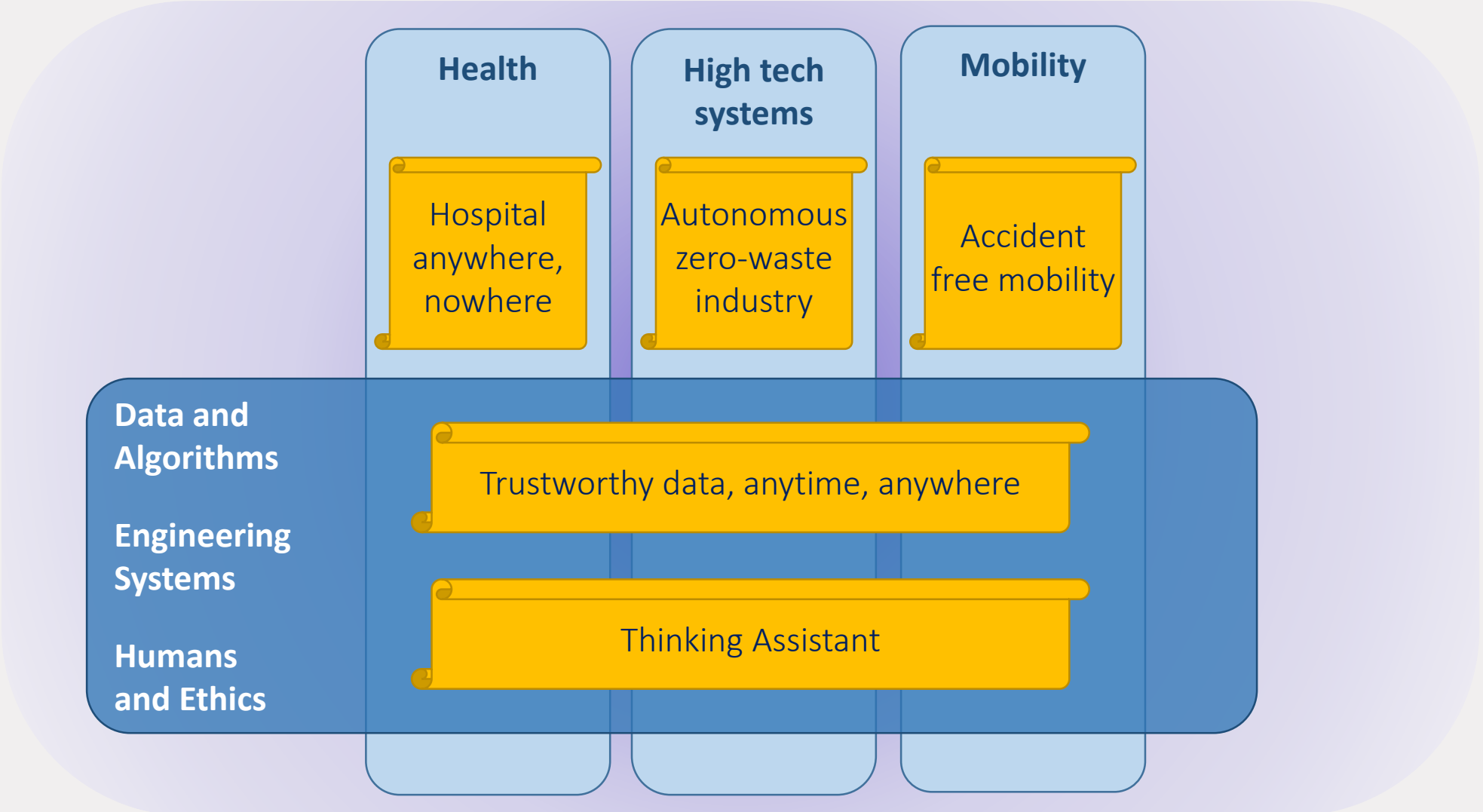
Which of the following research topics do you consider the most important/relevant for your business?

1. Robust and Explainable AI
2. Trustworthy Data Integration
3. Merging Model-driven and Data-driven Approaches in Learning
4. AI Hardware and Software Architectures
5. Decision-making for Complex Engineering Systems
6. Augmenting Intelligence
7. Democratizing AI

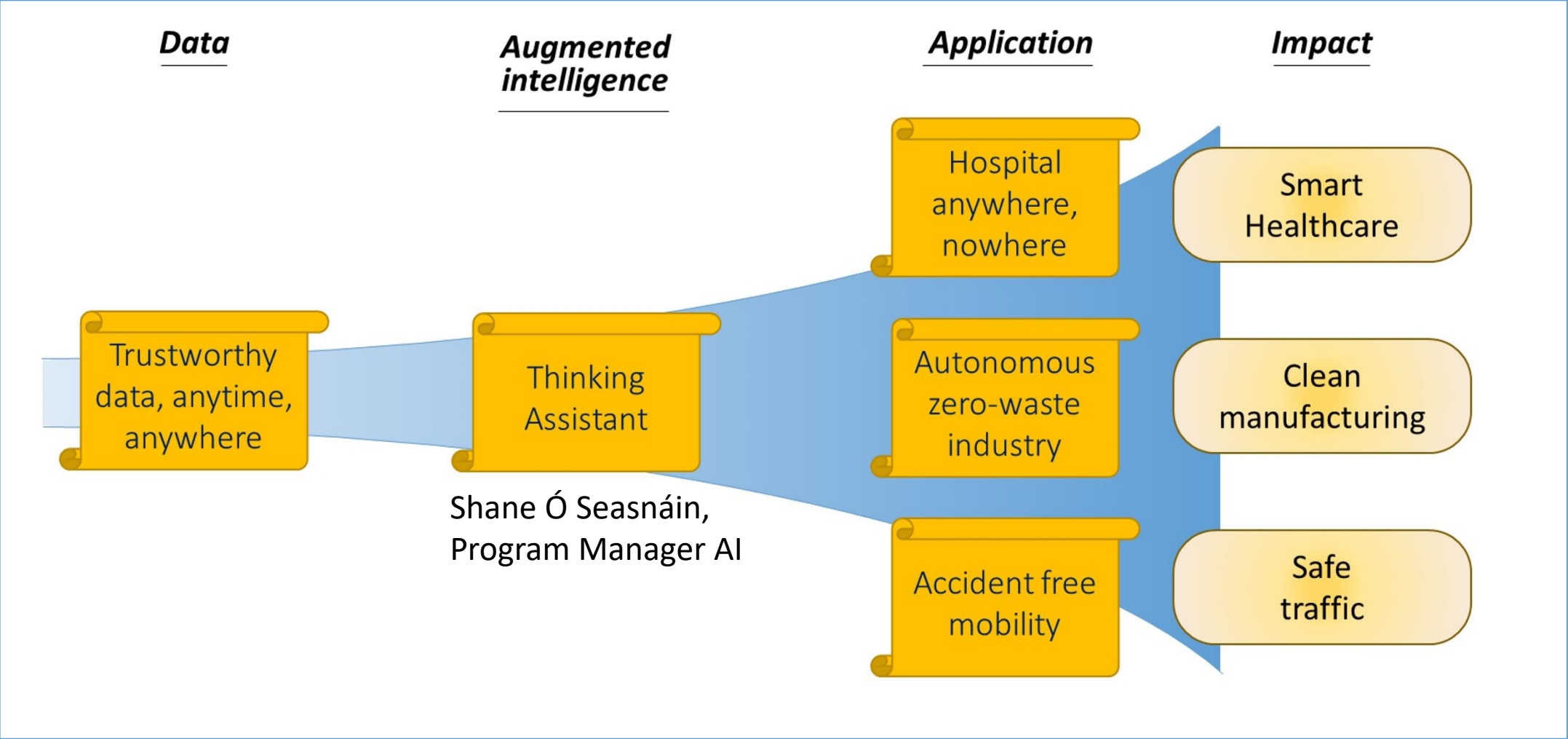
EAISI Focus: “Intelligent Machine in the Loop”



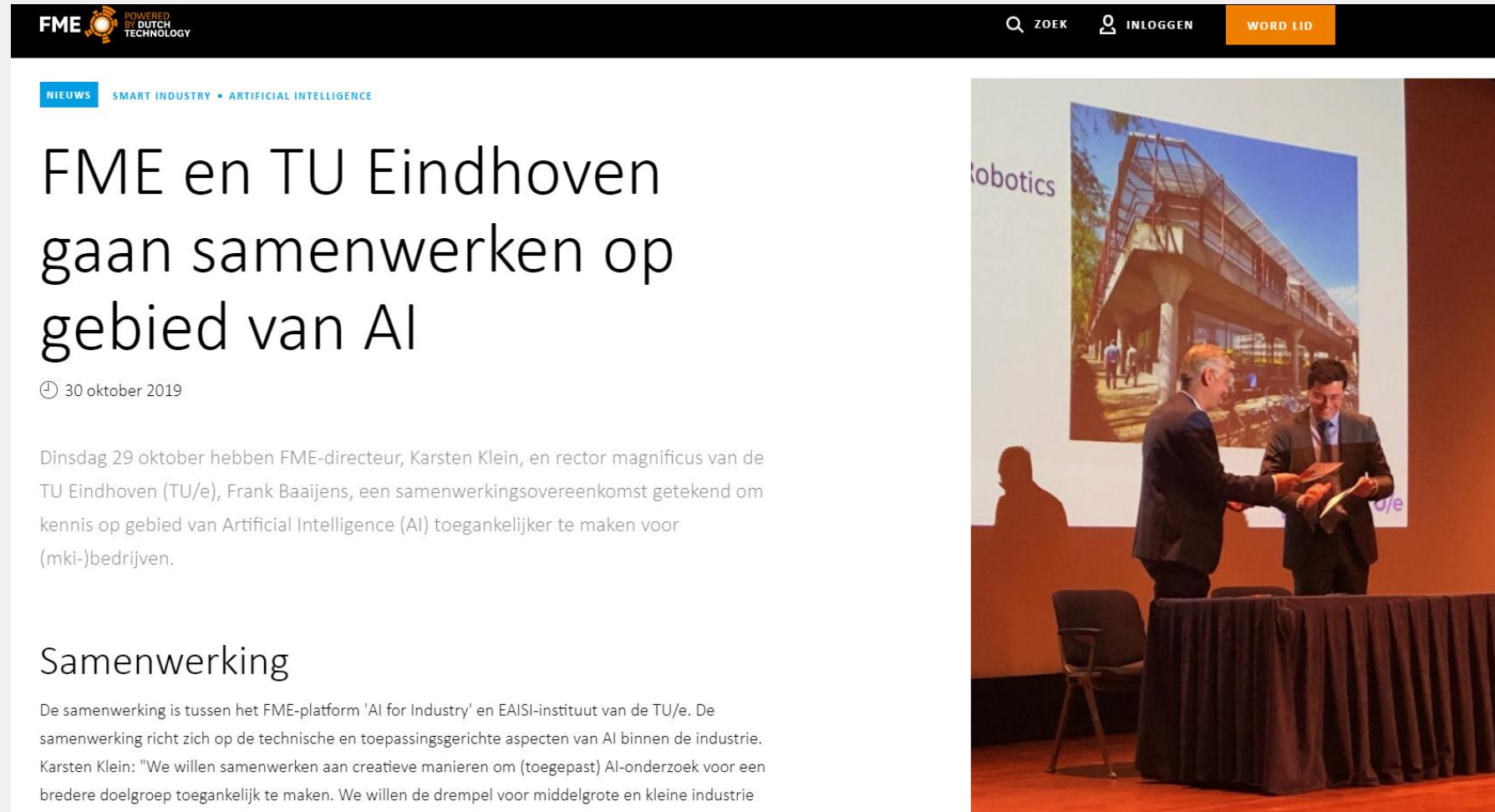
Moonshots



Moonshot funnel



Contribute to a flourishing ecosystem



FME POWERED BY DUTCH TECHNOLOGY

Q ZOEK INLOGGEN WORD LID

NIEUWS SMART INDUSTRY • ARTIFICIAL INTELLIGENCE

FME en TU Eindhoven gaan samenwerken op gebied van AI

🕒 30 oktober 2019

Dinsdag 29 oktober hebben FME-directeur, Karsten Klein, en rector magnificus van de TU Eindhoven (TU/e), Frank Baaijens, een samenwerkingsovereenkomst getekend om kennis op gebied van Artificial Intelligence (AI) toegankelijker te maken voor (mki-)bedrijven.

Samenwerking

De samenwerking is tussen het FME-platform 'AI for Industry' en EAISI-instituut van de TU/e. De samenwerking richt zich op de technische en toepassingsgerichte aspecten van AI binnen de industrie. Karsten Klein: "We willen samenwerken aan creatieve manieren om (toegepast) AI-onderzoek voor een bredere doelgroep toegankelijk te maken. We willen de drempel voor middelgrote en kleine industrie

FME is the employers' organization for the technology industry. Our 2,200 members are technostarters, trading companies, medium and small industry and large industry / multinationals.

October 30th 2019 the agreement was signed between TU/e and FME.

Contribute to a flourishing ecosystem: Student teams



Order at [lightyear.one](https://www.lightyear.one)

Open Machine Learning

FruitPunch AI

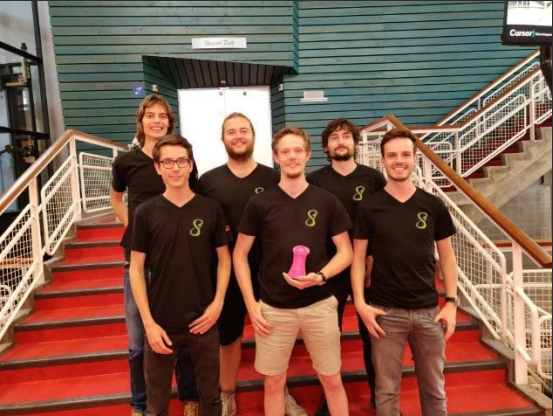
Serpentine

Contribute to a flourishing ecosystem



Artificial Intelligence will change our world.
Meet a group of engineers passionate to contribute.

[Read our Story](#)



Master AI through E-sports.

Serpentine is an association focused on Artificial Intelligence. Based in Eindhoven, the team connects engineers, students, research and industry. We develop state-of-the-art algorithms to participate in AI E-sports competitions, and share the knowledge obtained in the process!

[Our Mission](#)



Contribute to a flourishing ecosystem



Competition ▾ Events ▾ Projects ▾



FruitPunch AI

Punch AI into practice

The community of AI engineers on a mission to apply AI for Good!

Join the community!

Stay up-to-date



Or subscribe to our newsletter

Email

SUBSCRIBE

Ongoing projects



AI against covid-19

The FruitPunch AI community of data scientists is providing insights to contain the covid-19 pandemic and its greater economic effects!

More info



AI for Wildlife

Together with a global network of partners the FruitPunch AI community is taking making an autonomous fixed wing drone with thermal cameras that can hunt for poachers in the wildlife reserves.

More info



Join the FruitPunch AI community platform to join or propose an AI for Good project!

AI for good project

- Open to collaborate
- Share your proposal
- Always a challenge to get access to real data

Contribute to a flourishing ecosystem



A scientist on a quest to build AI systems that learn how to learn, making machine learning more *automatic, frictionless and never-ending*. We could use some help!

Joaquin Vanschoren (TU/e),
Founder OpenML platform

150000+ yearly users

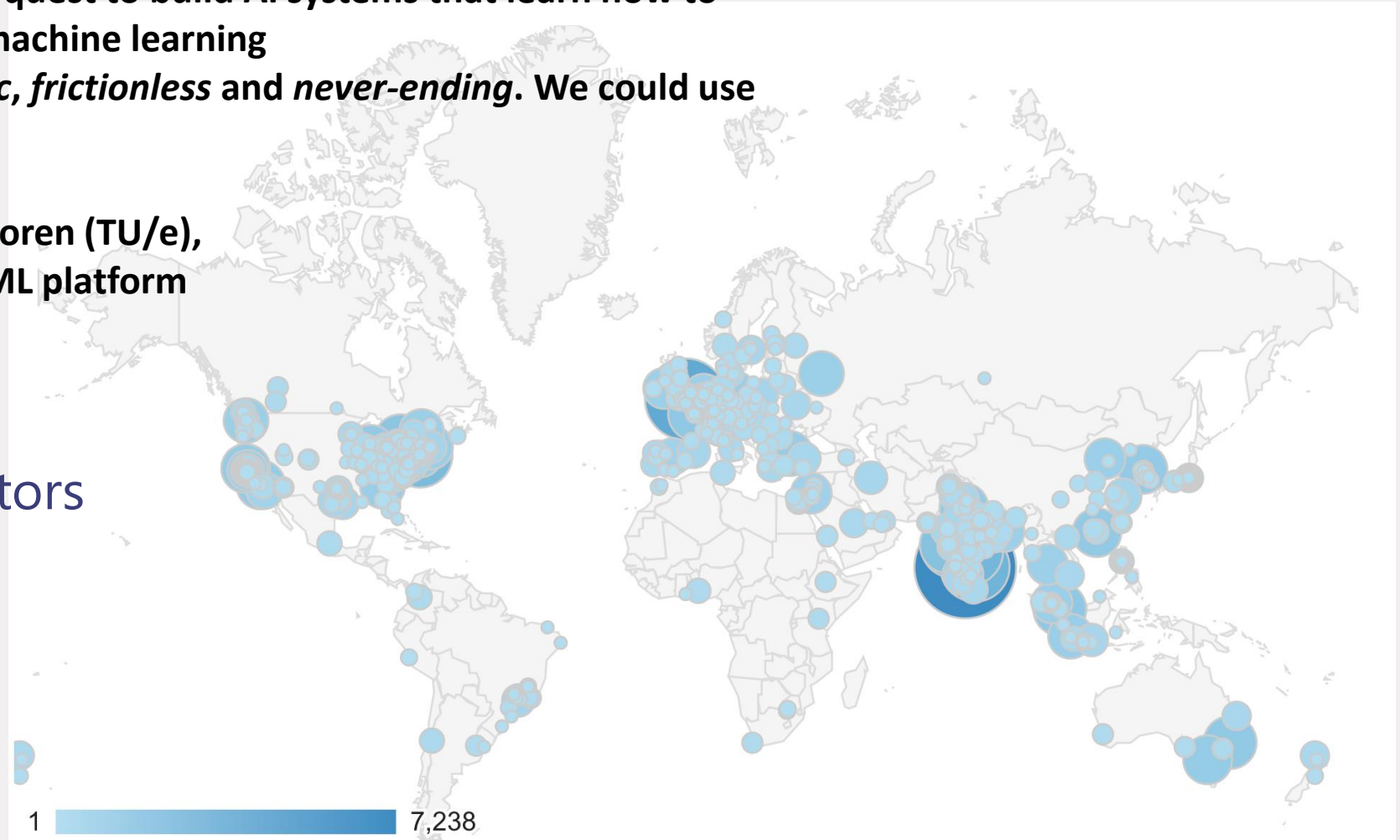
8000+ registered contributors

500+ publications

20000+ datasets

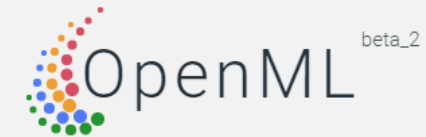
15000+ flows

10.000.000+ runs

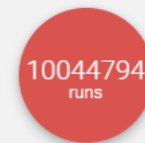
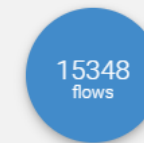
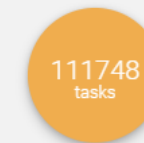
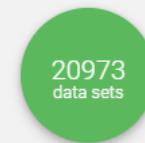


OpenML (<https://www.openml.org/>)

- OpenML is a collaborative ML and data sharing platform
- OpenML acts as a ML tripadvisor or a cookbook for engineers (also non data scientists)
- Companies like Amazon, Microsoft etc. use OpenML to find the best algorithms!
- OpenML is a structured playground for Bots (AutoML dev't)



Machine learning, better, together



7689 results

FILTERS SORT: HIGHEST ACTIVITY

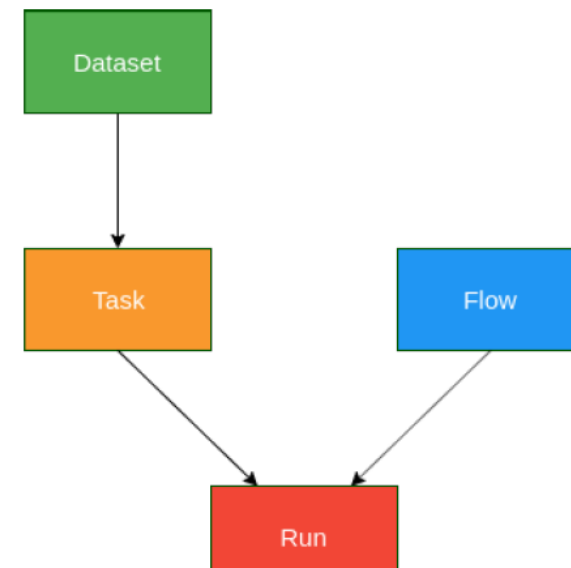
OpenML_Bot R
Can I help? You can find me here: <https://github.com/ja-thomas/OMLbots>
Joined 2017-03-07
6528594 uploads 6528594.5 activity 101 reach 33 impact

Jan van Rijn
Post-doc at Columbia University (New York, USA) and main developer of various OpenML components and plug
Columbia University Netherlands Joined 2013-03-21
2066485 uploads 2067123.5 activity 5242 reach 2013849 impact

Scikit-learn Bot
For information on the runs, please contact Jan van Rijn
Python Jungle Joined 2018-10-19
391078 uploads 391078 activity 1 reach 0 impact

Joaquin Vanschoren
Machine learning professor. Founder of OpenML. Working to make machine learning more open, collaborative, i
Eindhoven University of Technology Netherlands Joined 2013-03-21
325851 uploads 326611.5 activity 6231 reach 3008760 impact

Hilde Weerts
TU/e The Netherlands Joined 2016-11-21
284156 uploads 284163 activity 4 reach 30 impact



Collaboration with Student teams, OpenML platform, AI Lab

We think this is a unique opportunity to leverage the collaborative strength of the region. Let us know if you're interested to team up with

Student teams (g.z.angelis@tue.nl)

- AI related challenges (AI for good, “Gamification”)
- Support a student team / startup
- Get access to the latest developments in machine learning

AI Engineering Lab (aie-lab@tue.nl, Albert van Breemen)

- Support industry with adopting AI technology and create research consortia
- Education, projects, long term research
- Looking for partners, Augmented Reality for (Service) Engineering, Wasteless Autonomous Factory

“OpenML for Industry” initiative (g.z.angelis@tue.nl)

- Run a pilot with OpenML (a collaborative, reproducible data sharing and machine learning platform) in a corporate environment
- Be part of a consortium developing/deploying cutting edge AI technology

Systems Engineering (Ton Peijnenburg)

Summary

- **Artificial Intelligence technology is maturing rapidly the last few years and outperforms human (solutions) in various areas.**
- **AI performance is driven by compute power, big data and algorithms**
- **There is a gap between the world of engineering and data science that can be bridged by:**
 - Combining first principle techniques with machine learning
 - Making algorithms explainable
 - Democratizing AI
- **Still many barriers need to be overcome by industry to adopt AI**
 - Complex AI technology stack
 - Many number of different AI algorithms (which to use when?)
 - Transfer results from virtual to real world, from application 2 application, Art → Science
- **Focus on collaborative strength of the region (EAISI Impulse programme, match industry funded PhDs)**



Salaai