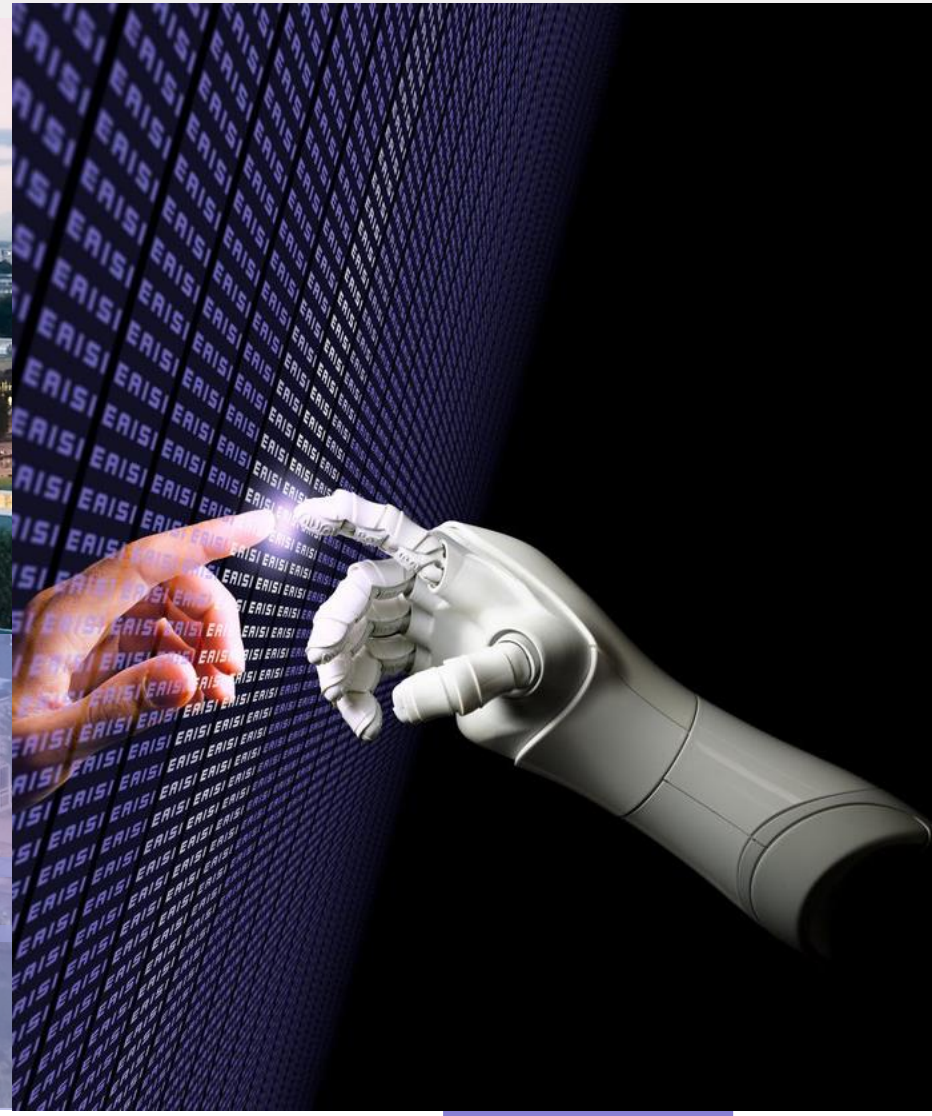

EAISI: the Eindhoven AI Systems Institute

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

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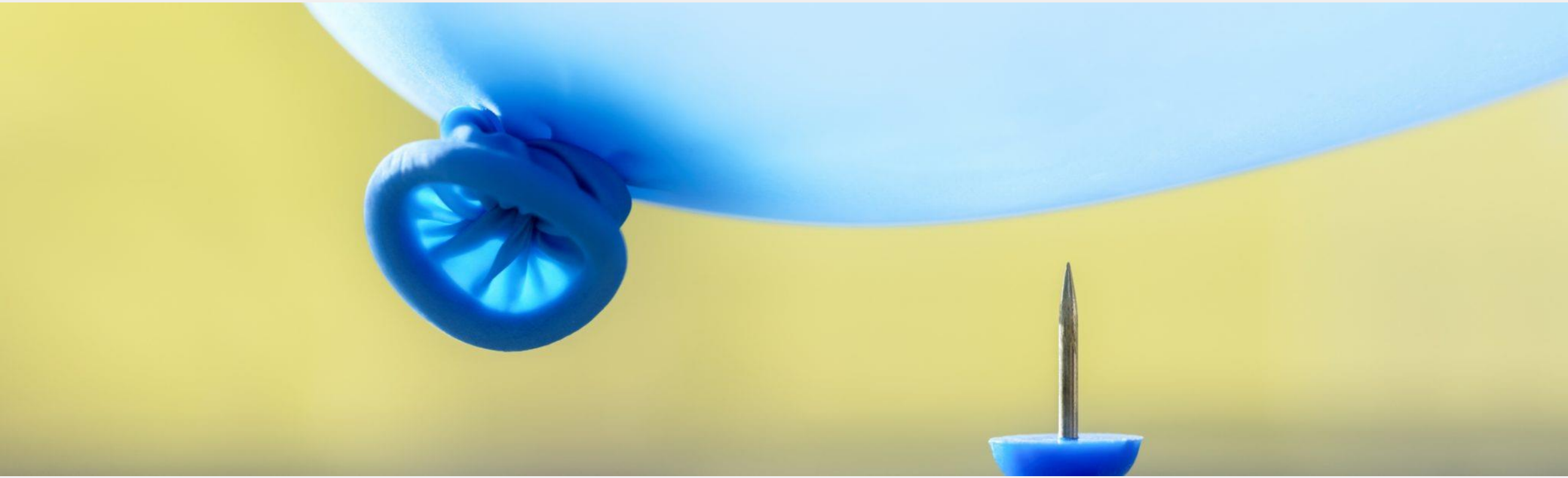
Artificial Intelligence is like a Swiss army knife …

… 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

TU/e EAISI

Positioning

opportunity & challenges

Research Agenda

programmes & moonshots

Collaboration and Valorisation

student teams & consortia & AIE Lab

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

Research	➢ 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	➢ 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	➢ Acquire an additional, external annual research budget of 30M€ on top of our own investment of 20M€
Positioning	➢ 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	➢ 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/

Spotify
Uses ML for recommending new music.
https://www.oreilly.com/ideas/machine-learning-at-spotify-you-are-what-you-stream

Apple
Developed speech recognition service Siri with ML.
https://machinelearning.apple.com/

Paypal
Uses ML to detect and combat fraud
https://www.paypal-engineering.com/tag/machine-learning/

2nd wave of AI applications

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.semioticlabs.com/nl/

Freenome
Startup using AI for early cancer detection.
https://www.freenome.com/

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High Tech prepares for AI

Data Science

DATA

↓ *is a*

NUMBER

↓ *has a*

Numerical/Logical meaning

↓ *analysed by*

Mathematics, Computer Science

AI (in) Engineering

DATA

↓ *generated by*

SENSOR

↓ *has a*

Physical meaning

↓ *analysed by*

Engineering, Science

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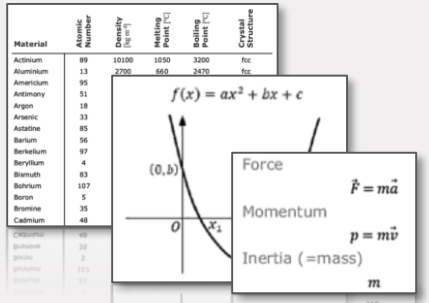
Designing high tech systems

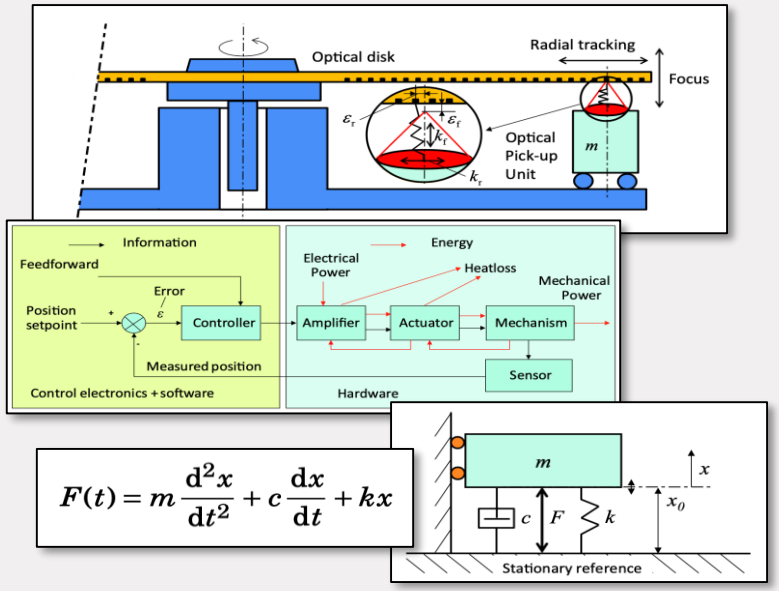


Engineer

First principles

MODEL

Data



Optical disk system

SYSTEM

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

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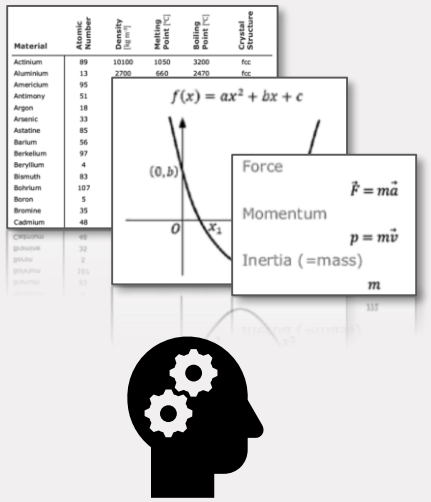
Growing design challenges



Engineer

First principles

MODEL

Data

MORE COMPLEXITY

MORE PERFORMANCE

MORE INTELLIGENCE

MORE INTEROPERABILITY

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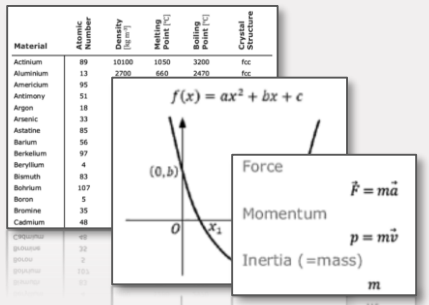
Growing design challenges

Complexer models and bigger data needed to deal with challenges



Engineer

First principles

COMPLEXER MODEL

BIGGER Data

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?

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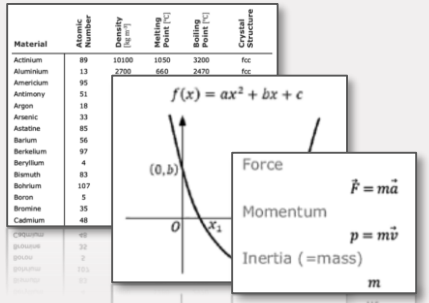
Growing design challenges

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

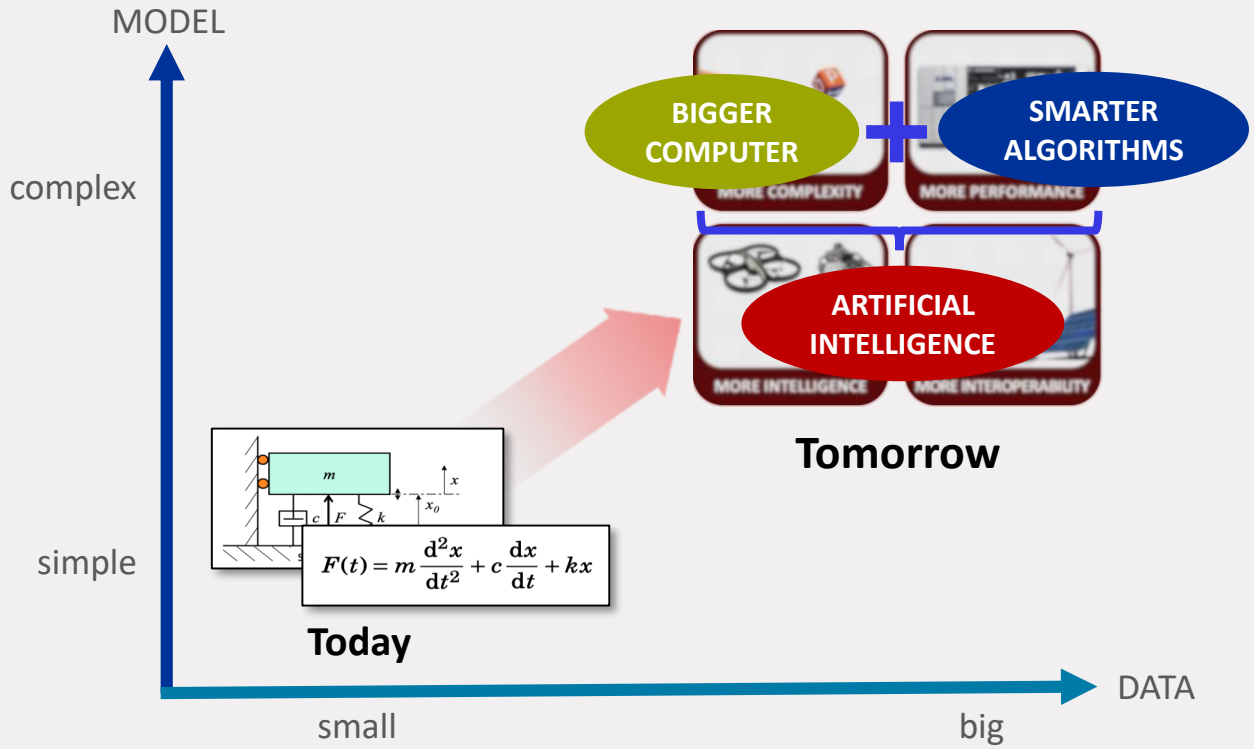


Engineer

First principles

COMPLEXER MODEL

BIGGER Data



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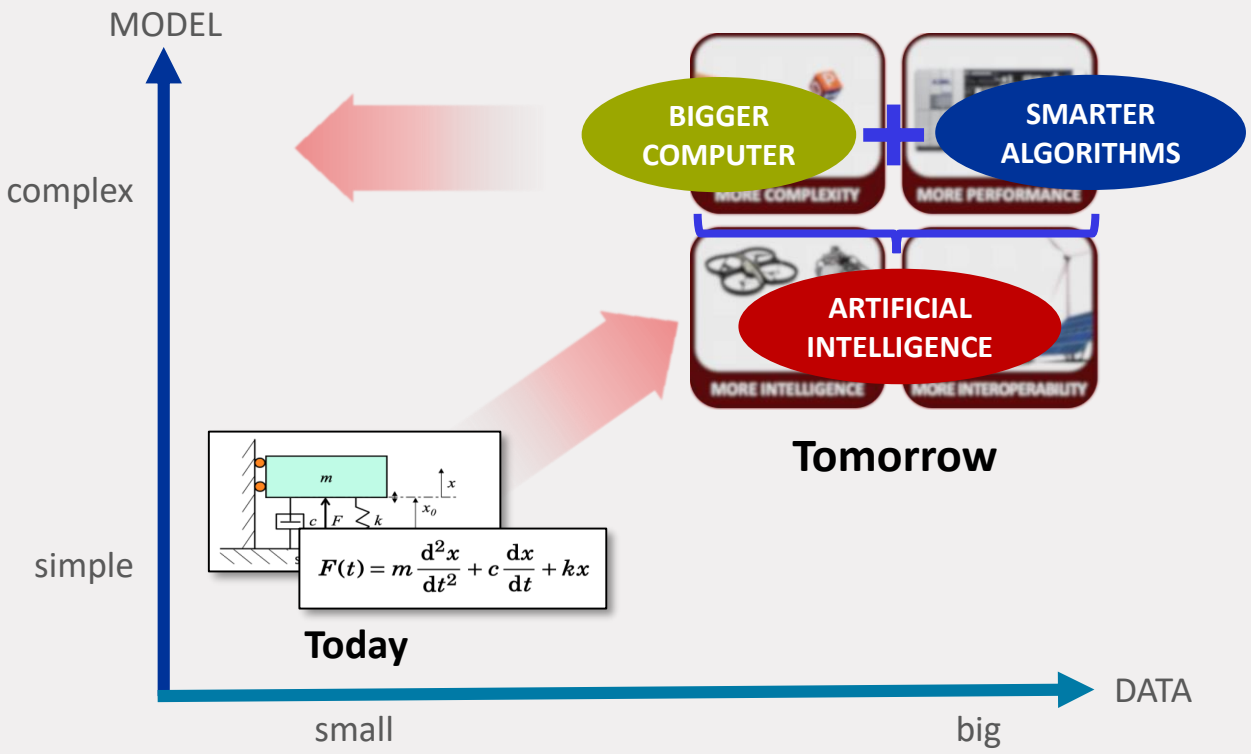
Growing design (and research) challenges

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



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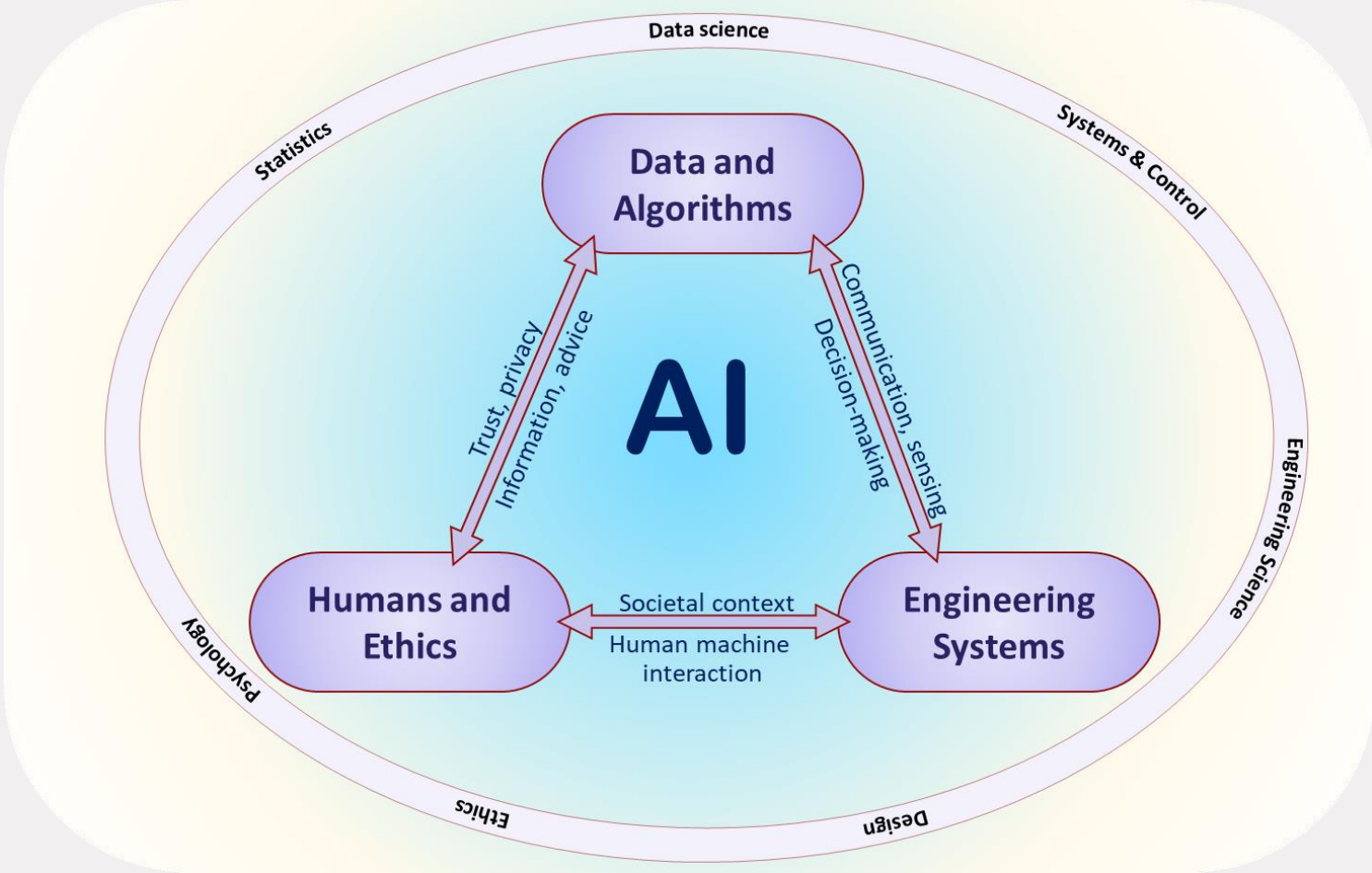
Which of the following AI adoptation barriers do you consider the most important/relevant for your business?

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



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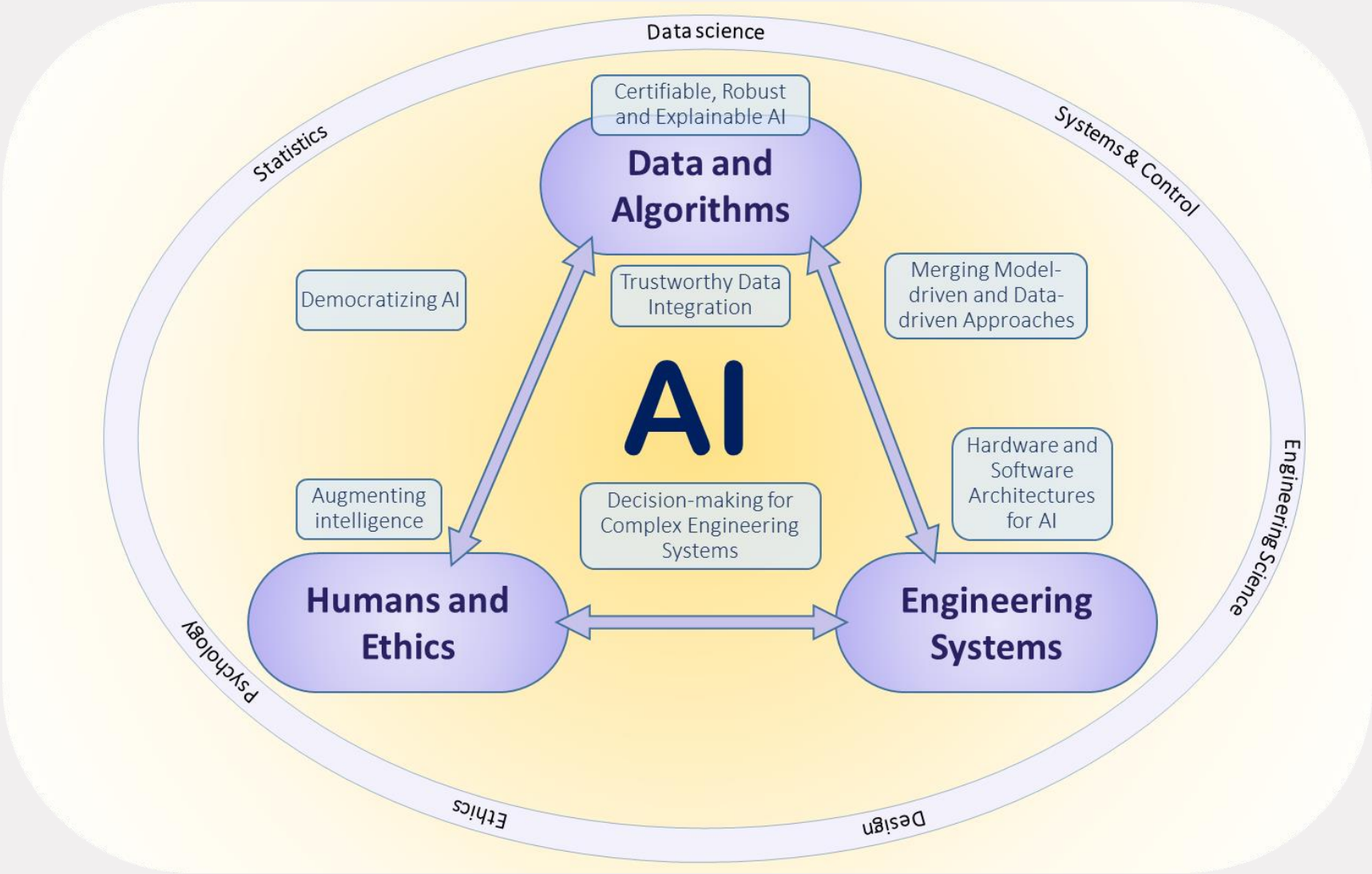
EAISI Research Domains and Program Lines



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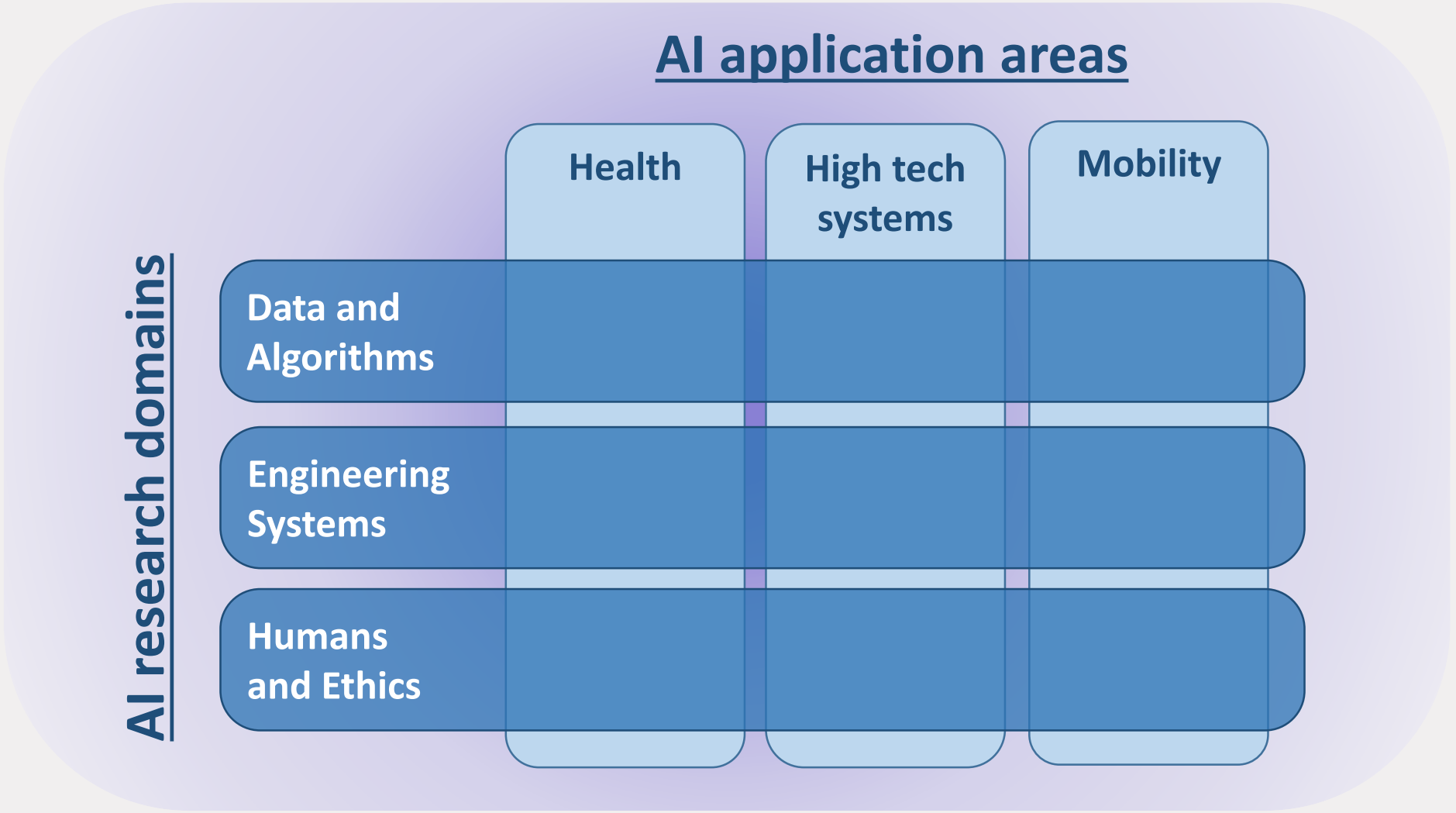
Which of the following research topics do you consider the most important/relevant for your business?

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”



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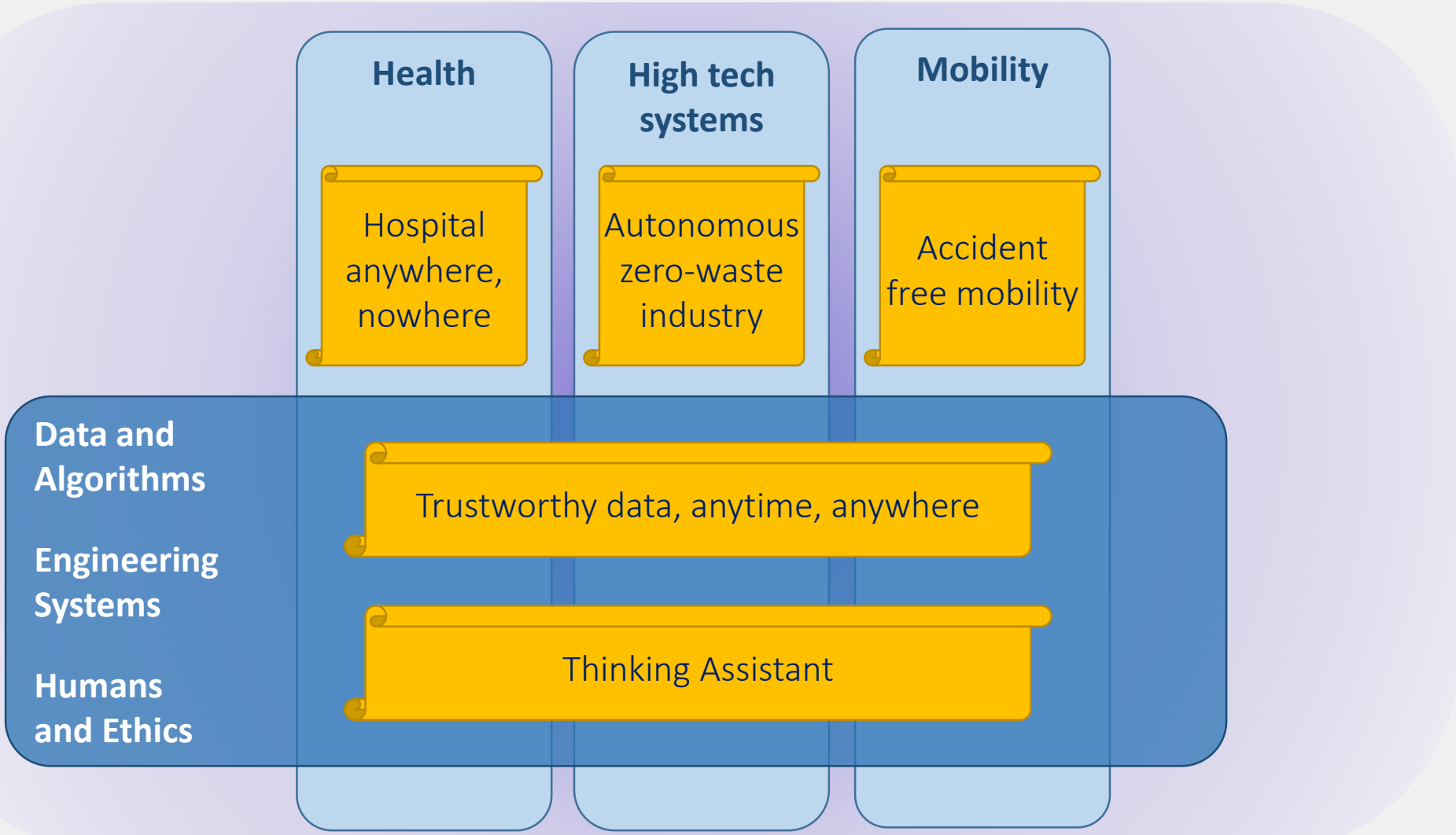
Moonshots



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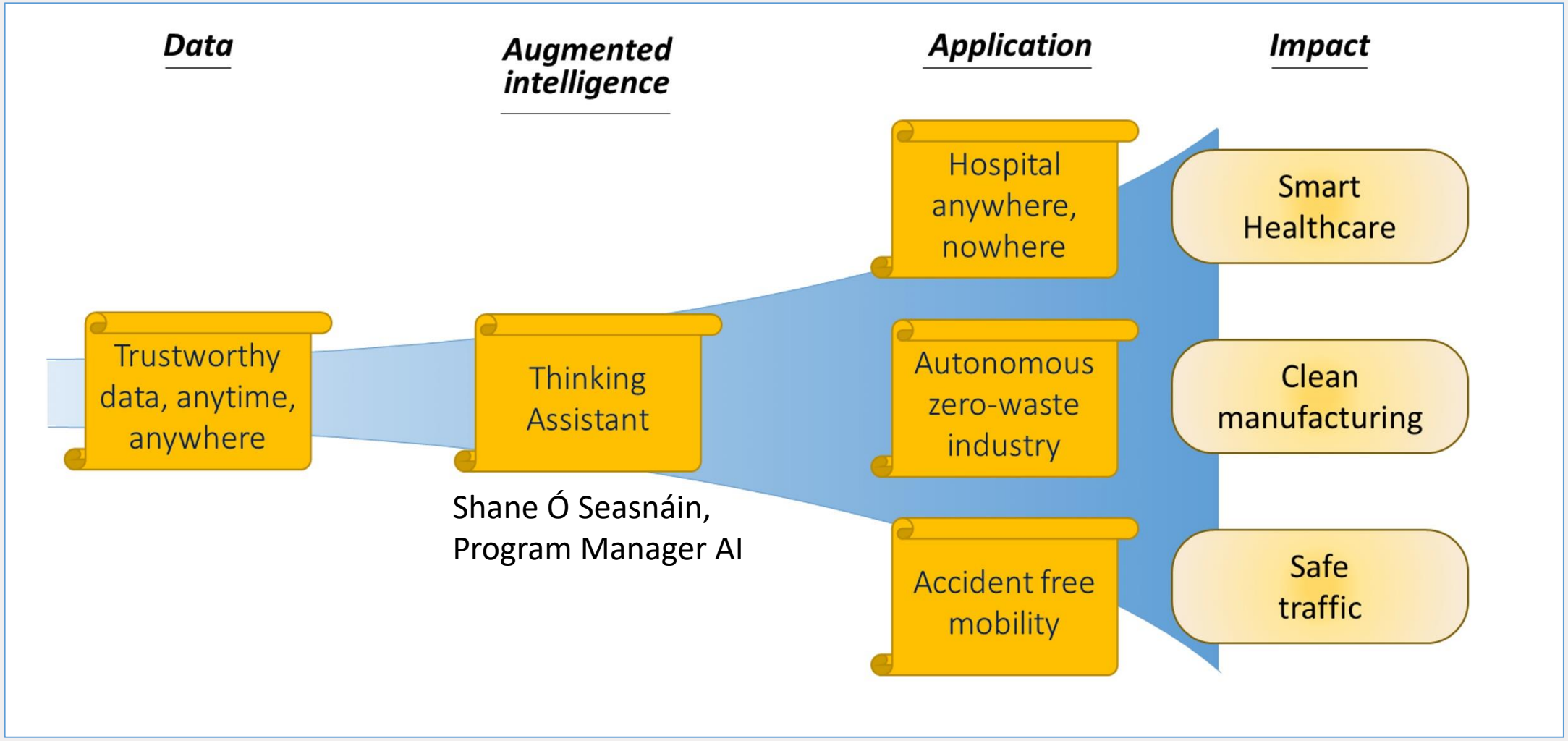
Moonshot funnel



Shane Ó Seasnáin,
Program Manager AI

Contribute to a flourishing ecosystem

FME POWERED BY DUTCH TECHNOLOGY 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.

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Contribute to a flourishing ecosystem: Student teams

Open Machine Learning

FruítPunch AI

Serpentine
Artificial Intelligence Association

Order at lightyear.one

https://www.tue.nl/en/our-university/student-teams/

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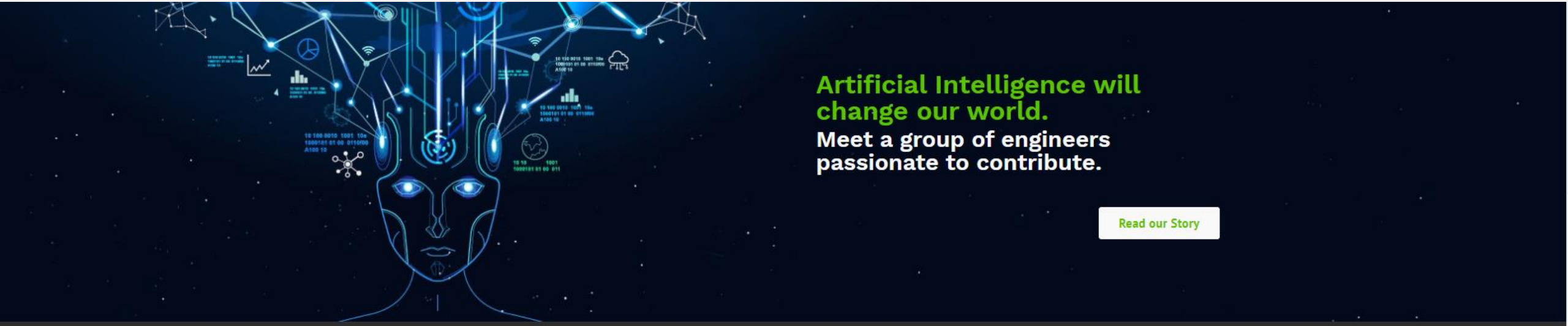
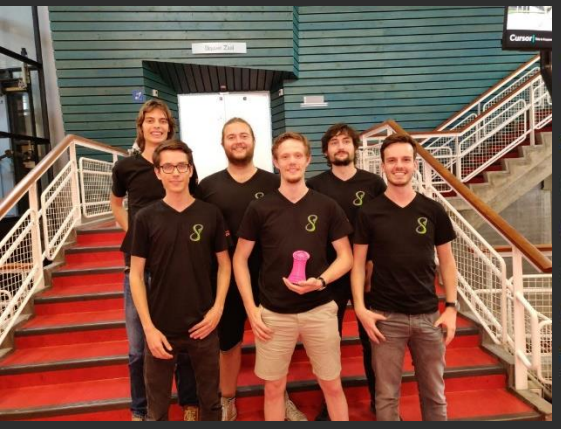
Contribute to a flourishing ecosystem

Serpentine
Artificial Intelligence Association





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

https://serpentineai.nl/

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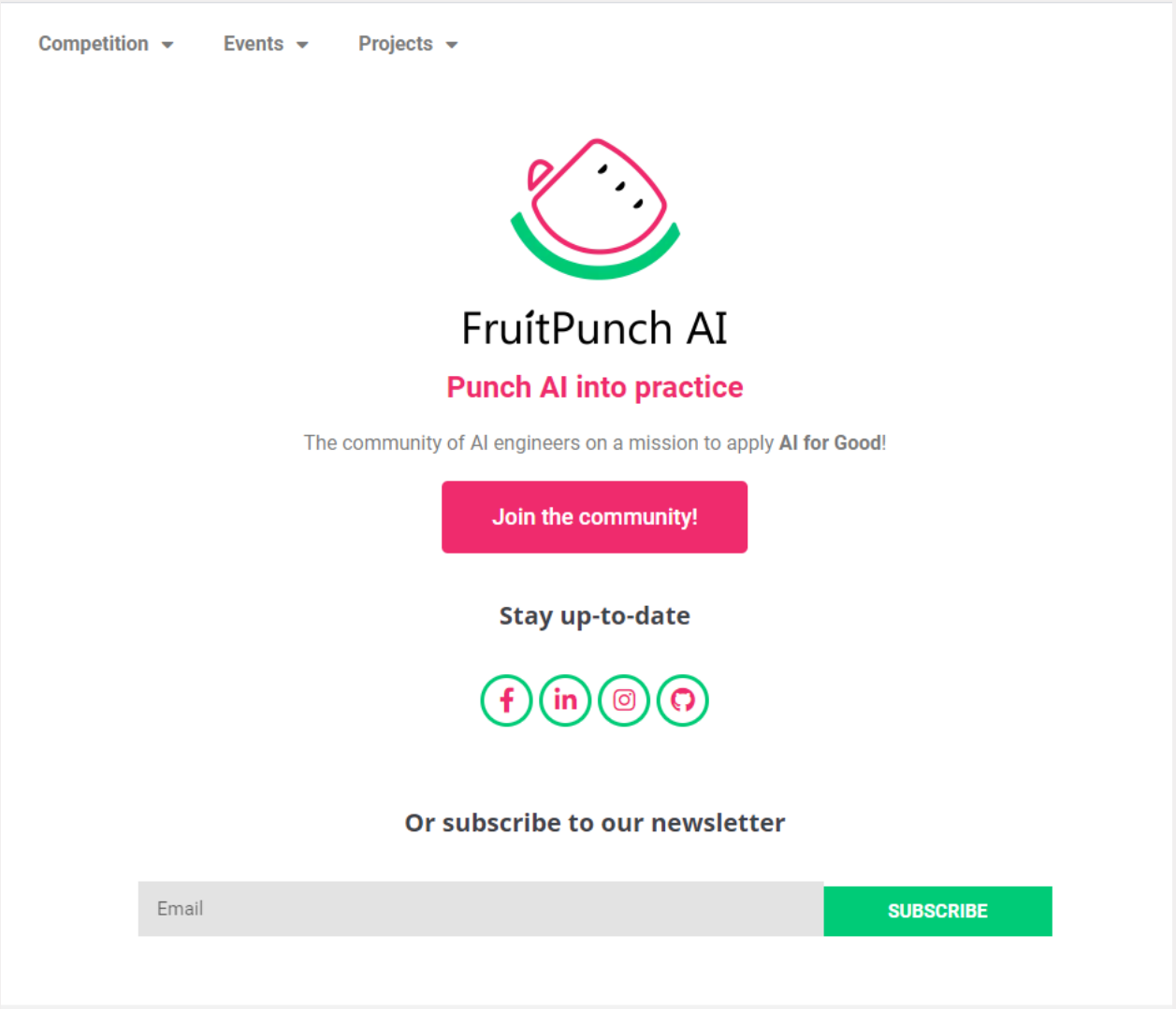
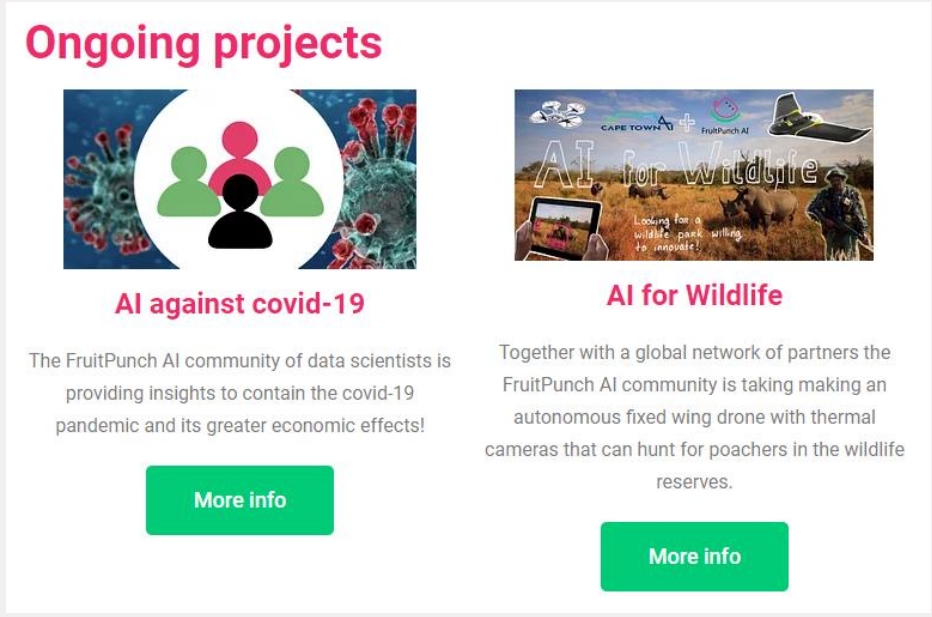
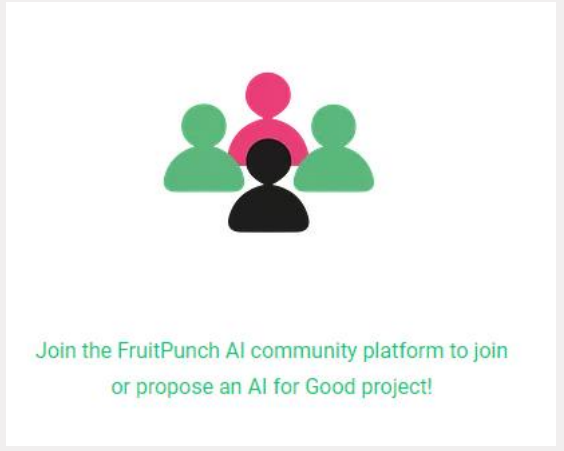
Contribute to a flourishing ecosystem

FruítPunch AI







AI for good project ....

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

https://fruitpunch.ai/

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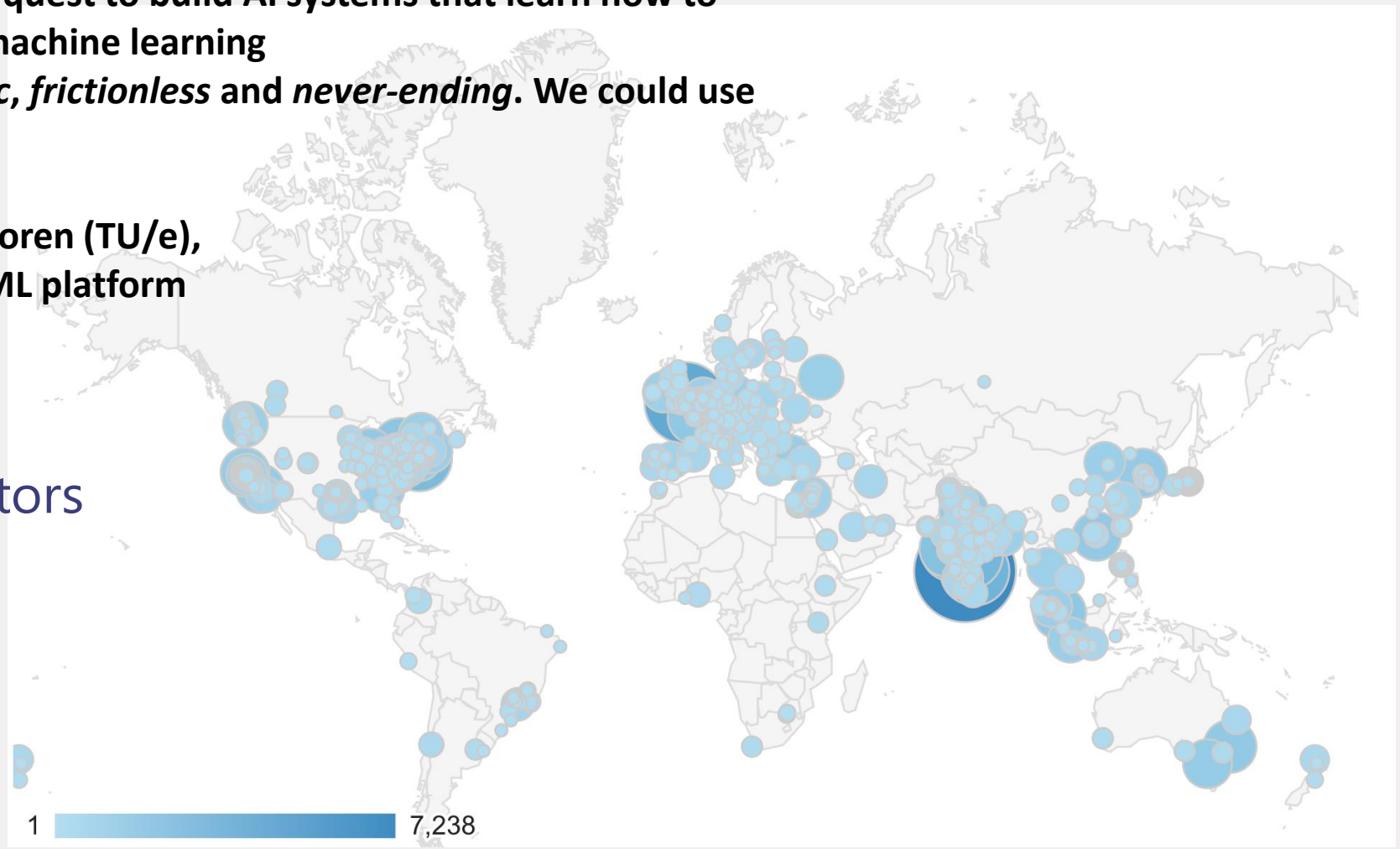
Contribute to a flourishing ecosystem

Open Machine Learning

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

https://www.openml.org/

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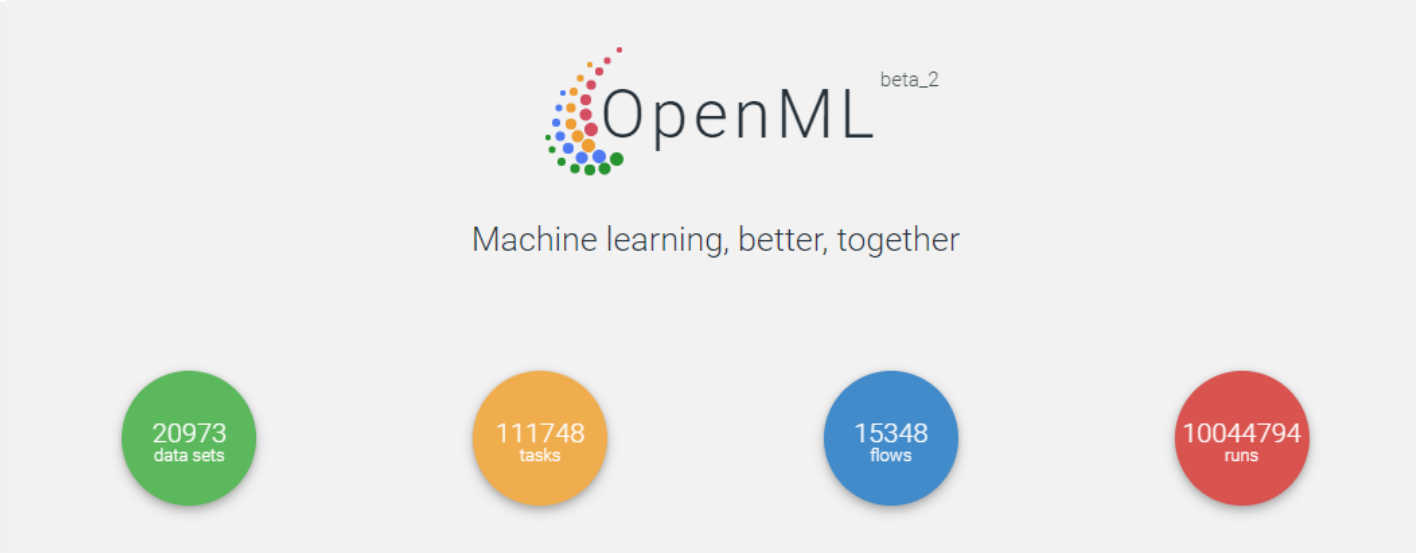
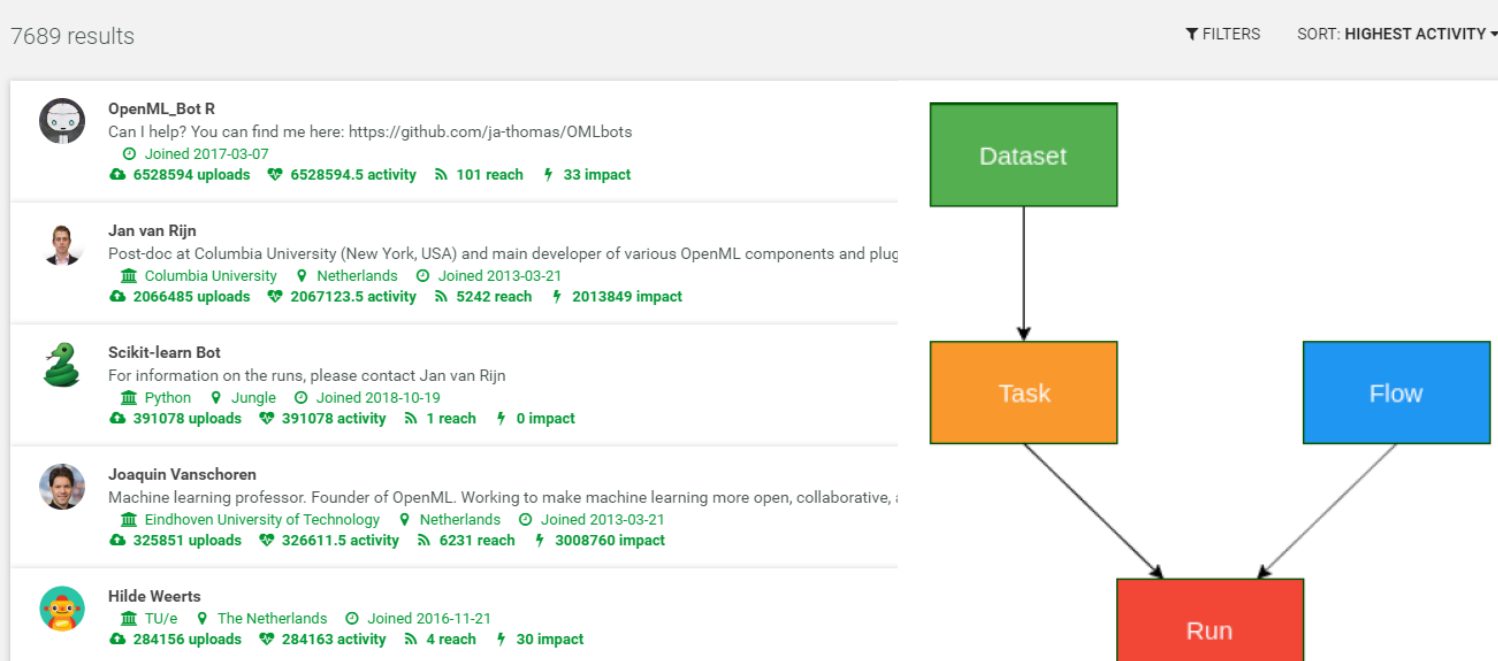
OpenML (https://www.openml.org/)

- 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)





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)**

EAISI

EINDHOVEN AI SYSTEMS INSTITUTE

TU/e

Salaai

EAISI EINDHOVEN AI SYSTEMS INSTITUTE TU/e