THE POTENTIAL OF AI AND LANGUAGE TECHNOLOGY – WHERE WE ARE, WHERE WE SHOULD BE HEADING

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ARTIFICIAL INTELLIGENCE (AI) HAS ENORMOUS POTENTIAL

- Machine learning system is never fully deterministic
- European approach to AI is risk based
  - excellence
  - human centred
- AI that contradicts human values is to be prohibited
- AI currently lacks transparency
- Cost of machine learning projects is driven by data availability
- Developing a machine learning system is slow, painful and costly
- Slovakia needs to support international collaboration and inclusion to European network of excellence
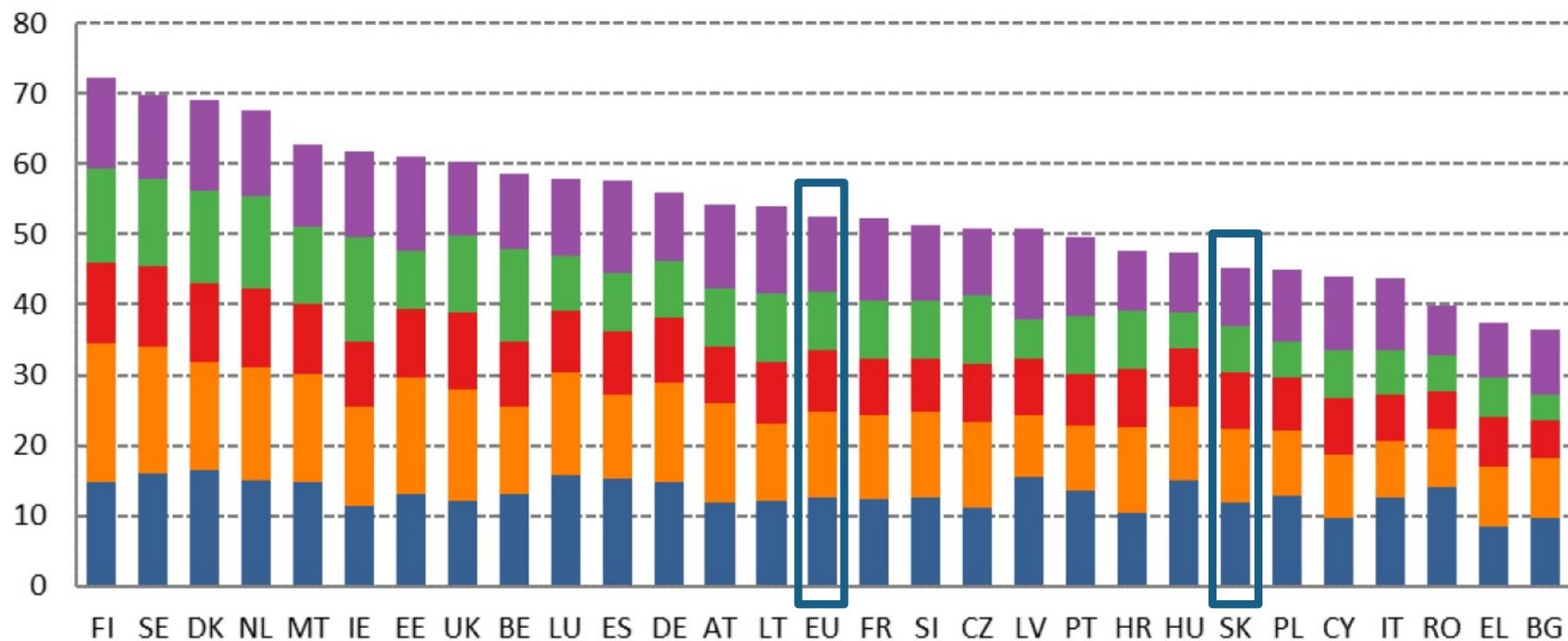
THE POTENTIAL OF ARTIFICIAL INTELLIGENCE

- AI represents one of the greatest opportunities for global societal and economic progress*

- Focus on AI in various initiatives and projects across Europe, e.g.
  - AI regulation 2020/04: AI Act, Coordinated Plan on AI, new Machinery Regulation
  - AI4EU: First European AI On-Demand Platform and Ecosystem
  - ICT-48-2020 Calls projects: European network of AI Excellence centres – TAILOR, AI4MEDIA, ELISE, HumanE-AI-Net, VISION

- Already now there are very prominent examples of AI in our every day lives...

EXAMPLES OF AI IN OUR LIVES

- Digital personal assistants
- Diagnostic support
- Predictive maintenance
- Marketing and sales promotion
- Online sales and products recommendation
- Chatbots
- Stock trading
- Optimal use of resources
- Quality management
- Customer and user support

STATUS QUO: HOW DIGITAL ARE WE?

Digital Economy and Society Index (DESI 2020)*

* https://ec.europa.eu/digital-single-market/en/desi
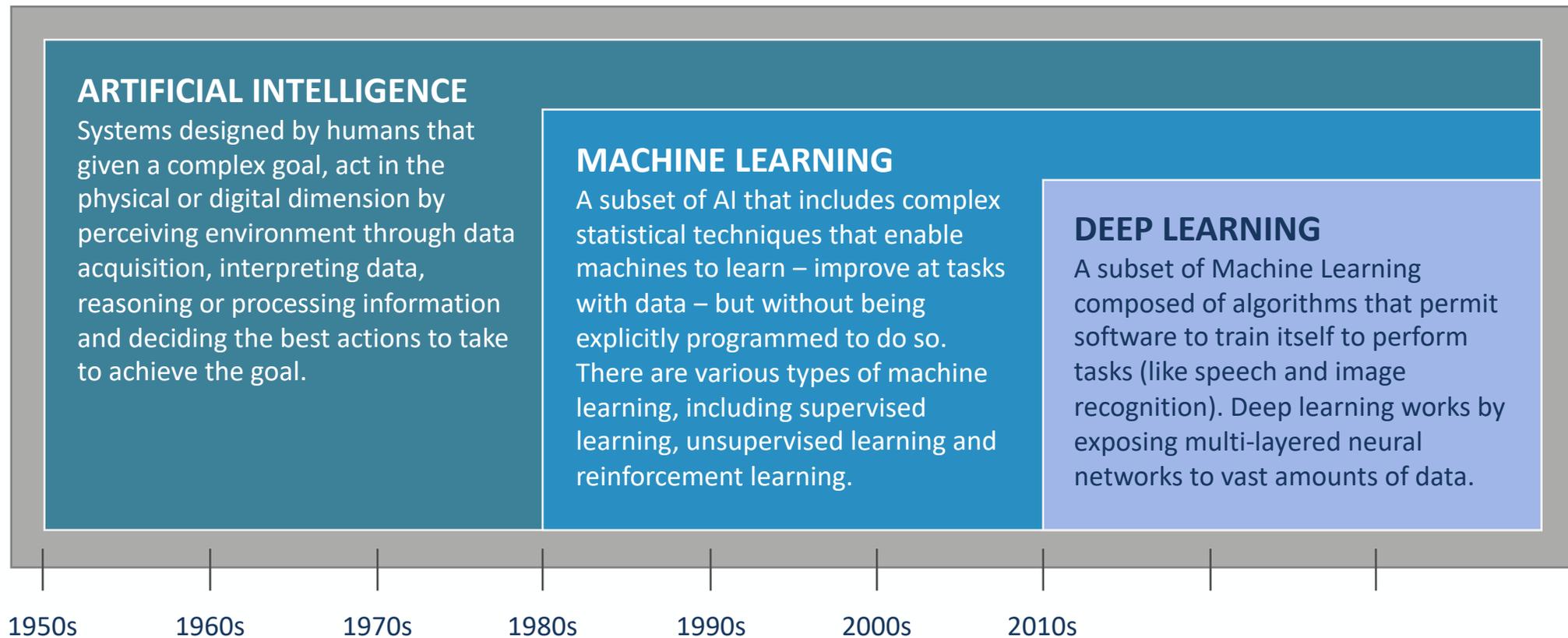
Definition of Artificial Intelligence*

" a software that is
- developed with one or more of the techniques and approaches and
- can, for a given set of human-defined objectives,
- generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with"

AI Techniques and Approaches

a) **Machine learning** approaches, including **supervised**, **unsupervised** and **reinforcement** learning, using a wide variety of methods including deep learning;

b) **Logic-** and **knowledge-based** approaches, including knowledge representation, inductive (logic) programming, knowledge bases, inference and deductive engines, (symbolic) reasoning and expert systems;

c) **Statistical** approaches, **Bayesian** estimation, **search** and **optimization** methods

POSITIONING AI, MACHINE LEARNING, DEEP LEARNING*

ARTIFICIAL INTELLIGENCE
Systems designed by humans that given a complex goal, act in the physical or digital dimension by perceiving environment through data acquisition, interpreting data, reasoning or processing information and deciding the best actions to take to achieve the goal.

MACHINE LEARNING
A subset of AI that includes complex statistical techniques that enable machines to learn – improve at tasks with data – but without being explicitly programmed to do so. There are various types of machine learning, including supervised learning, unsupervised learning and reinforcement learning.

DEEP LEARNING
A subset of Machine Learning composed of algorithms that permit software to train itself to perform tasks (like speech and image recognition). Deep learning works by exposing multi-layered neural networks to vast amounts of data.

| 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2010s |

yhil, K.K. Heang, R. Clogher, K. McBride (2019): „Hello, World: AI and its use in the public sector",
bservatory of Public Sector Innovation, p.23. Available online at https://oecd-opsi.org/projects/ai/

Cost of ML projects is driven by Data availability

NLP Data
- Unstructured
- Text
- Media
- In natural language
- With spellings and errors

NLP Tasks
- Acoustic Speech Recognition
- Text to Speech
- Dialog / Chat Bots
- Question-Answering
- Named Entity Recognition
- Information Extraction
- Text Summarization
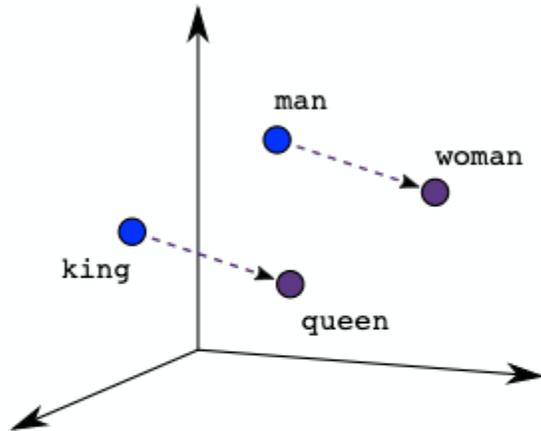- Sentiment Analysis (Emotion AI)

NLP Methods
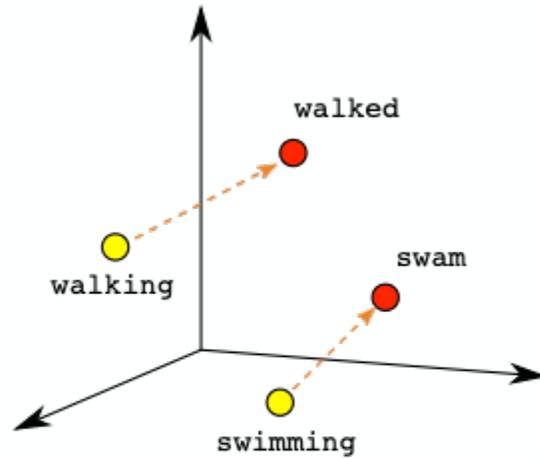- Linguistic
- Statistic
- Neural

Language and Intelligence

Problem: Human languages are incredibly elegant, efficient, flexible, complex!

- One word may mean many things

- Many ways of saying the same thing

- Meaning depends on context

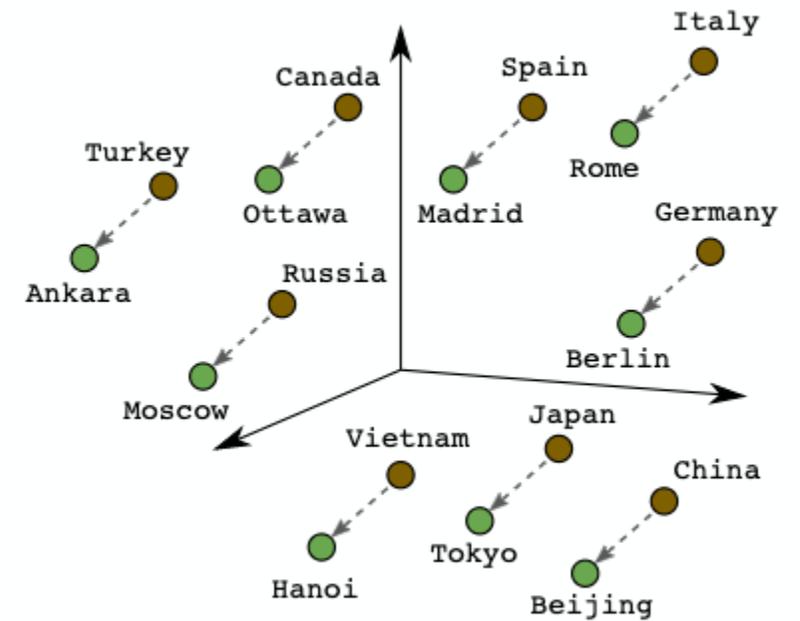- Literal and figurative language (metaphor)
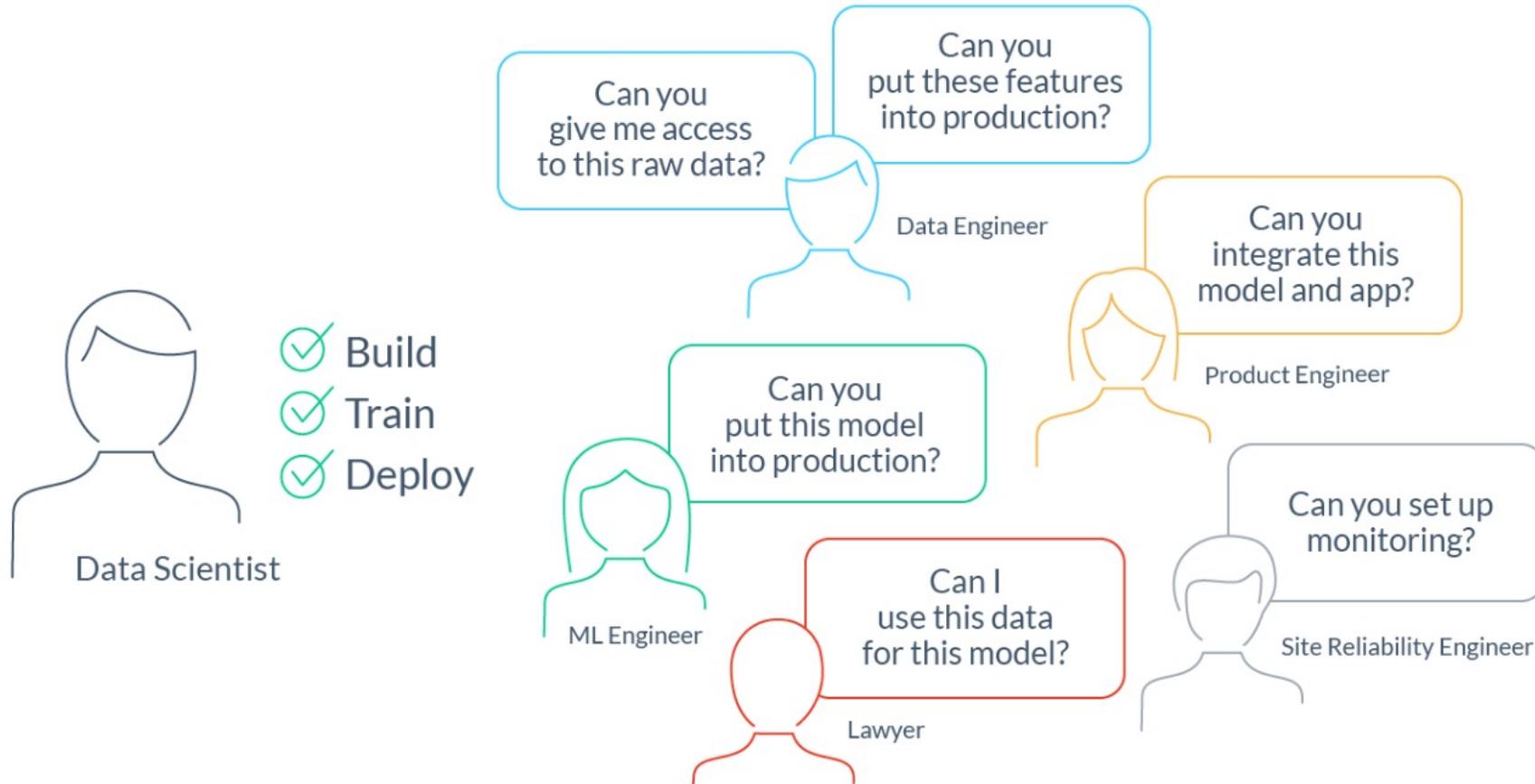
REPRESENTATION OF WORDS

Male-Female

Verb Tense

Country-Capital
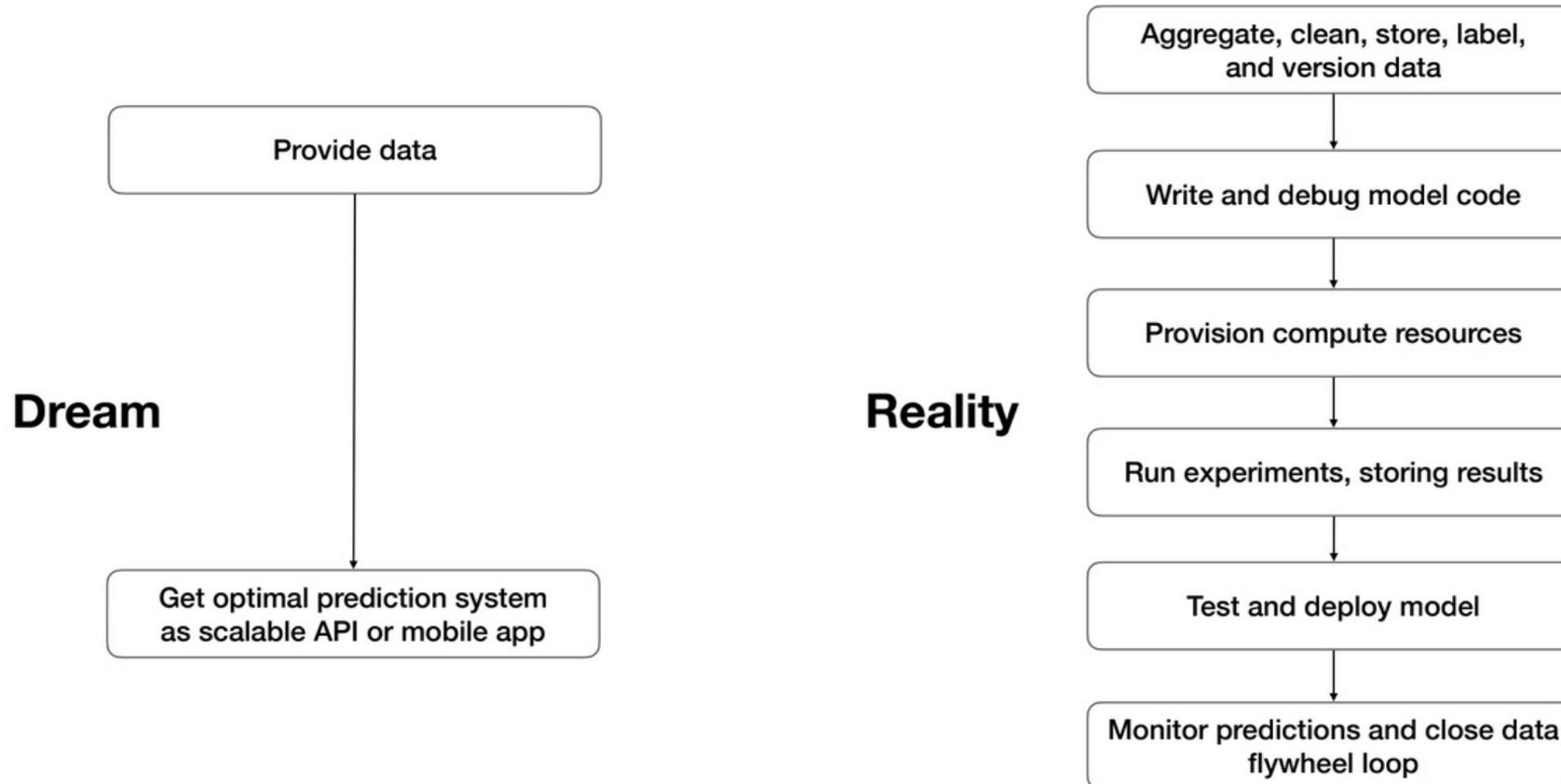
DEVELOPING A MACHINE LEARNING SYSTEM

The desired behaviour cannot be effectively expressed in software logic without dependency on external data

- ML is still research – you shouldn't aim for 100% success rate

- Never-fully deterministic

- Behavior dependent on the training and production data

- Model training takes extensive amounts of time

- Complex pipelines

- Data dependencies
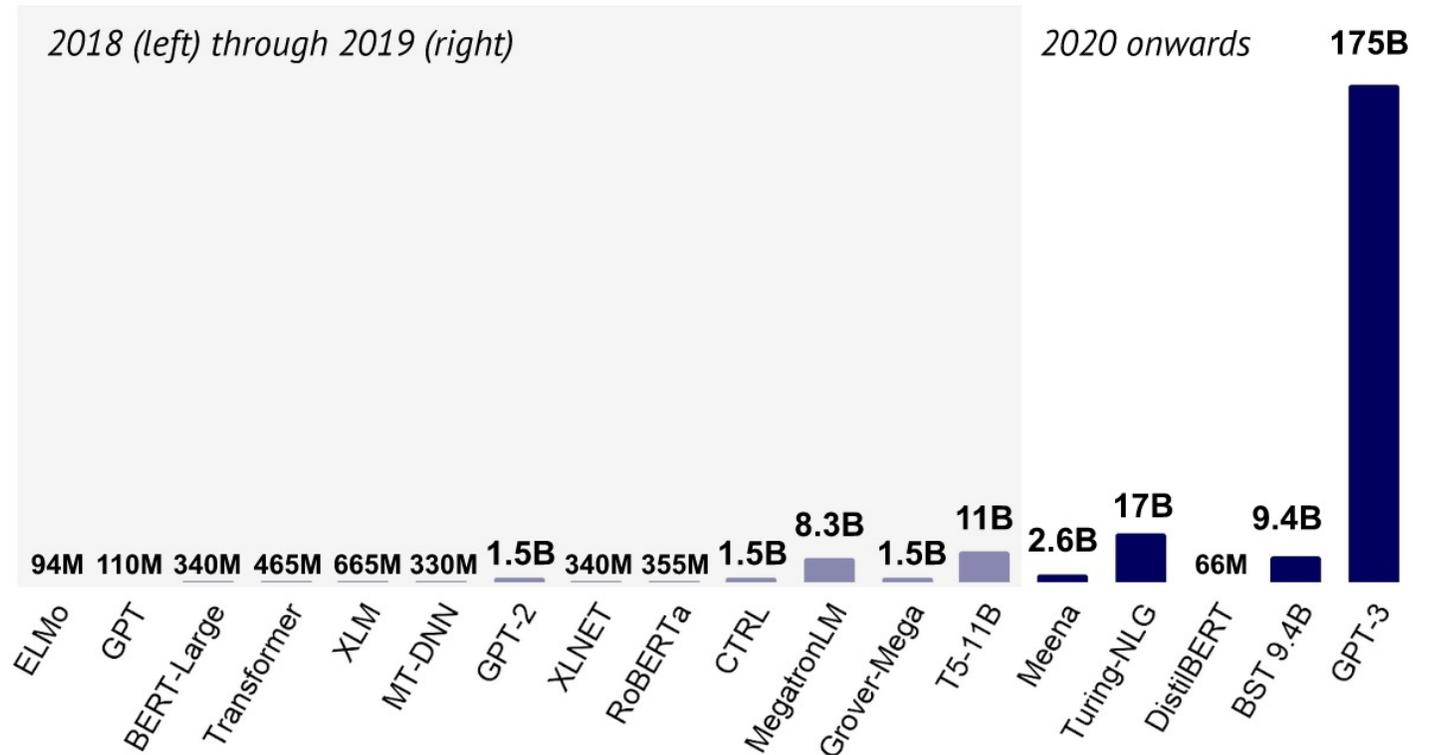
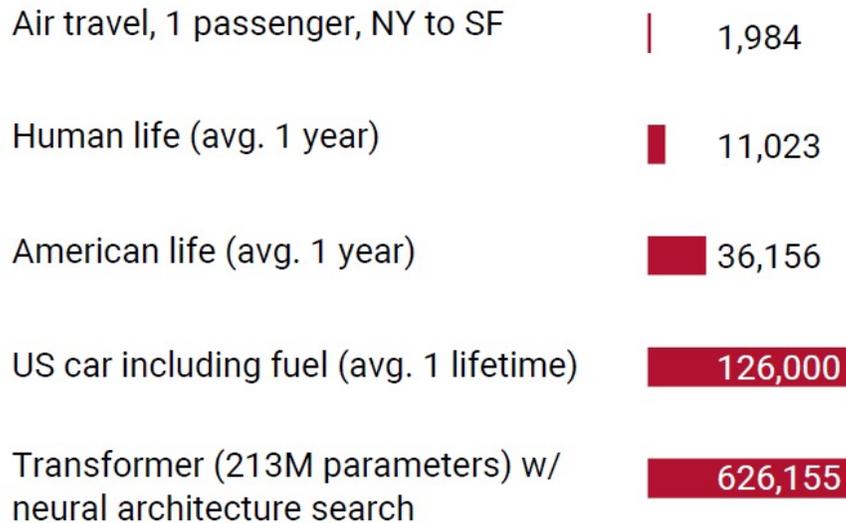# DEVELOPING MACHINE LEARNING SYSTEM IS COMPLEX
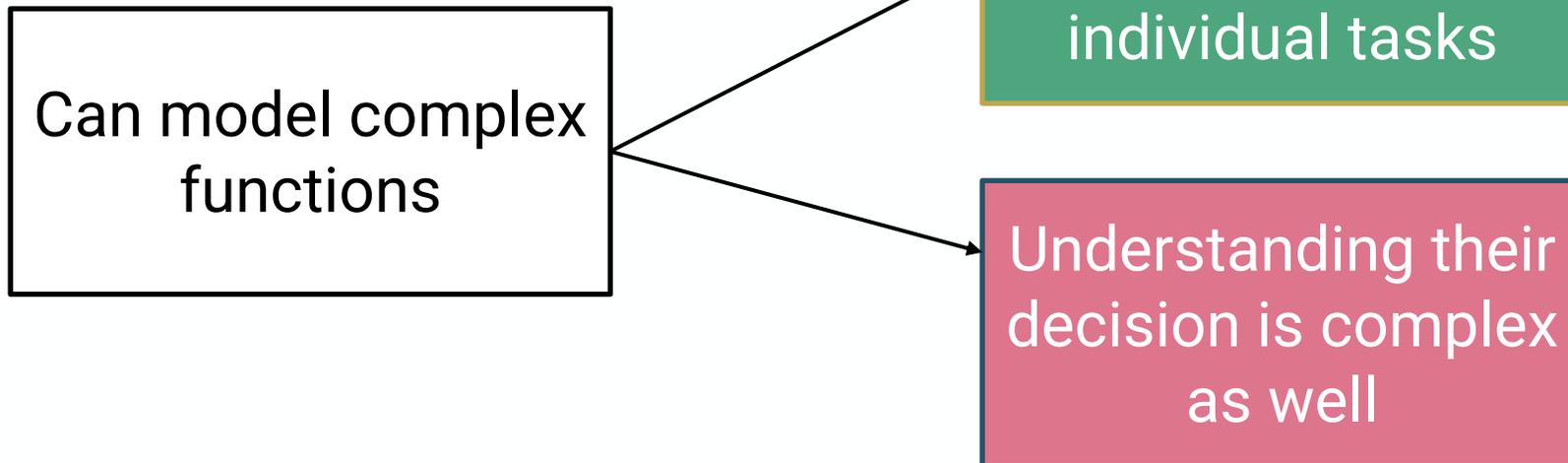
DEPLOYING ML IS SLOW AND PAINFUL

Dream

Provide data

↓

Get optimal prediction system as scalable API or mobile app

Reality

Aggregate, clean, store, label, and version data

↓

Write and debug model code

↓

Provision compute resources

↓

Run experiments, storing results

↓

Test and deploy model

↓

Monitor predictions and close data flywheel loop

S. Karayev, J. Tobin, P. Abbeel: Full Stack Deep Learning, 2020.

HUGE MODELS, LARGE COMPANIES AND MASSIVE TRAINING COSTS

- Scaling
- Carbon footprint
- Cost

Air travel, 1 passenger, NY to SF	1,984
Human life (avg. 1 year)	11,023
American life (avg. 1 year)	36,156
US car including fuel (avg. 1 lifetime)	126,000
Transformer (213M parameters) w/ neural architecture search	626,155

2018 (left) through 2019 (right)   *2020 onwards*   **175B**

Model	Value
ELMo	94M
GPT	110M
BERT-Large	340M
Transformer	465M
XLM	665M
MT-DNN	330M
GPT-2	1.5B
XLNET	340M
RoBERTa	355M
CTRL	1.5B
MegatronLM	8.3B
Grover-Mega	1.5B
T5-11B	11B
Meena	2.6B
Turing-NLG	17B
DistilBERT	66M
BST 9.4B	9.4B
GPT-3	175B

THERE IS NOT SUCH THING AS A FREE LUNCH - COMPLEXITY

Deep learning / Big parametric models

Can model complex functions

Often outperforms humans in individual tasks

Understanding their decision is complex as well
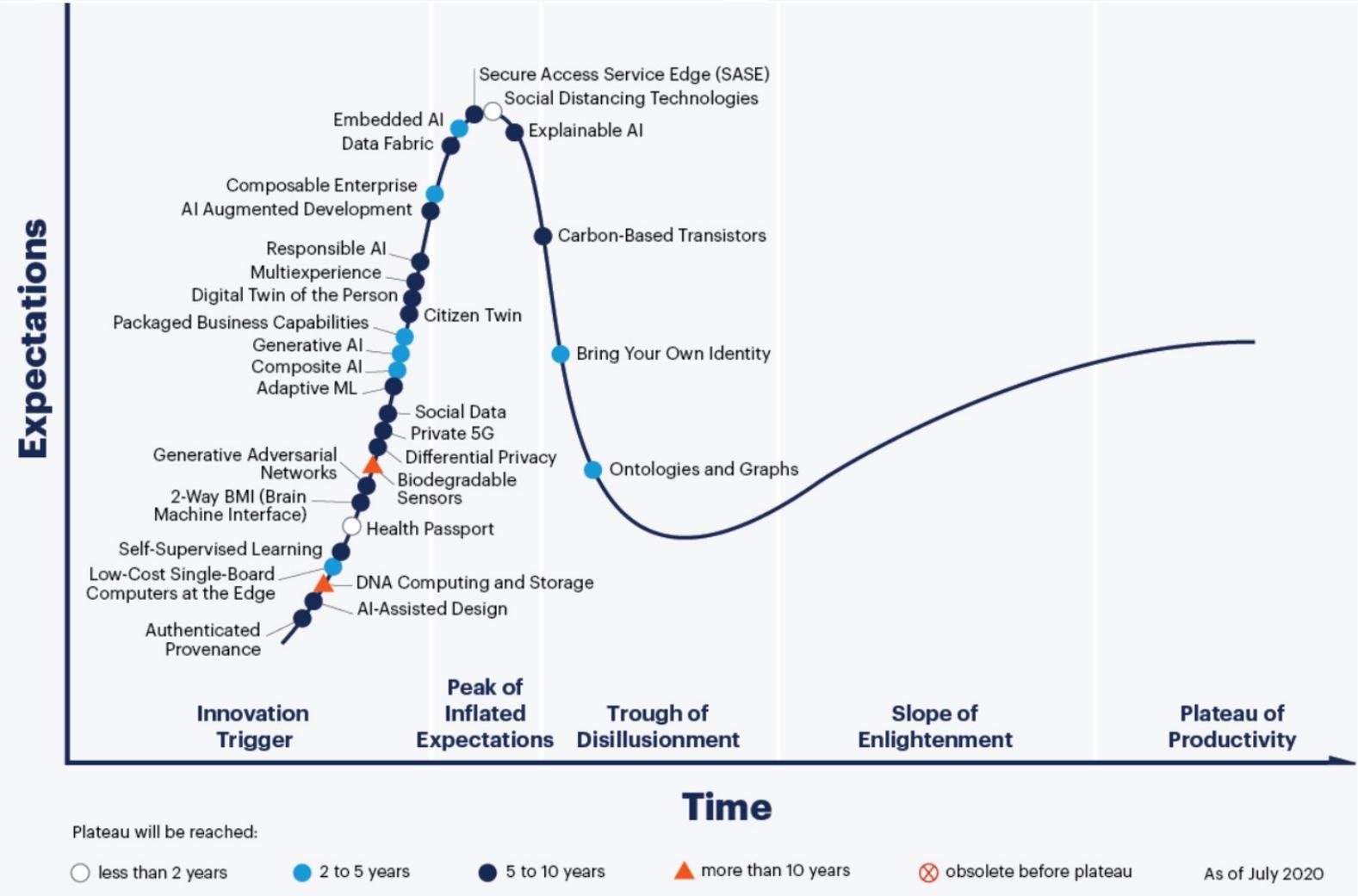
EXPLAINABLE AI (XAI) ADDRESSES THE PROBLEM OF TRADE-OFF BETWEEN ACCURACY AND INTERPRETABILITY
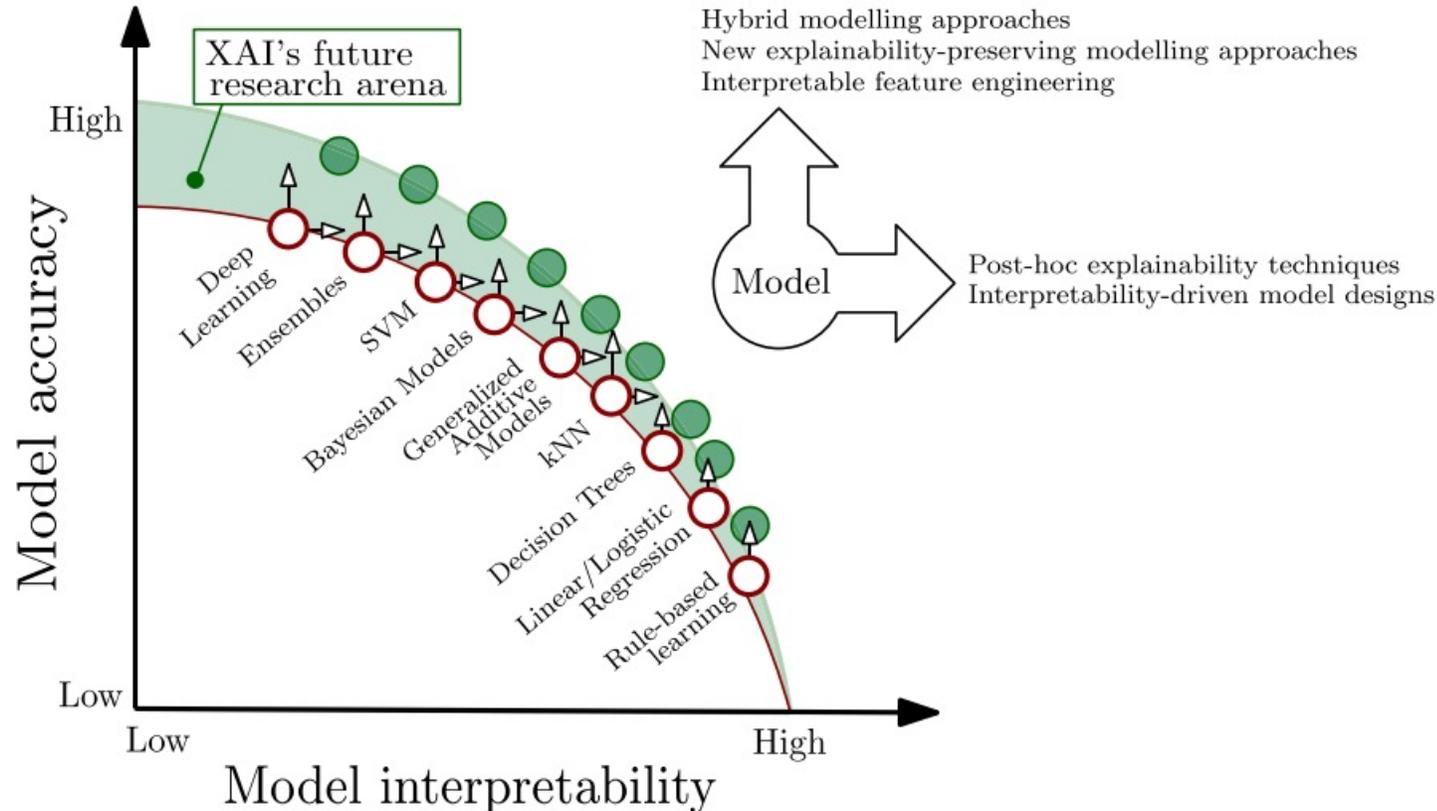
GARTNER'S 2020 HYPE CYCLE FOR EMERGING TECHNOLOGIES*

GARTNER'S 2020 HYPE CYCLE FOR ARTIFICIAL INTELLIGENCE*
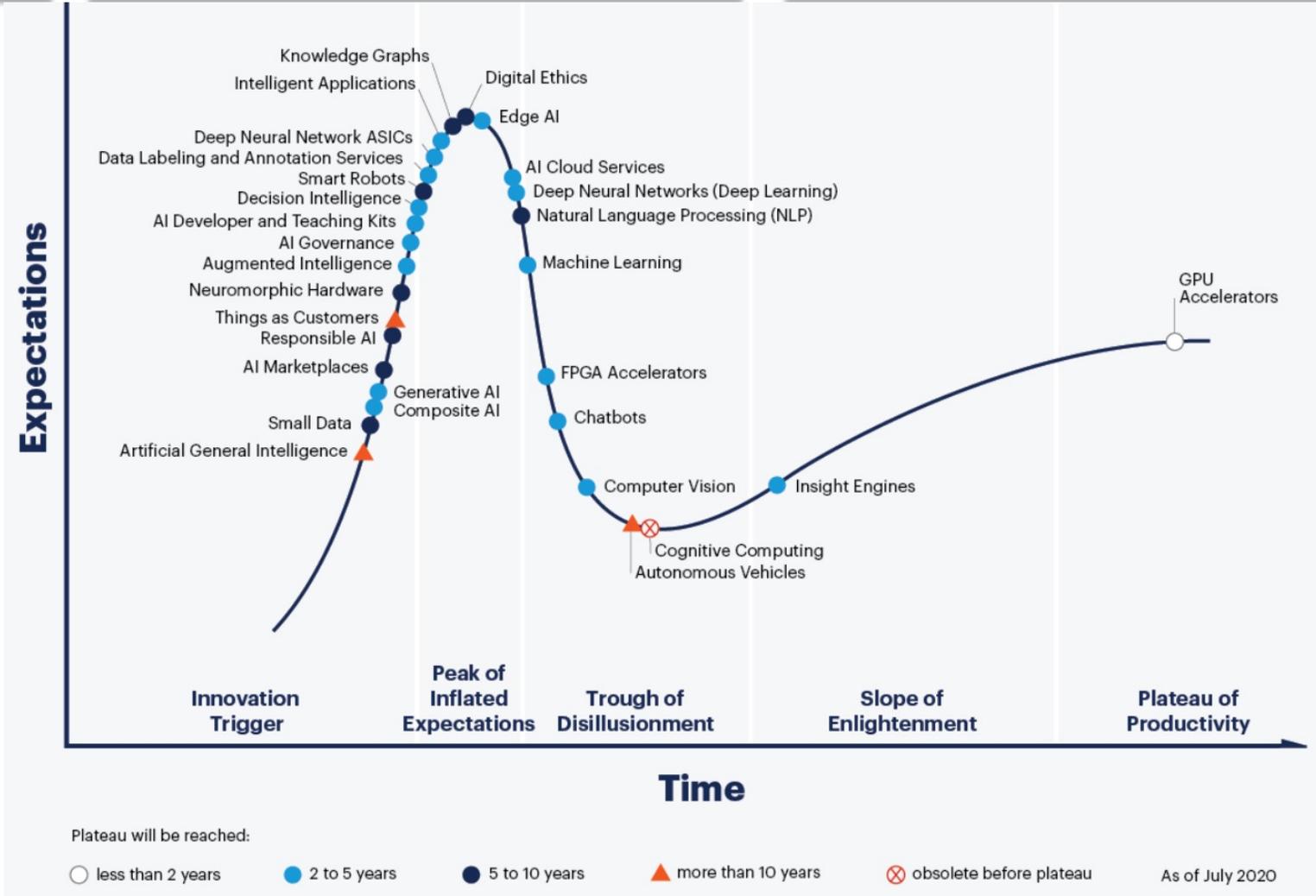
A European Strategy for Artificial Intelligence

AI is good...

- For citizens
- For business
- For public interest

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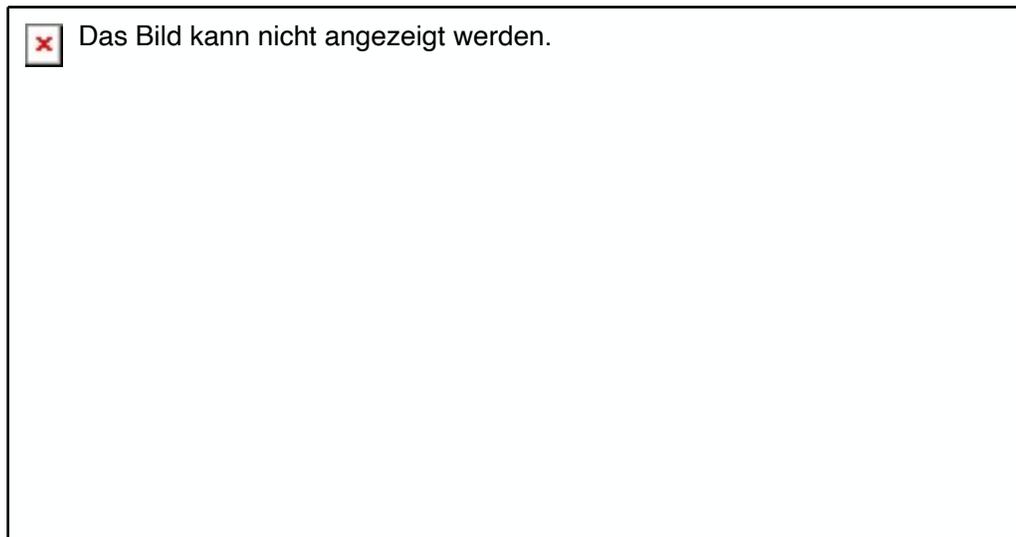
...BUT CREATES SOME RISKS

- For the safety of consumers
- For fundamental rights

A RISK-BASED APPROACH TO AI REGULATION

Unacceptable risk
e.g. social scoring

Prohibited

High risk
e.g. recruitment, medical devices

*Not mutually exclusive

Permitted subject to compliance with AI requirements and ex-ante conformity assessment

AI with specific transparency obligations
'Impersonation' (bots)

Permitted but subject to information/transparency Obligations

Minimal or no risk

Permitted with no restrictions

AI THAT CONTRADICTS EU VALUES IS PROHIBITED

Subliminal manipulation resulting in physical/ psychological harm

Exploitation of children or mentally disabled persons resulting in physical/psychological harm

General purpose social scoring

Remote biometric identification for law enforcement purposes in publicly accessible spaces (with exceptions)

AI: Where we should be heading - Slovakia

- Identify strategic sectors

- Build and mobilise research capacities

- Nurture talent and enable talent circulation

- Develop a data policy

- Develop Slovak language model and datasets

- Support international collaboration and inclusion to European network of excellence

- Provide an environment for companies to test, experiment and take up AI

- Support the funding and scaling innovative AI ideas and solutions

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