Introduction to Machine Learning – AICOSS

School of Advanced Professional Studies (SAPS)

COSS 인공지능
전남대학교 인공지능혁신융합대학사업단

THU
Technische Hochschule Ulm
University of Applied Sciences

AICOSS - AI Special Program

Machine learning – the *why* and the *what*

Why machine learning?

„The world's most valuable resource is no longer oil, but data"

The Economist 2017, https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data
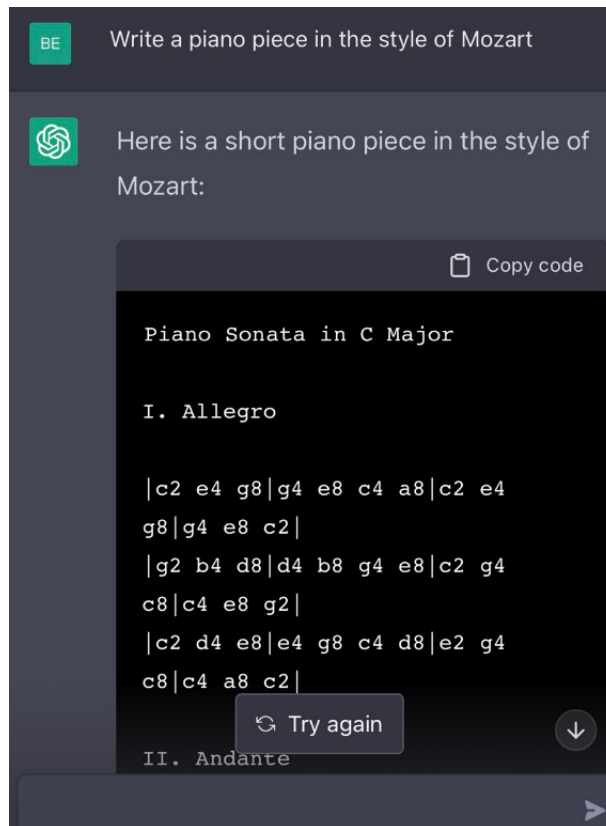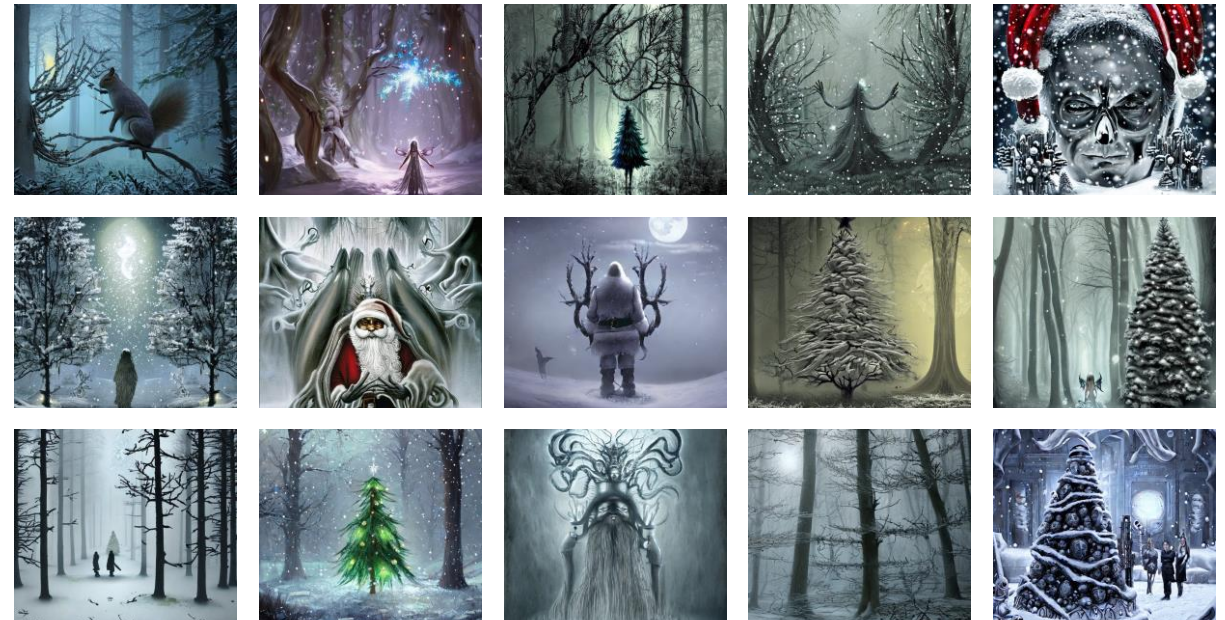
Why machine learning?

ChatGPT

Stable Diffusion

„christmas tree, forest, moon, squirrel, mystical fog,hr giger"

Rombach et al., *High-Resolution Image Synthesis with Latent Diffusion Models*, 2022
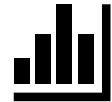
Why machine learning?

Natural Language Processing	Question answering; speech recognition; summarizing documents; classifying documents; finding entities in documents; searching documents for concepts
Computer Vision	Interpreting satellite and drone images (disaster detection); face recognition; automatic image description; recognizing traffic signs; autonomous driving
Medicine	Recognize anomalies in radiological images (CT, MRI and X-ray); tissue classification in microscopy images; feature identification in ultrasound
Biology	Protein folding; classification of proteins; applications in genomics (e.g. tumor-normal sequencing); cell classification; analysis of protein/protein interactions
Image generation	Colorizing B&W images; increasing image resolution; removing noise from images; transferring stylistics to images (e.g. Instagram filters)
Recommender Systems	Web search; Product recommendations
Games	Superhuman performance in chess, Go, many Atari games and real-time strategy games
Robotics	Dealing with objects that are difficult to locate (transparent, shiny, little texture) or that are generally difficult to grasp
Other applications	Finance and logistics forecasting; text-to-speech; many many more...

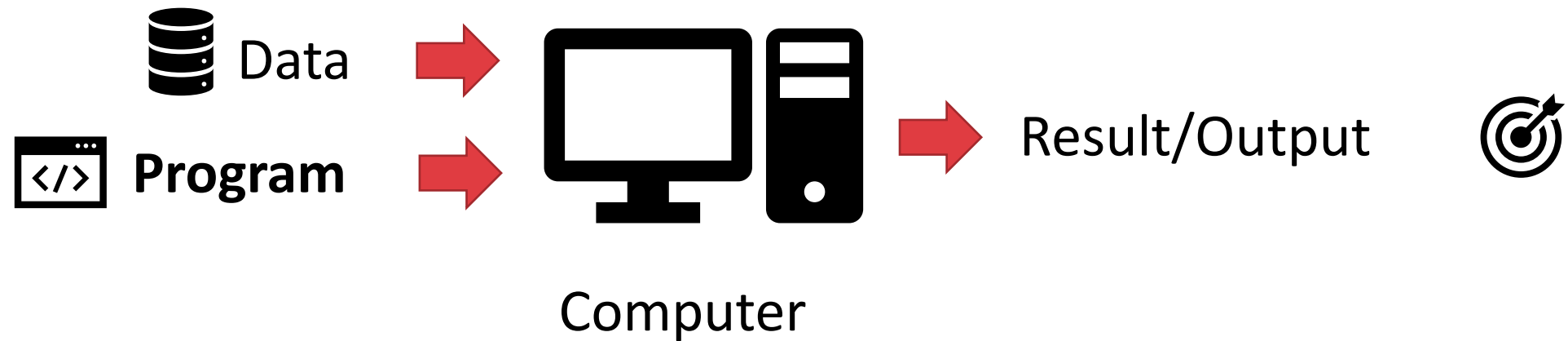# Why machine learning?

Practical reasons

- Less programming; more efficient

- Scaling and customization of products

- Solving "non-programmable" tasks
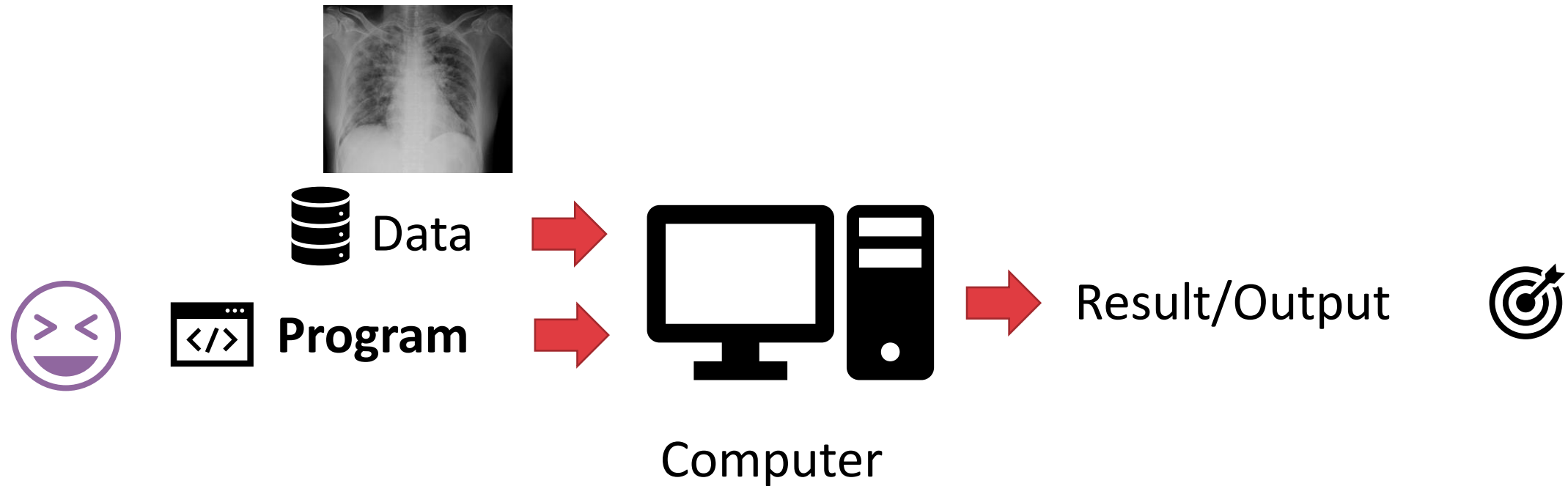
↔

„Philosophical" reasons

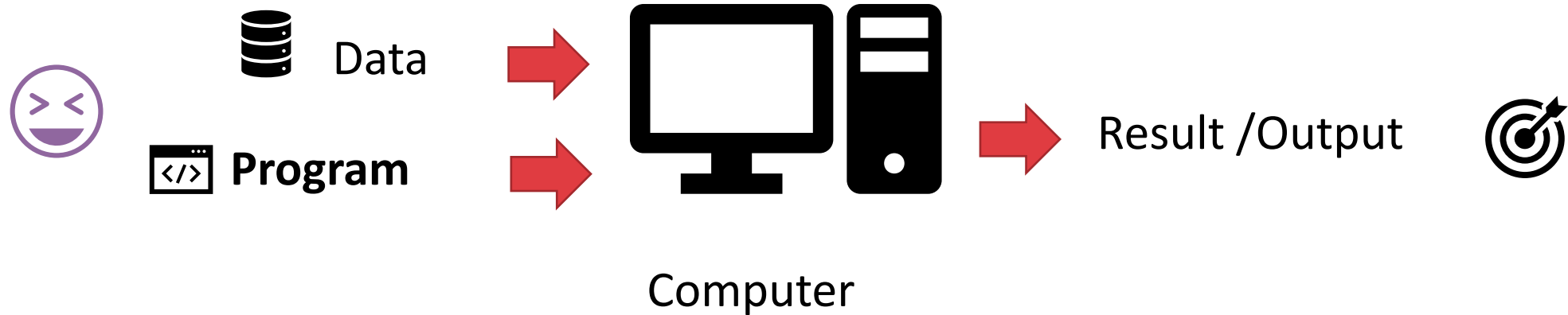# What is machine learning?

Classical computer science approach:

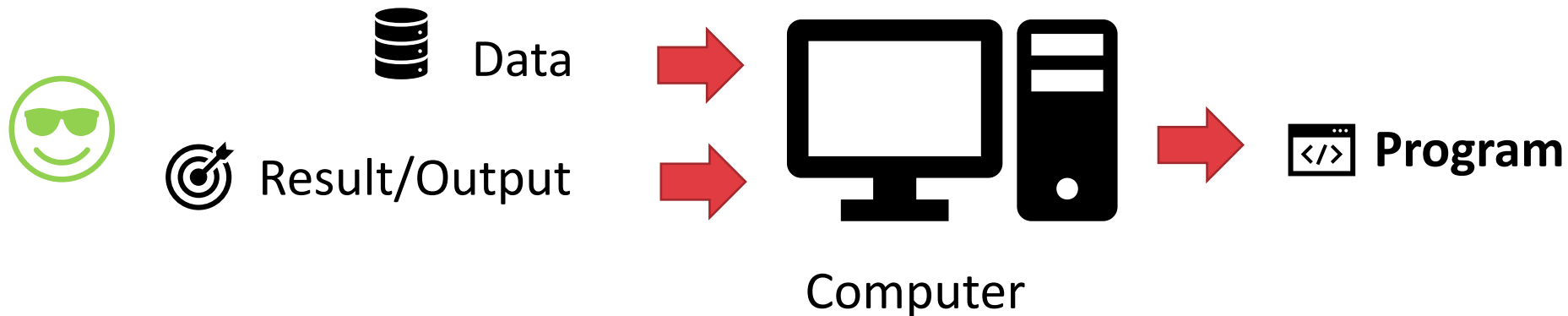# What is machine learning?

Classical computer science approach:

What is machine learning?
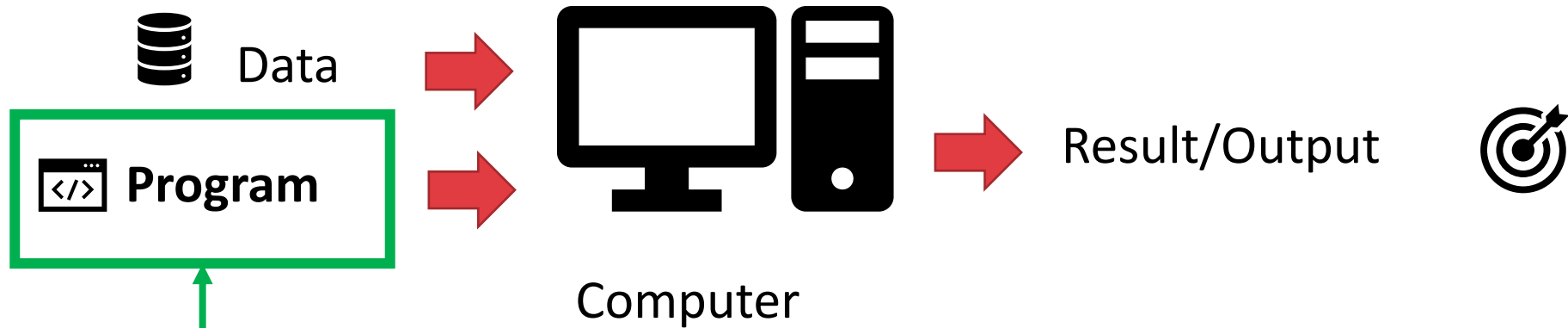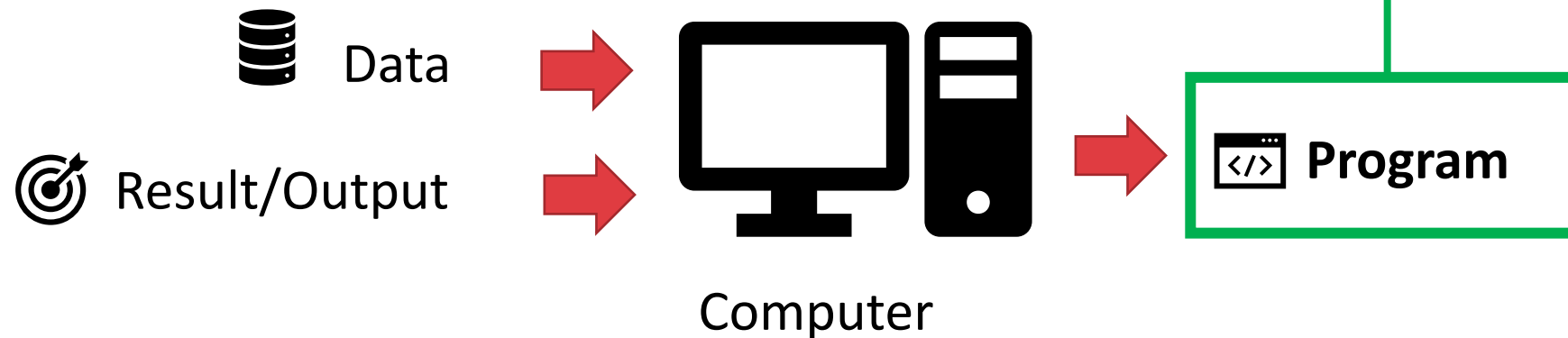
Classical computer science approach:

Data → Computer → Result /Output

Program →

Machine Learning:

Data → Computer → Program

Result/Output →

What is machine learning?

What is machine learning?

Formal definition: A computer program **A** is said to learn from experience **E** with respect to some class of tasks **T** and performance measure **P**, if its performance at tasks in **T**, as measured by **P**, improves with experience **E**. *(Tom M. Mitchell, 1997)*

Informal : Algorithms that *improve* in a *task* with increasing *experience*.

ML History

ML History

Samuel's Checkers Playing Program (1952)

- Program improves with the number of games (machine learning...)

- Evaluation of the board positions by a search tree

- Best move is determined using a minimax strategy

ML History

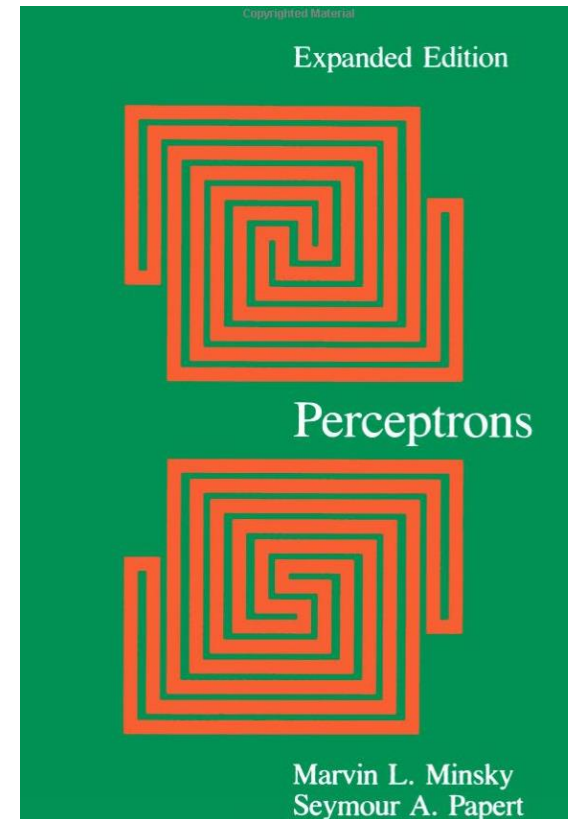## Perceptron 1957 (Frank Rosenblatt)

- Predecessor of today's neural networks:

  Multilayer Perceptron (MLP) -> Artificial Neural

  Networks -> Deep Learning

- Triggered great excitement around AI ("AI Boom")

x_1

$x_2 \longrightarrow$ output

x_3
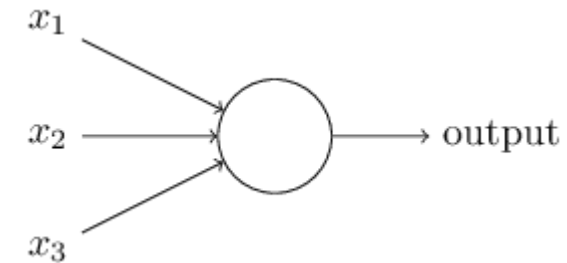
ML History

AI winter

- Minsky & Papert (1969) "ruin" AI

- Public and private investment in AI technology
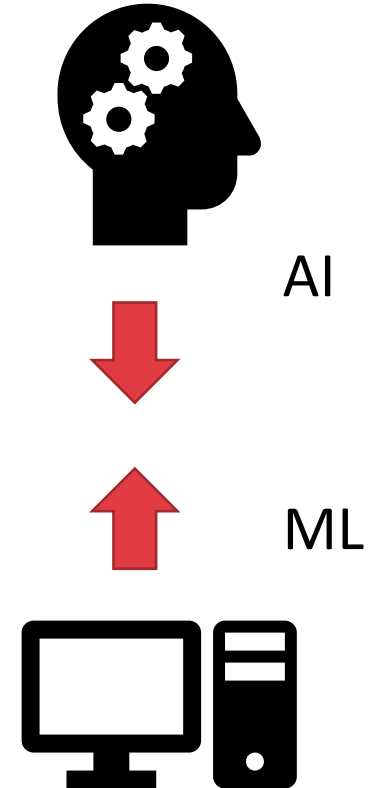
  and research collapses for decades

ML History

Resurrection as machine learning

Differences:

- ML: bottom-up, AI: top-down

- ML: More practical application, based on statistics
  and optimization, not logic

AI

ML

ML History

TD-Gammon (Gerald Tesauro 1992)

- Gerry Tesauro (IBM) trains a neural network that plays against itself again and again (100k+). It beats several backgammon world champions.

ML History

IBM Deep Blue (1997)

- IBM's Deep Blue chess computer wins against Garry Kasparov.

- Predominantly "brute-force" approach with calculation of 126 million positions per second. But the evaluation of a position is ML.

https://www.ibm.com/blogs/think/2017/05/deep-blue/

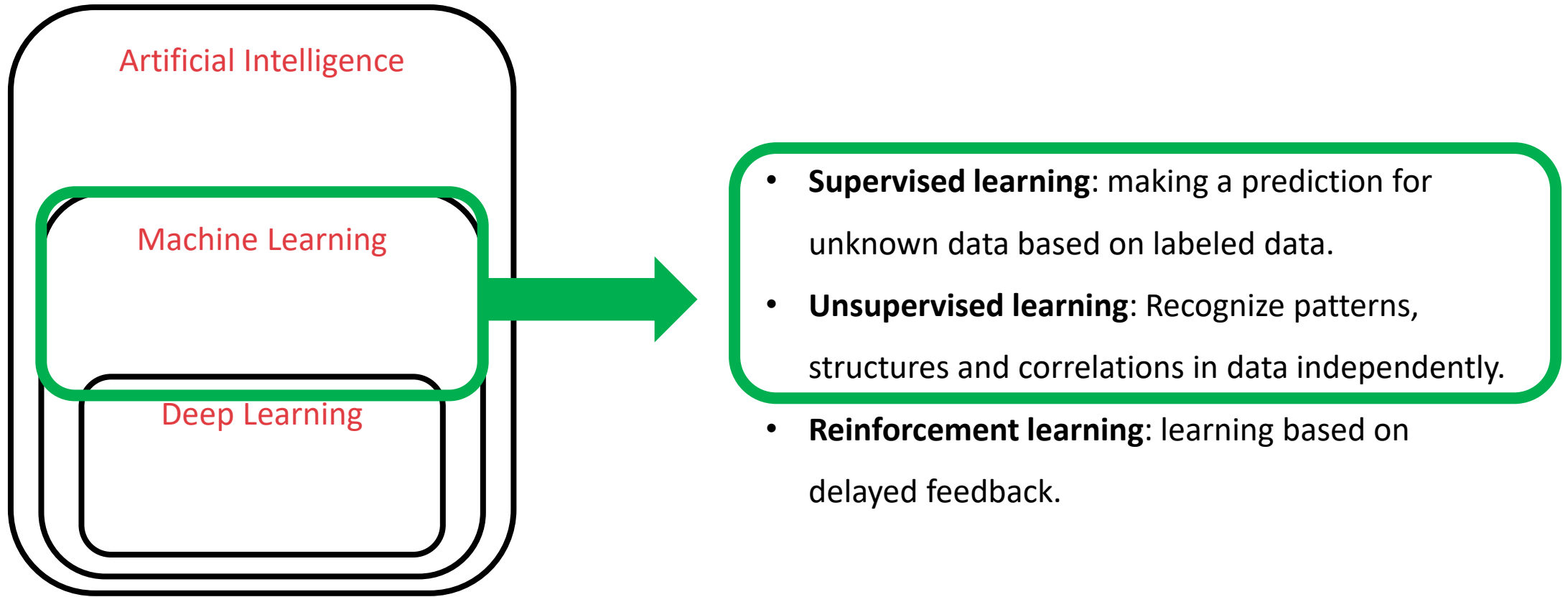# ML History

AI today: „Deep Learning Revolution"

- AlexNET wins 2012 ImageNet competition

- AlphaGo beats Lee Sedol 2016 in Go (2.1 x 10^{170} positions, cf. chess 10^{40})

- Now: LLMs, self-driving cars, robotics, etc.

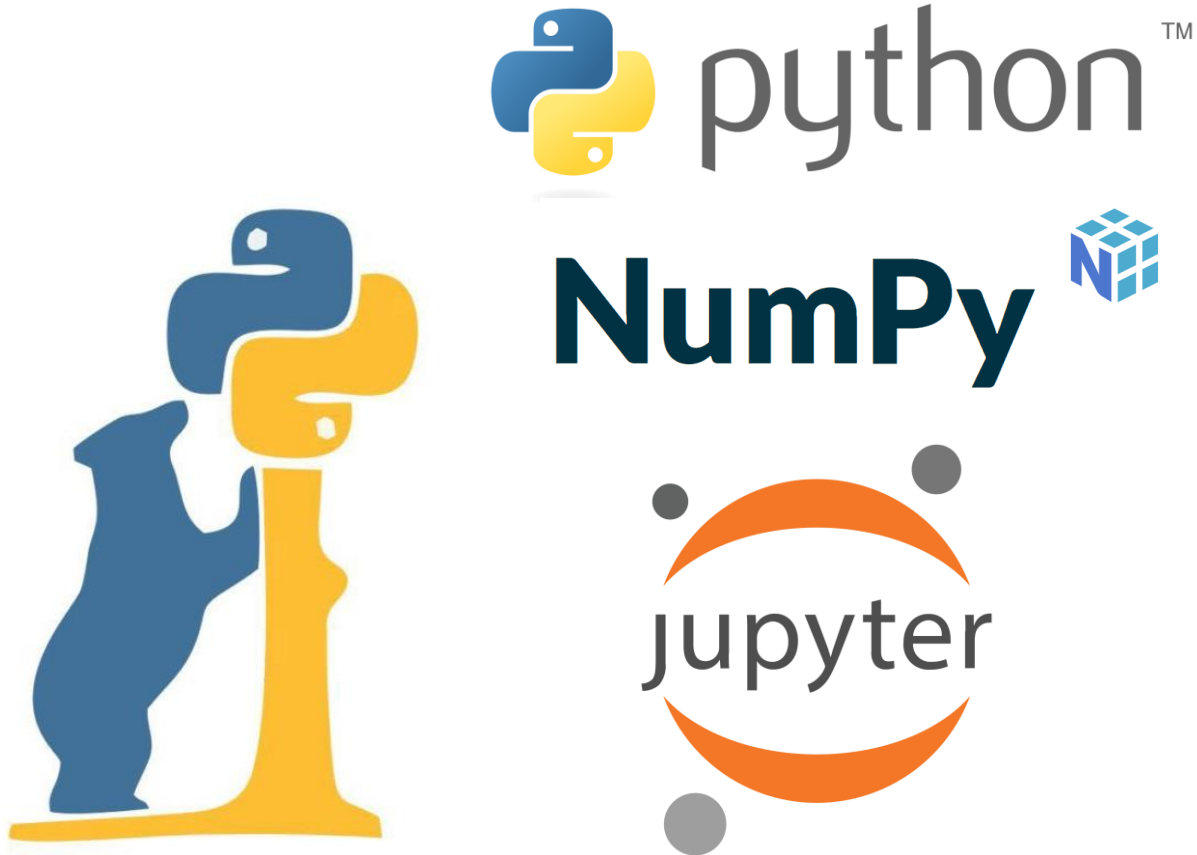https://www.theguardian.com/technology/2016/mar/15/alphago-what-does-google-advanced-software-go-next

Scope and structure of this week

ML scope

Artificial Intelligence

Machine Learning

Deep Learning

- **Supervised learning**: making a prediction for unknown data based on labeled data.
- **Unsupervised learning**: Recognize patterns, structures and correlations in data independently.
- **Reinforcement learning**: learning based on delayed feedback.

The **application** is the central element of the course!

Structure of this weeks course

Contents

- **Python for data science recap**

- Unsupervised learning

- Supervised learning

- Evaluation and hyperparameter tuning

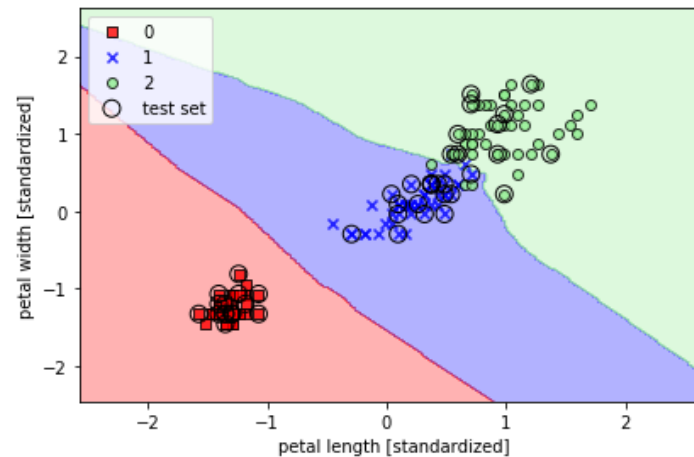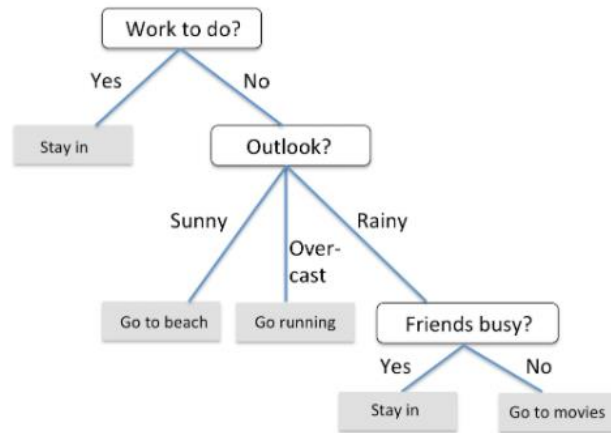- Ensemble learning

- (Simple) neural networks
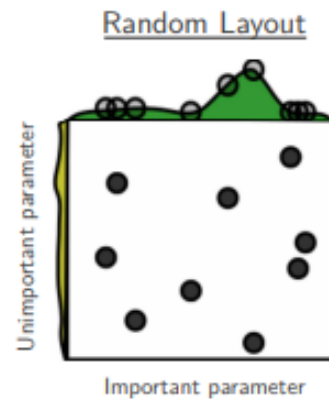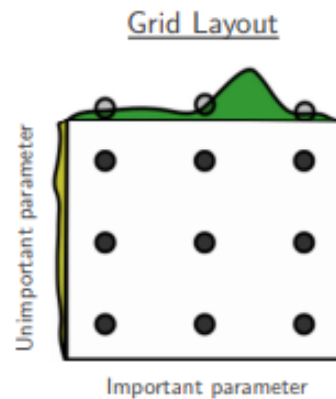
Structure of this weeks course

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- (Simple) neural networks

Structure of this weeks course

Contents

Structure of this weeks course

Predicted class

	P	N
P	True positives (TP)	False negatives (FN)
N	False positives (FP)	True negatives (TN)

Actual class

Grid Layout / Random Layout — Unimportant parameter vs Important parameter

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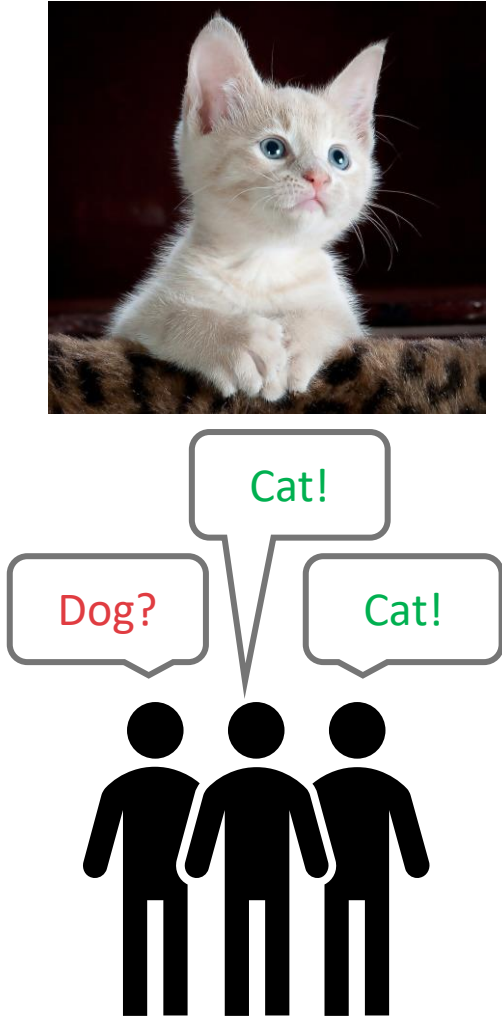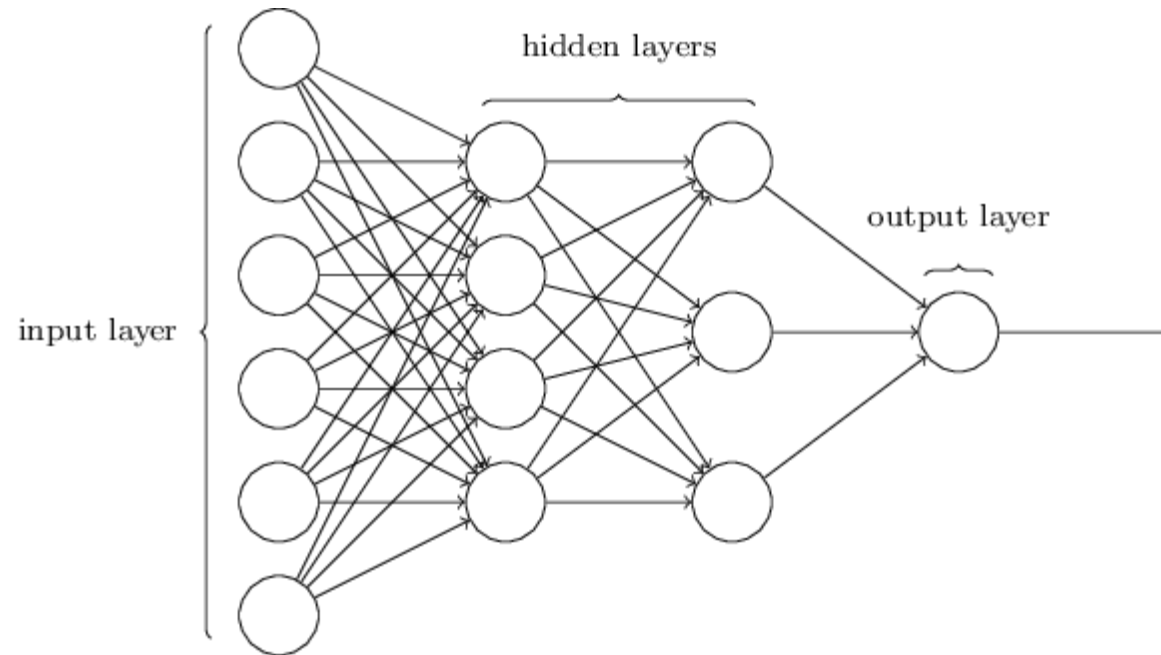- (Simple) neural networks

Structure of this weeks course

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Structure of this weeks course

input layer

hidden layers

output layer

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- **(Simple) neural networks**