Basics of Machine Learning

Patryk Neubauer & Marcin Walkowski
Gradient Science Club 2022

Plan for Today

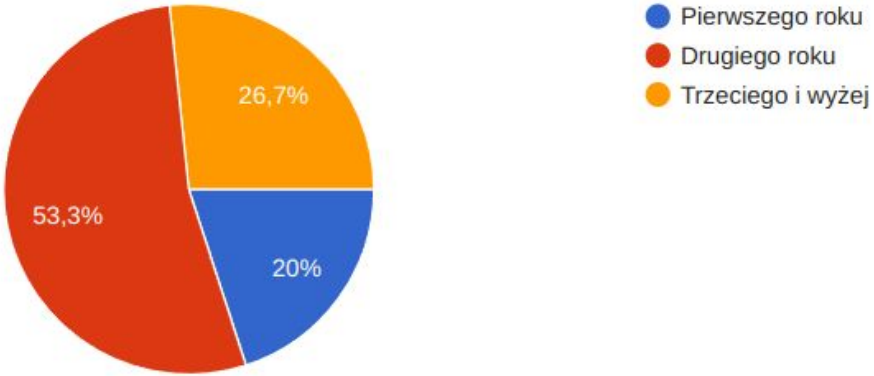
- **Gradient Science Club - housekeeping & news**
- What is Machine Learning?
- Data - the core of Machine Learning
- Types of Machine Learning algorithms - overview
- How to learn? - cost functions
- Supervised Learning
- Unsupervised Learning
- Learning process
- Reinforcement Learning
- **Kahoot Time**

Survey Results

Jestem studentem/studentką:

Kopiuj

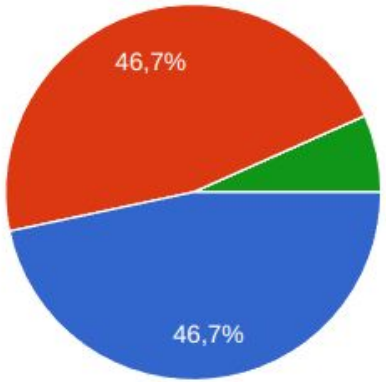
15 odpowiedzi



Moje doświadczenie z AI/ML:

Kopiuj

15 odpowiedzi

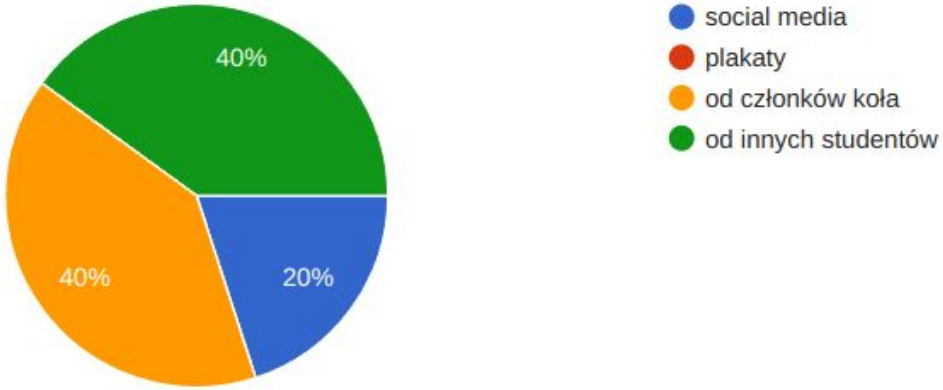


- nic nie wiem o tym temacie
- coś kiedyś poczytałem/am, ale nie mam dużo doświadczenia w praktyce
- zrobiłem/am kilka projektów związanych z ML
- pracuję w tej dziedzinie

O kursie organizowanym przez Gradient dowiedziałem/am się z:

Kopiuj

15 odpowiedzi



Od kursu oczekuje:

Kopiuj

15 odpowiedzi

Dodatkowe uwagi/pomysły:

2 odpowiedzi

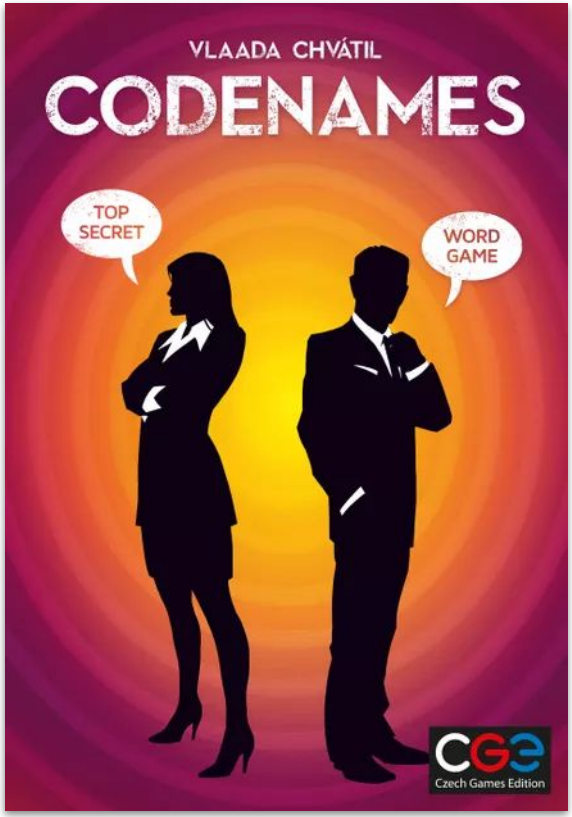
Coś o podstawach matematycznych

Lepiej by było żeby spotkania trwały 2 godziny, 1 godzina to zdecydowanie zbyt krótko żeby dobrze omówić temat. Jeśli udało by się wydłużyć spotkania to można by je rozdzielić według stopnia zaawansowania, np. we wtorki podstawy, a w czwartki bardziej zaawansowane rzeczy. Można też pomyśleć nad jakimiś dodatkowymi spotkaniami w laboratorium, żeby wykorzystać poznaną teorię w praktyce.

Gradient on Energy Day

Gradient on Energy Day (by WRS)

- **Where?** ETI Department at GUT
- **When?** 23-24 November (24 November 9:00 - 15:00 in our case)
- **Contact Point** Patryk Utkała (patrykutkala@gmail.com)



P: AI science club meeting, digital impressionism.

Guest Lectures

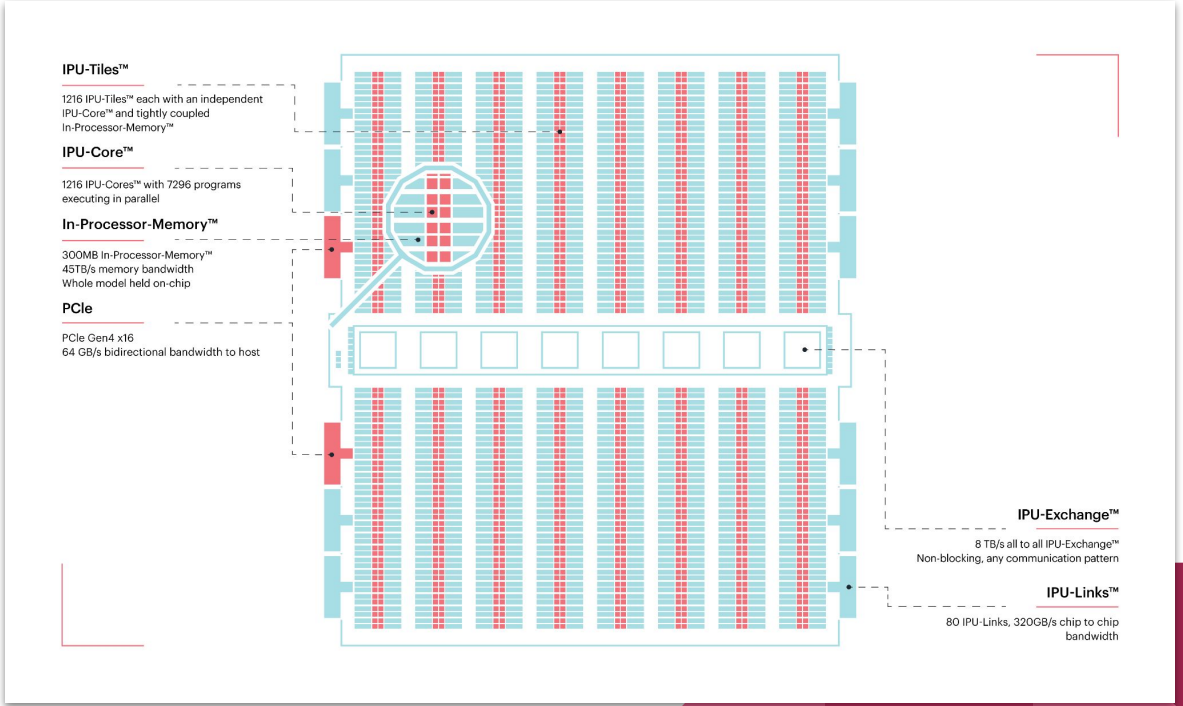
Topics proposed by Graphcore

- State of AI
- IPUs vs GPUs

State of AI

GPT3

IPUs vs GPUs


IPU-Tiles™
1216 IPU-Tiles™ each with an independent IPU-Core™ and tightly coupled In-Processor-Memory™
IPU-Core™
1216 IPU-Cores™ with 7296 programs executing in parallel
In-Processor-Memory™
300MB In-Processor-Memory™
45TB/s memory bandwidth
Whole model held on-chip
PCIe
PCIe Gen4 x16
64 GB/s bidirectional bandwidth to host
IPU-Exchange™
8 TB/s all to all IPU-Exchange™
Non-blocking, any communication pattern
IPU-Links™
80 IPU-Links, 320GB/s chip to chip bandwidth

Agenda

1.	~~**Basics of Machine Learning**~~	~~Patryk Neubauer~~	~~15-11-2022~~
2.	**Classical Algorithms**	Marek Jeliński	22-11-2022
3.	**Introduction to Deep Learning**	Bartek Kalita	29-11-2022
4.	**Computer Vision**	Dominik Kuczkowski	06-12-2022
5.	**Recurrent Neural Networks**	Patryk Utkała	13-12-2022
6.	**Reinforcement Learning**	Patryk Neubauer	20-12-2022
7.	**Machine Learning in Practice**	Marcin Walkowski	03-01-2023

What is Machine Learning?

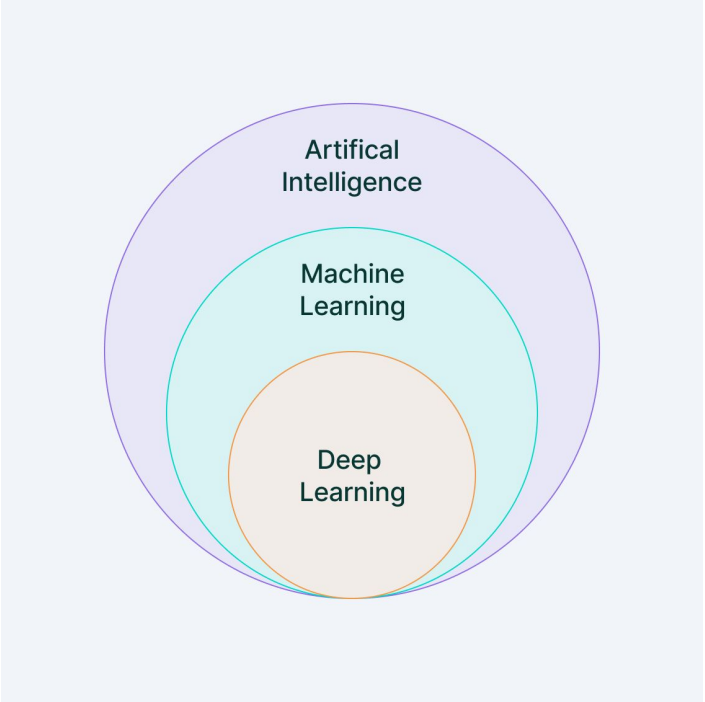
High Level Overview

Resources

- A High Level Overview of AI - IBM Z and LinuxONE Community
- Machine Learning Specialization course by Andrew Ng
- Stanford Machine Learning course

What is Machine Learning?

- Arthur Samuel (1959) - Field of study that gives computers the ability to learn without being explicitly programmed.
- Given some data, an algorithm learns from that data with respect to some task



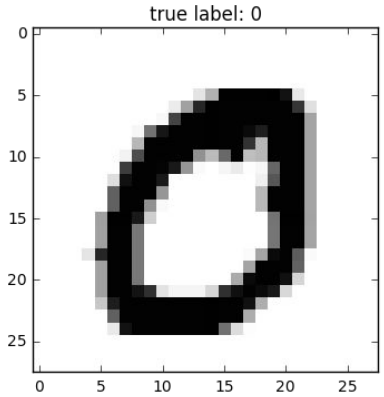
Data - the core of Machine Learning

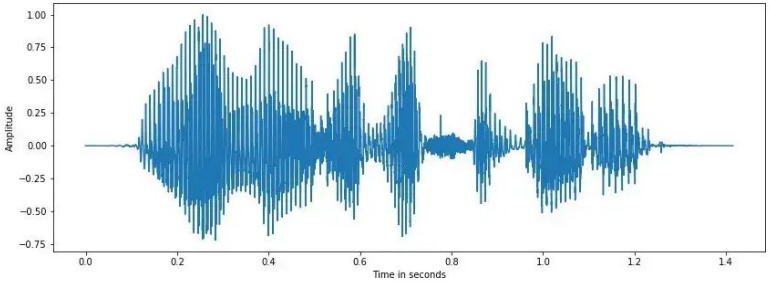
Data – the core of Machine Learning

- Data is one of, if not the most important thing in Machine Learning
- The model can be only as good as data
- The more the better
- Often, especially in classical problems – in tabular form
- Everything can be represented with numbers though

# SkinThick...	# Insulin	# BMI	# DiabetesP...	# Age	# Outcome
35	0	33.6	0.627	50	1
29	0	26.6	0.351	31	0
0	0	23.3	0.672	32	1
23	94	28.1	0.167	21	0
35	168	43.1	2.288	33	1
0	0	25.6	0.201	30	0
32	88	31	0.248	26	1

Diabetes dataset





Types of Machine Learning algorithms

Types of Machine Learning algorithms - overview

Mainly:

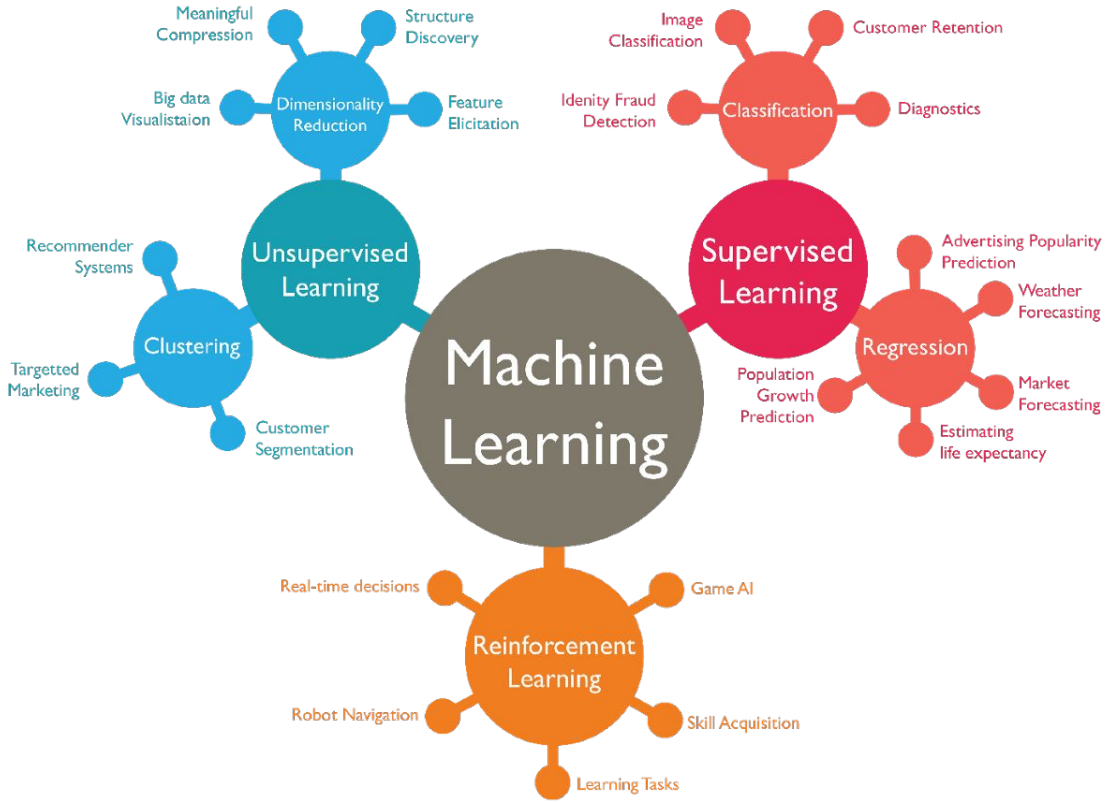
- Supervised - Data is labeled with a value (regression) or a class (classification) we want to predict.
- Unsupervised - Data has no labels, we want to look out for trends in the form of groups (clustering) or correlations (association) between the samples.

But also:

- Reinforcement Learning - Instead of conventional data, we have a model of the environment, with which an "agent" can interact
- Semi-Supervised Learning - Between supervised and unsupervised, the data has both labeled and unlabeled samples

and few other variants...

Types of Machine Learning algorithms – overview

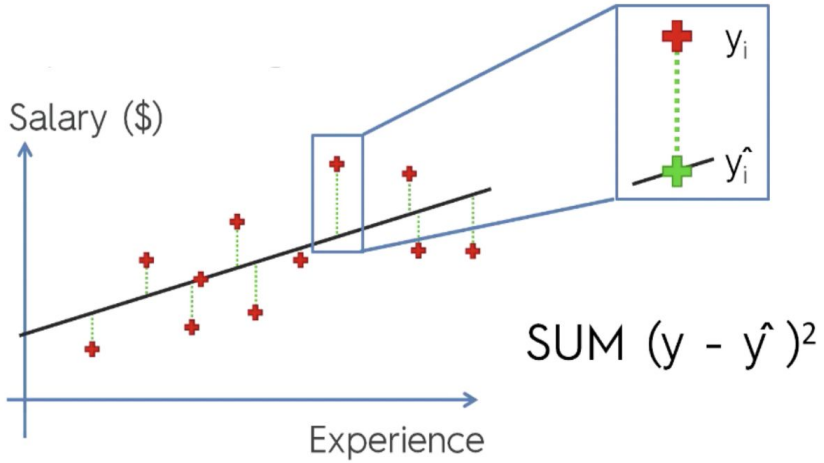


Source: https://towardsdatascience.com/machine-learning-types-2-c1291d4f04b1

How to learn? – cost functions

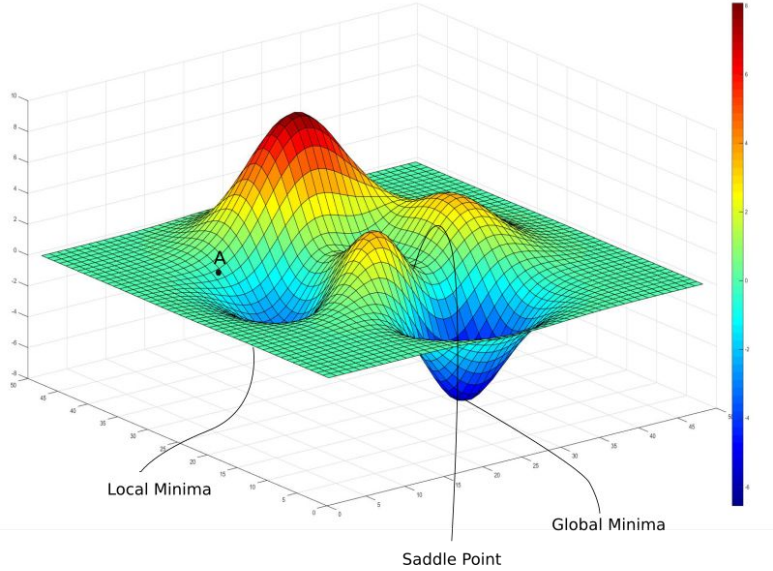
How to learn? - cost functions

- Cost function determines how well a model “fits” the data
- i.e. a measure of how wrong the model is in estimating th relationship between input and output.
- i.e. the difference between predictions and desired output
- Results in a single (real) number
- Cost function of a model over a dataset, can be as simple as a sum of distances between the real and predicted values.



How to learn? - cost functions

- Picking the right cost function for the task we want to do is crucial.
- Used during training to help us find the optimal* parameters of our algorithm
- Can be used in evaluation to determine how well the model performs



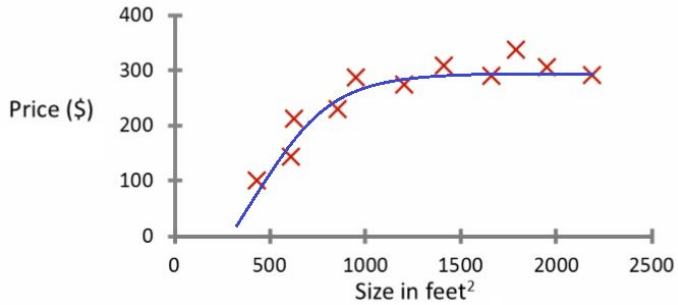
* - ideally, often not possible in practice

Supervised Learning

Supervised Learning - regression

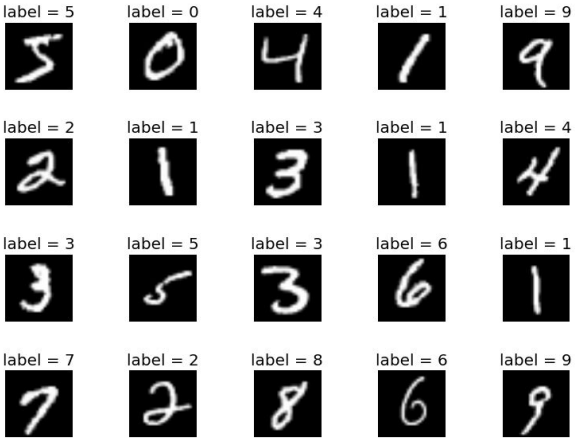
- The goal is to predict values based on some input - estimating function of features to labels
- Commonly used to make projections, such as for sales revenue for a business
- In simple scenarios, cost function is often a form of distance between predictions and real data.

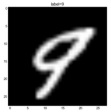
# LotArea	A Street	A LotShape	A LandCont...	A Utilities	# SalePrice
215245	Pave	IR3	Low	AllPub	375000
164660	Grvl	IR1	HLS	AllPub	228950
159000	Pave	IR2	Low	AllPub	277000
115149	Pave	IR2	Low	AllPub	302000
70761	Pave	IR1	Low	AllPub	280000
63887	Pave	IR3	Bnk	AllPub	160000



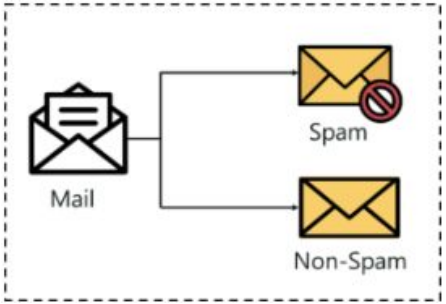
Supervised Learning - classification

- The goal is to predict a class of the given samples - can be binary (yes/no, true/false, 0/1) or multi-class (healthy/benign/malevolent, cat/dog/cow/frog, bus/car/plane ....)
- Predictions can be treated as probabilities* of the sample being one of the classes

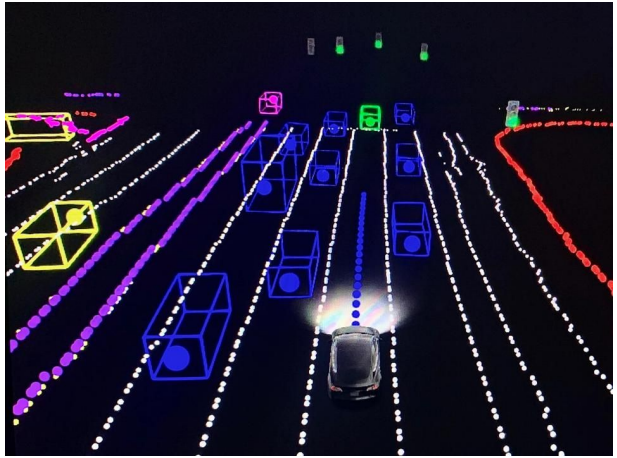




.32, .02, .05, .02, .04, .08, .12, .03, .02, .78
0 1 2 3 4 5 6 7 8 9

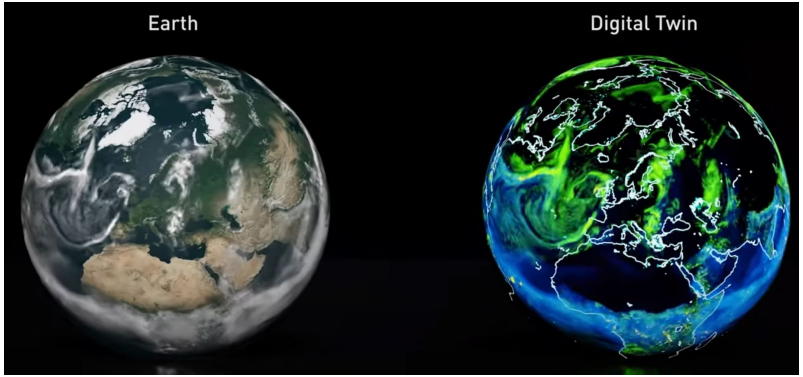


Supervised Learning - examples



Object detection

AlphaFold



FourCastNet - *Global weather prediction model*

Supervised Learning – examples

"An astronaut riding a horse in a photorealistic style."

"Close up of a cat wearing soldier helmet in the battle, ww2 historical photography, black & white"

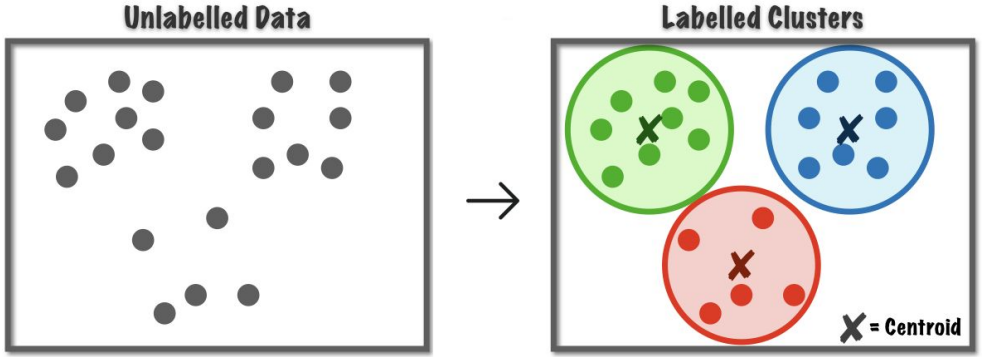
"A nebula shaped like a sea-horse."

Dall-E 2

Unsupervised Learning

Unsupervised Learning - clustering

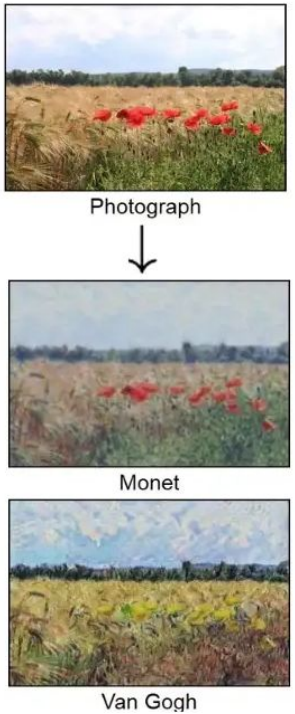
- The goal is to draw conclusions from unlabelled, seemingly random data
- Useful when grouping samples by their similarity might be useful
- Clustering e.g. songs on Spotify or serials on Netflix makes it easier to recommend new ones, based on what the user has seen already, by recommending unseens samples from the same cluster



Unsupervised Learning – examples

https://thispersondoesnotexist.com/

Super-resolution



Style-transfer

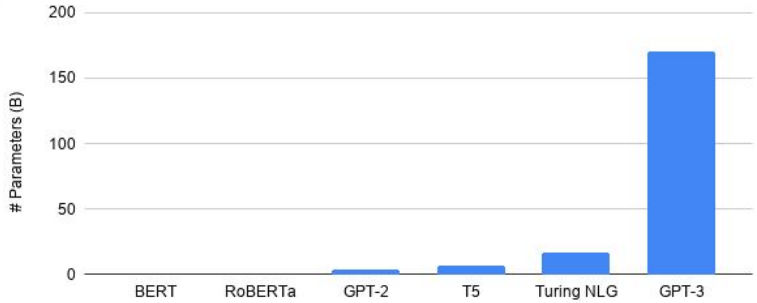
Unsupervised Learning – examples

Summarize this for a second-grade student:

Jupiter is the fifth planet from the Sun and the largest in the Solar System. It is a gas giant with a mass one-thousandth that of the Sun, but two-and-a-half times that of all the other planets in the Solar System combined. Jupiter is one of the brightest objects visible to the naked eye in the night sky, and has been known to ancient civilizations since before recorded history. It is named after the Roman god Jupiter.[19] When viewed from Earth, Jupiter can be bright enough for its reflected light to cast visible shadows,[20] and is on average the third-brightest natural object in the night sky after the Moon and Venus.

Jupiter is the fifth planet from the Sun. It is very large, much larger than any of the other planets in the Solar System. People have known about Jupiter for a long time, and it is one of the brightest objects you can see at night.

Brainstorm at least 5 ideas combining VR and fitness:
-A fitness program that is based in a virtual reality world
-A video game that gets the player up and moving around to control their on-screen character
-An app that uses virtual reality to take the user through a series of exercises
-A VR headset designed specifically for working out, with games and programs to get users motivated
-A social media platform for connecting with others who are interested in VR fitness



GPT-3

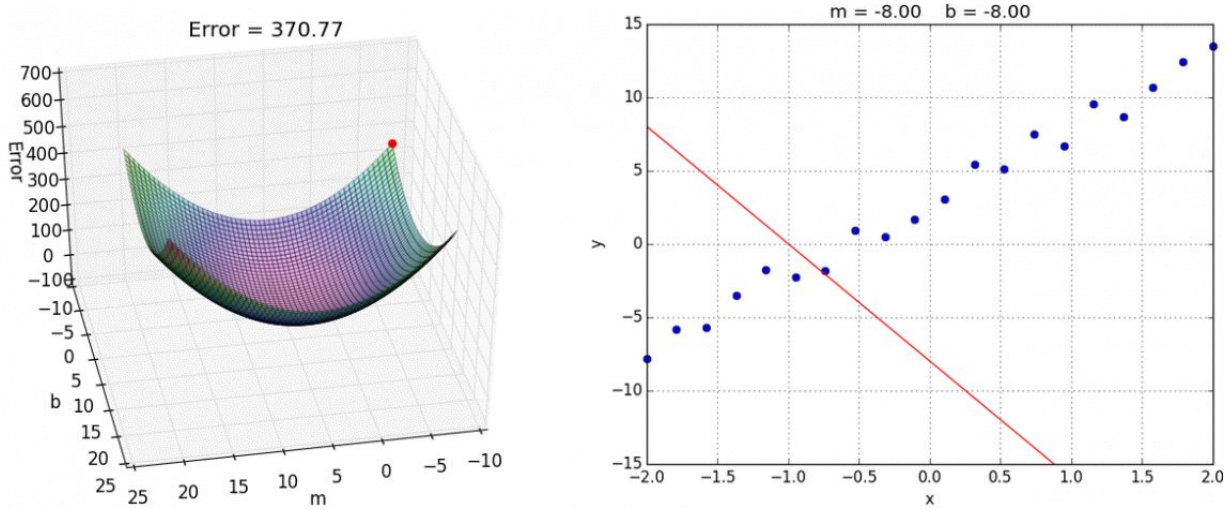
Learning process

Learning process

The general process is to:

- Start with random parameters
- Compute the error of the model with cost function
- Adjust the parameters
- Repeat until a stop condition is met
    - e.g. after reaching a certain number of repetitions or when the change of parameters or decrease of loss function falls below a threshold between repetitions

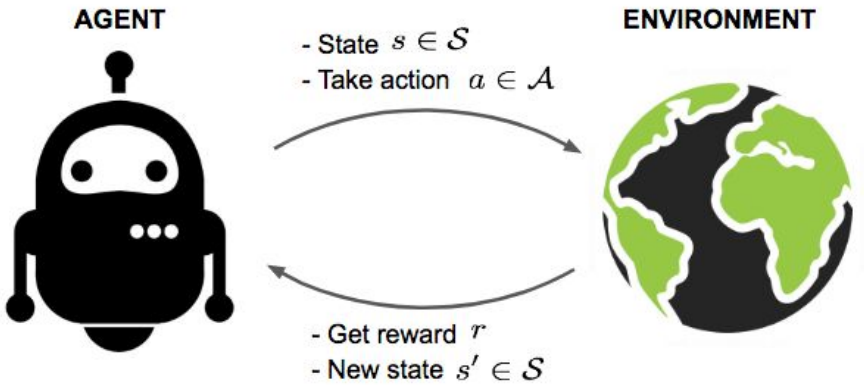
Learning process



https://miro.medium.com/max/2400/1*gkl-HRUK35WejSqimAja1w.gif

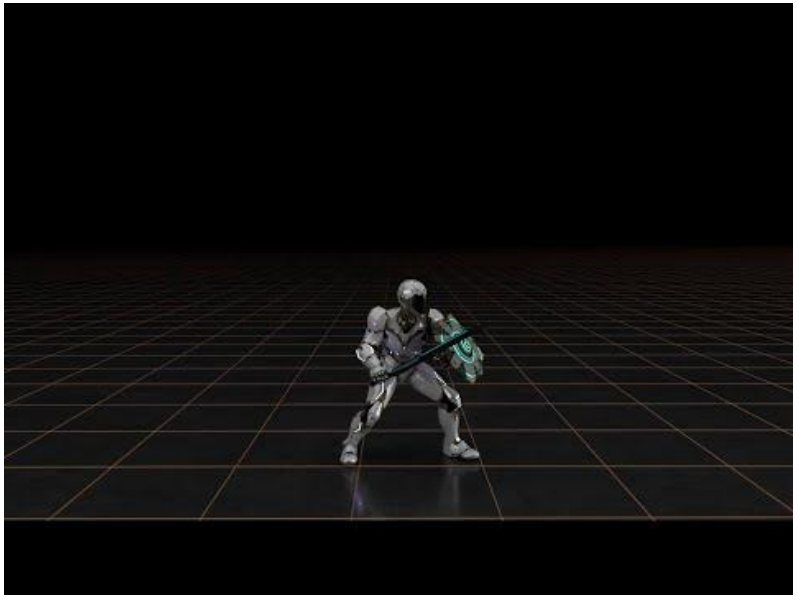
Reinforcement Learning

- Instead of traditional datasets, we learn from the environment
- Agent - an algorithm that interact with the environment and takes actions
- The environment consists of:
  - states - what the agent sees, based on it it chooses to do certain actions
  - actions - what the agent can do in the environment
  - rewards - a single number that either rewards or punishes the agent for his actions - used to improve decision making
- More on it later in the course!



Reinforcement Learning - examples

Self-driving cars



AI-Driven character animation

DeepMind's AI beats world's best Go player in latest face-off

AlphaZero & AlphaGo

Hands-on

Introduction to Google Colab

https://colab.research.google.com

Questions
&
Discussion

Kahoot

Kahoot Title

https://kahoot.it

Thank you!
See you next week
on **Classical Algorithms**