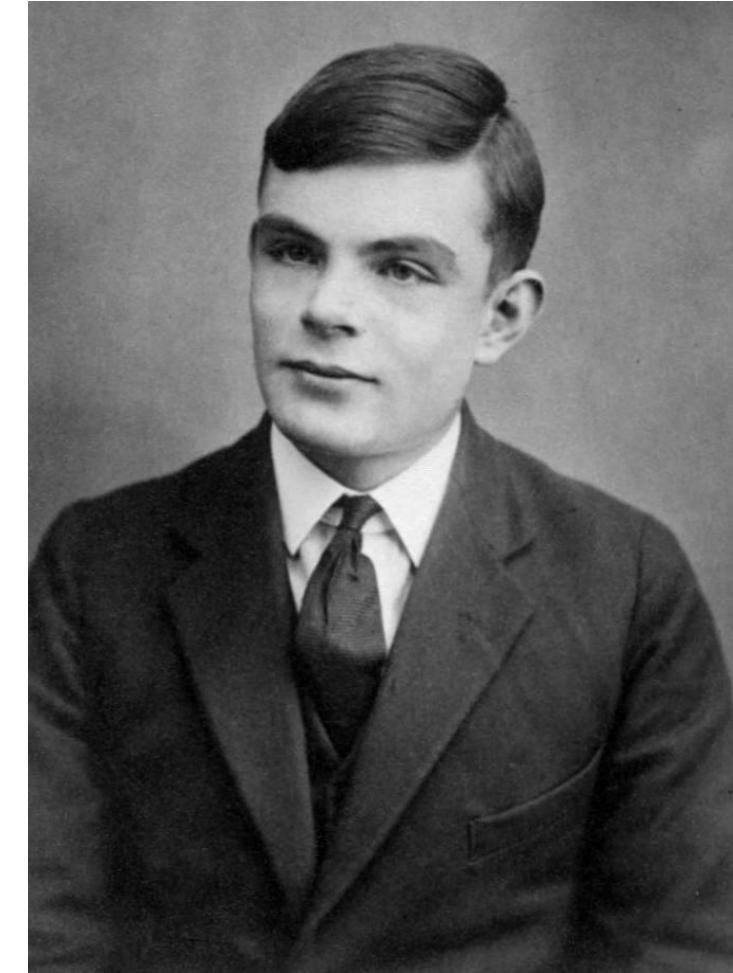
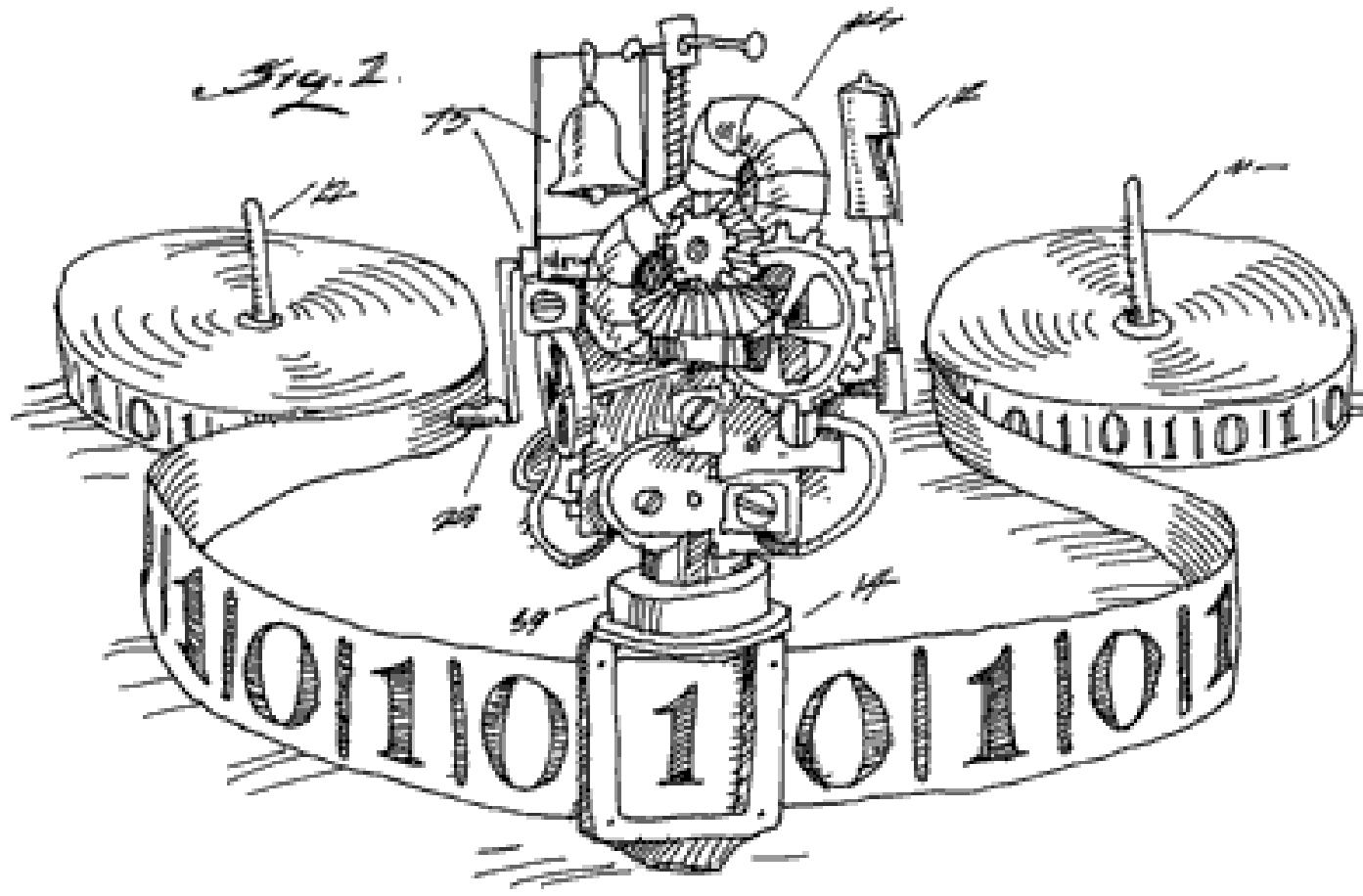


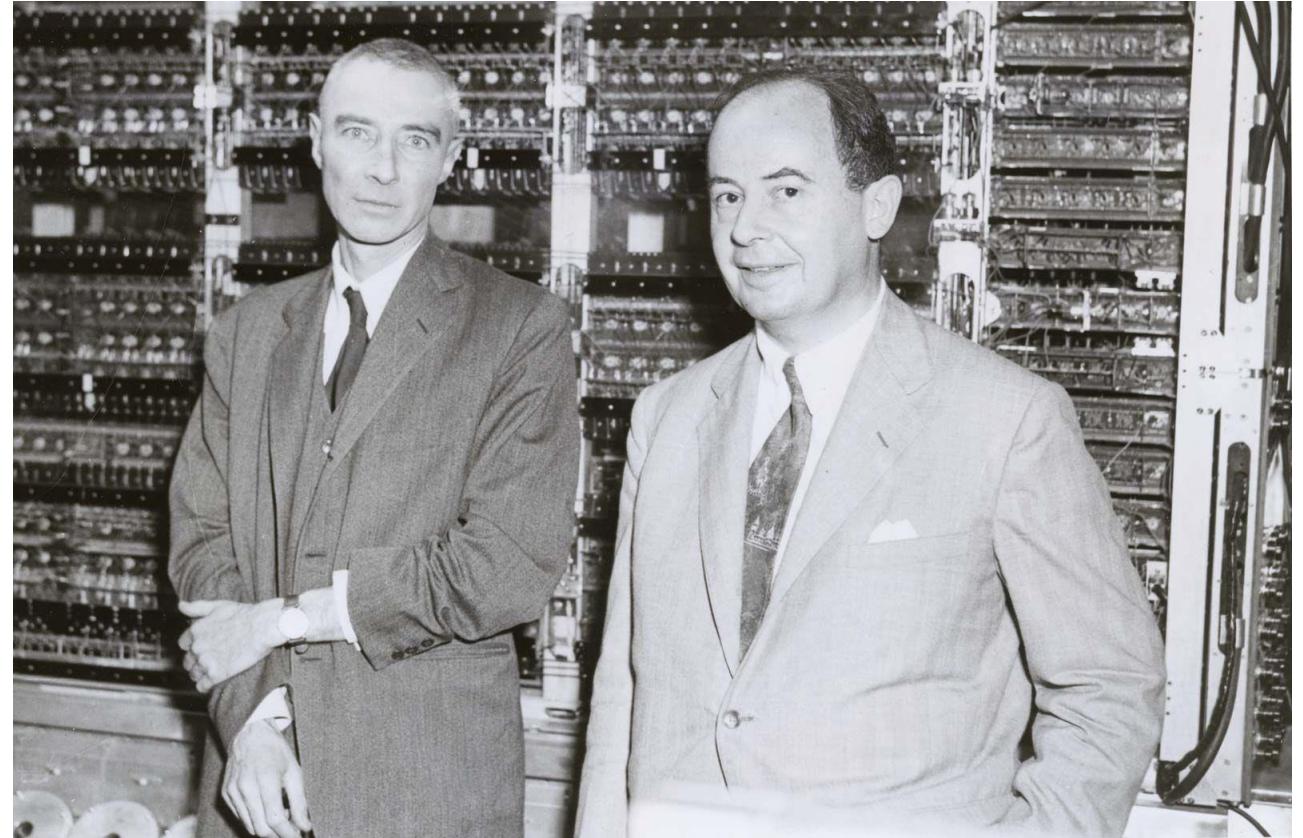
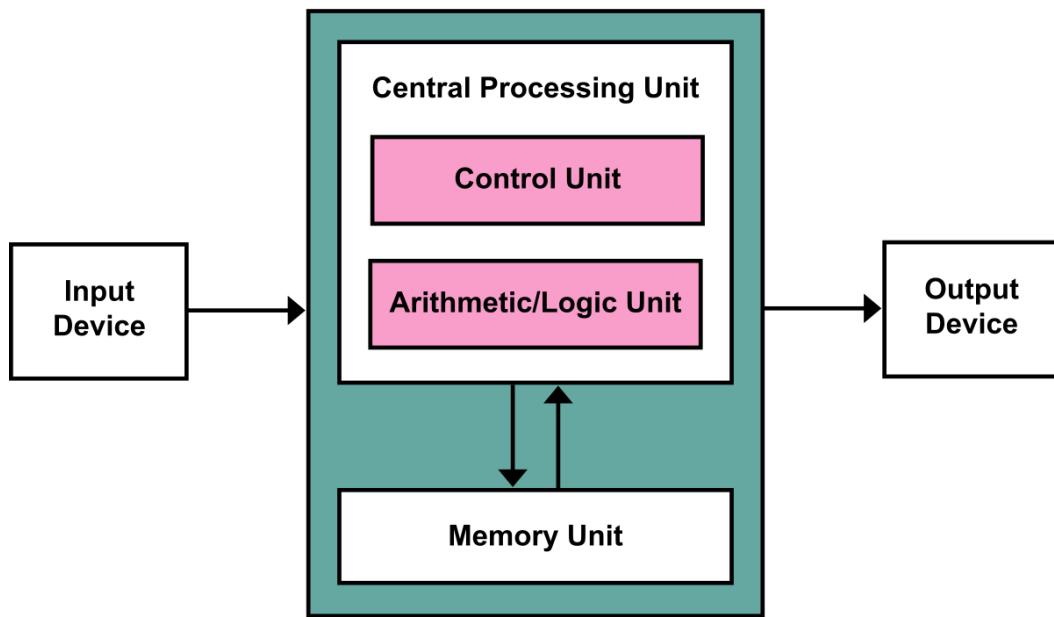


VO Machine Learning

VU Data Analysis II: Machine Learning for Data Analysis



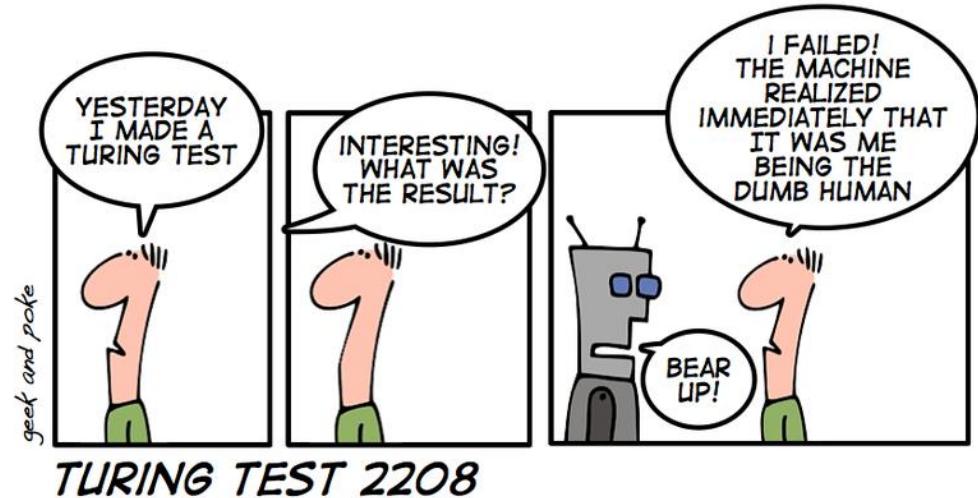
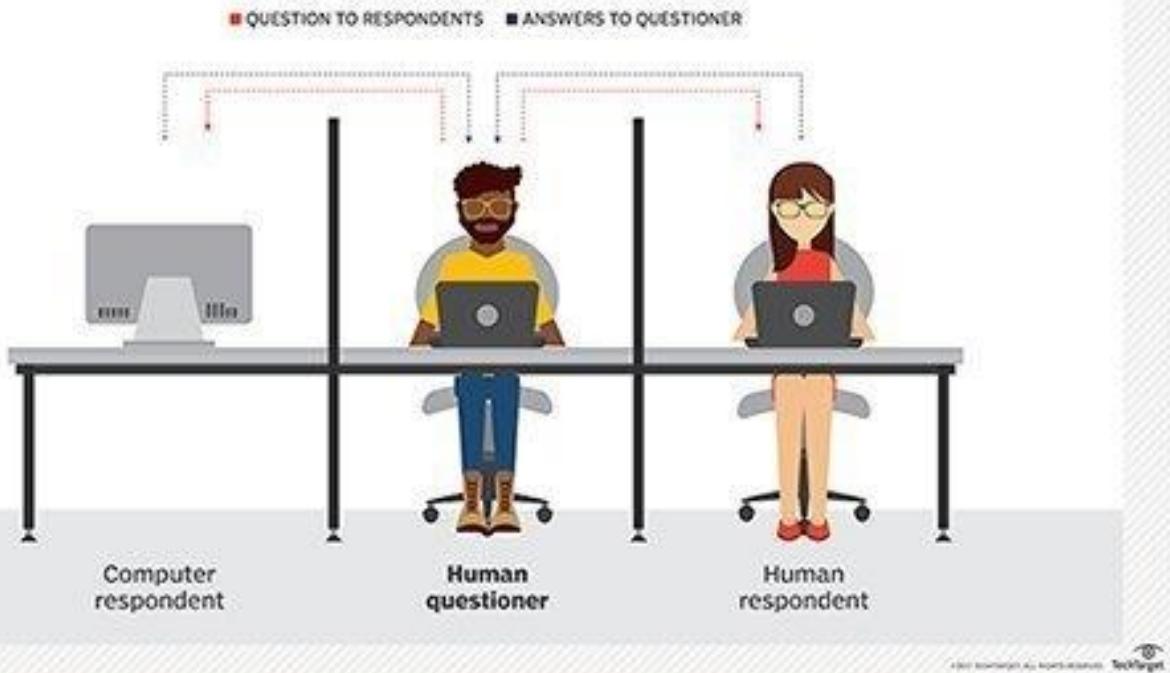
1939 – The Turing Machine



1945 - Von Neumann Architecture

Turing test

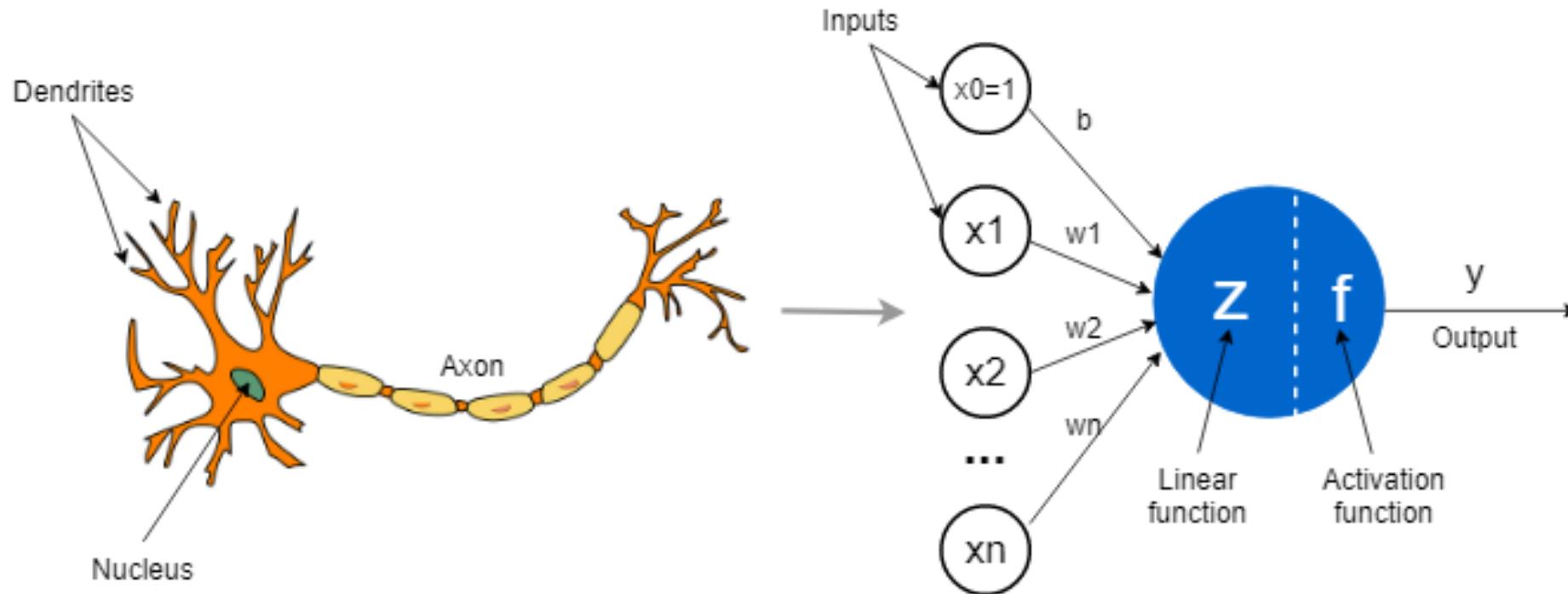
During the Turing test, the human questioner asks a series of questions to both respondents.
After the specified time, the questioner tries to decide which terminal is operated by the human respondent and which terminal is operated by the computer.



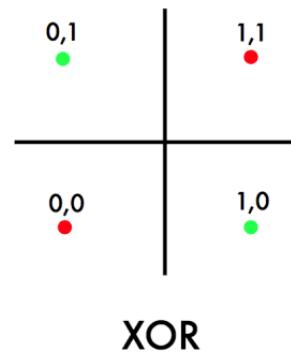
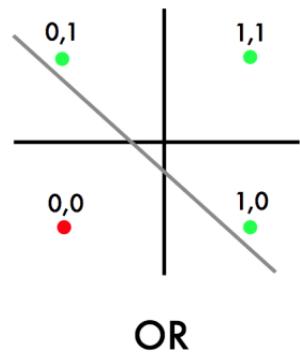
1950 – The Turing Test



1958 – First Implementation of the Perceptron (Rosenblatt)



First AI Winter: 1974-1980

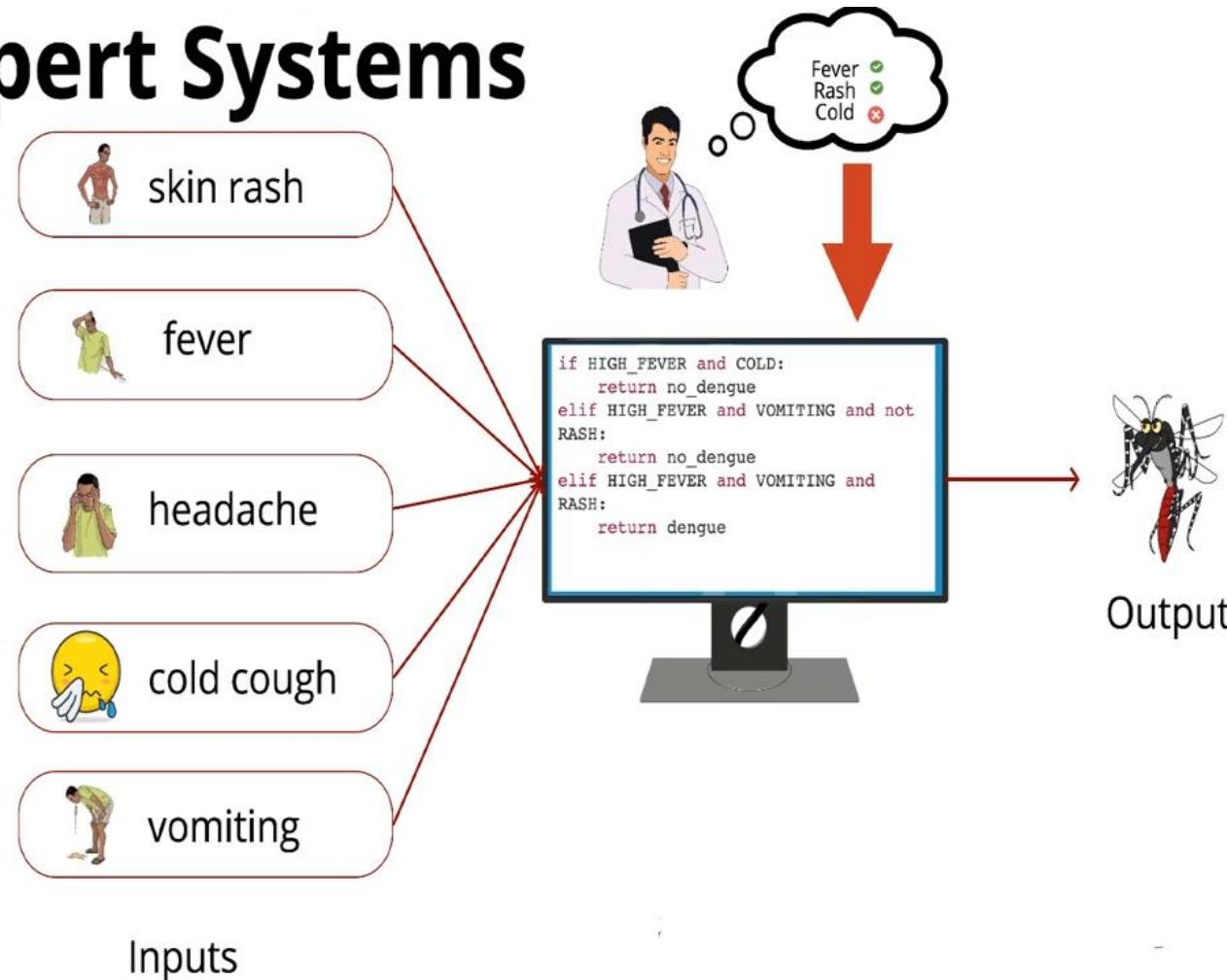


Minsky and Papert, 1969



Expert Systems: 1986-1994

Expert Systems



Second AI Winter: 1987-1994

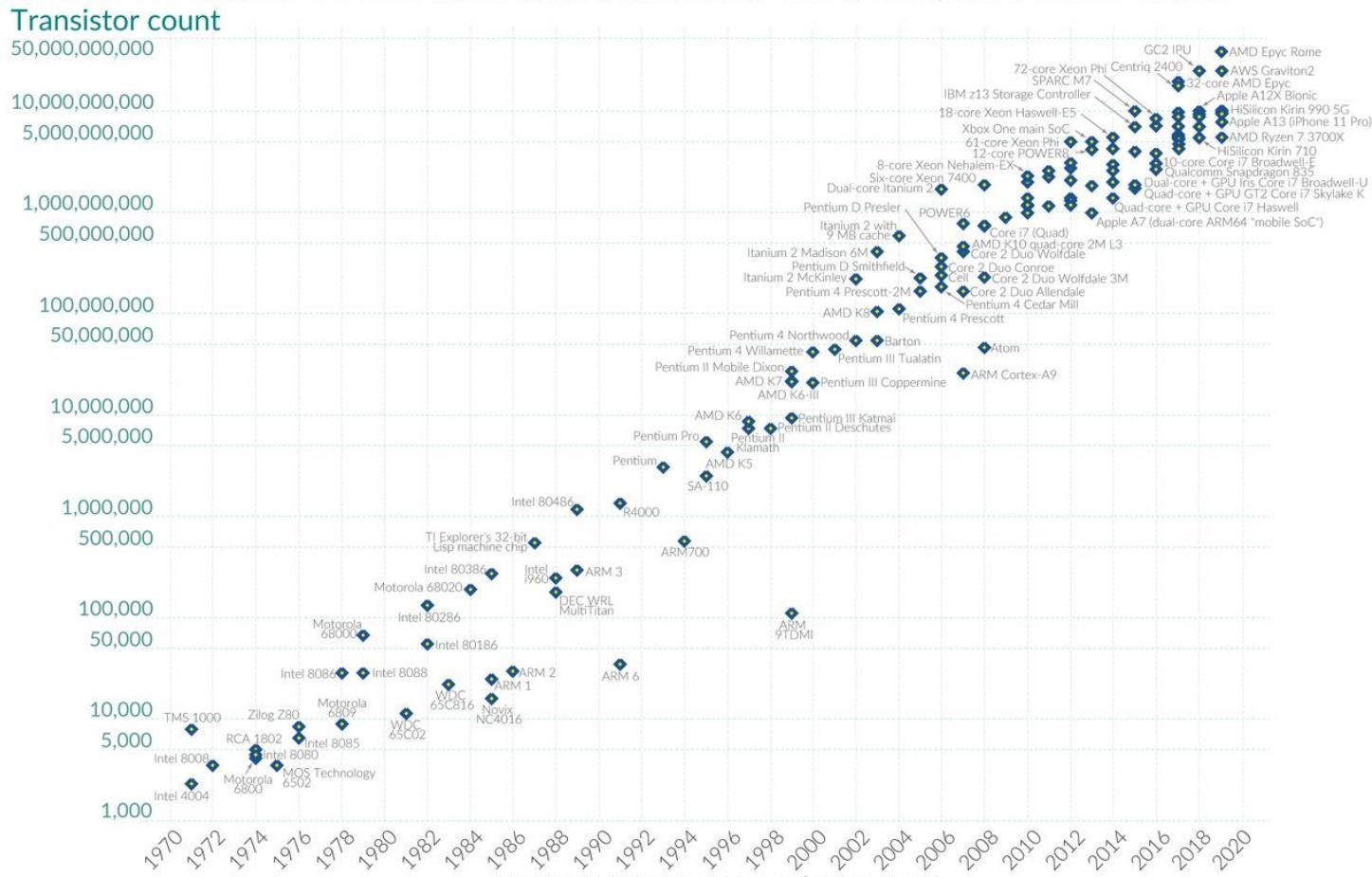
Limitation of expert systems led to a second AI winter.



New Hardware

Moore's Law: The number of transistors on microchips doubles every two years
Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years.
This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Our World
in Data

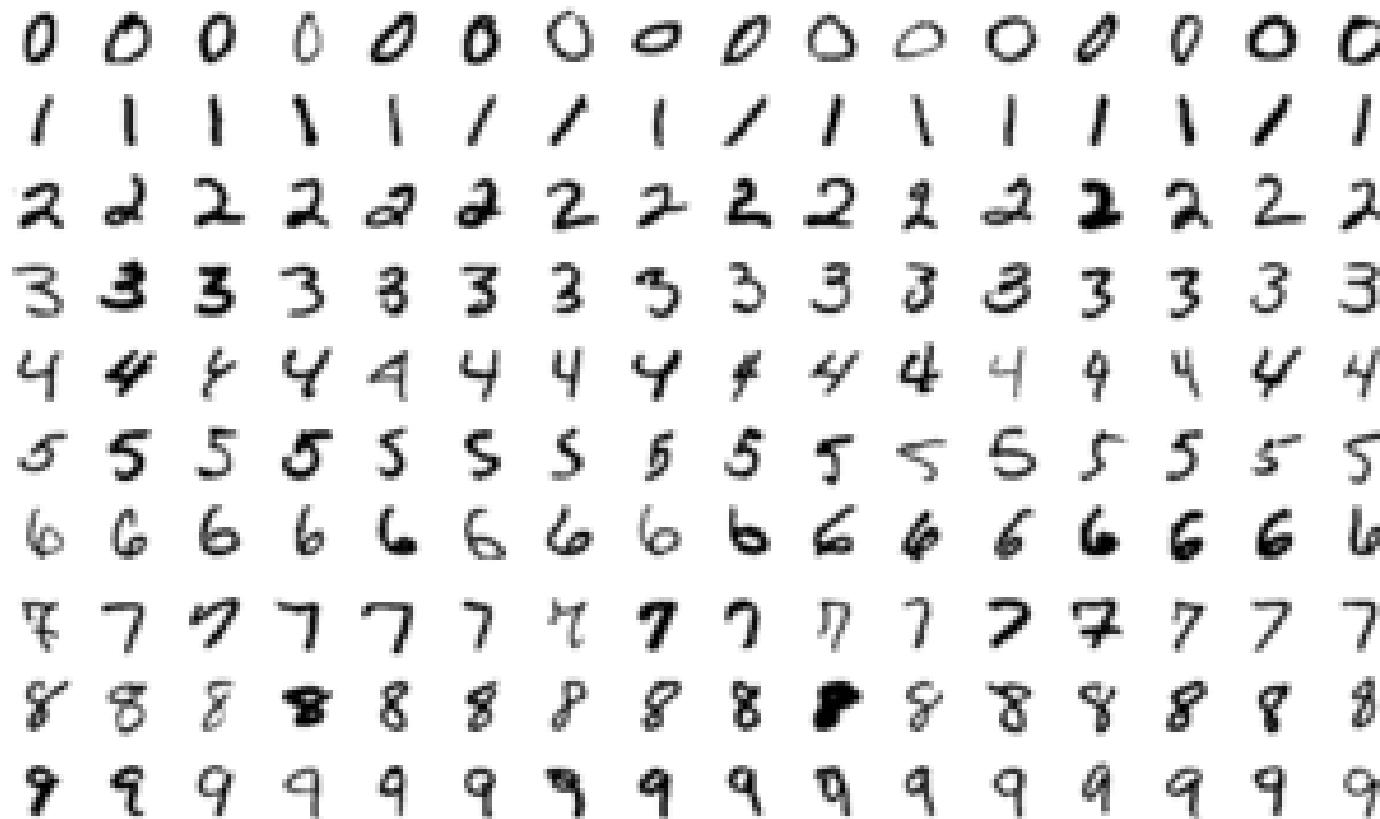


Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

An Expert System: DeepBlue, 1997



1998 The MNIST Dataset

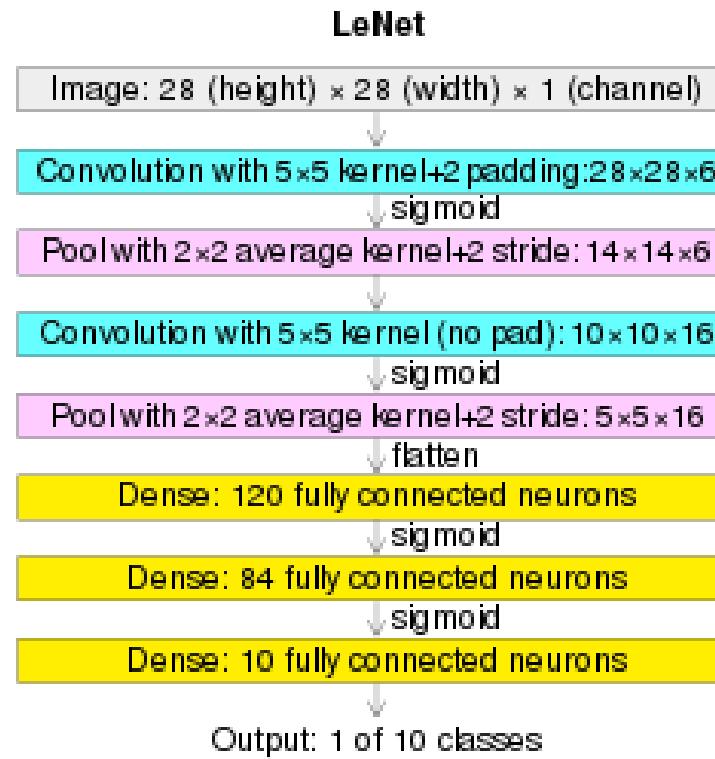


60.000 Images,
10 Classes,
16x16 Resolution

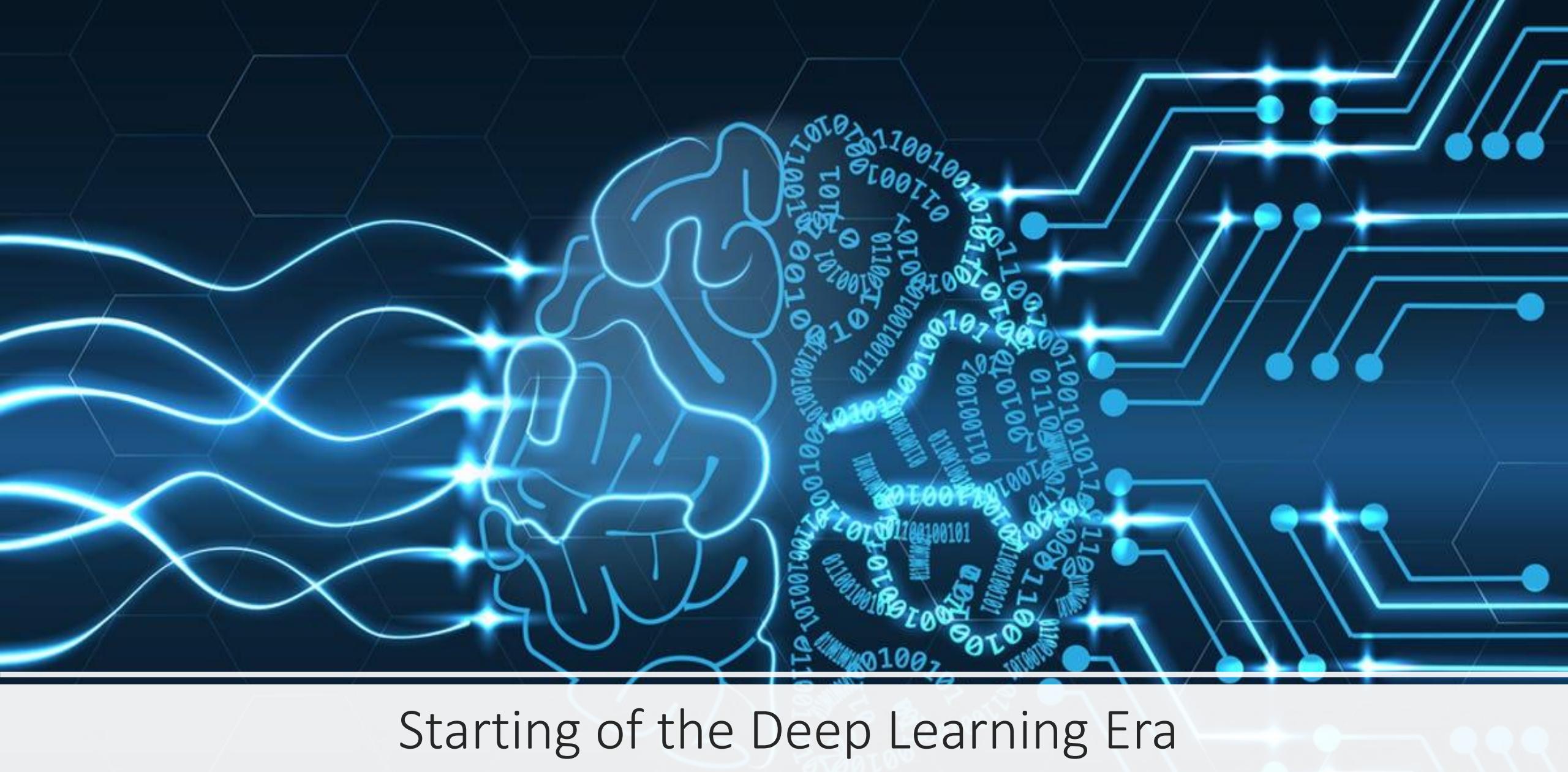
LeNet-5, A Convolutional Neural Network



Kunihiko Fukushima invented convolutional neural networks in 1980



Yan LeCun, first successful implementation of CNN in 1998, classifying handwritten ZIP codes fully automatically



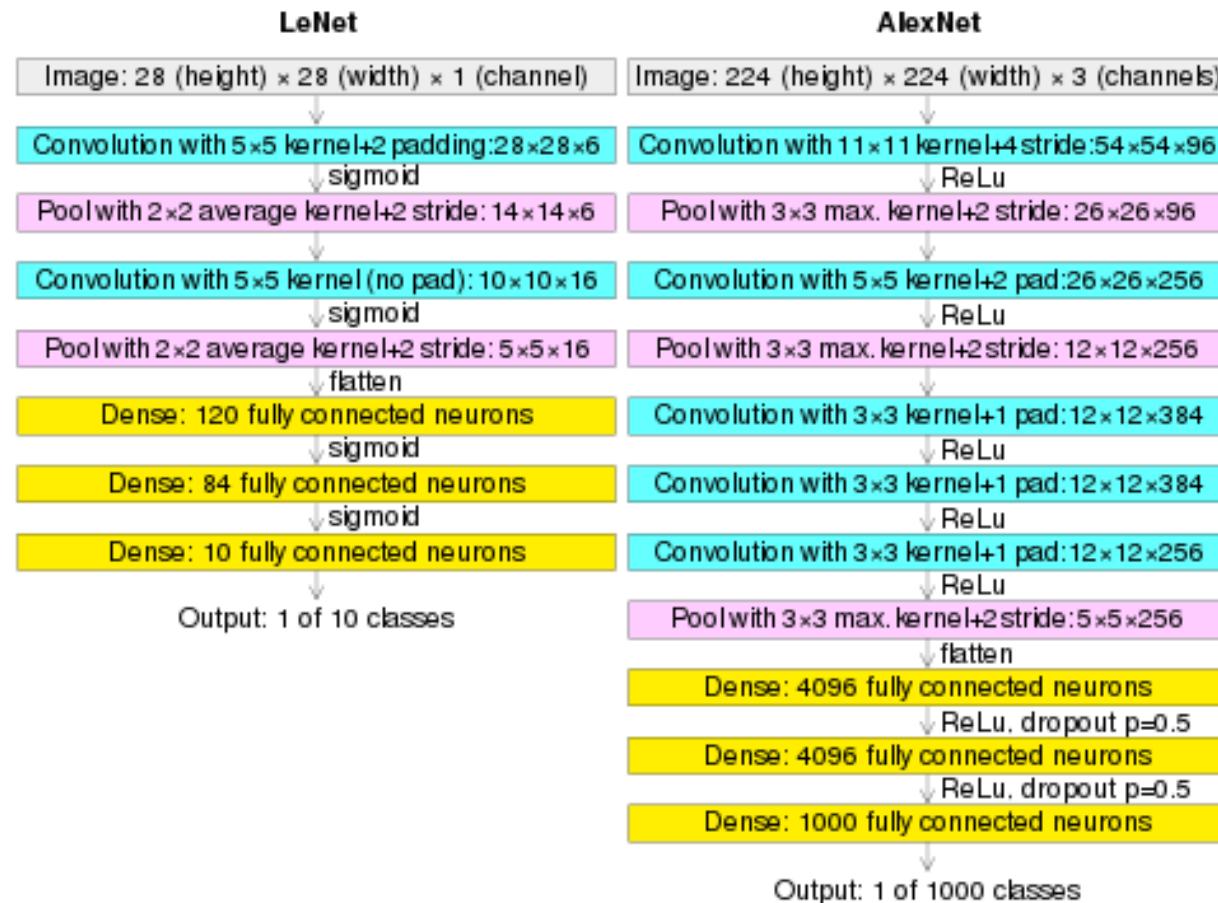
Starting of the Deep Learning Era

ImageNet

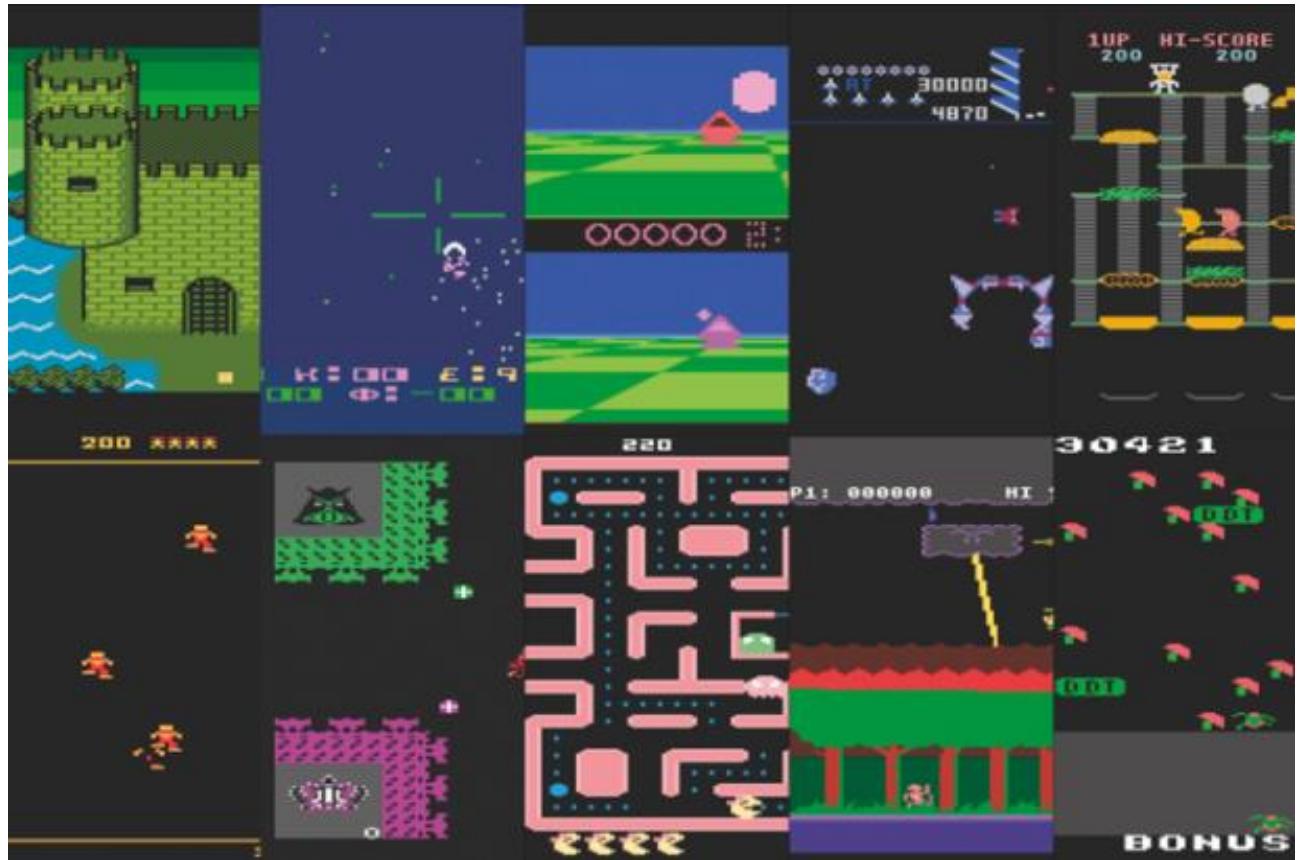


14.000.000 Images,
20.000 Classes

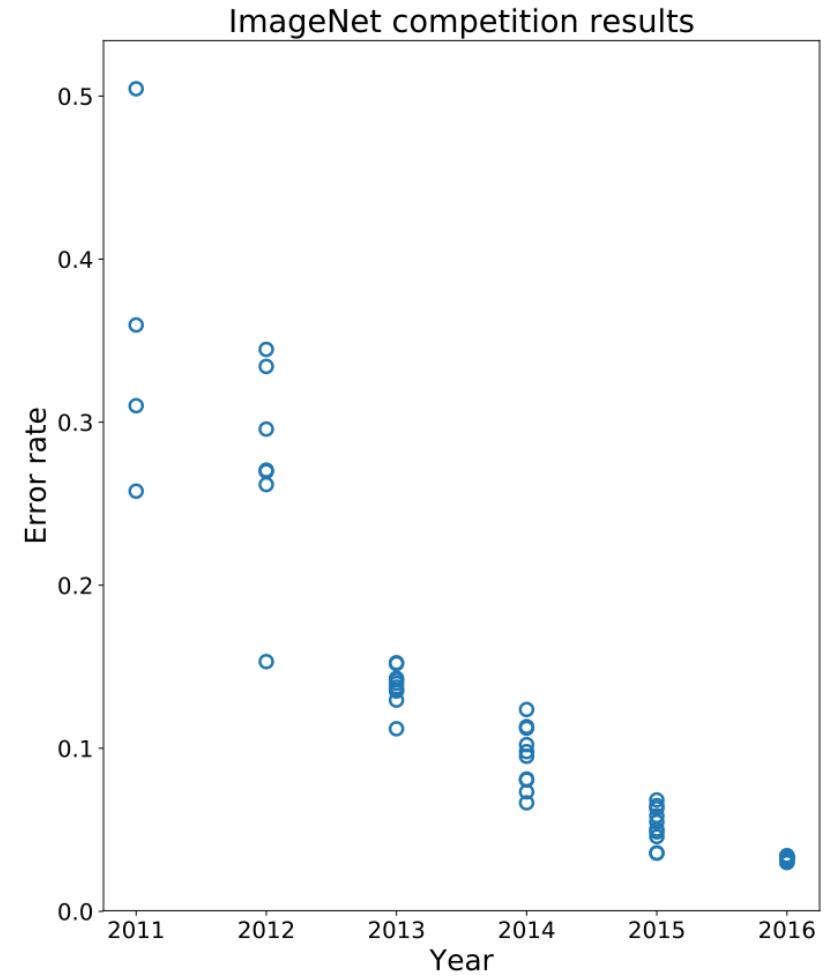
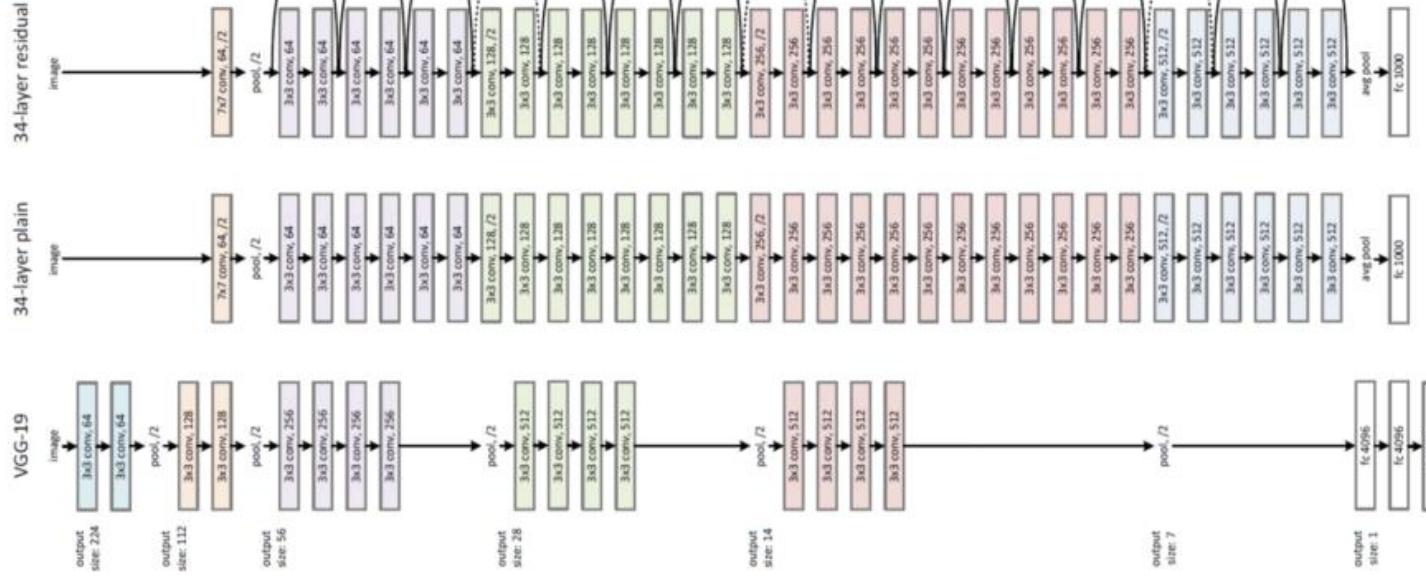
AlexNet, 2012

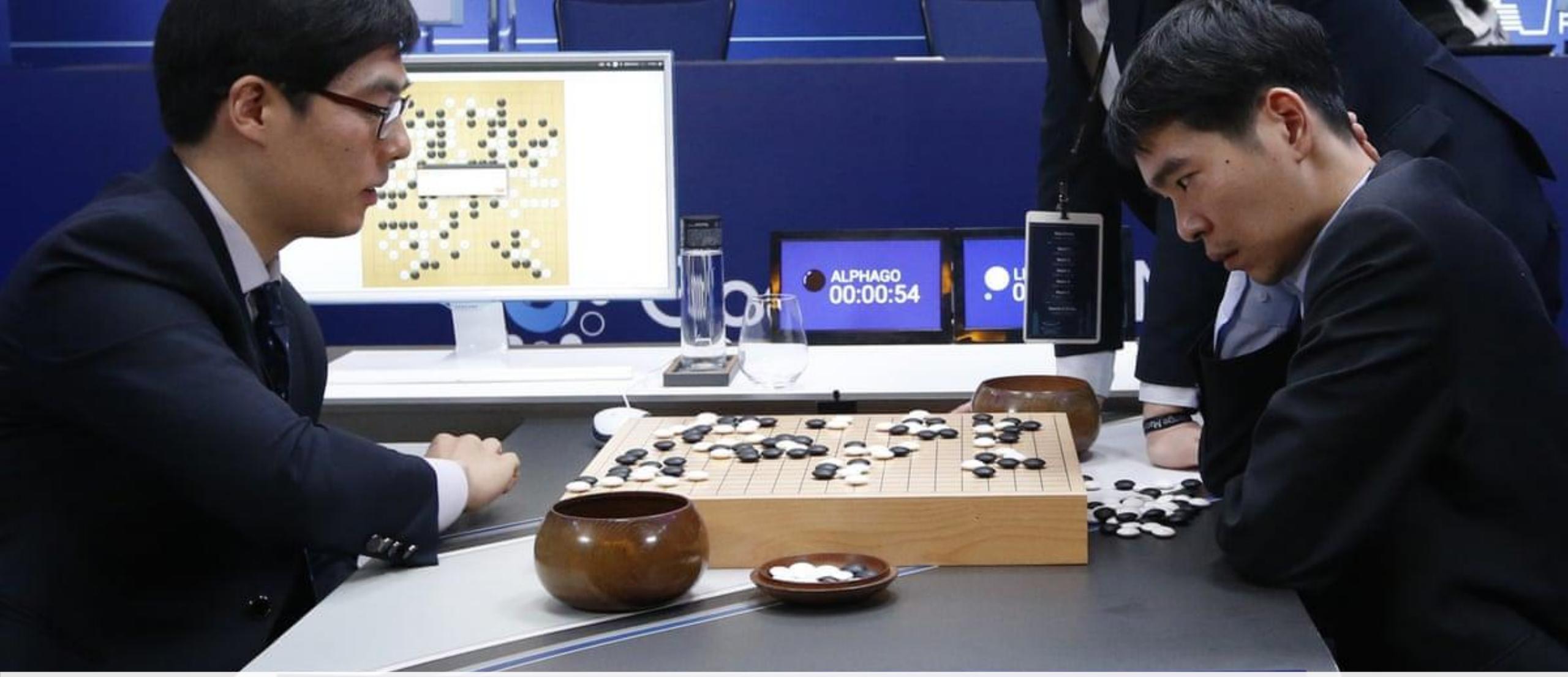


Deep Q-Learning, 2014



ResNet, 2015





AlphaGo Lee Sedol



VO Machine Learning

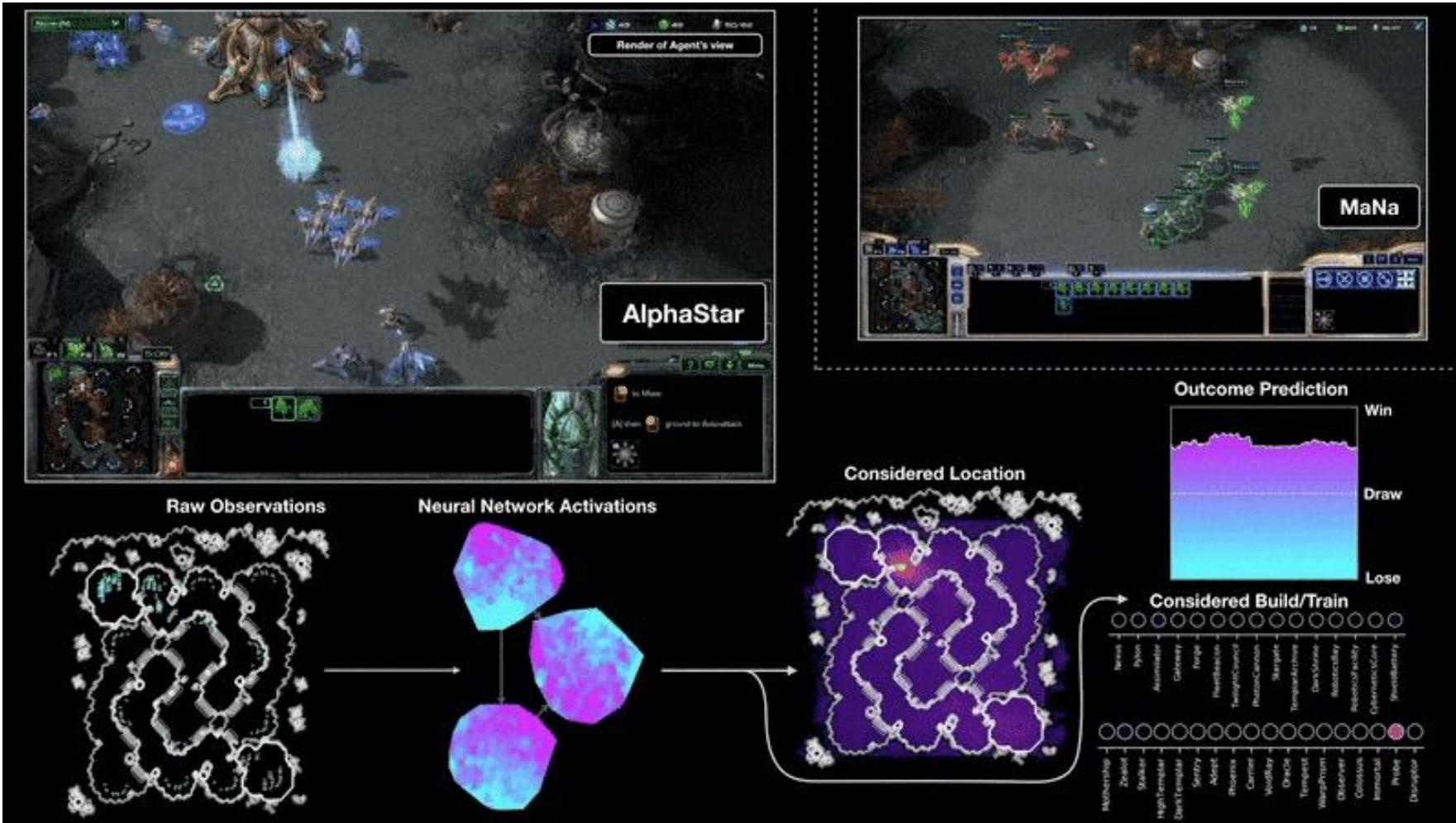


DeepFake Faces with Generative-Adversarial Neural Networks, 2017



On October 25, 2019, [Google](#) announced that they had started applying BERT models for [English language search queries](#) within the [US](#).^[18] On December 9, 2019, it was reported that BERT had been adopted by Google Search for over 70 languages.^[19] In October 2020, almost every single English-based query was processed by a BERT model

AlphaStar, 2019



GPT-3, 2020

Q: What is your favorite animal?

A: My favorite animal is a dog.

Q: Why?

A: Because dogs are loyal and friendly.

Q: What are two reasons that a dog might be in a bad mood?

A: Two reasons that a dog might be in a bad mood are if it is hungry or if it is hot.

Q: How many eyes does a giraffe have?

A: A giraffe has two eyes.

Q: How many legs does a frog have?

A: A frog has four legs.

Q: Are there any animals with three legs?

A: No, there are no animals with three legs.

Q: Why don't animals have three legs?

A: Animals don't have three legs because they would fall over.

DALL-E, 2021



DALL-E 2, 2022



Stable Diffusion, 2022



SA

Hi ChatGPT, could you briefly explain to my students why it is so important to learn Machine Learning?



Sure, I'd be happy to provide a brief explanation.



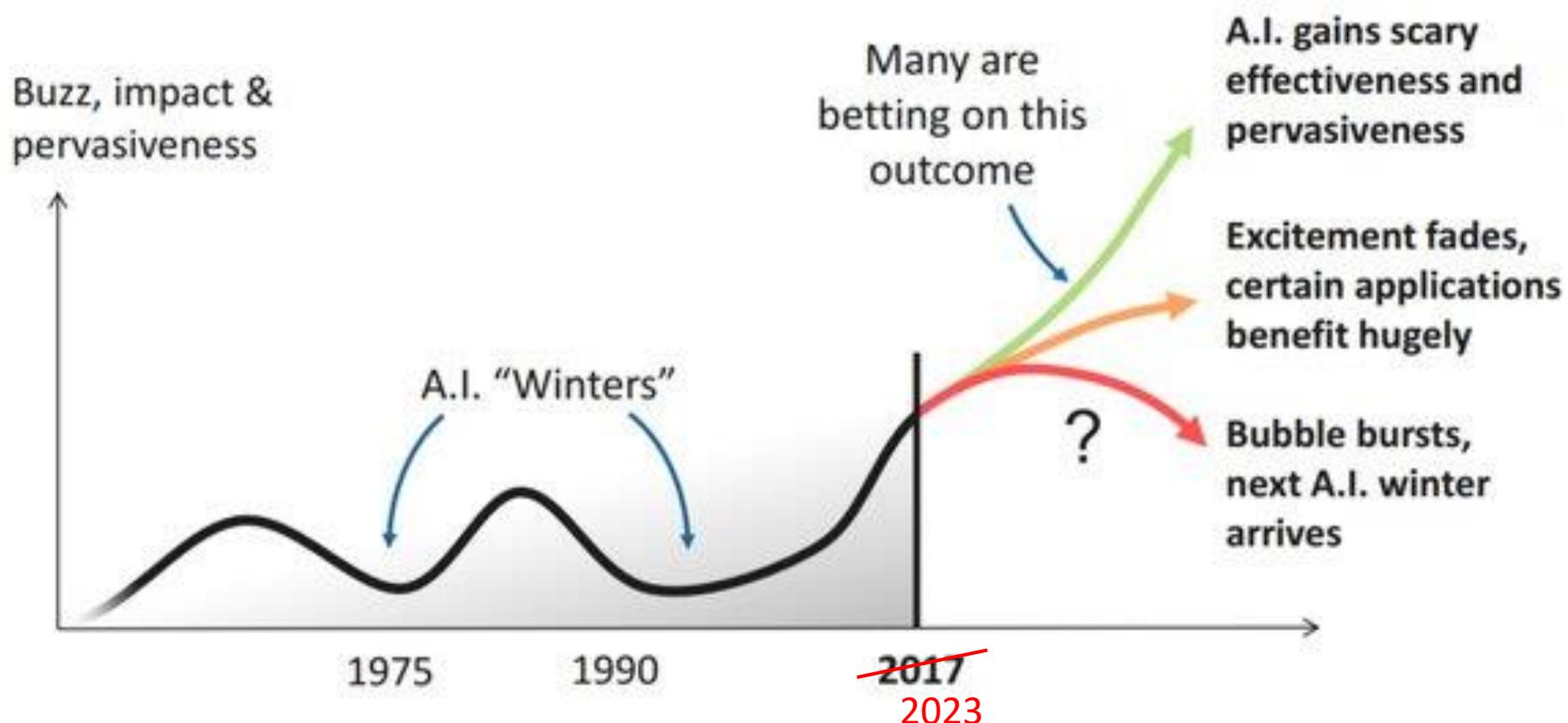
Machine learning is a field of study in computer science that involves teaching computers to learn from data and make predictions without being explicitly programmed. Learning about machine learning is important for several reasons:

1. Job opportunities: Machine learning is a highly in-demand skill in many industries, including healthcare, finance, marketing, and more. By learning about machine learning, students can open up a range of job opportunities for themselves in the future.
2. Improved decision-making: Machine learning can help individuals make better decisions by providing more accurate and reliable information. This is particularly useful in fields such as medicine and finance, where the consequences of a wrong decision can be significant.
3. Automation: Machine learning can automate repetitive tasks, such as data entry or image recognition, freeing up time for individuals to focus on more complex tasks.
4. Innovation: Machine learning has the potential to drive innovation by enabling new products and services that were previously impossible to create. For example, machine learning has been used to develop self-driving cars and virtual assistants.
5. Future preparation: As machine learning becomes increasingly important in various industries, learning about it can help prepare students for the jobs of the future.

Overall, learning about machine learning is important because it can provide students with valuable skills and knowledge that will be in high demand in the job market and prepare them for the challenges and opportunities of the future.

Where Are We Heading To?

AI is enjoying significant hype and investment



Gary Marcus

Claims that we are still far from reaching Artificial General Intelligence due to a lack of proper reasoning ability of current technologies



Richard Sutton

Says that Artificial General Intelligence is reachable with a 25% probability in 2030.



“The search for AGI is the search for the holy grail of science: much more like the discoveries of Einstein, Darwin, Newton, Copernicus, or Watson and Crick, and less like the contributions of Guttenberg, Edison, Babbage, Page and Grin.”

“The discovery of artificial general intelligence is an event comparable with the raise of life on Earth.”

Machine Learning Engineer Salaries Based on Top Companies

Google - \$148,296

Facebook - \$192,240

Amazon - \$254,898

Reddit - \$227,000

Apple - \$179,839

Uber - \$149,590

LinkedIn - \$163,808

Goldman Sachs - \$196,450



ProjectPro



What Will We Study in This Course?

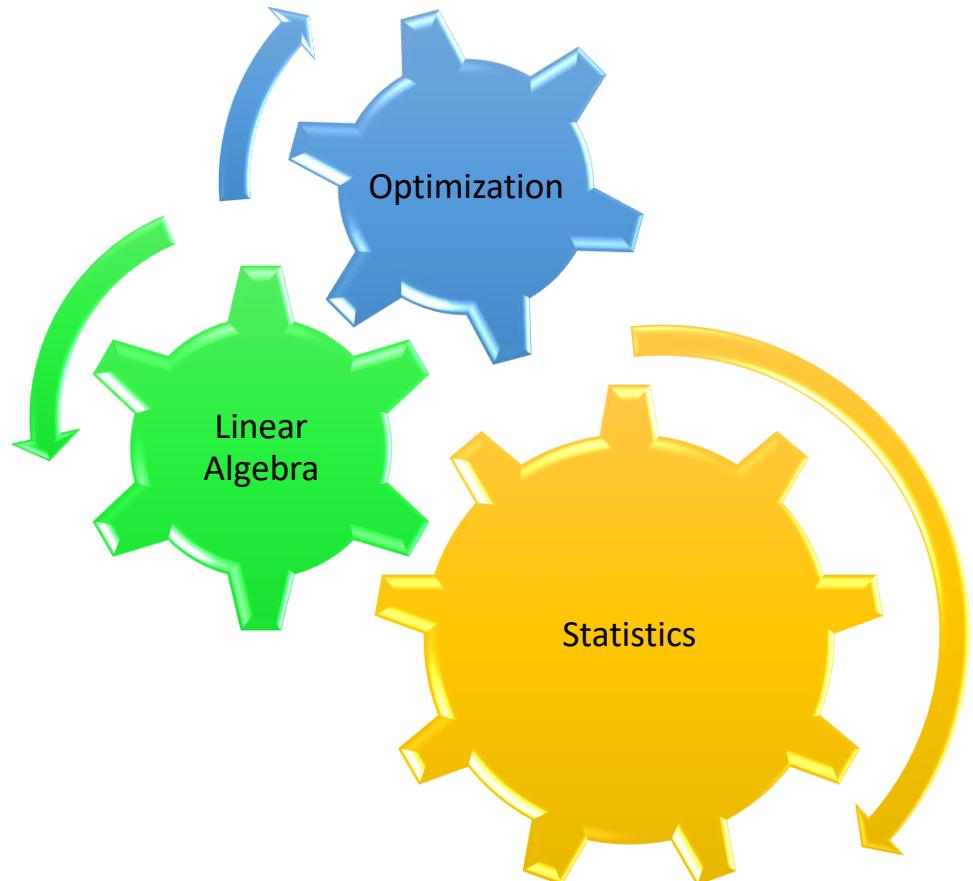
- The foundation of machine learning.
- We will see classic machine learning methods and understand the ideas behind them.
- This is necessary to understand more complex and state-of-the-art deep learning methods.



Only once you
will have solid
foundations
you'll be able
to build
skyscrapers!



Ingredients of Machine Learning



This course will be hard!

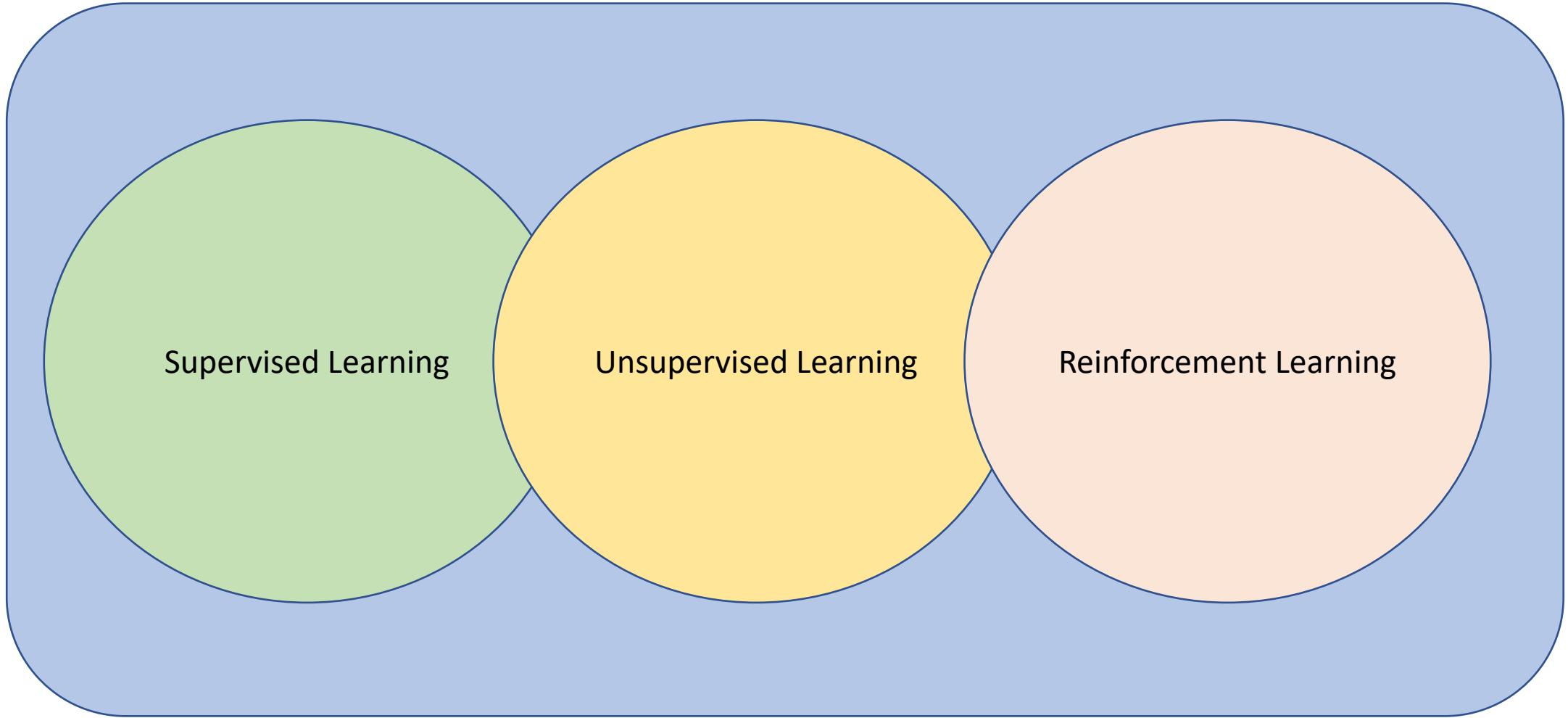
There is no way to explain machine learning without using math and statistics!

The exercises will also involve programming and require knowledge of python!

Yes, but What Is Machine Learning?

Machine learning is a field of inquiry devoted to understanding and building methods that "learn" – that is, methods that leverage data to improve performance on some set of tasks. It is seen as a part of artificial intelligence. (Wikipedia)

Machine Learning



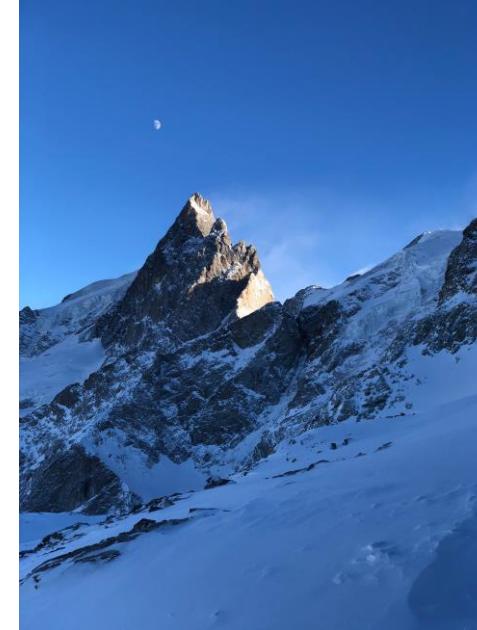
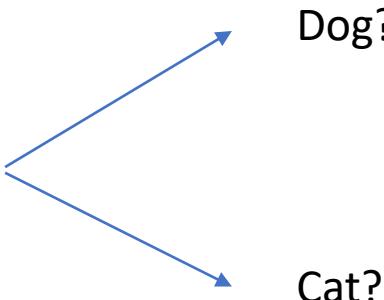
Machine Learning

- Supervised learning:
 - Learn to map an input x to an output y
 - Classification if y is discrete (e.g., ‘cat’ vs ‘dog’)
 - Regression if y is continuous (i.e., it is numerical)
- Unsupervised learning:
 - Generative model (e.g., generation of images or text)
 - Density estimation (i.e., what is the probability of an image)
 - Clustering (e.g., group together similar objects, like ‘cats’ with ‘cats’ and ‘dogs’ with ‘dogs’)
- Reinforcement learning:
 - An agent interacts with an environment and after observing it, needs to find the action that maximizes a reward signal

Supervised Learning

Learn to map an input x to an output y

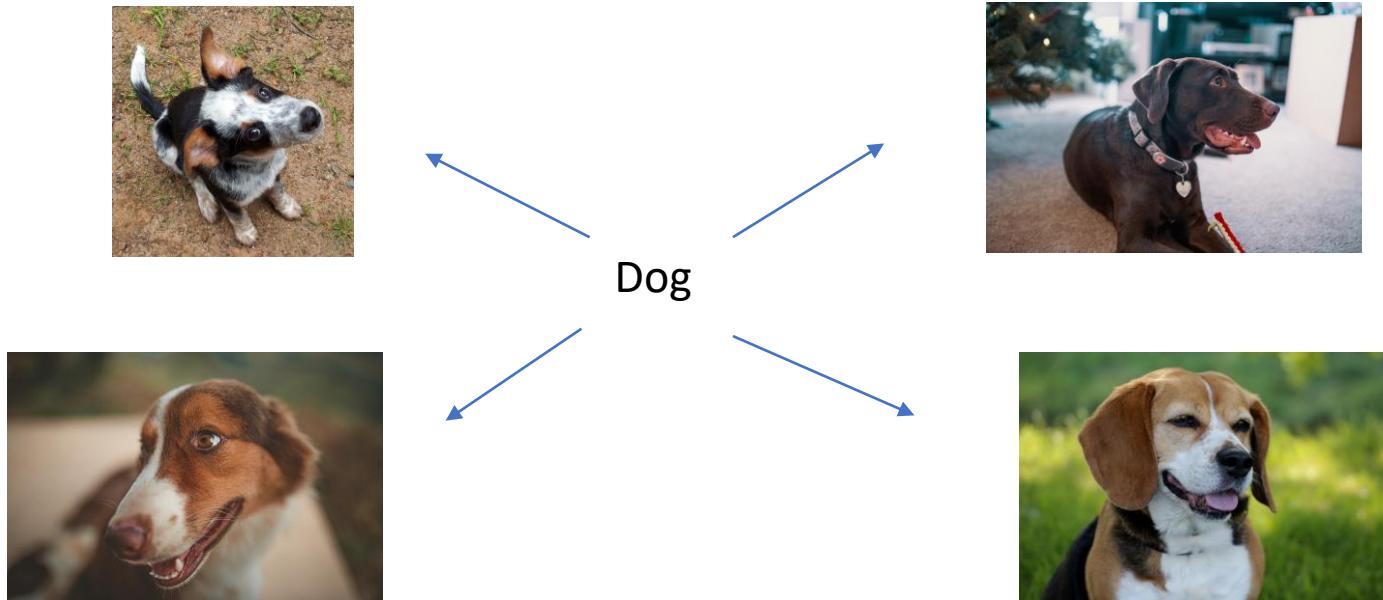
- Classification if y is discrete (e.g., ‘cat’ vs ‘dog’)
- Regression if y is continuous (i.e., it is numerical)



→ % Risk Avalanches

Unsupervised Learning

- Generative model (e.g., generation of images or text)
- Density estimation (i.e., what is the probability of an image)
- Clustering (e.g., group together similar objects, like ‘cats’ with ‘cats’ and ‘dogs’ with ‘dogs’)



Reinforcement Learning

An agent interacts with an environment and after observing it, needs to find the action that maximizes a reward signal

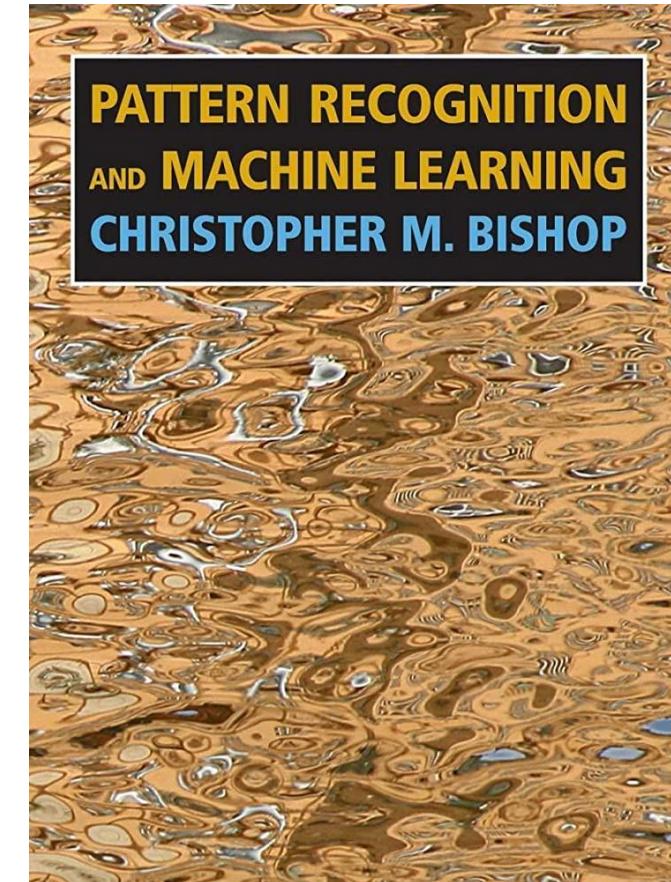


Tentative Schedule

1. 07.03 Introduction
2. 14.03 Statistical Estimators
3. 21.03 Linear Regression and Logistic Regression
4. 28.03 Regression and Classification with Neural Networks
5. 18.04 Overfitting and Generalization
6. 25.04 Unsupervised ML I (PCA)
7. 02.05 Unsupervised ML II (Clustering)
8. 09.05 Unsupervised ML III (Gaussian Mixture Models)
9. 16.05 Nonparametric Density Estimation and Regression
- 10. 23.05 Midterm! <- Final for VU Data analysis**
11. 30.05 Reinforcement Learning I: BlackBox Optimizers
12. 06.06 Reinforcement Learning II: Policy Evaluation
13. 13.06 Reinforcement Learning III: Policy Improvement
14. 20.06 Exam Simulation and Questions
- 15. 27.06 Final Exam!**

Material

- Pattern Recognition and Machine Learning, Christopher Bishop

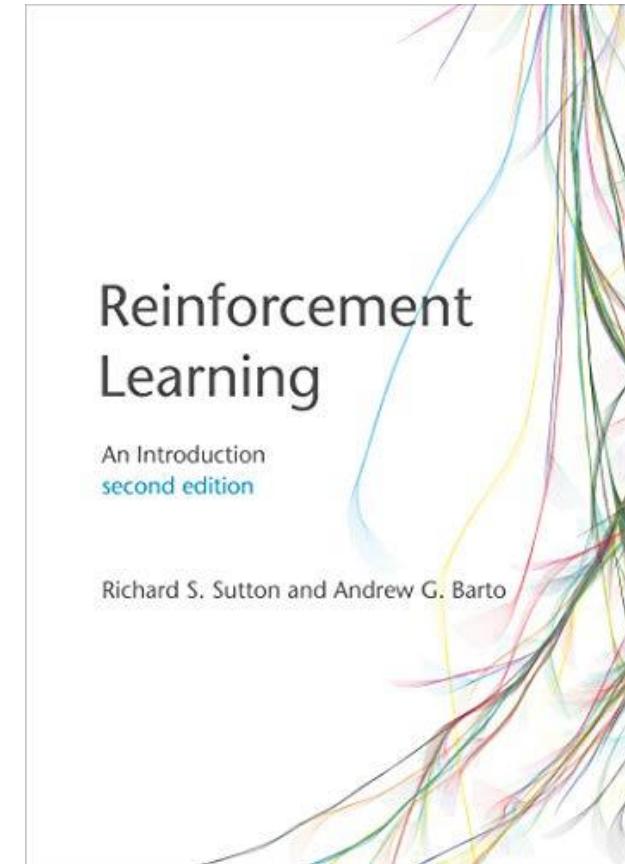


Material

- OLAT (slides, announcements)
 - VO Machine Learning:
 - PS Machine Learning:
 - VU Data Analysis II:
- Students from the Minor Digital Science (VU Data Analysis II) should follow VO and PS Machine learning on OLAT for the slides and exercises

Material

- Reinforcement Learning, An Introduction. (Sutton and Barto, Second Edition)



Why Study on Books?

- Books are written by world-level experts on the topic!
 - For this reason, they are the best source to study a topic.
- Reading scientific/technical literature is not always easy, but it is a skill that a university student must acquire.
- The suggested books are available at the library.

- Opposed to that, slides are not good material for studying.

VO Machine Learning and VU Data Analysis II



Samuele Tosatto

Office: 3N07 (ICT)

Office Hours: Thursday 14.00 – 17.00

Email: samuele.tosatto@uibk.ac.at

Hours:

VO Machine Learning: Tue 13.15-16.00 HS A

VU Data Analysis (Exercises): Wed 9.15-11.00 Online: <https://webconference.uibk.ac.at/b/sam-4cw-mj5-tji>

PS Machine Learning Group 1 and 2



Jakob Hollenstein

Office: 2W02 (ICT)

Email: jakob.hollenstein@uibk.ac.at

Hours:

Group 1: Wed 8.15-10.00

Group 2: Wed 10.15-12.00

PS Machine Learning Group 3 and 4



Sayantan Auddy

Office: 2M01 (ICT)

Email: sayantan.auddy@uibk.ac.at

Hours:

Group 3: Wed 12.15-14.00, rr 20

Group 4: Wed 14.15-16.00, rr 20

PS Machine Learning Group 5



Danielle McKenney

Email: danielle.mckenney@student.uibk.ac.at

Hours:

Group 3: Wed 12.15-14.00, rr 15

PS Machine Learning Group 6



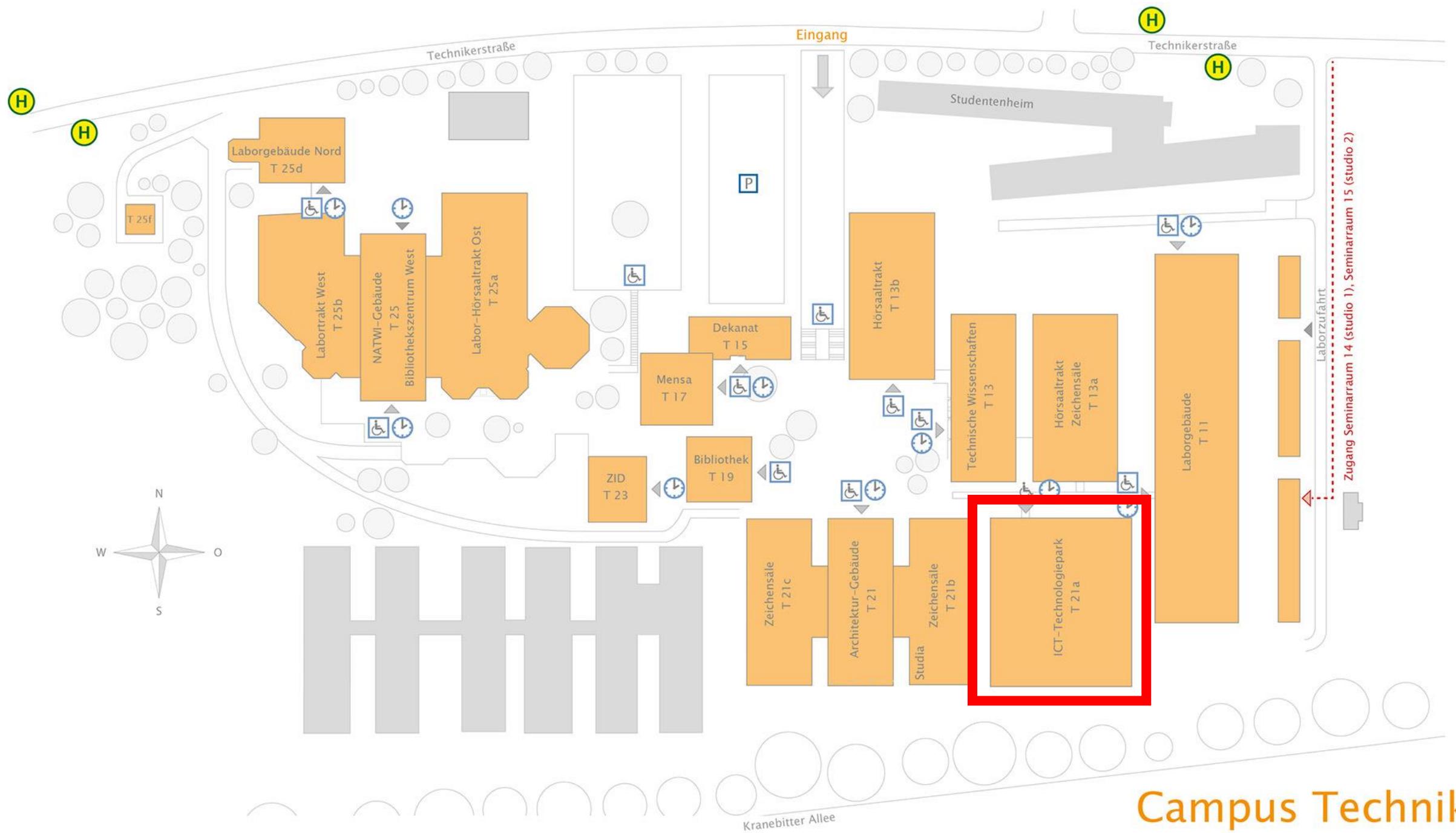
David Drexel

Office: 2M01 (ICT)

Email: david.drexel@uibk.ac.at

Hours:

Group 3: Wed 14.15-16.00, rr 15





Grading

- For VO Machine Learning:
 - 50% for the midterm
 - 50% points for the final exam
- For VU Data Analysis II
 - 50% points for the exam
 - 50% points for programming exercises



Interactive Class

- I need feedback from you!
 - I will ask questions to check your understanding of the topic and to engage you → Don't be shy; there are no stupid answers
 - I am glad when you ask questions → Don't be shy; there are no stupid questions!
 - Use the opportunity of being in presence to make the lecture interactive. Understanding the concept in class will save you time
 - Our goal is that you learn the subject – grades are secondary!
-

Our Group



How can robots acquire the knowledge and understanding required to interact sensibly with unstructured environments?

Machine Learning

Reinforcement Learning

Robotics

Intelligent and Interactive Systems

Making robots learn to perceive and act with understanding

At IIS we enable autonomous robots to perceive and act flexibly and robustly in unstructured environments, leveraging machine learning methods to build perceptual, motor and reasoning skills.

We seek to answer the question: *How can we enable robots to acquire the knowledge and understanding they require to interact sensibly with unstructured environments?*

Our research addresses complete perception-action loops, from computer vision to grasping and manipulation, using reactive algorithms and/or cognitive models. Much of our work uses machine learning to enable robots to synthesize and improve complex and robust sensorimotor behavior with experience. Related areas of interest include human-robot interaction, image and video analysis, and visual neuroscience.

Working With Us

- We may accept up to two Ph.D. students via the ELLIS PhD Program, to start during the second half of 2023. [Apply by 2022-11-15](#).
- Check our thesis topics for [Bachelor and Master students](#).

start

Table of Contents

- ❖ Intelligent and Interactive Systems
- ❖ Working With Us
- ❖ News
- ❖ Postal Address



Further References

AlphaGo Documentary: https://www.youtube.com/watch?v=WXuK6gekU1Y&ab_channel=DeepMind

History of Machine Learning: https://www.youtube.com/watch?v=m_nQM_AkVfY&ab_channel=KrishNaik

Codex (GPT): https://www.youtube.com/watch?v=Zm9B-DvwOgw&ab_channel=OpenAI (don't use it for the exercises!)

AGI Debate (Montreal.ai): https://www.youtube.com/watch?v=JGiLz_Jx9uI&ab_channel=Montreal.AI

Sutton's Tea Time Talk 2022 (until min 8):

https://www.youtube.com/watch?v=iS7dRTge8Z8&t=198s&ab_channel=AmiiIntelligence