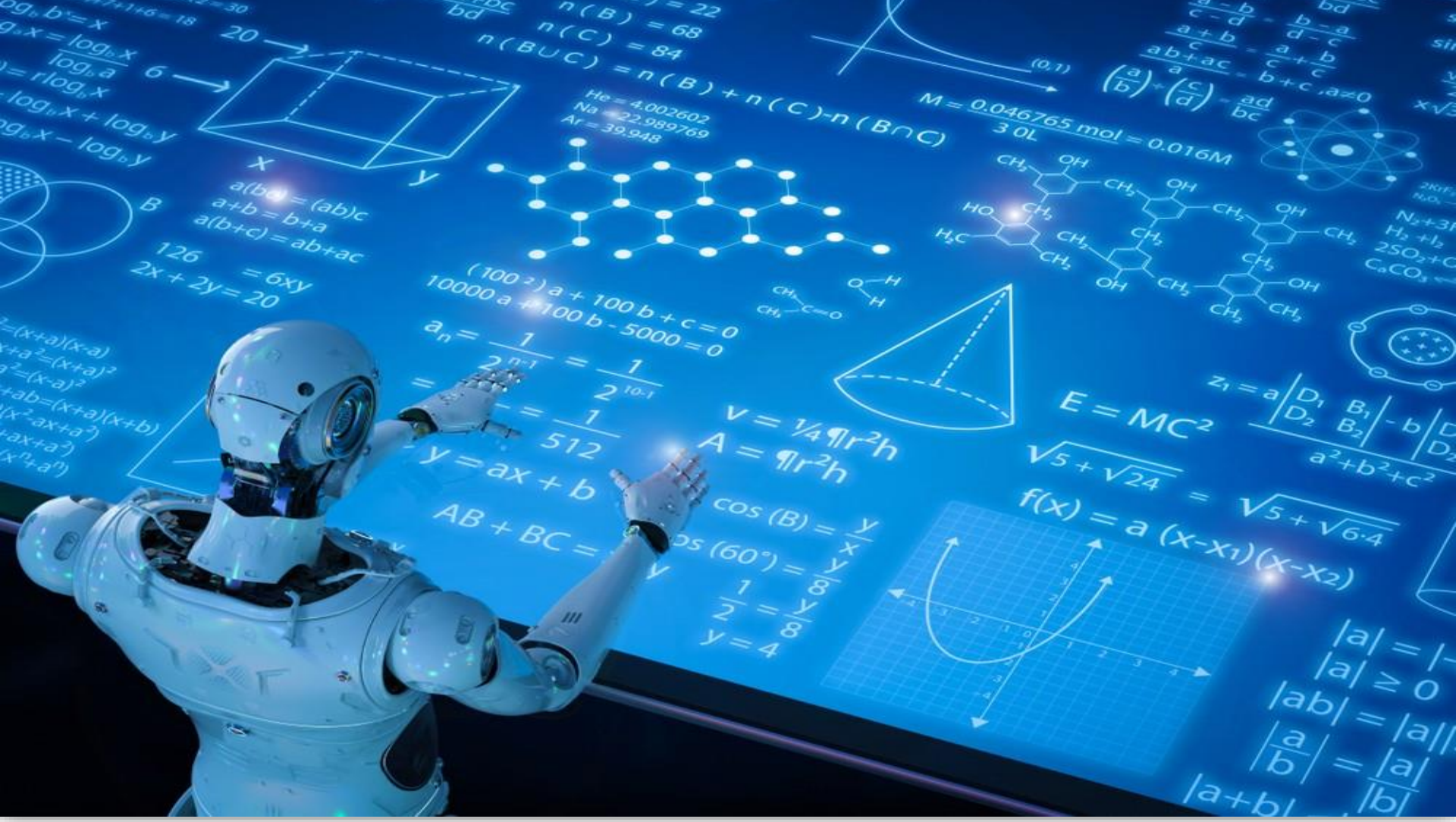

# *Machine Learning*

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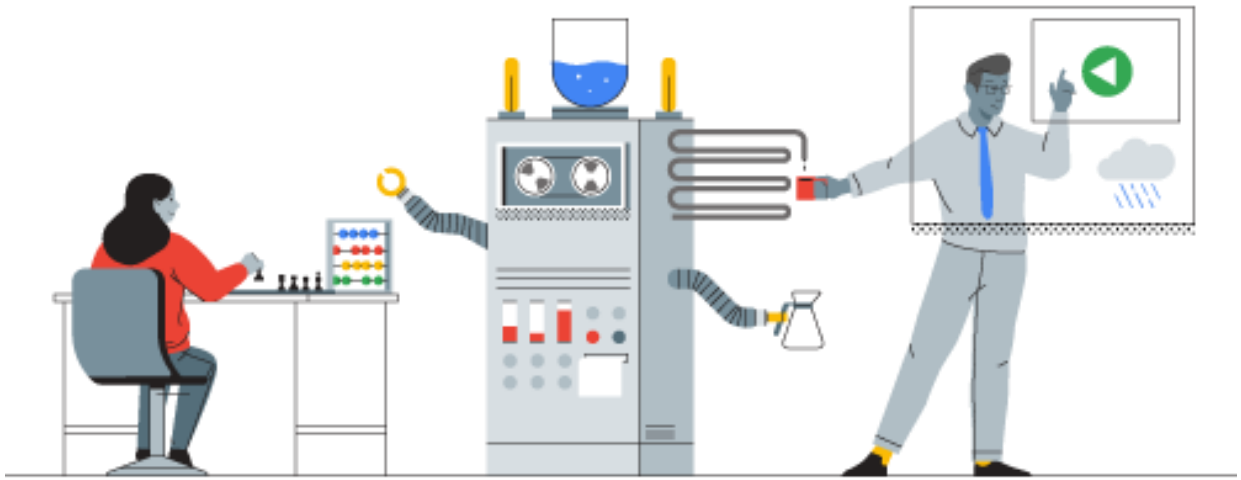
Asst. Professor
Computer Science and Engineering
Sejong University
Fall, 2020

# Outline

- **Overview of Machine Learning (ML)**
- **The History of ML**

# The History of Machine Learning



# Contributors

- **Philosophy**
  - Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality.
- **Mathematics**
  - Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability, probability.
- **Economics**
  - Utility, decision theory, rational economic agents
- **Neuroscience**
  - Neurons as information processing units.
- **Psychology**
  - How do people behave, perceive, process Cognitive Science information, represent knowledge.
- **Computer**
  - Building fast computers engineering
- **Control theory**
  - Design systems that maximize an objective function over time
- **Linguistics**
  - Knowledge representation, grammar

# Pascaline

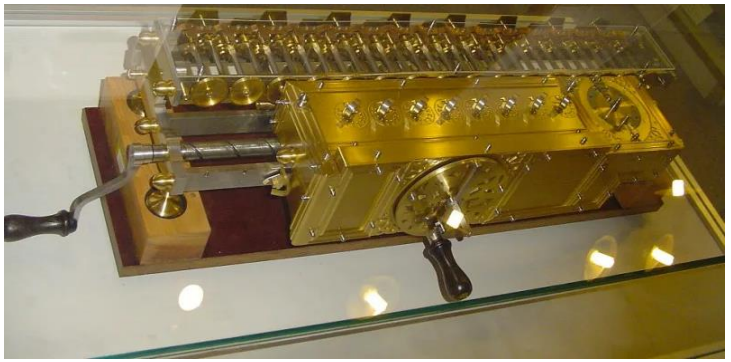
1642

- Pascal built an **Adding Machine**
- The first **calculator**

# Calculator

1694

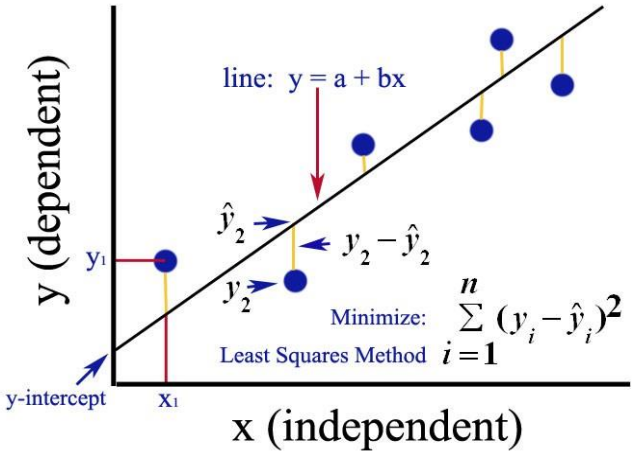
- Leibnitz **Reckoning Machine** (**Calculator**)



# Calculator

**1805**

- Adrien-Marie Legendre developed the **Calculator** for data fitting.



# Bayes' Theorem

1812

- Thomas Bayes defined **Bayes' Theorem**.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Posterior

Likelihood

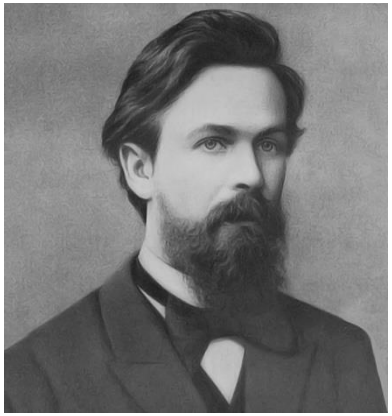
Prior

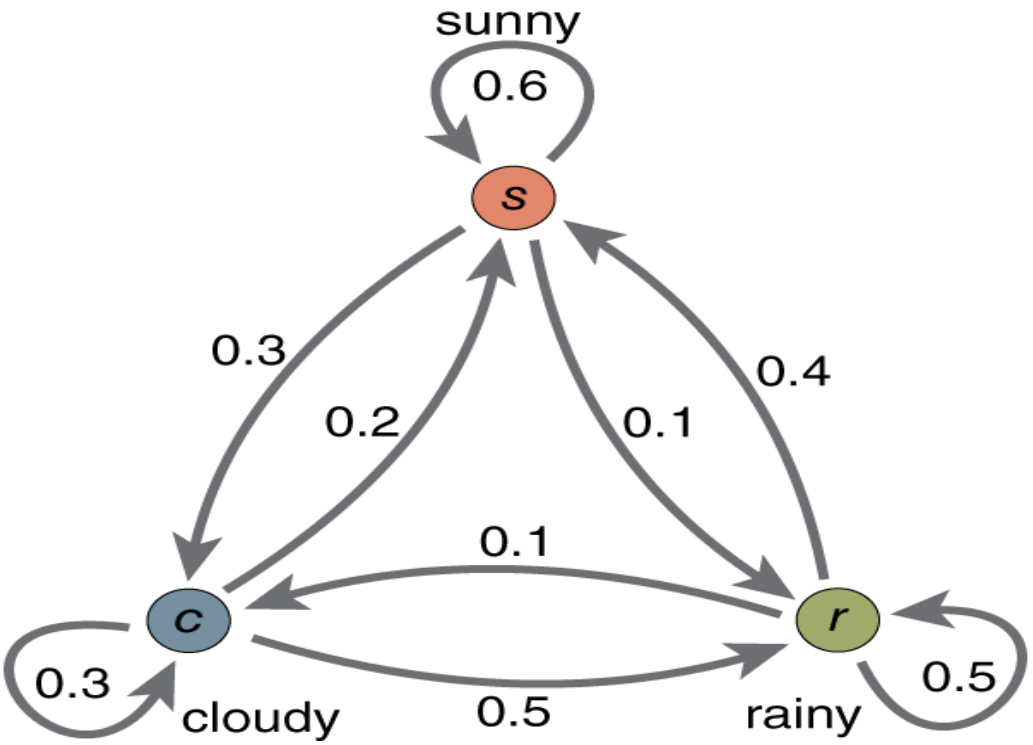
Normalizing constant

# Markov Chains

1913

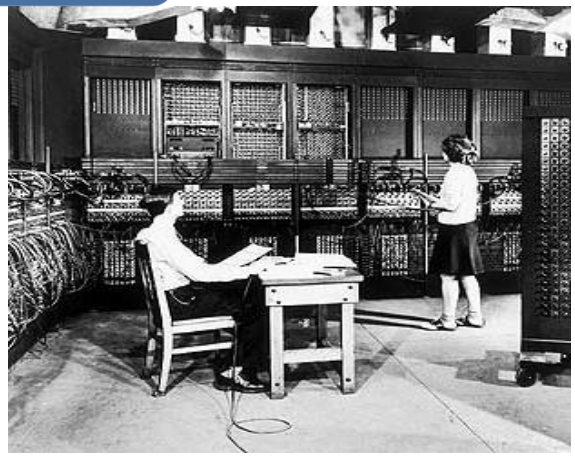
- Andrey Markov described analysis techniques later called **Markov Chains**.

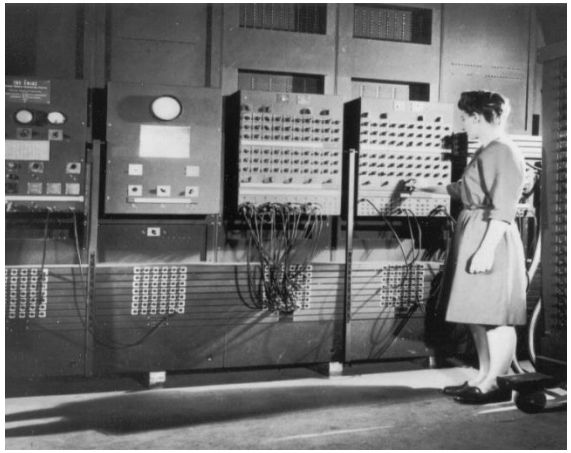


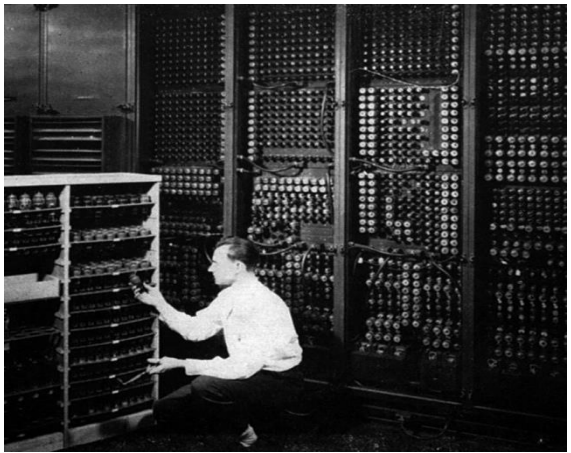


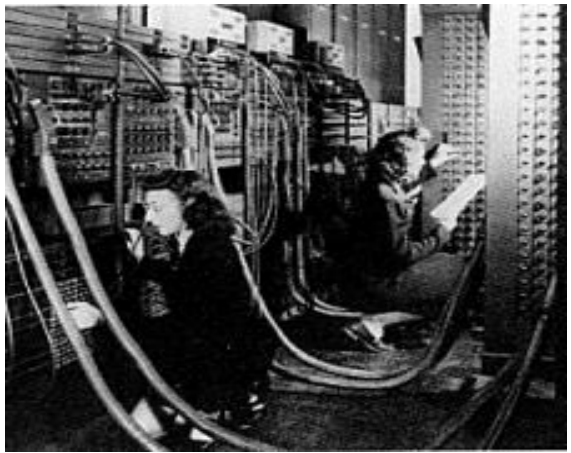
# Electronic Computers

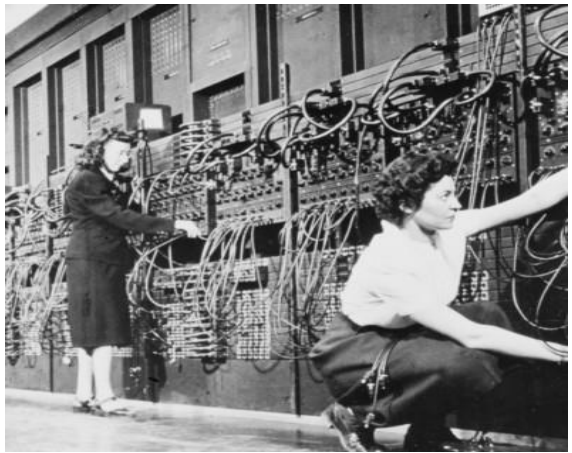
1913







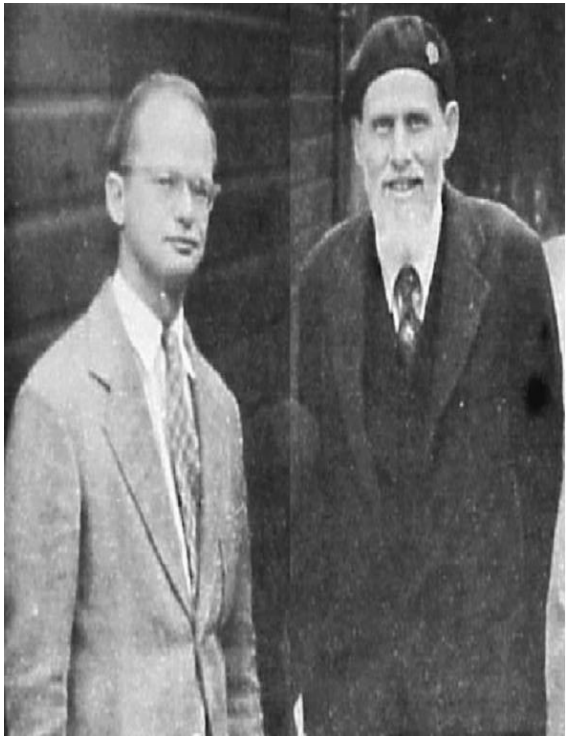


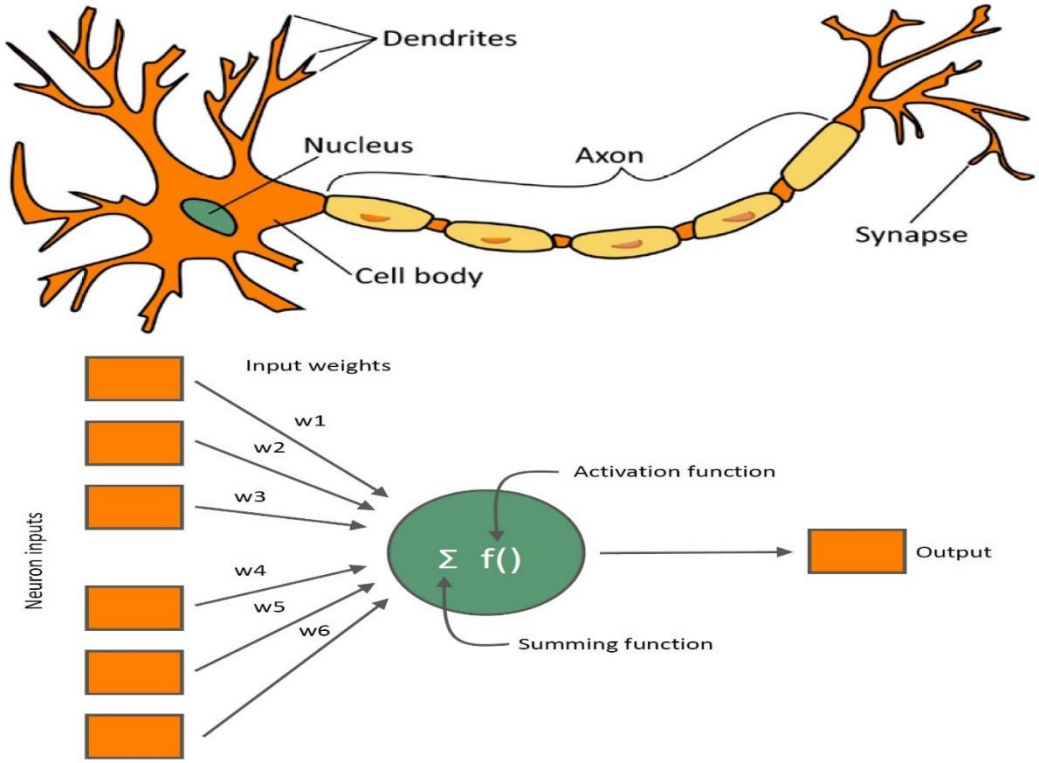


# Artificial Neurons

**1943**

• McCulloch and Pitts simplified mathematical model of neurons and introduced **Neural Networks** to model the Brain.



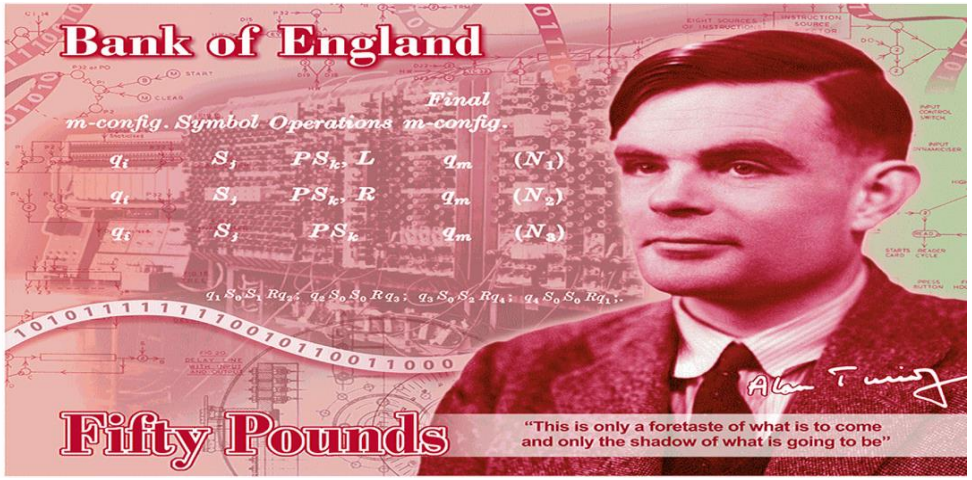


# Turing Machine

1950

- Alan Turing published "**Computing Machinery and Intelligence"**, in which he asked: "**Can machines think?**"

- '**Imitation Game**', a test to determine whether a computer was intelligent by asking a person to distinguish between a human and a computer when communicating with them both through typed messages.



# Loebner Prize

1990

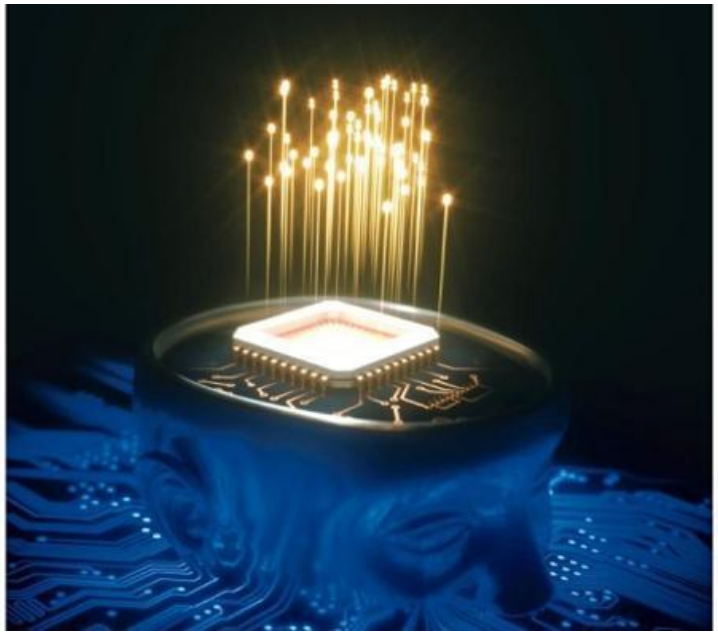
- Later **Loebner Prize was** established in 1990.
- Grand Prize of $100,000 and a Gold Medal for the first computer whose responses are indistinguishable from a human.


# The Turing Test

# Birth of AI

**1956**

- McCarthy coined the term "**Artificial Intelligence**".
- The term '**Artificial Intelligence**' made its advent at the "Dartmouth Summer Research Project on Artificial Intelligence" conference in Hanover, New Hampshire.



# Eliza

1966

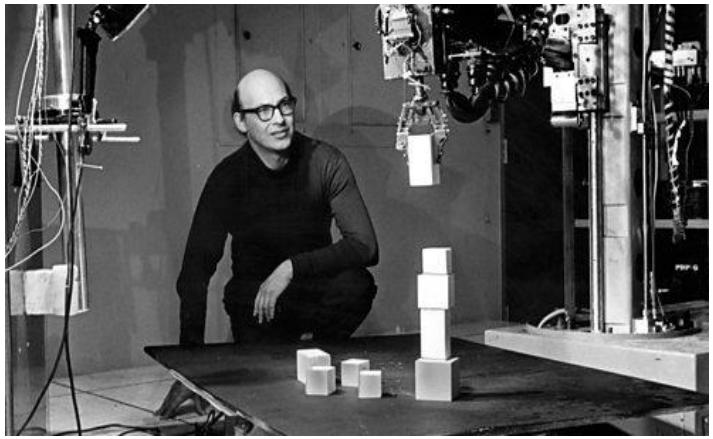
- Eliza – The First Known **Chat Bot**
- Natural language processing became a new trend.
- Passed an easy version of Turing Test.
- User could interact and prompt with various questions.

# Neural Network

**1968**

- Marvin Minsky and Dean Edmonds built the first **Artificial Neural Network** – a computer-based simulation of the way organic brains work.

- The **Stochastic Neural Analog Reinforcement Computer** (SNARC) learned from experience and was used to search a ***maze***, like a rat in a psychology experiment.

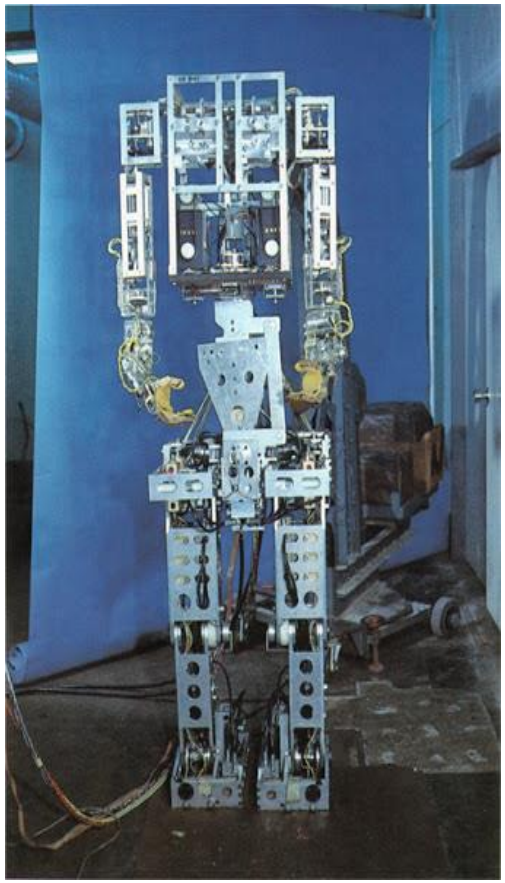


Marvin Minsky at MIT in 1968

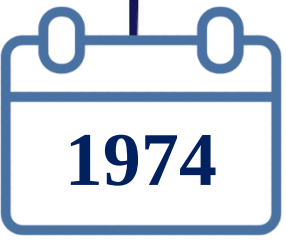
# WABOT-1

1972

- First **Intelligence Robot**: WABOT-1
- The first fun-scale anthropomorphic robot developed in the world.
- Consisted of a limb-control system, a vision system and a conversation system.
- Was able to communicate-with a person in Japanese.



# The First AI ‘Winter’




- In the 1970s, the capabilities of AI programs were limited.
- AI was subject to critiques and financial setbacks.
- AI researchers had **failed** to appreciate the difficulty of the problems they faced.
- Reasons:
  - Limited computer **power**
  - Lack of **data**
  - Commonsense **knowledge** and **reasoning**.
  - Governments and corporations were **losing faith** in AI.

- The **Second AI 'winter’** happened during 1987~1993.

# Expert Systems

1980

- An **expert system** is a computer system.
- Emulates the decision-making ability of a human expert.
- Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if–then rules

# Deep Blue

1997

- **Deep Blue** beat world chess champion Garry Kasparov in the first game of a match.
- Kasparov won the 1996 match, but in 1997 an upgraded Deep Blue then won a second match 3½ games to 2½.

# Roomba

2002

- **AI in Home**, Roomba
- **Roomba** is a series of autonomous robotic vacuum cleaners sold by iRobot.
- Roomba features a set of sensors that enable it to navigate the floor area of a home and clean it.
- Roomba's sensors can detect:
  - The presence of obstacles,
  - Detect dirty spots on the floor,
  - Sense steep drops to keep it from falling down stairs

# Watson

2011

- Watson won '**Jeopardy**!'

# ASIMO Honda Humanoid Robot

2011

- Honda **Humanoid Robot**
- The latest version of ASIMO was introduced with world's first autonomous behavior control technology.


https://www.youtube.com/watch?v=bSdYR-FHcA8

https://www.youtube.com/watch?v=1V9XUMCPGF8

# GoogleBrain

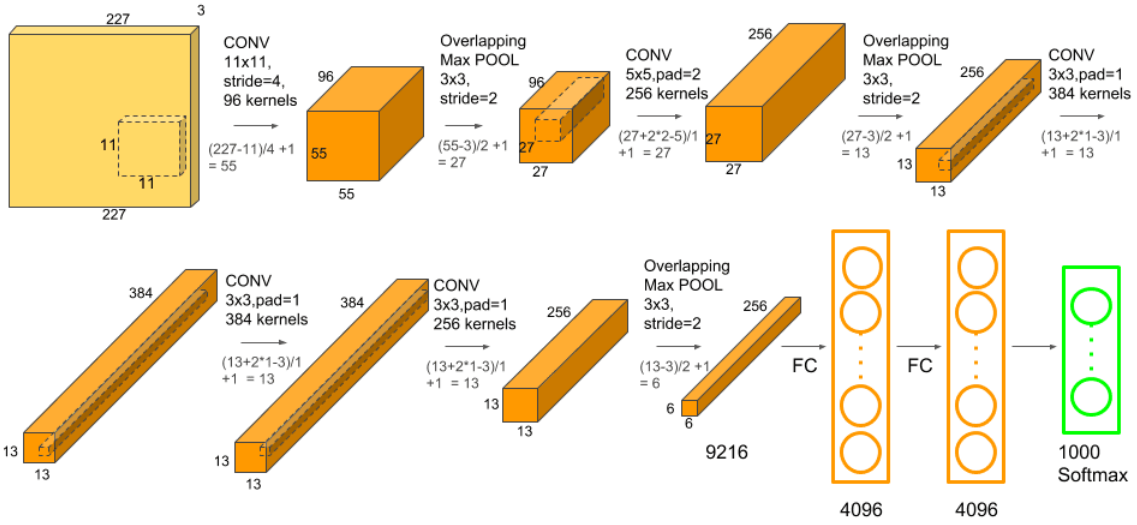
2012

- A deep neural network created by Jeff Dean, which focused on **pattern detection** in images and videos.

# AlexNet

2012

- AlexNet won the ImageNet competition by a large margin in 2012,
- It led to the use of GPUs and **Convolutional Neural Networks** in machine learning.
- They also created **ReLU**, which is an activation function that greatly improves efficiency of CNNs.



# DeepFace

2014

- A Deep Neural Network created by Facebook, which they claimed can **recognize** people with the same precision as a human can.

# Chatbot Eugene Goostman

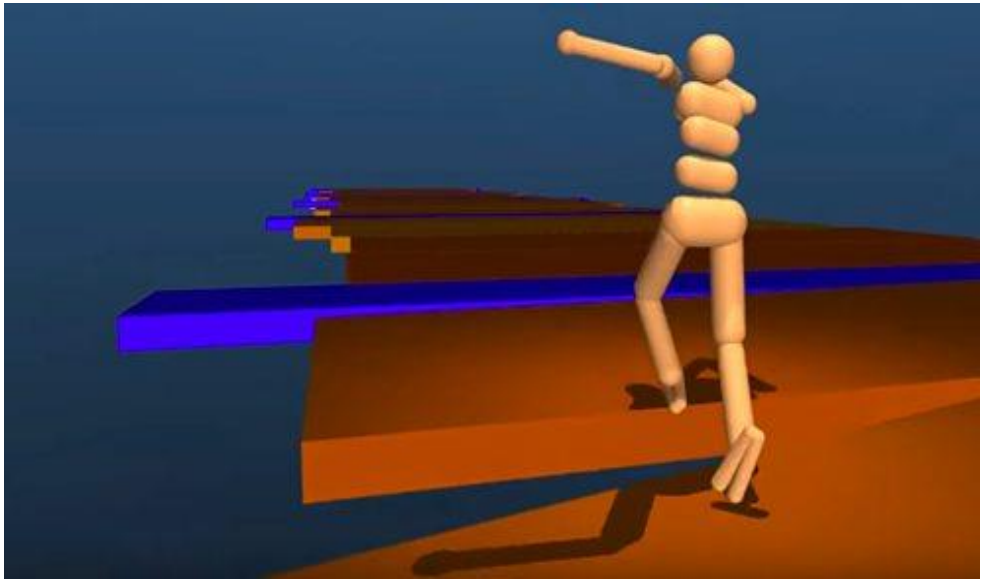
**2014**

- A portrayed as a **13-year-old Ukrainian boy**.
- Won A “Turing Test”.

# DeepMind

2014

- **Google DeepMind** gained prominence when it developed a neural network that could learn to **play video games**
- By analyzing the behavior of pixels on a screen.

DeepMind artificial intelligence moving an animated figure

# Amazon Echo

2015

- A brand of **smart speakers** developed by Amazon.
- connect to the voice-controlled intelligent personal assistant service Alexa, which will respond when you say "Alexa“
- The features of the device include:
  - voice interaction,
  - music playback,
  - making to-do lists,
  - setting alarms,
  - streaming podcasts,
  - playing audiobooks,

# AlphaGo beats Lee Sedol

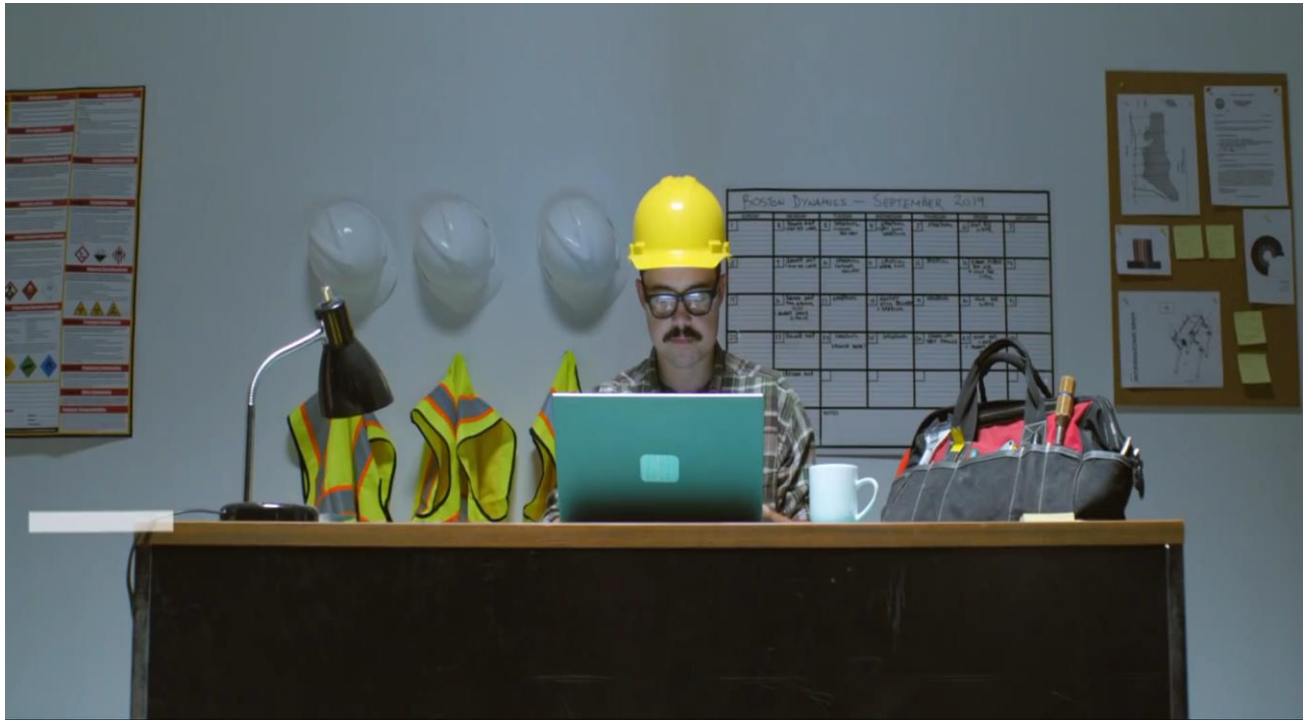
2016

- Developed by **DeepMind** researchers,
- AlphaGo won its first match against a professional in 2015, beat the world's number two player Lee Sedol in March 2016 and the number one player Ke Jie in 2017.
- AlphaGo's neural network is trained by playing both humans and computers, and uses a **Monte Carlo tree search algorithm** to find moves.

# 2016 Boston Dynamics's Spot

2016

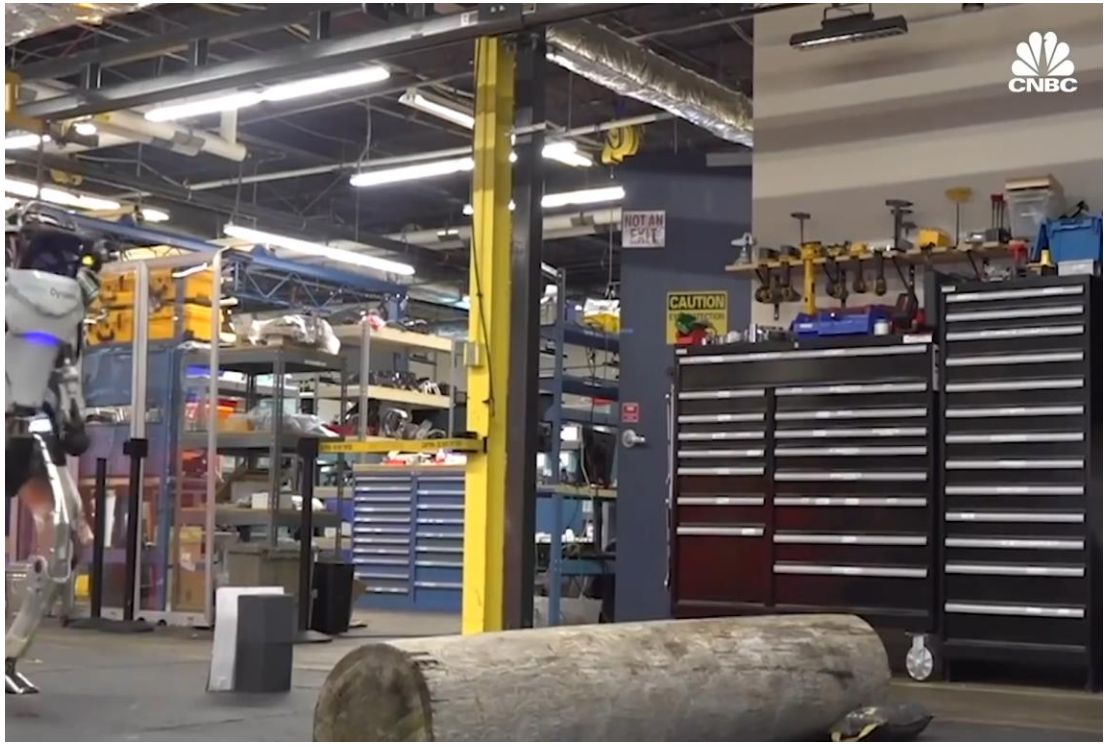
- Spot navigating challenging terrain,
- Picking up construction objects,
- Moving through bad weather,
- Picking itself up after a fall.



# Boston Dynamics's Atlas

2016

- The Agile Anthropomorphic Robot "**Atlas**" is a 6-foot (183 cm) bipedal humanoid robot,
- Based on Boston Dynamics' earlier PETMAN humanoid robot,
- Designed for a variety of search and rescue tasks.



# Henn-na Hotel

2016

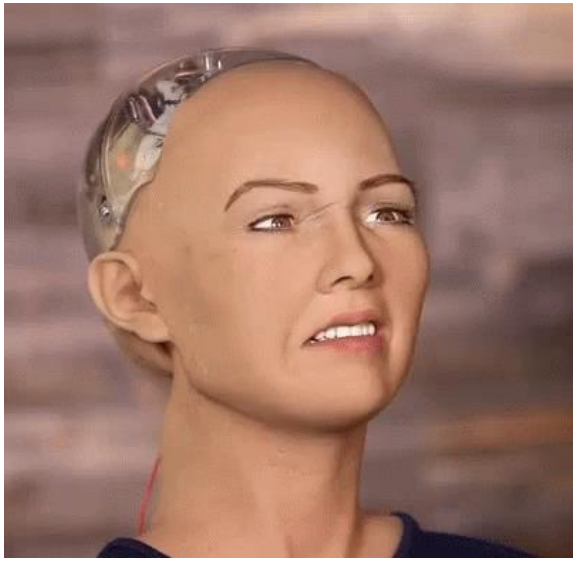
- A strange **hotel** in Nagasaki, fully staffed by robots.


https://www.youtube.com/watch?v=oCDY3kNz5hw

# Sophia

2016

- Created by Hanson Robotics.
- She is known as the first "**robot citizen**."
- Very similar to actual human being
- She is able to to see (image recognition), make facial expressions, and communicate through AI.



# GANs DeepFake

2017

# Samsung Bixby

2018


- A **virtual assistant**.
- Bixby's functions include:
  - **Voice**, where the user can speak to and ask questions, recommendations, and suggestions;
  - **Vision**, where Bixby's "seeing" ability is built into the camera app and can see what the user sees (i.e. object identification, search, purchase, translation, landmark recognition);
  - **Home**, where Bixby uses app-based information to help utilize and interact with the user (e.g. weather and fitness applications.)

# Furhat

2018

- Imitates of **human's face**
- Expresses emotions
- Speaks in 40 languages

www.furhatrobotics.com

https://youtu.be/i9oMkwnu0nk

# Handol

2019

- **HanDol**, developed by South Korea's NHN Entertainment Corp.,
- Took down the 36-year-old master after 180 stones in Lee's final match,
- Held in his hometown of Sinan, 400 kilometers south of Seoul.

# Patent applications filed by AI

2019

- The AI inventor, named "**DABUS**" by its creator Stephen Thaler, relies upon a system of many neural networks generating new ideas by altering their interconnections.
- A second system of neural networks detects critical consequences of these potential ideas and reinforces them based upon predicted novelty and salience.
- The DABUS AI has generated output that formed the basis for two patent applications:
  - One application claims a new type of beverage container based on fractal geometry,
  - The other claims a device for attracting enhanced attention that may help with search and rescue operations.

# State-of-the-art

## Computer Vision

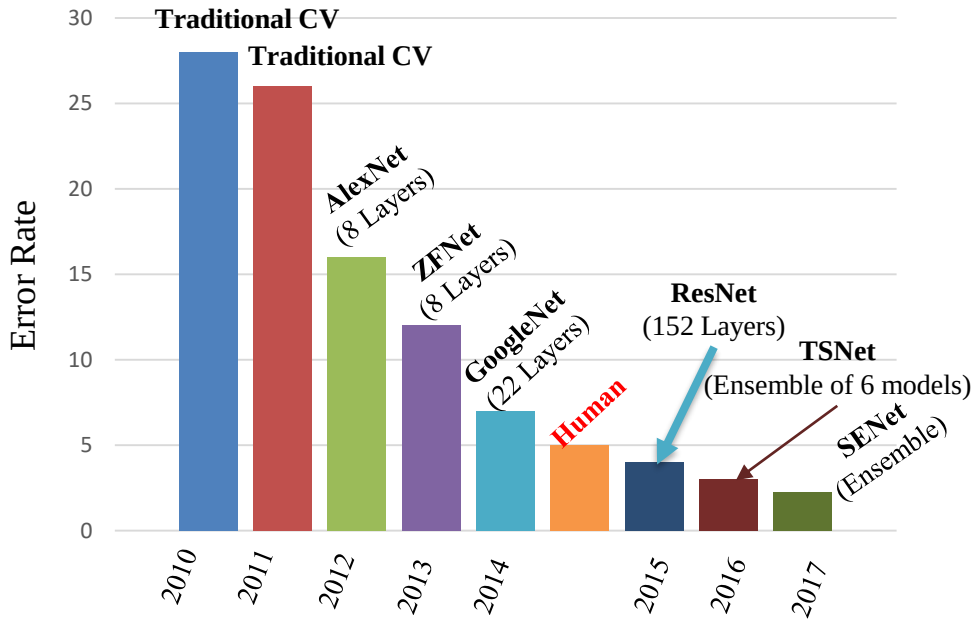
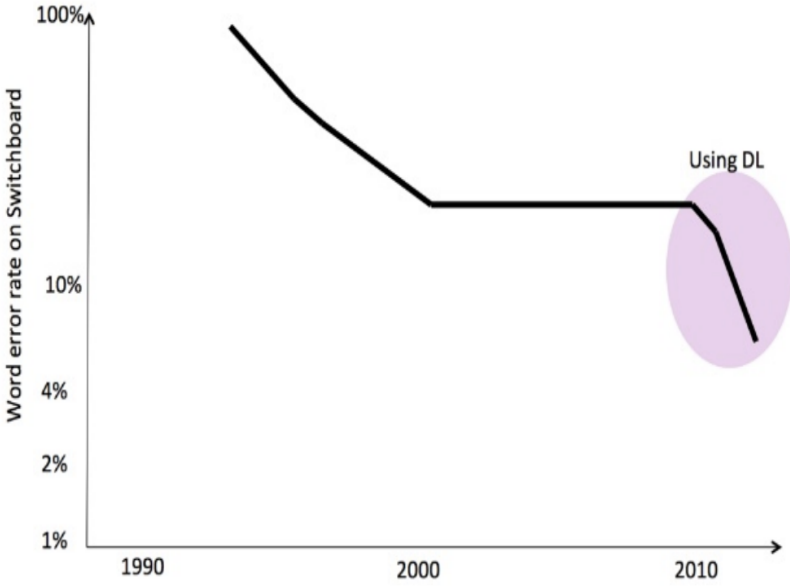


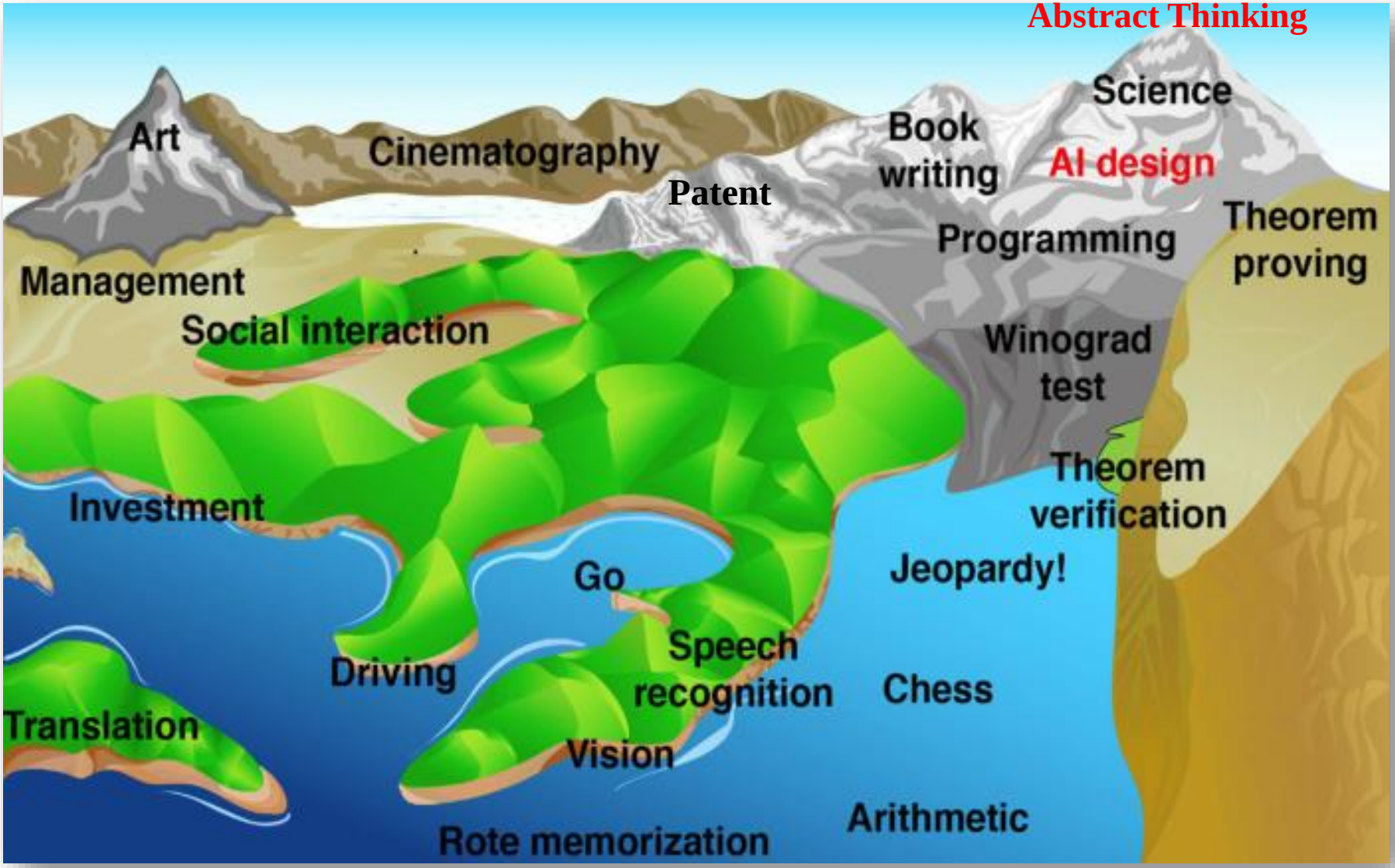

Image classifiers have surpassed human level accuracy.

## Speech Recognition




DL improved the accuracy of speech recognition significantly!

# AI Evolution



# Future of AI

- Based on the continued progress of Moore's law
- Measure progress
- Brute force vs cleverness
- New apps
- "By 2010 computers will disappear. They'll be so small, they'll be embedded in our clothing, in our environment. Images will be written directly to our retina, providing full-immersion virtual reality, augmented real reality. We'll be interacting with virtual personalities." (Ray Kurzweil in 2005)
  !!!!

# Future of AI

## The singularity

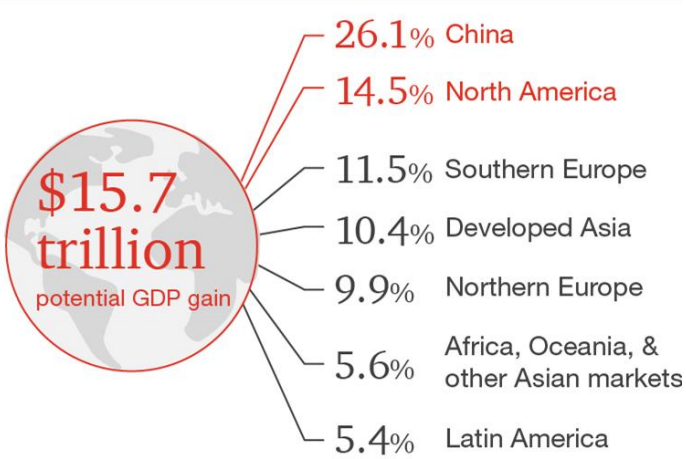
- Some computer scientists believe that once we develop a generalized AI at or above human level then it will develop more advanced versions of itself.
- This process is called the **singularity**, a term first used in this way by SF author Vernor Vinge.
- If this happens then the resulting exponential growth in AI capability will rapidly transcend human intelligence and we may find ourselves subservient to the machines.
- The likelihood of the singularity is studied by organizations such as the Cambridge Centre for the Study of Existential Risk, as even if it is considered very unlikely it would pose a serious threat to human survival.

BBC Click's Spencer Kelly and a humanoid robot

# Future of AI

- AI is growing and is here to stay. It will impact all geographies and sectors.

China and North America will see biggest AI gains by 2030




*Source: PwC Global Artificial Intelligence Study, 2017*

Global economic impact of AI in 2030 by sector

| Sector | $ trillion |
|---|---|
| Healthcare | $5.1 |
| Manufacturing | $4.0 |
| Financial Services | $2.1 |
| Retail | $2.0 |
| Energy | $1.7 |
| Transport & Logistics | $0.6 |
| Tech, media, telecom | $0.3 |

"AI will be either the **best**,
or the **worst** thing,
ever to happen to humanity."

— ***Stephen Hawking***


QUESTIONS?
COMMENTS?
CONCERNS?