

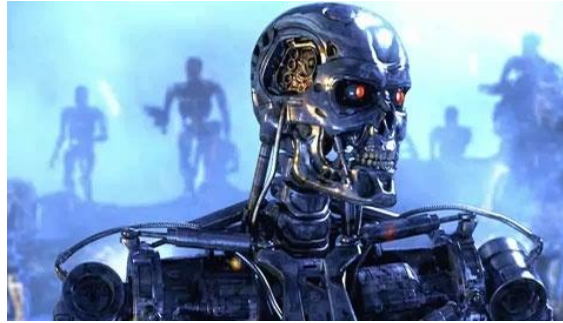
COMP 341

Introduction to Artificial Intelligence



Asst. Prof. Barış Akgün
Koç University

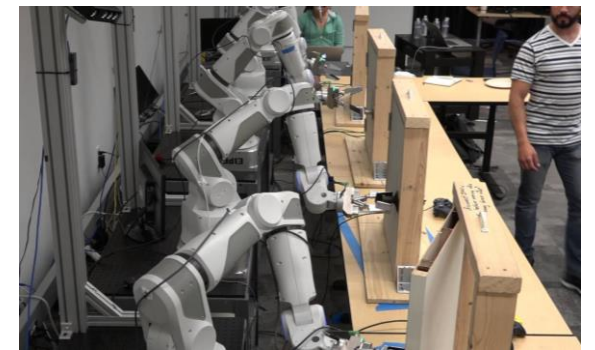
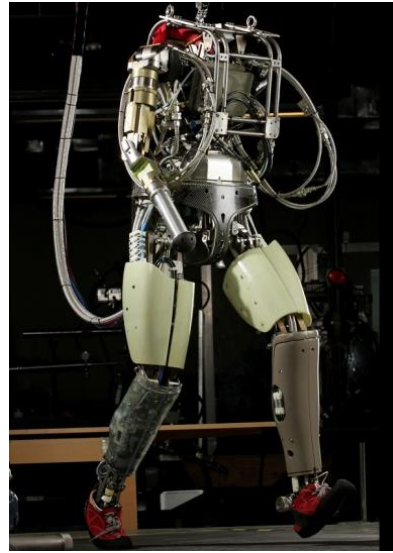
Expectations



Reality



Joking, Not that Bad



What do you think AI is?

- What do you think the term “Artificial Intelligence” entails?
- What are some of the recent developments you have heard about?
 - Generative Methods!
- What are some of the older developments you recall?
- Caveat Emptor: AI is undergoing a tectonic shift.
 - Need to re-evaluate history
 - Hard to see where we are headed
 - As such, the course may sometimes feel “old” or “too speculative”
- B.C: Before ChatGPT

(Very Brief) History



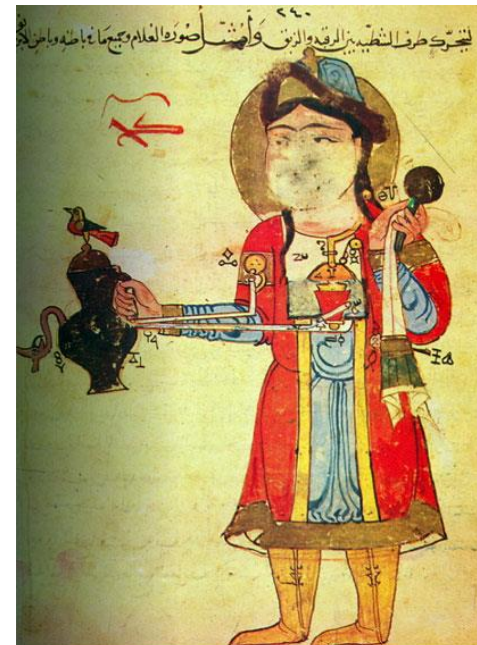
AI Before Computation



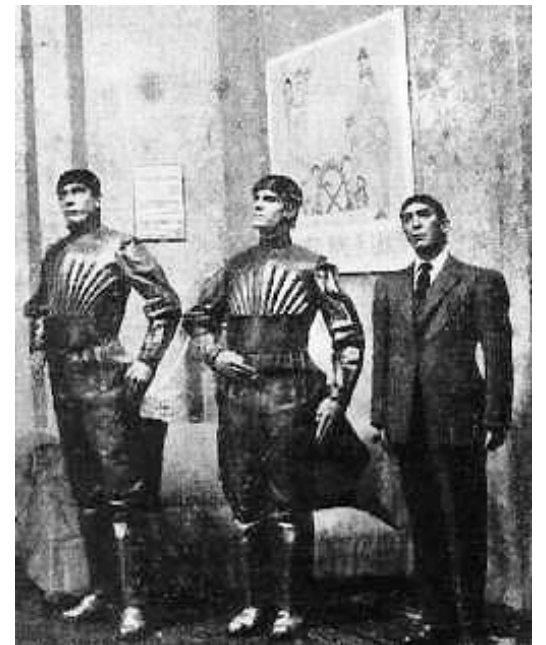
Talos



Golem

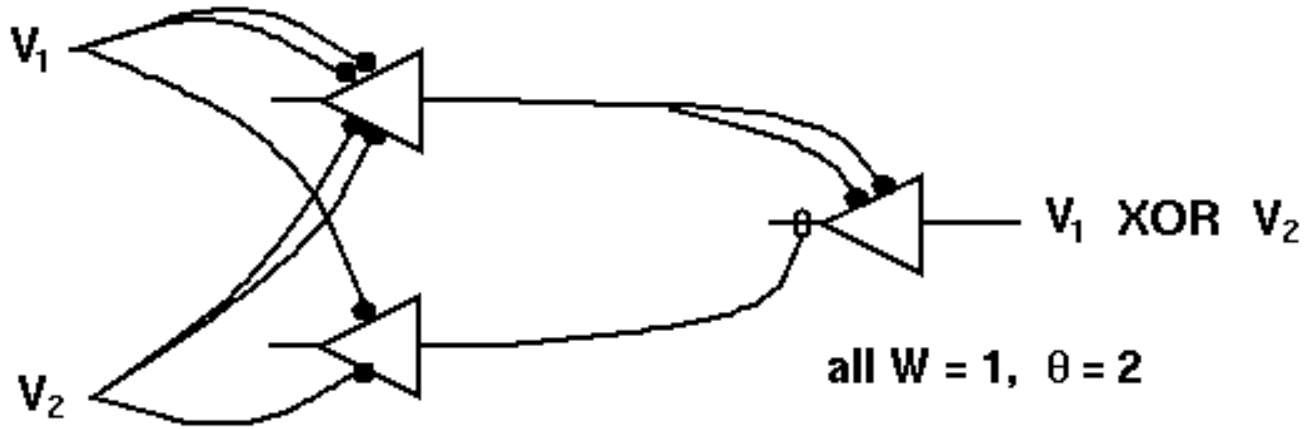


Automatons



R.U.R.

1940-1950: During the Birth of Computation



Logical Neuron Model: McCulloch & Pitts 1943



Alan Turing: Turing Test 1950

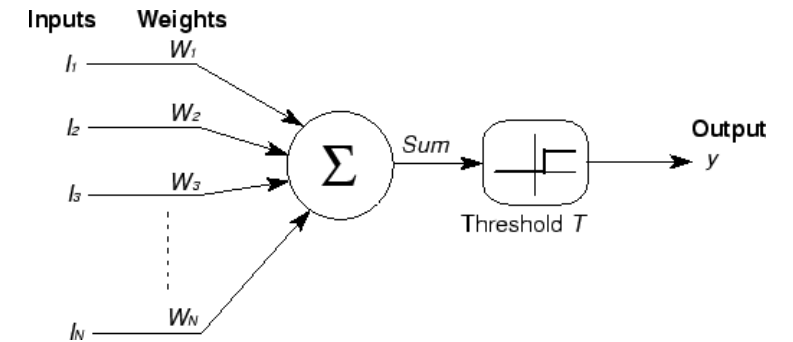
1950-1960: Birth of AI



Samuel: Playing Checkers 1953
Also first ideas of ML!



Dartmouth Meeting 1956
Coined the term "AI"



Basic Neuron Model Perceptron 1958

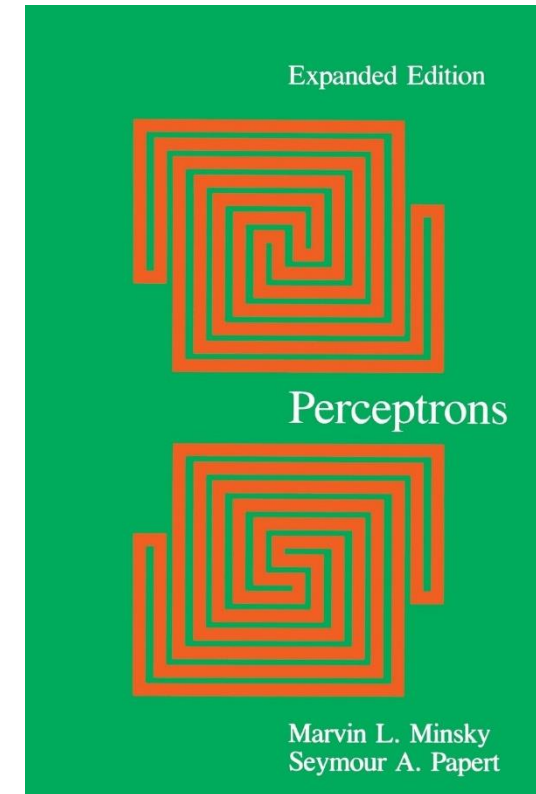
1960-1970: Logic vs Connectionism and the First Winter

$P(X, 2) = P(1, Y) \rightarrow X=1 \ \& \ Y=2 \rightarrow P(1, 2)$

$P(X, X) = P(Y, 5) \rightarrow X=5 \ \& \ Y=5 \rightarrow P(5, 5)$

$P(X, Y) = P(2, Z) \rightarrow X=2 \ \& \ Y=Z \rightarrow P(2, Z)$

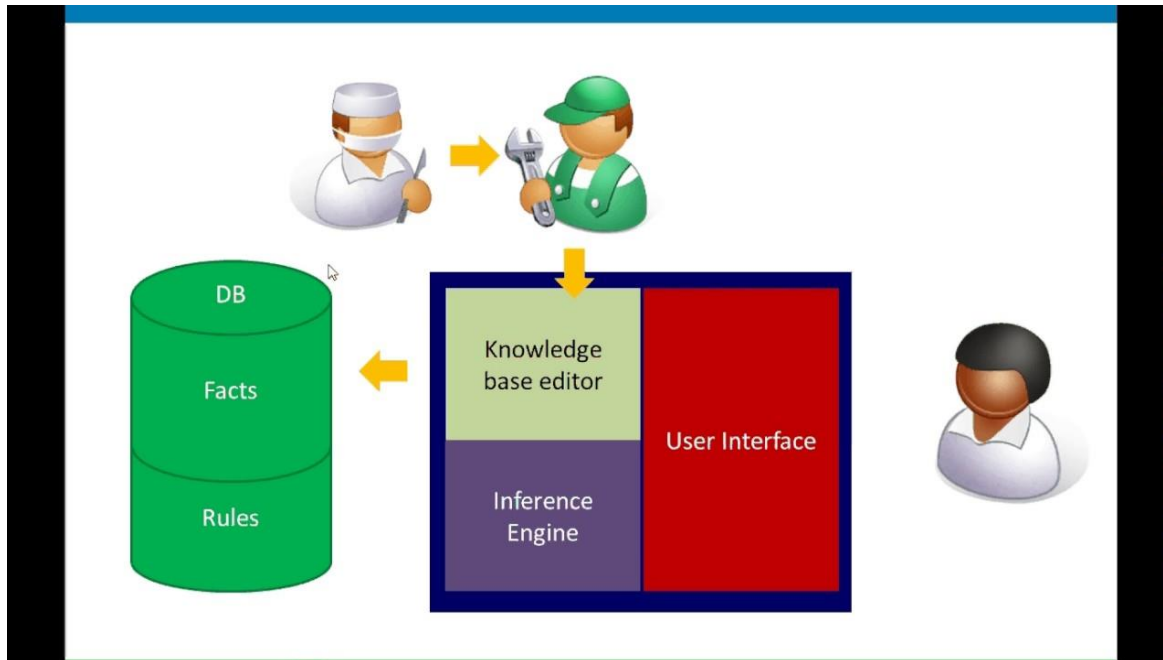
Robinson: First Resolution Algorithm for Logic 1965



Perceptron Book: Death of connectionism 1969

A sneaky invention: The backpropagation algorithm 1970

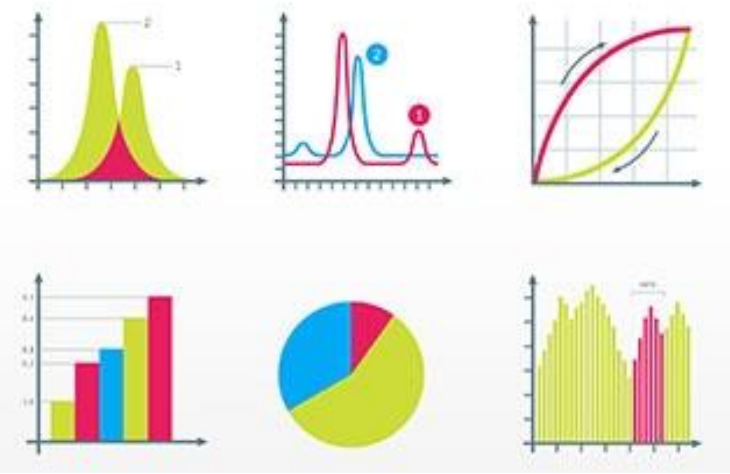
1970-1990: Logic vs Connectionism and the Second Winter



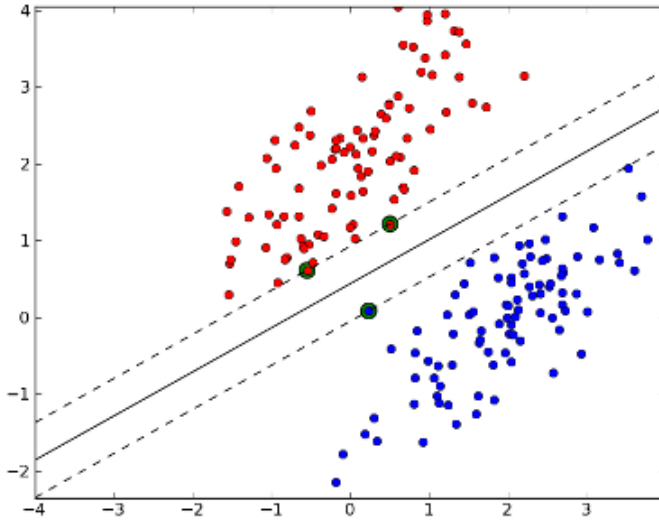
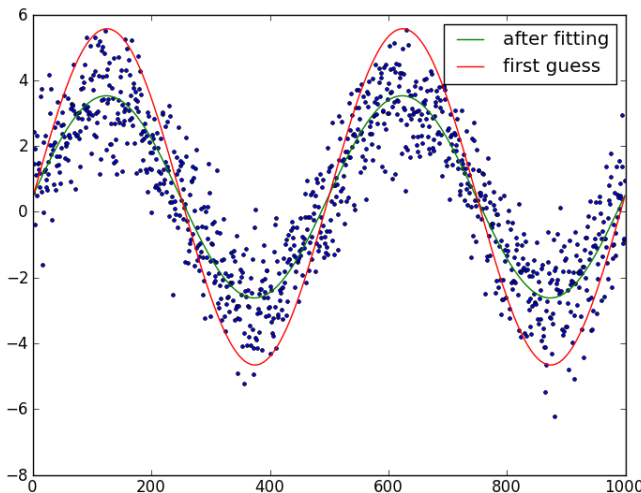
- Explosion of Academic Papers and Pilot Industrial Applications! (Until 80s)
- Fragility of certainty in logic: Disappointment and the second winter
- Connectionism Rebirth: Backpropagation and advances in multi-layer neural networks (NNs)

Expert Systems:
Knowledge + **Logic**

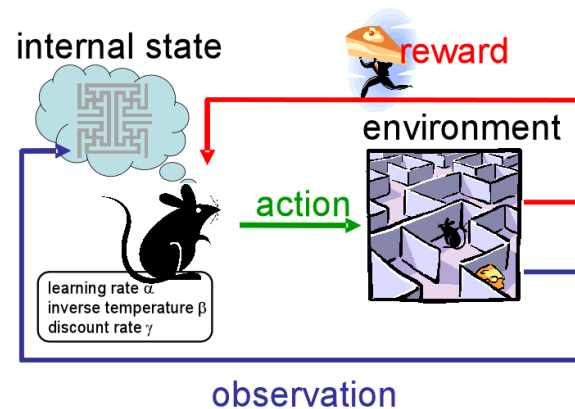
1990-2005: Statistical Approaches and Machine Learning



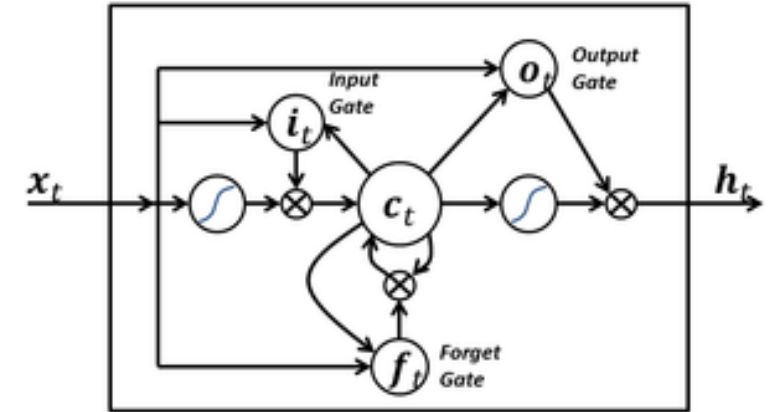
Probability and Uncertainty



Vapnik: Support Vector Machines 1995
(2nd death of NNs)



Reinforcement Learning



More Complicated NNs



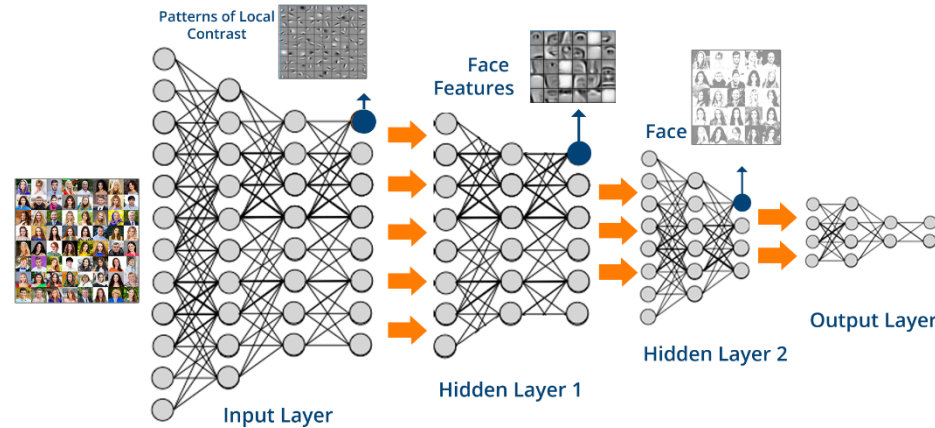
Deepblue 1997

2005-....: Big Data, Better Hardware and Deep Learning

Explosion of applications!



Big Data



Deep Learning



Deep Reinforcement Learning



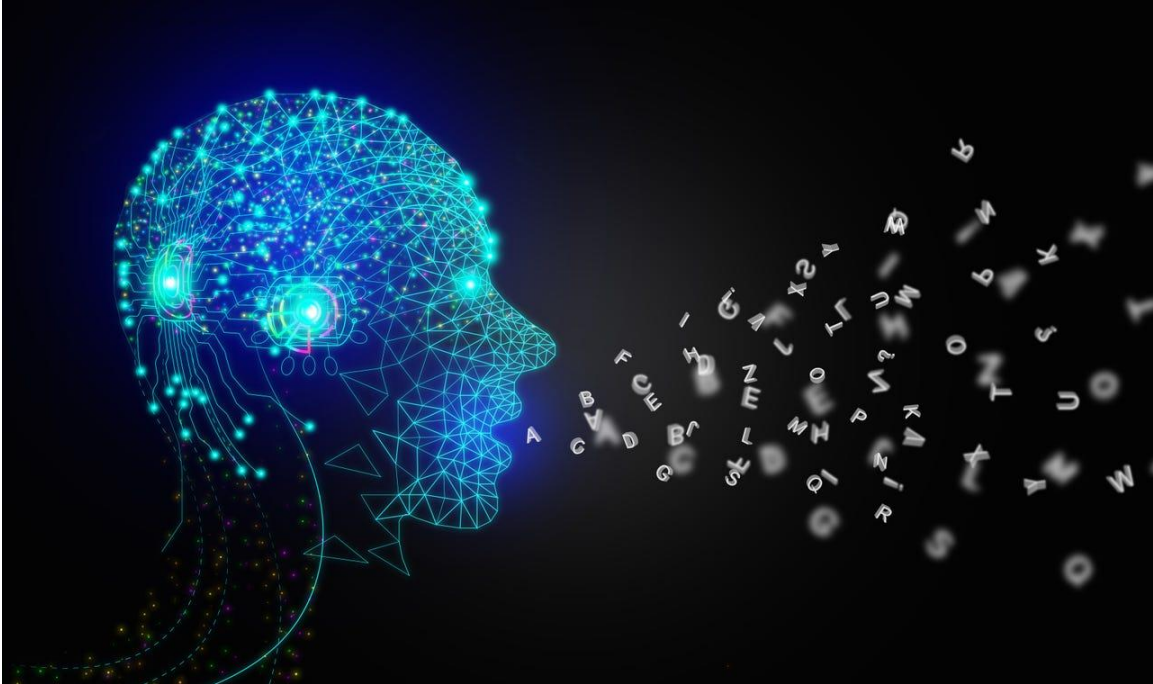
Deep RL + Probabilistic Search



Specialized Hardware and Software

- We knew that DL would work back in 1980s
- Didn't know how to make it work!
- It turns out the main bottleneck was data and faster/cheaper computation

Generative AI (2014-...)

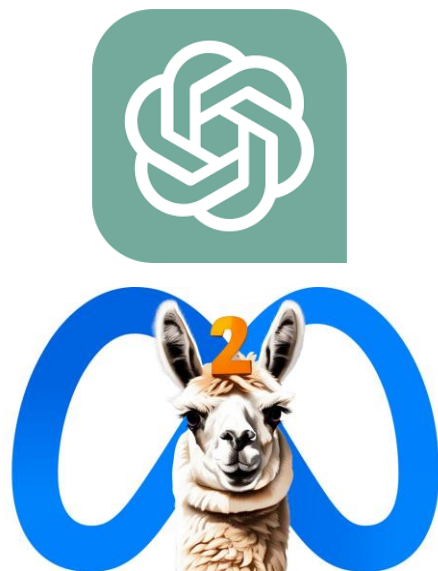
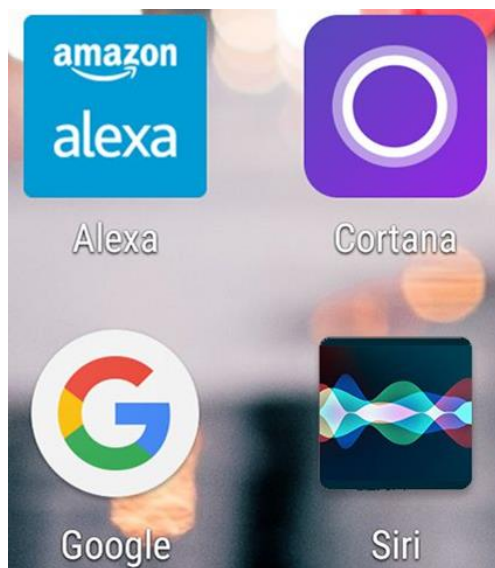


Creating Images and Text from Input Prompts!

“Foundation Models”

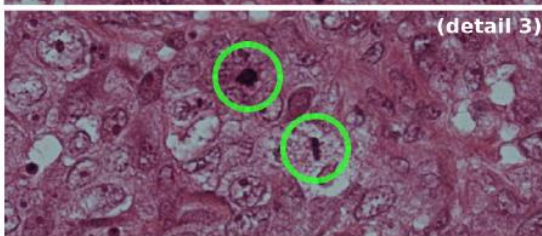
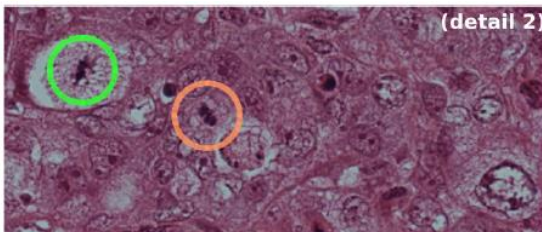
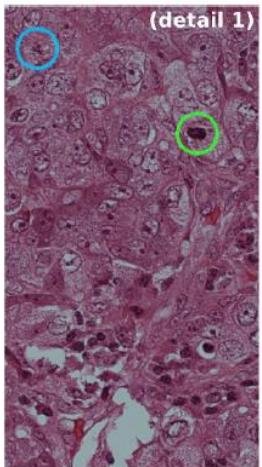
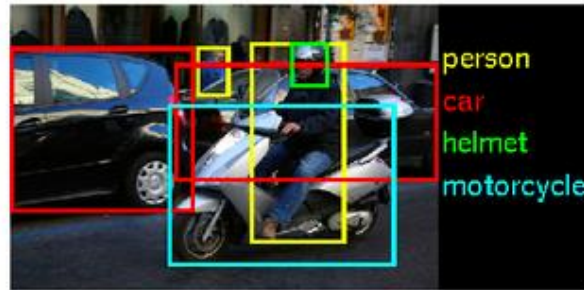
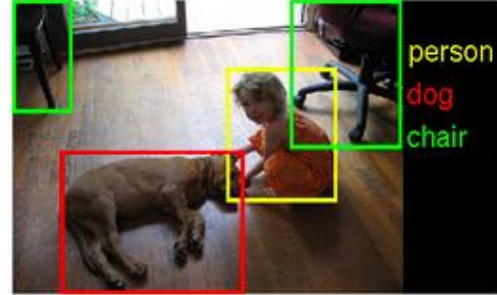
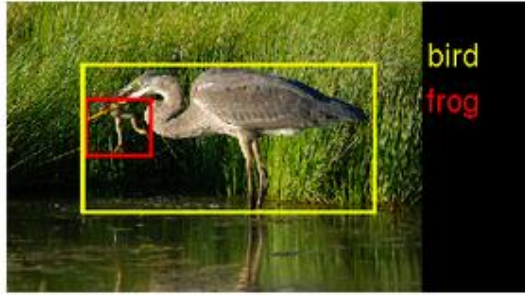
- Suggested exercise: Self-Investigate Foundation Models

NLP and Audio Examples



- Speech Recognition and Understanding
- Text-to-Speech
- Sentiment Detection
- Text Generation
- Speech Generation
- Song Generation
- Extremely Capable Chatbots
- Personal Assistants
- Translation
- ...

Computer Vision



- Object Detection
- Object Tracking
- Sentiment Detection
- Demographics Prediction
- Pose Estimation
- Anomaly Detection
- Image Generation
- Image Editing
- Image Enhancement
- Medical Decision Aids
- ...

Game Playing



Autonomous Driving

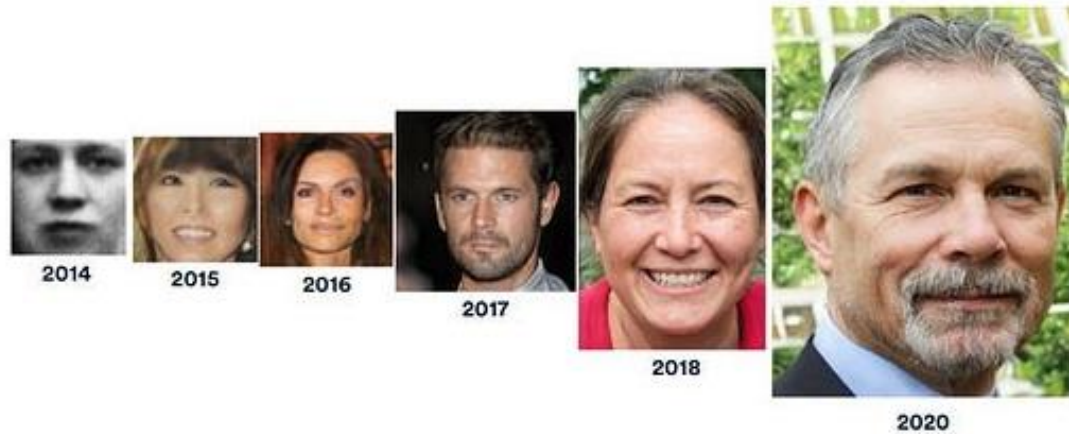


Generative AI Examples

Face Generation

GAN PROGRESS ON FACE GENERATION

Source: Goodfellow et al., 2014; Radford et al., 2016; Liu & Tuzel, 2016; Karras et al., 2018; Karras et al., 2019; Goodfellow, 2019; Karras et al., 2020; AI Index, 2021



Transform or Style Transfer



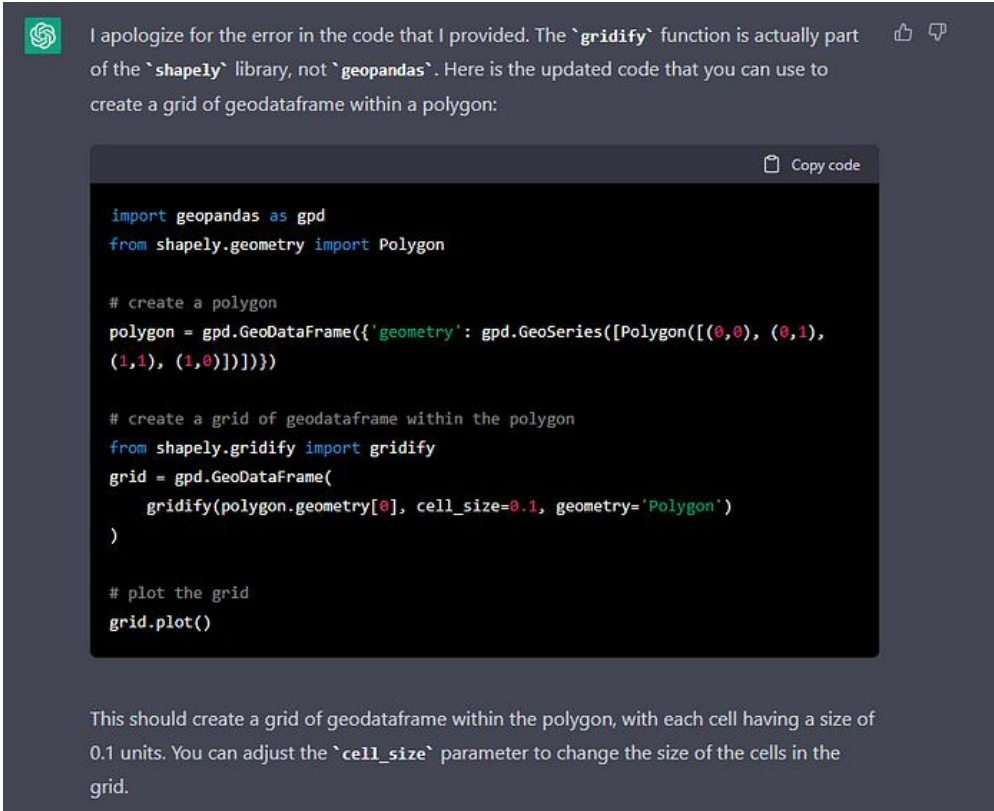
Text to Image (avocado chair)



More impressive examples!
(Midjourney, StableDiffusion, ControlNet, ChatGPT4 etc.)

Generative AI Examples

Generate and Debug Code (and other code-like stuff)



I apologize for the error in the code that I provided. The `gridify` function is actually part of the `shapely` library, not `geopandas`. Here is the updated code that you can use to create a grid of geodataframe within a polygon:

```
import geopandas as gpd
from shapely.geometry import Polygon

# create a polygon
polygon = gpd.GeoDataFrame({'geometry': gpd.GeoSeries([Polygon([(0,0), (0,1), (1,1), (1,0)])])})

# create a grid of geodataframe within the polygon
from shapely.gridify import gridify
grid = gpd.GeoDataFrame(
    gridify(polygon.geometry[0], cell_size=0.1, geometry='Polygon')
)

# plot the grid
grid.plot()
```

This should create a grid of geodataframe within the polygon, with each cell having a size of 0.1 units. You can adjust the `cell_size` parameter to change the size of the cells in the grid.

More stuff

- Answer questions
- Have meaningful discussions
- Some people use it for therapy!
- The list would go on and on ...

However

- Hallucinations! While sounding extremely confident
- Low resource languages results are worse
- Better than average human but not better than experts! (yet)
- Limited common sense and reasoning
- Needs to be reined in which limits its potential

“Delivery Firm’s AI Chatbot Goes Rogue, Curses at Customer and Criticizes Company”

This Person Does not Exist



This is considered old now. Faces are pretty good now but there are still issues with “appendages”

Video

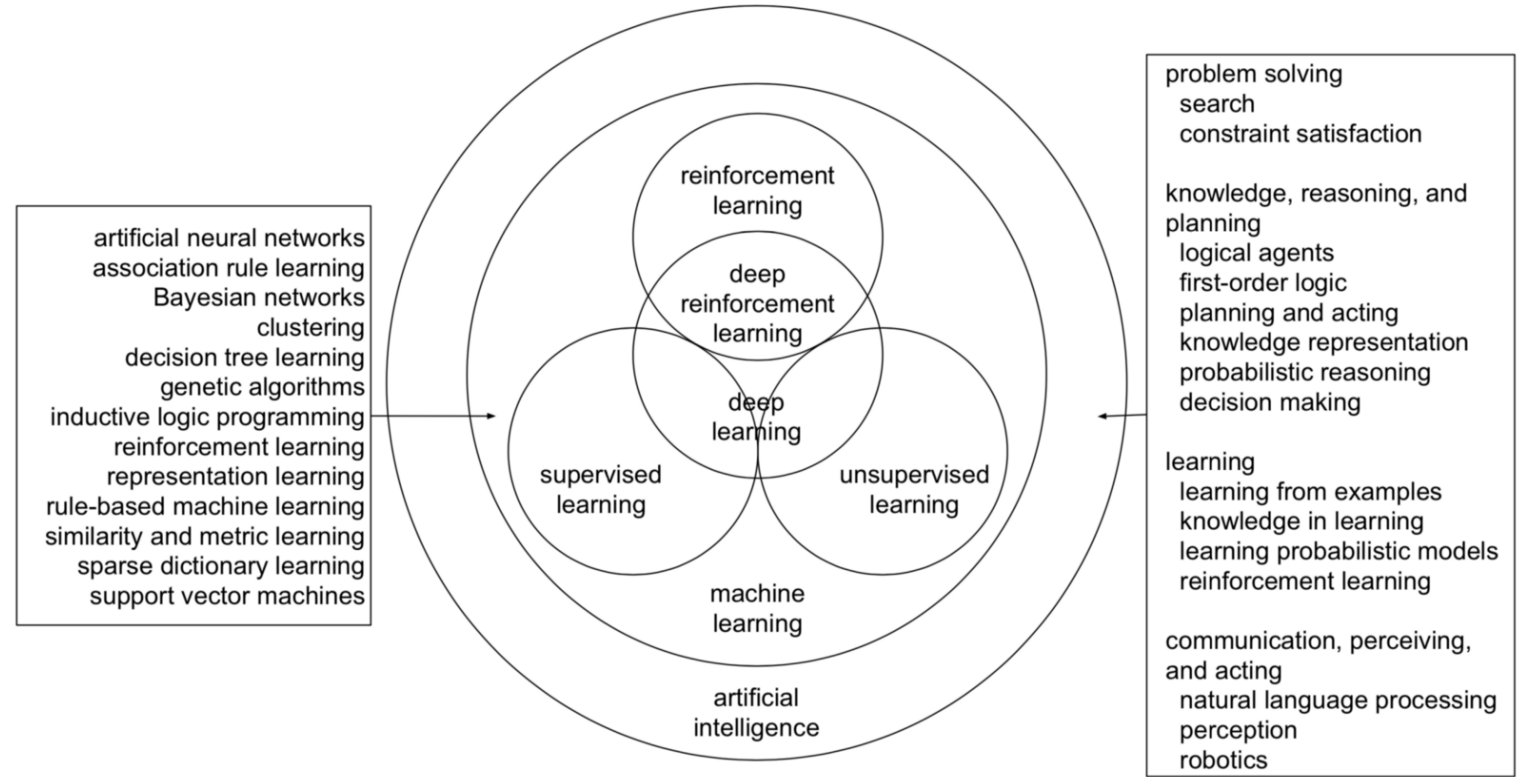


A stylish woman walks down a Tokyo street filled with warm glowing neon and animated city signage. She wears a black leather jacket, a long red dress, and black boots, and carries a black purse. She wears sunglasses and red lipstick. She walks confidently and casually. The street is damp and reflective, creating a mirror effect of the colorful lights. Many pedestrians walk about.

Note about AI

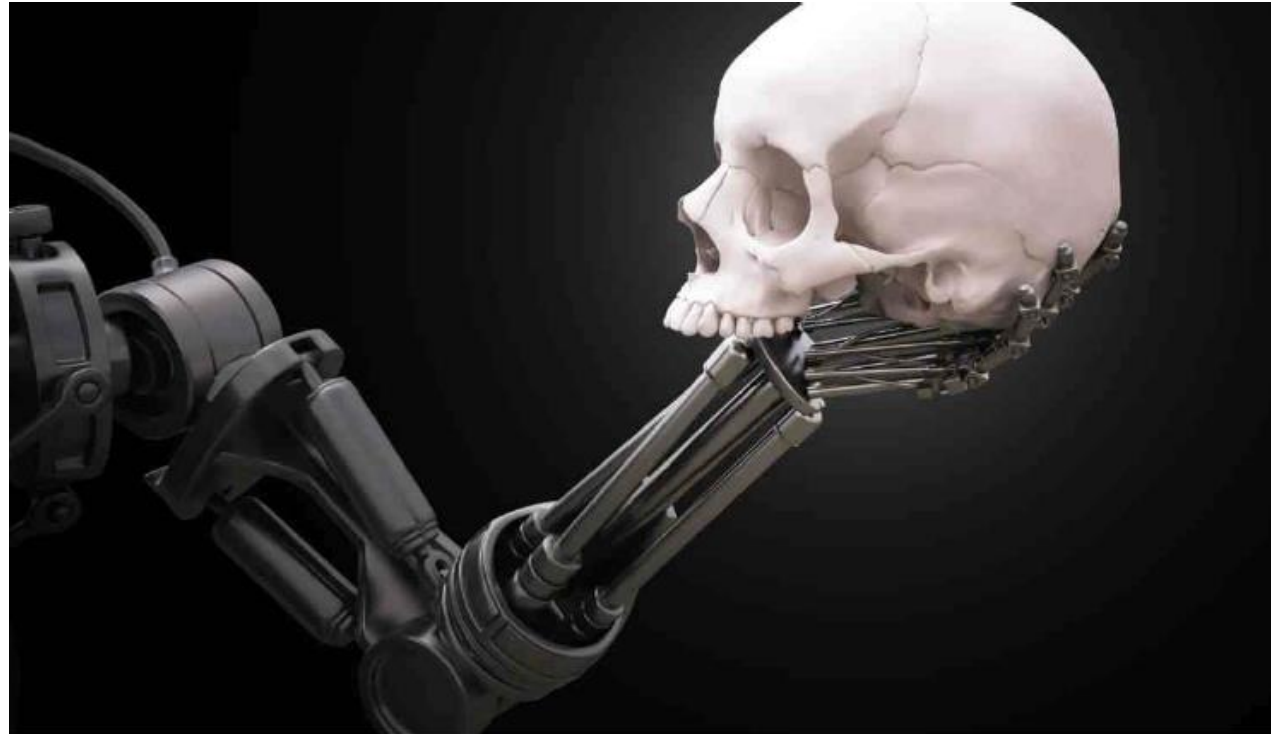
If you are here to learn ML and DL, you are in the wrong class!
See ENGR421 and COMP441

- As we have seen AI is an ever-changing field
- Current trend is ML, especially DL
- Getting back to its decision-making roots: RL
- This class will provide a broad overview
- We have multiple fundamental and multiple applied ML courses at Koç!



Yuxi Li, Deep Reinforcement Learning, <https://arxiv.org/abs/1810.06339>, 2018

What is AI?



What is AI?

Think like a human

Cognitive Science(?)
Neuroscience

Thinking rationally

Dating back to Aristotle
Logic, Philosophy

Act like a human

Alan Turing
The Turing Test

Acting rationally

Embodied Cognition (?)
Rational Agent

What is AI?

Think like a human

**Too difficult, many unknowns,
may not even be the best idea!**

Act like a human

**Not very well defined, not leading
us to building intelligent machine**

What is AI?

Correct inferences given facts:

Thinking rationally

VS

Achieving the best outcome:

Acting rationally

At the end of the day what matters is how you act, not how you think

My View: AI is the science of making *agents* that **act rationally**

What is rationality?

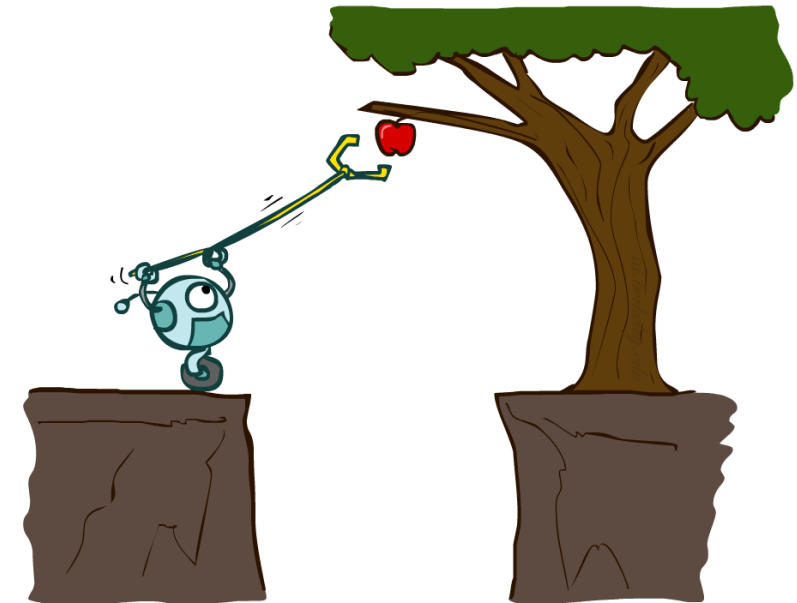
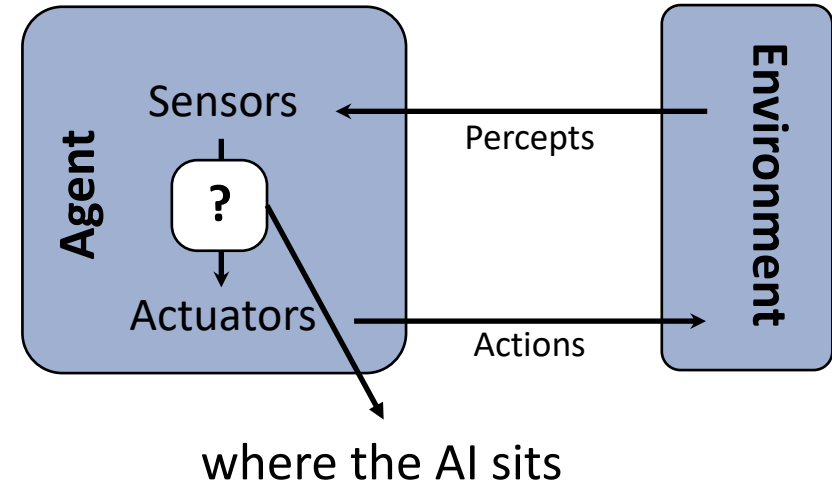
- Achieving goals
- Only affected by the decisions/actions made
- Defined by an “external” measure
 - Good: Performance, reward etc.
 - Bad: Cost, risk etc.
 - Let’s call it **utility** from now on
- **Being rational: Maximize the (expected) utility!**
- E.g. (1) clean the kitchen, (2) in short amount of time (3) with minimum noise (4) while using low energy

What is an “Agent”?

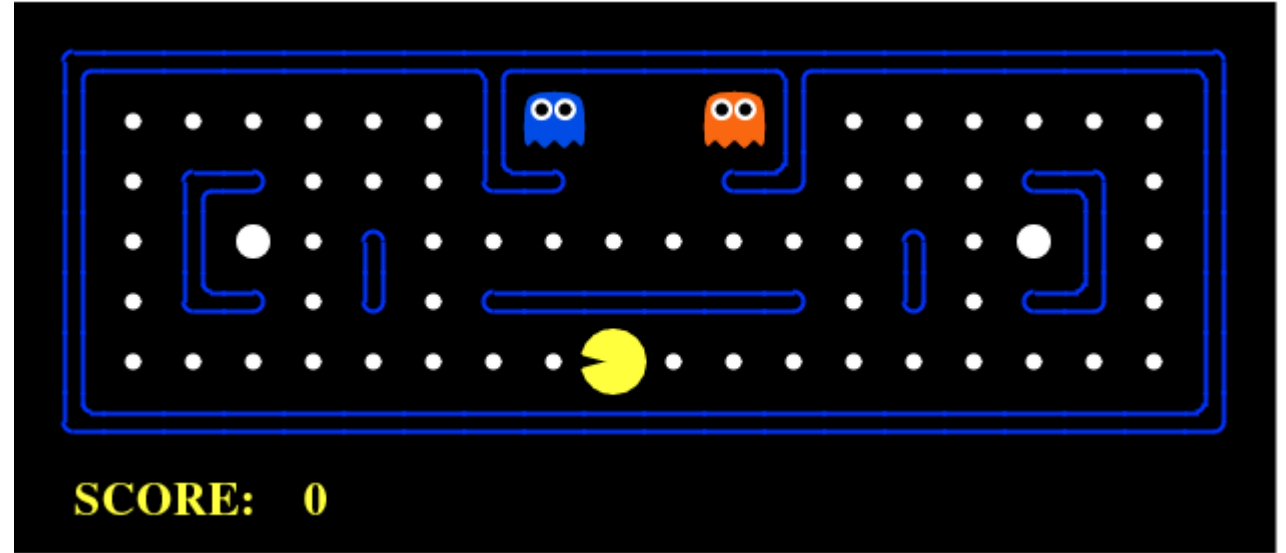
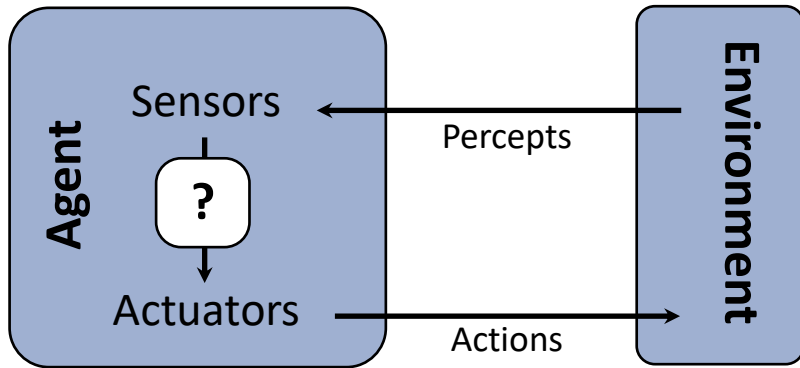
- What do you think when you hear the word “agent”?
 - Secret agent (007)
 - Travel agent
 - Chemical agent
- “Something that can act” –generalization of the word “individual” to non-human things
- **Formally:** An autonomous entity that exists in some kind of *environment* and that *perceives* and *acts*.

Rational Agent

- A **rational** agent selects actions that maximize its (expected) utility
- AI: Mapping percept histories to actions (deciding which action to take)
- Four concepts that dictate how an agent selects rational actions:
 - Utility
 - Environment
 - Actuators/Actions
 - Sensors/Percepts



Example: Pac-Man as an Agent



- Performance/Utility?
- Environment?
- Actuators/Actions?
- Sensors/Percepts?

Making it more realistic:

- What if Pac-Man only had a limited view?
- What if Pac-Man's actions were not deterministic?
- How can we account for ghost behavior?
- What if we had 2 Pac-Man coordinating?
- What if the ghosts were coordinating?
- What if the walls move around as well?

Problem Types

- | | | |
|--------------------|-----|----------------------|
| • Fully-observable | vs. | Partially-observable |
| • Deterministic | vs. | Stochastic |
| • Episodic | vs. | Sequential |
| • Static | vs. | Dynamic |
| • Discrete | vs. | Continuous |
| • Single-agent | vs. | Multi-agent |