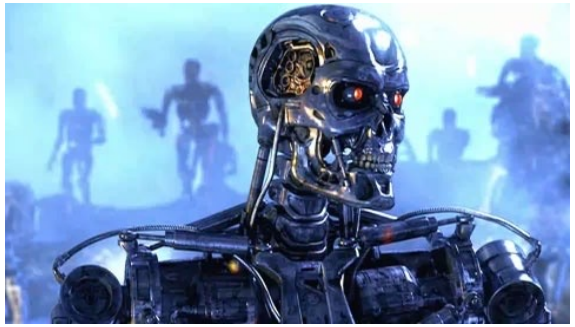
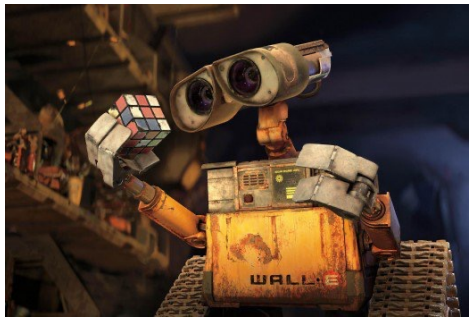
# COMP 341
# Introduction to Artificial Intelligence


Asst. Prof. Barış Akgün

Koç University

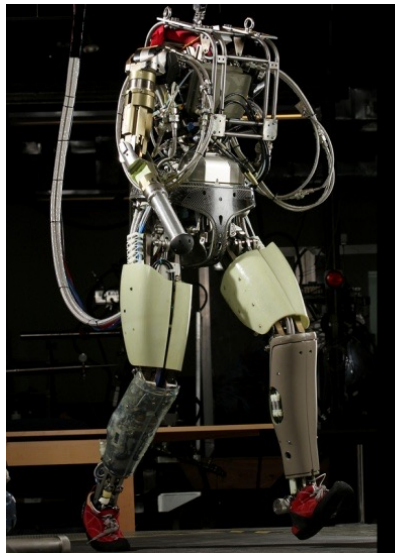
# Expectations

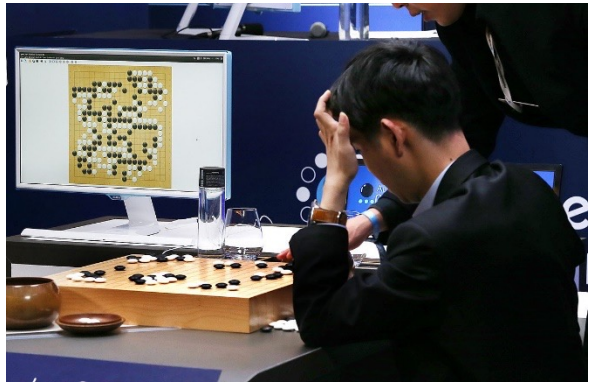




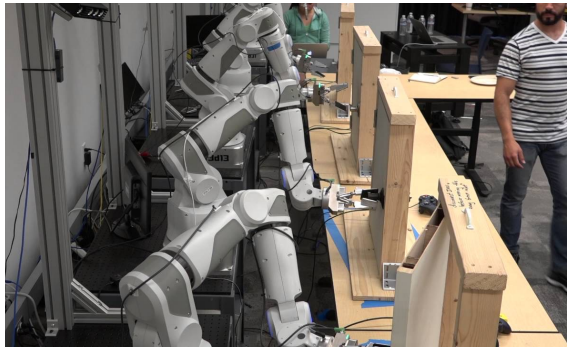

# Reality

# 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

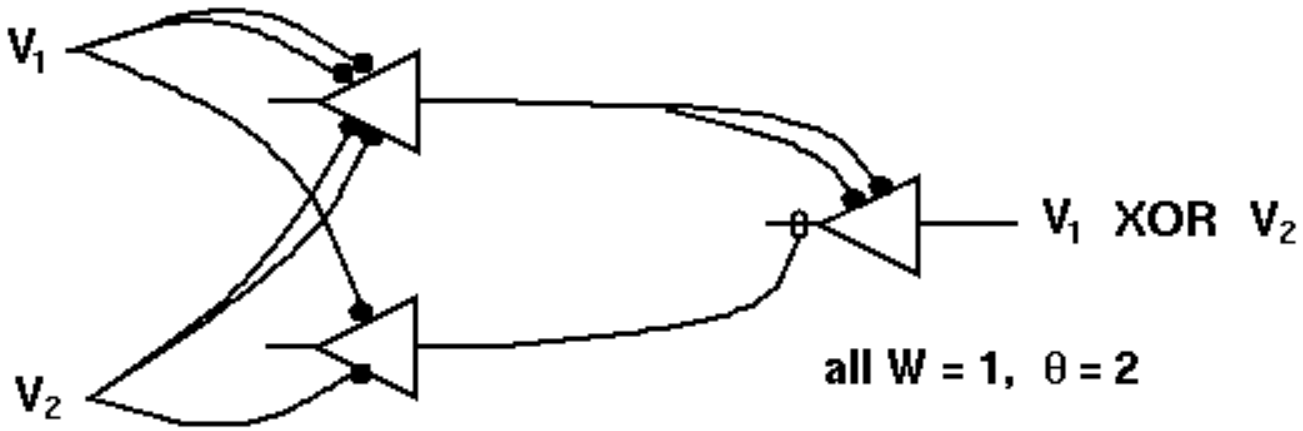
Talos

Golem

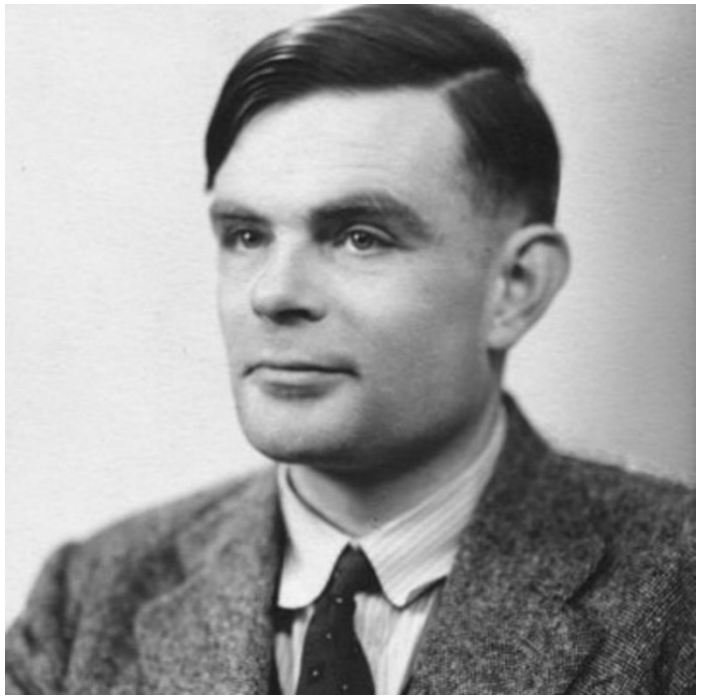
Automatons

R.U.R.

# 1940-1950: During the Birth of Computation




Logical Neuron Model: McCulloch & Pitts 1943

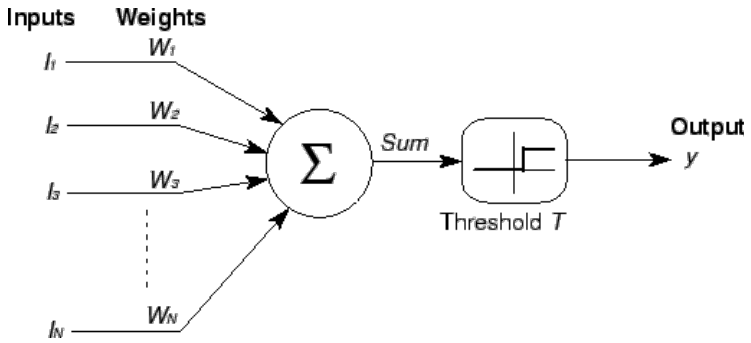


Alan Turing: Turing Test 1950

# 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

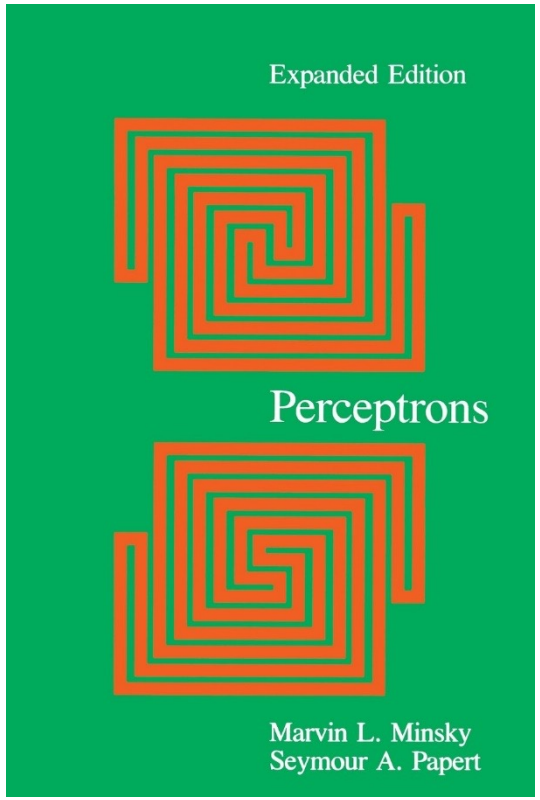
# 1960-1970: Logic vs Connectionism and the First Winter

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

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

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

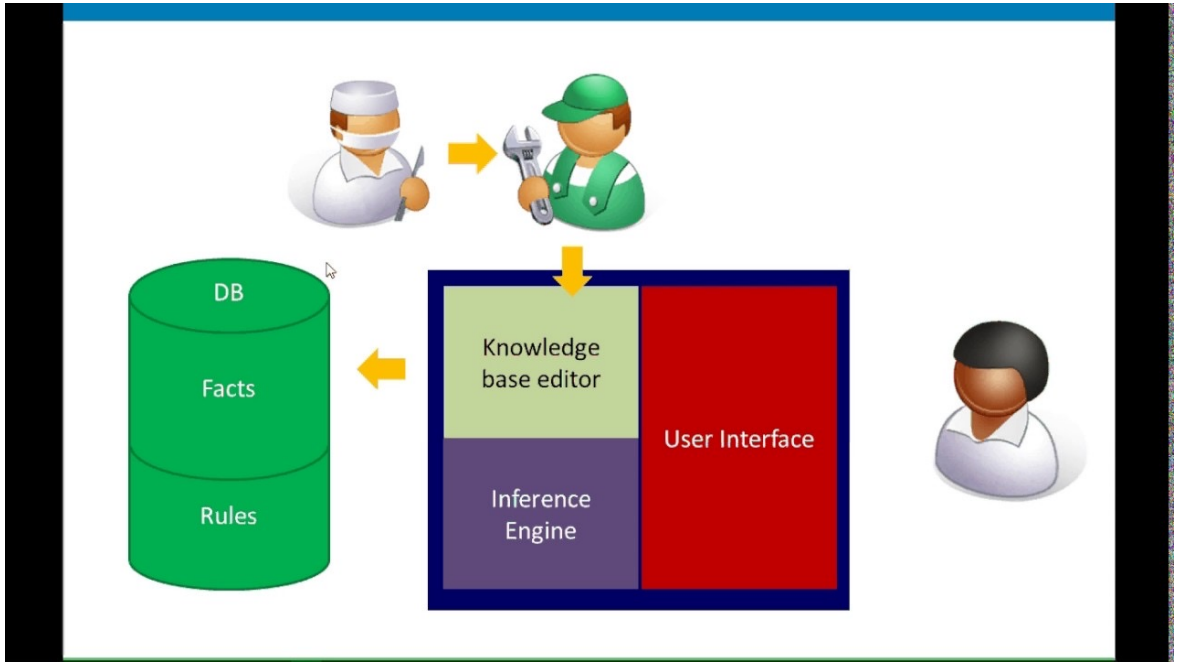
Robinson: First Resolution Algorithm for Logic 1965




Perceptron Book: Death of connectionism 1969

A sneaky invention: The backpropagation algorithm 1970

# 1970-1990: Logic vs Connectionism and the Second Winter



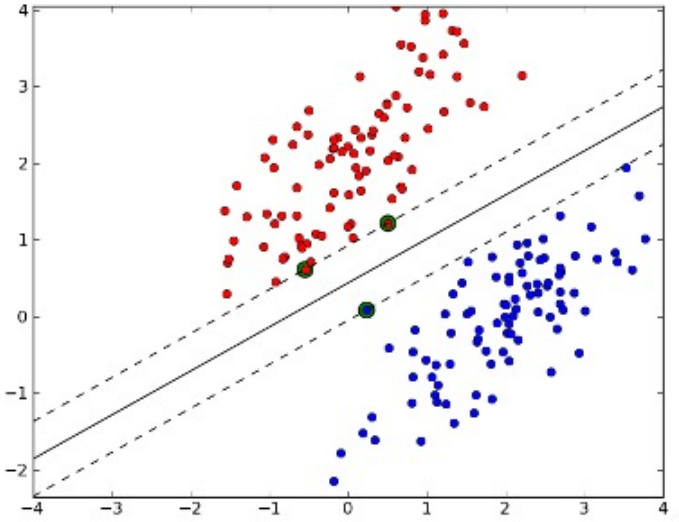

Expert Systems:
Knowledge + **Logic**

- Explosion of Academic Papers and Pilot Industrial Applications! (Until 80s)
- Fragility of certainty in logic: Disappointment and the second winter

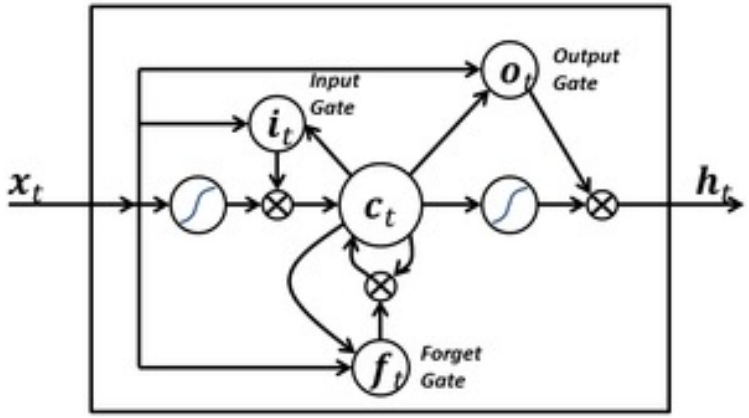
- Connectionism Rebirth: Backpropagation and advances in multi-layer neural networks (NNs)

# 1990-2005: Statistical Approaches and Machine Learning

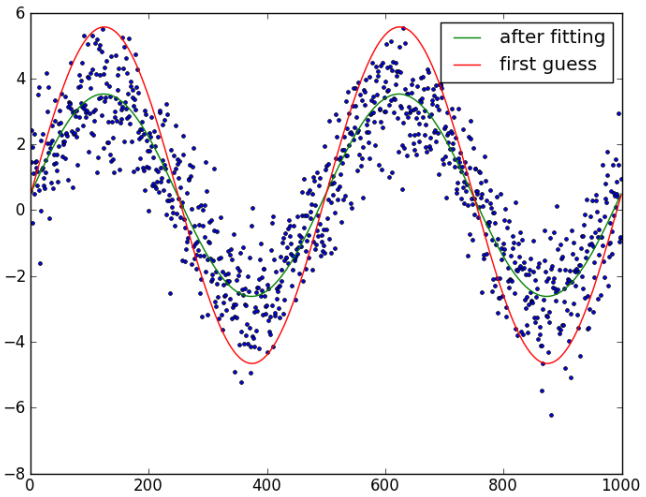
Probability and Uncertainty

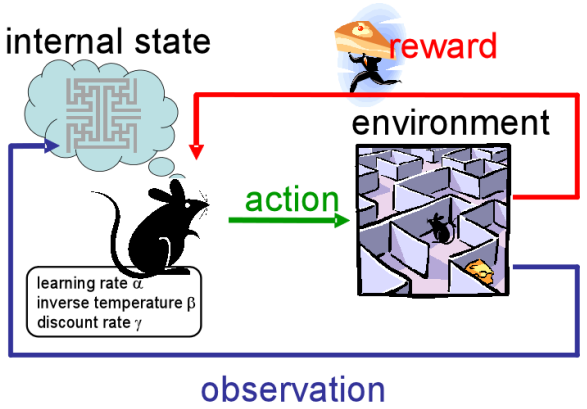


Vapnik: Support Vector Machines 1995 (2nd death of NNs)




More Complicated NNs



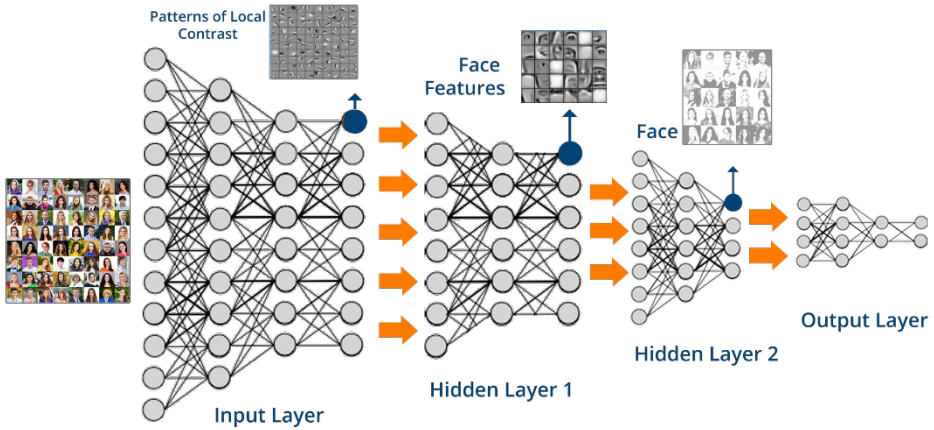

Reinforcement Learning

Deepblue 1997

# 2005-…: Big Data, Better Hardware and Deep Learning

**Explosion of applications!**

Big Data




Deep Learning

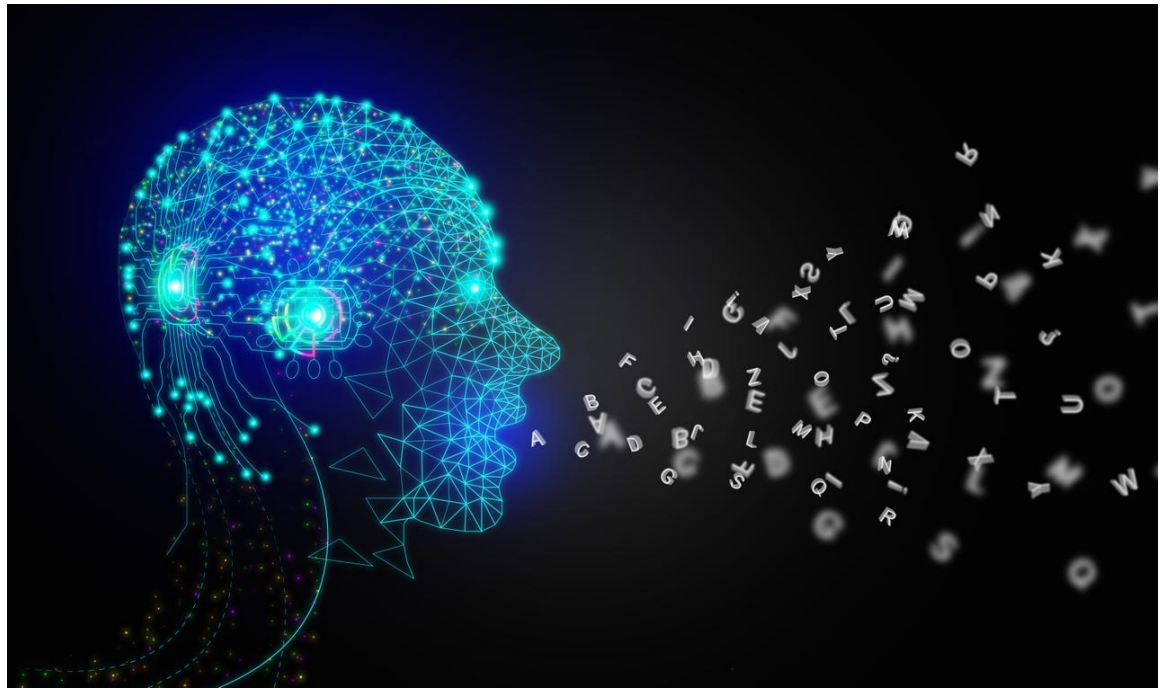

Deep Reinforcement Learning

Deep RL + Probabilistic Search

Specialized Hardware and Software

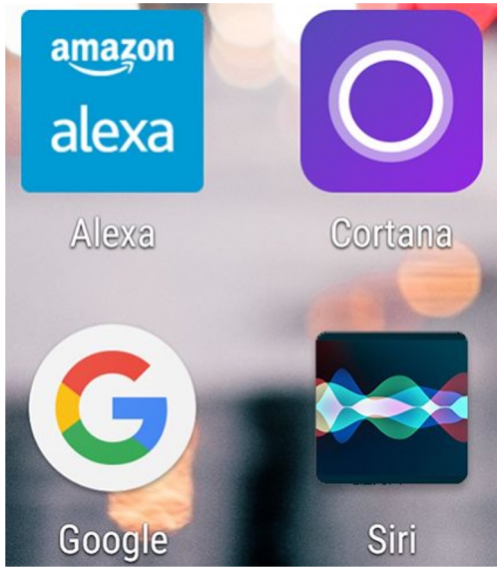
- We knew that DL would work back in 1980s
- Didn't know how to make it work!
- It turns out the main bottleneck was data and faster/cheaper computation

# Generative AI (2014-…)



Creating Images and Text from Input Prompts!

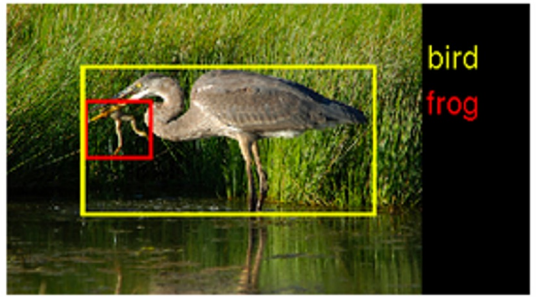
# NLP and Audio Examples

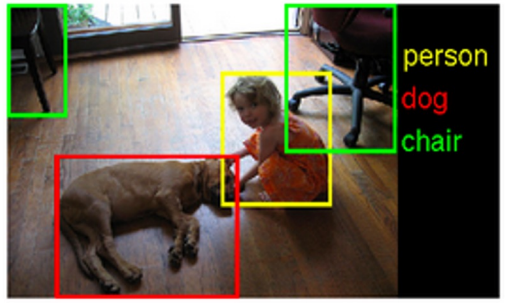




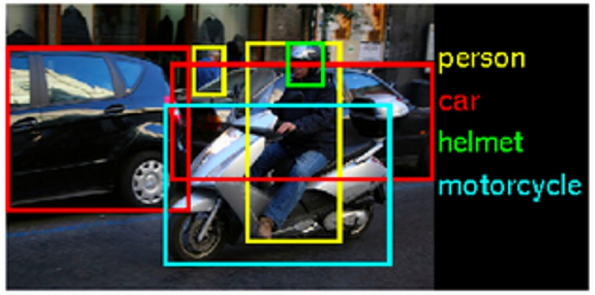
- Speech Recognition and Understanding
- Text-to-Speech
- Sentiment Detection
- Text Generation
- Speech Generation
- Song Generation
- Extremely Capable Chatbots
- Personal Assistants
- Translation
- …

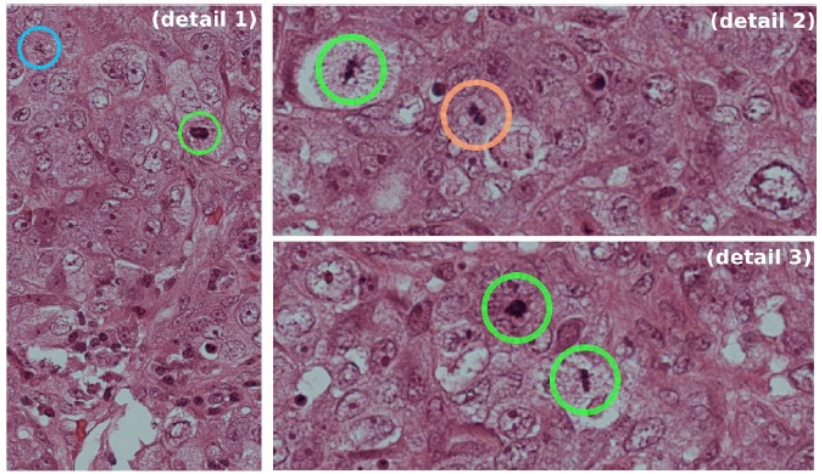
# Computer Vision







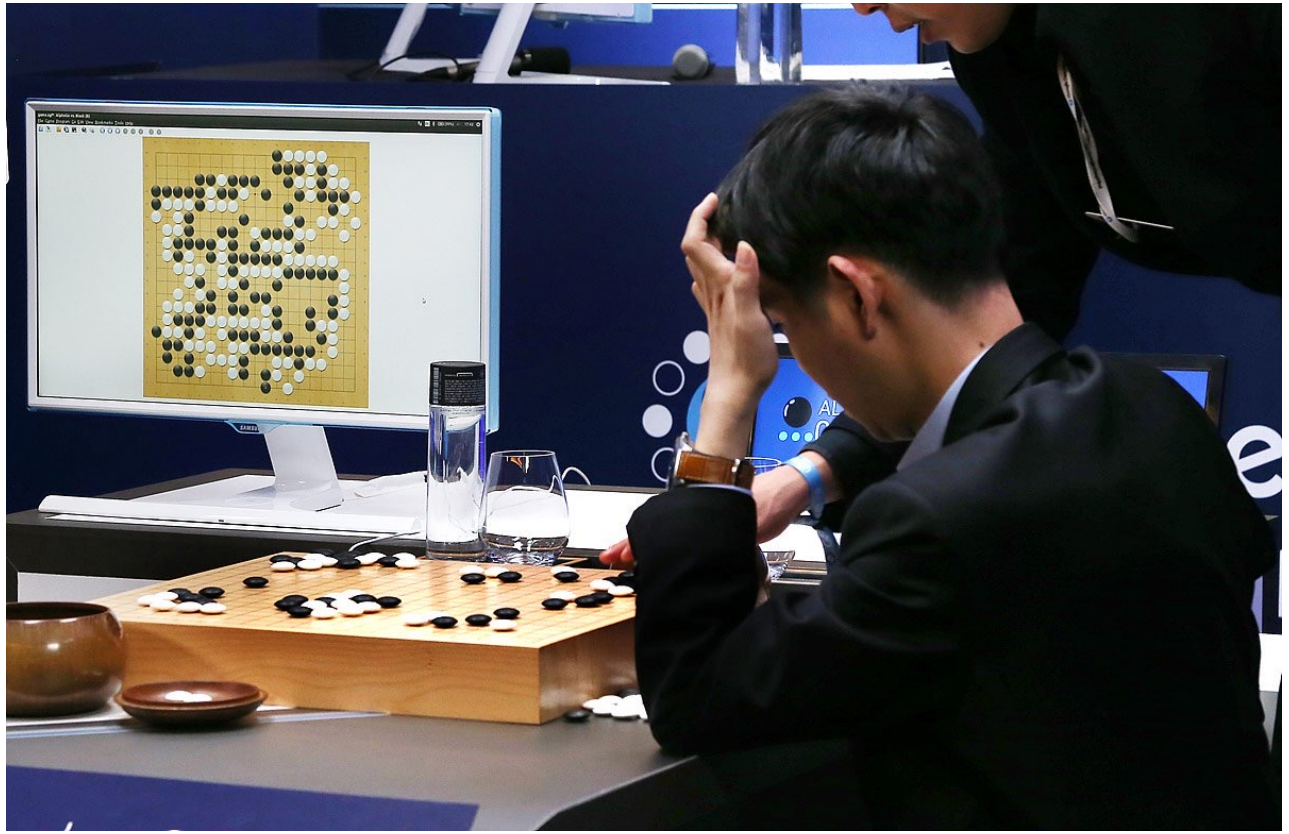

- Object Detection
- Object Tracking
- Sentiment Detection
- Demographics Prediction
- Pose Estimation
- Anomaly Detection
- Image Generation
- Image Editing
- Image Enhancement
- Medical Decision Aids
- …

# This Person Does not Exist

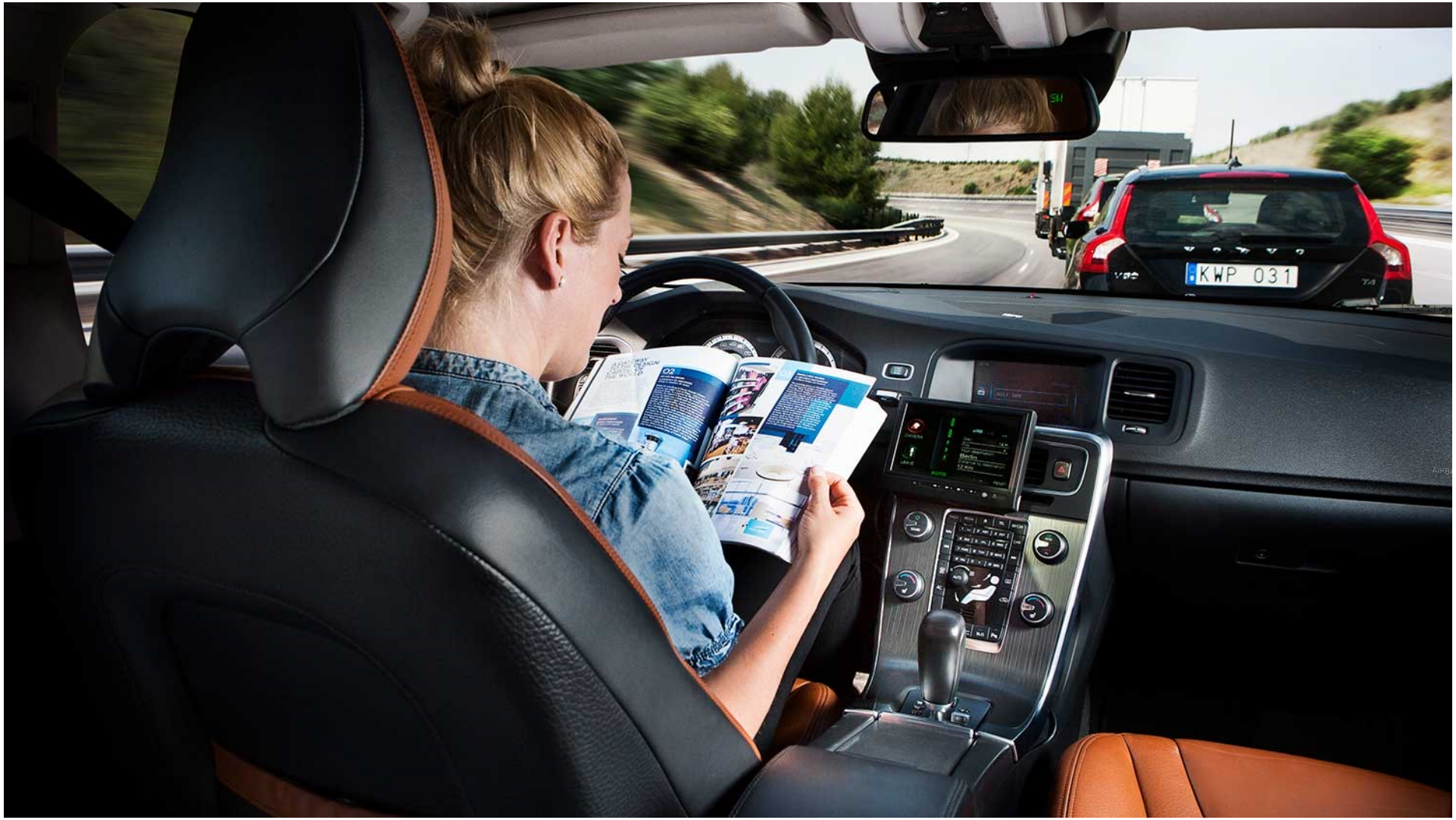
# “Foundation Models”

- Ungraded Homework: Self-Investigate Foundation Models

# Game Playing

# Autonomous Driving

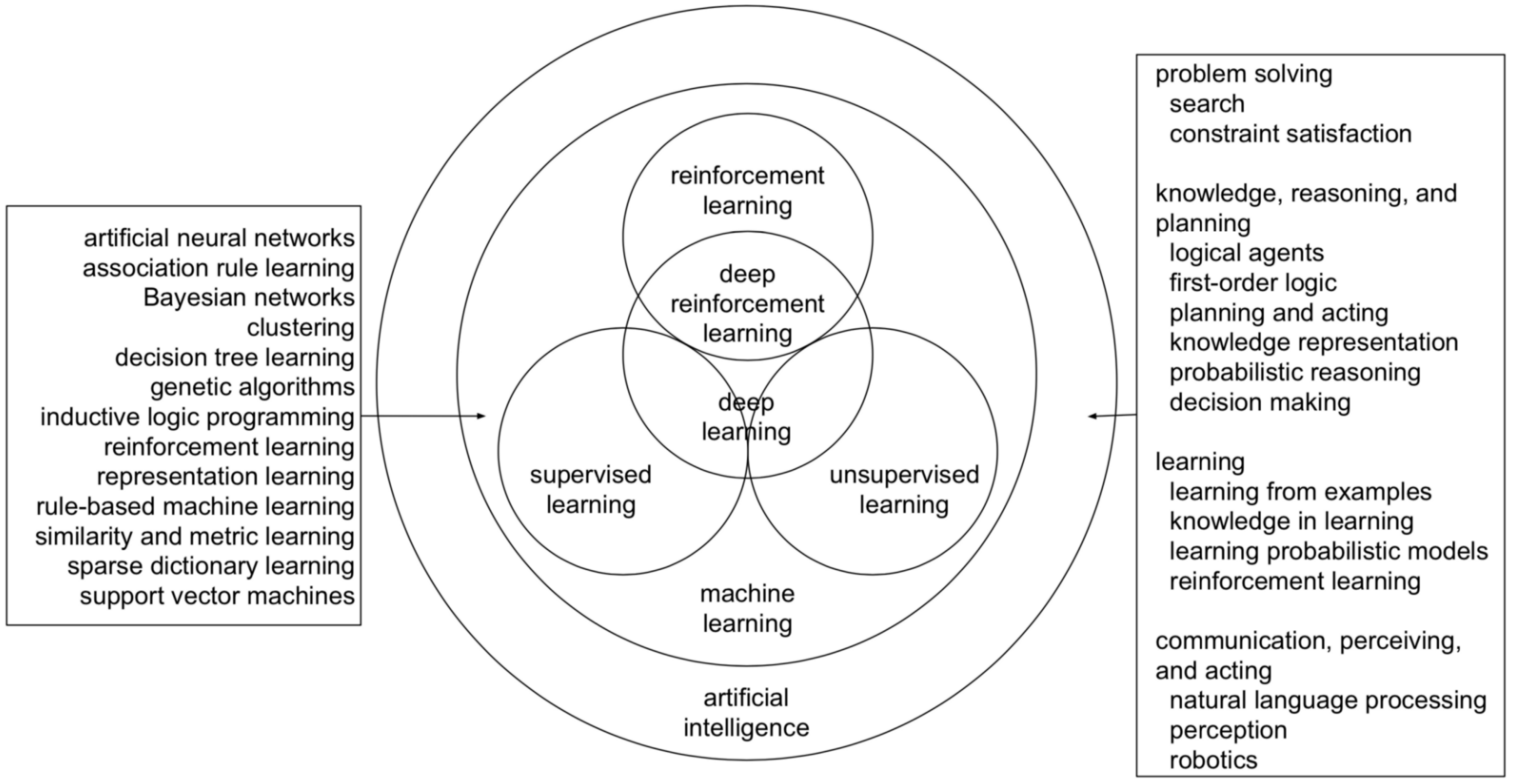


# Note about AI

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

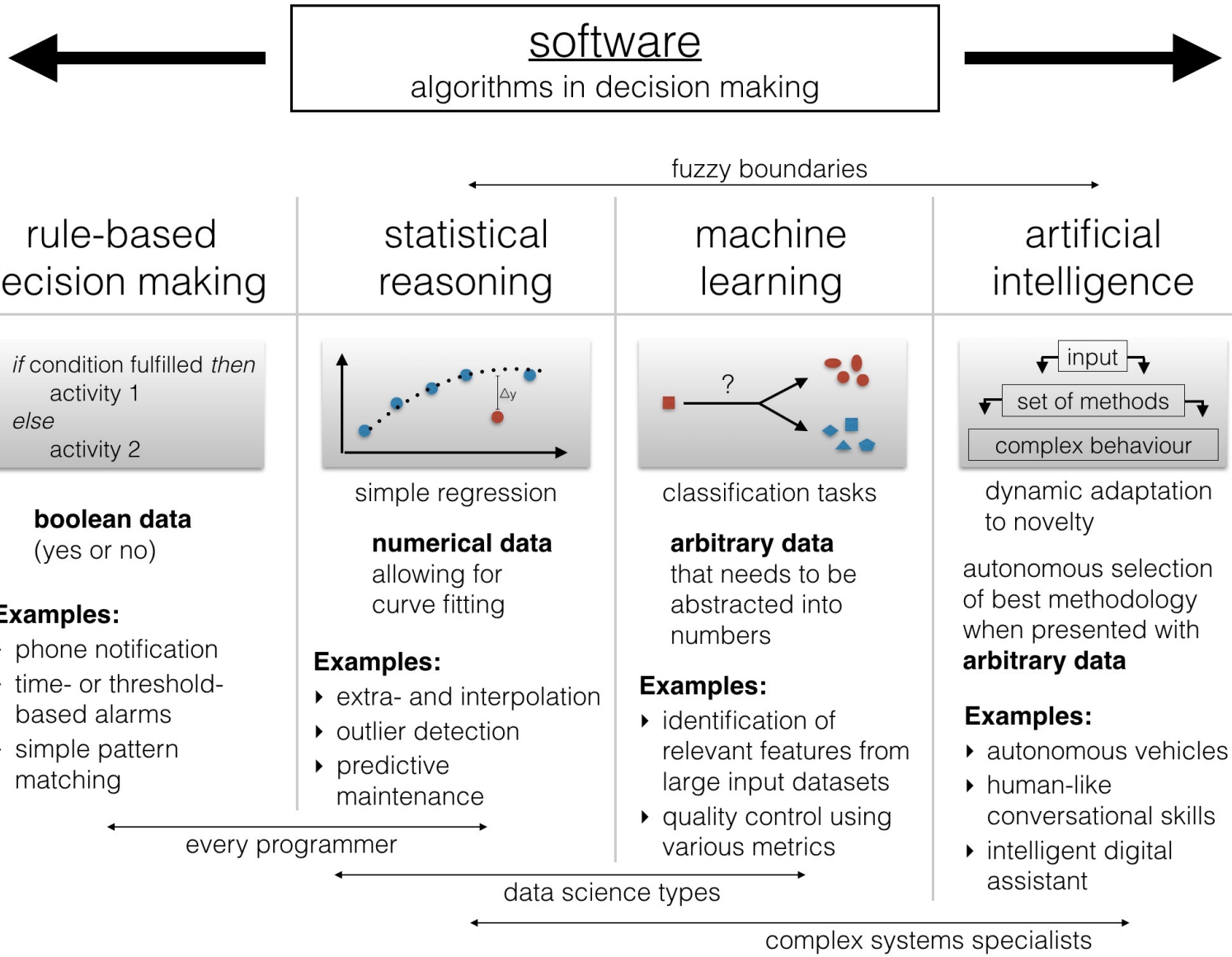
- As we have seen AI is an ever-changing field
- Current trend is ML, especially DL
- Getting back to its decision-making roots: RL

- This class will provide a broad overview
- We have multiple fundamental and multiple applied ML courses at Koç!

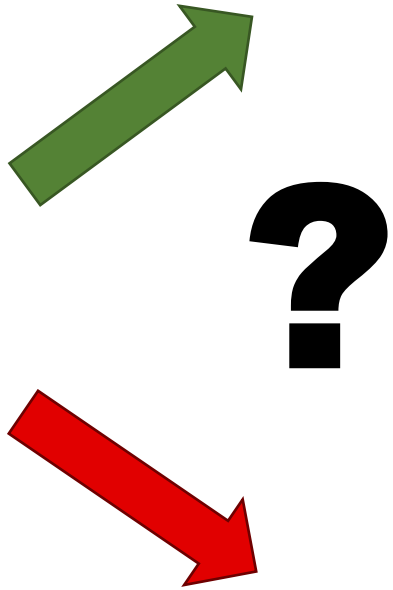



Yuxi Li, Deep Reinforcement Learning, https://arxiv.org/abs/1810.06339, 2018

# An Incomplete Summary of Decision-Making Algorithms

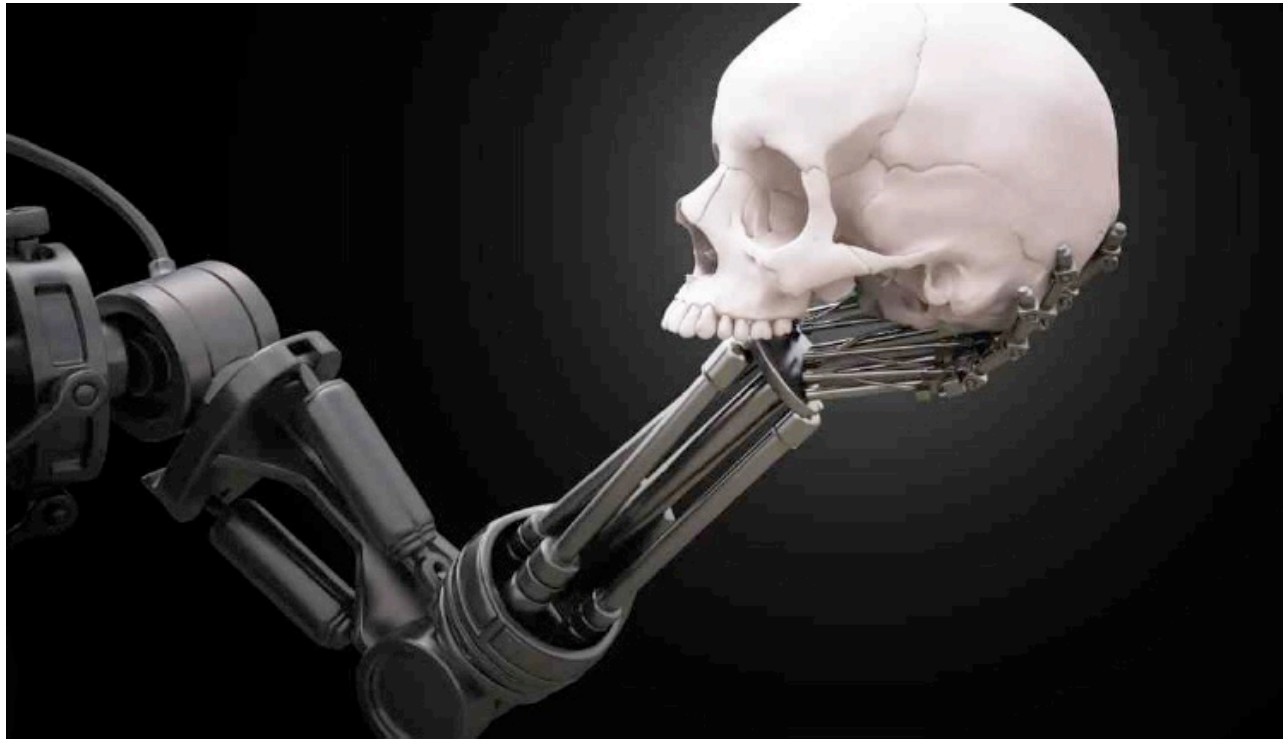



Next growth locomotive?




Is the winter coming?

# 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

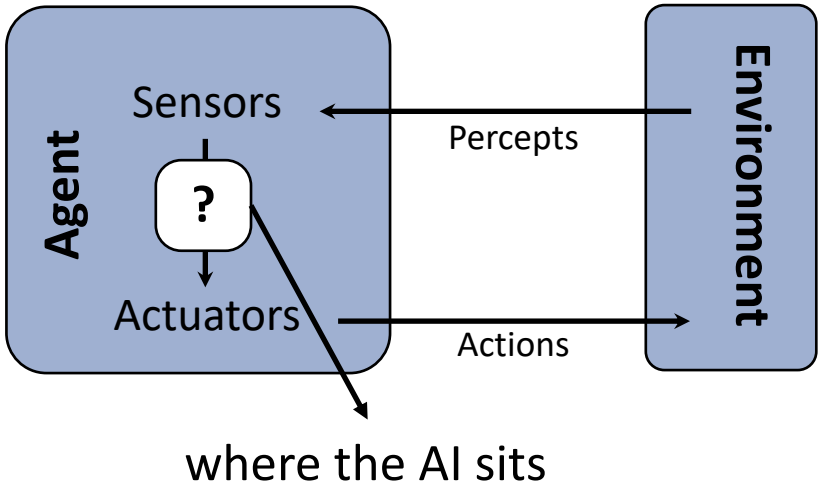
- **Formally:** An autonomous entity that exists in some kind of *environment* and that *perceives* and *acts*.

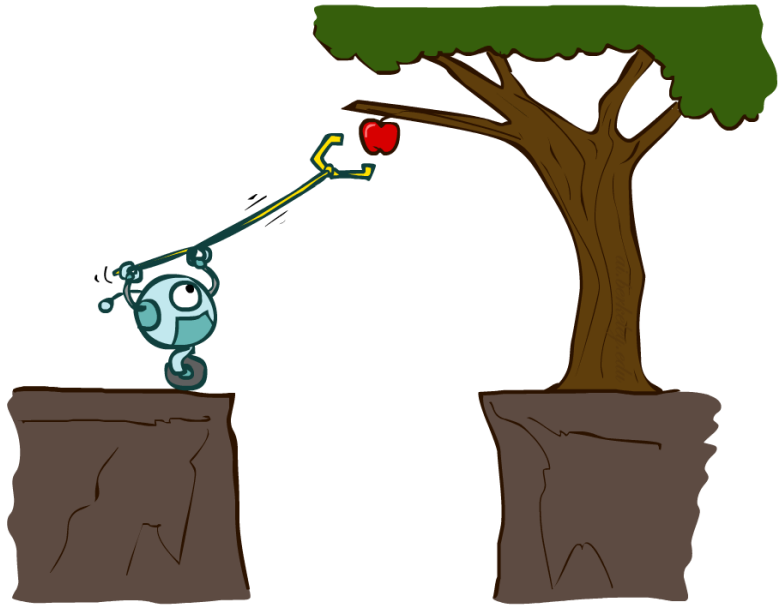
# Rational Agent

- A **rational** agent selects actions that maximize its (expected) utility

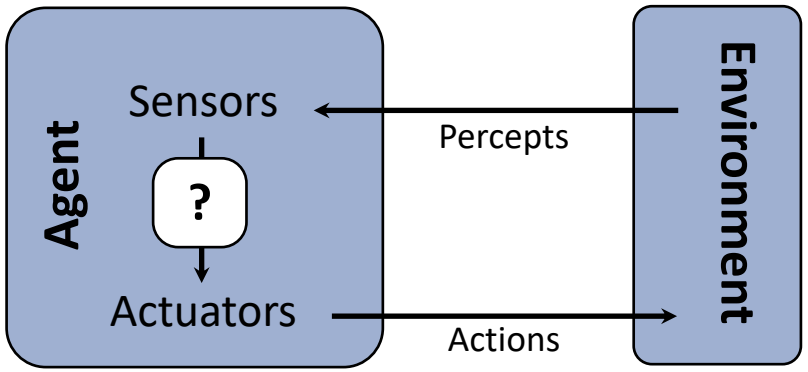
- AI: Mapping percept histories to actions (deciding which action to take)

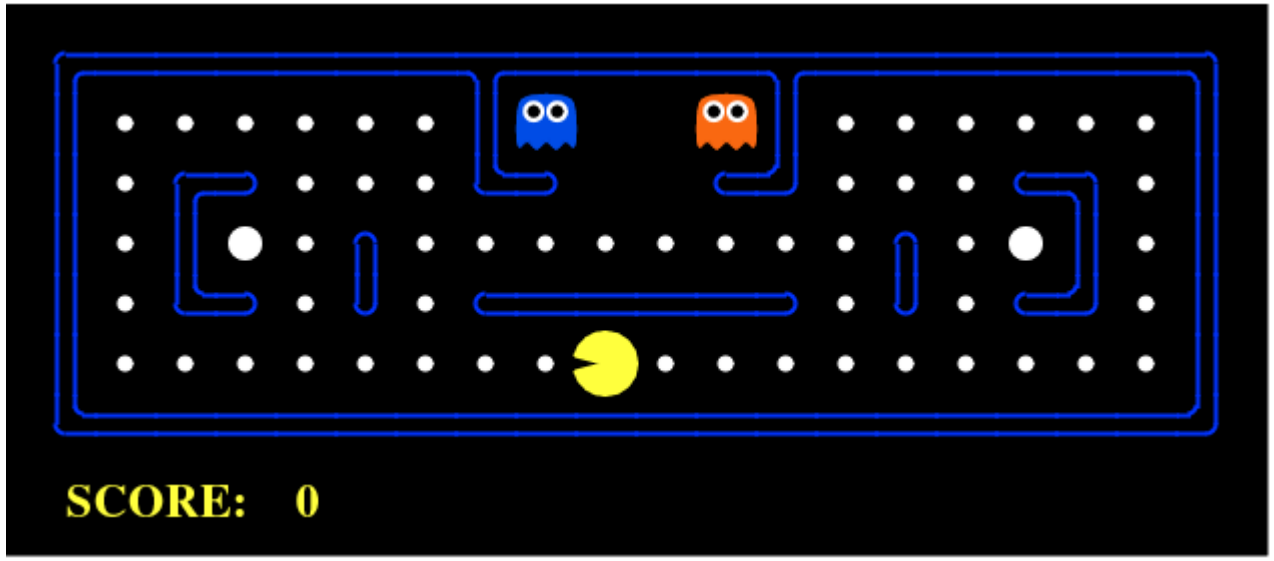
- Four concepts that dictate how an agent selects rational actions:
  - Utility
  - Environment
  - Actuators/Actions
  - Sensors/Percepts



# 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