

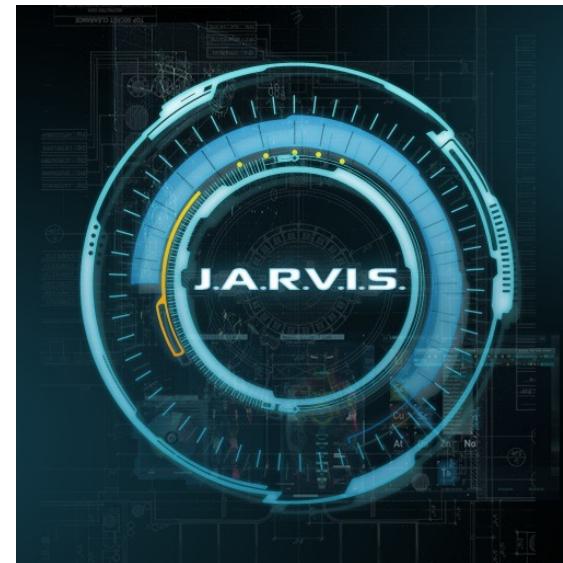
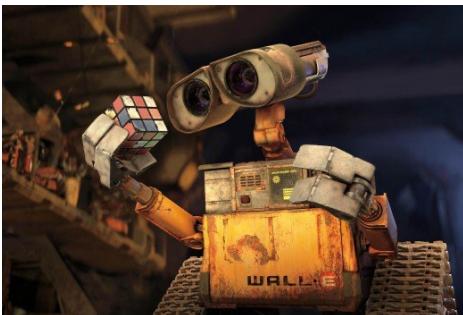
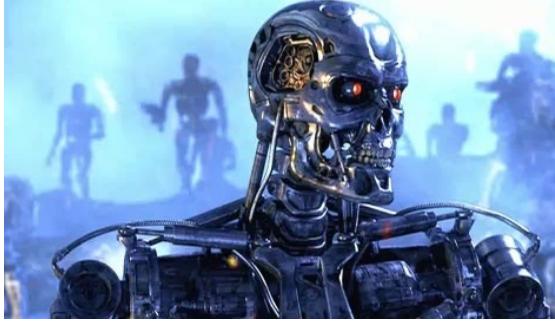
COMP 341

Introduction to Artificial Intelligence



Asst. Prof. Barış Akgün
Koç University

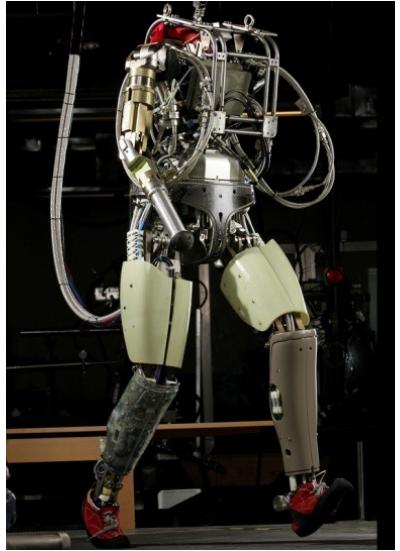
Expectations



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



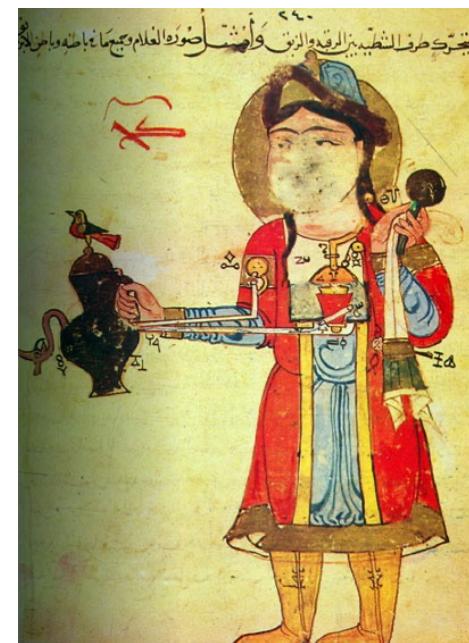
AI Before Computation



Talos



Golem

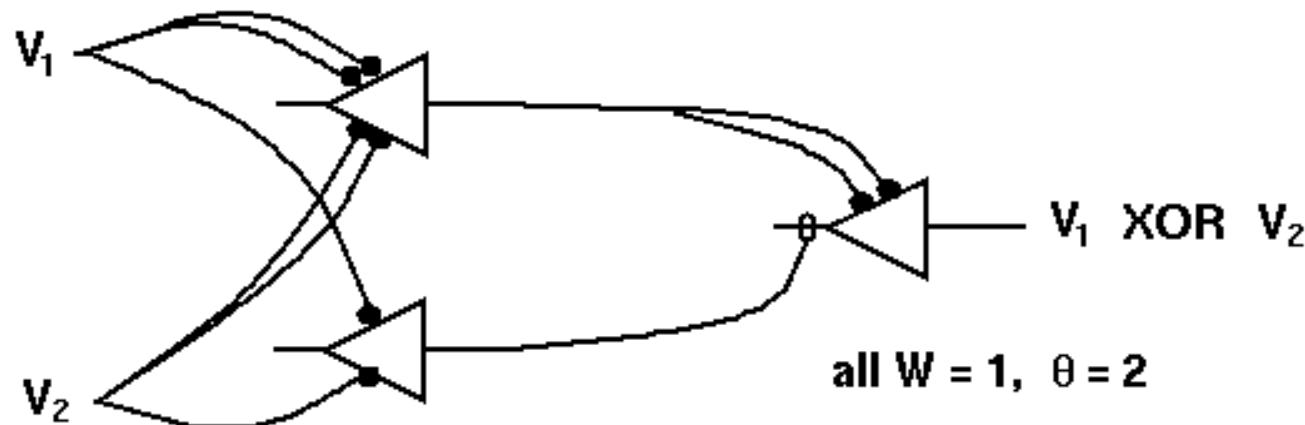


Automatons

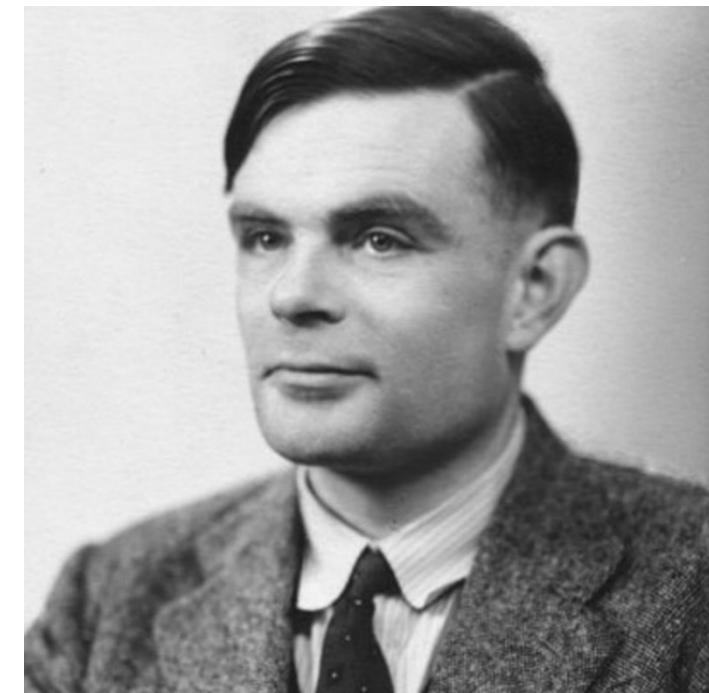


R.U.R.

1940-1950: During the Birth of Computation

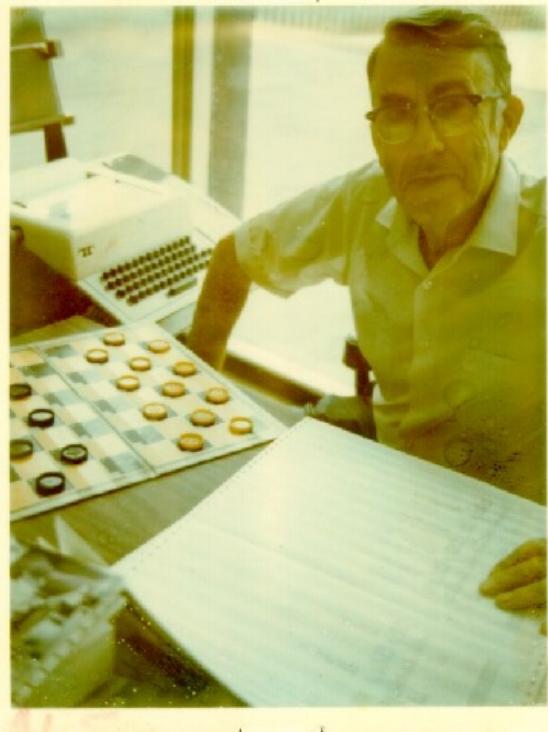


Logical Neuron Model: McCulloch & Pitts 1943



Alan Turing: Turing Test 1950

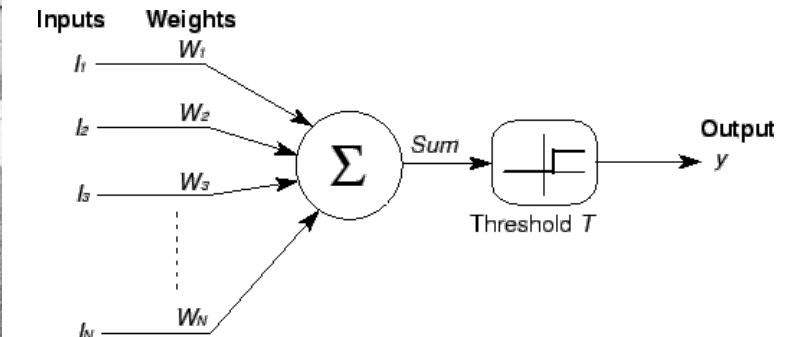
1950-1960: Birth of AI



Samuel: Playing Checkers 1953
Also first ideas of ML!



Dartmouth Meeting 1956
Coined the term “AI”



Basic Neuron Model Perceptron 1958

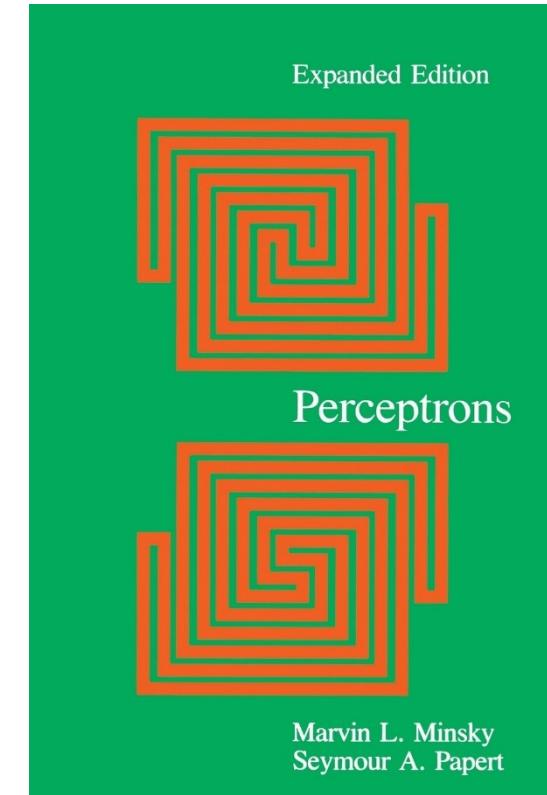
1960-1970: Logic vs Connectionism and the First Winter

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

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

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

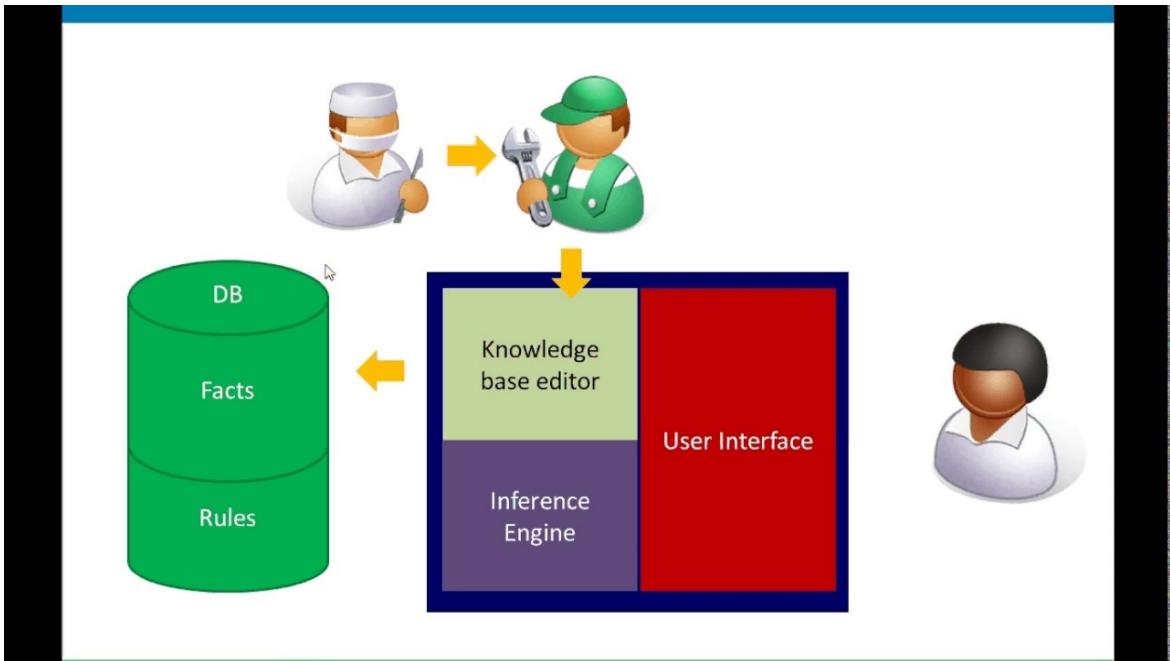
Robinson: First Resolution Algorithm for Logic 1965



Perceptron Book: Death of connectionism 1969

A sneaky invention: The backpropagation algorithm 1970

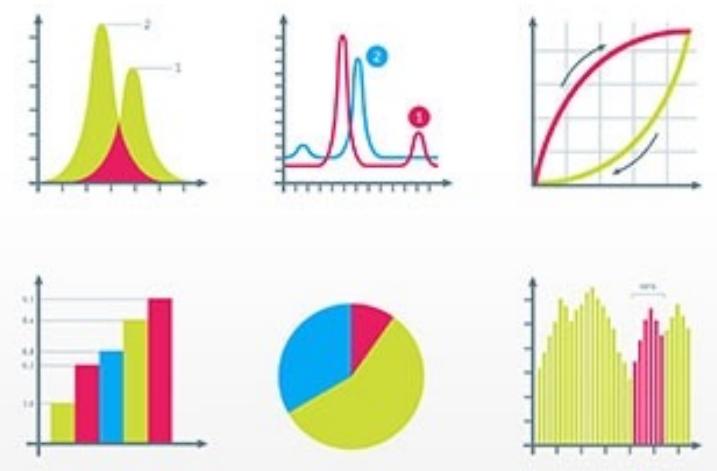
1970-1990: Logic vs Connectionism and the Second Winter



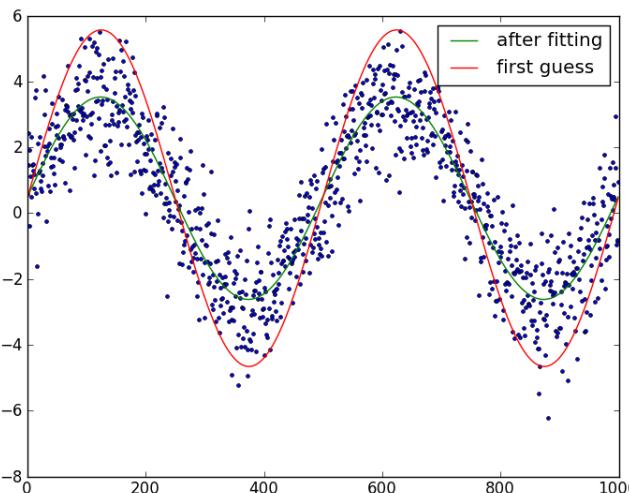
- Explosion of Academic Papers and Pilot Industrial Applications! (Until 80s)
- Fragility of certainty in logic: Disappointment and the second winter
- Connectionism Rebirth: Backpropagation and advances in multi-layer neural networks (NNs)

Expert Systems:
Knowledge + Logic

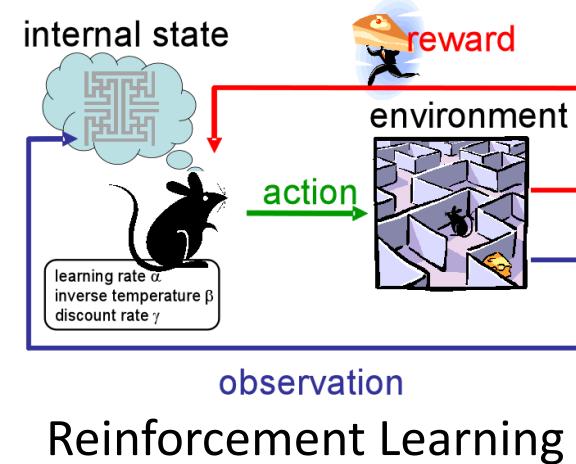
1990-2005: Statistical Approaches and Machine Learning



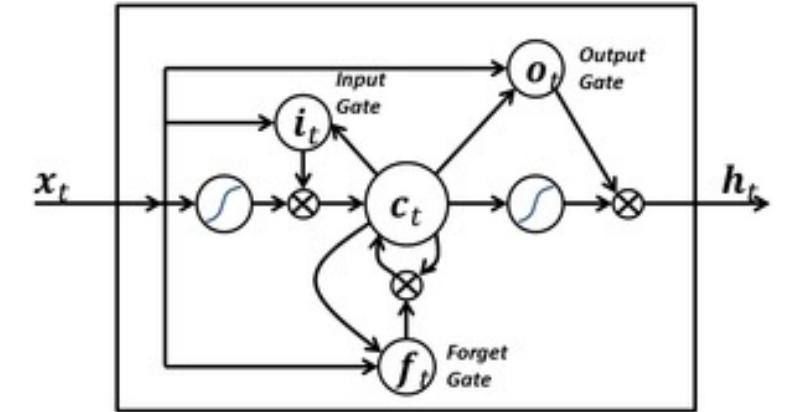
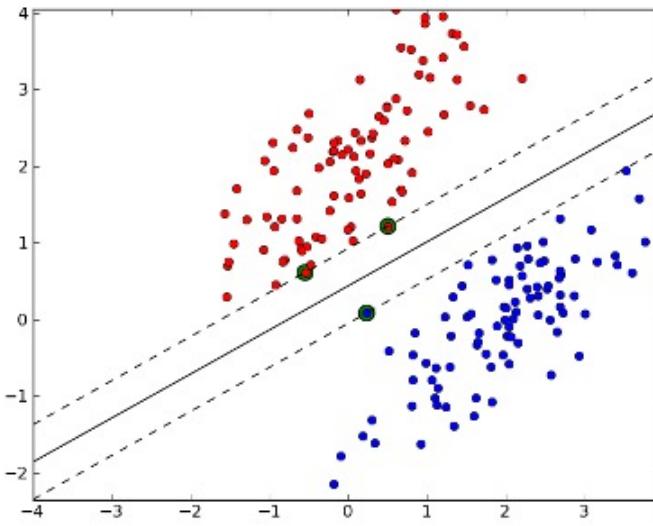
Probability and Uncertainty



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



Reinforcement Learning



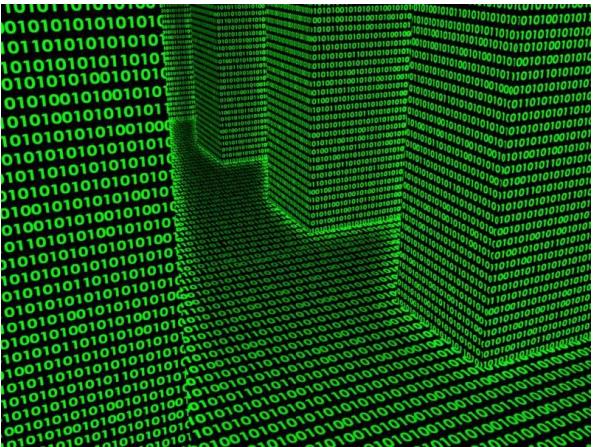
More Complicated NNs



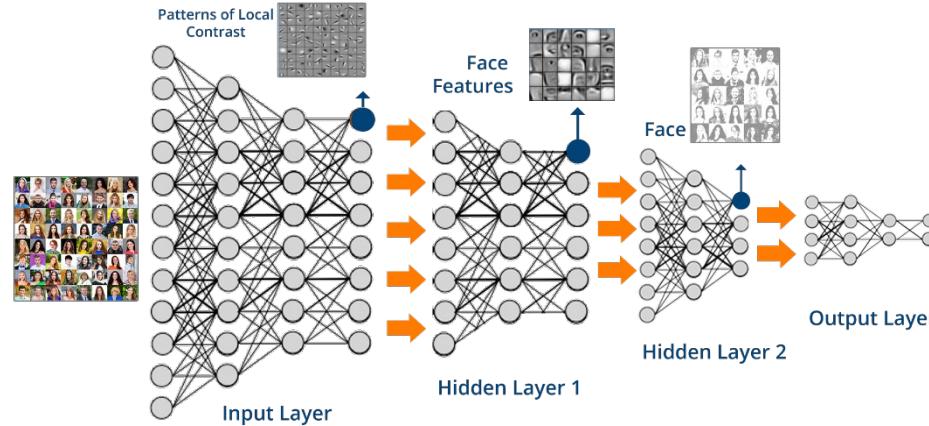
Deepblue 1997

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

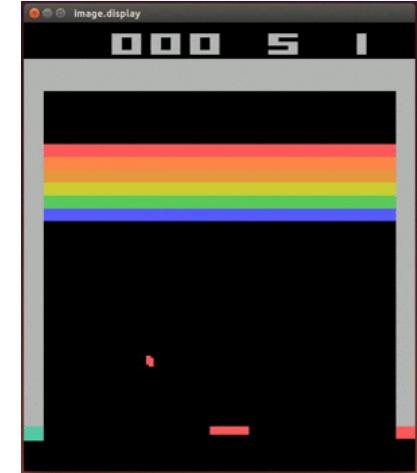
Explosion of applications!



Big Data



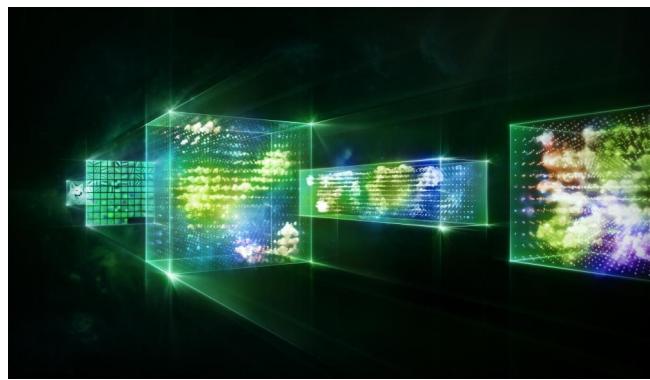
Deep Learning



Deep Reinforcement Learning



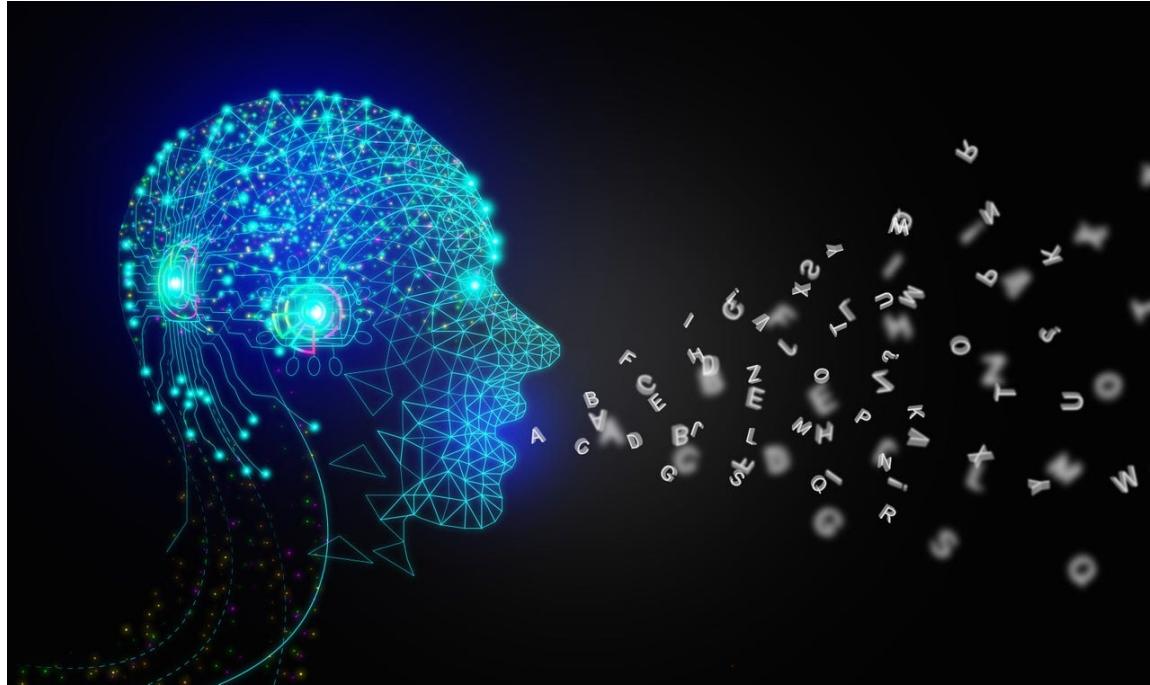
Deep RL + Probabilistic Search



Specialized Hardware and Software

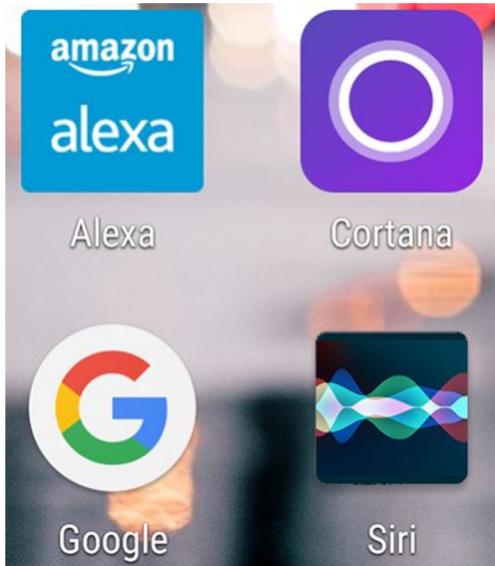
- We knew that DL would work back in 1980s
- Didn't know how to make it work!
- It turns out the main bottleneck was data and faster/cheaper computation

Generative AI (2014-...)



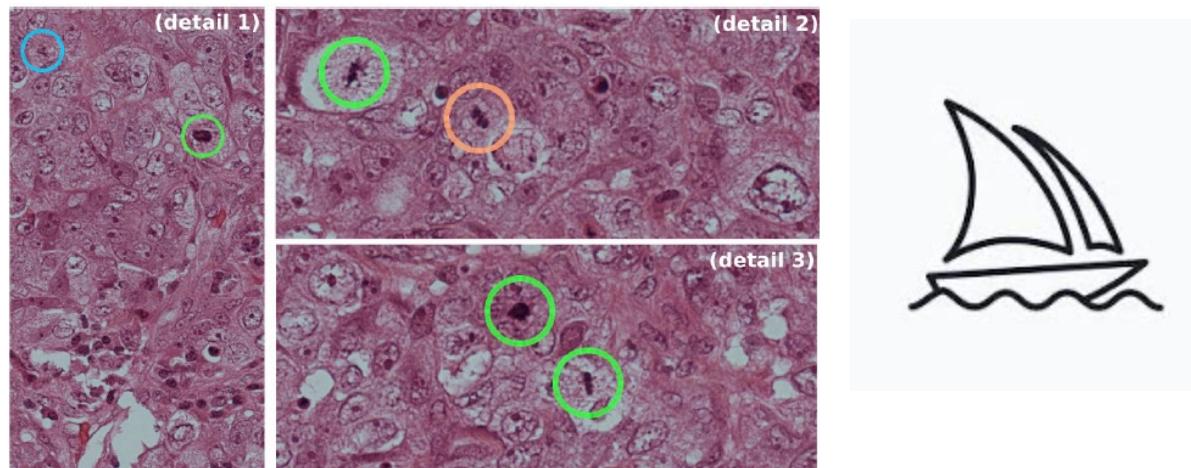
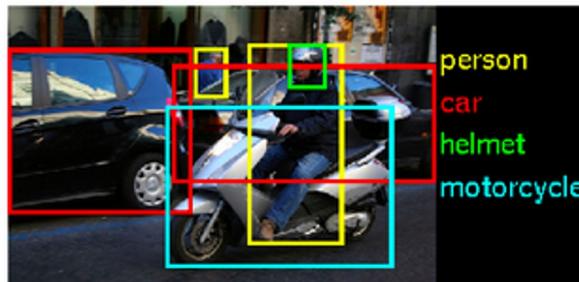
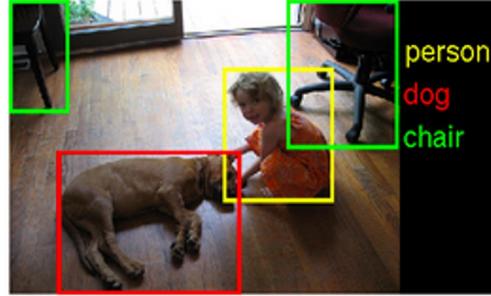
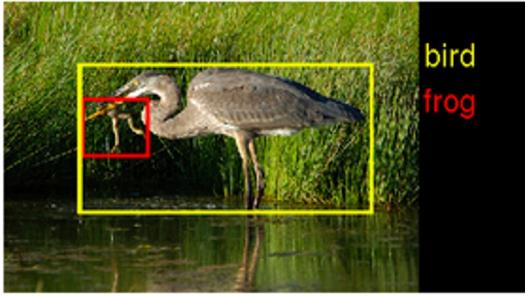
Creating Images and Text from Input Prompts!

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

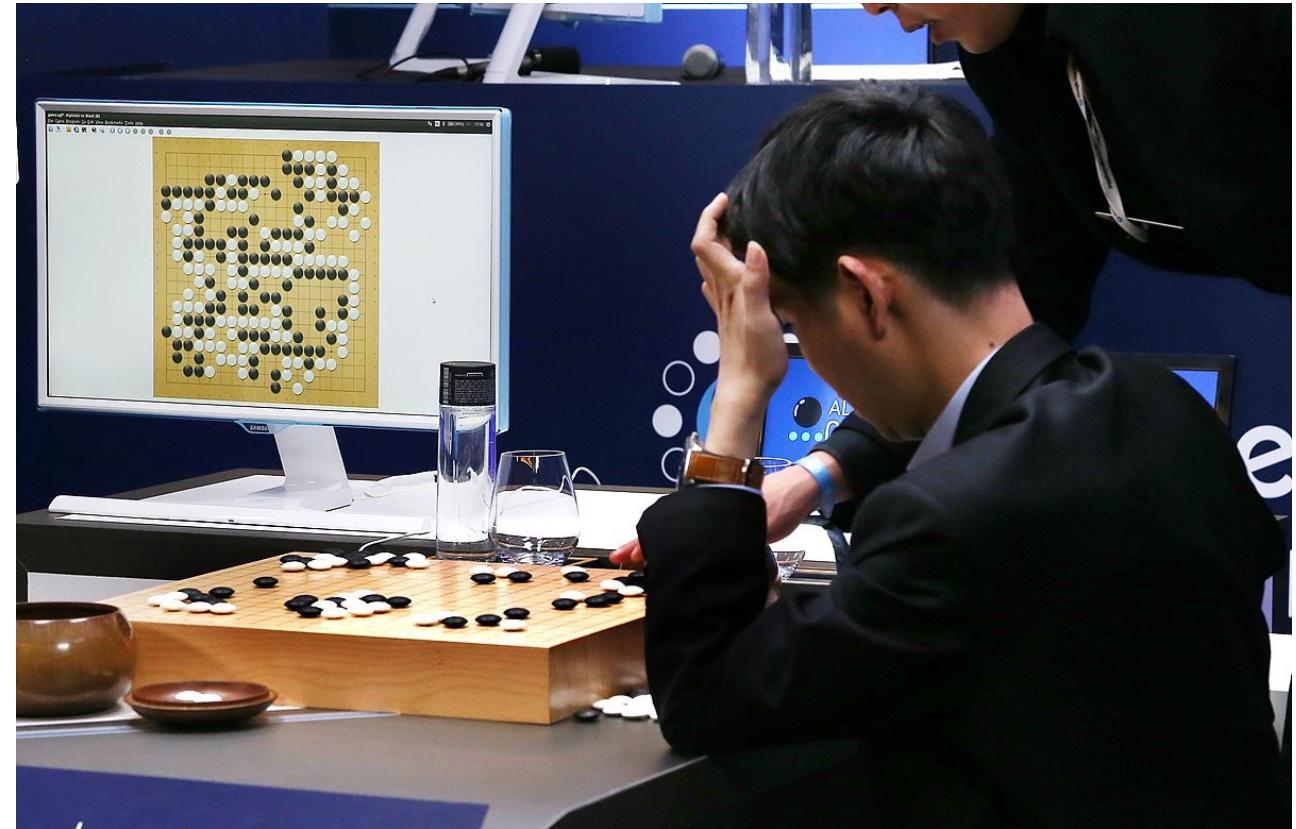


This is considered old now. Faces are pretty good now but there are still issues with “appendages”

“Foundation Models”

- Suggested exercise: Self-Investigate Foundation Models

Game Playing



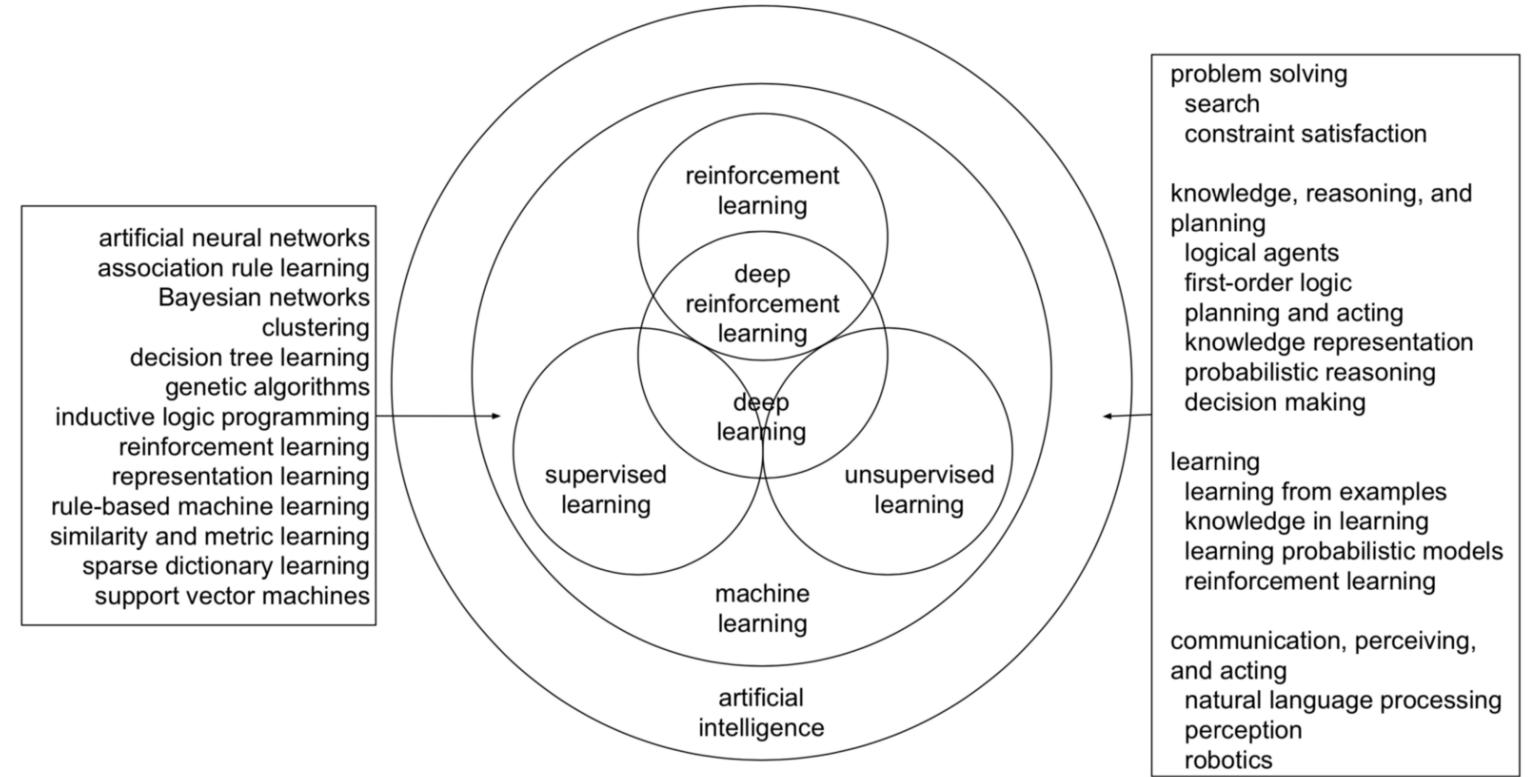
Autonomous Driving



Note about AI

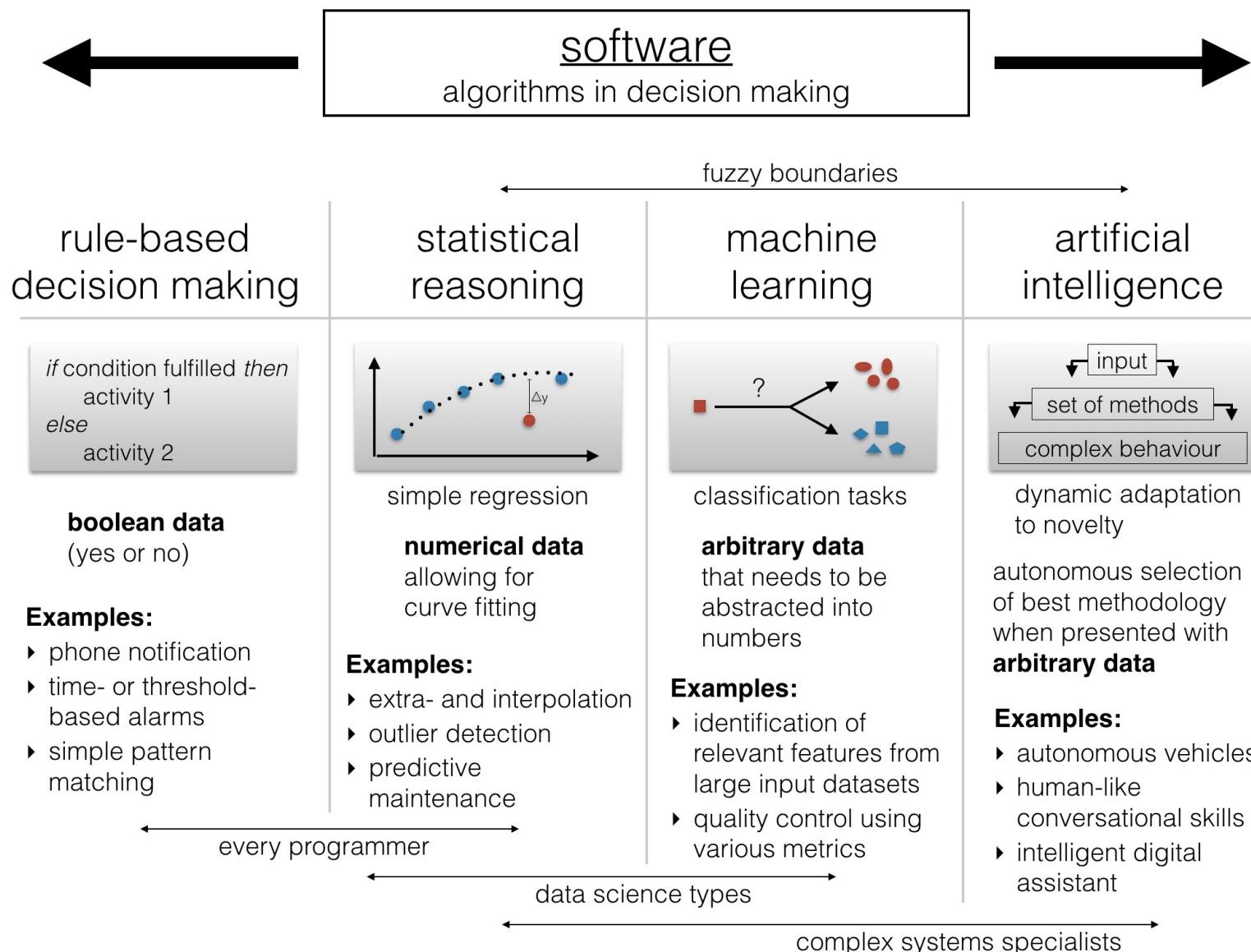
- As we have seen AI is an ever-changing field
- Current trend is ML, especially DL
- Getting back to its decision-making roots: RL
- This class will provide a broad overview
- We have multiple fundamental and multiple applied ML courses at Koç!

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



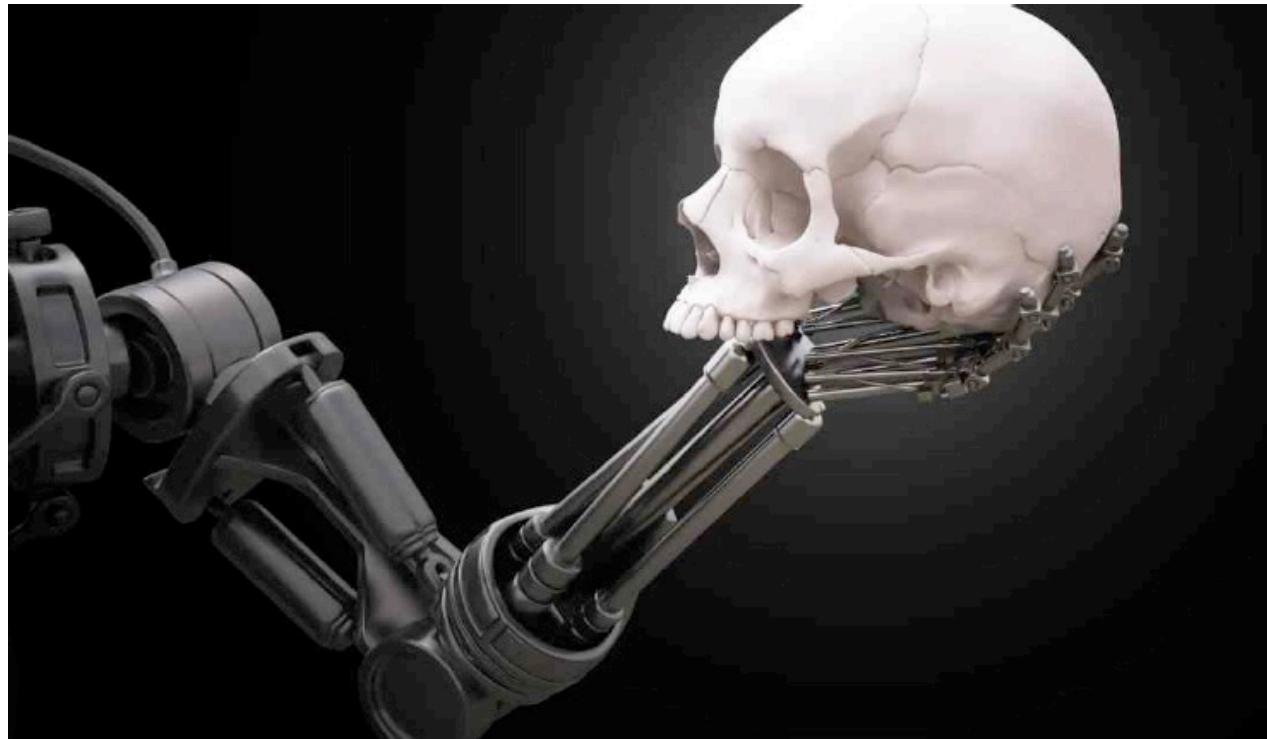
Yuxi Li, Deep Reinforcement Learning, <https://arxiv.org/abs/1810.06339>, 2018

An Incomplete Summary of Decision-Making Algorithms



Next growth locomotive?

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

Achieving the best outcome:

Acting rationally

vs

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?

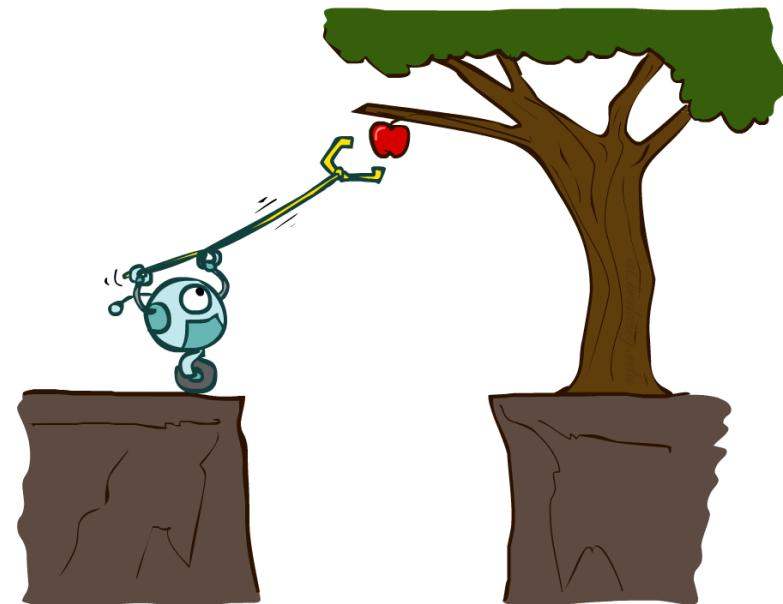
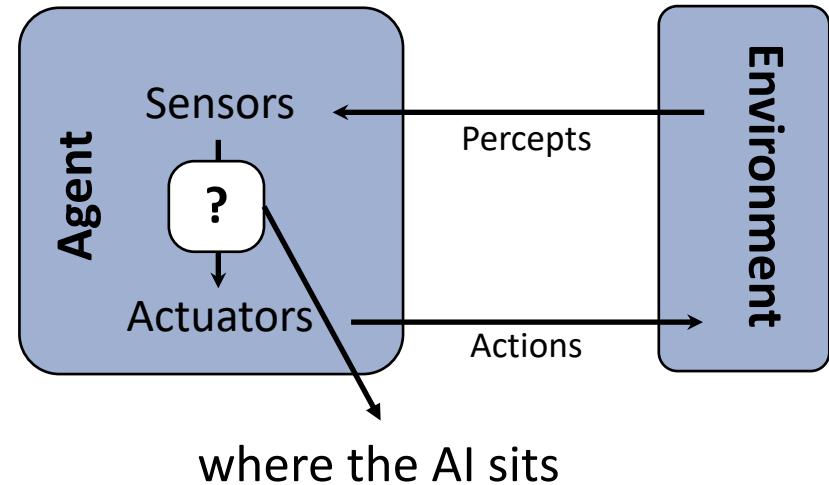
- Achieving goals
- Only affected by the decisions/actions made
- Defined by an “external” measure
 - Good: Performance, reward etc.
 - Bad: Cost, risk etc.
 - Let’s call it **utility** from now on
- **Being rational: Maximize the (expected) utility!**
- E.g. (1) clean the kitchen, (2) in short amount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

What is an “Agent”?

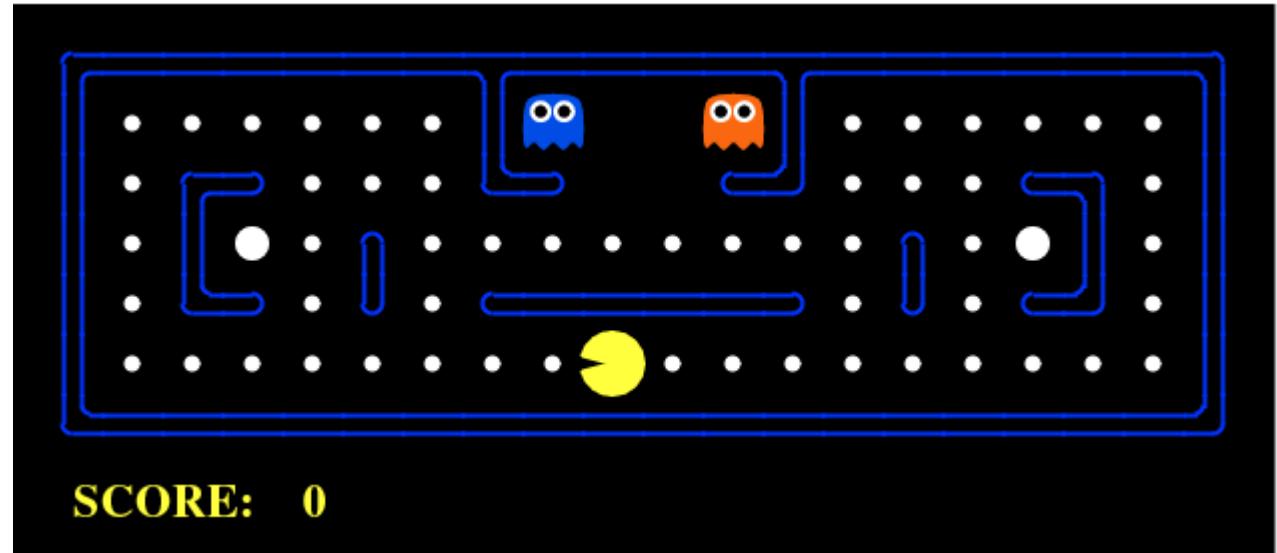
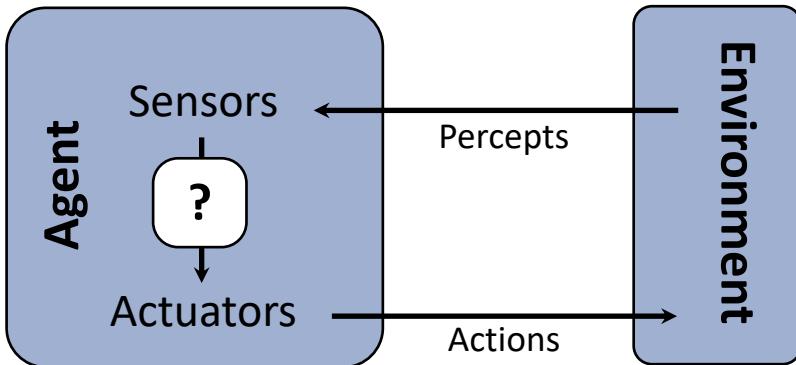
- What do you think when you hear the word “agent”?
 - Secret agent (007)
 - Travel agent
 - Chemical agent
- “Something that can act” –generalization of the word “individual” to non-human things
- **Formally:** An autonomous entity that exists in some kind of *environment* and that *perceives* and *acts*.

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