IS 7033: Artificial Intelligence and Machine Learning

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Agenda

- Course Logistics
- Course Overview
- What is AI?

Purpose of this class

- To teach you the basics of artificial intelligence
- To excite you about AI (beyond Deep Learning)

Course Objectives

- At the end of this course, you should
  - Be able to tackle real-world tasks with the appropriate techniques
  - Be more proficient at math and programming

Prerequisite

- Programming
- Discrete math, mathematical rigor
- Probability

Coursework

- Homework (60%)
  - Introduction
  - Graph
  - Probabilistic Graph Models
  - Bayesian networks
  - Markov Hidden Models
  - Reinforcement
  - Logic
- Project (40%)

Milestones: proposal, progress report, poster session, and final report

The Honor Code

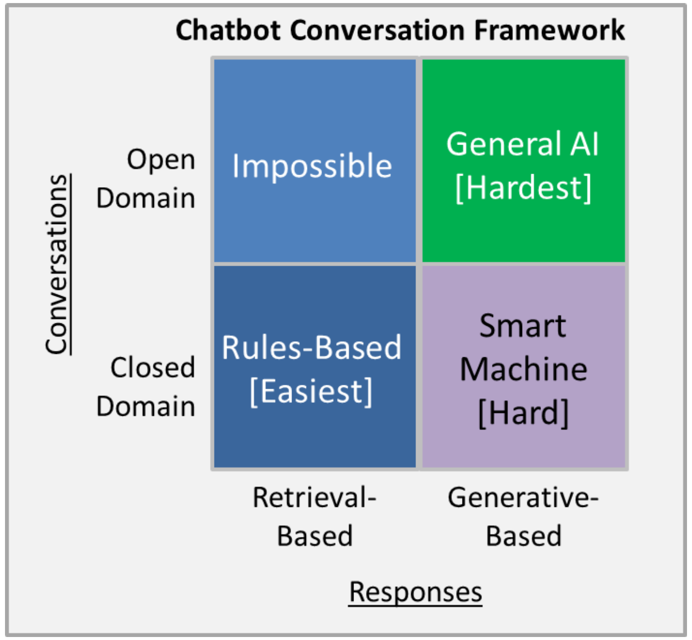
- Do collaborate and discuss together, but write up and code independently
- Do not look at anyone else’s writeup or code
- Do not show anyone else your writeup or code or post it online (e.g. GitHub)

Project – Chatbot

- Open domain – user can ask anything. There isn’t necessarily have a well-defined goal or intention.

The infinite number of topics and the fact that a certain amount of world knowledge is required to create reasonable responses makes this a hard problem. The chatbot **mitsuku** is the example for this.

- Closed domain – you are solving a particular business problem (ex: pizza bot, Banking, Medical bot, …)

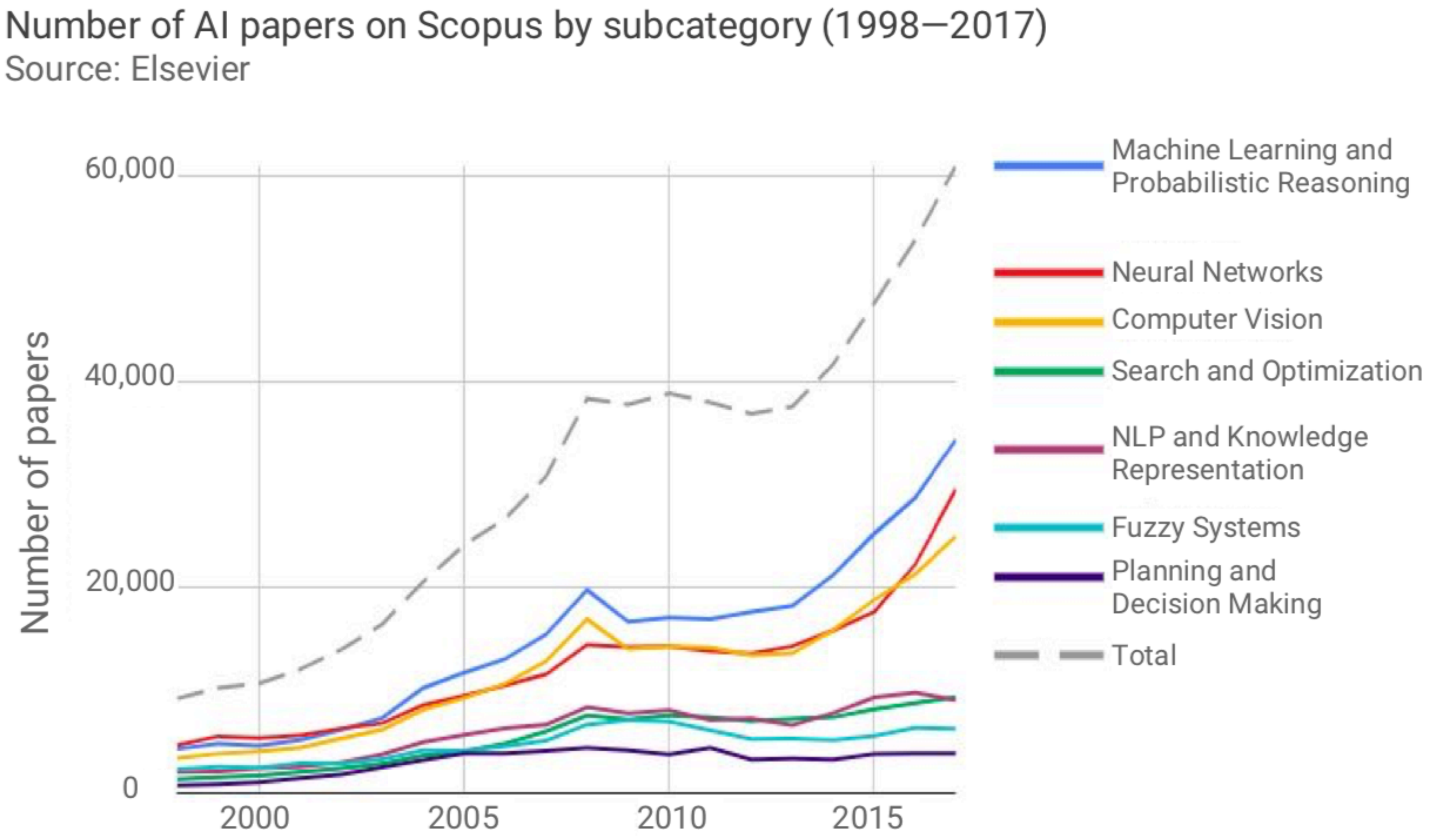


Projects – Computer Vision

- What is AI?
- Course overview?
- Course logistics?
- Optimization

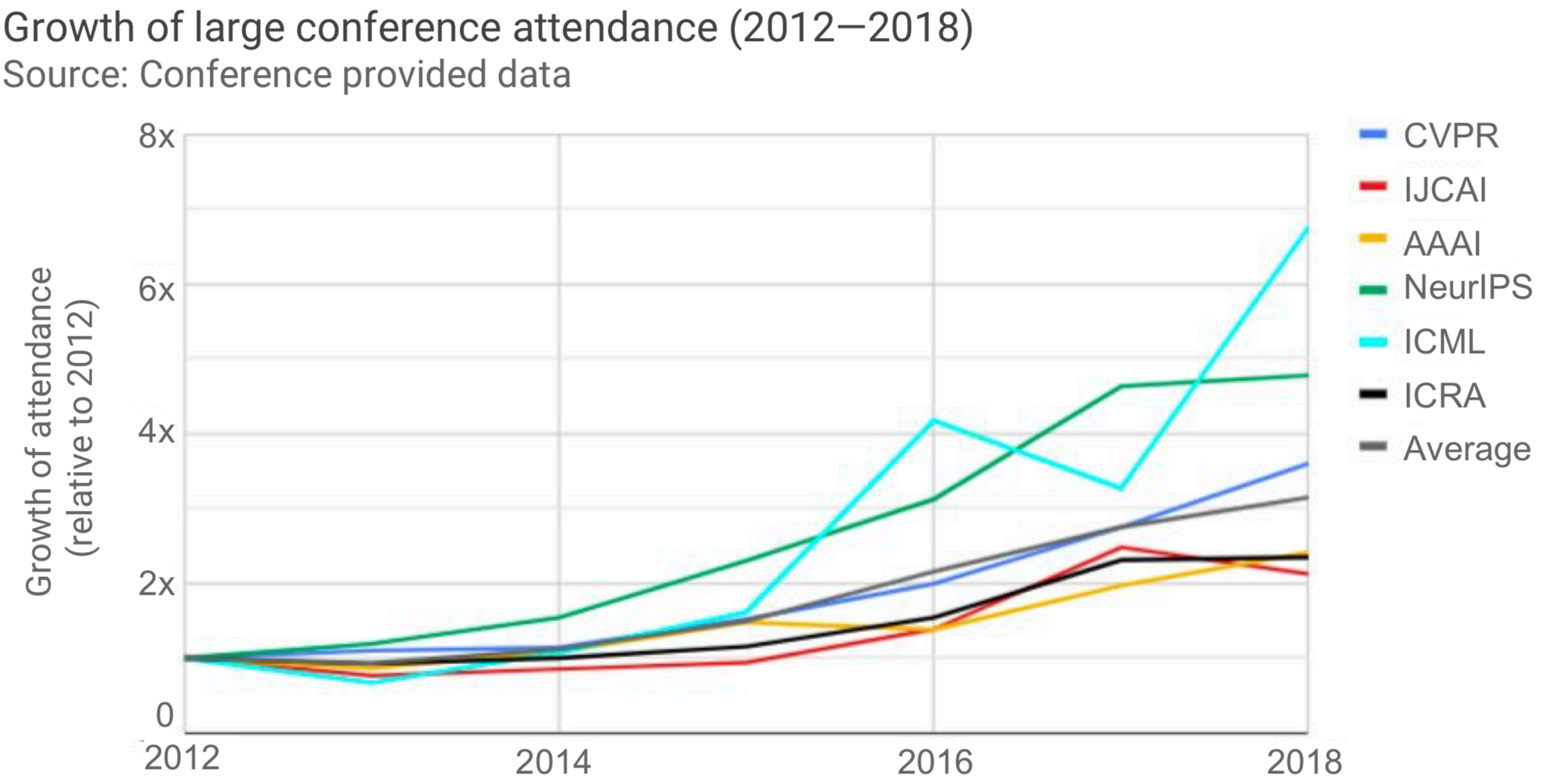
AI

Growth of annua
Source: Scopus
Growth in papers (relative to 1996)
9x
7x
5x
3x
1x

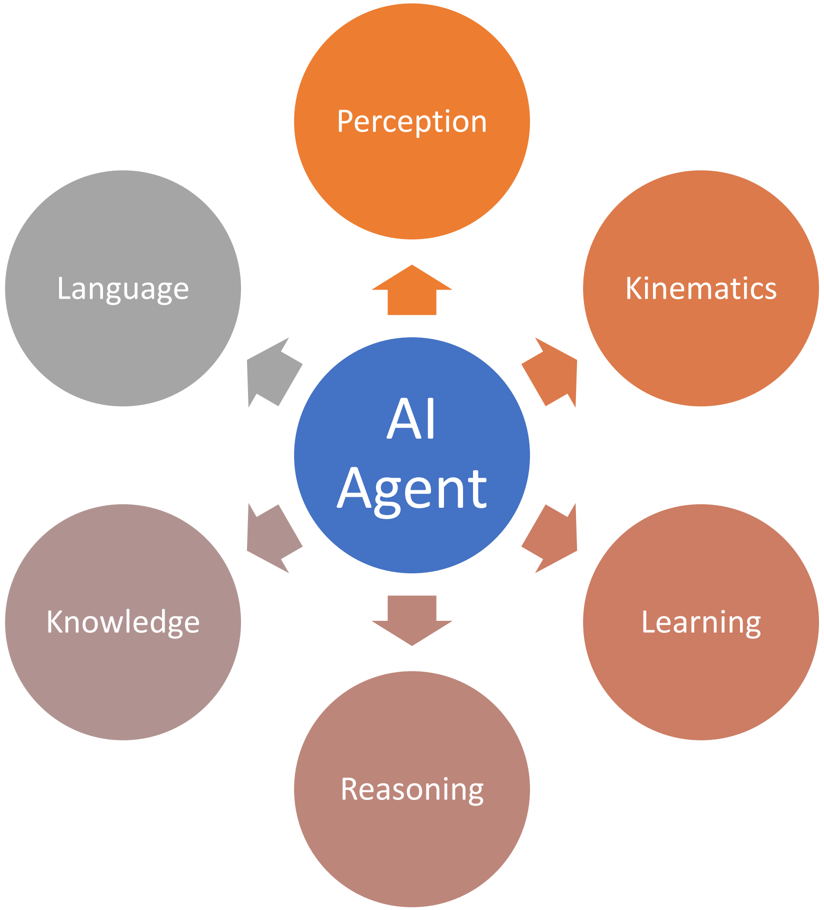


Number of AI papers on Scopus by subcategory (1998—2017)
Source: Elsevier
Number of papers
60,000
40,000
20,000
0
2000
2005
2010
2015
Machine Learning and Probabilistic Reasoning
Neural Networks
Computer Vision
Search and Optimization
NLP and Knowledge Representation
Fuzzy Systems
Planning and Decision Making
Total

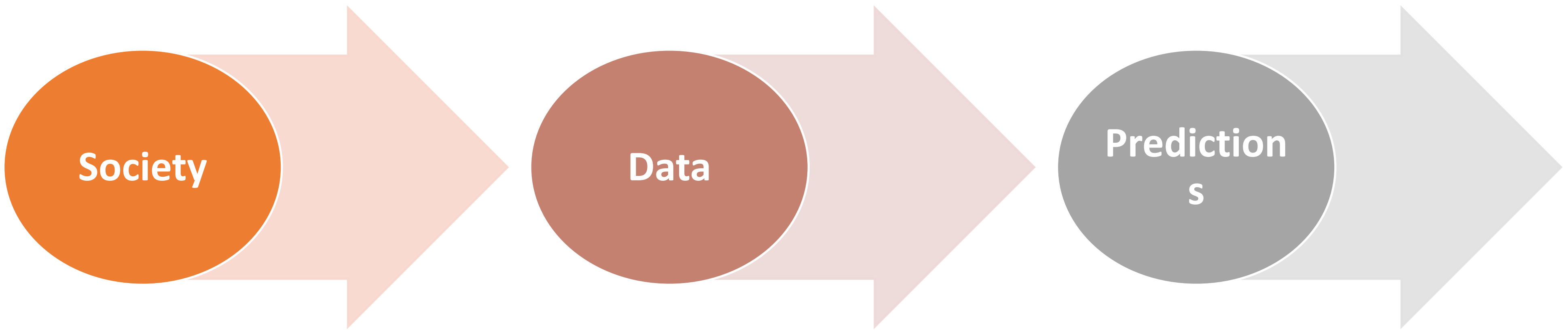
AI index


Growth of large conference attendance (2012—2018)
Source: Conference provided data
Growth of attendance
(relative to 2012)
8x
6x
4x
2x
0
2012
2014
2016
2018
CVPR
IJCAI
AAAI
NeurIPS
ICML
ICRA
Average

An intelligent agent



- AI Security
- Bias in machine learning
- Fairness



Two views of AI

- **AI Agents**: how can we re-create intelligence? Building agents with human-level intelligence.

- **AI Tools**: how can we benefit society? Developing tools that can benefit society.

Course Plan

Search problems
Markov decision processes
Adversarial games

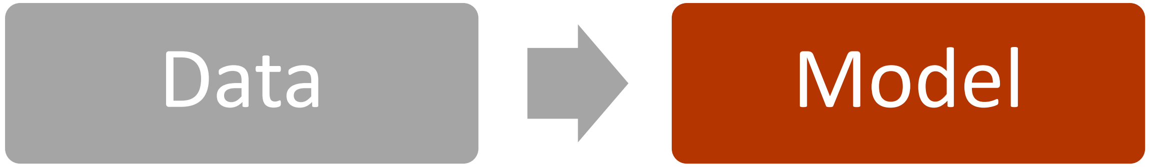
Constraint satisfaction problems
Bayesian networks

Reflex **States** **Variables** **Logic**

"Low-level intelligence" "High-level intelligence"

Machine Learning

Data Driven Learning



- The main driver of recent successes in artificial intelligence (AI)
- Move from “code” to data to manage the information complexity
- Requires a leap of faith: generalization

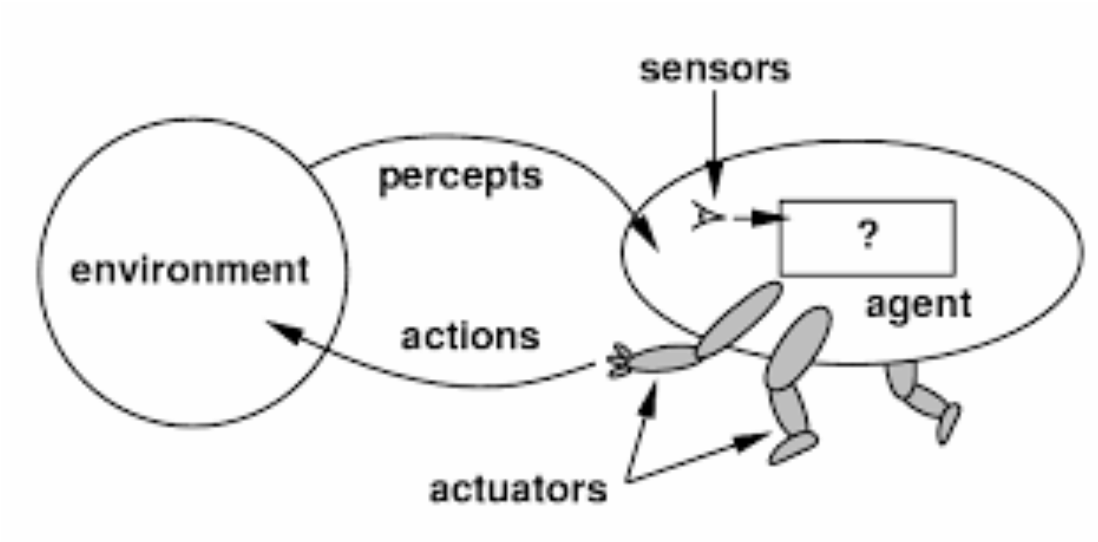
State-based models

- Search problems
- Markov decision processes
- Adversarial games

Agent and environments

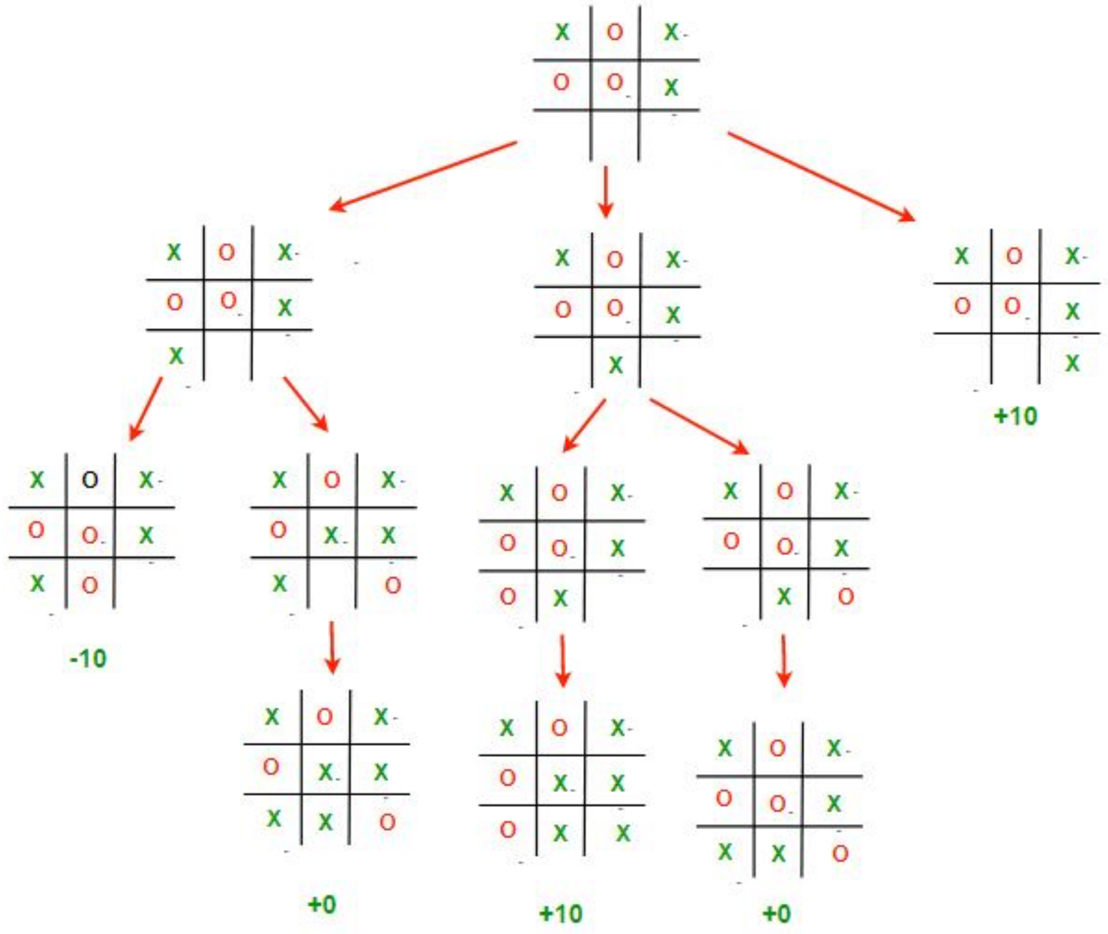
The agent function maps percept sequence to actions

f: P → A

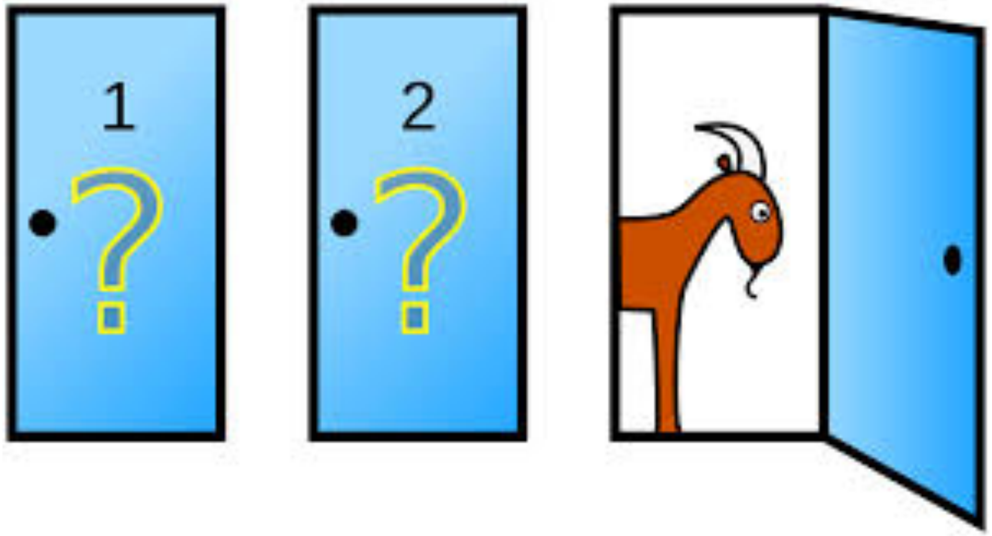


Perception Action Cycle

Tic Tac Toe



Monty Hall Gameshow



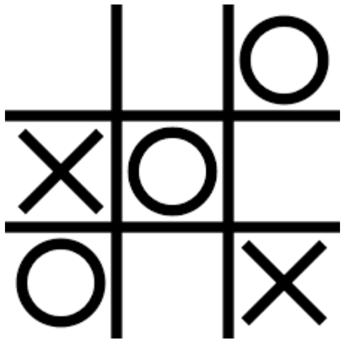
Environment States

- Fully Observable
- Partially Observable

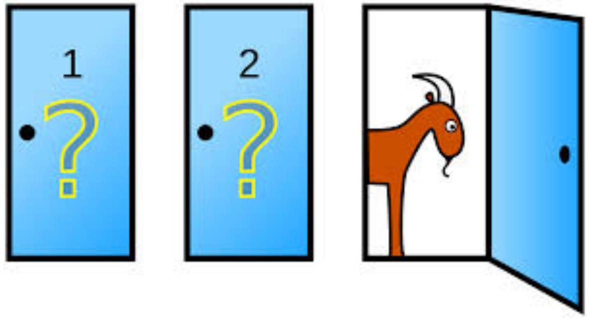
- Deterministic
- Stochastic

- Discrete
- Continuous

- Benign
- Adversarial



Monty Hall Gameshow



Example

Is playing a game of Poker any of the following?

- Partially observable
- Stochastic
- Discrete
- Adversarial

Is the task of recognizing handwritten text any of the following?

- fully observable
- Stochastic
- Continuous
- Benign

Driving on the Road

- Partially observable
- Stochastic
- Continuous
- Benign

Playing Chess

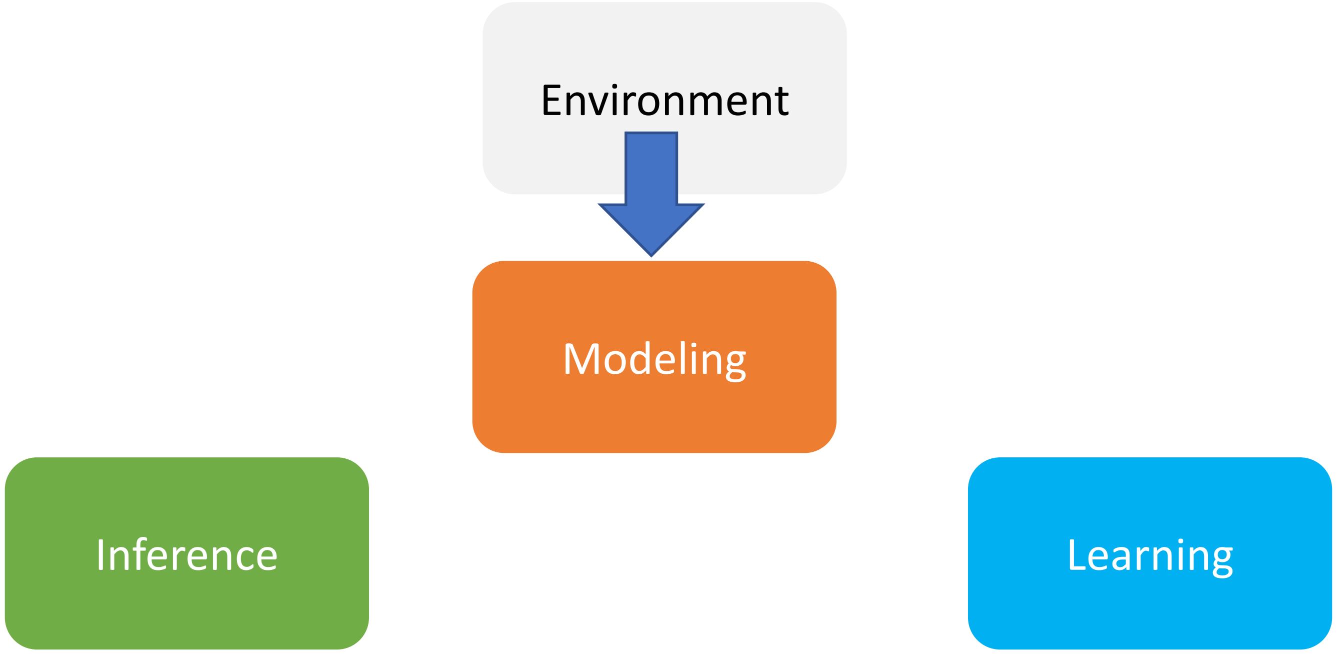
- Fully observable
- Deterministic
- Discrete
- Adversarial

Definition of Intelligence

- Rational Behavior – an intelligent agent it takes action to **maximize** its expected utility given a desired goal
- Consider constraints (such as computation, time, …)
- Rational Behavior and Bounded Optimality

Paradigm

Graphical Models (Inference and Learning)



Graphical models (or probabilistic graphical models) provide a powerful paradigm to jointly exploit probability theory and graph theory for solving complex real-world problems.

Optimization

- Discrete optimization

  Algorithmic tool: dynamic programming

  $$\min_{p \in \text{Paths}} \textbf{Distance}(p)$$ p = a discrete object

- Continuous optimization

  Algorithmic tool: gradient decent

  $$\min_{w \in R^n} \textbf{Loss}(w)$$ w = a vector of real numbers

Problem: computing edit distance

- Input: two strings, s and t
- Output: minimum number of character insertions, deletions, and substitutions it takes to change s into t.
- Examples:

s	t	distance
Cat	Cat	0
cat	dog	3
cat	at	1
cat	cats	1
a cat!	the cats!	4