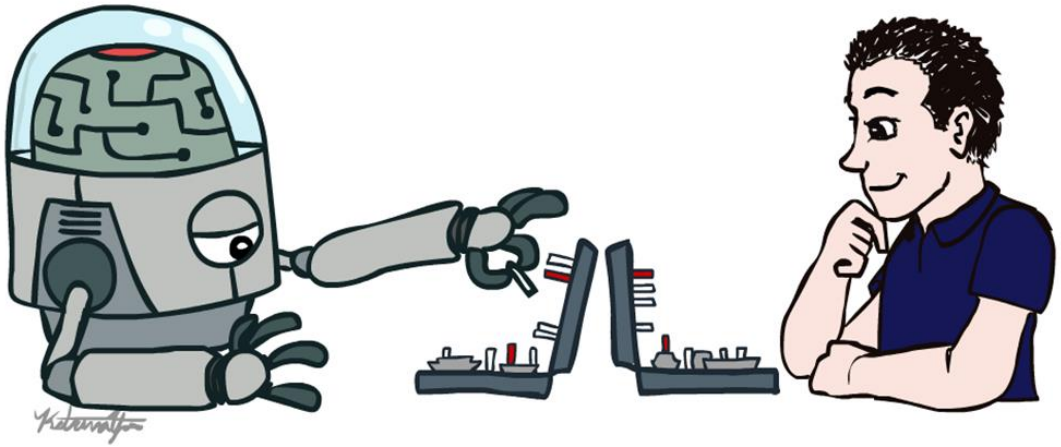
Artificial Intelligence

Introduction



Dr. Mohsin Ashraf
Assistant Professor
University of Central Punjab, Lahore

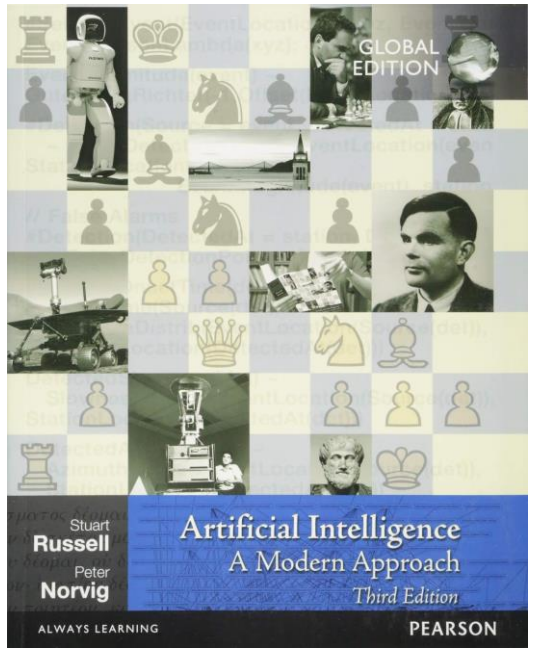
Modified slides of CS-188 Berkeley University

Recommended Books

- **Artificial Intelligence: A Modern Approach**,

  Russell & Norvig.

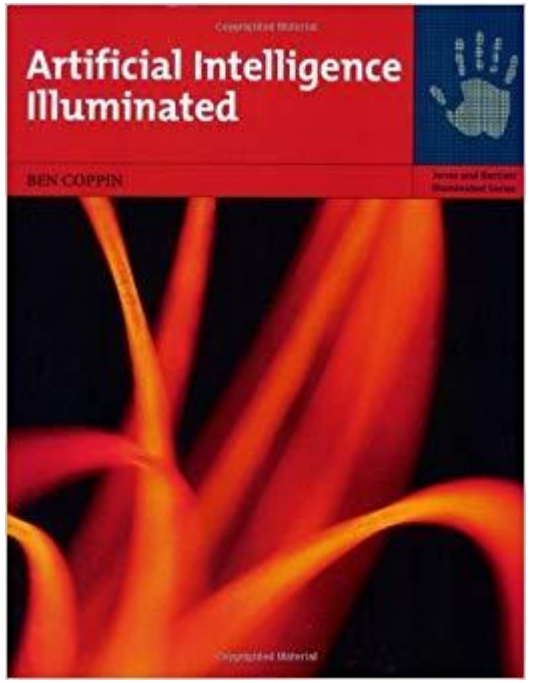
  (https://faculty.psau.edu.sa/filedownload/doc-7-pdf-a154ffbcec538a4161a406abf62f5b76-original.pdf)



- "**Artificial Intelligence Illuminated**"

  Ben Coppin,

  (http://futuresoft.yolasite.com/resources/Artificial%20Intelligence%20Illuminated.pdf)



Recommended Books

- “Artificial Intelligence – Structures and Strategies for Complex problem solving”, George F. Luger, Pearson International Edition, Sixth edition, 2009.
- “Artificial Intelligence: A new synthesis” Nils Nilsson, Morgan Kaufmann, 1998
- **UC Berkeley CS188 Intro to AI** (http://ai.berkeley.edu/home.html)

Grading (Tentative)

ITEM	WEIGHTAGE
Quizzes	15 %
Assignments	15 %
Class Participation	5%
Mid Term	20 %
Final Term	45 %
Total	**100**

Logistics

- Quiz may be un-announced.
- Read the book
- Plagiarism – Write your own Solution
- Deadline of the assignments will not be extended
- No Late submissions will be accepted.

Other Announcements

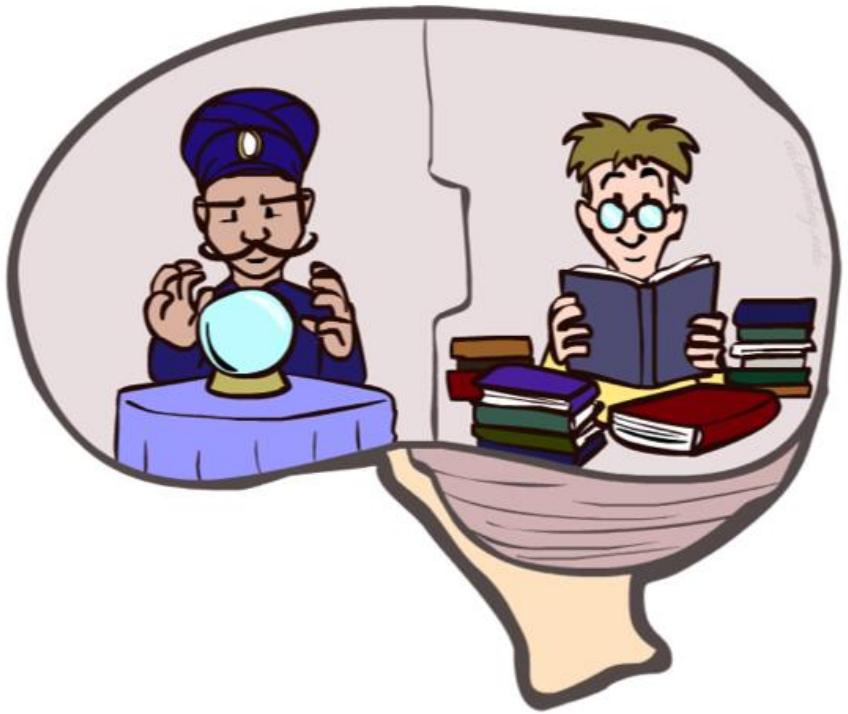
- Email address:
  - Usman.aamer@ucp.edu.pk
- Office:
  - CPS Building – 3rd floor
- Course Coordinator
  - Dr. Mohsin Ashraf

Course Topics

- Part I: Solving Problems by Searching
  - Fast search / planning
  - Constraint satisfaction
  - Heuristics
  - Adversarial and uncertain search

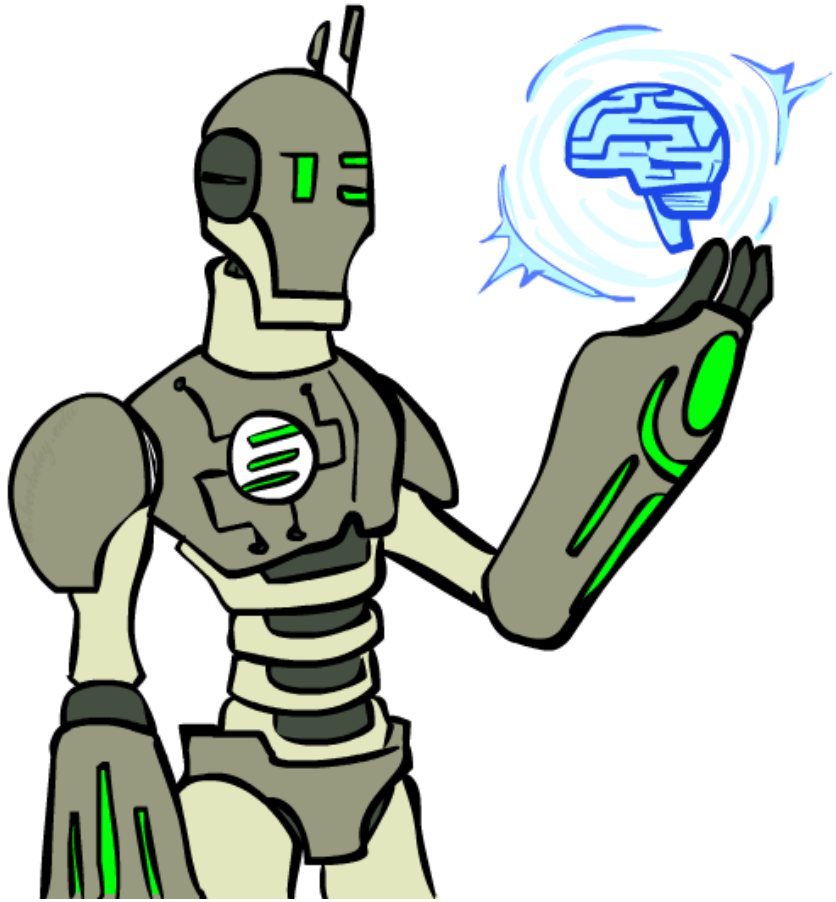
- Part II: Knowledge, reasoning, and Planning
  - Reasoning agents
  - Propositional logic
  - Predicate logic
  - Knowledge-based systems

- Part III: Machine Learning
  - Classification
  - Clustering
  - Neural Networks



Overview

- What is artificial intelligence?
- What can AI do?
- What is this course?



Question

- Is this mouse intelligence?
  - It depends on context
  - Route planning (Yes)
  - Mathematical problem solving (No)

- Is Google Intelligent?
  - Task specific intelligence

- Are humans intelligent?

Why AI?

- **Two main goals of AI:**
  - To create useful “smart” programs able to do tasks that would normally require a human expert
  - To understand human intelligence better as we test theories of human intelligence by writing programs which emulate them

What is Intelligence?

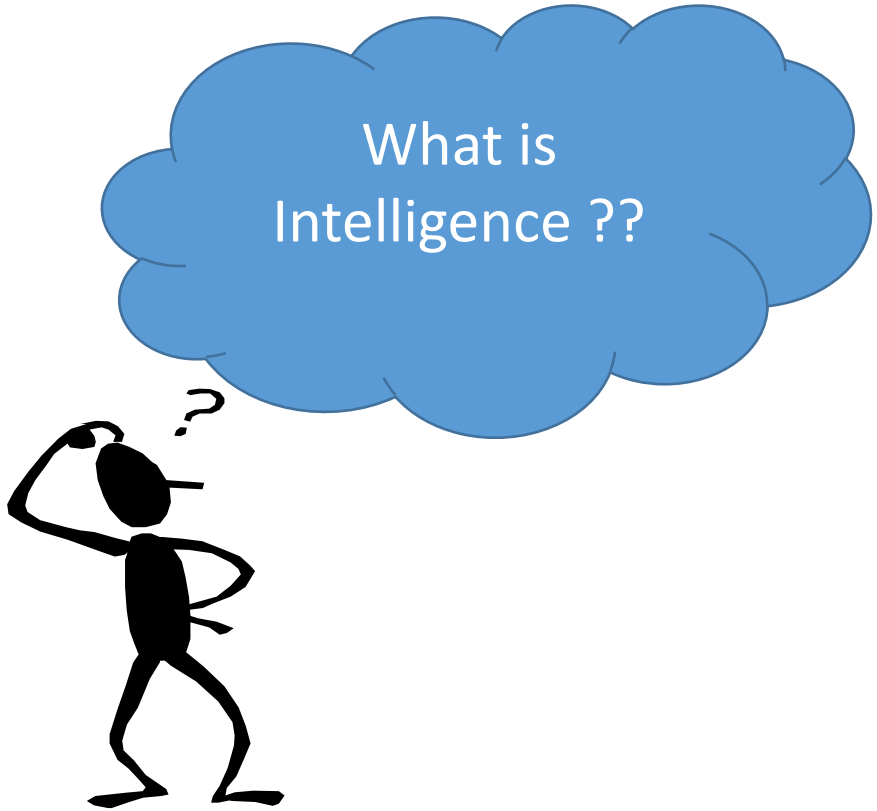
- Ability of problem solving
- Ability to think, plan and schedule
- Efficient memory and information manipulation
- Ability to tackle ambiguous and fuzzy problems
- Ability to understand and perceive

Artificial Intelligence

- "***Study of computations that make it possible to perceive, reason and act***."
- Branch of *Science* which deals with **helping machines to find solutions to complex problems in a more human-like fashion**

- In short, putting human intelligence into machines

Artificial Intelligence



- Perceive
- Understand
- Remember
- Think
- Reason
- Learn from Experience
- Adapt to the new Situation
- Problem Solving

Humans Vs Machines

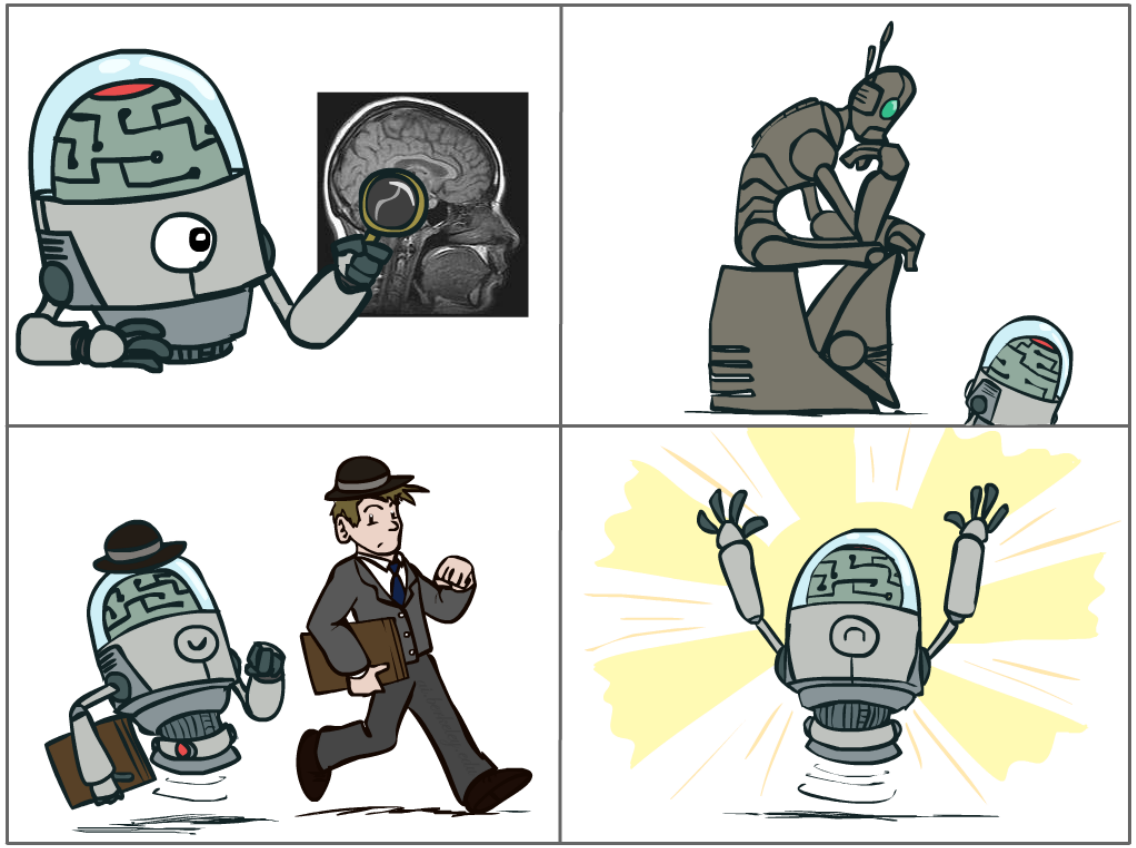
Humans	Machines
• Symbolic calculation • Natural language understanding • Not very precise • Knowledge • Generalize from examples • Deal with noisy inputs	• Numeric calculation • Machine Language • Precise • Data • Cannot generalize • Cannot deal with noise

What is AI?

The science of making machines that:

Think like people

Cognitive modeling approach



Think rationally

Laws of thought approach

Act like people

Turing Test approach

Act rationally

Rational agent approach

What is Artificial Intelligence

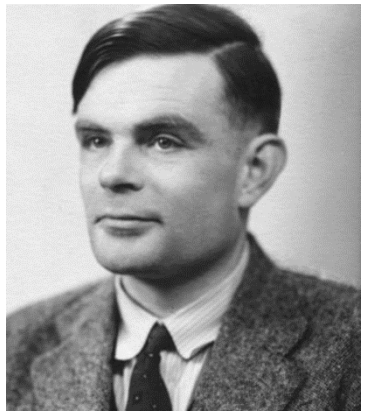
Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

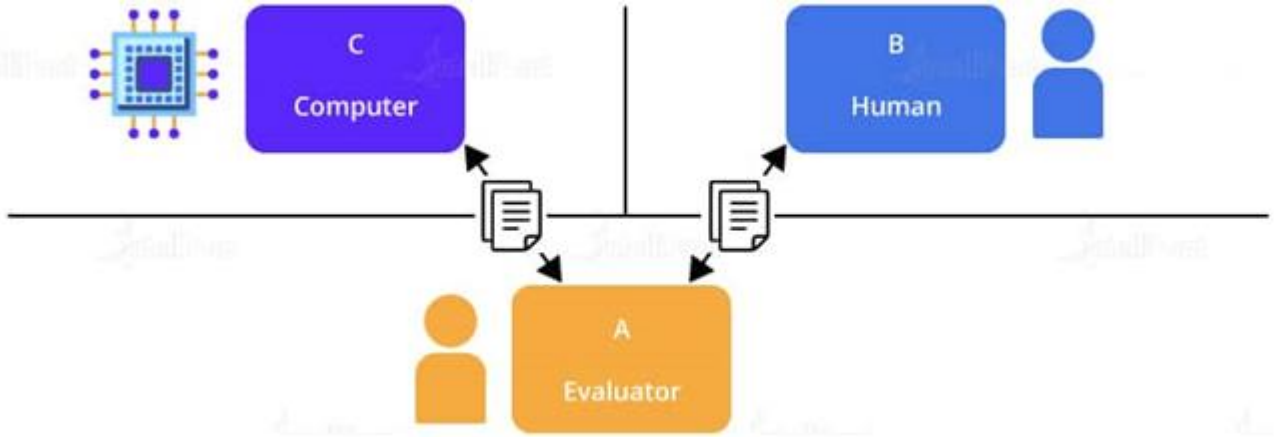
Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

Acting Humanly: Turing Test

- Alan Turing (1950) "Computing machinery and intelligence".

A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.





Turing Test Capabilities

Thinking Humanly:
The cognitive modeling approach

- For that we must determine how humans think.
- Need to get *inside* the actual workings of human minds.

Three ways to do this:

- Through introspection
  - trying to catch our own thoughts as they go by
- Through psychological experiments
  - observing a person in action
- Through brain imaging
  - observing the brain in action.

Thinking Humanly: The cognitive modeling approach

- Requires scientific theories of internal activities of the brain.
  - Cognitive Science: Predicting and testing behavior of human subjects (Hypothesis based)
  - Cognitive Neuroscience: Direct identification from neurological data (Data driven)
- However:
  - the available theories do not explain anything resembling human-level general intelligence
  - It may be impossible to identify the detailed structure of human problem solving using only externally-available data.

Thinking Rationally: Laws of Thought

- Aristotle: First to codify "right thinking"
- Several Greek schools developed various forms of logic:
  - Notation and rules of derivation for thoughts
  - Propositional logic, Predicate logic, etc.

- Always yield correct conclusions when given correct premises
  - E.g. "Socrates is a man; all men are mortal; therefore, Socrates is mortal."

- These laws of thought were supposed to govern the operation of the mind; their study initiated the field called **logic**.

Thinking Rationally: Laws of Thought

- **Problems:**
- Not easy to state informal knowledge in logical notation
- Mostly work for toy examples
- Big difference between solving a problem "in principle" and solving it “in practice”
  - Problems with just a few hundred facts can exhaust the computational resources of any computer
- How to measure if a program is thinking rationally
  - There is a difference between thinking and acting

Conclusion:

Right Thinking

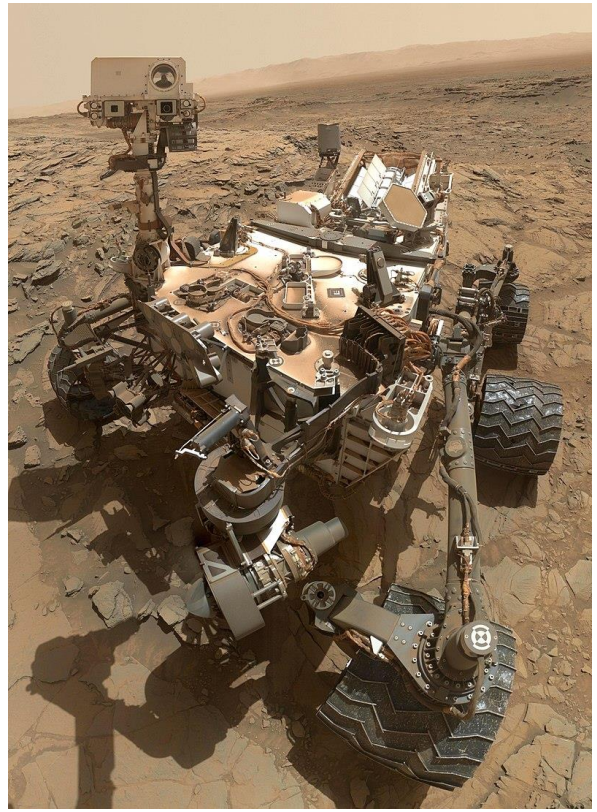
Must have rules and logic

Complex and Hard

Acting rationally: Rational agent

- An **agent** is something that acts.

- All computer programs do something, but computer **agents** are expected to do more:
  - Operate autonomously,
  - Perceive their environment,
  - Persist over a prolonged time period
  - Adapt to change, and create and pursue goals.
  - Make correct inferences



***Curiosity* (rover)**

Acting rationally: Rational agent

- A **rational agent** is one that acts so as **to achieve the best outcome** or, when there is uncertainty, the **best expected outcome**.
- Rational behavior: **doing the right thing**
- The right thing: the optimal (best) thing that is expected to maximize the chances of achieving a set of goals, in a given situation
- Making correct inferences is part of being a rational agent
- There are also ways of acting rationally that cannot be said to involve inference -- Reflex actions.

Acting rationally: Rational agent

- **Advantages** over other approaches
  - More **general** than the "laws of thought" approach
  - More **obedient** to scientific development than are approaches based on human behavior or human thought
  - **Standard of rationality (Logic)** is mathematically well defined and completely general
  - **Conclusion:**
  - Behave in right manner
  - Give max. Performance
  - Give Optimal Solution

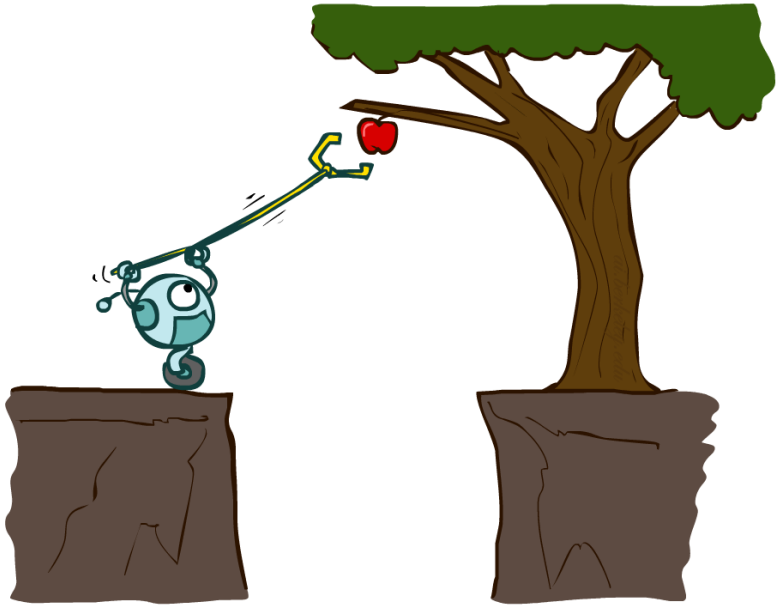
This course is about designing rational/intelligent agents

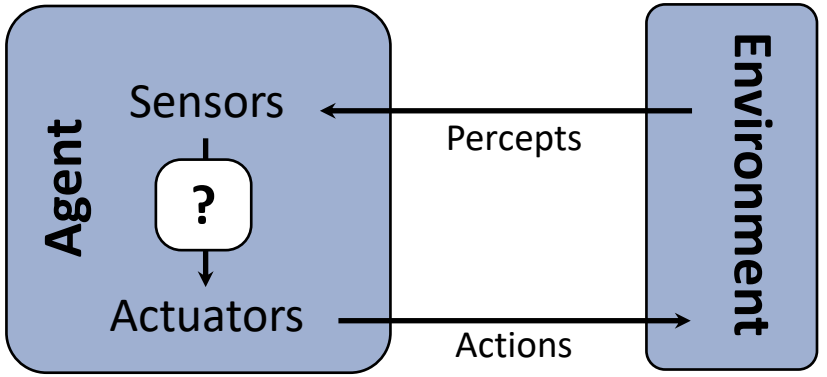
Build REPRESENTATIONS that support MODELS targeted at

THINKING PERCEPTION ACTION

Designing Rational Agents

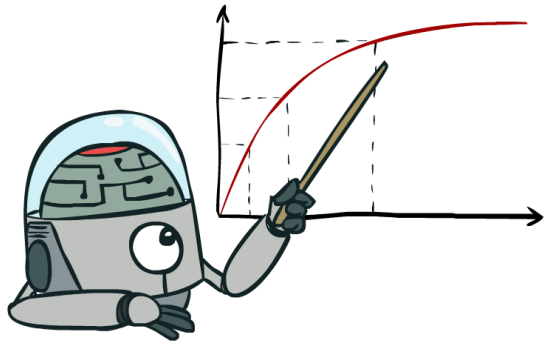
- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions
- **This course** is about:
  - General AI techniques for a variety of problem types
  - Learning to recognize when and how a new problem can be solved with an existing technique

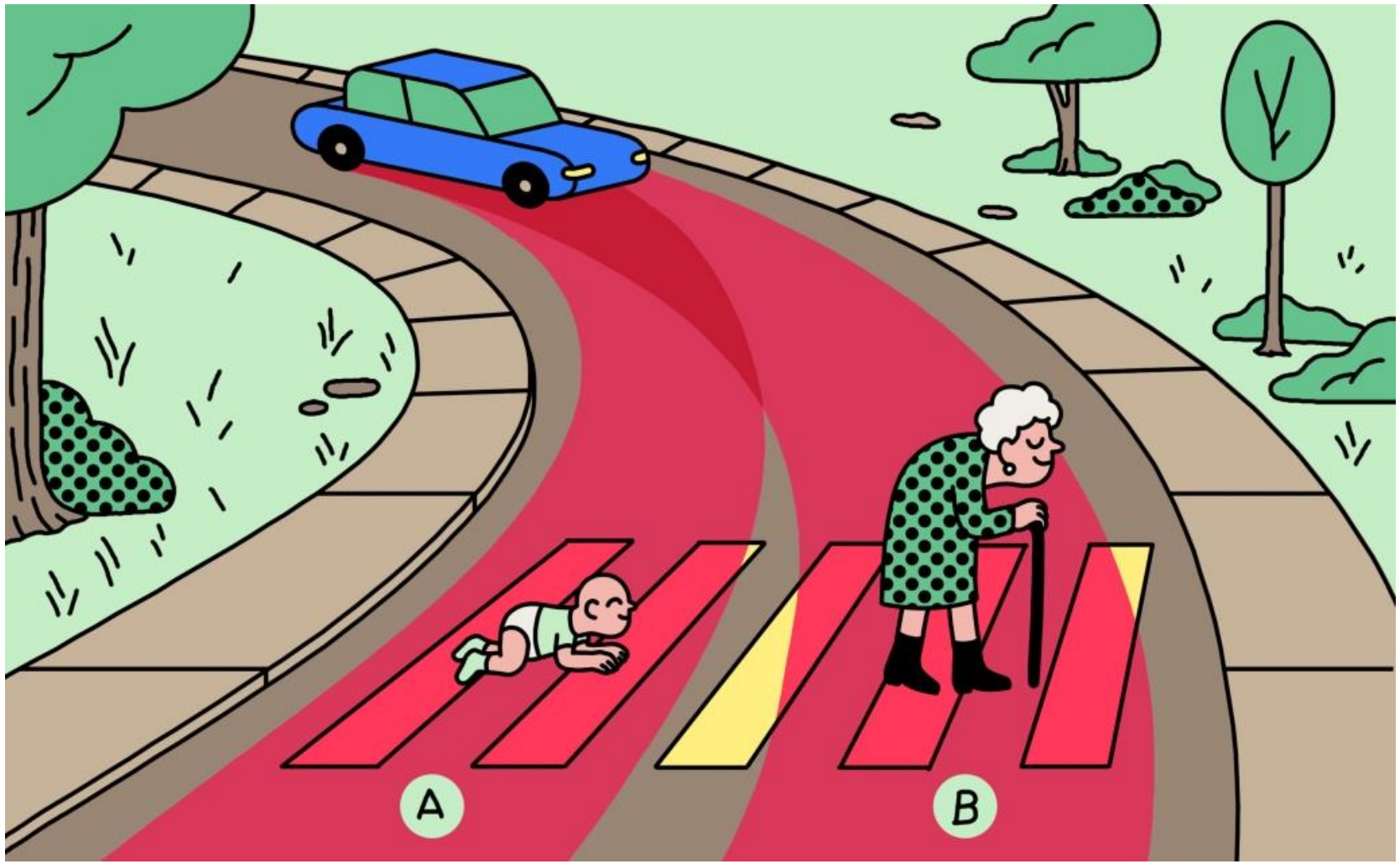




Rational Decisions

- We'll use the term rational in a very specific, technical way:
- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made (not the thought process behind them)
- Goals are expressed in terms of the utility of outcomes
- Being rational means **maximizing your expected utility**




A
B

Approaches to AI

- **Strong AI**
  - Strong AI aims to build machines that can truly reason and solve problems who is self aware and whose overall intellectual ability is indistinguishable from that of a human being.
    - Human-Like
    - Non-human Like

- **Weak AI**
  - Weak artificial intelligence (**weak AI**), also known as narrow AI, is artificial intelligence that is **focused on one narrow task**.
  - Deals with the creation of some form of computer-based artificial intelligence that **cannot** truly reason and solve problems, but can act as if it were intelligent.
  - **Siri** is a good example of narrow intelligence.

Weak and Strong AI

- **Weak AI** is AI that can not 'think', i.e. a computer chess playing AI does not think about its next move, it is based on the programming it was given, and its moves depend on the moves of the human opponent.
- **Strong AI** is the idea/concept that we will one day create AI that *can* 'think' i.e. be able to play a chess game that is not based on the moves of the human opponent or programming, but based on the AI's own 'thoughts' and feelings and such, which are all supposed to be exactly like a real humans thoughts and emotions and stuff.

Quick Quiz

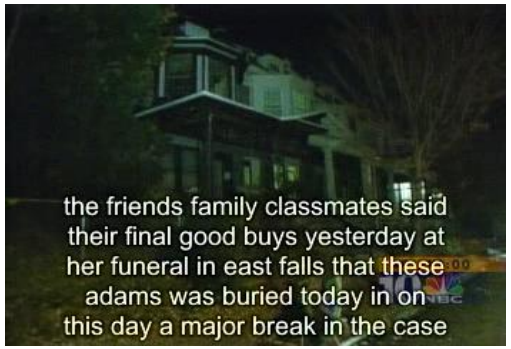
- To what extent are the following computer systems instances of artificial intelligence:
  - Supermarket bar code scanners.
  - Web search engines.
  - Voice-activated telephone menus.

Applications of AI

- Game playing
- Computer vision
- Natural language processing
- Diagnosis systems
- Control
- Optimisation
- Robotics

Natural Language

- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems
- Language processing technologies
  - Question answering
  - Machine translation
  - Web search
  - Text classification, spam filtering, etc…




"Il est impossible aux journalistes de rentrer dans les régions tibétaines"

Bruno Philip, correspondant du "Monde" en Chine, estime que les journalistes de l'AFP qui ont été expulsés de la province tibétaine du Qinghai "n'étaient pas dans l'illégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959

Vidéo Anniversaire de la rébellion


"It is impossible for journalists to enter Tibetan areas"

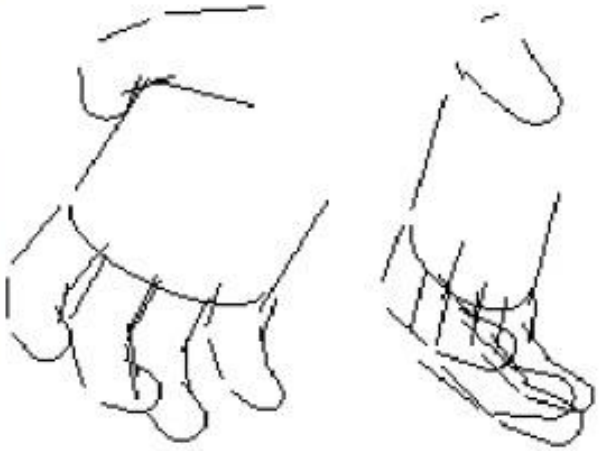
Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

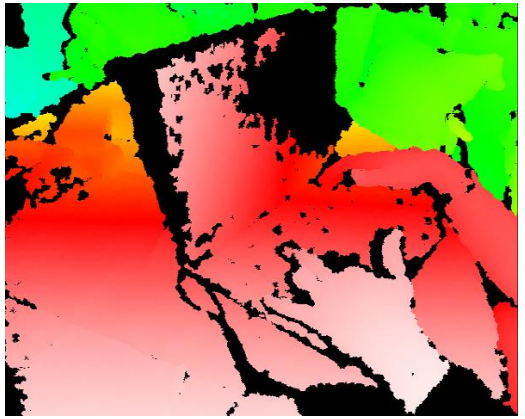
Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959

Video Anniversary of the Tibetan rebellion: China on guard

Vision (Perception)

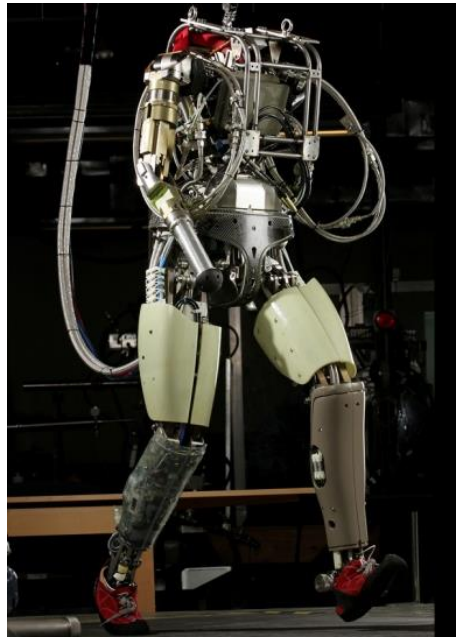
- Object and face recognition
- Scene segmentation
- Image classification



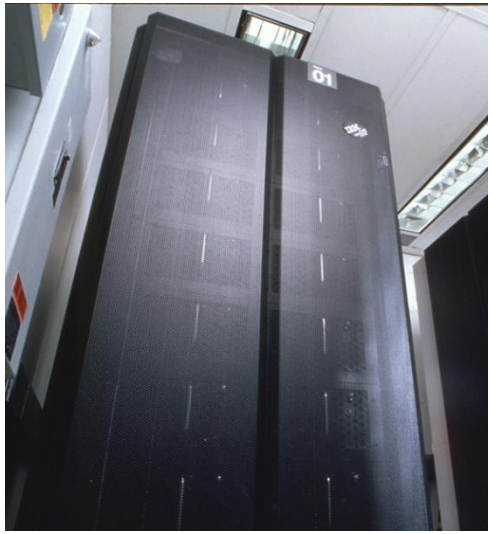


Robotics

- Robotics
- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation…



Game Playing



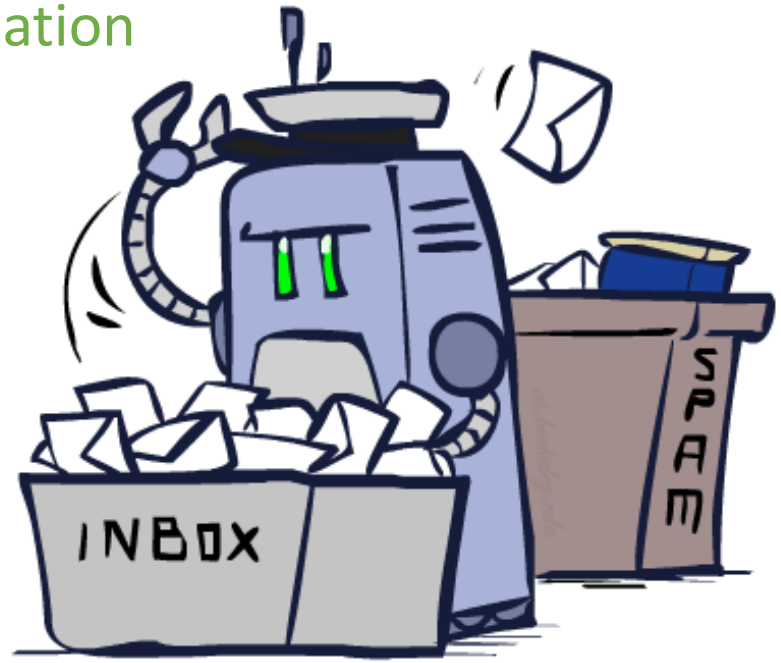
- Classic Moment: May, '97: Deep Blue vs. Kasparov
  - First match won against world champion
  - “Intelligent creative” play
  - 200 million board positions per second
  - Humans understood 99.9 of Deep Blue's moves
  - Can do about the same now with a PC cluster
- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??
- 1996: Kasparov Beats Deep Blue

  “I could feel --- I could smell --- a new kind of intelligence across the table.”
- 1997: Deep Blue Beats Kasparov

  “Deep Blue hasn't proven anything.”
- Huge game-playing advances recently, e.g. in Go!

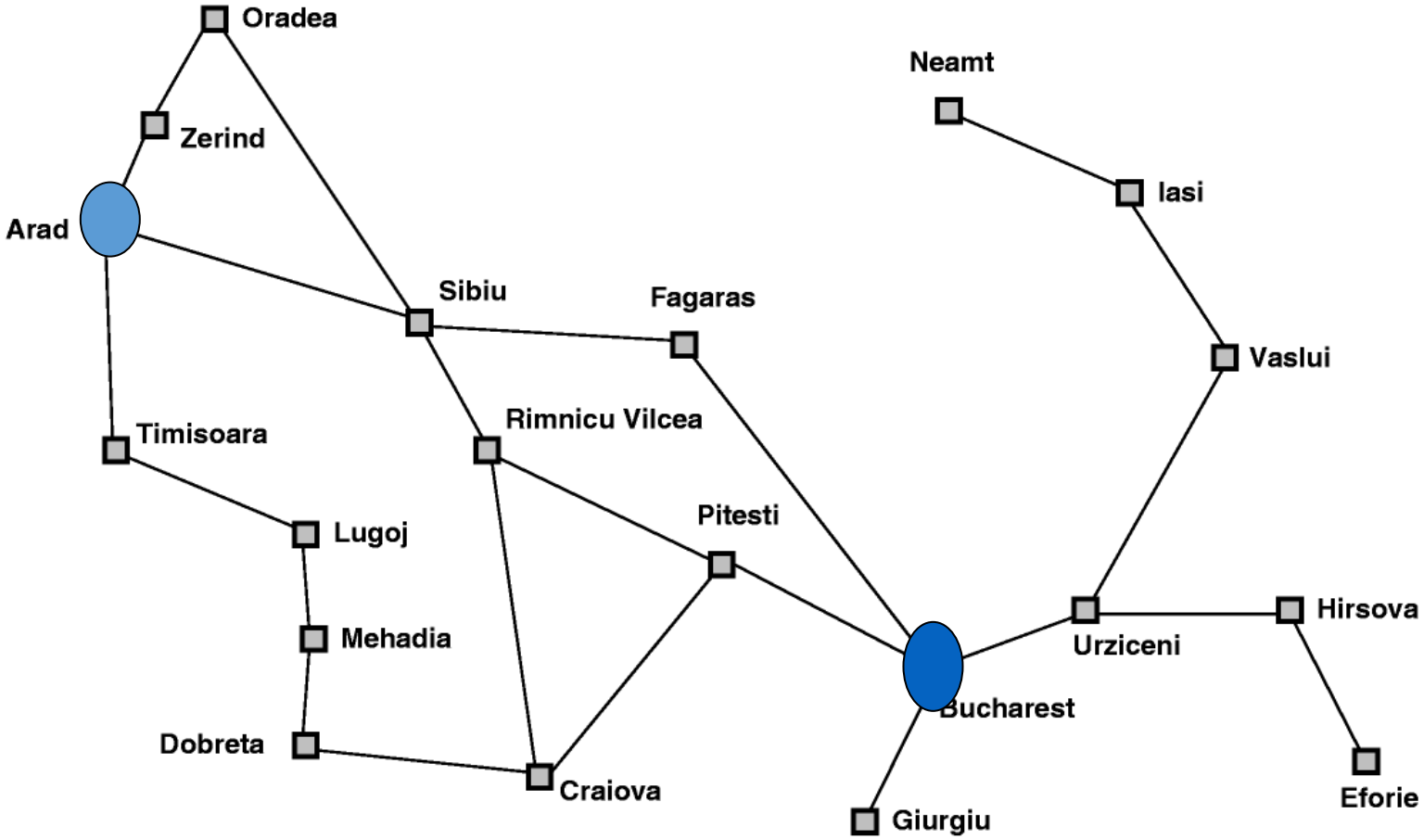
Decision Making

- Applied AI involves many kinds of automation
  - Scheduling, e.g. airline routing, military
  - Route planning, e.g. Google maps
  - Medical diagnosis
  - Web search engines
  - Spam classifiers
  - Automated help desks
  - Fraud detection
  - Product recommendations
  - … Lots more!



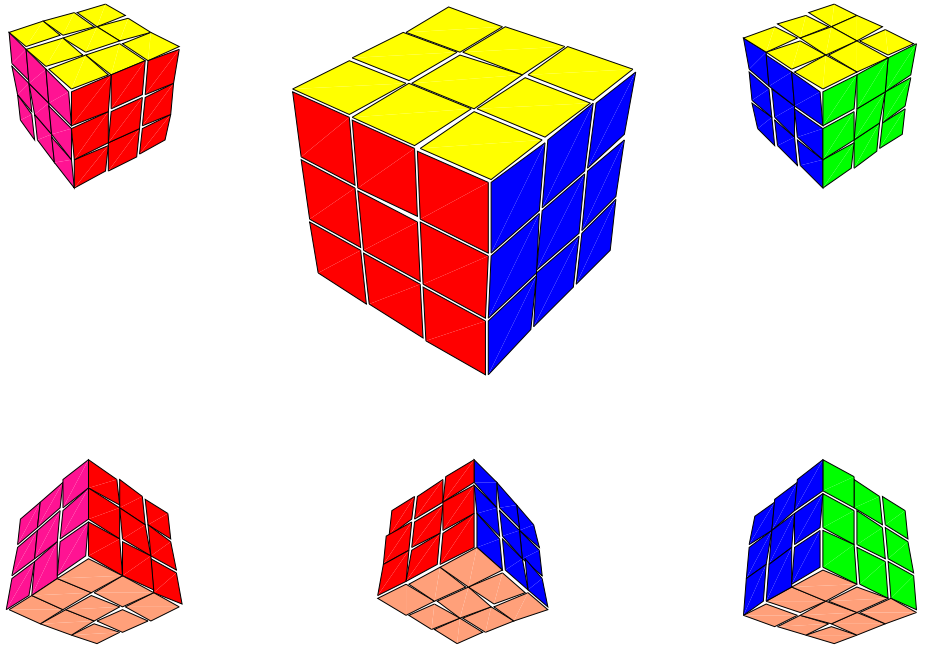
AI Topics: A Quick Introductory Overview

Classic AI search problems: Map searching (navigation)



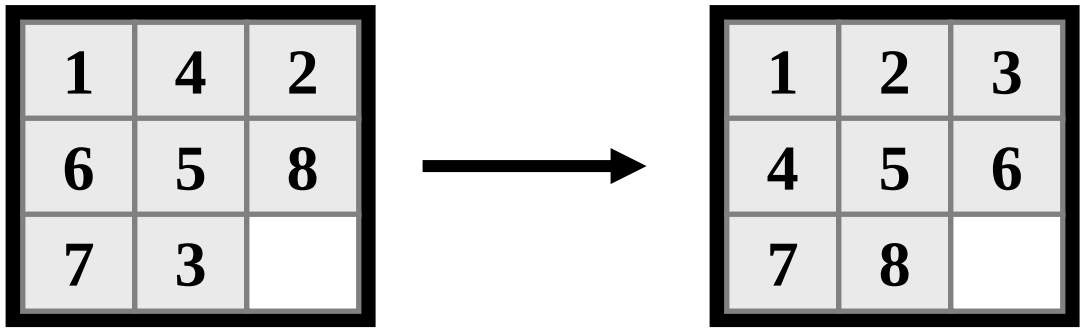
AI Topics: A Quick Introductory Overview

- Classic AI search problems
  - 3*3*3 Rubik's Cube



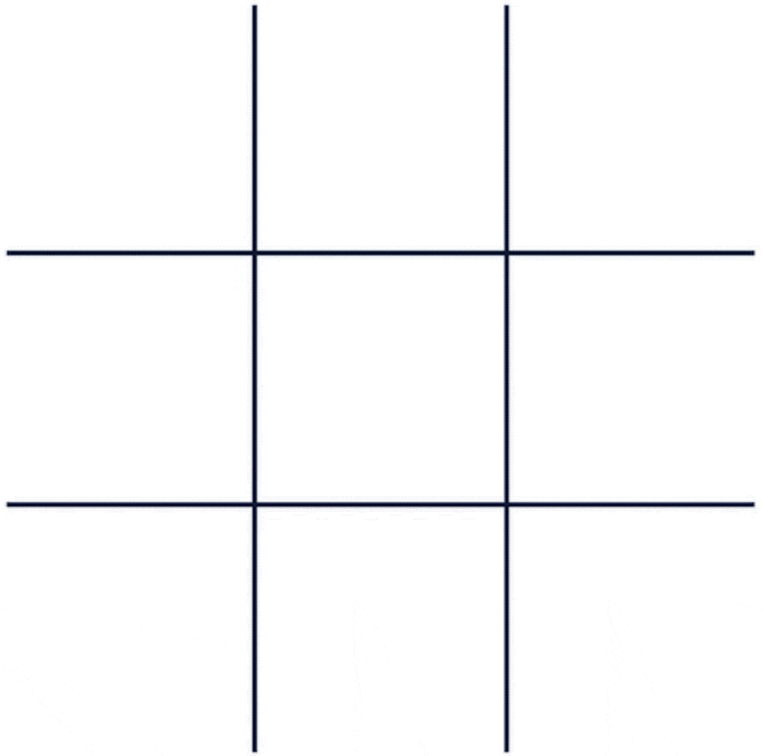
Classical AI Search Problems

- 8-Puzzle



1	4	2
6	5	8
7	3	

Classical AI Search Problems



Classical AI Search Problem

- Pac-Man