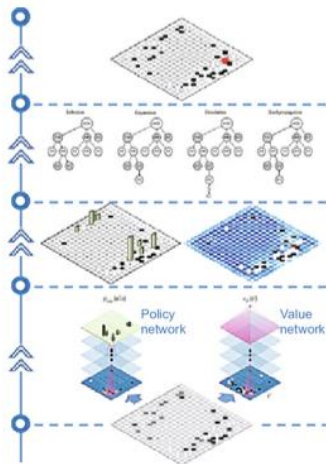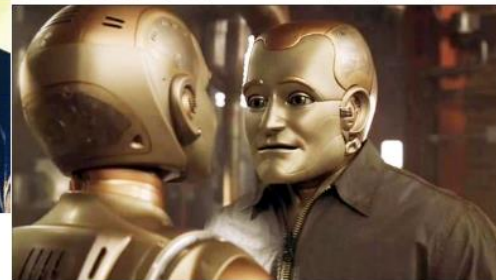# Introduction to Artificial Intelligence

Lecture: Introduction to AI

Outline

- What is Artificial Intelligence (AI)?
- The Foundations of Artificial Intelligence
- The History of Artificial Intelligence
- The State of the Art

AI: Dreams for everyone

# AI: Sophia Robot

AI: Deep Blue – AlphaGo

Deep Blue vs. Kasparov
(02/1996 and 05/1997)

AlphaGo vs. Lee Sedol
(03/2016)

Intelligence vs. Artificial Intelligence

- **Intelligence** includes the capacity for logic, understanding, learning, reasoning, creativity, and problem solving, etc.
- **Artificial intelligence** (AI) attempts not just to understand but also to build intelligent entities.
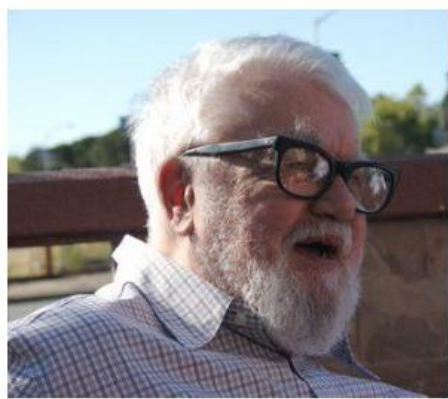
John McCarthy
(1927 – 2011)

Marvin Minsky
(1927 – 2016)

Allen Newell
(1927 – 1992)

Arthur Samuel
(1901 – 1990)

Herbert Simon
(1916 – 2001)

The fields of AI

- AI research aims to build intelligent entities that are capable of simulating humans in different aspects.
    - Thinking: learning, planning, knowledge refinement
    - Perception: see, hear, feel, etc.
    - Communication in natural languages
    - Manipulation and moving objects

What is AI?

| 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 .. ." (Hellman, 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 at,* 1998) "AI ... is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Acting humanly

- The Turing Test approach (Alan Turing, 1950):
  - *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.*
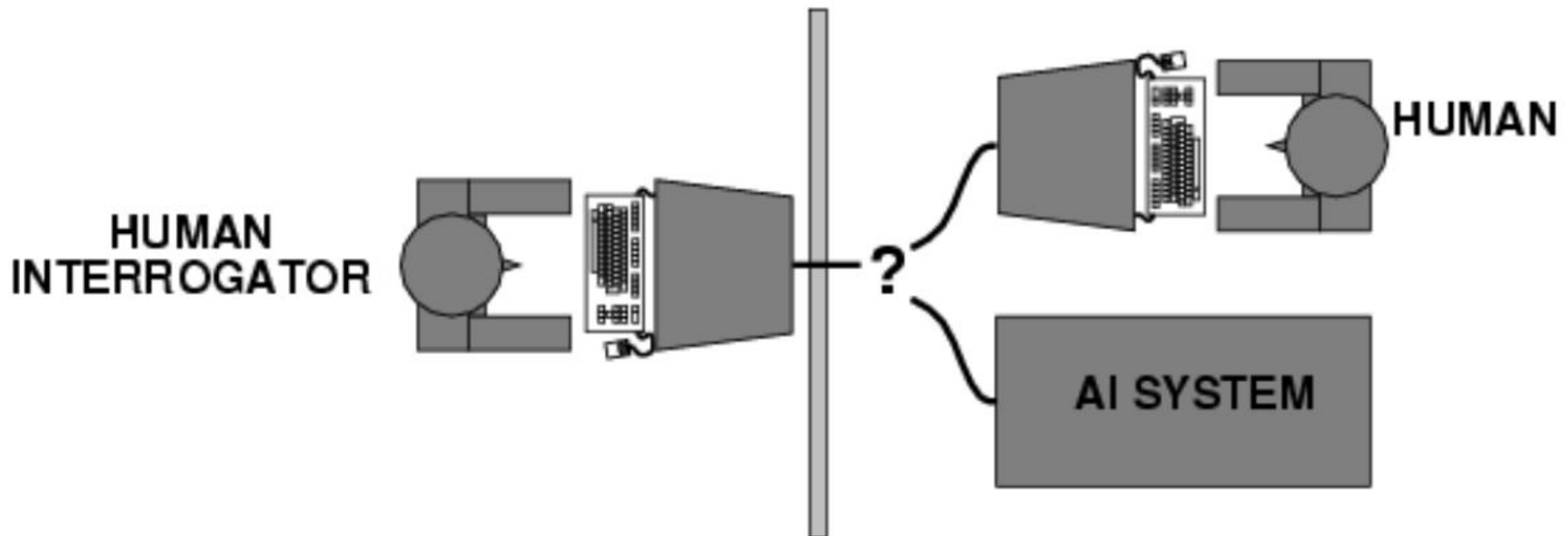
Acting humanly

- Other Turing Test: Chihuahua and muffin

Thinking humanly

- Cognitive modeling approach
- The program's input-output behavior matches corresponding human behavior.
- We need to get inside the actual workings of human minds
  - Introspection: trying to catch our own thoughts as they go by
  - Psychological experiments: observing a person in action
  - Brain imaging: observing the brain in action

Thinking humanly

- General Problem Solver – GPS (Newell and Simon, 1961)
  - Not merely solve problems correctly
  - Compare the trace of its reasoning steps to traces of human subjects solving the same problems
- Cognitive Science
  - Computer models from AI
  - Experimental techniques from psychology
- These approaches are now distinct from AI
  - Share the available theories but do not explain anything resembling human intelligence
  - All share a principal direction

Thinking rationally

- The laws of thought approach
- "Right thinking" = irrefutable reasoning processes
  - Example of Aristotle (381BC − 322BC)

All men are mortal.	$\forall$x.man(x)$\Rightarrow$mortal(x)
Socrates is a man.	man(Socrates)
Therefore, Socrates is mortal.	mortal(Socrates)

- Obstacles:
  - Not all intelligence is mediated by logic behavior
  - Solving a problem "in principle" is different from doing in practise.

Acting rationally

- The rational agent approach
- Rational behavior = "doing the right thing"
  - The "right thing" is what is expected to maximize goal achievement given the available information.
- An agent is just something that perceives and then acts

$$f: P^* \rightarrow A$$

- A rational agent acts to achieve the best outcome or, when there is uncertainty, the best expected outcome.

Goals of AI

- AI studies the intelligent part concerned with humans and represents those actions using computers.
- Make computers more useful by letting them take over dangerous or tedious tasks from human
- Understand principles of human intelligence

Related research fields

Field	Description
Philosophy	Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality.
Mathematics	Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability, probability.
Economics	Utility, decision theory, rational economic agents
Neuroscience	Neurons as information processing units.
Psychology/ Cognitive Science	How do people behave, perceive, process information, represent knowledge.
Computer Engineering	Building fast computers
Control Theory	Design systems that maximize an objective function over time
Linguistic	Knowledge representation, grammar

Common topics in AI

- Search (includes Game Playing)
- Representing knowledge and reasoning with it
- Planning
- Learning
- Natural language processing
- Expert systems
- Interacting with the Environment
  - Vision, Speech recognition, Robotics, etc.

Pros and Cons of AI

- Pros:
  - More powerful and more useful computers
  - New and improved interfaces
  - Solve new problems
  - Better handling of information
  - Relieve information overload
  - Conversion of information into knowledge
- Cons:
  - Increased costs
  - Difficulty with software development - slow and expensive
  - Few experienced programmers

Solving problems by searching

- Search is the fundamental technique of AI, either "uninformed" or "informed".
- Search for the first answer that satisfies our goal or keep searching until we find the best answer.


One possible solution

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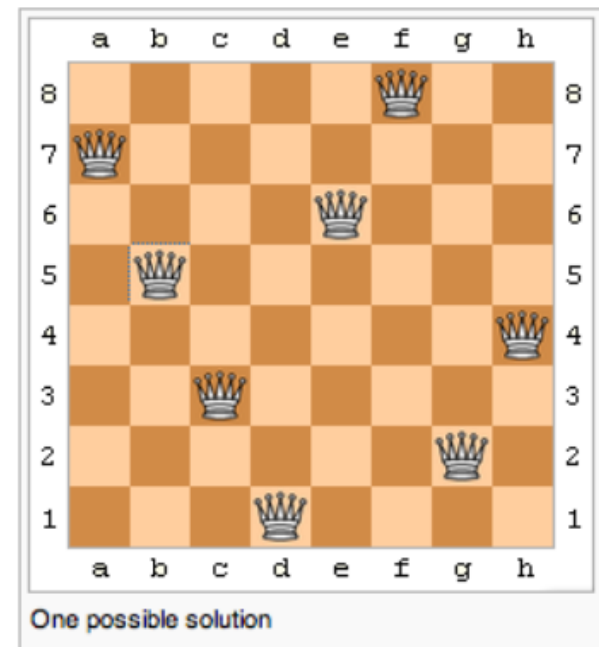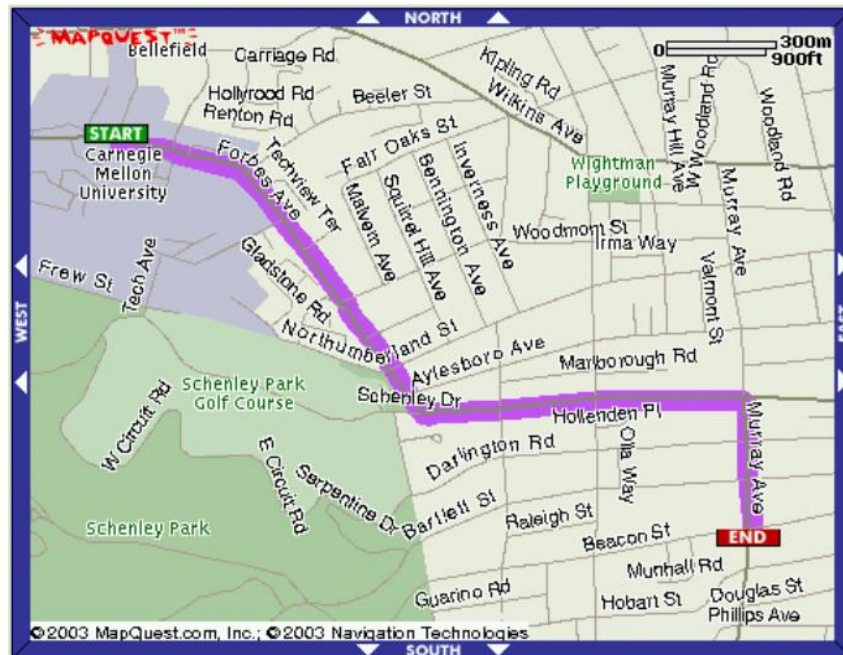
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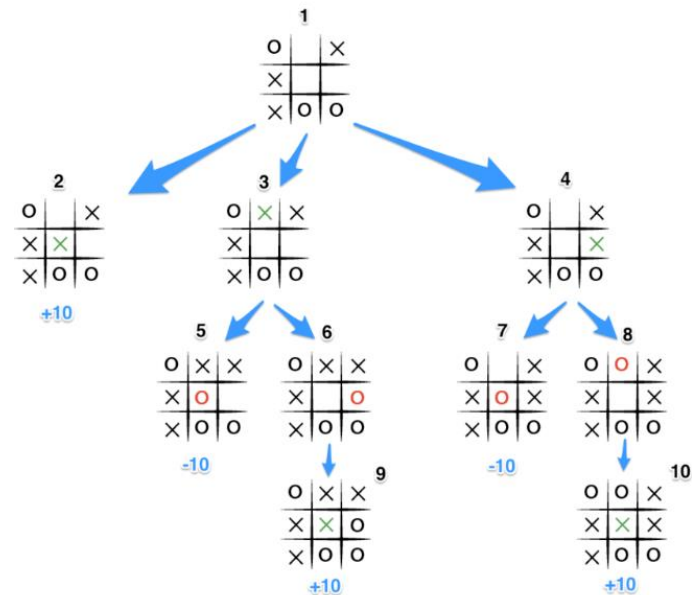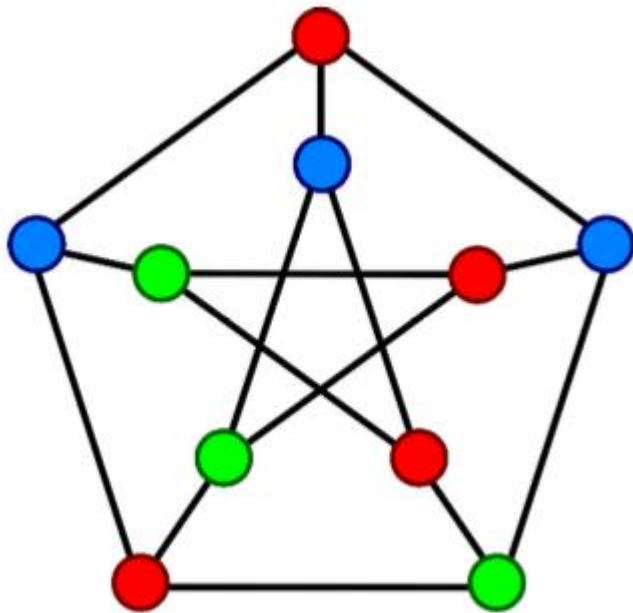
Knowledge and reasoning

- To act rationally in our environment, then we must have some way of describing that environment and drawing inferences from that representation.
  - How do we describe what we know about the world ?
  - How do we describe it concisely ?
  - How do we describe it so that we can get hold of the right piece of knowledge when we need it ?
  - How do we generate new pieces of knowledge ?
 - How do we deal with uncertain knowledge ?

Knowledge and reasoning

- Propositional logic and predicate logic
- Inference techniques: forward chaining, backward chaining, and resolution
- Uncertain knowledge and reasoning
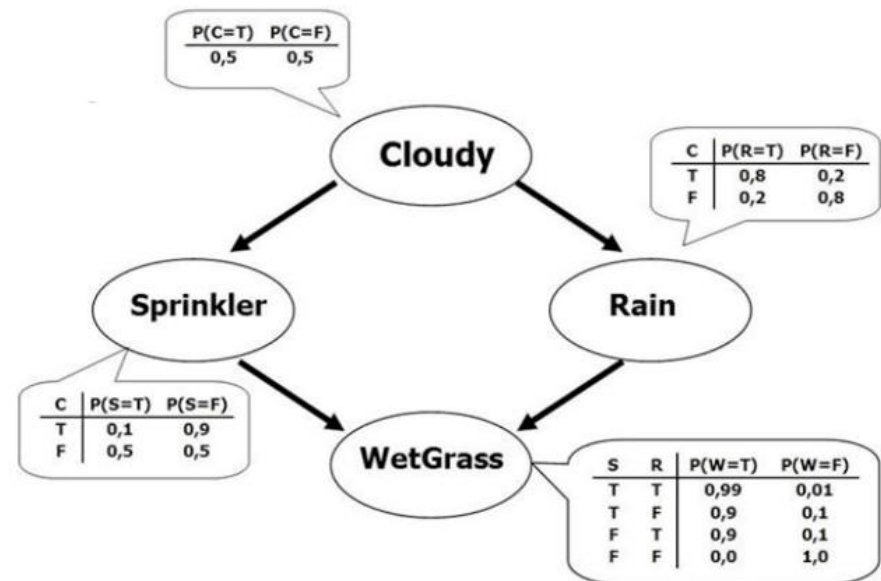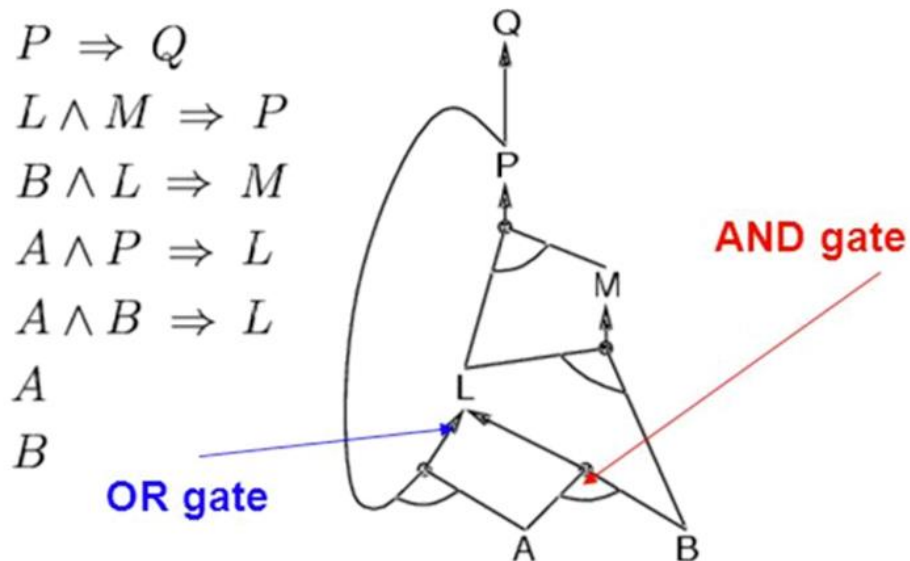
Machine Learning

- If a system is going to act truly appropriately, then it must be able to change its actions in the light of experience.
  - How do we generate new facts from old ?
  - How do we generate new concepts ?
 - How do we learn to distinguish different situations in new environments?
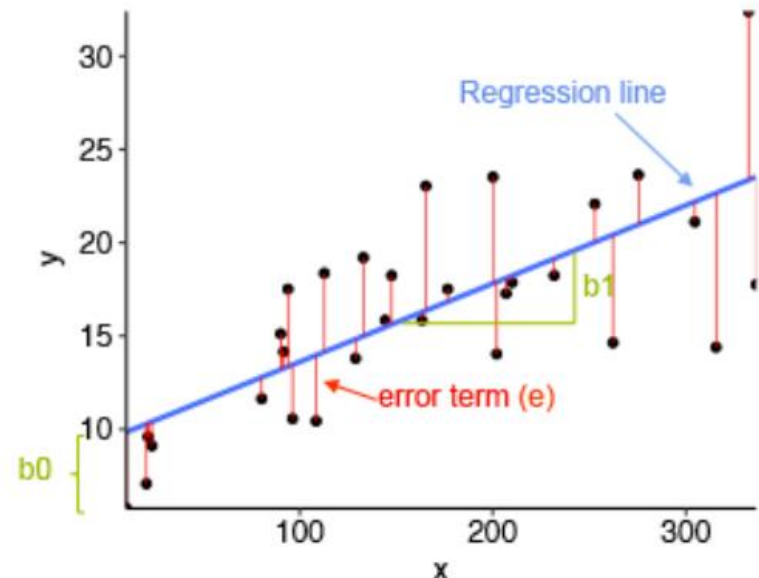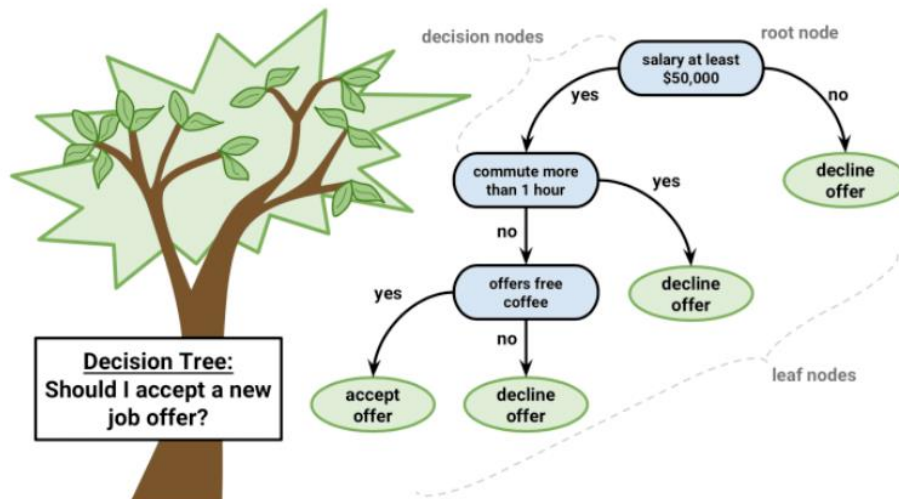
History of AI

- ***1940-1950: Early days***
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's "Computing Machinery and Intelligence"
- ***1950—70: Excitement: Look, Ma, no hands!***
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
  - 1956: Dartmouth meeting: "Artificial Intelligence" adopted
  - 1965: Robinson's complete algorithm for logical reasoning
- ***1970—90: Knowledge-based approaches***
  - 1969—79: Early development of knowledge-based systems
  - 1980—88: Expert systems industry booms
  - 1988—93: Expert systems industry busts: "A Winter"

History of AI

- 1990—: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems... "A Spring"?
- 2000—: Where are we now?

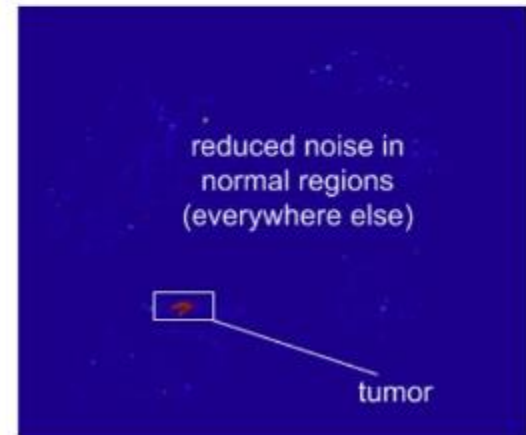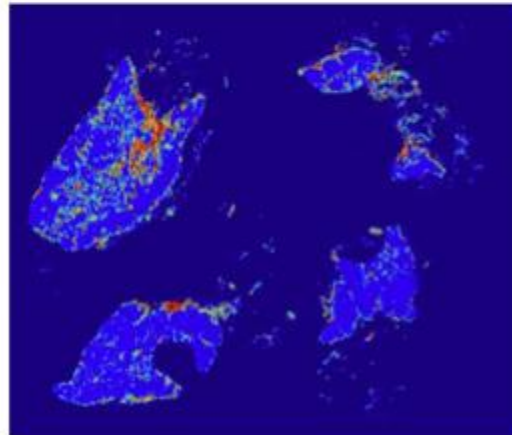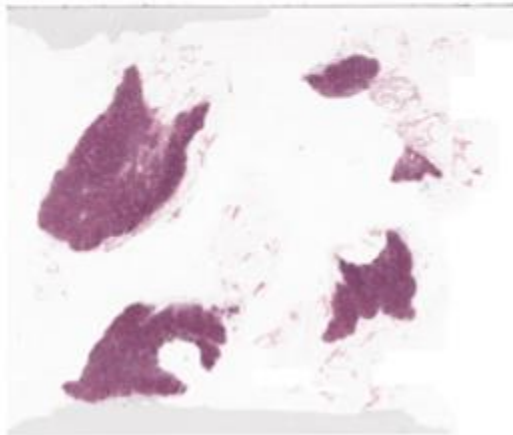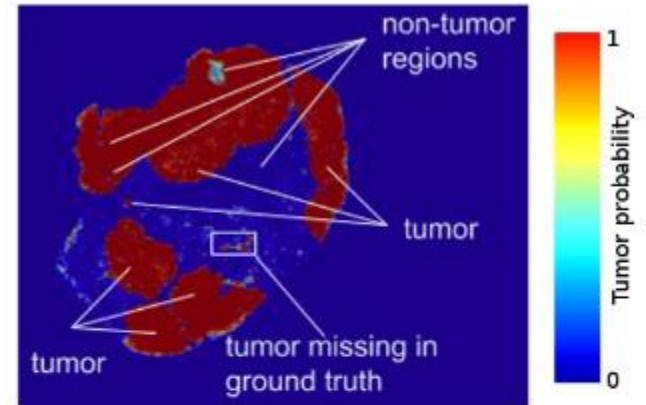# Recent advancements
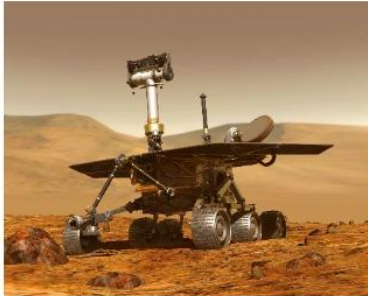
Autonomous rovers

Analysis of data
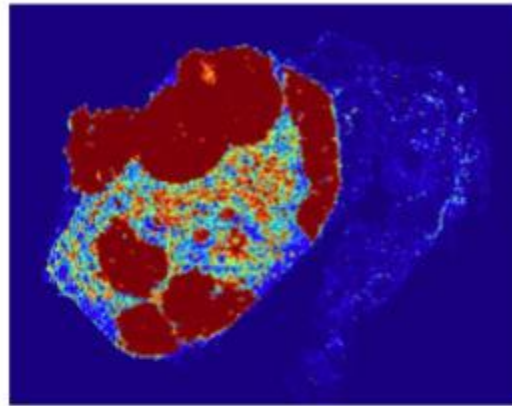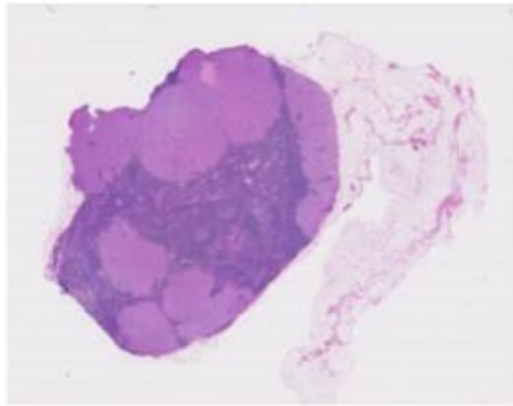

Telescope scheduling
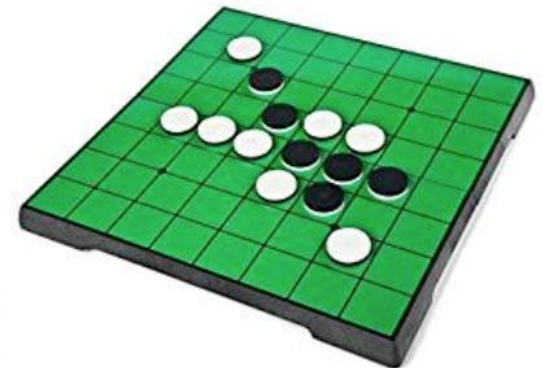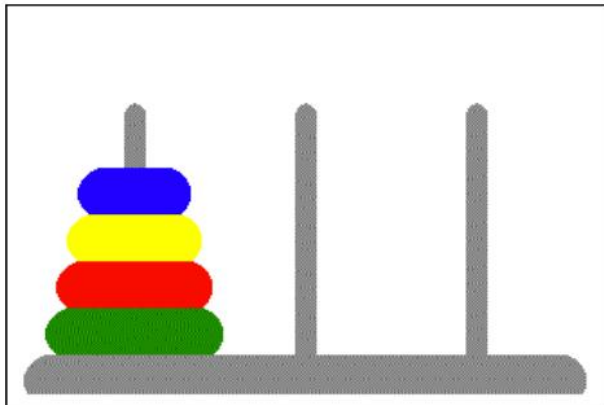
Recent advancements

Recent advancements

Homework

- Find 03 recent advancements in AI.
- Briefly introduce the selected advancements.
- Determine, as deeply as possible, the subfields of them.

References

- Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA.
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