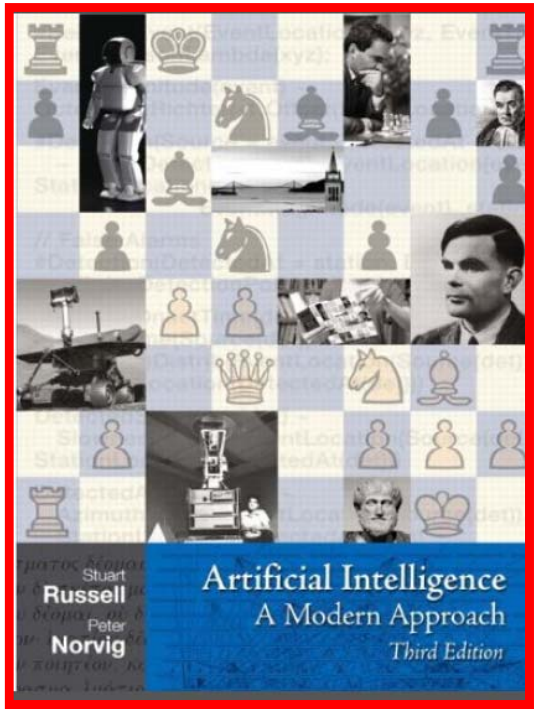
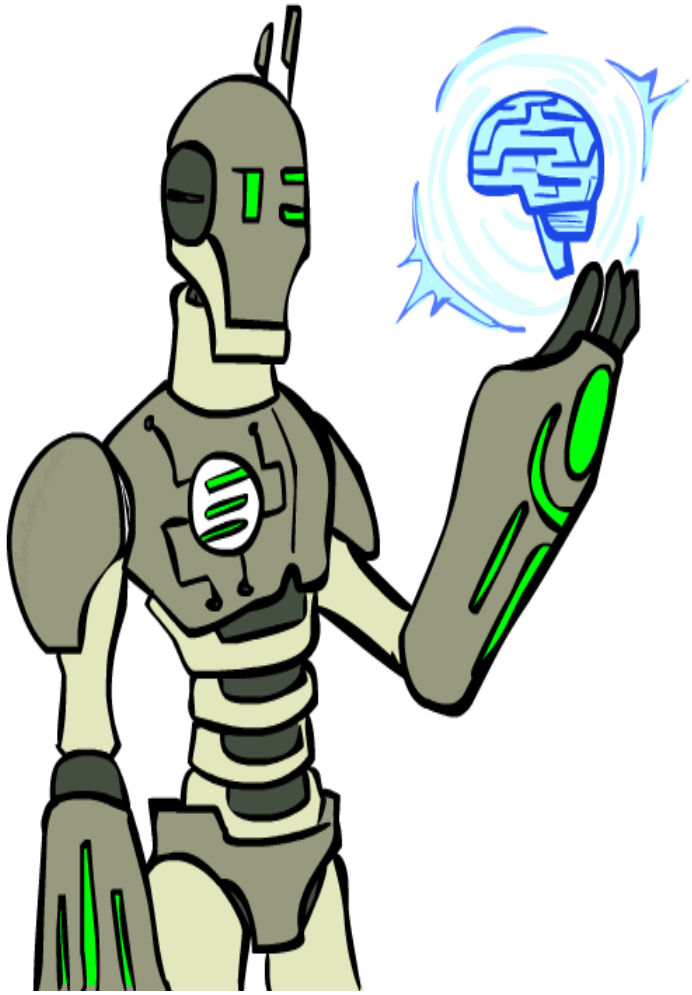


(Chapter-1)
Introduction

Yanmei Zheng

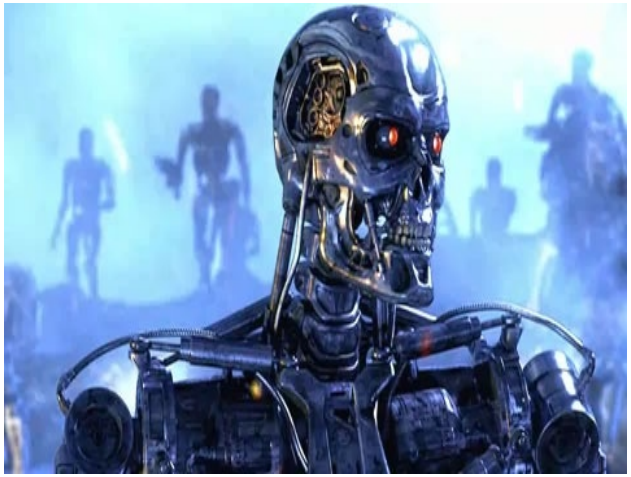
Today

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



Sci-Fi AI?

Artificial Intelligence Ex Machina…



What is AI?

- Artificial Intelligence (AI)
  - Intelligent behavior in artifacts
  - "Design computer programs to make computers smarter"
  - "Study of how to make computers do things at which, at the moment, people are better"
- Intelligent behavior
  - Perception, reasoning, learning, decision, communicating, acting in complex environments
- Long term goals of AI
  - Develop machines that do things as well as humans can or possibly even better
  - Understand intelligent behaviors

Definition

- Artificial intelligence is…
  - The science of getting computers to do the things they can't do yet?
  - Finding fast algorithms for NP-hard problems?
  - Getting computers to do the things they do in the movies?

- No generally accepted definition…

Science and engineering

- AI is one of the great intellectual adventures of the 20th and 21st centuries.
  - What is a mind?
  - How can a physical object have a mind?
    - Is a running computer (just) a physical object?
  - Can we build a mind?
  - Can trying to build one teach us what a mind is?

What Is AI?

- Can machines think?
  - Depend on the definitions of “machine”, “think”, “can”
- “Can”
  - Can machines think now or someday?
  - Might machines be able to think theoretically or actually?

Natural Language

- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems
- Language processing technologies
  - Question answering(IBM Watson)
  - Machine translation


"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."

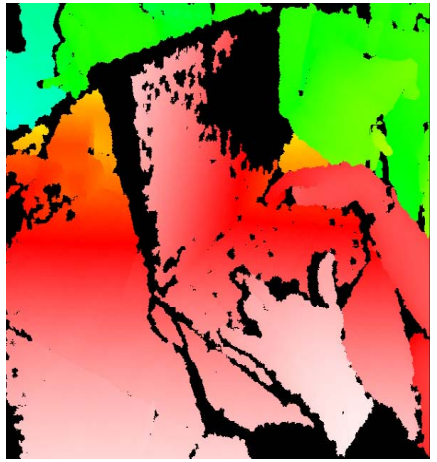
Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959

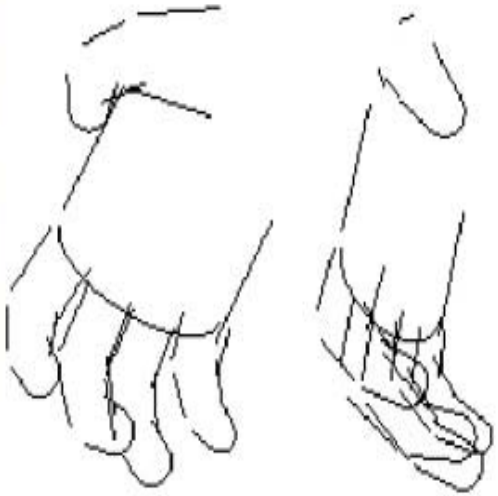
Video Anniversary of the Tibetan rebellion: China on guard

  - Web search
  - Text classification, spam filtering, etc…

Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification





Images from Erik Sudderth (left), wikipedia (right)

Demo1: VISION – lec_1_t2_video.flv

Demo2: VISION – lec_1_obj_rec_0.mpg

Vision (Perception)

Reading license plates, zip codes, checks

Face detection

Reconstructing 3D

Instance recognition

Vision (Perception)

- Instance recognition

Vision (Perception)

- Object/image categorization

Image Classifier Demo | Demo | About | Terms

Image Classifier Demo

NYU

Upload your images to have them classified by a machine! Upload multiple images using the button below or dropping them on this page. The predicted objects will be refreshed automatically. Images are resized such that the smallest dimension becomes 256, then the center 256x256 crop is used. More about the demo can be found here .

+ Upload Images | Remove All | Show help tips

I agree to the Terms of Use

Predicted objects:

1. Sorrel (1.00)
2. Ox (0.00)
3. Hartebeest (0.00)
4. Rhodesian Ridgeback (0.00)
5. Redbone (0.00)

Remove

Other objects:

Matthew Zeiler, New York University:
http://horatio.cs.nyu.edu/index.html

Vision (Perception)

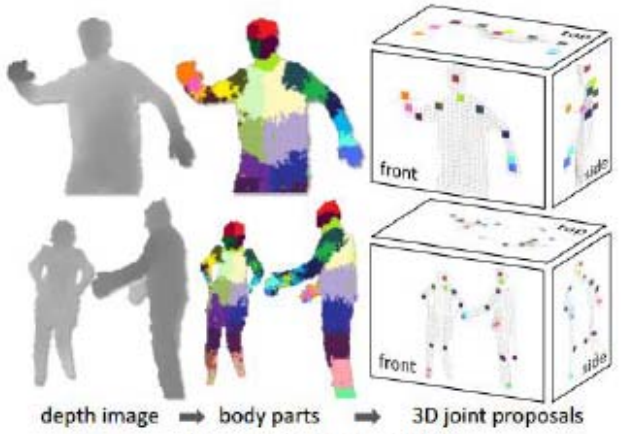
Augmented reality

Kim et al. 2009

Unusual event detection

Soft biometrics

IBM, Feris et al.

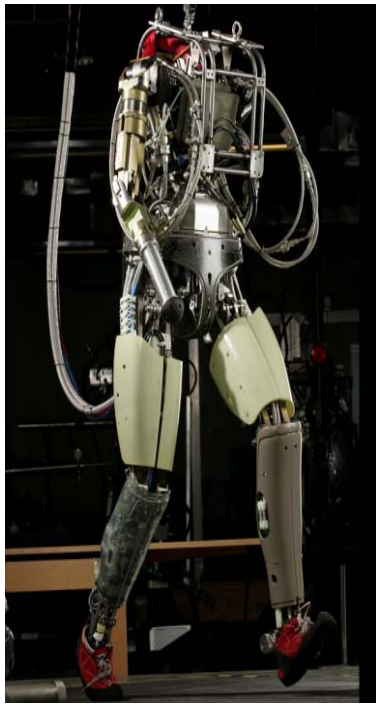


Shotton et al. 2011

Pose & tracking

Robotics

- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation…
- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control



Images from UC Berkeley, Boston Dynamics, RoboCup, Google

Logic

- Logical systems
  - Theorem provers
  - NASA fault diagnosis
  - Question answering
- Methods:
  - Deduction systems
  - Constraint satisfaction
  - Satisfiability solvers (huge advances!)

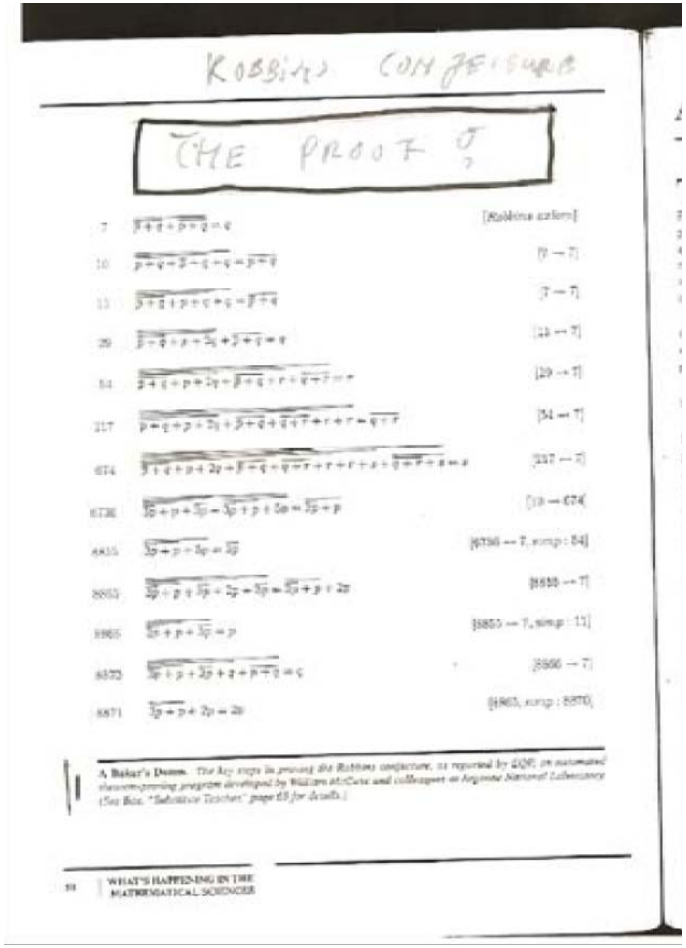


Image from Bart Selman

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!

Text from Bart Selman, image from IBM’s Deep Blue pages

Decision Making

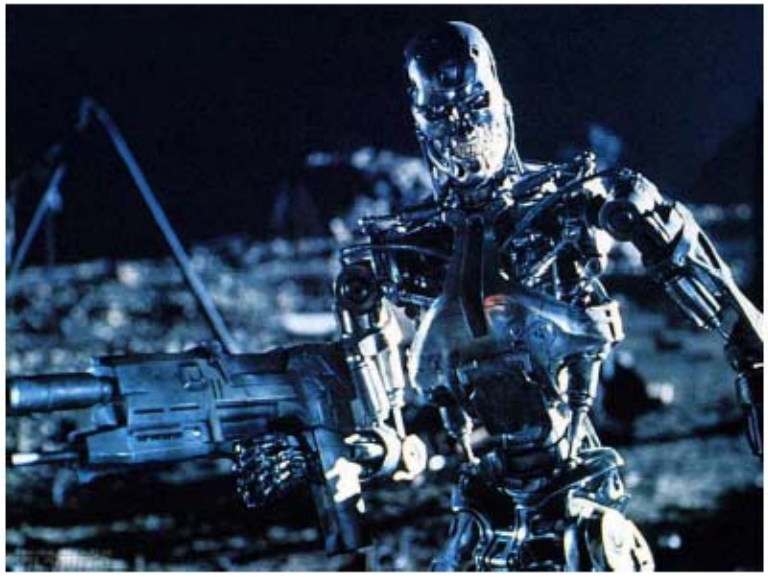
Applied AI involves many kinds of automation

- 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!

Ethics, implications

- Robust, fully autonomous agents in the real world

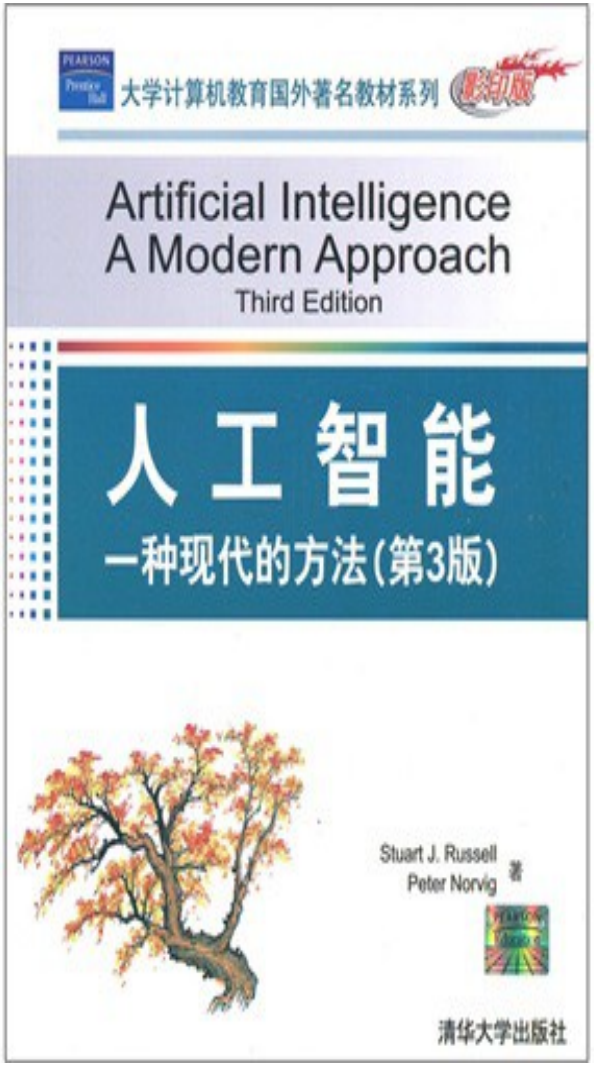
- What happens when we achieve this goal?

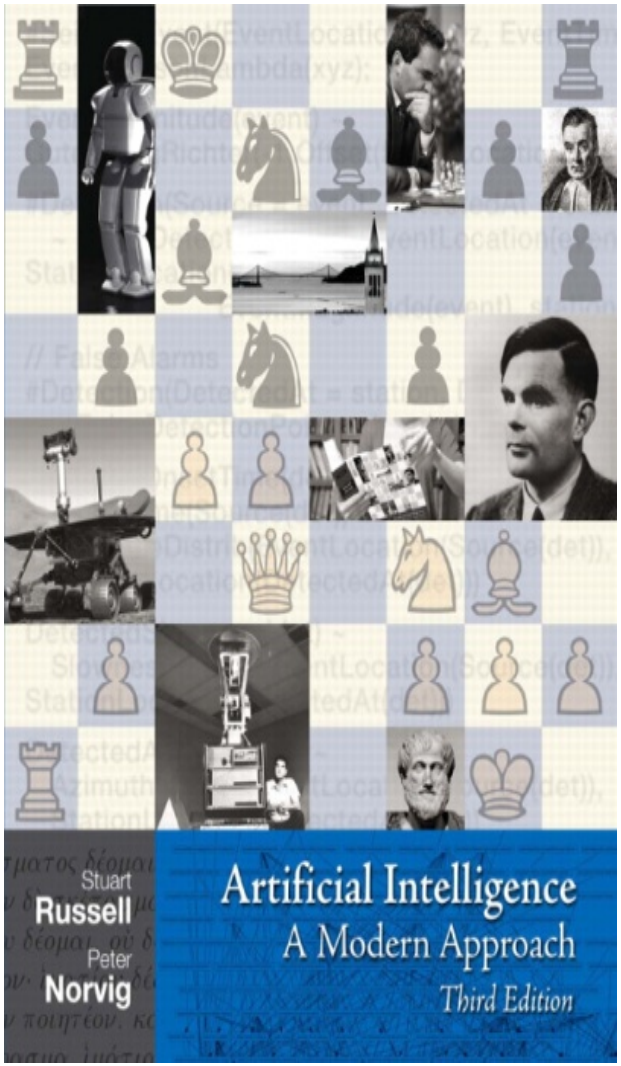


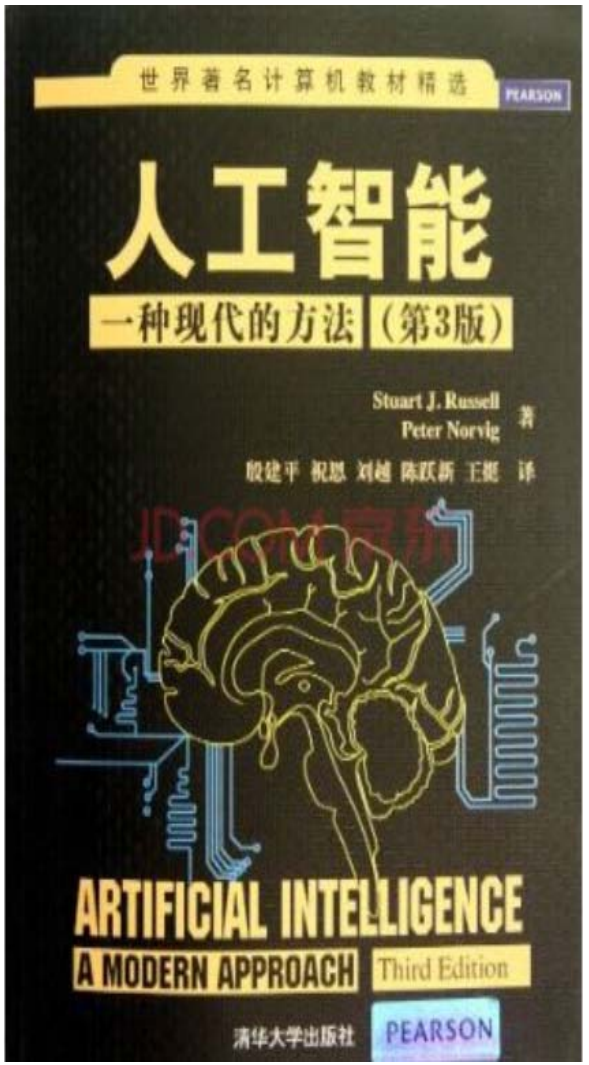
Some Hard Questions…

- Who is liable if a robot driver has an accident?
- Will machines surpass human intelligence?
- What will we do with superintelligent machines?
- Would such machines have conscious existence? Rights?
- Can human minds exist indefinitely within machines (in principle)?

Textbook







Web: http://aima.cs.berkeley.edu/

Goal of this course

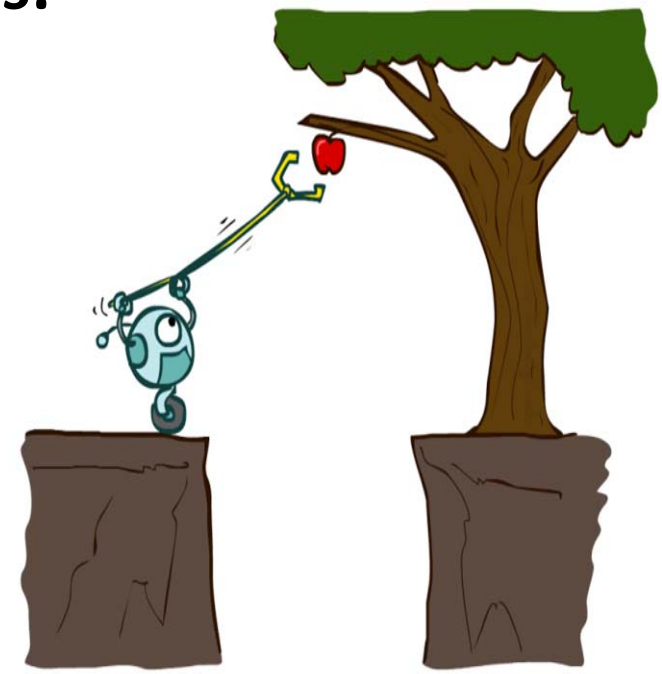
- Learn about Artificial Intelligence
  - Increase your AI literacy
  - Prepare you for topic courses and/or research

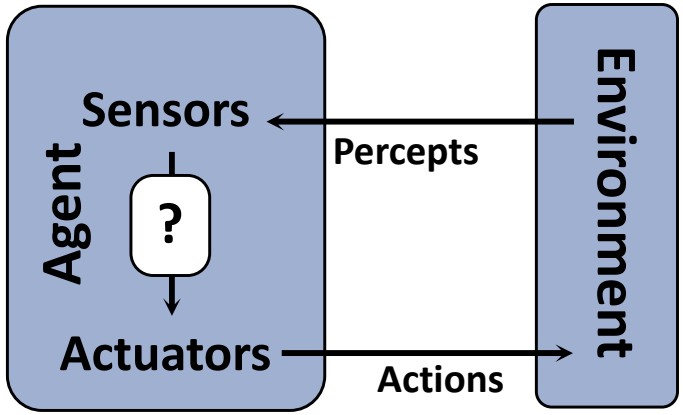
Course overview

1. Introduction and Agents (chapters 1,2)
2. Search (chapters 3,4,5,6)
3. Logic (chapters 7,8,9)
4. Uncertainty (chapters 13,14)
5. Learning (chapters 18,20)

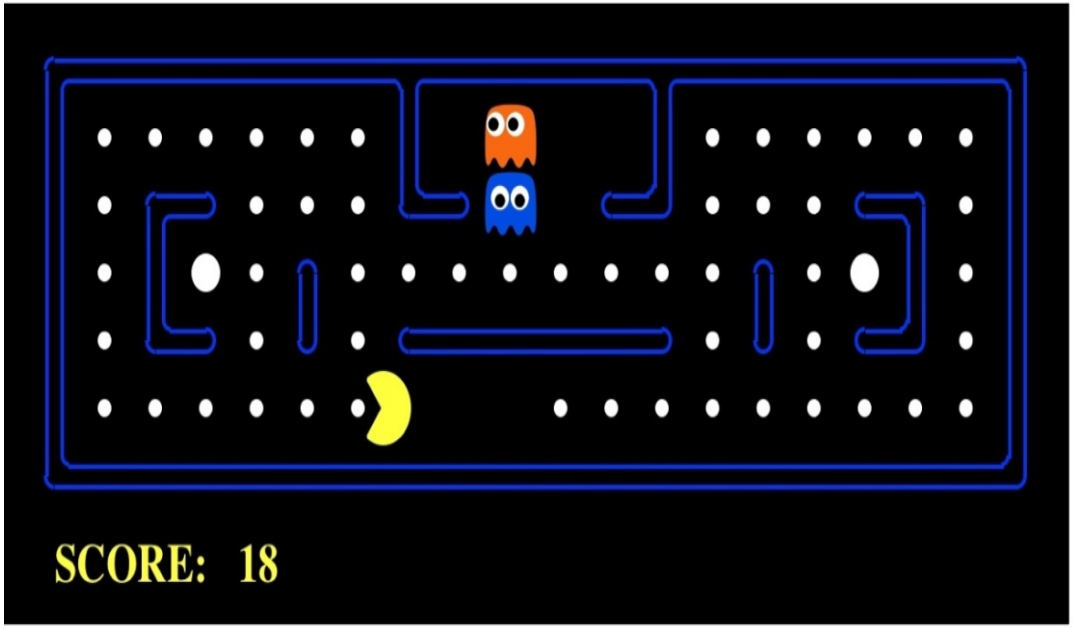
Designing Rational Agents

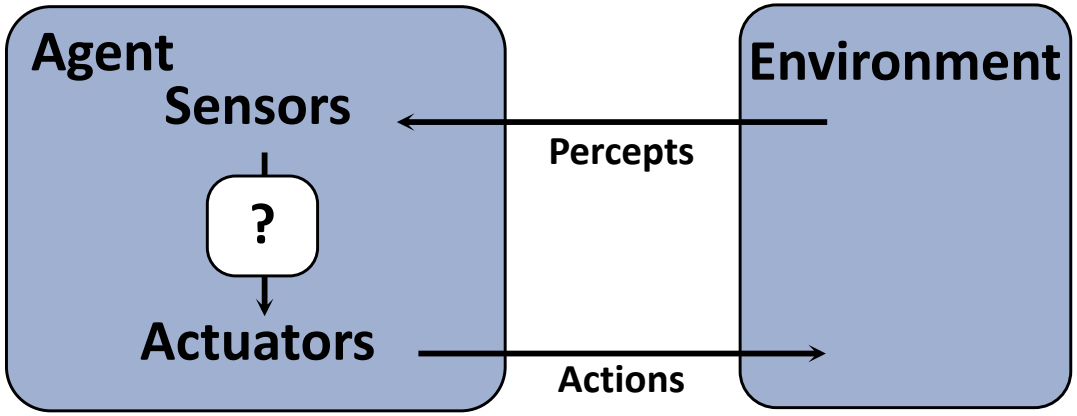
- An agent is an entity that *perceives* and *acts*.
- A rational agent selects actions that maximize its (expected) utility.
- Characteristics of the percepts, environment, and action space dictate techniques for selecting rational actions
- This course is about:
  - General AI techniques for a variety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





Pac-Man as an Agent



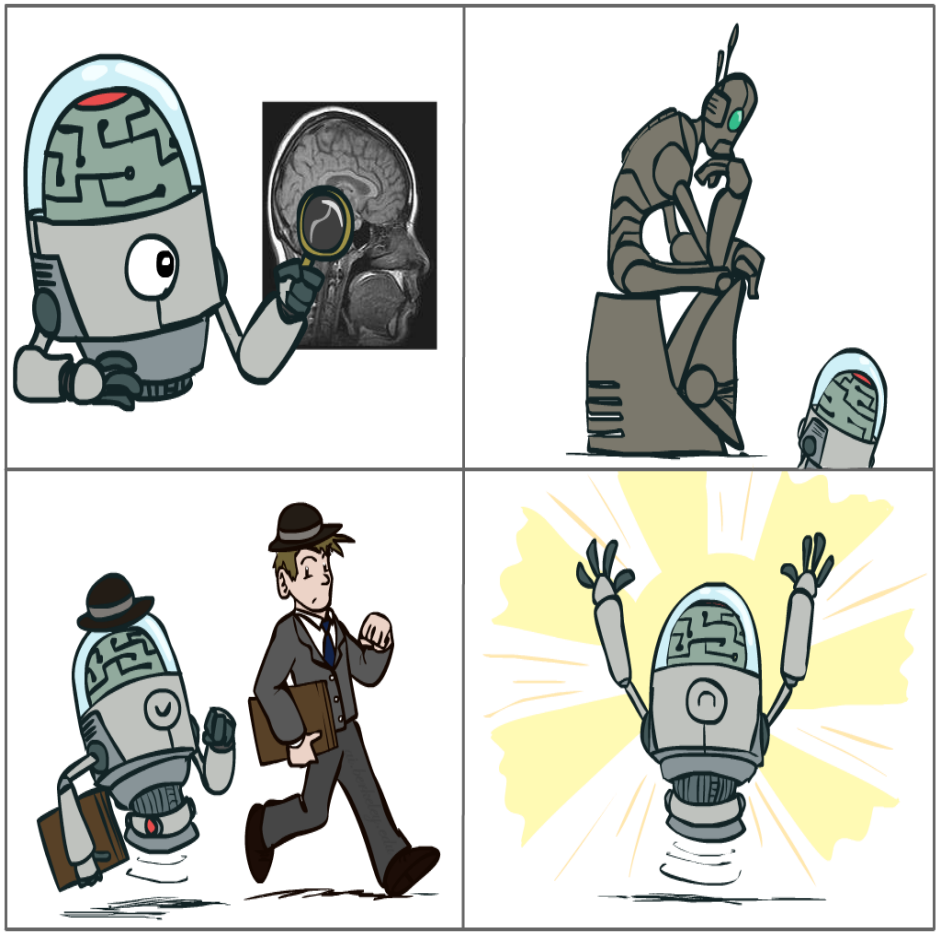


What is AI?

What is AI?

The science of making machines that:

Think like people



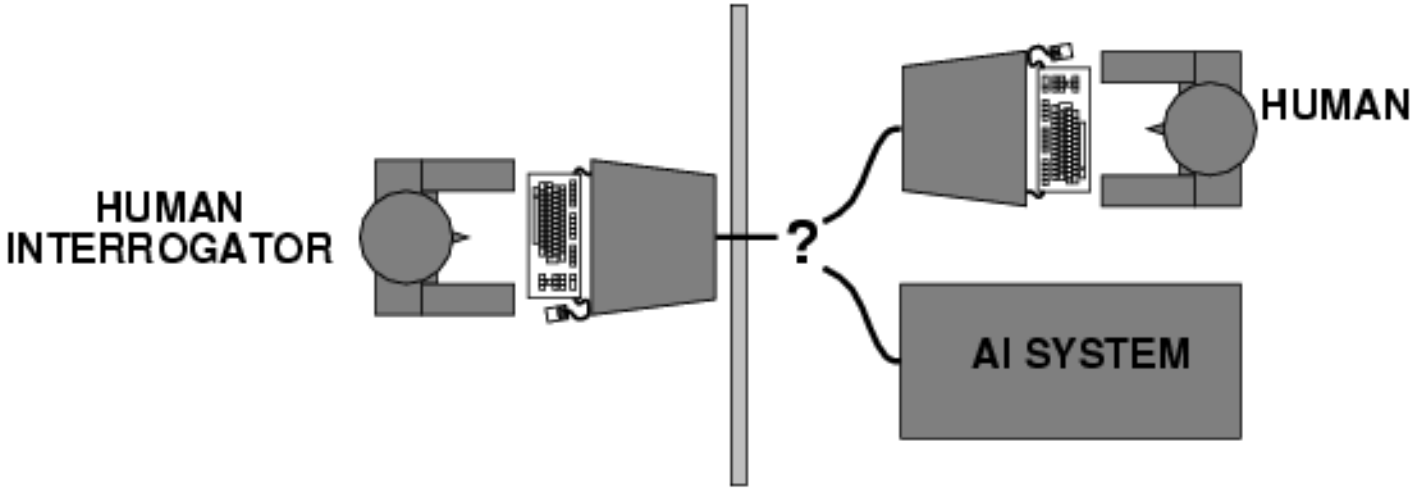
Think rationally

Act like people

Act rationally

Acting humanly: Turing Test

- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" → "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game



- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes

- Suggested major components of AI: knowledge, reasoning, language understanding, learning

Thinking humanly: cognitive modeling

- 1960s "cognitive revolution": information-processing psychology
- Requires scientific theories of internal activities of the brain
- -- How to validate? Requires
  1) Predicting and testing behavior of human subjects (top-down)
  or 2) Direct identification from neurological data (bottom-up)
- Both approaches (roughly, Cognitive Science and Cognitive Neuroscience), are now distinct from AI

Thinking rationally: "laws of thought"

- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of *logic*: *notation* and *rules of derivation* for thoughts; may or may not have proceeded to the idea of mechanization
- Direct line through mathematics and philosophy to modern AI
- Problems:
  1. Not all intelligent behavior is mediated by logical deliberation
  2. What is the purpose of thinking? What thoughts should I have?

Acting rationally: rational agent

- Rational behavior: doing the right thing

- The right thing: that which is expected to maximize goal achievement, given the available information

- Doesn't necessarily involve thinking – e.g., blinking reflex – but thinking should be in the service of rational action

Rational agents

- An agent is an entity that perceives and acts
- Abstractly, an agent is a function from percept histories to actions:

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

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- Remark: computational limitations make perfect rationality unachievable
  → design best program for given machine resources

Rational Decisions

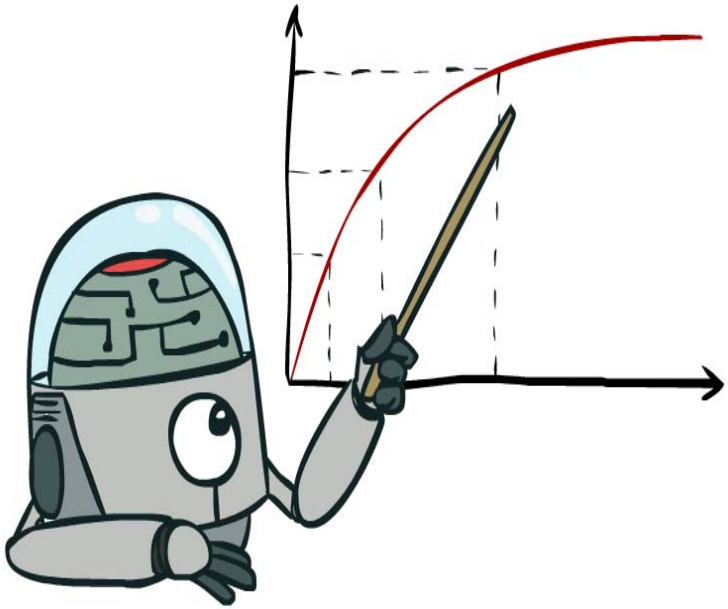
We'll use the term rational in a very specific, technical way:

- 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 better title for this course would be:

Computational Rationality

Maximize Your Expected Utility



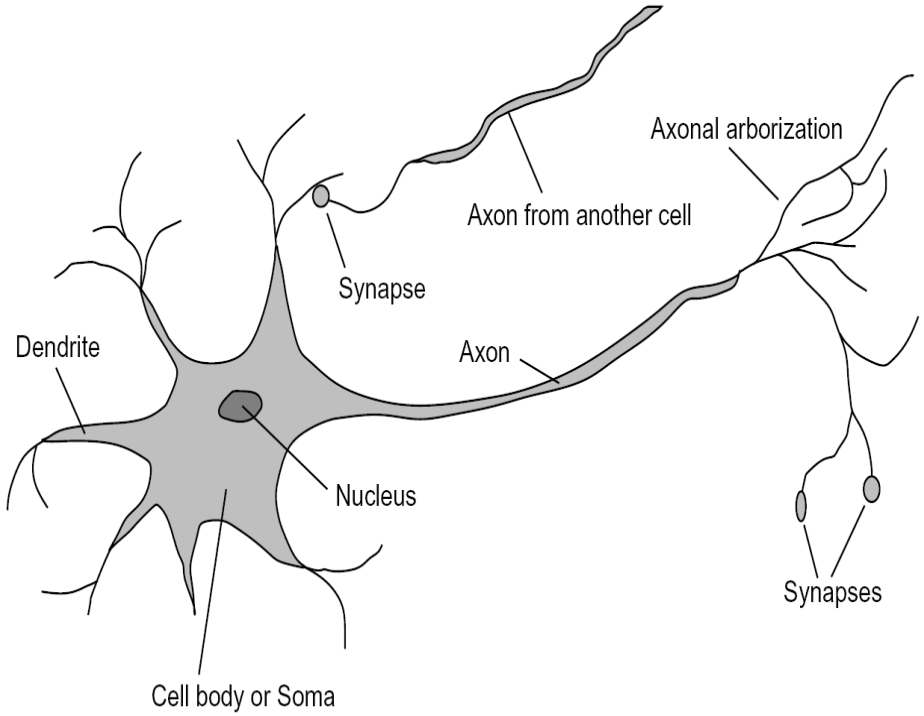
Computer and Brain

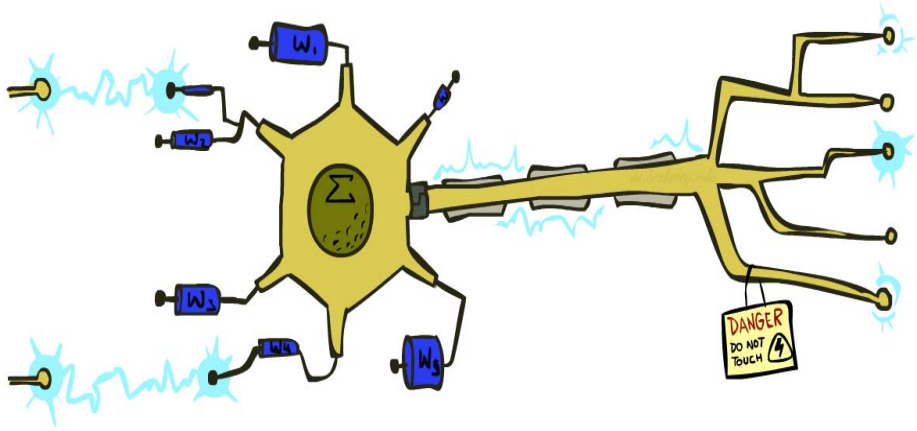
What About the Brain?

- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- "Brains are to intelligence as wings are to flight"
- Lessons learned from the brain: memory and simulation are key to decision making

Some (Simplified) Biology

- **Very loose inspiration: human neurons**

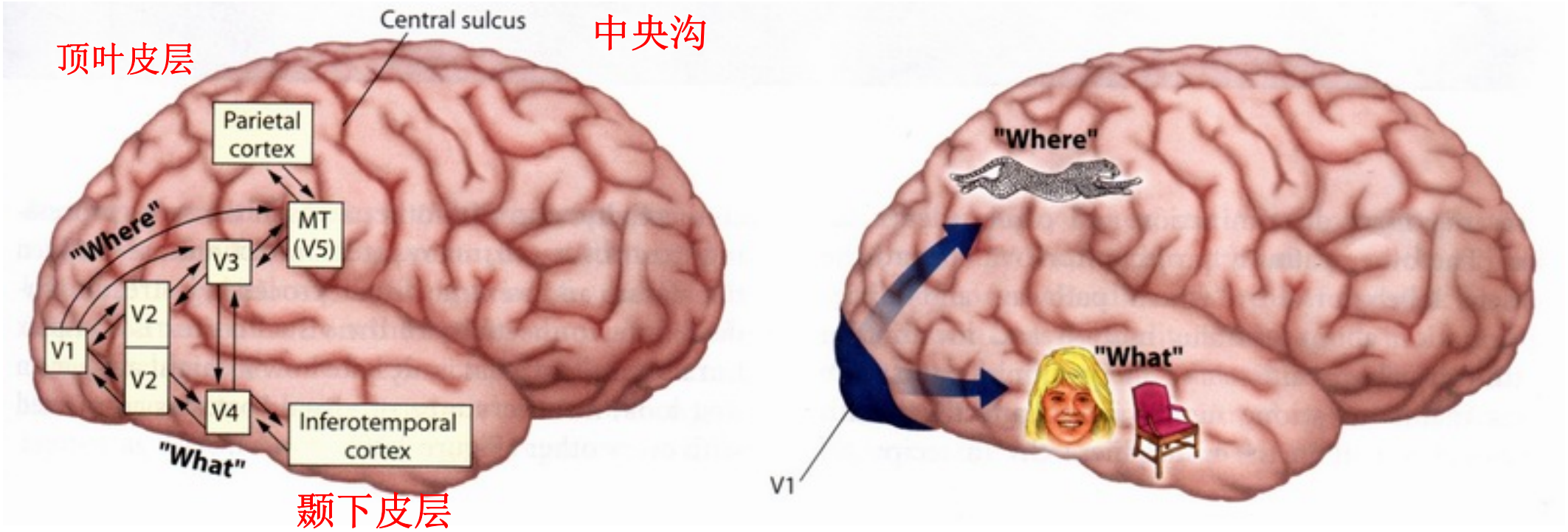




Computer Sci. and Brain Sci.

Information Processing in Digital Computer	Information Processing in the Brain
Computing based on Logic	Computing based on Statistics
CPU and Storage: Separated	CPU and Storage: Unified
Data Processing & Storage: Simple	Data Processing & Storage: Unknown
Intelligent Information Processing: Complicated and Slow	Intelligent Information Processing: Simple and Fast
Cognitive capability: Weak	Cognitive capability: Strong
Information Process Mode: Logic – Information – Statistics	Information Process Mode: Statistics —concepts—logic

Visual Information Processing



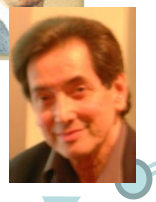
‘Where’: the motion and spatial location

‘What’: the detailed features, form, and object identity

Progress of brain-like models

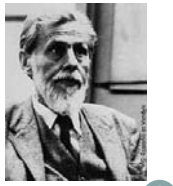
CNN, 1998, 2012
RNN, 1982, 2013

S. Amari 1967
S. Grossberg

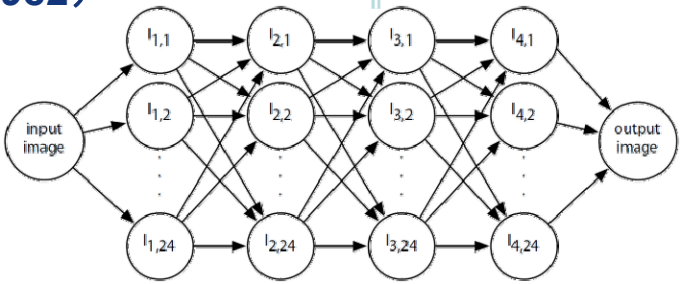


Deep learning, 2005, 2009

F. Rosenblatt



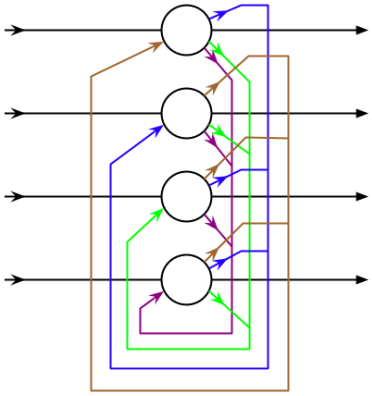
Hopfield Neural network（1982）

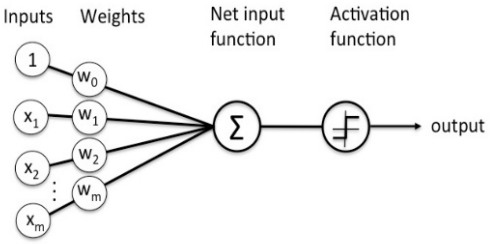


The multilayer perceptron(1972)
Fukushima, Neocognitron(1980)

The perceptron algorithm
（1957）

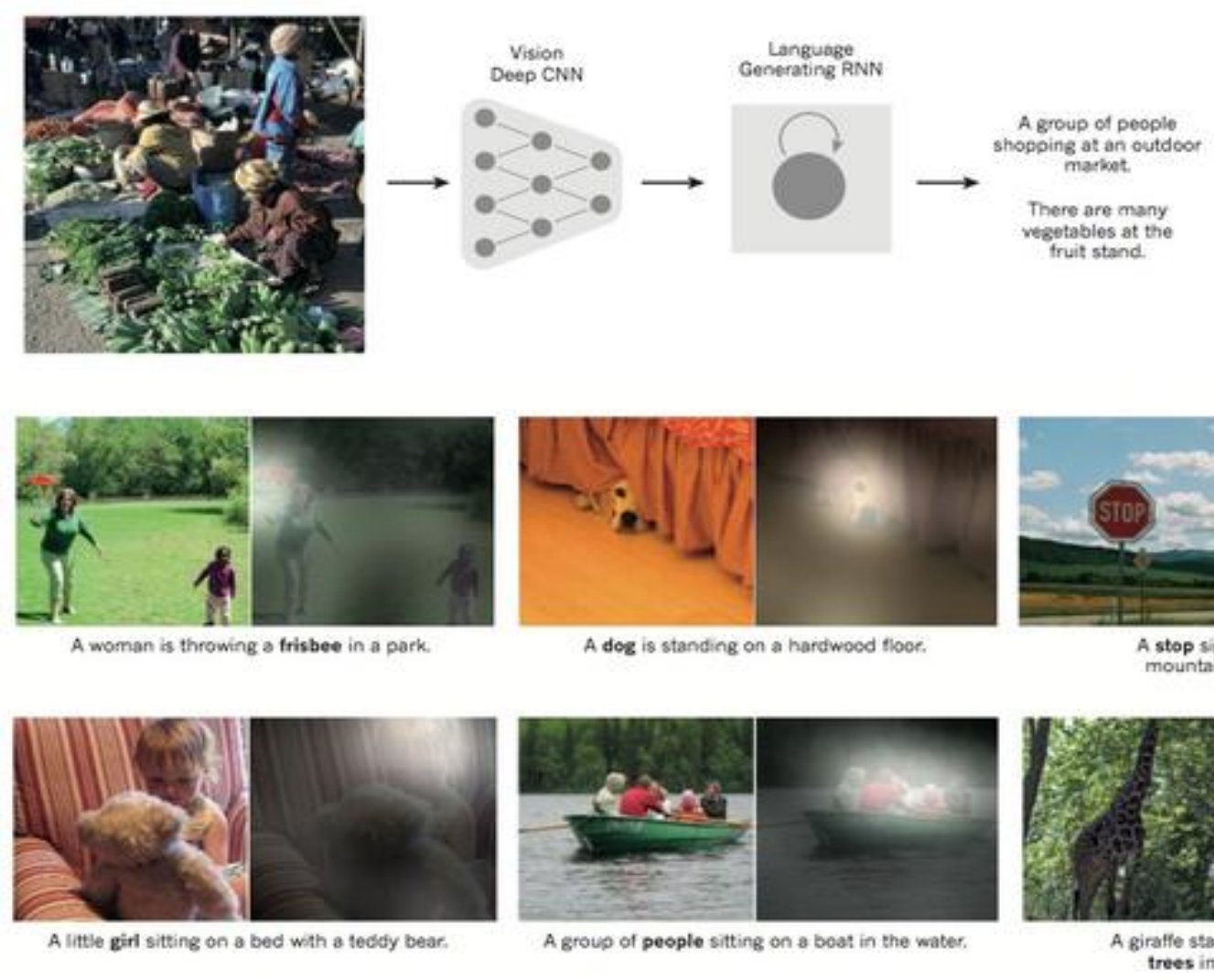
McCulloch—Pitts' neuron model
（ 1943 ）



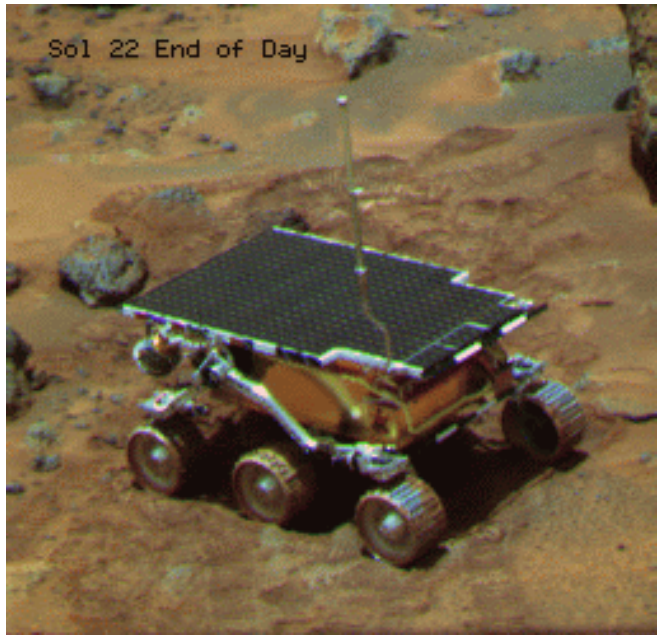


Schematic of Rosenblatt's perceptron.

Deep learning



Intelligent Systems



AI prehistory

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
Neuroscience	Physical substrate for mental activity
Psychology	Phenomena of perception and motor control, experimental techniques
Computer engineering	Building fast computers
Control theory	Design systems that maximize an objective function over time
Linguistics	Knowledge representation, grammar

A (Short) 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 reasonin
- 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: "AI Winter"
- 1990—: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… "AI Spring"?
- 2000—: Where are we now?

Abridged history of AI

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
1956	Dartmouth meeting: "Artificial Intelligence" adopted
1952—69	Look, Ma, no hands!
1950s	Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1965	Robinson's complete algorithm for logical reasoning
1966—73	AI discovers computational complexity Neural network research almost disappears
1969—79	Early development of knowledge-based systems
1980--	AI becomes an industry
1986--	Neural networks return and became popular
1987--	AI becomes a science
1995--	The emergence of intelligent agents

State of the Art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- Proved a mathematical conjecture (Robbins conjecture) unsolved for decades (1996 by W. McCune)
- No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- Proverb solves crossword puzzles better than most humans

Thank you

End of Chapter 1