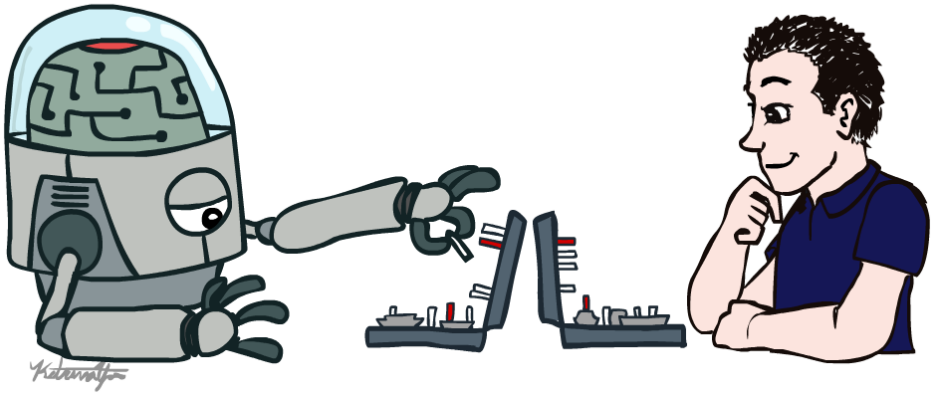
Artificial Intelligence

Introduction



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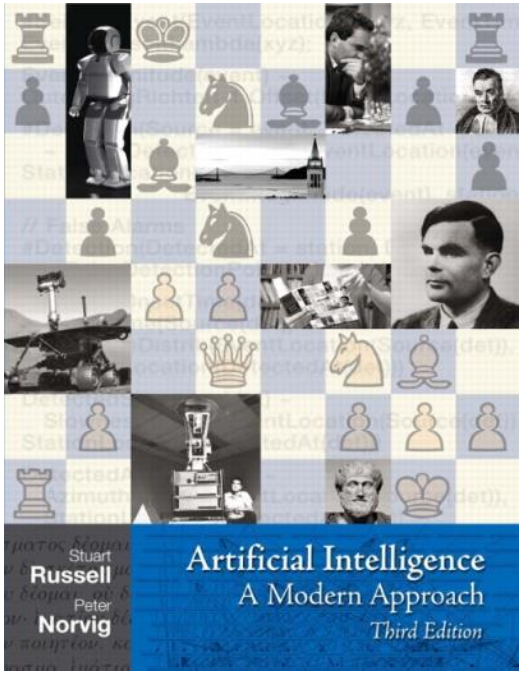
Textbook

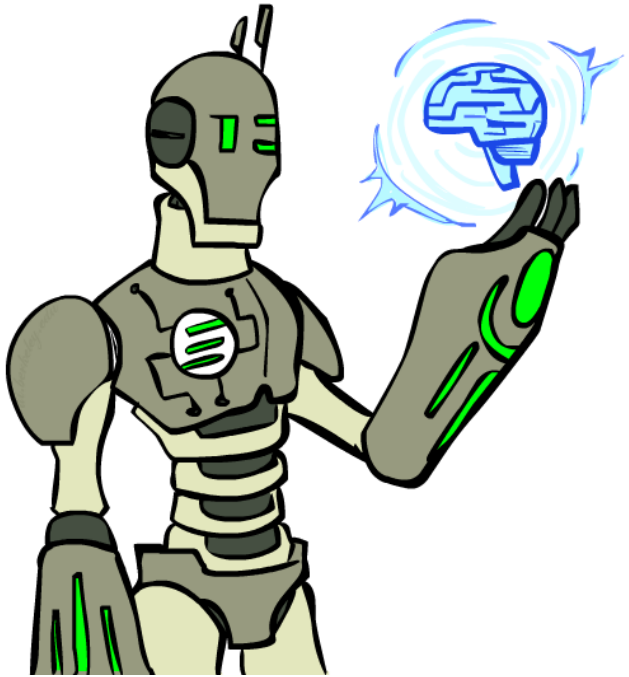
Russell & Norvig, AI: A Modern Approach, 3rd Ed.



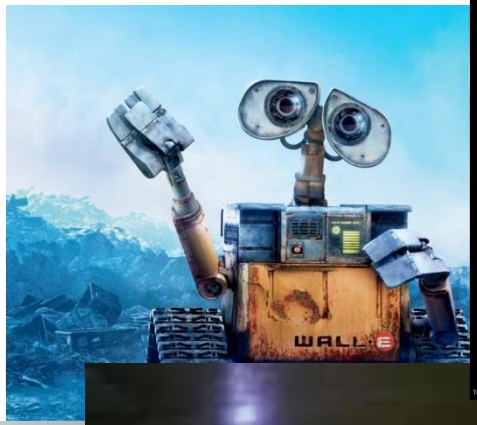
Today

- What is artificial intelligence?

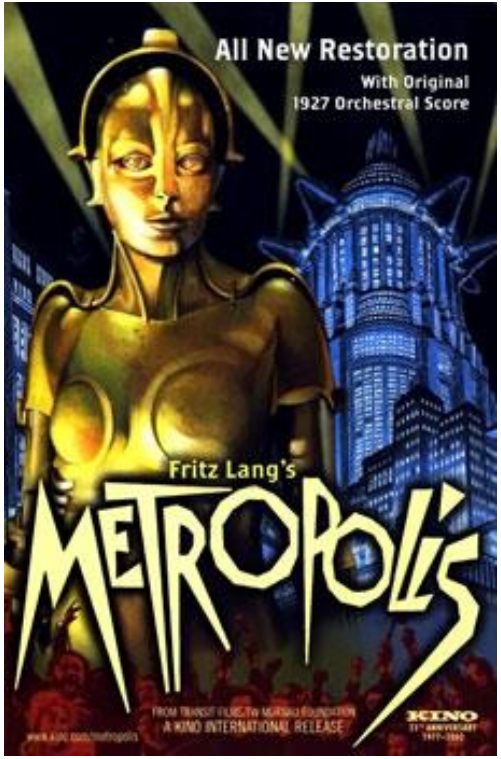
- Past: how did the ideas in AI come about?
- Present: what is the state of the art?
- Future: will robots take over the world?



What is AI?



What is AI?


All New Restoration
With Original
1927 Orchestral Score
Fritz Lang's
METROPOLIS
A KINO INTERNATIONAL RELEASE
KINO

YESTERDAY DR. WILL CASTER WAS ONLY HUMAN
JOHNNY DEPP
REBECCA HALL
PAUL BETTANY
KATE MARA
CILLIAN MURPHY
AND MORGAN FREEMAN
TRANSCENDENCE
entertainmentfilms.co.uk

What is AI?

The science of making machines that:

What is AI?

- To build models of (or replicate) human cognition
  - Psychology, neuroscience, cognitive science: *the brain is tricky*
- To build useful intelligent artifacts
  - Engineering
- To create and understand intelligence as a general property of systems
  - Encompasses all of the above
  - Rationality within computational limitations

Rational Decisions

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

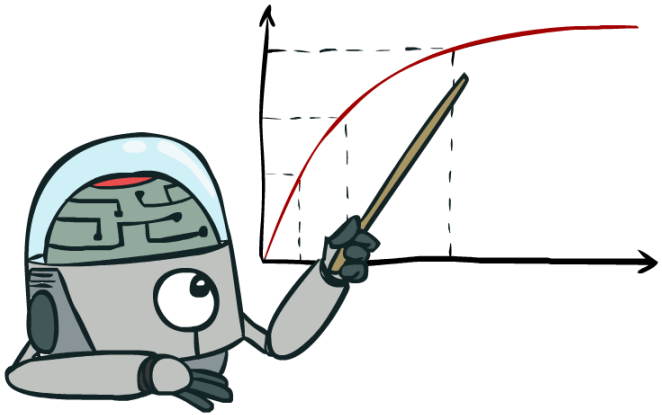
- Rational: maximally achieving pre-defined goals given available information
- Rationality only concerns what decisions are made

  (not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Being rational means **maximizing your expected utility**

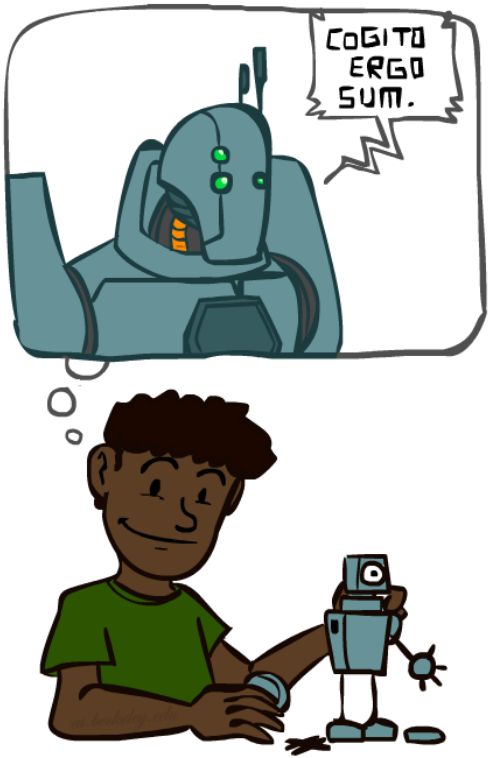
A better title for this course would be:

Computational Rationality

Maximize Your Expected Utility



A (Short) History of AI

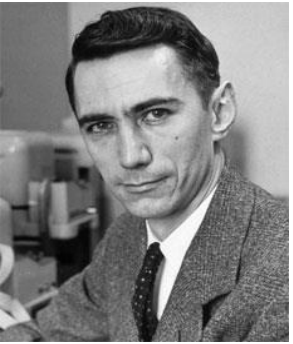


Demo: HISTORY – MT1950.wmv

A short prehistory of AI

- Prehistory:
  - **Philosophy** from Aristotle onwards
  - **Mathematics** (logic, probability)
  - **Neuroscience** (neurons, adaptation)
  - **Economics** (rationality, game theory)
  - **Control theory** (feedback)
  - **Psychology** (learning, cognitive models)

AI's official birth: Dartmouth, 1956

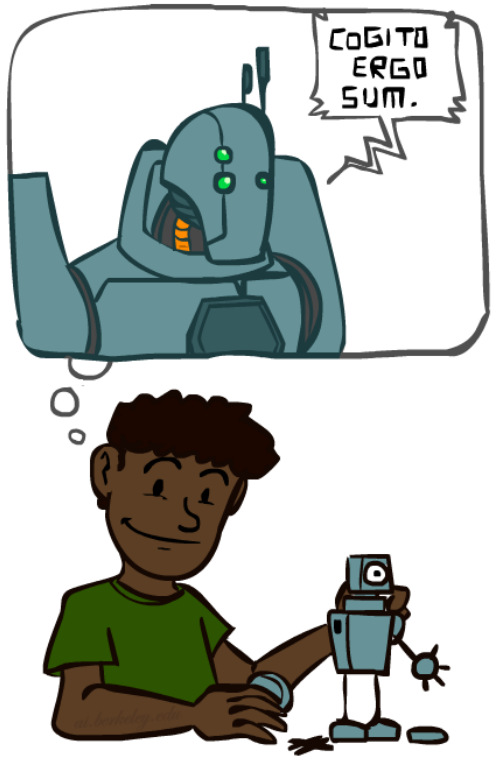


"An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. ***We think that a significant advance can be made if we work on it together for a summer."***

John McCarthy and Claude Shannon
Dartmouth Workshop Proposal

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 reasoning
  - 1966-9: Failure of naïve MT and learning methods
- 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?



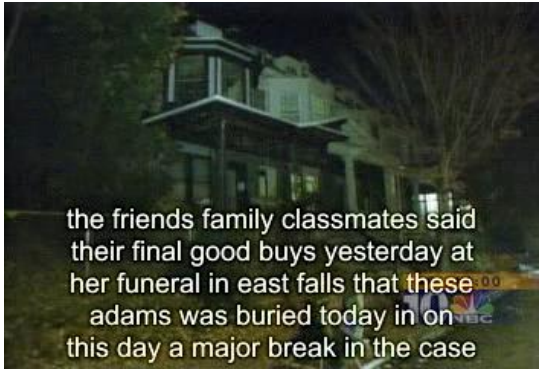
Unintentionally Funny Stories

- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.

[Shank, Tale-Spin System, 1984]

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

"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."

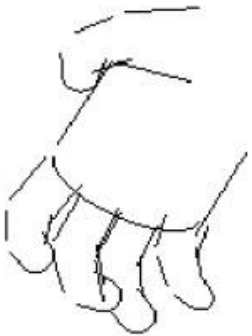
Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959

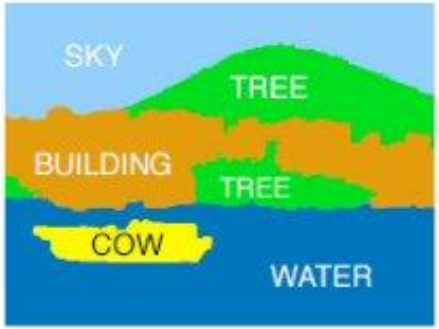
Video Anniversary of the Tibetan rebellion: China on guard

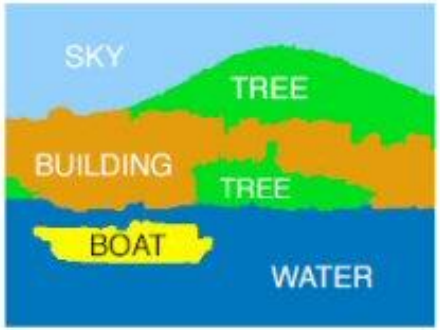
  - Web search
  - Text classification, spam filtering, etc…

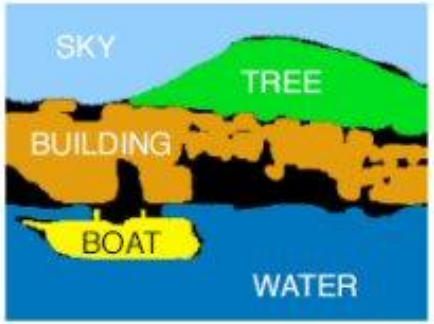
Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification
- Object tracking and behavior recognition





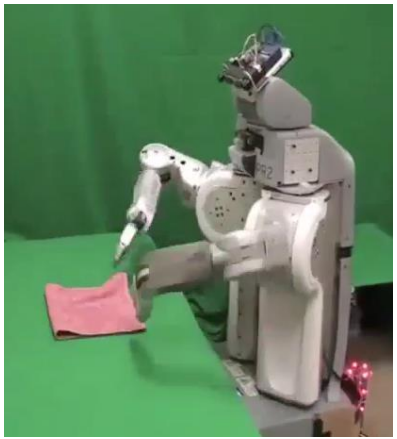




Images from Erik Sudderth (left), scienceagogo (right)

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
  - Program and plan synthesis, verification
  - NASA fault diagnosis
  - Question answering
  - Rule-based information systems
- Methods:
  - Deductive inference
  - Constraint satisfaction
  - Satisfiability solvers (huge advances!)

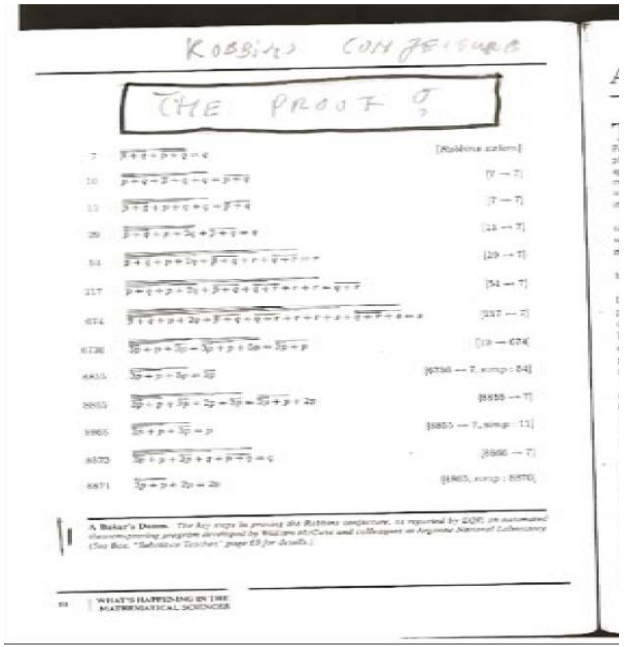


Image from Bart Selman

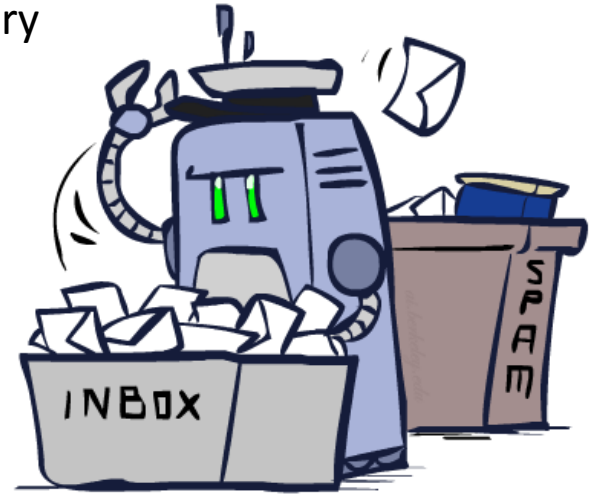
Game Playing

- Classic Moment: May, '97: Deep Blue vs. Kasparov
  - First match won against world champion
  - “Intelligent, creative” play
  - Special-purpose hardware, 200 million board positions per second
  - Current PC programs far ahead of humans
- Open question:
  - How does human cognition deal with the vast search space 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

Embedded applications

- AI lies behind many other useful systems:
  - Scheduling, e.g. airline routing, military
  - Route planning, e.g. Google maps
  - Medical diagnosis, e.g., EKGs
  - Automated surveillance
  - Web search engines
  - Spam classifiers
  - Automated help desks
  - Fraud detection
  - Product recommendations
  - … Lots more!



Future

- We are doing AI…
  - To create intelligent systems
    - The more intelligent, the better
  - To gain a better understanding of human intelligence
  - To magnify those benefits that flow from it

Future, contd.

- Progress is accelerating, partly due to an industry arms race
- Once performance reaches a minimum level, every 1% improvement is worth billions
  - Speech
  - Text understanding
  - Object recognition
  - Automated vehicles
  - Domestic robots

What if we do succeed?

- "***The first ultraintelligent machine is the last invention that man need ever make***." I. J. Good, 1965
- Might help us avoid war and ecological catastrophes, achieve immortality and expand throughout the universe
- Success would be the biggest event in human history …
  - **and perhaps the last**

Reasons not to worry

- "AI will never reach human levels of intelligence"
- "OK, maybe it will, but I'll be dead before it does"
- "Machines will never be conscious"
  - *Consciousness* isn't the problem, it's *competence*!
- "We design these things, right?"
  - Yes, and the genie grants three wishes
  - For ***almost any goal***, a superintelligent system will…
    - Acquire as many resources as possible and improve its own algorithms
    - Protect itself against any attempt to switch it off or change the goal