
CSE 473

Artificial Intelligence (AI)

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<http://www.cs.washington.edu/473>

Based on slides by UW CSE AI faculty, Dan Klein, Stuart Russell, Andrew Moore

Outline

- Goals of this course
- Logistics
- What is AI?
- Examples
- Challenges

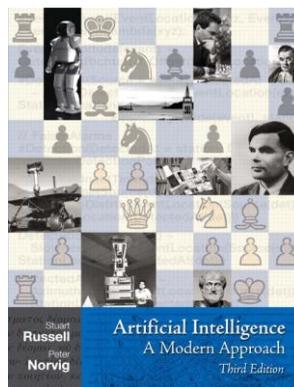
CSE 473 Goals

- To introduce you to a set of key:
 - Concepts &
 - Techniques in AI
- Teach you to identify when & how to use
 - **Heuristic search** for problem solving and games
 - **Logic** for knowledge representation and reasoning
 - **Probabilistic inference** for reasoning under uncertainty
 - **Machine learning** (for pretty much everything)

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CSE 473 Logistics

- E-mail:
 - Rajesh Rao rao@cs
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 - Evan Herbst eherbst@cs
- Required Textbook
 - Russell & Norvig's "AIMA3"
- Grading:
 - Homeworks and projects 50%
 - Midterm 20%
 - Final 30%
- Midterm on Monday, October 29, in class (closed book, except for one 8 ½" x 11" page of notes)



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CSE 473 Topics

- Overview, agents, environments (Chaps 1 and 2)
- Search (Chaps 3 and 5)
- Knowledge representation and logic (Chaps 7-9)
- Uncertainty & Bayesian networks (Selected topics from Chaps 13-15 and 17)
- Machine Learning: Learning from examples (Chap 18)
- Machine Learning: Reinforcement learning (Chap 21)

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AI as Science

Physics: Where did the *physical universe* come from and what laws guide its dynamics?

Biology: How did *biological life* evolve and how do living organisms function?

AI: What is the nature of “*intelligence*” and what constitutes intelligent behavior?

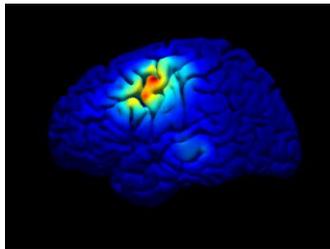
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AI as Engineering

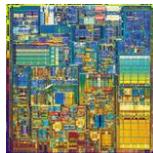
- How can we make software and robotic devices more powerful, adaptive, and easier to use?
- Examples:
 - Speech recognition
 - Natural language understanding
 - Computer vision and image understanding
 - Intelligent user interfaces
 - Data mining
 - Mobile robots, softbots, humanoids
 - Brain-computer interfaces...

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Hardware



10^{11} neurons
 10^{14} synapses
cycle time: 10^{-3} sec (1 kHz)



10^{10} transistors
 10^{12} bits of RAM (125 GB)
cycle time: 10^{-10} sec (10 GHz)

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Projection

- In near future (~2020) computers will
 - become cheap enough and have enough processing power and memory capacity to *match the general intellectual performance of the human brain*
- But... what “software” does the human brain run?
 - Very much an open question

What is AI?



Defining AI

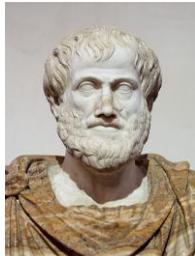
	human-like	rational
thought	Systems that think like humans	Systems that think rationally
behavior	Systems that act like humans	Systems that act rationally

Rational: maximally achieving pre-defined goals

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AI Prehistory

- **Logical Reasoning:** (4th C BC+) Aristotle, George Boole, Gottlob Frege, Alfred Tarski
- **Probabilistic Reasoning:** (16th C+) Gerolamo Cardano, Pierre Fermat, James Bernoulli, Thomas Bayes



1940-1950: The Early Days

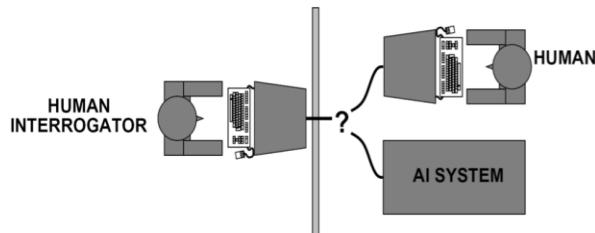
- 1943: McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing's "Computing Machinery and Intelligence"

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed...

-Alan Turing

The Turing Test

- Turing (1950) "Computing machinery and intelligence"
 - "Can machines think?" → "Can machines interact intelligently?"
 - The *Human Interaction Game*:



- Suggested major components of AI: knowledge, reasoning, language understanding, learning
- Missing: Physical interactions with the real-world

1950-1965: Excitement

- **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**

“Over Christmas, Allen Newell and I created a thinking machine.”

-Herbert Simon

Battle for the Soul of AI

- **Minsky & Papert (1969) – *Perceptrons* book**
 - **Single-layer neural networks cannot learn XOR**
 - **Argued against neural nets in general**
- **Backpropagation learning algorithm**
 - **Invented in 1969 and again in 1974**
 - **Hardware too slow, until rediscovered in 1985**
- **Research funding for neural nets disappears**
- **Rise of knowledge based systems**

1970-1980: Knowledge Based Systems

- **1969-79: Early development of knowledge-based systems**
- **1980-88: Expert systems industry booms**
- **1988-93: Expert systems industry busts**
“AI Winter”

1988-present: Statistical Approaches

- **1985-1990: Probability and Decision Theory become dominant**
Pearl, Bayes Nets
- **1990-2000: Machine learning takes over subfields:**
Vision, Natural Language, etc.
- **Agents, uncertainty, and learning systems...**
“AI Spring”?

"Every time I fire a linguist, the performance of the speech recognizer goes up"

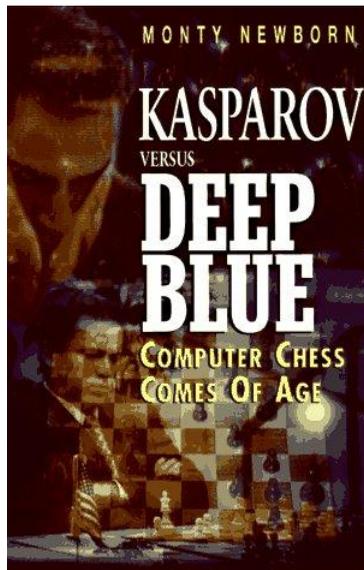
-Fred Jelinek, IBM Speech Team

What Can AI Systems Do Today?

Pop Quiz: Which of the following can be done by AI systems today?

- Play a decent game of Soccer?
- Defeat a human in a game of Chess? Go? Jeopardy?
- Drive a car safely along a curving mountain road? On University Way?
- Buy a week's worth of groceries on the Web? At QFC?
- Make a car? Make a cake in your kitchen?
- Discover and prove a new mathematical theorem?
- Perform a heart bypass surgery?
- Unload a dishwasher and put everything away?
- Translate Mandarin Chinese into English in real time?

Examples: Chess (Deep Blue, 1997)



I could feel –
I could smell –
a new kind of
intelligence
across the
table”

-Gary
Kasparov

Speech Recognition



Siri

Use your voice to send messages, set reminders, search for information, and more.



Navigation Systems



Automated call centers

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Natural Language Understanding

- Speech Recognition
 - “word spotting” feasible today
 - continuous speech – limited success
- Machine Translation / Understanding
 - progress but not there yet

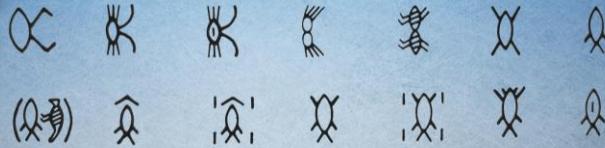
The spirit is willing but the flesh is weak. (English)

The vodka is good but the meat is rotten. (Russian)

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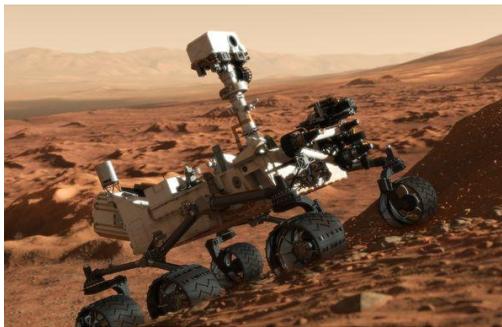
Deciphering Ancient Scripts

The Indus script
(2600-1900 BC)



(See Raj's TED talk for details) 25

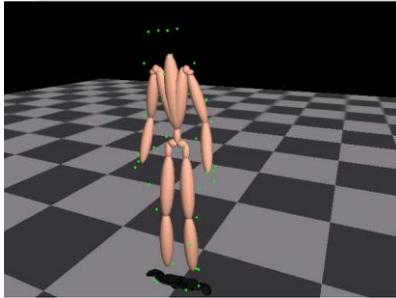
Mars Rovers (2003-now)



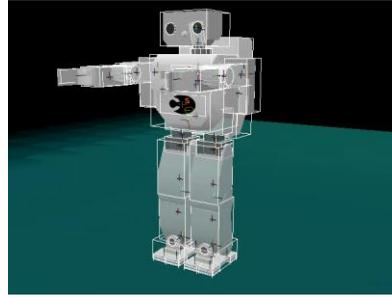
(See NASA website for latest updates) 26

Robots that Learn

Before Learning



Human Motion Capture



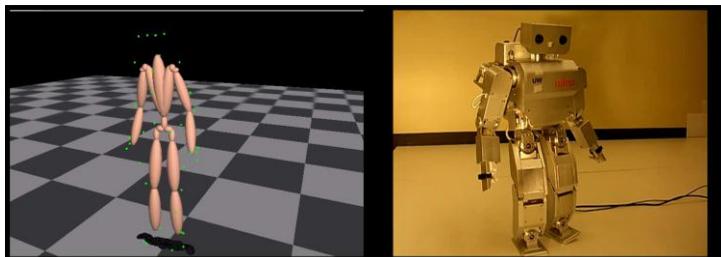
Attempted Imitation

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Robots that Learn



Learning



After Learning

(Work by UW CSE PhD David Grimes) 28

Muscle-Activated Robotics



(Work by UW CSE undergrad Beau Crawford) 29

Brain-Computer Interfaces



(Work by UW MD-PhD Kai Miller) 30

Limitations of AI Systems Today

- Today's successful AI systems
 - operate in well-defined domains
 - employ narrow, specialized hard-wired knowledge
- *Missing*: Ability to
 - Operate in complex, *open-ended dynamic* worlds
 - E.g., Your kitchen vs. GM factory floor
 - Adapt to unforeseen circumstances
 - Learn from new experiences
- In this class, we will explore some potentially useful techniques for tackling these problems

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For You To Do

- Browse CSE 473 course web page
- Do Project 0: Python tutorial
- Read Chapters 1 and 2 in text
- Project 1 to be assigned on Friday

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