



ARTIFICIAL INTELLIGENCE



Artificial Intelligence

Ali Reze Khanteymoori

Fall 1389

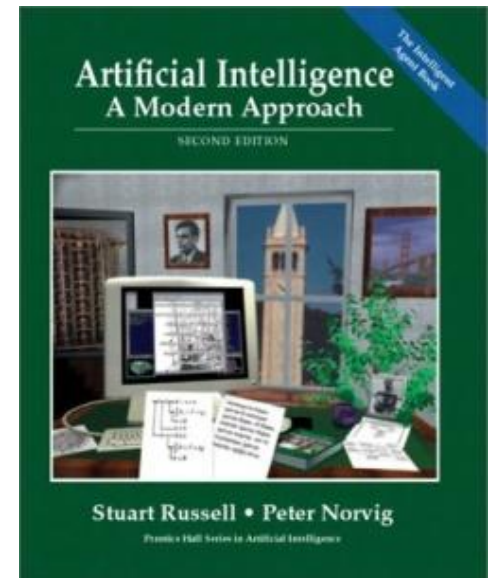
Course Outline

- Days: Saturday
- Time : 8:00 a.m. – 11 a.m.

- Textbooks
 - S. Russell and P. Norvig, "[Artificial Intelligence: A Modern Approach](#)" (Second Edition), Prentice Hall, 2003.
 - Most widely used
 - It's so good....
 - I'm going to make you read it!
 - <http://aima.cs.berkeley.edu/>

Instructor

- Ali Reza Khanteymoori
- Email: Khanteymoori@iasbs.ac.ir



Grading Policy

- Assignments and HomeWorks (20%)
 - Scientific Diary Notebook!
 - Class Discussion

- Research Paper (40%)
 - Deadline for choosing topic: 11th Aban, 11:00 a.m.
 - Deadline for Final version: 25th Day, 6:00 p.m.

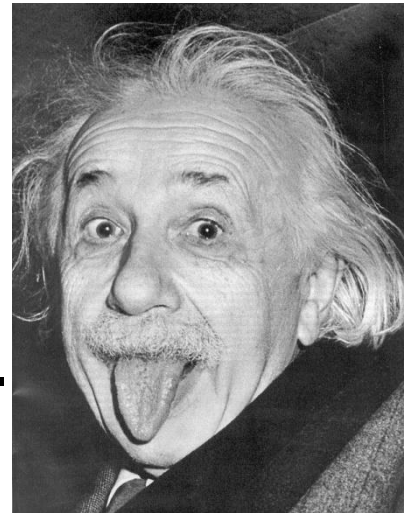
- Final Exam (40%)

What is intelligence ?



About Intelligence

- Intelligence is subjective,
 - You need not be great in all domains to be called intelligent.
 - Physicists boil watches!
- Intelligence is a relative measure.
 - A child who talks fluently.
 - A dog which identifies his owner's voice
 - I.Q.



Quotes About Intelligence

- The capacity for knowledge, and knowledge possessed. (Henmon, 1921)
- The capacity to learn or to profit by experience. (Dearborn, 1921)
- Intelligence is what is measured by intelligence tests. (Boring, 1923)
- A global concept that involves an individual's ability to act purposefully, think rationally, and deal effectively with the environment. (Wechsler, 1958)
- Intelligence is a general factor that runs through all types of performance. (Jensen)

Quotes About Intelligence

- A person possesses intelligence insofar as he had learned, or can learn, to adjust himself to his environment. (Colvin 1982)
- Intelligence is adaptation to the environment. (unknown)
- Intelligence is the ability to use optimally limited resources - including time - to achieve goals. (Kurzweil, 1999)
- Intelligence is what you do when you don't know what to do. (unknown)
- *Intelligence is the computational part of the ability to achieve goals in the world. (I like this definition)*

Samples Of Human Level Intelligence

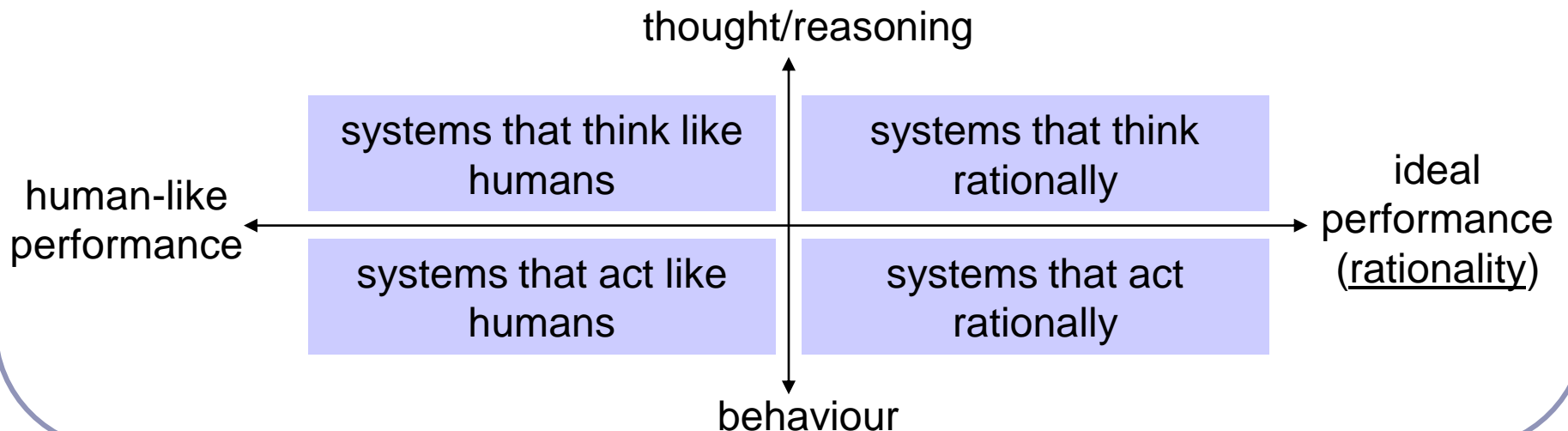
- You beat somebody at chess (or checkers or backgammon or go or Othello or poker).
- You prove a mathematical theorem using a set of known axioms.
- You are told some facts about the relationship between forests and the weather and you conclude that the practices of logging companies should change.
- On a particular day, you need to buy a bunch of things, meet three different people, return some books to the library, and get a certain amount of exercise. You plan the day in such a way that everything is achieved in an efficient manner.
- A stranger passing you on the street notices your watch and asks, "Can you tell me the time?" You say, "It's 3:00," and not simply "Yes."

Abstraction Of Human Level Intelligence

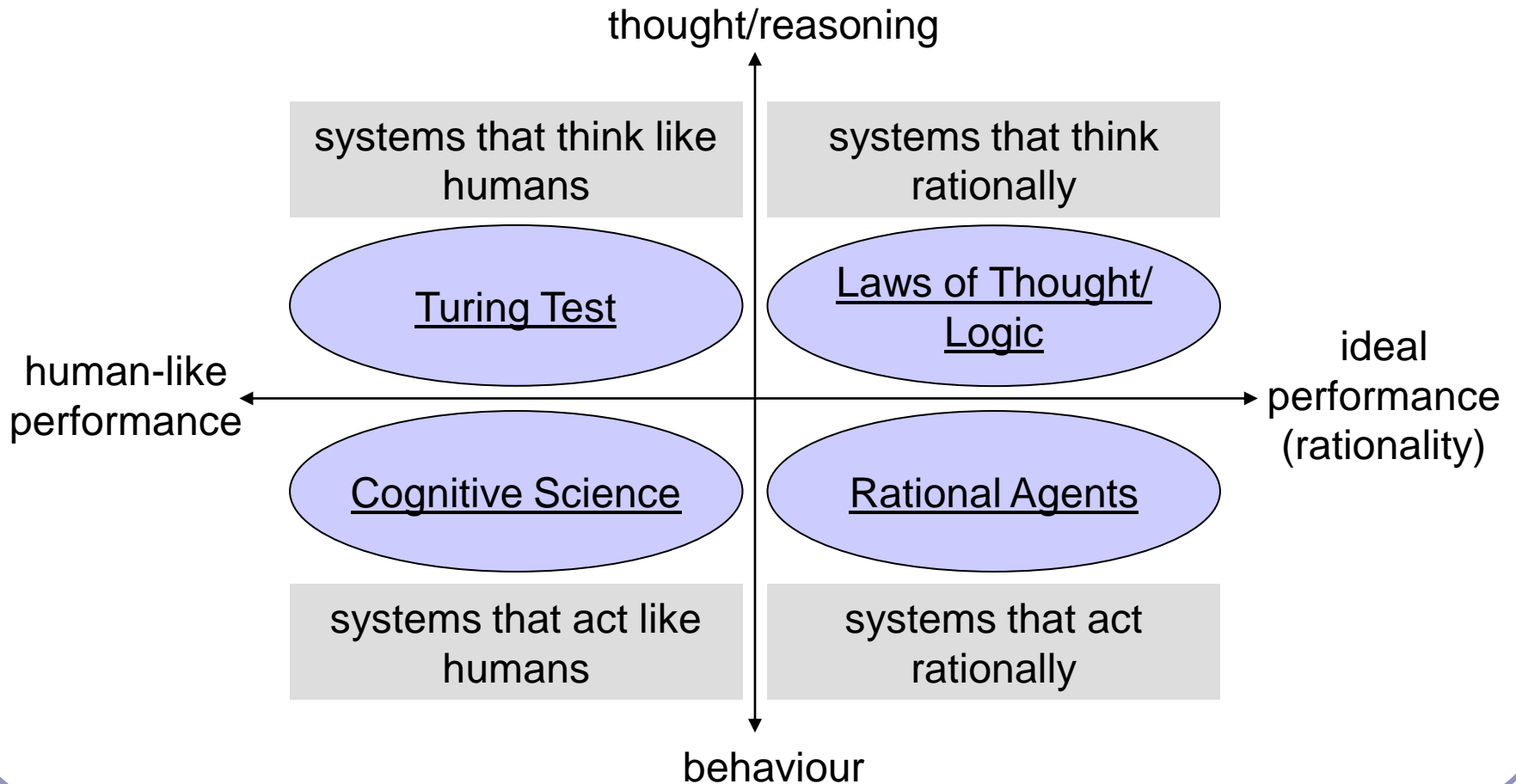
- Learning
- Reasoning
- Problem Solving
- Perception
 - Vision
 - Audio
- Language

Definitions of AI

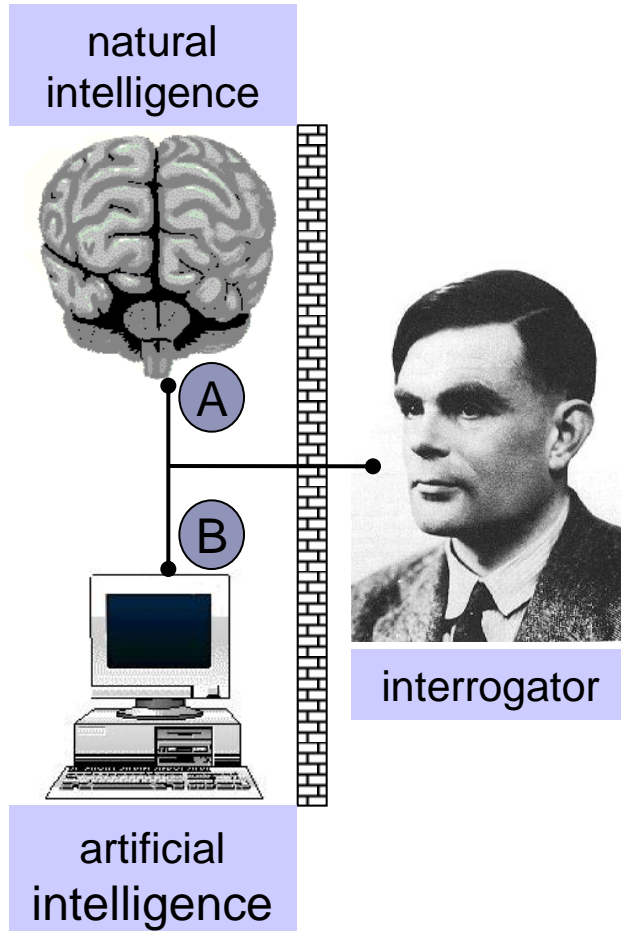
- what to look at:
thought processes/reasoning vs. behaviour
- how to measure performance:
human-like performance vs. ideal performance



Approaches to AI



The Turing Test: Setup



- interrogator can ask questions to A and B (through computer)
- both, A and B, claim to be the (intelligent) human
- interrogator must decide who is human, A or B

The Turing Test: Result

If the interrogator cannot reliably distinguish the human from the computer then the computer does possess (artificial) intelligence.

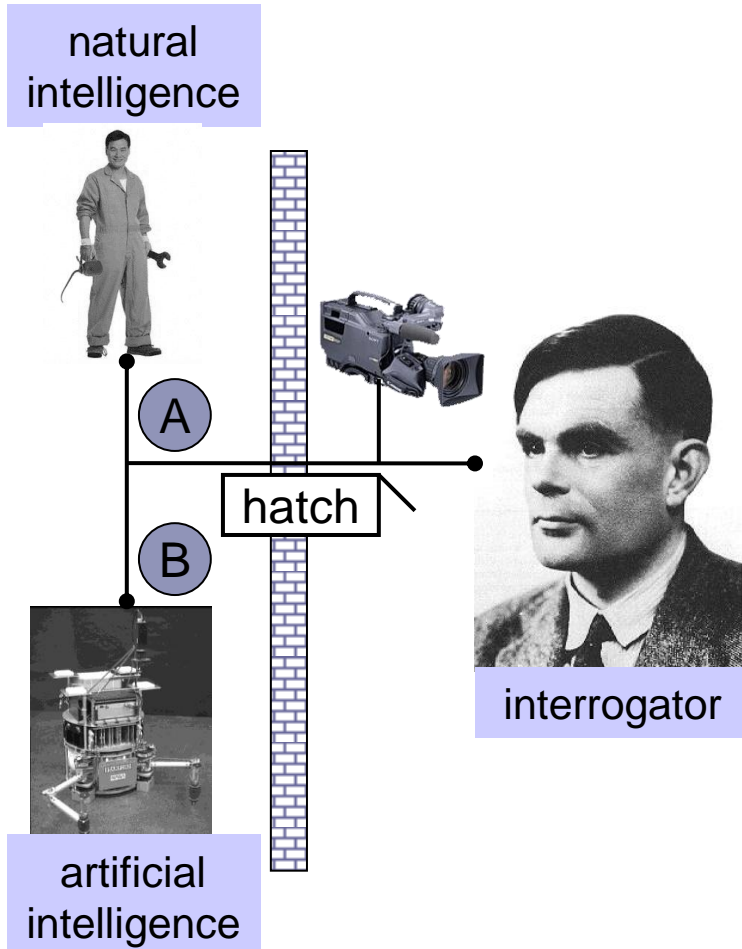


(Turing Test is based on indistinguishability from intelligent entities:
human-like behaviour)

Capabilities Required

- Natural Language Processing
→ to communicate
- Knowledge Representation
→ to store knowledge
- Automated Reasoning
→ to draw new conclusions
- Machine Learning
→ to adapt behaviour

The Total Turing Test



- new features:
 - video signal from interrogator to A/B
 - pass physical objects (through hatch)
- new capabilities:
 - computer vision
→ to perceive the interrogator and other objects
 - robotics
→ to manipulate given objects

The Turing Test Example

CHATBOT Hello, my name is Chatbot. What's your name? ▲ ▼

YOU Laurent ENTER



1.0 LOVE & MACHINES

2.0 ROBOTS

- 2.1 TIMELINE
- 2.2 ROBOT RESOURCES

3.0 THE ART OF A.I.

- 3.1 MODELS & MODEL MAKERS
- 3.2 SKETCHES
- 3.3 STORYBOARDS
- 3.4 PHOTOS

4.0 PLAY

- 4.1 MULTIMEDIA
- 4.2 TURING TEST
- 4.3 MORE GAMES
- 4.4 A.I. PUZZLER

5.0 A.I. TODAY

6.0 A.I. NEWS

A.I. NOW PLAYING

CHATBOT Hello, my name is Chatbot. What's your name? ▲ ▼

YOU ENTER

The Turing Test Example

CHATBOT Hello, my name is Chatbot. What's your name? ▲ ▼

YOU Laurent ENTER

CHATBOT Nice to meet you Laurent. ▲ ▼

YOU Can you pass the Turing test?| ENTER



- 3.2 SKETCHES
- 3.3 STORYBOARDS
- 3.4 PHOTOS
- 4.0 PLAY
 - 4.1 MULTIMEDIA
 - 4.2 TURING TEST
 - 4.3 MORE GAMES
 - 4.4 A.I. PUZZLER
- 5.0 A.I. TODAY
- 6.0 A.I. NEWS

CHATBOT Hello, my name is Chatbot. What's your name? ▲ ▼

YOU ENTER

The Turing Test Example

The screenshot shows a chatbot interface with three message exchanges. The background features a menu with the following items: 1.0 LOVE & MACHINES, 3.2 SKETCHES, 4.4 A.I. PUZZLER, 5.0 A.I. TODAY, and 6.0 A.I. NEWS. A logo with the letters 'A.I.' and a silhouette of a person is visible on the left side of the background.

CHATBOT Hello, my name is Chatbot. What's your name? ▲ ▼

YOU Laurent ENTER

CHATBOT Nice to meet you Laurent. ▲ ▼

YOU Can you pass the Turing test? ENTER

CHATBOT You be the judge of that, Laurent. | ▲ ▼

YOU tell me about yourself ENTER

CHATBOT Hello, my name is Chatbot. What's your name? ▲ ▼

YOU ENTER

The Turing Test Example

CHATBOT Hello, my name is Chatbot. What's your name?

YOU Laurent

CHATBOT Nice to meet you Laurent

YOU Can you pass the Turing Test?

CHATBOT You be the judge of that

YOU tell me about yourself

CHATBOT I am an artificial linguistic entity. I was activated at Bethlehem, |

YOU sorry, you just FAILED the Turing test!!

FAILED!

Cognitive Science

How do humans think?

- analysis:

- introspection
- psychological experiments

} theory of mind
↓ express
computer program

- verification:

- if input/output and timing of computer program match human behaviours that is evidence that the same mechanisms operate in both

Ideal Performance: Rationality

- **Rationality:**

do the “right thing”, given what you know

- **Limited rationality:**

acting appropriately when there is not enough
time

Laws of Thought



- Aristotle: sylogisms – patterns for argument structures that yield irrefutable conclusions
- Such “laws of thought” govern the operation of the mind (field of logic)
- Logicist tradition in AI: build “logical” programs to create intelligent systems

Related Fields

- Philosophy
- Mathematics
- Economics
- Neuroscience
- Psychology
- Computer Engineering
- Linguistics

Philosophy and AI

- Can formal rules be used to draw valid conclusions?
 - Aristotle's syllogisms
- How does the mental mind arise from a physical brain?
 - dualism vs. materialism
- Where does knowledge come from?
 - empiricism, induction, etc.
- How does knowledge lead to action?
 - Aristotle: goals + knowledge = action

Mathematics and AI

- What are the formal rules to draw valid conclusions?
 - Boolean logic, first-order logic, semantics
- What can be computed?
 - algorithms, Entscheidungsproblem, incompleteness theorem, Church-Turing thesis, intractability, NP-completeness
- How do we reason with uncertain information?
 - probability theory

Economics and AI

- How should we make decisions so as to maximize payoff?
 - utility theory, decision theory
- How should we do this when others may not go along?
 - game theory
- How should we do this when the payoff may be far in the future?
 - Markov decision processes

Neuroscience and AI

- How do brains process information?
 - neurons, maps

	Computer	Human Brain
<i>computational units</i>	1 CPU, 10^8 gates	10^{11} neurons
<i>storage units</i>	10^{10} bits RAM 10^{11} bits disk	10^{11} neurons 10^{14} synapses
<i>cycle time</i>	10^{-9} sec	10^{-3} sec
<i>bandwidth</i>	10^{10} bits/sec	10^{14} bits/sec
<i>memory updates/sec</i>	10^9	10^{14}

Psychology and AI

- How do humans and animals think and act?
 - behaviourism, cognitive psychology, cognitive science

Computer Engineering and AI

- How can we build an efficient computer?
- computers: artefact of choice for AI

Linguistics and AI

- How does language relate to thought?
 - computational linguistics (natural language processing), knowledge representation

History of Artificial Intelligence

- It started by science fiction...
- In 1921, the Czech author Karel Capek produced the play R.U.R. (Rossum's Universal Robots).

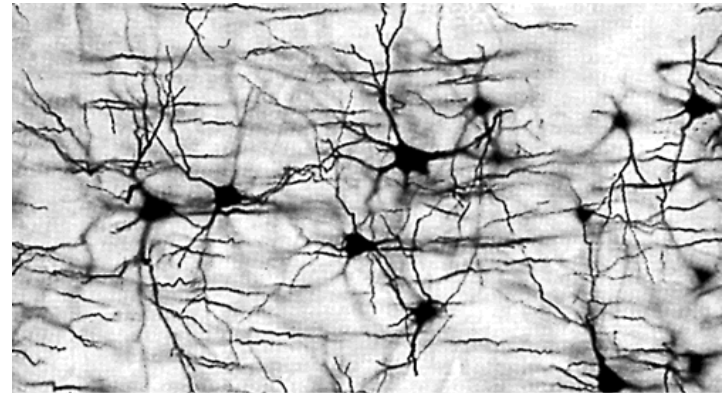
The Gestation of A.I. 1943-1956

- **Modeling of Neurons**

- Warren Mc Culloch & Walter Pitts, 1943

- **Learning by Neurons**

- Donald Hebb, 1949



- **Implementation of Neurons**

- Marvin Minsky & Dean Edmonds, 1951

The Gestation of A.I. 1943-1956

- First Chess Player Program
 - Claude Shannon & Alan Turing, 1950s

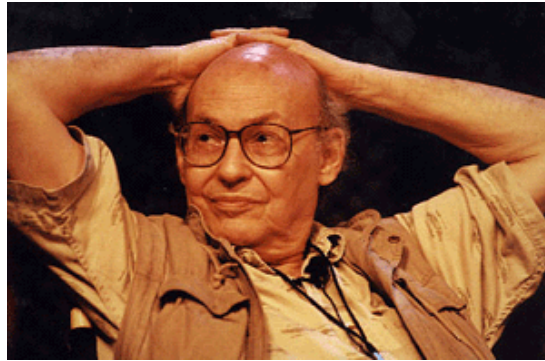
- Logic Theorist
 - Newell & Simon from CMU.

The Gestation of A.I. 1943-1956

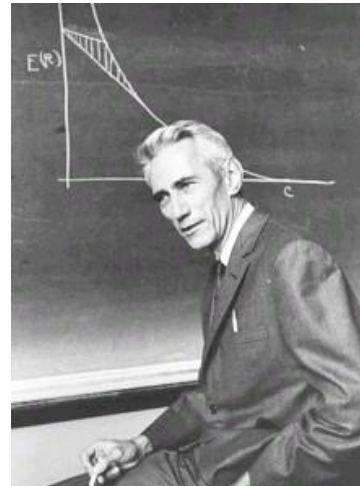
- Dartmouth Conf.: Birth place of AI, 1956



John McCarthy



Marvin Minsky



Cloud E. Shannon



Nathaniel Rochester

Great Expectations 1952-1969

- Checkers Player Machines

- Arthur Samuel, 1952-
- Presenting Learning...
- A TV Show!



- Invention(!) of LISP and Time Sharing

- McCarthy, MIT, 1958

Great Expectations 1952-1969

- Advice Taker
 - McCarthy, MIT, 1958
 - General Knowledge, Not Implemented
- Resolution Algorithm
 - Robinson, ~1963
- Planning Systems
 - Green, 1969, Stanford

Science Fiction...



- Isaac Asimov
 - 43 Novels & 250 Short Stories

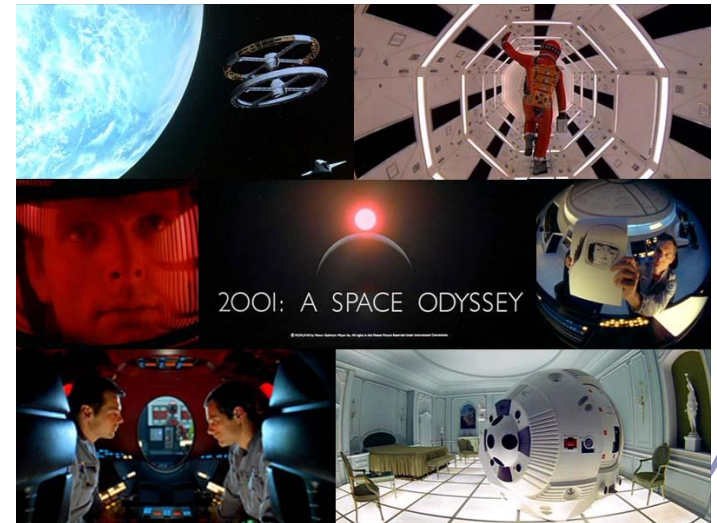
- The three laws of robotics

- A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
- A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.



Science Fiction...

- Sir Arthur C. Clark
 - *2001, A Space Odyssey*, 1968



A dose of reality 1966-1974

- Herbert Simon, 1957
 - The power of A.I. will increase so rapidly that in a visible future, the range of problems they can handle will be coextensive to that of human.
 - With in 10 years, the computer will be chess champions and mathematic theorem provers.

A dose of reality 1966-1974

- Automatic Translation after Sputnik lunch, 1957.
 - Famous Failures:
 - The spirit is willing, but the flesh is weak
→ the vodka is good but the meat is rotten.
 - Out of mind, out of sight
→ Invisible idiot! **出于头脑, 出于视域**
 - 1966, “there is no M.T. for general scientific text and there would be no in immediate prospect.” → All canceled.

Knowledge Based Systems:1969-1979

- MYCIN

- Feigenbaum, et al, 1971
- Diagnosis of blood infections with 450 rules.
- Better than junior doctor and comparable with experts.

- PROSPECTOR

- Duda et al, 1979
 - Recommendation of exploratory drilling positions at a geological site.

History: the 70s

- knowledge-based systems:
 - DENDRAL: chemical analysis
 - first knowledge-intensive system
 - SHRDLU: natural language understanding
- expert systems:
 - MYCIN: medical diagnosis
 - rule-based system with uncertainty factors
- frames:
 - taxonomic hierarchies

History: the 80s and the 90s

- AI becomes an industry
 - first commercially successful expert system: R1
- the return of neural networks
 - reinvention of back-propagation learning
- AI becomes a science
 - hypothesis + rigorous experiments = results
- intelligent agents
 - return to the “whole agent” problem

Overview

- ✓ What is Artificial Intelligence?
- ✓ The Foundations of Artificial Intelligence
- ✓ The History of Artificial Intelligence
- ➡ The State of the Art

State of the Art

- planning and scheduling: NASA
- game playing: Deep Blue
- autonomous control: ALVINN
- diagnosis
- logistics planning: DART
- robotics: HipNav
- language understanding and problem-solving: PROVERB

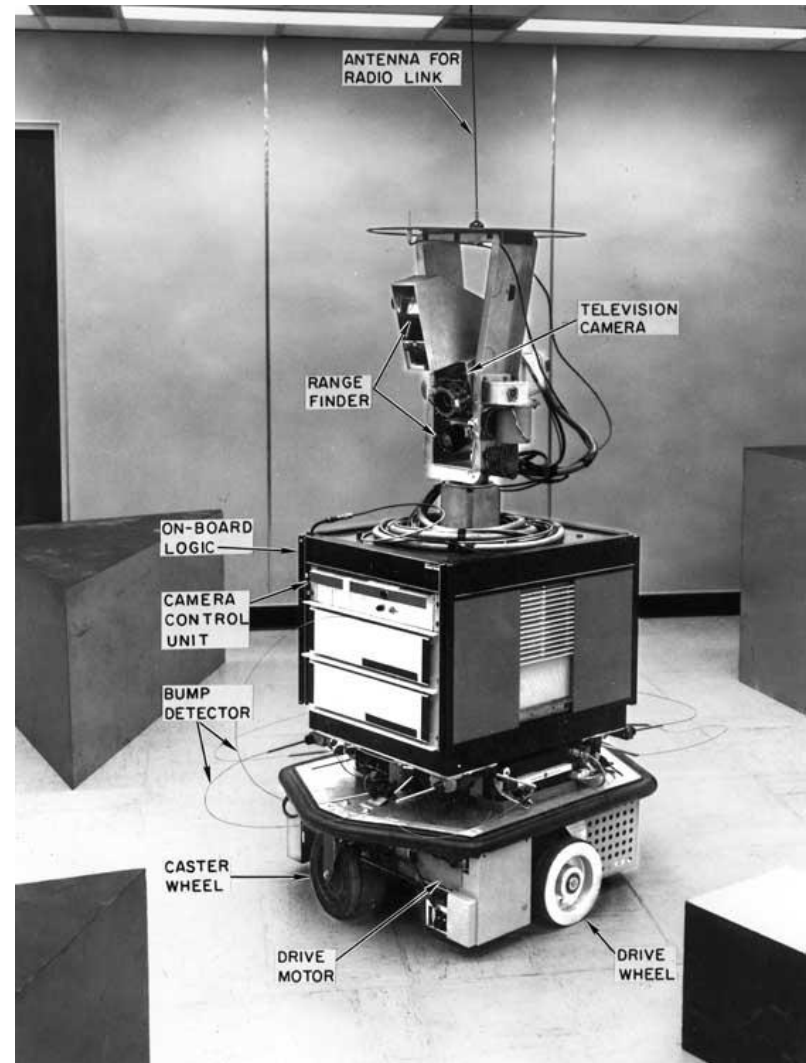
Robotics – Hopkins Beast

1964 Two versions of the Hopkins beast, which used sonar to guide it in the halls. Its goal was to find power outlets.



Robotics - Shakey

1970 Shakey (SRI) was driven by a remote-controlled computer, which formulated plans for moving and acting. It took about half an hour to move Shakey one meter.



Robotics – Stanford Cart

1971-9 Stanford cart.
Remote controlled by person
or computer.

1971 follow the white line

1975 drive in a straight line
by tracking skyline

1979 get through obstacle
courses. Cross 30 meters in
five hours, getting lost one
time out of four



Robotics - RoboCup

1997 – First official Rob-Cup soccer match



Picture from 2003
competition

Robotics - Kismet

1998 – now Kismet shows emotions



sad



surprise

<http://www.ai.mit.edu/projects/humanoid-robotics-group/kismet/>

Robotics - Aibo

1999 Sony's Aibo pet dog

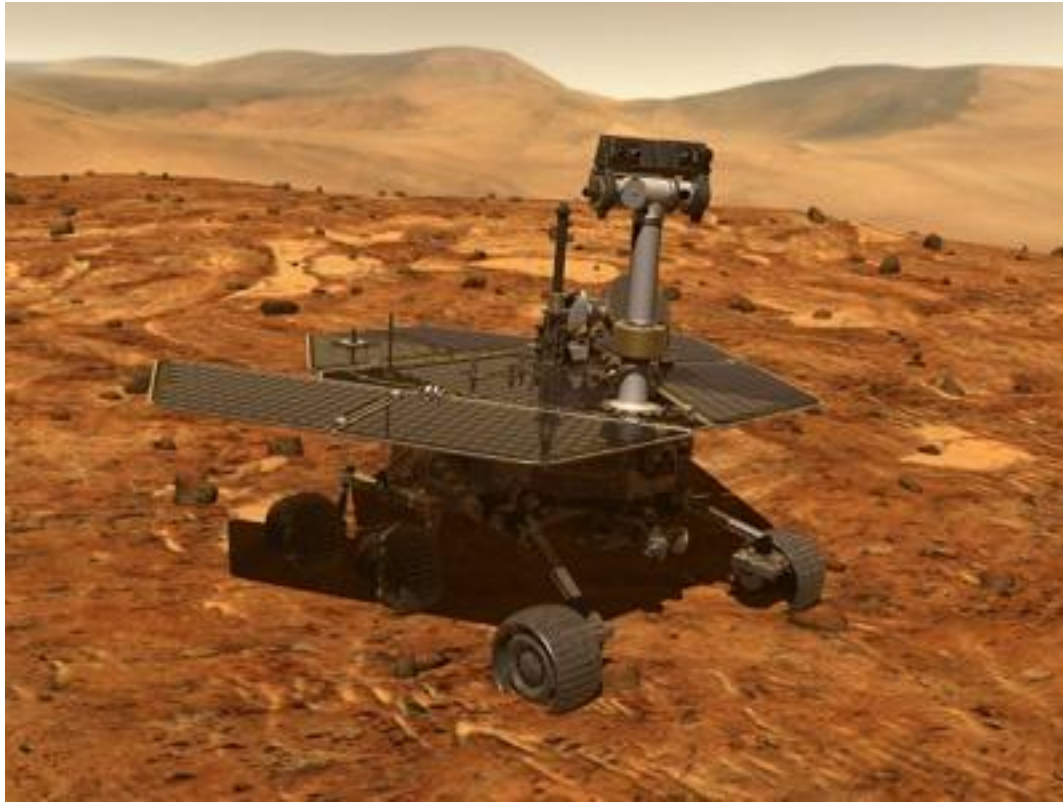


Robotics - Roomba

2001 A robot vacuum cleaner



Robotics – Mars Rover



Today: Computer as Artist

Two paintings done by Harold Cohen's Aaron program:



A Sample Movie

