Introduction

CSE-345: Artificial Intelligence

Recommended Books

- **Artificial Intelligence**
  - Elaine Rich
  - Kevin Knight
- **Artificial Intelligence A Modern Approach**
  - Stuart Russell
  - Peter Norvig
- **Introduction to Artificial Intelligence & Expert Systems**
  - Dan W. Patterson

Outlines

- What is Artificial Intelligence (AI)?
- Related research fields
- A brief review of AI history
- Some key persons

What is intelligence? [*Wikipedia]*

- Also called intellect
- An umbrella term used to describe a property of the mind that encompasses many related abilities, such as the capacities
  - to reason,
  - to plan,
  - to solve problems,
  - to think abstractly,
  - to comprehend ideas,
  - to use language, and
  - to learn

What is intelligence? [*Dictionary*]

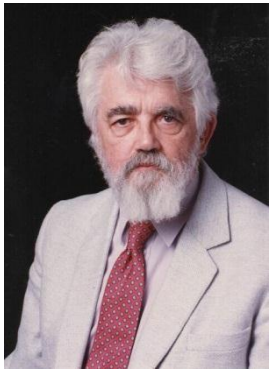
- Ability to acquire, understand & apply knowledge, or the ability to exercise thought & reason

Intelligence is more than this!!!

What's involved in Intelligence?

- Ability to interact with the real world
  - to perceive, understand, and act
    - e.g., speech recognition and image understanding
- Reasoning and Planning
  - modeling the external world, given input
  - solving new problems, planning, and making decisions
  - ability to deal with unexpected problems, uncertainties
- Learning and Adaptation
  - we are continuously learning and adapting
  - our internal models are always being "updated"
    - e.g., a baby learning to categorize and recognize animals

What is Artificial Intelligence(AI)?



[John McCarthy, Dartmouth Conference, 1956]

- "the science and engineering of making intelligent machines, especially intelligent computer programs."

What is AI?

Textbooks often define AI as

[Russell and Norvig, 2003]

- "the study and design of computing systems that perceives its environment and takes actions like human beings".

[Rich and Knight, 1991]

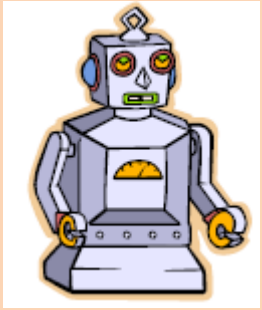
- "the study of how to make computer do things to which at the moment, people are better".

Goals of AI

Systems that think like humans

Systems that Think rationally

Systems that act like humans



Systems that act rationally

Thinking humanly: Cognitive Science

- Effort to make computer think; i.e. the machine with minds, in the full and literal sense.
- Focus is not just on behavior and I/O, but looks at reasoning process
- Computational model as to how result were obtained.

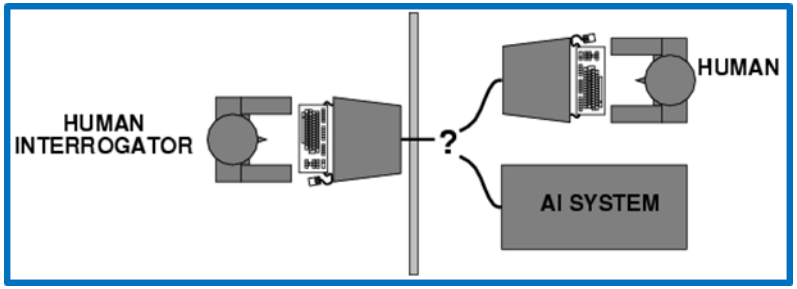
Goal is not just to produce human-like behavior, but to produce a sequence of steps of the reasoning process, similar to the steps followed by a human in solving the same task.

Acting humanly: Turing Test

- Art of creating machines that perform functions requiring intelligence when perform by people
- Focus is on actions, and not intelligent behavior centered around representation of the world.
- Is not concerned with how the get result but to the similarity to what human results are

Goal is to develop systems that are human-like

Example: Turing Test ,1950



Includes physical interactions with environment

- speech recognition
- computer vision
- robotics

Turing's predictions

- By 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Suggested major components of AI: knowledge representation, reasoning, language understanding, learning

Problem: not **reproducible, constructive, or amenable to mathematical analysis**

Thinking rationally: Laws of Thought

- Study of mental faculties through the use of computational models; i.e. study of the computations that make it possible to perceive , reason, and act.
- Focus is on inference mechanism that are provably correct and guarantee an optimal solution.
- Develop systems of representation to allow inference to be like **"Socrates is a man. All men are mortal. Therefore, Socrates is mortal."**

Goal is to formalize the reasoning process as a system of logical rules and procedures for inference.

The issues is, not all problem can be solved just by reasoning and inferences.

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

Aristotle (Nicomachean Ethics):

Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good

Strong AI vs. Weak AI

- AI research aims to create AI that can replicate human intelligence completely.

➢ **Strong AI**

- refers to a machine that approaches or supersedes human intelligence
  - if it can do typical human tasks
  - if it can apply a wide range of back ground knowledge and
  - if it has some degree of self-consciousness.
- aims to build machine whose overall ability is indistinguishable from that of human being.

➢ **Weak AI**

- refers to the use of software to study or accomplish specific problem solving or reasoning tasks that do not encompass the full range of human cognitive abilities
  - e.g. a chess program
- does not achieve self abilities; it is merely an intelligent, a specific problem solver

Foundations of AI

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/ Statistics	modeling uncertainty, learning from data
Economics	utility, decision theory, rational economic agents
Neuroscience	neurons as information processing units.
Psychology/ Cognitive Science	how do people behave, perceive, process cognitive information, represent knowledge.
Computer Engineering	building fast computers
Control theory	design systems that maximize an objective function over time
Linguistics	knowledge representation, grammars

Potted history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 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 to popularity
- 1987 AI becomes a science
- 1995 The emergence of intelligent agents -- “-bots”
- 2003 Human-level AI back on the agenda

Is AI important?

- Most important developments of this century
- It will affect the lives of most individuals in civilized countries by the end of the century
- And countries leading in the development of AI by then will emerge as the dominant economic powers of the world
- Became apparent to many world's leading economic countries (during late 1970's)
  - Japan (Fifth generation)
  - UK (Alvey Project)
  - Canada, Russia, Italy, France, Singapore etc
  - USA (MCC, DARPA, ALV)

- **The future of a county is closely tied to the commitment it is willing to make in funding research programs in AI**

Task Domains

Mundane Tasks

Perception

-Vision

-Speech

Natural Language

-Understanding

-Generation

-Translation

Commonsense reasoning

Robot control/HRI

Formal Tasks

Games

-Chess

-Backgammon

-Checkers

- Go

Mathematics

-Geometry

-Logic

-Integral Calculus

- Proving properties of programs

Expert Tasks

Engineering

-design

-Fault finding

-Manufacturing planning

Scientific analysis

Financial analysis

Medical diagnosis

Success Stories of AI Agent

- ✓ Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- ✓ Proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- ✓ 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

State of the art

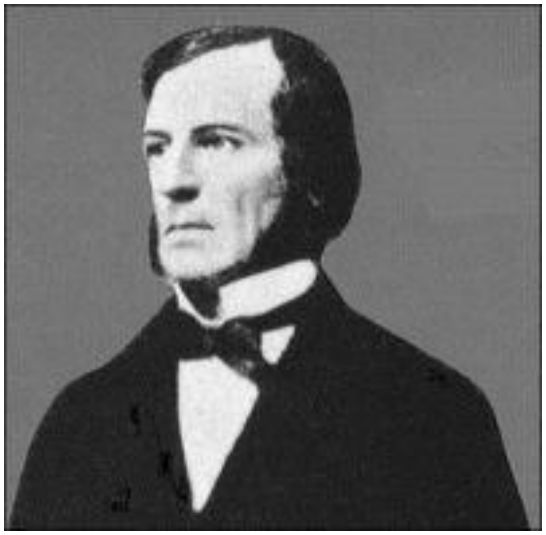
Which of the following can be done at present?

- ☑ Play a decent game of table tennis
- ☑ Drive safely along a curving mountain road
- ☒ Drive safely along Telegraph Avenue
- ☑ Buy a week's worth of groceries on the web
- ☒ Buy a week's worth of groceries at Berkeley Bowl
- ☑ Play a decent game of bridge
- ☒ Discover and prove a new mathematical theorem
- ☒ Design and execute a research program in molecular biology
- ☒ Write an intentionally funny story
- ☑ Give competent legal advice in a specialized area of law
- ☑ Translate spoken English into spoken Swedish in real time
- ☒ Converse successfully with another person for an hour
- ☒ Perform a complex surgical operation
- ☒ Unload any dishwasher and put everything away

SOME KEY PERSONS

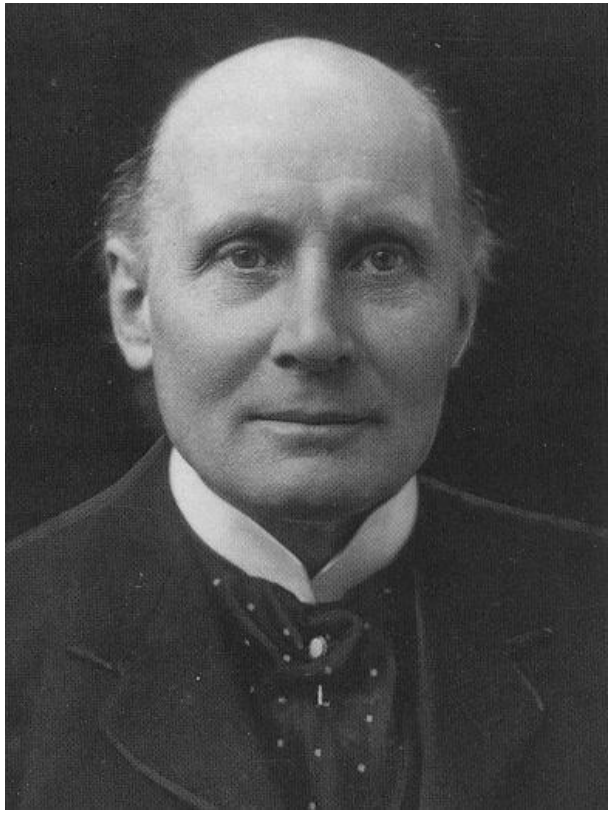
George Boole (1815-1864)

- George Boole was not a computer scientist.
- **Boolean algebra was** developed by him.
- This has become one of the mathematic. foundations of computer science.



Alfred North Whitehead (1861- 1947)

- Alfred North Whitehead was an English mathematician who became a philosopher.
- He wrote on algebra, logic, foundations of mathematics, philosophy of science, physics, metaphysics, and education.
- He co-authored the epochal **Principia Mathematica** with Bertrand Russell.



Bertrand Arthur William Russell, 3rd Earl Russell (1872–1970)

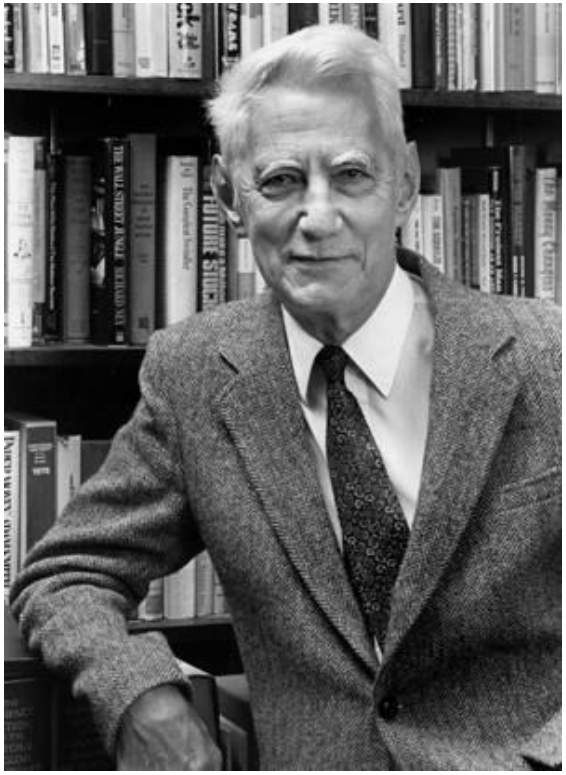
- **Bertrand Arthur William Russell, 3rd Earl Russell was a philosopher,** historian, logician, mathematician, advocate for social reform, and pacifist.
- A prolific writer, he was a populariser of philosophy and a commentator on a large variety of topics.
- He was a prominent anti-war activist, championing free trade between nations and anti-imperialism.
- He wrote the essay On Denoting and was co-author (with Alfred North Whitehead) of ***Principia Mathematica***, an attempt to ground mathematics on the laws of logic.

Alan Turing (1912-1954)

- Turing is often considered to be the father of modern computer science.
- Turing provided an influential formalization of the concept of the algorithm and computation with the **Turing machine.**
- With the **Turing test,** he made a significant & characteristically provocative contribution to the debate regarding AI: whether it will ever be possible to say that a machine is conscious & can think.

Claude Shannon(1916-2001)

- **Shannon,** an American electrical engineer and mathematician, was "the father of information theory“.
- He is also credited with founding both digital computer and digital circuit design theory in 1937, when, as a 21-year-old master's student at MIT, he wrote a thesis demonstrating that electrical **application of Boolean algebra** could construct and resolve any logical, numerical relationship.

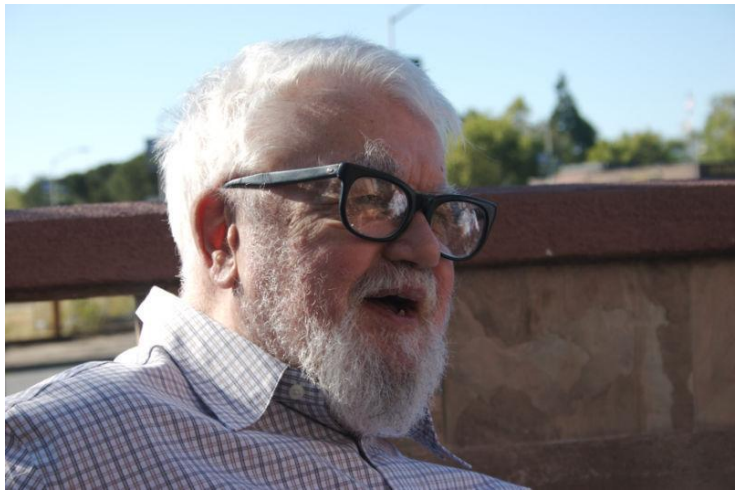


John von Neumann (1903-1957)

- **John von Neumann** was a Hungarian-American mathematician who made major contributions to a vast range of fields including
  - **set theory**
  - functional analysis
  - quantum mechanics
  - ergodic theory
  - economics and game theory
  - **computer science**
- The so called conventional CPU based computer was proposed by him, and he is generally regarded as one of the foremost mathematicians of the 20th century.

John McCarthy

- **John McCarthy** (born September 4, 1927, in Boston, Massachusetts), is an American computer scientist & cognitive scientist.
- He received the Turing Award in 1971 for his major contributions to the field of AI.
- He was responsible for the coining of the term "Artificial Intelligence" in his 1955 proposal for the 1956 Dartmouth Conference and is the inventor of the **Lisp programming language.**

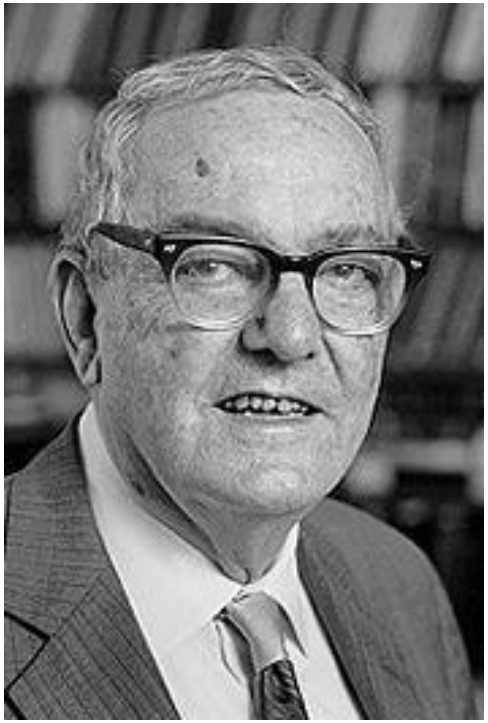


Marvin Lee Minsky

- **Marvin Lee Minsky** (born August 9, 1927) is an American cognitive scientist in the field of AI, co-founder of MIT's AI laboratory, & author of several texts on AI & philosophy.
- Minsky won the Turing Award in 1969, the Japan Prize in 1990, the IJCAI Award for Research Excellence in 1991, & the Benjamin Franklin Medal from the Franklin Institute in 2001.

Herbert Alexander Simon (1916-2001)

- **Herbert Alexander Simon** was an American political scientist whose research ranged across the fields of cognitive psychology, computer science, public administration, etc.
- Simon was a truly innovative thinker. He was among the founding fathers of several of today's most important scientific domains, including artificial Intelligence, information processing, decision-making, problem-solving, etc.
- He coined the terms bounded rationality & satisfiying, and was the first to analyze the & to propose a preferential attachment mechanism to explain power law distributions.



Allen Newell (1927-1992)

- **Allen Newell** was a researcher in computer science and cognitive psychology at the RAND corporation and at Carnegie Mellon University's School of Computer Science.
- He contributed to the **Information Processing Language** (1956) and two of the earliest AI programs, the Logic Theory Machine (1956) and **the General Problem Solver** (1957) (with Herbert Simon).
- He was awarded the ACM's A.M. Turing Award along with Herbert Simon in 1975 for their basic contributions to AI & the psychology of human cognition.

Edward Albert Feigenbaum

- **Edward Albert Feigenbaum** (born January 20, 1936) is a computer scientist working in the field of AI.
- He is often called the "**father of expert systems.**"
- In his PhD thesis, carried out under the supervision of Herbert Simon, he developed EPAM, one of the first computer models of how people learn.
- He received the ACM Turing Award, jointly with Raj Reddy in 1994 "For pioneering the design and construction of large scale artificial intelligence systems, demonstrating the practical importance & potential commercial impact of artificial intelligence technology".

The END