Overview of Artificial Intelligence (AI)

- What is AI? -- Some traditional definitions
- AI Ancient History
- AI and Modern Philosophy
- What is AI? -- The Contemporary Approach
- AI Collaborators
- AI Recent History
- State of the Art

Good Old-Fashioned AI (GOFAI): "Strong" AI

- AI is the branch of computer science concerned with making computers intelligent, just like people.
- Problems:
  - what is intelligence?
  - is machine intelligence even possible?

A Behavioral Definition of AI

- AI is the branch of computer science concerned with the automation of intelligent *behavior,* or
- AI produces program behavior which, if one observed such behavior in a human, one would say that it required intelligence.

AI As the Study of Human Intelligence ("Weak" AI)

- AI is the multidisciplinary *study* of human intelligence through attempts to artificially model it

AI Ancient History

- 800 B.C. -- Moving statue of the god Amon in ancient Egypt operated with levers by a concealed priest.
- 300-100 B.C. -- Automated figures (like singing ravens) through the force of steam and water in Greek city of Alexandria.

Aristotle's Logic of Syllogisms (350 B.C.)

All men are mortal.

Socrates is a man.

Therefore, Socrates is mortal.

All S are P.

a is an S.

Therefore, a is a P

All S are P.

a is not a P.

Therefore, a is not an S

17th Century Continental Rationalism: Rene Descartes

- Built an automaton called "my daughter Francine" which was so lifelike in movement a superstitious ship captain threw it overboard.
- Developed theory of mind/body dualism:
  - *res extensa*: physical stuff
  - *res cogitans*: mental stuff
- Mind/body duality is often made analogous to the software/hardware distinction in computers.
- However, Descartes believed machines would never be able to think

17th Century Continental Rationalism: Gottfried Leibnitz

- Was a mind/body dualist, but believed in “pre-established harmony” between mind and body, not causal interaction between them
- Suggested a "reasoning calculus" to mechanize thought: assign every concept a number and solve problems through numeric manipulation
- Proposed the collection of expertise and knowledge of individuals into encyclopedic knowledge bases

17th Century Continental Rationalism: Benedict Spinoza

- Believed in monism: Double-aspect theory
- Came up with a complete philosophy, including treatment of human actions and desires, using the model of deductive proofs.

17th Century British Philosophy: Thomas Hobbes

- Believed if God can make natural life, man can make artificial life (the commonwealth)
- Believed that *ratiocination*, or the use of one's cognition to reason from sense and memory, is the same as *computation*
- The basis of modern AI and cognitive science's computational model of the mind

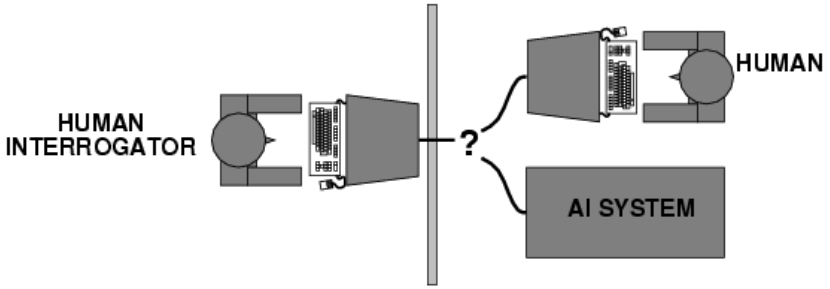
What is AI? -- The Contemporary Approach

Views of AI fall into four categories:

Thinking humanly	Thinking rationally
Acting humanly	Acting 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
- Anticipated all major arguments against AI in following 50 years
- 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
- Problem: Not all intelligent behavior is mediated by logical deliberation

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

AI Collaborators

- **Philosophy** Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality

AI Collaborators

- 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

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- **Economics** — utility, decision theory

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• **Neuroscience**	physical substrate for mental activity

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• **Linguistics**	knowledge representation, grammar

Abridged history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain

Early Work in Cybernetics and Artificial Neural Networks

- Norbert Wiener:
  - Created cybernetics, the science of control
  - Feedback control of anti-aircraft guns
  - Couched feedback theory in terms of information, not energy
- McCulloch and Pitts: Computing with artificial neural networks
- D. O. Hebb: Learning with artificial neural networks

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Alan Turing

- Turing machines – theory of computer science
- Turing test for intelligence
- Colossus:
  - first electronic computer
  - cracked German codes enabling the Normandy landing

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The 1956 Dartmouth Conference

- Theme:
  - "Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."
- Participants
  - Marvin Minsky: converted from neural networks to symbol processing point of view
  - John McCarthy: coined term “AI”
  - Claude Shannon: invented switching circuits
  - Nathaniel Rochester: designed first popular IBM
  - Newell & Simon: wrote first AI program

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Early AI Program Successes

- **Logic Theorist** proved 38 of the first 52 theorems in Chapter 2 of *Principia Mathematica*
- **SAINT** (Slagle) performed calculus integration
- **STUDENT** (Bobrow) solved algebra story problems
- **ANALOGY** (Evans) solved analogy problems
- **SHRDLU** (Winograd) natural language understanding and planning in the blocks world
- **ELIZA** (Weizenbaum) simulated a psychotherapist

An Impressive Script from Eliza

Men are all alike. (human)

IN WHAT WAY (machine)

They're always bugging us about something or other.

CAN YOU THINK OF A SPECIFIC EXAMPLE

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE

He says I'm depressed most of the time.

I AM SORRY TO HEAR YOU ARE DEPRESSED

It's true. I am unhappy.

DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY

Script from Eliza (cont'd)

I need some help, that much seems certain.

WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP

Perhaps I could learn to get along with my mother.

TELL ME MORE ABOUT YOUR FAMILY

My mother takes care of me.

WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU

My father.

YOUR FATHER

You are like my father in some ways.

WHAT RESEMBLANCE DO YOU SEE

Script from Eliza (cont'd)

You are not very aggressive but I think you don't want me to notice that.

WHAT MAKES YOU THINK I AM NOT VERY AGGRESSIVE

You don't argue with me.

WHY DO YOU THINK I DON'T ARGUE WITH YOU

You are afraid of me.

DOES IT PLEASE YOU TO BELIEVE I AM AFRAID OF YOU

My father is afraid of everybody.

WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR FATHER

Bullies.

DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE

A Less Impressive Eliza Script

I don't understand your motives.

WHY DON'T YOU UNDERSTAND MY MOTIVES?

Shouldn't I be?

WHY DO YOU SAY THAT JUST NOW?

That's just the way it is.

SUPPOSE THAT'S JUST THE WAY IT WERE NOT.

So?

I AM NOT SURE I UNDERSTAND YOU FULLY.

You harp on the same questions too much.

WHAT DOES THAT SIMILARITY SUGGEST TO YOU?

I don't get you.

DO YOU WISH THAT YOU DID GET I?

Eliza Script with Mistaken Identity

Do you think that I can use the computer this morning?

WHY DO YOU ASK?

I might be able to make some additional telecomp sales.

WHY AREN'T YOU SURE?

My prospective customers have never seen a demonstration of this system.

DOES THAT MEAN VERY MUCH TO YOU?

Of course it does.

YOU SEEM VERY POSITIVE ABOUT THAT.

This is ridiculous.

WHAT DO YOU MEAN THIS IS RIDICULOUS?

Is there any reason I can't use the computer now?

TELL ME MORE ABOUT YOUR PROSPECTIVE CUSTOMERS.

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Random Sampling of Expert System Applications

- Software fault prediction
- Evaluating tomato ripeness
- Source identification of mobile device images
- Stock portfolio management
- Fuzzy pattern mining for classification
- Evaluation of fabric pilling resistance
- Image segmentation
- Health care data classification

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- 1986-- Neural networks return to popularity as part of machine learning

Random Sampling of Neural Net Applications

- Vehicle control
- Game playing
- Radar pattern recognition
- Face identification
- Data mining
- Spam filtering
- Cancer diagnosis

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- 1987-- AI becomes a science—triumph of neats over scruffies

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- 1995-- The emergence of intelligent agents -- “-bots”

Examples

- ***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
- IBM's ***Watson*** beats best humans at Jeopardy!

Super- Or Par-human Level

- Backgammon, Bridge
- Chess, Crosswords
- Jigsaw puzzles
- Car driving
- Scrabble
- Quiz show question answering
- Go
- OCR for printed text

Sub-human Level

- Handwriting recognition
- Object recognition
- Translation
- Speech recognition
- Word-sense disambiguation
- Natural language processing

State of the art

“A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labeled AI anymore”

(N. Bostrum)