Last update: September 1, 2012

CMSC 421, Artificial Intelligence

Chapter 1

What is AI?

- ♢ Systems that **think** intelligently, or systems that **act** intelligently?
- ♢ Do it **like humans do it**, or **some other way**?

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Computers that

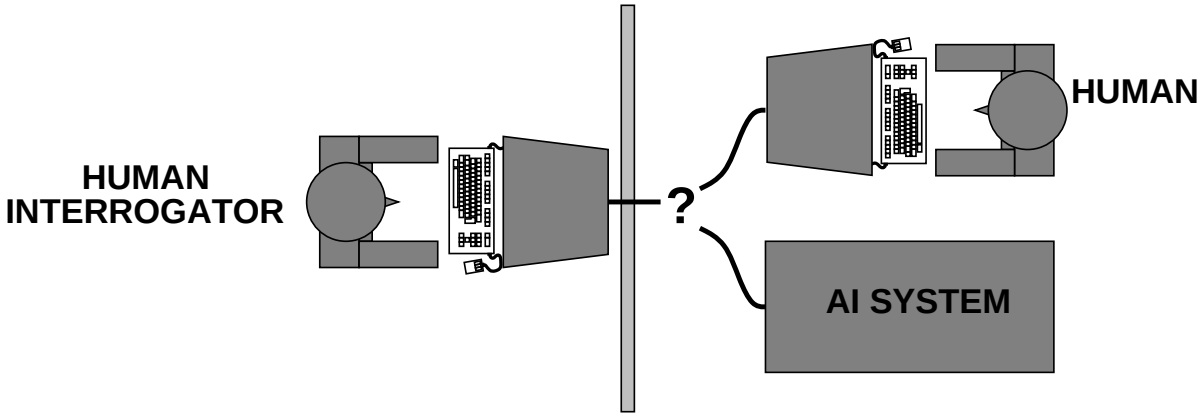
think like humans	think rationally
act like humans	act rationally

The Turing test

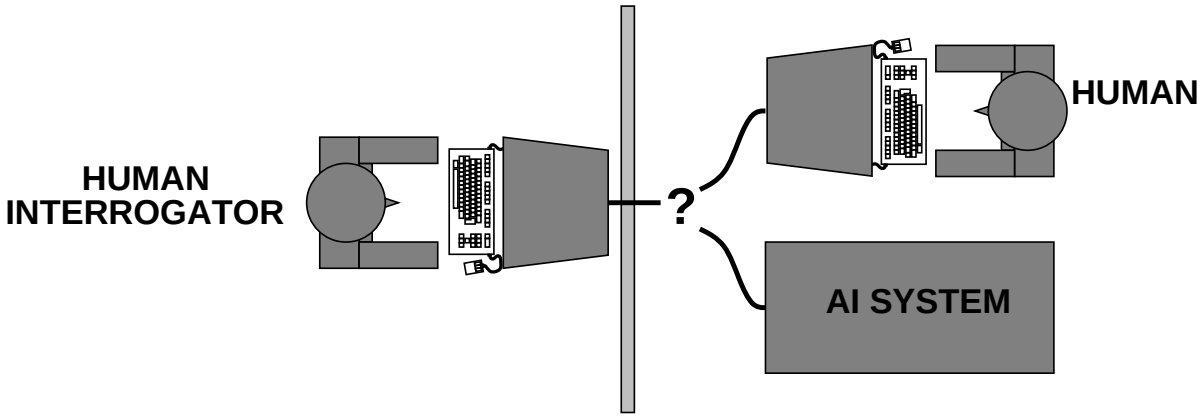
think like humans	think rationally
act like humans	act rationally

♢ Turing (1950) "Computing machinery and intelligence"

- the *Imitation Game*



The Turing test



♢ Turing anticipated all major arguments against AI for the next 50 years

♢ Suggested several major components of AI:

- knowledge, reasoning, language, understanding, learning

♢ Predicted that by 2000, a machine might have a 30% chance of fooling an ordinary person for 5 minutes

♢ Problem: Turing test isn't **reproducible**, **constructive**, or amenable to **mathematical analysis**

Information-processing Psychology

think like humans	think rationally
act like humans	act rationally

♢ Scientific theories of internal activities of the brain

- What level of abstraction? "knowledge" or "circuits"?
- How to validate? Requires one of:

  1) Predicting and testing behavior of human subjects (top-down)
  $\Longrightarrow$ Cognitive Science

  2) Direct identification from neurological data (bottom-up)
  $\Longrightarrow$ Cognitive Neuroscience

- Both are now distinct from AI

♢ Both share with AI the following characteristic:

- **We don't yet have theories that explain or produce anything resembling human-level general intelligence**

Logical reasoning

think like humans	**think rationally**
act like humans	act rationally

♢ *Normative* (or *prescriptive*) rather than descriptive

- Aristotle: what are correct arguments/thought processes?

♢ The ancient Greeks developed various forms of *logic*:

- **notation** and **rules of derivation** for thoughts
- Direct line through mathematics and philosophy to modern AI

♢ Problems:

1) Not all intelligent behavior involves logical deliberation

2) What is the purpose of thinking?

   – Out of all the thoughts (logical or otherwise) that I **could** have, what thoughts **should** I have?

Acting rationally

think like humans	think rationally
act like humans	**act rationally**

♢ *Rational* behavior: doing the "right thing"

- Aristotle (Nicomachean Ethics):

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

♢ The textbook's interpretation of "doing the right thing":

- doing whatever is expected to maximize goal achievement, given the available information

♢ Doesn't necessarily involve thinking

  – e.g., blinking reflex

- but means that thinking should be in the service of rational action

Rational agents

♢ Russell & Norvig's book focuses on designing *rational agents*

♢ An *agent* is an entity that perceives and acts

- Implements a function from percept histories to actions:

$$f : \mathcal{P}^* \rightarrow \mathcal{A}$$

♢ For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

♢ Caveats:

- Computational limitations make perfect rationality **unachievable**
  → design best program for the available machine resources
- Not an absolute standard of rationality
- Instead, it's rationality **relative to the performance measure**

♢ When (and why) should we believe a performance measure is adequate?

Ideas Adapted from Other Fields

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
Psychology	adaptation phenomena of perception and motor control experimental techniques (psychophysics, etc.)
Economics	formal theory of rational decisions
Linguistics	knowledge representation, grammar
Neuroscience	physical substrate for mental activity
Control theory	homeostatic systems, stability simple optimal agent designs

Brief History of AI

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
1952–69	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
1966–74	AI discovers computational complexity Neural network research almost disappears
1969–79	Early development of knowledge-based systems
1980–88	Expert systems industry booms
1988–93	Expert systems industry busts: "AI Winter"
1985–95	Neural networks return to popularity
1988–	Resurgence of probability; general increase in technical depth Soft computing (fuzzy logic, genetic algorithms, etc.)
1995–	Popularity of the notion of "agents"
2003–	Human-level AI back on the agenda

State of the art

Which of the following can be done at present?

♢ Drive safely along a curving mountain road

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- ♢ Play a decent game of bridge

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- ♢ Play a decent game of bridge
- ♢ Write an intentionally funny story

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- ♢ Translate spoken English into spoken Swedish in real time

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- ♢ Converse successfully with another person for an hour

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- ♢ Unload any dishwasher and put everything away

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- ♢ Explore the Martian landscape

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- ♢ Explore the Martian landscape
- ♢ Explore downtown Washington

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- ♢ Explore downtown Washington

Unintentionally funny stories

One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe threatened to hit Irving if he didn't tell him where some honey was. The End.

Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.

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]

Unintentionally funny stories

Joe Bear was hungry. He asked Irving Bird where some honey was. Irving refused to tell him, so Joe offered to bring him a worm if he'd tell him where some honey was. Irving agreed. But Joe didn't know where any worms were, so he asked Irving, who refused to say. So Joe offered to bring him a worm if he'd tell him where a worm was. Irving agreed. But Joe didn't know where any worms were, so he asked Irving, who refused to say. So Joe offered to bring him a worm if he'd tell him where a worm was ...