

Last update: September 2, 2008

# ARTIFICIAL INTELLIGENCE

## CMSC 421: CHAPTER 1

# Outline

- ◇ Syllabus and administrivia - see the web site
- ◇ What is AI?
- ◇ A brief history
- ◇ The state of the art

## My teaching style

- ◇ Lecture slides; will work out details on the board
  - ◇ To give you an idea of what's coming, I've already posted some older versions of my slides.
  - ◇ They're out-of-date, and I'll update them as I go along.
  - ◇ I'll post the updated slides on the web after each class
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- ◇ **Any questions?**

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# What is AI?

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Computers that

think like humans	think rationally
act like humans	act rationally

# Acting like humans

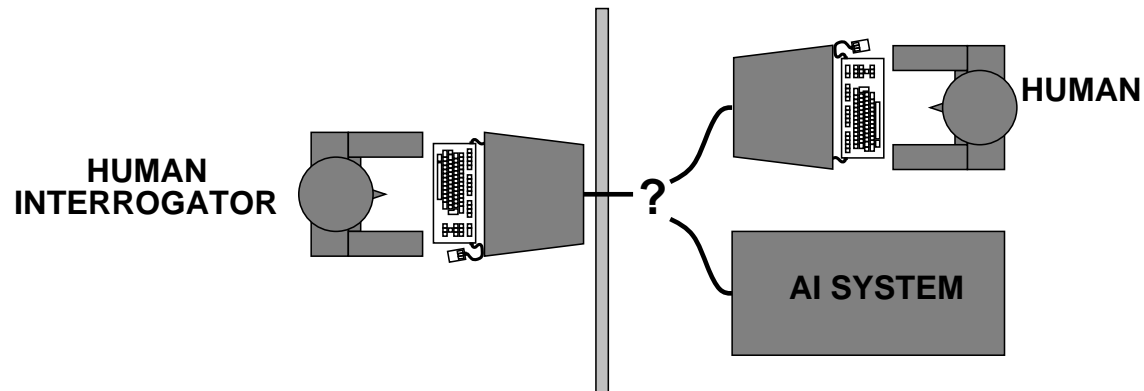
think like humans	think rationally
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How many of you have heard of the Turing Test?

# Acting like humans: The Turing test

Turing (1950) “Computing machinery and intelligence”:

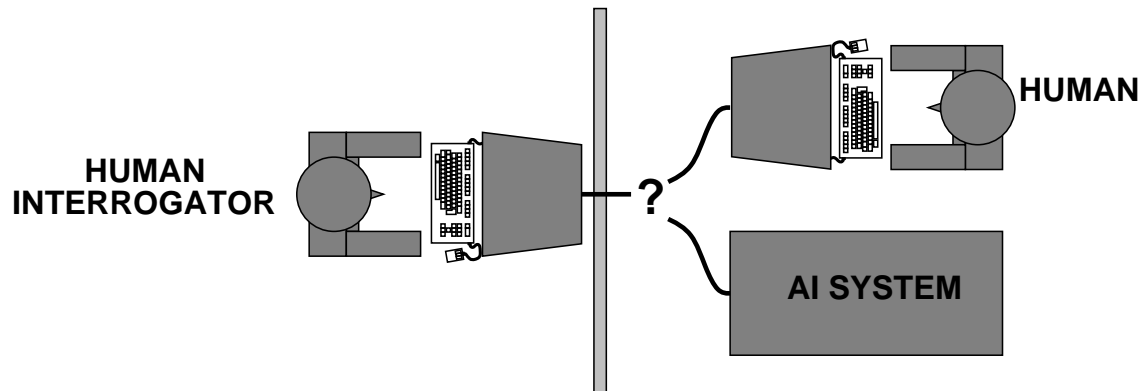
◇ the Imitation Game



# Acting like humans: The Turing test

Turing (1950) “Computing machinery and intelligence”:

◇ the **Imitation Game**



- ◇ Predicted that by 2000, a machine might have a 30% chance of fooling an ordinary person for 5 minutes
- ◇ Anticipated all major arguments against AI in following 50 years
- ◇ Suggested major components of AI: knowledge, reasoning, language understanding, learning

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

# Thinking like humans: Cognitive Science

<b>think like humans</b>	think rationally
act like humans	act rationally

Information-processing psychology

Scientific theories of internal activities of the brain

- What level of abstraction? “**Knowledge**” or “**circuits**”?
- 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

But both share with AI the following characteristic:

**the currently available theories do not explain or engender anything resembling human-level general intelligence**

# Thinking rationally: Laws of Thought

think like humans	<b>think rationally</b>
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 is mediated by logical deliberation
- 2) **What is the purpose of thinking?** What thoughts **should** I have out of all the thoughts (logical or otherwise) that I **could** have?

# Acting rationally

think like humans	think rationally
act like humans	<b>act rationally</b>

**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**

# Rational agents

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

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

Abstractly, an agent is 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, 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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- × Drive safely along US 1
- ◇ Buy a week's worth of groceries on the web

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Which of the following can be done at present?

- ✓ Drive safely along a curving mountain road
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- ✓ Buy a week's worth of groceries on the web
- ◇ Buy a week's worth of groceries at the local Giant

## State of the art

Which of the following can be done at present?

- ✓ Drive safely along a curving mountain road
- × Drive safely along US 1
- ✓ Buy a week's worth of groceries on the web
- × Buy a week's worth of groceries at your local Giant
- ◇ Play a decent game of bridge

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- × Buy a week's worth of groceries at your local Giant
- ✓ Play a decent game of bridge
- ◇ Write an intentionally funny story

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Which of the following can be done at present?

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- × Drive safely along US 1
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- × Buy a week's worth of groceries at your local Giant
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- × Write an intentionally funny story
- ◇ Give competent legal advice in a specialized area of law

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- ✓ Play a decent game of bridge
- × Write an intentionally funny story
- ✓ Give competent legal advice in a specialized area of law
- ◇ Translate spoken English into spoken Swedish in real time

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- × Buy a week's worth of groceries at your local Giant
- ✓ Play a decent game of bridge
- × 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

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- ✓ Play a decent game of ping-pong
- ◇ Unload any dishwasher and put everything away

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- ✓ Play a decent game of ping-pong
- × Unload any dishwasher and put everything away
- ◇ Explore the Martian landscape

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- ✓ Play a decent game of ping-pong
- × Unload any dishwasher and put everything away
- ✓ Explore the Martian landscape
- ◇ Explore downtown Washington

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- ✓ Play a decent game of ping-pong
- × Unload any dishwasher and put everything away
- ✓ Explore the Martian landscape
- × Explore downtown Washington