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CMSC 421, Artificial Intelligence

Chapter 1

What is AI?

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♢ 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

Acting like humans

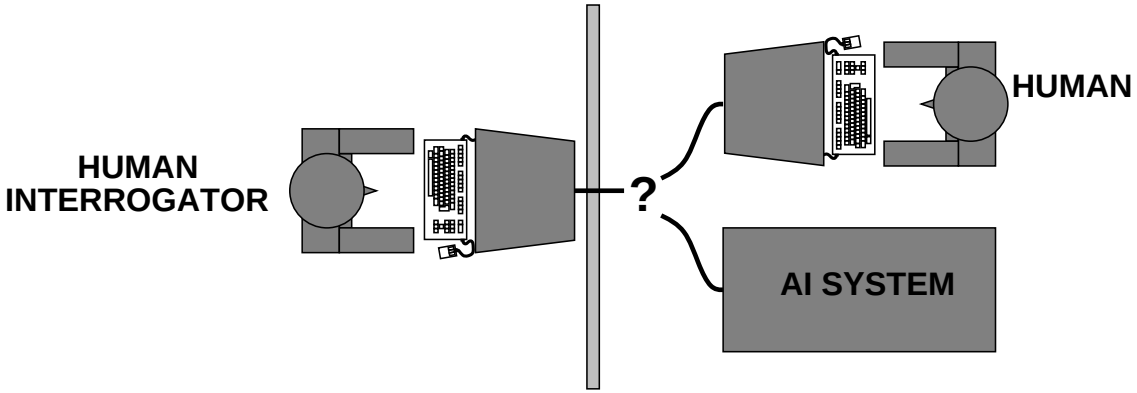
think like humans	think rationally
act like humans	act rationally

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

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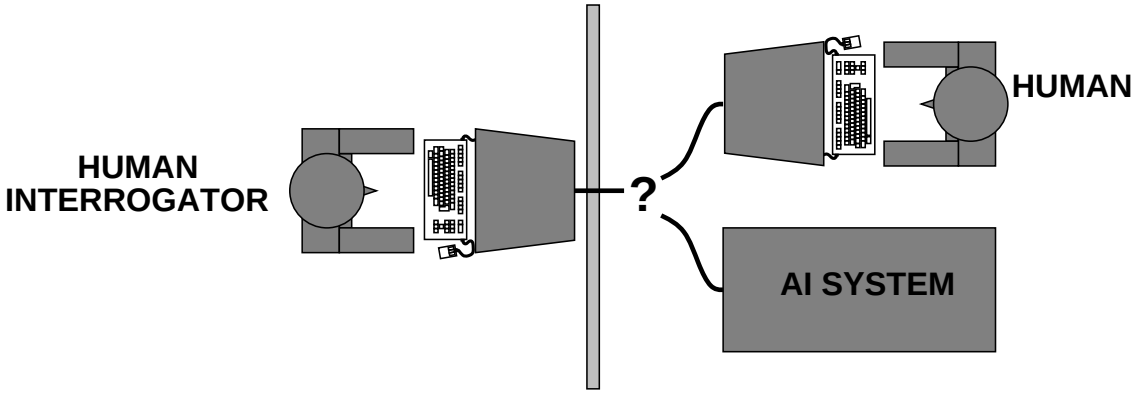

♢ Predicted that by 2000, a machine might have a 30% chance of fooling an ordinary person for 5 minutes

♢ 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

think like humans	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:

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

Thinking rationally: Laws of Thought

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 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	**act rationally**

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 means that 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

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

State of the art

Which of the following can be done at present?

- $\surd$ Drive safely along a curving mountain road
- $\times$ Drive safely along US 1
- $\diamondsuit$ Buy a week's worth of groceries on the web

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 the local Giant

State of the art

Which of the following can be done at present?

- $\surd$ Drive safely along a curving mountain road
- $\times$ Drive safely along US 1
- $\surd$ Buy a week's worth of groceries on the web
- $\times$ Buy a week's worth of groceries at your local Giant
- $\diamondsuit$ Play a decent game of bridge

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Which of the following can be done at present?

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- $\times$ Drive safely along US 1
- $\surd$ Buy a week's worth of groceries on the web
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- $\surd$ Play a decent game of bridge
- $\diamondsuit$ Write an intentionally funny story

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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 your local Giant
- √ Play a decent game of bridge
- × Write an intentionally funny story
- ♢ Give competent legal advice in a specialized area of law

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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

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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 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
- ♢ Play a decent game of ping-pong

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- √ 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
- √ Play a decent game of ping-pong
- ♢ Unload any dishwasher and put everything away

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- √ Translate spoken English into spoken Swedish in real time
- × Converse successfully with another person for an hour
- √ Play a decent game of ping-pong
- × Unload any dishwasher and put everything away
- ♢ Explore the Martian landscape

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- √ Translate spoken English into spoken Swedish in real time
- × Converse successfully with another person for an hour
- √ 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