ARTIFICIAL INTELLIGENCE

CHAPTER 1

Outline

- \Diamond What is AI?
- ♦ A brief history
- \Diamond The state of the art

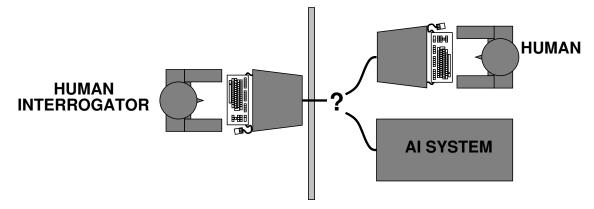
What is AI?

Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

Acting humanly: The Turing test

Turing (1950) "Computing machinery and intelligence":

- 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 Al 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 humanly: Cognitive Science

1960s "cognitive revolution": information-processing psychology replaced prevailing orthodoxy of behaviorism

Requires 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 Al

Both share with AI the following characteristic:

the available theories do not explain (or engender) anything resembling human-level general intelligence

Hence, all three fields share one principal direction!

Thinking rationally: Laws of Thought

Normative (or prescriptive) rather than descriptive

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 Al

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

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

This course is about designing rational agents

Abstractly, an agent is a function from percept histories to actions:

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

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

Caveat: computational limitations make perfect rationality unachievable

→ design best program for given machine resources

AI prehistory

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 plastic physical substrate for mental activity

Control theory homeostatic systems, stability

simple optimal agent designs

Potted 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 Al 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	Al 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: "Al Winter"	
1985–95	Neural networks return to popularity	
1988–	Resurgence of probability; general increase in technical depth	
	"Nouvelle AI": ALife, GAs, soft computing	
1995–	Agents, agents, everywhere	
2003-	Human-level AI back on the agenda	

Which of the following can be done at present?

♦ Play a decent game of table tennis

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- ♦ Drive safely along a curving mountain road

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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.

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 . . .