Introduction to Artificial Intelligence: cs580

Dr. Zoran Duric
Office: S&T II, Rm. 427
email: zduric@cs.gmu.edu
Office Hours: Tue. 2:00-4:00pm or by app.
URL: http://www.cs.gmu.edu/∼zduric/
Course: http://www.cs.gmu.edu/∼zduric/cs580.html

Outline

- ♢ Course overview
- ♢ What is AI?
- ♢ A brief history
- ♢ The state of the art

Course overview

- ♢ lisp
- ♢ intelligent agents
- ♢ search and game-playing
- ♢ logical systems
- ♢ planning systems
- ♢ uncertainty—probability and decision theory
- ♢ learning
- ♢ language
- ♢ perception
- ♢ robotics
- ♢ philosophical issues

What is AI?

"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models" (Charniak+McDermott, 1985)
"The study of how to make computers do things at which, at the moment, people are better" (Rich+Knight, 1991)	"The branch of computer science that is concerned with the automation of intelligent behavior" (Luger+Stubblefield, 1993)

Views of AI fall into four categories:

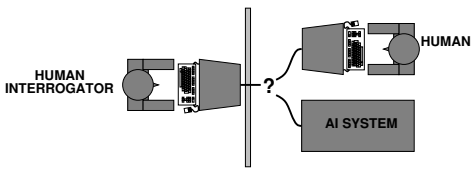
Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

Examining these, we will plump for acting rationally (sort of)

Acting humanly: The 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

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 AI

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 AI

Problems:
1) Not all intelligent behavior is mediated by logical deliberation
2) What is the purpose of thinking? What thoughts should I 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:

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

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.)
Linguistics	knowledge representation, grammar
Neuroscience	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 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 probabilistic and decision-theoretic methods
	Rapid increase in technical depth of mainstream AI
	"Nouvelle AI": ALife, GAs, soft computing

State of the art

Which of the following can be done at present?

◇ Play a decent game of table tennis
◇ Drive along a curving mountain road
◇ Drive in the center of Cairo
◇ Play a decent game of bridge
◇ Discover and prove a new mathematical theorem
◇ Write an intentionally funny story
◇ Give competent legal advice in a specialized area of law
◇ Translate spoken English into spoken Swedish in real time