Artificial Intelligence

Chapter 1

Outline

- Course overview
- What is AI?
- A brief history
- 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”:
- “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

Administrivia

Class home page: http://inst.eecs.berkeley.edu/~cs188 for lecture notes, assignments, exams, grading, office hours, etc.

Assignment 0 (lisp refresher) due 1/27
account forms from 727 Soda.

See syllabus: Chapter 1 for today’s material, Chapter 2 for Thursday.

Code: integrated lisp implementation for AIMA at aima.cs.berkeley.edu
Updated version posted locally (see class page)
Lisp/emacs/AIMA tutorial:
  - Online, or in person 1–3 on Fri 1/21 and 10–12 on Mon 1/24, 271 Soda
Discussion section this week: Lisp refreshment
Prerequisites: CS 61A, and Math55/CS70
Sections 105 and 106 are primarily intended for non-CS majors
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?

1) Predicting and testing behavior of human subjects (top-down)
2) Direct identification from neurological data (bottom-up)

Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI

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 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

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 percepts to actions:

\[ f : P \to A \]

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 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
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
◊ Drive safely along a curving mountain road
◊ Drive safely along Telegraph Avenue
◊ Buy a week’s worth of groceries on the web

◊ Buy a week’s worth of groceries at Berkeley Bowl

◊ Play a decent game of bridge
State of the art

Which of the following can be done at present?

- Play a decent game of table tennis
- 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 Berkeley Bowl
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- 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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- 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
- Perform a complex surgical operation

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.

Hard questions

Will machines surpass human intelligence? Should they?

What will we do with superintelligent machines?

Do such machines have conscious existence? Rights?

Should we replace the human race with superhuman machines?

Can human minds exist indefinitely within machines?