Artificial Intelligence: Introduction

Chapter 1

Outline

We consider here:

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

What is AI?

What is AI?

Consider the following table that can be used to classify definitions of AI:

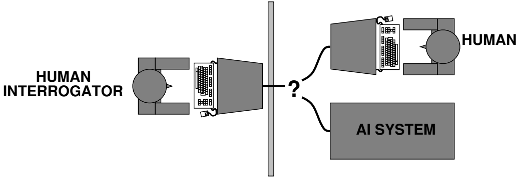
Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

- On the left side we have a comparison with how humans *behave*.
- On the right side we have a comparison with an *ideal* reasoner.
- The top concerns *reasoning*
- The bottom concerns *behaviour*

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*



The Turing test

- Anticipated all the major arguments against AI
- Suggested major components of AI: knowledge, reasoning, language understanding, learning
- Based on action: a Turing test-passing AI must be able to do anything that a human can.
- Problem:
  - TT is not *reproducible* or amenable to *mathematical analysis*
  - Based on *deception*. (This is exploited by many entrants for the *Loebner prize*).
  - Too weak: an AI may be very useful without being able to pass the Turing test.

TT Alternative: The Winograd Challenge

Idea:

Ask a series of questions such as:

Joan thanked Susan for all the help she had given.

Who had given the help?

a) Joan

b) Susan

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Joan thanked Susan for all the help she had given.
Who had given the help?

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b) Susan

or:

John could not put the trumpet in the suitcase because it was too large.
What was too large?

a) the trumpet
b) the suitcase

The Winograd Challenge

- A human would have an easy time with these questions
- Any existing program would have a *tough* time with them.
- "Google-proof"

See:
http://www.newyorker.com/online/blogs/elements/2013/08/why-cant-my-computer-understand-me.html

Thinking humanly: Cognitive Science

- How do humans think? Three ways to find out:
  - Introspection
  - Observing behavior
  - Brain imaging
- Goal of **cognitive science**: understand the human mind through a combination of experimentation and simulation.
- In the early days, human-like *thinking* and human-like *acting* were sometimes confused.

Thinking rationally: Laws of Thought

Ask:

How *should* a rational agent think?

- So, *normative* (or *prescriptive*) rather than *descriptive*
- Aristotle first asked: what are correct arguments/thought processes?
- Over the last 100 or so years, formal *logic* has been developed to provide principles of correct reasoning.
- Arguably logic says how an agent *should* act.

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Problems:

1. Not all intelligent behavior is mediated by logical deliberation
2. There is a big difference between solving a problem in principle and in practice.

Acting rationally

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Acting rationally

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- So, *rational behavior* = doing the right thing
- *Q:* What is "doing the right thing"?
  A: That which is expected to maximize goal achievement, given available information
- May not involve thinking (e.g., blinking reflex) but thinking should be in the service of rational action
- May not be able to guarantee the best outcome.

☞ The text (and the course) will concentrate on general principles of rational agents and on components for constructing them

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*
- Problem: *computational limitations make perfect rationality unachievable*

☞ So we want to design the best *program* for given machine resources

AI prehistory (see the text)

Areas that have some bearing on AI:

Philosophy	logic, knowledge representation, reasoning, foundations of learning, language, rationality
Mathematics	formal representation and proof, algorithms, computation, (un)decidability, (in)tractability, probability
Psychology	adaptation, perception and motor control, experimental techniques (psychophysics, etc.)
Economics	formal theory of rational decisions
Linguistics	knowledge representation, natural language understanding, grammar
Neuroscience	physical substrate for mental activity
Control theory	homeostatic systems, stability, simple optimal agent designs

Selected history of AI (again, see the text)

1950	Turing's "Computing Machinery and Intelligence".
1950s	Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist,
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, wane again.
1988–	Resurgence of probability; increase in technical depth.
2001–	Availability of massive datasets. Machine learning gains popu
2006–	"Deep learning" and widespread use of neural networks.

State of the art (2010-ish)

What can AI do today?

- NASA's Remote Agent program is an autonomous planner for spacecraft operations
- Game playing

  ☞ There's Deep Blue. A team at U Alberta has solved checkers and is working on poker. Also Go.
- Drive a vehicle

  ☞ An autonomous vehicles are around the coprner, and are being licensed in several states in the US.
- Diagnosis

  ☞ Good progress is being made in (limited) medical diagnosis systems
- Logistics and Planning

  ☞ The text mentions successes in the US in military planning.

State of the art (circa 2010) (continued)

- Robotics
  ☞ Surgeon's assistants. As well, there is steady progress in (e.g.) robocup
- Learning
  ☞ E.g. spam filters
- Problem solving
  ☞ E.g. crossword solver. General Game Competition. Others?
- Machine translation
- Others?

State of the art

What about the following?

- Drive safely along a curving mountain road
- Buy a week's worth of groceries on the web? At Save-On?
- Play a decent game of bridge? Poker?
- 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
- Perform a complex surgical operation
- Unload a dishwasher and put everything away

AI research at SFU

AI researchers:

- Robotics: Richard Vaughan.
- Linguistics, Machine translation: Anoop Sarkar. Veronica Dahl. Fred Popowich.
- Logic, constraint satisfaction, theorem proving: James Delgrande, David Mitchell. Eugenia Ternovska.
- Vision, image processing: Greg Mori, Ze-Nian Li, Mark Drew, Kangkang Yin, Yasu Furukawa.
- Computational biology: Maxwell Libbrecht, Leonid Chindelevitch, Martin Ester, Ghassan Hamarneh