Artificial Intelligence: Introduction

Chapter 1

Outline

We consider here:

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

What is AI?

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

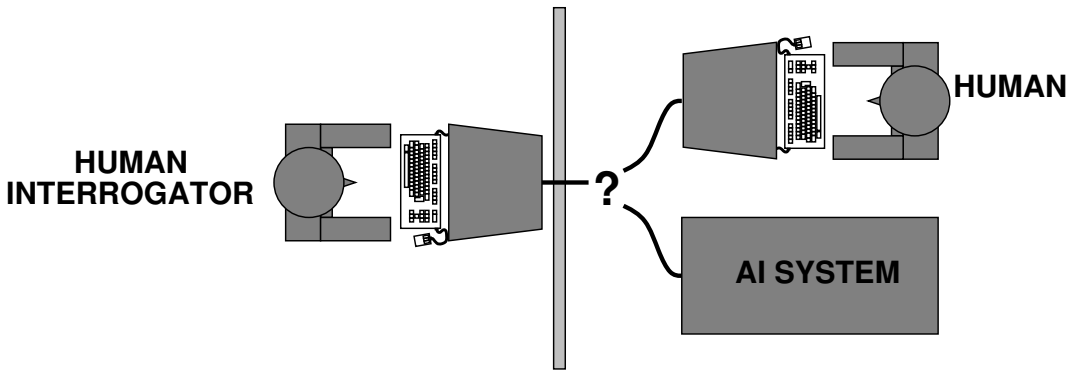
Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

- 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*

Thinking Humanly: The Turing test

Turing (1950) "Computing machinery and intelligence":

- *Can machines think?* $\rightarrow$ *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
- Problem:
  - TT is not *reproducible* or amenable to *mathematical analysis*
  - Based on *deception*.
    - This is exploited by many entrants for the *Loebner prize*.

TT Alternative: The Winograd Challenge

Idea:

Ask a series of questions such as:

Joan thanked Susan for all the help she had given.

Who gave the help?

a) Joan

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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

- 1960s "*cognitive revolution*": Information-processing psychology replaced the prevailing view of *behaviorism*
- Required 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 humans (top-down) or
    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

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* think.

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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.

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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*

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- 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*
- 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
1988–	Resurgence of probability; increase in technical depth
1995–	Intelligent agents as a focus
2001–	Availability of massive datasets
2003–	Some seemingly-impressive applications

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 corner.
- 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 (circa 2010) (continued)

What are some more recent AI successes?

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