What is Intelligence

Textbook Definitions

- Thinking like humans
- Acting like humans
- Thinking rationally
- Acting rationally

However, it depends on the definition: whatever the (intelligence) test tests.

But Really, What is AI?

Diverse areas: http://www.aaai.org

- Problem solving
- Reasoning
- Theorem proving
- Learning
- Planning
- Knowledge representation
- Perception and Robotics
- Agents
- and more

What is AI?

A folk (popular) view of AI

From http://www-2.cs.cmu.edu/afs/cs.cmu.edu/user/zhuxj/www/travel/fun/images/terminator.jpg (top); Universal studio’s movie “Terminator” (bottom)
Approaches

Two basic stances

- Strong AI:
  1. Build something that actually thinks intelligently.
  2. Simulation of thought would give rise to the phenomenology of thought (i.e., how it feels like to think).

- Weak AI:
  1. Build something that behaves intelligently.
  2. Not worried about its feelings.

Problems

- Strong AI:
  Hard to determine if something is really consciously intelligent or not (the other minds problem in philosophy).

- Weak AI:
  Utility of the result is limited by the stated goal. Hard to achieve a general usefulness as in true intelligence.

Overview

- Related academic disciplines
- History of AI
- Hard Problems
- Current Trends

Foundations of AI

- Philosophy
- Mathematics
- Psychology
- Cognitive Science
- Linguistics
- Neuroscience
Philosophy of Mind

The mind-body problem:

• Dualism: Mind and body are separate entities.

• Monism: Only mind or body exist, but not both
  1. Idealism: all things are mental
  2. Materialism: all things are material

• Epiphenomenalism: mental phenomena are just side-effects of physical change in the brain (i.e. they do not have causal power over behavior).

Too many variations to mention all.

Mathematics

• Algorithm (al-Khowarazmi)
• Boole
• Hilbert
• Gödel: Incompleteness theorem
• Turing: Halting problem
• Cook and Karp: P, NP, and the like


Psychology

• Behaviorism: stimulus-response and conditioning
• Functionalism: internal representations and processes. Implementation independent.
• Perceptual psychology: vision, audition, etc.
• Cognitive psychology: cognition as information processing.
• Holistic vs. localist debate: emergent vs. simple summation.

Linguistics

• WW II: machine translation.
• Phonetics, syntactic theory, semantics, discourse, etc.
• Innate vs. learned?: Chomsky
• Syntax: finite automata, context free grammar, etc.
• Semantics: semantic nets
• Sub-symbolic: self-organizing maps, episodic memory, recurrent neural nets, etc.
Cognitive Science

Interdisciplinary field studying human perception and cognition, ranging over:

- Neuroscience
- Behavioral science
- Social science
- Psychology
- Computational science
- Information theory
- Cultural studies

Neuroscience

- Staining: Golgi, Nissl
- Hubel and Wiesel: orderly structure of cat visual cortex
- PET scans and CAT scans: localizing functional modules
- fMRI imaging: cognitive and perceptual tasks
- Optical imaging: orderly structure
- TMS: zap and numb your brain

History of AI (I)

Gestation (1943–1956)

- McCulloch and Pitts: early neural nets
- Minsky and Papert: limitations of perceptron
- Newell and Simon: physical symbol system hypothesis
  - Logic Theorist
- Dartmouth Workshop (1956): AI was born
  It is 50(+1) years old (2007)!
  http://en.wikipedia.org/wiki/AI@50

History of AI (II)

Early successes (1952–1969)

- General problem solver
- McCarthy: LISP
- Toy domains: ANALOGY, STUDENT (algebra).
- Widrow and Hoff: adalines
- Rosenblatt: perceptrons
History of AI (III)

The 60’s and 70’s

- ELIZA
- Genetic algorithms
- Knowledge-based systems: avoid the weak method, i.e. search
  - scientific domain
  - engineering domain
  - natural language

The 80’s: 5th generation AI – Prolog.

50th anniversary in 2006: http://en.wikipedia.org/wiki/AI@50

- Some quotes from the 50th anniversary event (Rodney Brooks):
  - the social sophistication of 10-year-old
  - the manual dexterity of a 6-year-old
  - the language ability of 4-year-old
  - the visual object recognition of a 2-year-old

Hard Problems (I)

- Physicalism, materialism, and naturalism: brain causes mind.
- Functionlism: if it functions in the same way, a silicon brain can also be conscious.
- Dualism and homunculus: the Cartesian theatre.
- Wide vs. narrow content: real correspondence, or limited to experiential state?
- Intentionality: how can we believe in things that do not exist, such as Poseidon.

Hard Problems (II)

- Semantic content and syntactic symbols: how can syntactic constructs possess intenionality?
- Symbol grounding: sensory devices produce grounded symbols, and composite symbols can be constructed.
- Problem of qualia: why do we feel in such a way?
- Turing test and Searle's Chinese Room
  - system reply
  - robot reply
Hard Problems (III)

- However, the assumption that a collection of unconscious things are unconscious is invalid: think about organic vs. inorganic, life vs inanimate matter.
- Searle’s point of view: mind is an emergent phenomena of the neural substrate (biological naturalism).

Current Trends

- Learning: instead of hand-coding or strict reasoning.
- Neural networks and statistical methods
- Genetic algorithms (Evolutionary algorithms)
- Embodied robotics; Dynamical systems approach
- Bioinformatics
- Computational Neuroscience
- Distributed Agents
- Some thoughts on consciousness: Crick and Koch

What We Will Discuss

- Search
- Game tree search