

CSCE 315: Programming Studio

- Introduction to Artificial Intelligence
- Fall 2010

1

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.**

2

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)

3

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**

4

Approaches

Two basic stances

- Strong AI:
 1. Build something that actually thinks intelligently.
 2. Simulation of thought would give rise to the phenomenonology of thought (i.e., how it feels like to think).
- Weak AI:
 1. Build something that behaves intelligently.
 2. Not worried about its feelings.

5

Overview

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

7

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.

6

Foundations of AI

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

8

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.

9

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.

11

Mathematics

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

Representation/Interpretation, Symbol/Computing: the computer/software metaphor.

10

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.

12

Cognitive Science

Interdisciplinary field studying human perception and cognition, ranging over:

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

13

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>

15

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

14

History of AI (II)

Early successes (1952–1969)

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

16

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.

17

Hard Problems (I)

- Physicalism, materialism, and naturalism: brain causes mind.
- Functionalism: 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.

19

History of AI (IV)

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

18

Hard Problems (II)

- Semantic content and syntactic symbols: how can syntactic constructs possess intentionality?
- 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

20

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).

21

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

22

What We Will Discuss

- Search
- Game tree search

23