Lecture 1
What is AI?

EECS 348

Intro to Artificial Intelligence

Doug Downey

Outline

1) What is AI: The Course
2) What is AI: The Field
3) Why to take the class (or not)
4) A Brief History of AI
5) “Predict the future” poll

What is AI: The Course

- Communication
  - Web site, e-mails to class
  - In class
  - Send feedback early and often
- Grading
  - 6 problem sets
  - Late assignments not graded
- Midterms (weeks 3 and 8)
- Final: Othello Tournament

More on Problem Sets

- Programming (in pairs) and exercises (indv.)
  - PS 1: AI history and search
  - PS 2: Sudoku solver
  - PS 3: Logic and Agents
  - PS 4: Othello player I
  - PS 5: Machine Learning
  - PS 6: Othello player II

- Code:
  - Language?
  - Code in pairs – write reports individually

Topics

1. Introduction to AI, chapter 1.
2. Search, chapters 3, 4.
3. Constraint Satisfaction, Chapter 6.
4. Logic and agents, Ch 7-8.
5. Game playing, chapter 5.
6. Machine learning, chapters 18-20.
7. The Big Questions (final week) chapters 26, 27.

Textbook

Artificial Intelligence: A Modern Approach
Russell and Norvig

Goals of this Course

- To teach you the main ideas of AI

- To introduce you to a set of key techniques and algorithms from AI

- To introduce you to the applicability and limitations of these methods

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- *What are the most fundamental scientific questions?*

What is Intelligence?

What is Artificial Intelligence?

- Dimensions:

  Human-like vs. rational

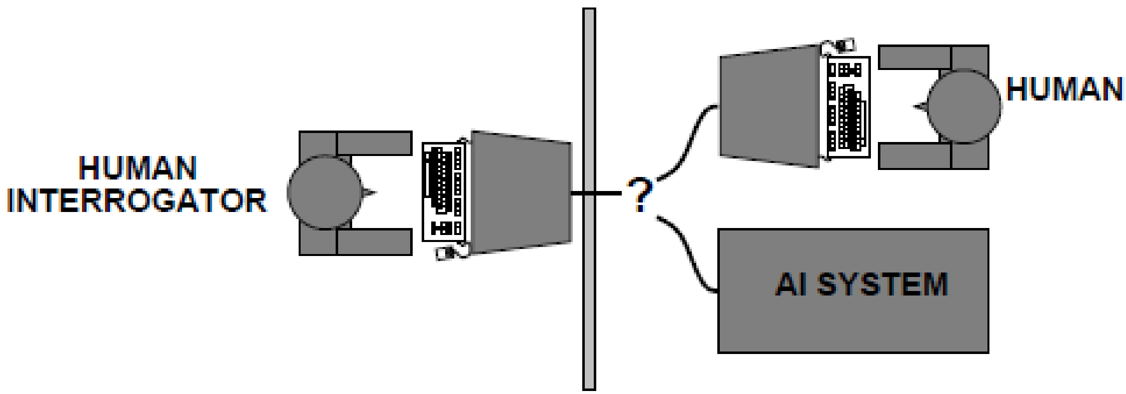
  Behavior vs. thought

Human-like behavior

- Dimensions:

  Human-like vs. rational   **Behavior** vs. thought

- Turing test (1950):



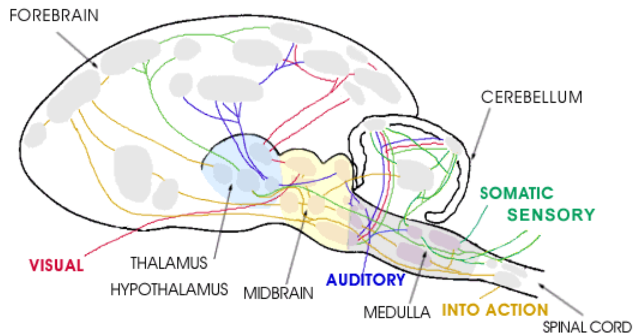
Human-like thought

- Dimensions:

  Human-like vs. rational — Behavior vs. **thought**

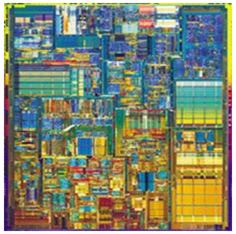
- Must choose level of abstraction
  - **Knowledge?**
  - **Neurons?**
- How to validate?
  - **Predict and test behavior from human subjects (top-down)**
  - **Measure neurological data (bottom-up)**
- **Cognitive Science** and **Cognitive Neuroscience**
  - Both fields distinct from AI today

Human vs. Computer Hardware

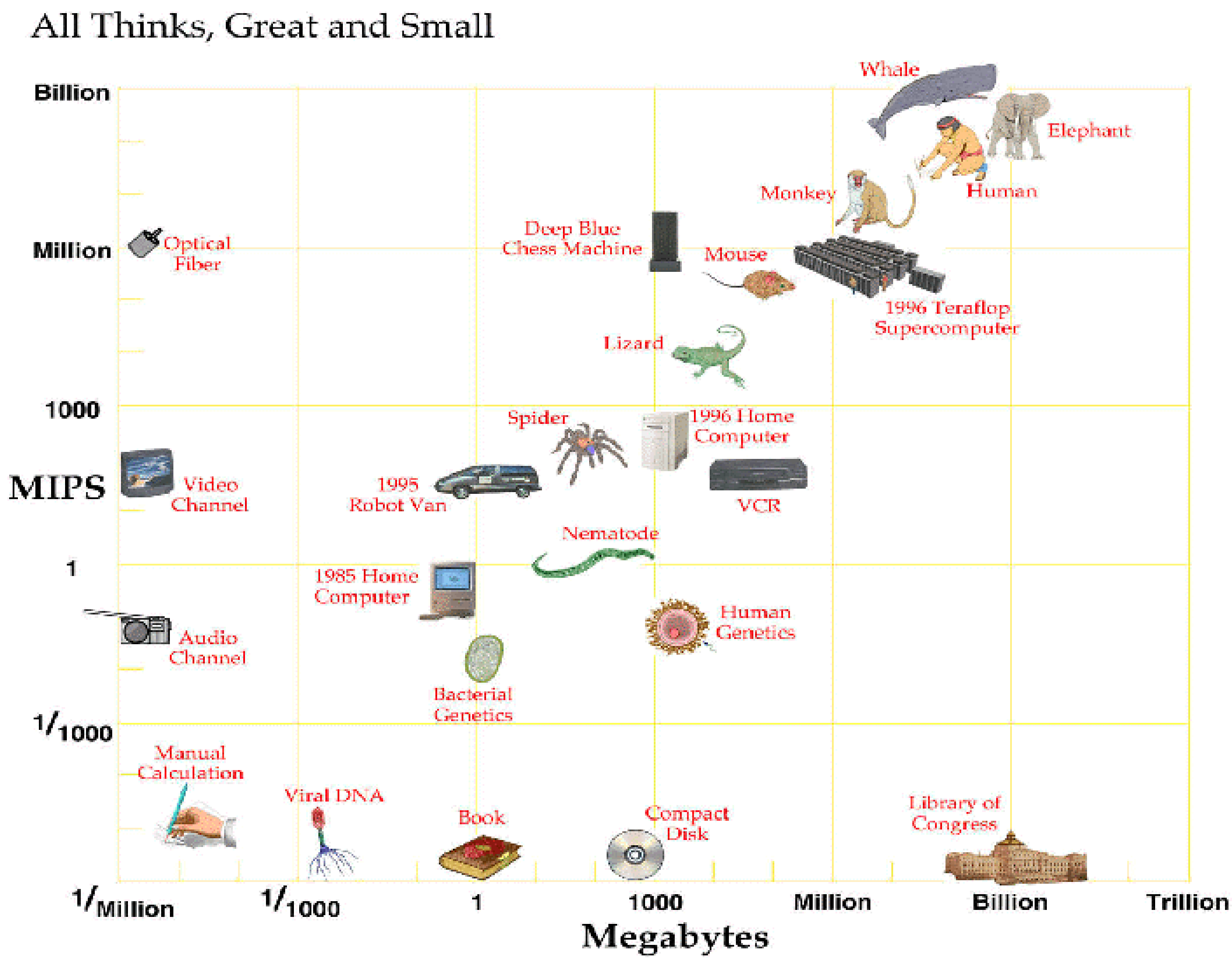


10^{11} neurons
10^{14} synapses
cycle time: 10^{-3} sec

10^{9} transistors
10^{11} bits of RAM
cycle time: 10^{-9} sec



Computer vs. Brain



- Conclusion
  - In near future we can have computers with as many processing elements as our brain, but:
    - fewer interconnections (wires or synapses)
    - much faster updates.

- Fundamentally different hardware may require fundamentally different algorithms
  - Very much an open question.
  - Neural net research.

Thinking Rationally

- Dimensions:

  Human-like vs. **rational** Behavior vs. **thought**

- *Prescriptive*: what would an *ideal* agent think?
  - vs. *descriptive* (what do people *actually* think)
- Harkens to ancient Greeks: logical notation and rules of derivation for thoughts
- Problems:
  - Lots of (rational) actions not due to thought at all
  - What thoughts *should* I think?

Acting Rationally

- Dimensions:

  Human-like vs. **rational** Behavior vs. thought

- Rational agents "do the right thing"
  - Take actions that are optimal for achieving *goals*

- Computational limits prohibit complete rationality
  - Thus, attempt to be "as rational as possible" given resource constraints
- Textbook focuses on "acting rationally" as the definition of AI

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Why not to take the class

- It won’t be easy
- You have to like/tolerate programming
- You’re best off if you already know:
  - A fair amount about algorithms and data structures
  - The basics of probability theory
  - The basics of first-order logic

Why to take the class

- Touches on a huge number of other fields
    - Mathematics, Philosophy, Neuroscience, Psychology, Cognitive Science, Economics, and of course Computer Science

- Get to play with fun algorithms

- Get to think about the future

- Material has potentially large impact

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Going way back

- (4th C BC+) Aristotle, George Boole, Gottlob Frege, Alfred Tarski
  - formalizing the laws of human thought
- (16th C+) Gerolamo Cardano, Pierre de Fermat, James Bernoulli, Thomas Bayes
  - formalizing probabilistic reasoning
- (1950+) Alan Turing, John von Neumann, Claude Shannon
  - thinking as computation
- (1956) John McCarthy, Marvin Minsky, Herbert Simon, Allen Newell
  - start of the field of AI

Classical AI

- The principles of intelligence are separate from any hardware / software / wetware implementation

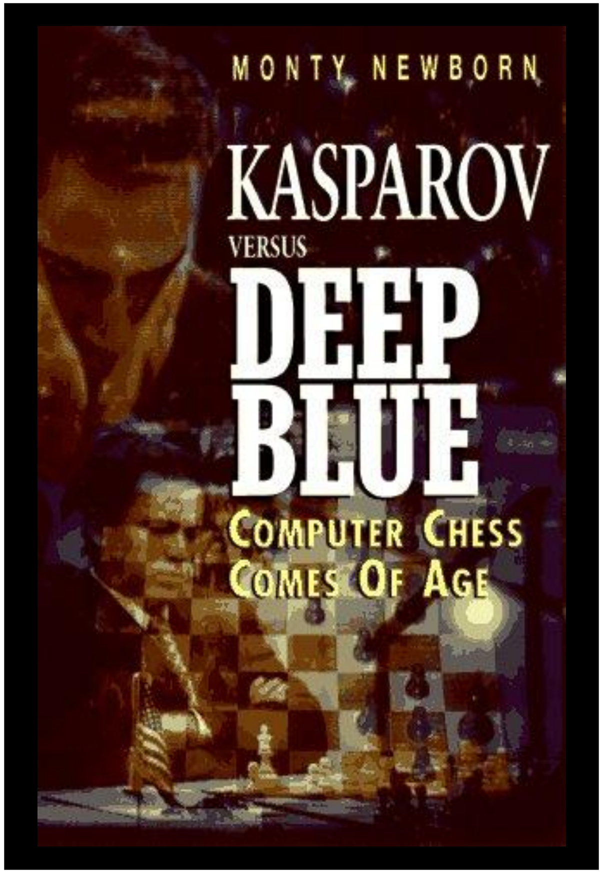
- Look for these principles by studying how to perform tasks that require intelligence

Success Story: Expert Systems

- Gather knowledge from experts, codify it in software
- Example: Mycin (1980)
  - Expert level performance in diagnosis of blood infections

- Rose to prominence in early 80s. Today: 1,000’s of systems
  - Everything from diagnosing cancer to configuring aircraft
  - Often outperform e.g. doctors in clinical trials

Success Story: Chess



I could feel – I could smell – a new kind of intelligence across the table
- Kasparov

•Examines 5 billion positions / second
•Intelligent behavior emerges from brute-force search

Autonomous Systems

- In the 1990's there was a growing concern that work in classical AI ignored crucial scientific questions:
  - How do we integrate the components of intelligence (*e.g.* learning & planning)?
  - How do perception and action interact with reasoning?
  - How does the demand for real-time performance in a complex, changing environment affect the architecture of intelligence?

RoboCup

Provide a standard problem where a wide range of technologies can be integrated and examined

By 2050, develop a team of fully autonomous humanoid robots that can win against the human world champion team in soccer.

Key Hard Problem for AI

- Today's successful AI systems
  - operate in well-defined domains
  - employ narrow, specialized knowledge

- *Commonsense Knowledge*
  - needed to operate in messy, complex, open-ended worlds
    - Your kitchen vs. GM factory floor
  - understand unconstrained Natural Language

Role of Knowledge in Natural Language Understanding

- Speech Recognition
  - "word spotting" feasible today
  - continuous speech – rapid progress
  - turns out that "low level" signal not as ambiguous as we once thought
- Translation / Understanding
  - limited progress

  The spirit is willing but the flesh is weak. (English)

  The vodka is good but the meat is rotten. (Russian)

Syntactic, Semantic, Analogical Knowledge

- Time flies like an arrow.
- Fruit flies like a banana.
- Fruit flies like a rock.

How to Get Commonsense?

- CYC Project (Doug Lenat, Cycorp)
  - Encoding 1,000,000 commonsense facts about the world by hand
  - Coverage still too spotty for use!

- Alternatives?
- Open Mind
- KnowItAll

Recurrent Themes

- Neural nets vs Logic
  - McCulloch & Pitts 1943
  - Died out in 1960’s, revived in 1980’s
    - Neural nets vastly simplified model of real neurons, but still useful & practical – massive parallelism
    - particular family of learning and representation techniques
- Logic vs Probability
  - In 1950’s logic seemed more computationally & expressively attractive (McCarthy, Newell)
    - attempts to extend logic “just a little” to deal with the fact that the world is uncertain!
  - 1988 – Judea Pearl’s work on Bayes nets
    - provided efficient computational framework
  - Today – no longer rivals
    - hot topic: combining probability & first-order logic

Recurrent Themes, cont.

- Weak vs Strong Methods
  - Weak – general search methods
    - A* search, constraint propagation, ...
  - Rise of "knowledge intensive" approach
    - expert systems
    - more knowledge, less computation
  - Today: resurgence of weak methods
    - desktop supercomputers
    - in highly competitive domains (Chess) exceptions to the general rules are most important!
  - How to combine weak and strong methods seamlessly?

(Re-)Current Themes

- Combinatorial Explosion
- Micro-world successes don’t scale up.
- How to organize and accumulate large amounts of knowledge?
- How to translate from informal, ill-structured statements to formal reasoning (e.g., understand a story)?
- What are reasonable simplifying assumptions?

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In the future…

- A computer will pass the Turing Test in:
    a) <20 years
    b) 20-50 years
    c) 50-100 years
    d) 100+ years
    e) Never

The future…

- 80% of households will have humanoid robots in…
    a) <20 years
    b) 20-50 years
    c) 50-100 years
    d) 100+ years
    e) Never

The future…

- The **most crucial** advance needed for progress in AI is:
  - a) Better hardware (Faster CPUs/more RAM)
  - b) Better software (algorithms)
  - c) Better understanding of human intelligence/brains
  - d) Better ways to harness human participation