331 – Intro to Intelligent Systems

(More) History and Intro to AI

Week01b

T.J. Borrelli

Important Features of AI

1. The use of computers to do reasoning, pattern recognition, learning, or some other form of inference.
2. A focus on problems that do not respond to algorithmic solutions.
3. A concern with problem-solving using inexact, missing, or poorly defined information.
4. Reasoning about the significant qualitative features of a situation.
5. An attempt to deal with issues of semantic meaning as well as syntactic form.

Important Features of AI

6. Answers that are neither exact nor optimal, but are in some sense "sufficient".

7. The use of large amounts of domain-specific knowledge in solving problems.

8. The use of meta-level knowledge to effect more sophisticated control of problem-solving strategies.

Intractability and AI

- Some well-known NP-complete problems:
  - Longest Path
  - Hamiltonian Cycle
  - 3-CNF
  - Circuit-Sat
  - Formula-Sat
  - Clique
  - Vertex Cover
  - Traveling Salesperson
  - Subset Sum
  - Graph Coloring
  - Crossword Puzzles
  - Longest Common Subsequence (LCS) for more than 2 strings

Intractability and AI

- More well-known NP-complete problems:
  - 0-1 Knapsack
  - Exam Scheduling and CPU Register Assignment (Graph Coloring)
  - 3D matching
  - Chess
  - Minesweeper ($1,000,000 Grand Challenge to solve it in p-time!)
  - Tetris
  - Rubic's Cube
  - Lloyd Puzzle (8-slide puzzle)
  - Cracker Barrel puzzle

Intractability and AI – Coping with NP-completeness:

1. Brute force - you will need additional resources (parallel machines) and probably will still not be able to solve

2. Efficient non-deterministic machines (quantum computers?)

3. Small inputs

4. Special cases

5. Restrict the problem (parameterize the complexity)

For example, in chess there are 448 possible moves for each play. Therefore, for n plays, there are 448^n possible moves. If you create a game tree with each branch labeled with a possible move, you could win the game by "looking ahead" and following the branches that lead to the winning game configuration. This would require a tree with 448^n branches. Too big. Prune the tree by using a heuristic to cut off unpromising branches, or look ahead a few branches at a time.

Intractability and AI

6. Use a heuristic (a “rule-of-thumb”, usually arising from trial-and-error or experimentation). Neural networks, genetic algorithms, fuzzy logic, simulated annealing, tabu search, hill climbing (problem of local optimum, may not be globally optimal). For example, to navigate through a maze, you could use a heuristic such as the “right-hand-rule” (place your right hand on the wall and always follow the wall that your hand is touching - does not always work). Or you could drop pebbles at intersections to mark corridors that have already been investigated. This will always work, but you may need LOTS of pebbles

7. Randomization (Monte-Carlo techniques). Throw a die. Trade memory for randomness (random walk).

8. Use an approximation algorithm. You will have to settle for a near-optimal solution.

AI in the 20th Century

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
1955	Dartmouth meeting: the name "Artificial Intelligence" adopted
1950s	Early AI programs, including Samuel's checkers program,
	Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1965	Robinson's complete algorithm for logical reasoning
1966-73	AI discovers computational complexity
	Neural network research almost disappears
1969-79	Early development of knowledge-based systems, “Blocks World”
1980	AI becomes an industry
1986	Neural networks return to popularity
1987	AI becomes a science
1995	The emergence of intelligent agents

AI in the 21st Century

- AI is everywhere
- Fuzzy logic is used in elevators, washing machines and cars
- Intelligent agents are used in many software applications
- Robots explore other worlds, and toy robots play with children (and some adults)
- Expert systems diagnose diseases and recommend remedies
- Computer games use AI

Applications of AI

- Game Playing
- Automated Reasoning and Theorem Proving
- Expert Systems
- Natural Language Understanding and Semantic Modeling
- Modeling Human Performance
- Planning and Robotics
- Languages and Environments for AI
- Machine Learning
- Alternative Representations: Neural Nets and Genetic Algorithms
- Computer vision and Image Understanding

Strong AI and Weak AI

- There are two entirely different schools of AI:
- Strong AI:
  - This is the view that a sufficiently programmed computer would actually *be* intelligent and conscious, and would think in the same way that a human does
  - Strong AI is currently the stuff of science fiction, although there are many that believe that machines will indeed be capable of real thought at some point in the future
- Weak AI:
  - This is the use of methods modeled on intelligent behavior to make computers more efficient at solving problems
- This course is concerned with Weak AI

Another Dichotomy in AI

- Another pair of schools of thought in AI is the so called “neats” vs “scruffies”
- Neats:
  - – Those that think AI theories should be rooted in mathematical rigor and appreciate an elegant solution
  - – Notable neats: John McCarthy, Allan Newell (GPS)
- Scruffies:
  - – Those that would rather try out lots of different ideas (trial-and-error) and assess what works best in a pragmatic way
  - Notable scruffies: Marvin Minsky, Terry Winograd (HCI)
- Both approaches are important as sometimes the “elegant” solution is not necessarily the most correct

Chinese Room Counter-Argument

John Searle 1980 – “The Chinese Room” counter-argument

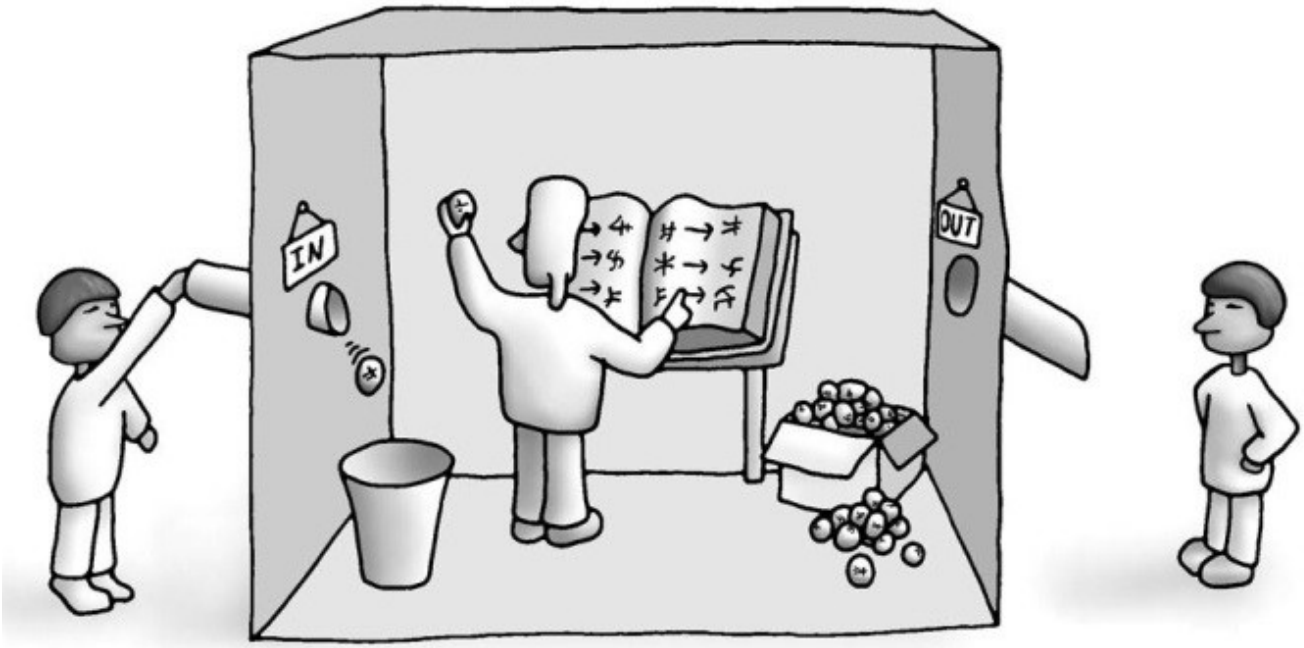


Image from http://10est.com/11/the-chinese-room

HAL – Fantasy or Reality?

- HAL – the computer in the film 2001: A Space Odyssey
  - Plays chess with humans (and wins)
  - Reads people's lips
  - Engages in conversation with humans
  - Eventually goes insane
- Computers can play chess, and beat some players
- Reading lips is very hard to automate.
- The conversational skills of the best systems today are very weak

Strong Methods and Weak Methods

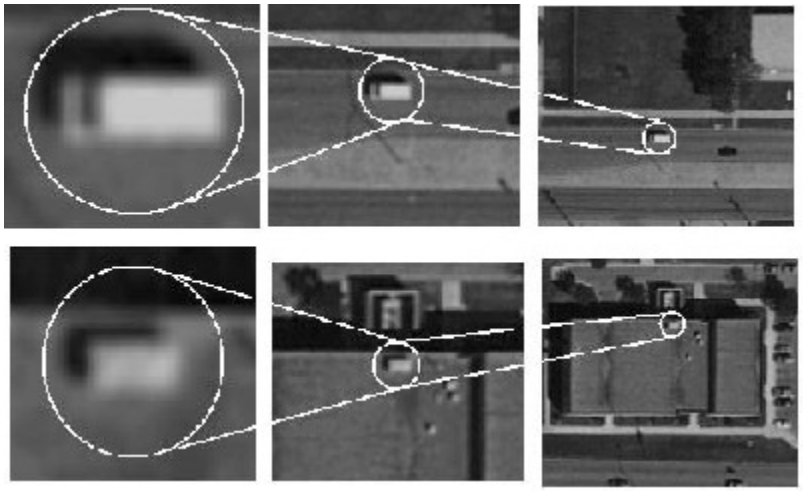
- Not to be confused with Strong AI and Weak AI
- Strong methods use knowledge about the world to solve problems
- Weak methods use logic and other symbolic systems
- Strong method systems rely on weak methods, as knowledge is useless without a way to handle that knowledge
- Weak methods are in no way inferior to strong methods – they simply do not employ world knowledge

Strong Methods Use Context

Count all the chairs

Strong Methods Use Context

Which one is a car?



Strong Methods Use Context

Are these letters “A” or “H”?

Strong Methods Use Context

Are these letters “A” or “H”?