CSE373: Data Structures and Algorithms

Algorithms and Problem Solving

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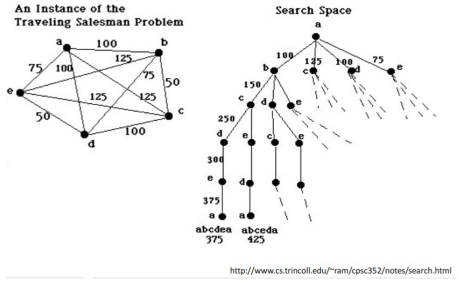
This lecture material represents the work of multiple instructors at the University of Washington. Thank you to all who have contributed!

Types of Problems

- Path-finding
  - Maze-solving, Towers of Hanoi, traveling salesman, etc.
- Strategy finding
  - Game playing
- Decision problems (alternative form of each of the others)
  - "Is this maze solvable?"
  - "Does there exist a TSP tour of cost < k ?"
  - "Can white force a win in 5 moves from this chess position?"
  - "Can you determine which coin in N is fake using only k weighings on a balance scale?"

Problem Instance vs Search Space (Graph of cities vs graph of problem space)



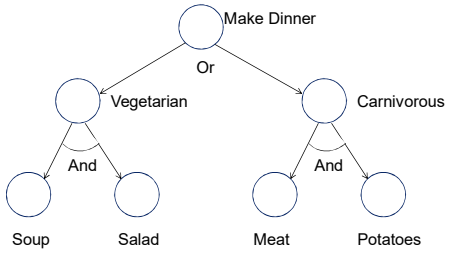
http://www.cs.trincoll.edu/~ram/cpsc352/notes/search.html

Methods for Solving TSP

- Note that TSP is NP-Complete, so solutions could take a long time.
- Backtracking
- Branch-and-Bound (prune the search tree as we go).
- Parallel processing (speedups may be disappointing, if only a few cores are available)
- Genetic search
- Simulated annealing (Surprisingly good solutions to "practical TSP" instances with many cities -- hundreds -- can be found quickly.)

Problem Solving Using AND-OR Graphs

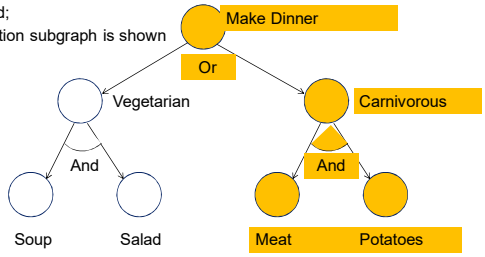
- Overall Problem: Make Dinner



Problem Solving Using AND-OR Graphs

- Overall Problem: Make Dinner

Solved;
a solution subgraph is shown

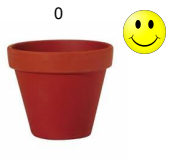


Problem Solving with AND-OR Graphs

- A node is solved if
- (a) It is a leaf and the leaf is solved.
- (b) It is an AND node, and all its children are solved.
- (c) It is an OR node and at least one of its children is solved.

The Game of 21 (variant of Nim)

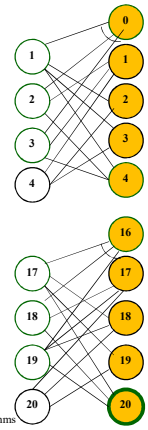
- The pot starts out empty.
- Players take turns adding to the pot, increasing it by either 1, 2 or 3.
- A player who raises the pot to 21 or more loses the game.



AND-OR Graph for 21

Player A's move; **Player B's move**

Player A can force a win by always moving to the next green state: 4, 8, 12, 16, and then 20.
These nodes are AND nodes, because player A can force a win from each of the three descendants of any of these nodes.



Automatic Problem Solving

- Classical artificial intelligence, also known as GOFAI = good old-fashioned A.I.
- Algorithms typically use heuristics to search through the problem space.
- Newer algorithms employ randomness: genetic search, stochastic search, simulated annealing.
- Game-playing systems employ specialized search algorithms (e.g., alpha-beta search), and specialized data structures (Zobrist hashing tables), and pattern recognition (e.g., as in Alpha-GO)
- Consider taking CSE 415 (A.I.) or CSE 190D (Problem Solving).