Backtracking

4-12-2002

Opening Discussion

- What did we talk about last class?
- Do you have any questions about the assignments?

Backtracking

- This method is basically a standard recursive depth-first decent over the possible solutions to a problem. In the worst case it examines all the solutions to a problem and from that it picks the best one as the solution to the optimization.
- The way we often visualize this is as a tree of possible solutions that we are recursing through. The leaves denote solutions.

Knapsack Problems

- Consider a thief who is robbing a store. In the store are a number of items of weight, w_i, and value, v_i. There are two forms of this problem. In the 0/1 knapsack problem each item must be taken as a whole. Alternately the thief could take fractional amounts of each item. In both cases he wants maximum value for a weight W.
- The first is what we are interested in because the second can easily be solved with a greedy algorithm. This can also be solved using Dynamic Programming.

Subset Tree

- The solution tree when we are asked to decide on an optimal subset of a certain set is called a subset tree. This is what the 0/1 knapsack problem requires.
- These are typically exponential in size because each element of the original set is either in the subset or not so the tree branches twice at every level.

Bounding Functions

- The thing that save us is that we can rule out certain paths without traversing all children. Strategies that kill nodes without looking at their children are called bounding functions.
- For the 0/1 knapsack we can kill paths that have more weight than we can carry. What other ways can we kill paths?

Tic-Tac-Toe

- Your book gives the example of a program to find the best moves to make in a Tic-Tac-Toe game.
- Here the first play can be one of 9 moves. The next player gets 8 options and so on. The total number of possible games is 9!.
- In the book the objective is to find paths that help one player win. This way the tree can be pruned using a "minimax" strategy.

Permutation Tree

- When the problem asks for a permutation on a set the solution tree is called a permutation tree and it typically scales factorially.
- This is what we get for the Tic-Tac-Toe problem. It also happens to be the type of solution tree we get for a famous problem called the travelling salesman problem (TSP).

Minute Essay

- Another interesting problem to solve using backtracking is trying to get out of a maze. Describe in English how this might work. Feel free to write pseudocode if you want.
- In theory you should turn in assignment #5 on Monday.