

CS F364

Design & Analysis of Algorithms

ALGORITHMS – DESIGN TECHNIQUES

- Exact Solutions

- Search

- Approach

- Modeling as a Graph problem

SEARCHING FOR SOLUTIONS

- One “algorithmic” approach for solving hard problems is to “search” the solution space:
 1. Characterize “feasible” solutions:
 1. Characterize “feasible” solutions for sub- problems
 2. Construct “feasible” solutions out of “feasible” solutions for sub-problems
 3. Test such “feasible” solutions for “validity” or “acceptability”.

SEARCH – HOW DOES IT WORK?

- Given that it is difficult (or *it is not known how*) to “compute” a solution directly:
- the algorithm is intended to search the space of solutions by ***brute-force***:
 - test all possible solutions one by one;
 - construct larger solutions from smaller solutions by exploring all possible incremental choices

SEARCH MODELED AS A GRAPH PROBLEM

- Solution space can be viewed as a *directed graph*:
 - Vertices are “feasible, partial solutions” (i.e. for sub-problems)
 - An edge leads from one partial solution to another (more constrained solution)
 - Number of edges in a vertex correspond to the number of “choices” available for constructing a feasible solution
- Searching the space for a solution is to traverse the graph until a “valid” solution is found

SEARCH MODELED AS A GRAPH PROBLEM [2]

- Note that although the solution space can be defined it is not a “given”
 - i.e. the solution space (i.e. the solution graph) has to be generated on-the-fly:
 - Start with an initial partial solution (i.e. root vertex)
 - Identify choices that can be made and for each choice generate the next partial solution (i.e. adjacent vertex)

SEARCH MODELED AS A GRAPH PROBLEM - REPRESENTATION

- Observation:
 - If each edge is monotonic (i.e. from a “less constrained” partial solution to a “more constrained” partial solution)
 - then the graph won't have cycles.
- Question:
 - Should the graph be represented as a *tree* or a *DAG*?
- Hints:
 - Do you keep track of visited vertices (i.e. previously seen / examined solutions) ?
 - Do you have sufficient memory to keep track of all visited vertices?

SEARCH MODELED AS GRAPH TRAVERSAL

- If searching the solution space is modeled as graph traversal:
 - what should be the traversal technique used?
- Questions:
 - When is Breadth-First search suitable?
 - When is Depth-First search suitable?
- Graph Traversal requires a “to be expanded” data structure:
 - A queue in the case of BFS
 - A stack in the case of DFS
- If solutions can be weighted (for potential “to lead to good solutions”), then
 - one can choose Best-First-Search i.e.
 - expand the vertex with maximum potential
- Example Problems??