CSci 421
Introduction to Algorithms

Final Study Guide

Final Exam: Monday March 12, 2001

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- Growth rates of functions: o, O, Ω and Θ notation; definitions, limit test.
- Induction and examples of designing algorithms by induction: Horner's rule, maximal induced subgraph, 1-1 mappings, skyline, max consecutive subsequence, max increasing subsequence.
- Dynamic Programming. Postage stamps/making change. Minimum edit distance/string alignment. $0-1$ knapsack.
- Greedy Algorithms
  - Examples where greedy algorithms may fail: $0-1$ knapsack problem, stamps/making change.
  - Greedy algorithms for fractional knapsack problem, and optimal prefix codes (Huffman codes).
- Graph Algorithms
  - Graph definitions: directed-, undirected-, weighted-graph; path, simple path, cycle, simple cycle, connected graph, tree, spanning tree, cut.
  - Minimum spanning tree problem. Characterization of MST in case all edge weights are distinct: the MST is unique; an edge is in the MST iff it is the lightest edge in some cut; an edge is in the MST iff it is not the heaviest edge in any simple cycle. Algorithms for computing a MST.
  - All pairs shortest paths; Floyd-Warshall algorithm. Transitive Closure.
  - Single source shortest paths; Dijkstra algorithm.
  - Depth-first search. Tree-, cross-, forward-, back-edges; DFS numbering.
  - Strongly connected components. Definitions, exits, LOW function.
  - Maximum Flow and matching. Capacity, flow, residual capacity/graph, augmentation, Max Flow/Min Cut Theorem. Integrality Theorem. Ford-Fulkerson and Edmonds-Karp algorithms. Bipartite matching; reduction to flow.
- NP-completeness. P, NP, verification/certificates/witnesses, nondeterminism, reduction, completeness. Example problems: **SAT, 3-SAT**, clique, vertex cover, 0-1 knapsack, partition, coloring, Hamilton cycle, TSP.
- Coping with NP-completeness. Restricted subproblems, exhaustive search, branch-and-bound, guaranteed approximations, heuristics.