Fundamental Techniques

- The greedy method
  - philosophy (greedy choice, substructure property)
  - problems
    - Fractional knapsack
      - algorithm
      - run-time
    - Task scheduling
      - algorithm
      - run-time

- Divide & Conquer
  - philosophy (divide, recur, conquer)
  - problems
    - Merge Sort
      - algorithm
      - run-time
    - Integer Multiplication
      - algorithm
      - runtime
    - recurrence equations and master theorem

- Dynamic programming
  - philosophy (subproblem optimality) (bottom-up)
    - define subproblems
    - show subproblem optimality
    - express solution to a larger problem through solutions to smaller problems
    - recurrence formula
    - implementation
  - problems
  - 0/1 knapsack problem
    - solution and algorithm
    - complexity
  - matrix chain multiplication
    - solution and algorithm
    - complexity
Directed graphs

- Definitions
  - in-degree, out-degree, directed path, reachability, directed cycle, DAGs, strong connectivity
- Representation
  - \( s \rightarrow (\text{in-degree}) \)
  - \( s \rightarrow (\text{outgoing edges}) \)
- Directed DFS (complexity)
  - strong connectivity algorithm (complexity)
- Transitive closure
  - definition
  - algorithm (Floyd-Warshall)
    - running time
- DAGs and topological sorting
  - any topological sorting algorithm
    - (one by one, DFS)
  - running time

Weighted graphs

- Shortest path problem formulation
- Shortest path tree and Dijkstra's algorithm
  - algorithm
  - complexity
  - applicability (no neg. edges)
- Bellman-Ford algorithm
  - algorithm
  - complexity
  - applicability (neg. edges-ok, negcycles-no)
- Shortest path in DAGs and linear time algorithm
  - algorithm (uses topological sorting)
  - applicability (neg. edges-ok)
  - all pairs shortest path (Floyd-Warshall)
Minimum Spanning Trees

- Definitions
  - Prim-Jarnik's algorithm
    - algorithm
    - complexity
    - properties behind the correctness (partition property) (cycle property)
  - Kruskal's Algorithm
    - algorithm (diff. from P-Y. approach)
    - data structure and implementation (find, union)
    - complexity

- Boruvka's Algorithm

Maximum Flow

- Definitions (edge capacity, flow network, source, sink, flow, cut, flow over cut, cap. of a cut)
- Maximum Flow problem formulation
- Flow augmentation
  - augmenting path
- Ford-Fulkerson's algorithm
  - be able to apply/use
  - complexity
- Max-Flow and Min-Cut Theorem

String Matching

- def. (string, substring, prefix, suffix)
- Problem formulation
- Brute-Force alg.
  - algorithm
  - complexity
- Knuth-Morris-Pratt's alg.
  - algorithm (be able to use)
  - Failure function (no details of content)
  - complexity
- Boyer-Moore algorithm
  - algorithm
  - cost of occurrence function (run time to build)
  - run time of the BM algorithm