Reading: Chapters 1-6

Problems and Algorithms

- Stable Marriage
  - Men Propose
  - $O(n^2)$
- interval scheduling
  - greedy by finish time
  - $O(n \log n)$
- MST
  - Kruskal (greedy by value)
  - Prim (like Dijkstra)
  - $O(m \log n)$
- weighted matroid
  - greedy by value
  - $O(n \log n)$ usually
- shortest paths
  - Dijkstra
  - $O(m \log n)$
- sorting
  - mergesort
  - $O(n \log n)$
- exponentiation
  - repeated squaring
  - $O(n)$ ($n = \# \text{ bits}$)
- integer multiply
  - D&C alg
  - $O(n^{\log_2^3})$
- convolution, poly mult
  - FFT based alg.
  - $O(n \log n)$
- weighted interval scheduling
  - DP
  - $O(n \log n)$
- integer knapsack
  - DP
  - $O(n \mathcal{C})$
Techniques

• greedy
  • runtime: by progress.
  • correctness: greedy stays ahead or greedy is optimal.

• divide and conquer
  • correctness: by induction.
  • runtime: by recurrences
  • subproblems form tree

• dynamic programming
  • correctness: by induction.
  • runtime: count subproblems (size of memoization table \times cost to combine)
  • subproblems form DAG.

Algorithm Design Flow Chart

[model problem]  
|  
|  
<does greedy work>--------------/
|  
| no yes
|  
| [find subproblem] |
|  
|  
| indep | dep |
|  
| [divide & conquer] [dynamic prog] |
|  
|  
| \ | / |  
\ | / |--->[problem solved]<--/