Topic Ω: Course Overview

CPS 230, Fall 2001

Reminder of tools, topics we have covered:

- Asymptotic notation for representations, running times
- Analysis frameworks: Worst-case, best-case, average-case, probabilistic (randomized), amortized
- Divide-and-Conquer paradigm (Strassen's algorithm, quicksort, merge sort)
- Solving recurrences (small cases, substitution (guess and prove by induction), iteration, Master method)
- Comparison-based sorting—insertion, merge, quick
- Lower bounds and adversaries
- Linear-time sorting—counting, bucket, radix
- Linear-time median finding and order statistics
- Dynamic data structures: binary search trees, red-black trees, splay trees, B-trees, heaps, union-find

- Hashing, universal hashing
- Dynamic programming
- Greedy algorithms:
  when locally optimal $\Longrightarrow$ globally optimal
  (e.g., Huffman codes, Prim's algorithm for MST, Kruskal's algorithm for MST)
- Amortization: cost of *sequences* of operations
  (e.g., splay trees)
- External memory algorithms—need to build locality into algorithms since data transfer is done via large contiguous blocks (e.g., distribution paradigm, merge paradigm, B-trees)
- Single-source shortest paths (Dijsktra, Bellman-Ford)
- All-pairs shortest paths as matrix multiplication or repeated squaring (Floyd-Warshall)
- P, NP, and NP-Completeness!
- Approximation algorithms (vertex cover, traveling salesperson)—WILL NOT BE ON FINAL

Themes

Techniques:

- Divide-and-Conquer, greedy, dynamic programming
- Lazy algorithms (for good amortized performance or for batched dynamic external memory algorithms)
- Adversary for lower bounds
- Invariants (correctness, efficiency!)
- Approximation algorithms

Transformation and reuse:

- Heaps/sorting; Prim/Dijkstra, all pairs shortest paths
- Data structure augmentation (R-B)
- Tabulating and reusing solutions (Dynamic Programming)
- Duality (merge/distribution)
- NP-completeness (reduction arguments)
  $L' \leq_{\mathrm{P}} L$ means that L is at least as hard as L', up to a polynomial factor in the running time.

Thank you, and good luck!