Final Review
OUR FIELD HAS BEEN STRUGGLING WITH THIS PROBLEM FOR YEARS.

STRUGGLE NO MORE! I'M HERE TO SOLVE IT WITH ALGORITHMS!

SIX MONTHS LATER:
WOW, THIS PROBLEM IS REALLY HARD.
YOU DON'T SAY.
Final Exam Coverage

Comprehensive, all topics covered
(but with post-midterm bias)
assigned reading
slides
homework & solutions
midterm review slides still relevant, plus those below
Design Paradigms

Greedy
emphasis on correctness arguments, e.g. stay ahead, structural characterizations, exchange arguments

Divide & Conquer
recursive solution, superlinear work, balanced subproblems, recurrence relations, solutions, Master Theorem

Dynamic Programming
recursive solution, redundant subproblems, few do all in careful order and tabulate; OPT table (usually far superior to “memoization”)
Examples

Dynamic programming
  Fibonacci
  Making change/Stamps, Knapsack
  Weighted Interval Scheduling
  RNA
  String Alignment
Examples & Concepts

Flow and matching
- Residual graph, augmenting paths, max-flow/min-cut, Ford-Fulkerson and Edmonds-Karp algorithms, (preflow-push), integrality,

reductions to flow
- e.g. bipartite matching, “baseball elimination”
Complexity, II

P vs NP

Big-O and poly vs exponential growth
Definition of NP – hints/certificates and verifiers
Example problems from slides, reading & hw
  SAT, 3-SAT, circuit SAT, vertex cover, quadratic Diophantine equations, clique, independent set, TSP, Hamilton cycle, coloring, max cut, knapsack

P ⊆ NP ⊆ Exp (and worse)
Reduction, incl. definition(s) of (polynomial time) reduction
SAT ≤_p e.g., IndpSet, Knap, Ham, 3color: how, correctness, ≤_p, implications
Definition of NP-completeness
NP-completeness proofs
2x, 1.5x approximations to Euclidean TSP
We prove NP-hardness results for five of Nintendo’s largest video game franchises: Mario, Donkey Kong, Legend of Zelda, Metroid, and Pokémon. Our results apply to Super Mario Bros. 1, 3, Lost Levels, and Super Mario World; Donkey Kong Country 1–3; all Legend of Zelda games except Zelda II: The Adventure of Link; all Metroid games; and all Pokémon role-playing games. For Mario and Donkey Kong, we show NP-completeness. In addition, we observe that several games in the Zelda series are PSPACE-complete.
Final Exam Mechanics

Closed book, 1 pg notes (8.5x11, 2 sides, handwritten)

(no bluebook needed; scratch paper may be handy; calculators probably probably unnecessary)

Comprehensive: All topics covered

assigned reading

slides

homework & solutions
Some Typical Exam Questions

Give $O(\cdot)$ bound on $17n^*(n-3+\log n)$, or on code \{\text{for } i=1 \ldots \}\}

True/False: If $X$ is $O(n^2)$, then it’s rarely more than $n^3 + 14$ steps.

Explain why a given greedy alg is/isn’t correct

Give a run time recurrence for a recursive alg, or solve a simple one

Simulate any of the algs we’ve studied

Give an alg for problem X, maybe a variant of one we’ve studied, or prove it’s in NP

Understand parts of correctness proof for an algorithm or reduction

Implications of NP-completeness

Reductions

NP-completeness proofs
Good Luck!

(And please take a minute to fill out the online course evaluation.)