Honors Algorithms
Alan Siegel

We also cover the first 3.5 chapters from *Intro. to Theory of Computation* by Sipser, and the first 2.5 chapters from *A Guide to the Theory of NP-Completeness* by Garey and Johnson.

Topics

Recurrence equations
The general theory of first order difference equations and some methods for second order linear difference equations.

Sorting
Standard sorting algorithms with fairly detailed analyses. Includes Paige-Tarjan Lexicographic Sorting with applications.

Search and Advanced Data Structures
Heaps, Fibonacci heaps, Enhanced Dictionaries, Universal Hashing, Union-Find (limited analysis only), Prioritized Search Trees, Splay Trees (if time permits).

Adaptive BFS and Path Algorithms
Shortest Path (Floyd-Warshall, Dijkstra), path recovery, problem reductions and transformations. Includes an advanced study of applications such as VLSI switch-level simulation, and methods to adapt these basic algorithms to a wide variety of different problems.
MST (Prim, Kruskal).

DFS (Connectivity, Biconnectivity, and Strong Connectivity)
Tarjan’s algorithms, Sharir’s Strong Connectivity Algorithm. Includes a detailed analysis of the design decisions that went into these algorithms.

Lower Bounds
We present four basic lower bounds, but cover the issues by example as opposed to a systematic development of the subject.

Algorithmic paradigms and applications
Dynamic Programming, Greedy algorithms, Divide-and-Conquer, Backtracking (if time permits). Illustrative examples and applications.

Randomization
Hashing, polynomial identity testing (if time permits).

NP-Completeness
Roughly the first 2.5 chapters of Garey and Johnson, but with less emphasis on Cooke’s Theorem but a little more on reduction methods.

Finite automata and regular language (Sipser) (ch 1), PDA’s and CFLs (ch 2), Decidability (ch 3-4).

Homework
Homework will be assigned every week. Over the course of the semester, about 150 problems are assigned, and more than half will be quite challenging.