CS616 – Design and Analysis of Algorithms – Syllabus
University of Virginia
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Course description (from the graduate catalog): Analyzes concepts in algorithm design, problem solving strategies, proof techniques, complexity analysis, upper and lower bounds, sorting and searching, graph algorithms, geometric algorithms, probabilistic algorithms, intractability and NP-completeness, transformations, and approximation algorithms.

Special emphasis will be placed on problem solving, unifying ideas, proof techniques, the “scientific method”, as well as striving for elegance, insights, and generalizability in developing algorithms and proofs.

Prerequisites: Discrete mathematics, and undergraduate algorithms course or equivalent


Supplemental reading: “How to Solve It”, by George Polya, Princeton University Press

Selected papers at: http://www.cs.virginia.edu/~robins/CS_readings.html

Office hours: Tues & Thur 6:15-7:45pm (after every class lecture), and other times by appointment
Also Email Q&A, and a running course-related blog

Class structure: two exams (midterm and final), several problem sets, with problems taken from the textbook and other sources, and a term project (involving implementing and demoing some algorithms and/or related concepts and ideas). Extra credit will be given throughout the semester for solving challenging problems.

We will cover as many selected topics from the following list as time permits:

Fundamentals:
• Review of asymptotics
• Review of basic data structures
• Review of basic algorithms

Sorting and searching:
• Review of classical sorting
• Interpolation Search
• Specialized sorting methods
• Deterministic Kth selection
• Lower bounds on max & min
• Majority detection
• Meta algorithms

Advanced data structures:
• Skip lists
• Amortized analysis
• Fibonacci heaps
• Perfect hashing, cuckoo hashing

Graph algorithms:
• Lowest common ancestor
• Minimum spanning trees
• Shortest paths trees
• Radius-cost tradeoffs
• Steiner trees
• Minimum matchings
• Network flows
• Degree-constrained trees

Numerical algorithms:
• Linear programming
• Matrix multiplication
• Karatsuba’s algorithm

Distributed algorithms:
• Distributed models
• Asynchronous consensus impossibility
• Leader election in a ring
• Leader election in graphs
• Distributed MSTs
Computational geometry:
- Lower bounds
- Chan's convex hull algorithm
- Segment intersection
- Planar subdivision search
- Voronoi diagrams
- Nearest neighbors
- Geometric minimum spanning trees
- Delaunay triangulations
- Minimum density trees
- Minimum bounding box
- Distance between convex polygons
- Smallest Enclosing Circle
- Triangulation of polygons
- Collinear subsets
- Probabilistic analysis

String matching:
- Knuth-Morris-Pratt
- Boyer-Moore
- Edit distance
- Longest increasing subsequence
- Smith-Waterman algorithm

NP-completeness:
- Polynomial time and intractability
- Space and time complexity
- Problem reductions
- NP-completeness of satisfiability
- Independent sets
- Graph colorability
- Travelling salesperson problem
- Approximation heuristics