Tentative Syllabus

The following is a tentative logically-ordered syllabus for EC504. The actual material covered may be a subset or superset of this syllabus, depending on class progress and makeup, and will likely follow a different order. Please see the CourseSchedule topic for an updated schedule of course topics.

I. Fundamentals
   o Software
      ■ Java Language basics
         ■ Object-orientation
         ■ Exceptions
         ■ Generics, collections
         ■ Threads, concurrency, events
         ■ Lambdas (closures), annotations, reflection
      ■ engineering
         ■ version control
         ■ peer review
         ■ agile development
   ■ Applications
      ■ networking
      ■ databases
      ■ graphics
      ■ Android
   o Analysis
      ■ Recurrences
         ■ Asymptotic notation
            ■ $O, \Omega, \Theta, o, \omega$
            ■ limits, properties, limitations
         ■ Master method
         ■ Annihilators
      ■ Approaches
         ■ Worst case
- Best case
- Expected case
  - Probability
    - Distributions
    - Expected value
  - Chernoff bounds
- Amortized
- Core algorithms
  - Selection
    - linear-time
    - randomized
  - Sorting
    - information theoretic bounds
    - comparison-based
      - insertion, selection, bubble, merge, heap, quick
    - non-comparison
      - counting, bucket, radix
- Core data structures
  - stacks
  - queues
  - linked lists
  - binary search tree
  - binary heap

II. Containers
- Balanced search trees
  - randomized
  - rotation-based
    - AVL, Red-black
  - misc
    - B-trees, B+-trees
    - Splay trees
- Priority queues
  - heaps: Binomial and Fibonacci
  - leftist, treaps
- Hash-based structures
  - hashmap
    - chaining
    - Simple Uniform Hashing
  - open Addressing
    - load factor
      - Expected analysis
    - probing
hash chains
• applications
  • Bloom filters
  • cryptocurrency

III. Graphs and Networks
• Representations
• Traversals
  • breadth first
  • depth first search
  • constrained
• Minimum spanning trees and routing
• Shortest paths
  • Single-source
  • All pairs
• Disjoint-set data structures
  • Relaxation
  • Specialized graphs
• Minimum Flow
• Linear algebra
  • eigenvalues/eigenvectors
  • exponentiation
• Applications
  • networking
  • data reconciliation

IV. Miscellaneous
• Query processing
  • String search
    • Finite automata, KMP, Boyer-Moore
    • Regular expressions
  • SQL and query algebra
  • join strategies, concurrency
  • substring alignment
• Optimization
  • Dynamic Programming
    • Optimal substructure
    • Integer Knapsack
    • Edit distance * “Big data”
    • Map-reduce
    • Linear programming
    • FFT
    • Optimization
• Parallelization
- multi-threaded models
- Computational complexity
  - Turing machines
  - NP completeness and reductions
  - Approximations
  - Complexity classes
- Security and number theory
  - Rainbow tables
  - RSA encryption and challenges
  - Elliptic curve cryptography
- Computational geometry and graphics
  - Line segment intersection
  - Convex hull