Final Study Guide

The final exam will be cumulative and any may include any material from lectures/assignments/quizzes from the entire semester. The following list of topics outline all material after the midterm. For a list of topics from before the midterm, see the 'Midterm Topics List'

- **Algorithms**
  - Linear search/binary search
  - Bubble sort/insertion sort
  - Greedy algorithms
  - $\mathcal{O}, \Omega, \Theta$ notation
  - Complexity of matrix operations
    - Matrix-matrix addition
    - Mat-vec multiplication
    - Matrix-matrix multiplication
- **Number theory**
  - divisibility ($a \mid b$)
  - The division algorithm
  - Congruence modulo m
  - Fast modular exponentiation (using binary representation of exponent)
  - prime vs composite
  - Fundamental theorem of arithmetic
  - trial division
  - prime sieve of Eratosthenes
  - gcd
  - Euclidean algorithm
  - Solving linear congruences
  - inverse of a mod m
  - Bezout's theorem
  - Solving systems of linear congruences
    - Back substitution
    - Chinese remainder theorem
  - Fermat's little theorem
  - Encryption/decryption
    - Shift/Caesar cipher
    - Affine cipher
    - RSA
- **Recursion**
  - recursive sequences
  - recursive functions
  - recursive sets

  - recursive factorial algorithm

- **Combinatorics**
  - The product rule/sum rule
  - Pigeonhole principle (generalized)
  - permutations/combinations
    - w/ and w/out repetition
  - Binomial theorem

- **Probability**
  - experiment, sample space, event
  - definition of discrete probability in terms of cardinalities
  - probabilities of complements and unions of events
  - probability distributions
  - uniform distribution
  - conditional probabilities
  - Bayes' theorem
  - Law of total probability

- **Recurrences**
  - Solving counting problems with recurrences
  - linear homogeneous recurrence relations
  - characteristic polynomial
  - Nonhomogeneous recurrences

- **Relations**
  - relations as graphs
  - reflexive, symmetric, transitive
  - equivalence relations
  - equivalence classes

- **Graph theory**
  - directed/undirected graphs
  - adjacency list/adjacency matrix
  - degree sequence
  - the handshake theorem
  - in/out degrees
  - walks/paths/Eulerian tours
  - disconnectedness/connectedness
  - connected components
  - strongly/weakly connected
  - graph coloring
  - bipartite graphs
  - chromatic number of a graph
  - greedy coloring theorem
  - 4 color theorem