CS3340 Analysis of Algorithms

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• **Textbook:**

  Introduction to Algorithms (third edition, 2009)
  T.H. Cormen, C.E. Leiserson, R.L. Rivest, and C. Stein,
  
  Algorithm Design and Application (2014)
  by M.T. Goodrich and R. Tamassia

• **Assignments:**

  3 assignments, 10 % each
  all three will involve some programming
  use Java, Python, or C++
  should be independent work

• **Examinations:**

  Midterm Exam, 25%
  Final Exam, 45%
  close-book exams
Goals of the course

• Survey important data structures and algorithms to help us design efficient programs (software)
• Introduce mathematical techniques for the analysis of algorithms
• Concentrate on the logical process that leads to the creation of the algorithm, rather than the algorithm itself
• The techniques for evaluating the performance of algorithms would be useful in this process
• The idea is that Computer Science is more than mere recipes; it is about computational thinking
Synopsis

- **Algorithms**: precisely stated general problem-solving methods suitable for computer implementation

- **Data structures**: methods of organizing data involved in computation

- They are central objects of study in computer science

- They go hand-in-hand: neither can be studied fruitfully without knowledge of the other
World of algorithms

• Sequential algorithms

• Parallel algorithms:
  many computers or processes working concurrently
    - synchronously: all computers working together to solve a problem such as sorting
    - asynchronously: computers working independently usually on a network (distributed database systems)

• Randomizing algorithms:
  flip a coin, use outcome wisely

• Approximation algorithms:
  find good approximation in polynomial time
(... continued)

- Computational geometry:
  very useful for robotics

- Computational biology algorithms:
  solving molecular biology problems with computational methods

- Genetic algorithms:
  use mutation, splicing and other genetic principles for optimization

- DNA computing algorithms:
  used for computation by solely manipulating DNA strands

- etc.
Topics

• Induction, order of magnitude, solving recurrence relations.
• Binary trees. Basic set operations (search, insert, delete, intersection, union). Heaps.
• red-and-black trees: simplest B-tree.
• Sorting. Various sorting methods: quicksort, mergesort, heapsort, etc. Lower bounds on sorting. Selection.
• String matching and sequence comparison. Huffman coding.
• Union-find.
• Graph algorithms:
  depth-first search, cycles, topological sort, shortest paths, transitive closure, spanning trees, connected components, maximum flow.
(... continued)

- Algorithms design techniques:
  divide-and-conquer, dynamic programming, analysis of recurrences
- NP-completeness
- Parallel algorithms