CS3340 Analysis of Algorithms

Instructor: Dr. Kaizhong Zhang
Office: MC 372
Telephone: Ext. 83826
Course Email: cs3340b<at>uwo.ca
Home Page: owl.uwo.ca/portal and www.csd.uwo.ca/courses/CS3340b/
• **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, 8 % each  
  all three will involve some programming  
  use Java, Python, or C++  
  should be independent work  

• **Examinations:**

  Midterm Exam, 31%  
  Final Exam, 45%  
  Closed book exams, allowing one 8.5x11 information sheet
• Late penalty and Self-reported Absence:

+ The late penalty percentage: \( \text{round}(2^{(\text{days}+1)/5}) \times 5 \)

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+ Self-reported absence:
  – In Assignment Submission Form,
    State clearly the two days requested
    Include a text copy of the email from UWO
  – Do not need to contact instructor
  – Will not reply inquiry
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