CS 520 - Advanced Analysis of Algorithms

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1 General Information

1. Meeting Times: Tu-Th, 9:30 am $-$ 10:45 am
   Location: 251, ESB-E.
2. Contact Information: 749 ESB, k.subramani@mail.wvu.edu.
3. Office Hours: By appointment.
4. Textbook - [NN09] is the official course textbook. Additionally, I recommend [CLRS09] as an excellent reference.
5. URL - `http://www.csee.wvu.edu/~ksmani/courses/fa13/gaoa/gaoa.html`.
6. Assessment:
   (a) Homework Assignments (4) - There will be four homework assignments, as per the following schedule:

Assignment Date	Submission Date
09/05	09/12
09/26	10/03
10/29	11/05
12/01	12/10

Table 1: Homework Schedule

   Each homework is worth 20% (for a total of 80%) of your grade.
   (b) Final - The final will be held on December 17 (in-class, closed book, $11:00$ am $-$ $1:00$ pm) and is worth 20% of your grade.
   (c) A maximum of 5 bonus points will be awarded for class performance
7. Grade Boundaries
   (a) **A**: 80 and up
   (b) **B**: $65-79$
   (c) **C**: $50-64$
   (d) **D**: $45-49$
   (e) **F**: $0-44$
8. Grading policy - If you have any questions about the grading, you must contact the intructor within two days of your paper being returned.
9. Makeup Policy - If for some reason, you are unable to attend a test or an exam, please meet me at the earliest and I will set an alternate date.

10. **Course Objectives** - The objectives of this course are as follows:
    (a) Introduce rigorous algorithmic analysis at the graduate level.
    (b) Develop basic design paradigms such as Divide-And-Conquer, Greedy and Dynamic Programming.
    (c) Develop advanced design paradigms such as Backtracking and Branch-And-Bound.
    (d) Introduce the theory of **NP-completeness**.
11. **Learning Outcomes** - Upon successful completion of this course, students will be able to:
    (a) Rigorously apply order metrics to computational problems.
    (b) Design an algorithm for a problem and analyze its resource complexity.
    (c) Distinguish between Branch-And-Bound and Backtracking.
    (d) Identify the possibility of intractability for a given problem.

2 Syllabus Sketch and Weekly Schedule

2.1 Algorithmic Mathematics

Notation, Functions, Mathematical Induction, Theorems and Lemmas, Logarithms, Sets, Permutations and Combinations, Probability and Randomness. These topics will be covered from [CLRS09] and Appendix A and B of [NN09] (4 Lectures).

2.2 Algorithms: Efficiency, Analysis and Order

Importance of Efficiency, Analysis (including loop invariants), Order. These topics will be covered from Chapter 1 of [NN09] (3 Lectures).

2.3 Divide-and-Conquer

Solving Recurrences, Binary Search, Mergesort, Quicksort, Integer Multiplication, Strassen's Matrix Multiplication Algorithm, When not to use Divide-and-Conquer. These topics will be covered from Appendix B and Chapter 2 of [NN09] (5 Lectures).

2.4 Dynamic Programming

The Binomial Coefficient, Floyd's algorithm for Shortest Paths, Dynamic Programming and Optimization problems, Chained Matrix Multiplication, Optimal Binary Search Trees, The Traveling Salesman problem. These topics will be covered from Chapter 3 of [NN09] (5 Lectures).

2.5 The Greedy Approach

Minimum Spanning Trees, Single-Source Shortest Path Trees, Scheduling, Huffman codes, Greedy versus Dynamic Programming. These topics will be covered from Chapter 4 of [NN09] (5 Lectures).

2.6 Backtracking

The backtracking technique, The n-Queens problem, The Sum-of-Subsets problem, Graph coloring, Hamilton Circuit problem, Backtracking for Knapsack. These topics will be covered from Chapter 5 of [NN09] (3 Lectures).

2.7 Branch-and-Bound

Branch-and-bound for Knapsack, The Traveling Salesman Problem. These topics will be covered from Chapter 6 of [NN09] (2 Lectures).

2.8 Computational Complexity and Intractability

Intractability, Three problem paradigms, The theory of **NP**, Handling **NP-Hard** problems. These topics will be covered from Chapter 9 of [NN09] (6 Lectures) .

I would like to reiterate that the above enumeration is a sketch of topics that I intend to cover. Due to various reasons, certain topics may be dropped or added. In such cases, advance notice will be given.

3 Inclusivity Statement

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Accessibility Services (293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see http://diversity.wvu.edu.

References

[CLRS09] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. *Introduction to Algorithms*. The MIT Press, Cambridge, MA, 3rd edition, 2009.

[NN09] Richard Neapolitan and Kumarss Naimipour. *Foundations of Algorithms Using C++ Pseudocode*. Jones and Bartlett, 2009.