CSCI 364 – Fall 2008
Foundations of Computing

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Course Description

This course considers questions related to the categorization of problems. We will begin with a consideration of problems that cannot be solved efficiently, and we will study techniques to compute approximate solutions for these problems plus measures of the effectiveness of these solutions.

In the remainder of the course, we will study the formal connection between problems and languages. We will see how to describe each type of language using appropriate grammars, define the machine required to process each type of language, and consider their limitations. Ultimately, we will see problems that cannot be solved by any computer.

Course Goals

Upon completion of this course, a successful student will be able to:

- Identify NP-Complete problems and design appropriate approximation algorithms.
- Describe the hierarchy of languages and give an example in each category.

Required Text

- *Introduction to Languages and the Theory of Computation* Third Edition by John Martin

Graded Material

- **Homework** – The goal of homework problems is for you to explore the current content of the course. Most assignments will consist of pencil-and-paper type problems and will be due at the next class session. Occasionally, problems requiring programming will be assigned, and you will be given additional time to complete these assignments. Homework problems will always be discussed in class they day they are due, and therefore will not be accepted late. Grades for homework will be on a three point scale: 3 indicates that you solved the problem, 2 means that you made significant progress, 1 says that you attempted the problem, and 0 means that you did no work for the problem. Because this grading system is new, we will determine the mapping of average scores to final homework grades after a few assignments have been returned.

- **Research Project** – During the third week of the term, each student will select a problem to consider for the remainder of the semester. I will provide a list of potential problems, or you may select one of your own – subject to my approval. The problem will form the basis of the research project where you will consider approximation algorithms for the problem.

  For this project, there will be two separate presentations. On Friday, October 3, each student will present a 10 to 15 minute talk about their problem and their proposed approximation scheme. Final presentations of your results will be given on Monday, December 8 and Wednesday, December 10 and should be 30 minutes in length. We will discuss further details of each presentation as they approach.

  Your final work will also be written up in a 3 to 5 page single-spaced document written in the style of a traditional computer science research paper. I will give you examples of such papers as well as further instructions later in the semester.

- **Tests** – Two tests will be given during the semester. The in-class portion of each test will be administered on Wednesday, October 8 and Monday, November 17, and the take-home portion will be due a week later.

- **Final** – The final exam will be cumulative, and will be administered orally. You will schedule a mutually agreeable time to meet with me in my office *during or before* the final exam time scheduled by the registrar.

Grade Determination

- (40%) Homework
- Project
  - (5%) Presentation #1
  - (10%) Presentation #2
  - (15%) Final Paper
- (20%) Tests
- (10%) Final

Responsibilities

Your attendance is expected at each class meeting. You are also responsible for the contents of reading assignments, handouts, class activities, and class email.

If you have a disability that may affect your participation in this course, please contact me immediately to discuss academic accommodations.

Academic Honesty

Other than on tests, I *encourage* you to discuss the material and work with other students. Although this policy also applies for the project, it is specifically meant for homework assignments. Talking through your thinking on theoretical problems helps you get you past places you

are stuck. This policy does not allow you to copy another student's work verbatim – you must produce your own code or write-up of the material. Work together to learn the concepts, but keep in mind that you are ultimately responsible for the material on the tests.

Course Outline

Date	Reading(s)	Topic(s)
M Aug 25		• Day 1 Activities
W Aug 27	• Chapter 1	• Basic Mathematical Objects
F Aug 29	• Section 2.1	• Basic Proof Techniques
M Sept 1		• Labor Day
W Sept 3	• Sections 2.2 and 2.3	• Inductive Proofs
F Sept 5	• Sections 2.4 and 2.5	• Recursive Definitions and Structural Induction
M Sept 8	• Garey and Johnson / Knuth	• Introduction to NP-Completeness / Generating Tuples and Permutations
W Sept 10		• Project Introduction
F Sept 12	• CLR Chapter 34 Intro and Section 34.1	• Polynomial Time
M Sept 15	• CLR Sections 34.2 and 34.3	• Defining NP
W Sept 17	• CLR Section 34.4	• NP-Completeness Proofs
F Sept 19	• CLR 34.5	• NP-Completeness Proof Examples
M Sept 22	• CLR Chapter 35 Intro and Section 35.1	• Approximation Algorithms and Competitive Analysis
W Sept 24	• CLR Section 35.2	• Approximation of the Traveling Salesman Problem
F Sept 26	• TBD	• Other Approximation Techniques
M Sept 29		• Presentation Overview and Example
W Oct 1		• NP-Completeness Wrap-Up
F Oct 3		• Presentations
M Oct 6		• Fall Break
W Oct 8		• Test #1
F Oct 12		• No class - CCSC conference
M Oct 13	• Sections 3.1 through 3.3	• Regular Expressions and Finite Automata
W Oct 15	• Sections 3.4 and 3.5	• Properties of Finite Automata

Date	Reading(s)	Topic(s)
F Oct 17		• Finite Automata Wrap-Up
M Oct 20	• Section 4.1	• Non-Deterministic Finite Automata
W Oct 22	• 4.2	• Non-Deterministic Finite Automata
F Oct 24	• Section 4.3	• Kleene's Theorem
M Oct 27		• NFA Wrap-Up and Project Updates
W Oct 29	• Sections 5.1 and 5.3	• Pumping Lemma for Regular Languages
F Oct 31	• Sections 5.4 and 5.5	• Regular Language Problems
M Nov 3	• Sections 6.1 and 6.2	• Context-Free Grammars
W Nov 5	• Sections 7.1 and 7.3	• Push-Down Automata
F Nov 7	• Section 7.4	• PDA to CFG conversions
M Nov 10	• Section 7.5	• CFG to PDA conversions
W Nov 12	• Section 8.1	• Pumping Lemma for Context-Free Languages
F Nov 14	• Sections 8.2 and 8.3	• Context-Free Language Problems
M Nov 17		• Test #2
W Nov 19	• Sections 9.1 and 9.2	• Turing Machines
F Nov 21	• Sections 9.3 and 9.4	• Combining Turing Machines and Alternative Models
M Nov 17	• Sections 9.5 through 9.7	• Non-Deterministic and Universal Turning Machines
W Nov 26 - F Nov 28		• Thanksgiving Break
M Dec 1	• Sections 11.1 and 11.2	• Unsolvable Problems
W Dec 3	• Section 11.3	• Turning Machine Problem Reductions
F Dec 5	• Sections 11.5 and 11.6	• Post's Correspondence Problem
M Dec 8		• Final Presentations
W Dec 10		• Final Presentations
F Dec 12		• Review

The details of this syllabus and schedule are subject to change based on our progress through the material.