IE 496: Computational Methods in Optimization
Syllabus

Dr. Ted Ralphs

Spring 2012

1 Miscellaneous Course Information

Instructor:	Dr. Ted Ralphs
Office:	473 Mohler Lab
Phone:	8-4784
E-mail:	ted@lehigh.edu
Office Hour:	TR 11:00-12:00 or by appointment
Web page:	http://coral.ie.lehigh.edu/~ted
Course web page:	http://coral.ie.lehigh.edu/~ted/teaching/ie496/
Course meeting time:	TR 5:45-7:00

2 Description of Course

This course will cover a wide range of topics related to the computational methods encountered in operation research applications. The lectures will focus primarily on the theoretical aspects of computation, but with the goal of understanding computation in practice. Assigned exercises will focus on employing the computational methods discussed in class to in real-world applications. Topical coverage will include data structures, design and analysis of algorithms (sequential and parallel), programming paradigms and languages, development tools and environments, numerical analysis, and matrix computations.

3 Course Objectives

The goals of this course are for students to:

1. Understand basic models of computation and how to use them to analyze the efficiency of algorithms.
2. Understand the fundamentals of how a computer's architecture affects the performance of an algorithms.
3. Understand basic programming paradigms and the tools for implementations using these paradigms.

4. Understand the data structures that are typically used in optimization algorithms.

5. Learn to use basic programming environments and tools.

4 General Course Requirements

4.1 Prerequisites

All students should have a good undergraduate mathematics background, especially linear algebra, and have had at least one course in programming. Knowledge of C++ and/or Python will be a plus. I expect some familiarity with logic and proof techniques, as well as basic knowledge of mathematical modeling and modeling languages.

4.2 Text and Readings

There will be no textbook for the class. However, there will be required readings associated with each lecture. Most readings will be from a number of different textbooks we'll be referring to and will be made available in PDF format, but there will also be some reading of research papers and articles on the Web. Students are encouraged to seek supplementary material. Links to suggested supplementary reading material can be accessed from the course page.

4.3 Lectures

You are expected to attend and participate in the lectures. Part of the grade will be determined by overall class participation. Lecture materials will be available for reference before the lecture on the course web page.

4.4 Assignments

There will be problem sets due approximately every 2 weeks. Students are encouraged to work together, but each student should write up his/her solutions independently.

4.5 Exams and Projects

There will be no formal exams, but there will be a final project.

5 Course Timeline

The following timelines are subject to change.

5.1 Schedule of Homeworks and Quizzes

Homework/Exam	Date
Homework #1	January 26
Homework #2	February 9
Homework #3	February 23
Homework #4	March 15
Homework #5	March 29
Homework #6	April 12
Final Project	May 4

5.2 Blocks

Block 1: Fundamentals. We discuss the fundamentals of computer architecture and how we model it for the purposes of analysis.

Block 2: Analysis of Algorithms. We describe how to use models of computation to assess the efficiency of algorithms.

Block 3: Programming. We discuss programming paradigms, what languages are available and how they compare, the role of compilers, and communication protocols for parallel computation.

Block 4: Data Structures. We discuss basic data structures, their analysis, and their role in implementing algorithms.

Block 5: Combinatorial Algorithms. We discuss the implementation of combinatorial algorithms arising in optimization applications.

Block 6: Numerical Algorithms. We discuss the implementation of numerical algorithms.

5.3 Tentative Schedule of Topics

Lecture	Block	Topic
1	Fundamentals	Computer Architectures
2		Laguages and Compilers
3		Models of Computation
4		Complexity Analysis
5	Analysis of Algorithm	Induction and Recursion
6		Synthesis
7		Analyzing Parallel Algorithms
8		Parallel Algorithm Design
9		Programming Paradigms
10		Profiling and Debugging
11	Data Structures	Lists, Stacks, and Queues
12		Binary Trees and Heaps
13		Union Find and Hash Tables
14		Matrices and Vectors
15	Combinatorial Algorithms	Greedy Algorithms
16		Minimum Spanning Tree
17		Parallel MST and Parallel Component Labeling
18		Matroids
19		Search Algorithms
20	Numerical Algorithms	Introduction to Numerical Algorithms
21		Matrix Computations
22		Solving Systems of Equations
23		Scaling, Iterative Improvement, and Sparse Systems
24		Linear Programming and the Simplex Algorithm

6 Course Policies and Procedures

6.1 Referencing the Work of Others

You should attempt the problem sets on your own before consulting outside references. However, I encourage the use of research materials as a way to supplement your understanding of the course material, as long you heed the following common-sense ground rules. First, you may not consult my solutions or the problems sets of other students from previous offerings of this course. Second, external sources may be used only to improve your own understanding. You may not quote directly from any source and you should not write down anything that you do not understand. When you write your solutions, you should do it on your own without the direct help of any external sources. If you do use external references in improving your understanding, please cite them! Failure to cite references will be treated as cheating and will not be tolerated. If you are diligent about citing references, you will come out ahead in the end. Please ensure that you understand the spirit and the letter of these rules before beginning any class work.

6.2 Respect for Intellectual Property

In both your classwork and your research, it is important that you be aware of and respect the intellectual property rights of others. Unless explicitly stated otherwise, all materials available on the Internet, in libraries, and elsewhere are considered intellectual property and can only be used with the permission of the owner. Please be aware of the license you are being granted when you use these materials and what you are and are not allowed to do with them.

6.3 Group Work

You are encouraged to work together on problem sets, especially those designated as group work. However, unless the problem set is specifically designated as group work, you must ultimately demonstrate your understanding of the material by writing up your own solutions without the help of other students or their written work. If you consult with other students (or faculty) on a problem set, this should be considered equivalent to consulting any other reference and should be cited appropriately. This policy will be strictly enforced.

6.4 Turning in Assignments

All assignments should be submitted electronically by e-mailing a ZIP file to the instructor by the beginning of the class period in which the assignment is due. The official turn-in time of the assignment will be the time stamp on the e-mail. The PDF file should have the name `<Network ID>-HW*.zip` where the "*" is replaced by the assignment number and the subject of the e-mail should be "IE496 Assignment *," where "*" is replaced by the assignment number. LaTex is strongly recommended for producing any written solutions.

6.5 Lateness

I will allow a total of 7 days of lateness on laboratory assignments throughout the semester. These 7 days can be split up in any way you choose. In other words, you can have one assignment late by 7 days or 7 assignments each late by one day. After that, there is a penalty of 10% off per late-day on each assignment. No assignment will be accepted more than 7 days late. Exceptions to this rule will be made on a case-by-case basis. Please let me know if you will be turning in an assignment late.

6.6 Learning Styles

There are many different styles of learning. Some people gain better understanding from listening to something being explained orally. Some get better understanding from written material. Some like a combination of both. I do my best to accommodate various styles of learning. However, feel free to let me know what your learning style is so that I can take that into account when determining the future direction of the course.

6.7 Office Hours and Appointments

I very much appreciate and enjoy getting as much feedback from my students as possible, even if it is not all positive. Please don't be afraid to tell me what you think. If you want to just stop by

to chat, feel free. My door is usually open, but if you could utilize office hours as much as possible, I would appreciate it. If you would like to make an appointment outside office hours, just call or send an e-mail.