ISE 407: Computational Methods in Optimization
Syllabus

Dr. Ted Ralphs

Fall 2020

1 Miscellaneous Course Information

Instructor:	Dr. Ted Ralphs
Office:	323 Mohler Lab (due to COVID-19, no meetings in office)
Zoom:	https://lehigh.zoom.us/my/ted.ralphs
E-mail:	ted@lehigh.edu
Office Hour:	T 3:00-4:00 or by appointment (please message me on Slack)
Web page:	http://coral.ie.lehigh.edu/˜ted
Course web page:	http://coral.ie.lehigh.edu/˜ted/teaching/ie407/
Course meeting time:	T 16:25-17:40, R 15:00-16:15

2 Description of Course

This course covers a wide range of topics related to the computational methods encountered in operation research applications. The lectures will focus on both the theoretical and empirical 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 computer architecture, compilers, models of computation, data structures, design and analysis of algorithms (sequential and parallel), programming paradigms and languages, development tools and environments, numerical analysis, and combinatorial algorithms.

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 theoretical efficiency of algorithms.

2. Understand the fundamentals of how ancillary elements of a computer systems (hardware, compiler, communication network, etc.) affect the performance of an algorithms.

3. Learn how to use the various tools and programming environments available for development of compuational software.

4. Understand basic programming paradigms and the ways to implement algorithms using these paradigms.

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

6. Learn to do effective computational experiments and empirical analysis.

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 some form of individual evaluation of your development skills, as well as a final project with intermediate deliverables.

5 Course Schedule

Block 0: Basic Tools We discuss some of the basic tools used for development and that will be needed in the class.

Block 1: Fundamentals. We discuss the fundamentals of computer architecture, the basic principles of programming, how compilers work, and what determines the efficiency of computer code.

Block 2: Models of Computation and Complexity. We describe how to model a computer and how to use models of computation to assess the efficiency of algorithms theoretically.

Block 3: Programming, Data Structures, and Empirical Analysis. We discuss basic data structures, how to implement and/or use them effectively, and how to perform computational experiments.

Block 4: Combinatorial Algorithms. We discuss the implementation of combinatorial algorithms arising in optimization applications. Thi block will build upon the data structures discussed in Block 3.

Block 5: Numerical Algorithms. We discuss the implementation of numerical algorithms arising in optimization applications with a focus on numerical analysis and practical issues that arise in floating point computation.

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 through Google Classroom. If you need to submit multiple auxiliary files, you may submit a single ZIP file, but please submit a single, separate PDF for each assignment containing the overall write-up. The name of any files you submit should have your Lehigh E-mail, e.g., `tkr2`, as a prefix. 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.