Course program and reading list

Semester 1 Year 2024

School: Efi Arazi School of Computer Science B.Sc

Complexity Theory

Lecturer:

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Tutors:

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Course No.:	Course Type :	Weekly Hours :	Credit:
3967	Lecture	3	4

Course Requirements :	Group Code :	Language:
Final Paper	241396701	Hebrew

Prerequisites

Prerequisite:

77 - Algorithms
3699 - Computational Models **OR** 643 - Automata And Formal

Languages

Course Description

This is a mathematical class in which we will study the capabilities and limitations of efficient computation. We will classify various computational problems into different classes according to the amount of resources they require and prove reductions between them. We will then introduce more advanced algorithmic techniques (such as randomized algorithms and approximation algorithms) and study their limitations as well.

Topic include: time complexity, the classes P and NP, polynomial time reducibility between problems, the Cook-Levin theorem and the theory of NP completeness, space complexity, randomized algorithms, approximation algorithms.

Course Goals

The goal of the class is to introduce you to the basic concepts of complexity theory, and to allow you to argue about the limits of efficient computation, and to recognize and formally prove computational hardness.

The study of computation also raises (and, in some cases, answers) philosophically interesting questions such as: Are there problems that cannot be solved efficiently? Is solving a problem more difficult than verifying a solution? Can "creativity" be automated? Is there randomness in the universe, and does it increase our computational capabilities? What is a "proof"?

Grading

The final grade will be a weighted average of the homework problem set grades, in-class moodle midterms and a final exam.

The homework grade will be the grade of top n-2 problem sets grades out of the n problem sets which
will be published for submission (roughly once a week, for a total of roughly 11 problem sets).

The midterm exams will be held in class in form of a short moodle quiz.

The final grade composition is:
1. Homework grade: 15%
2. Midterm grade: 5%
3. Final Exam: 80%

To pass the course you must get at least 60/100 in the final exam. A bonus of 5 points will be given to the grade of each problem set that was prepared with a word processor.

Note: To allow you flexibility you are automatically granted permission not to submit 2 problem sets during the semester. If you have a qualifying reason for not submitting a problem set (miluim, medical reason, etc.) you should submit the appropriate documents to the student secretariat (Mazkirut Hastudentim). These will not count towards the two problem sets you are allowed not to submit (e.g., if the student secretariat notifies us that you were on Miluim for a week during the semester then you will be excused from submitting 1+2=3 problems sets).

Learning Outcomes

After completing this class students should be able to:

1. Identify and classify problems according to their complexity class, and understand the
   implications of this classification to the ability to solve a problem.
2. Prove computational hardness of problems using reductions.
3. Suggest methods to overcome computational intractability when it is encountered.

Lecturer Office Hours

Will appear on Piazza.

Teaching Assistant

Mr. Idan Brodet
Mr. Eviatar Cohen

Additional Notes

Course website: We will use www.piazza.com to host the class website, where you can find notes, problem sets, a discussion group, and announcements. You should have received an invitation to join the website to your RUNI email account. Moodle will only be used for electronically submitting problem sets, and perhaps a few other activities.

It is always worth checking the web site for corrections and announcements before starting to work problem sets. Occasionally students will find mistakes and omissions in the problems' statements after the homework has been posted on the site. So it is worth checking for updates even after you have started working on the homework.

Homework submission policy: In writing the homework solution to be turned in, a student may not use any written notes or homework solutions prepared together with or by another person, nor any solutions to homework problems posted on the web or otherwise. In other words, you are required to write your homework from scratch on your own without having any other written material with you. The assignment questions have been carefully selected for their pedagogical value and may be similar to questions on problem sets from past offerings of this course or courses at other universities. Using any preexisting solutions from these other sources is strictly prohibited.

Reading List

The course will closely follow the textbook Introduction to the Theory of Computation by M. Sipser.

A more advanced, sources that will be useful in the latter parts of the class is the book Computational
Complexity: A Modern Approach by S. Arora and B. Barak.