Polytechnic School of Engineering, NYU
CS 6033: Design & Analysis of Algorithms 1
Course Syllabus
Spring 2020

Prof: Linda Sellie
Office Hours: Wednesday 3:10 - 5:00 and by appointment.
Office: 370 Jay Street, room 848
Contact Information: Please send a message to me on NYU Classes. **Do not send email.**
Class communication: We will use the course site on PIAZZA. NYU Classes is for the syllabus, posting homework assignments, lecture notes, and grade posting.

Catalog description: Review of basic data structures and mathematical tools. Data structures: priority queues, binary search trees, balanced search trees. B-trees. Algorithm design and analysis techniques illustrated in searching and sorting: heapsort, quicksort, sorting in linear time, medians and order statistics. Design and analysis techniques: dynamic programming, greedy algorithms. Graph algorithms: elementary graph algorithms (breadth-first search, depth-first search, topological sort, connected components, strongly connected components), minimum spanning trees, shortest paths. String algorithms. Geometric algorithms. Linear progsramming. Brief introduction to NP-completeness.

Prerequisites: You *must* have taken these courses to take this course.

- CS5403: Data Structures and Algorithms, or equivalent knowledge of fundamental data structures.
- CS6003: Foundations of Computer Science, or equivalent knowledge of discreet mathematics for computer science.
- A programming course beyond "Introduction to Programming".

Additionally, you should not take this course if you have taken a similar course with a B or better grade.

Textbook: Cormen, Leiserson, Rivest, and Stein, Introduction to Algorithms, 3rd Edition, MIT Press, 2009; ISBN-13: 9780262033848; ISBN: 0262033844. It is known as CLRS.

We have free access to CLRS on BOOKS24x7 on the NYU library web site
`http://library.nyu.edu`, search for books24x7).

Approximate Grading Scale Your final grade will be determined roughly as follows: homework assignments 10%, quizzes 15%, midterm 35%, and final 40%. (Extra consideration in determining your grade will be based by your exam scores, especially the final exam.)

The tentative schedule for the midterm is March 11, 2020. The final is May 13, 2020.

Attendance at exams is mandatory. Make-up exams will only be given in the case of a emergency, such as illness, which must be documented, e.g. with a doctor's note. In such cases, you must notify me as early as possible, preferably before the exam is given. If you miss an exam without a valid excuse, you will receive a grade of *zero* for that exam. The exams will be closed book and no notes.

Course Work Quizzes (approximately weekly) will be on the required background material of the course, and on topics covered in the homework assignments/lectures. The first quiz is optional. The grade for this quiz can replace the grade for any other quiz in the semester.

Homework assignments (approximately weekly) will be posted on NYU Classes. Announcements, and the occasional helpful hint will be posted on Piazza. You are responsible for being aware of any information posted there, so you should check it regularly.

Although the homework makes up a relatively small percentage of the final grade and is a lot of work, it is a key component to mastering the course material. Experience has shown that you will not do well on the exams if you have not done the homework. Please experiment with writing code for the algorithms; no formal programming assignments will be given.

No late homework assignments will be accepted.

Academic Dishonesty: Cheating will not be tolerated. Absolutely no communication with other students is permitted on exams. I advise you that I will seek a F in the course for any cheating on an exam. So, if you copy a single answer from someone else, I will be seeking an F in the course for you. There are possible additional actions at my discretion including involving the CS department and the administration.

Please see the university policy: https://engineering.nyu.edu/academics/code-of-conduct/academic-dishonesty

Policy on Collaboration: You may discuss general approaches on how to do the homework assignments with other students. You may work with **one** other student to work out the details of the questions, and to write up the solution. If you work with another student, you **must** put both names and netID's on top of the assignment. Additionally, if you work with a partner, **only one** of you will *submit* the assignment on NYU Classes (but both of you are responsible to make sure it was submitted). If you do not have your name on top of the assignment, you will not receive any points for that assignment. If you work together, you must fully understand the work you submit. Your submission must be your (and your partner's) work. If there is any evidence that the work is not yours (and your partner's) work (such as copying from others, from the Internet, paying a third party to carry out the work, etc) it will be considered academic dishonesty. You will receive a 0 for the assignment, you will be reported to the department and the Dean of Student Affairs, and potentially receive a F for this course.(See http://cis.poly.edu/policies/)

APPROXIMATE SCHEDULE Please check for updates during the semester. Lectures slides will be posted on NYU classes a day or two after the lecture.
The precise order and content, especially of the later parts of the course, may change. We will work down the list of topics given in the syllabus.

- Introduction: What's an algorithm? Why do we want to study algorithms? Termination. Correctness. Performance. How to measure performance of an algorithm? Models of computation, abstract machines. RAM. Best-, worst-, and average-case performance. Review of asymptotic notation: big-O, big-Ω and big-Θ; little-o, and little-Ω. Chapters 1, 2 & 3.
- Review of basic data structures. Abstract data types (ADTs). Common ADTs: arrays, stacks, queues, linked lists, priority queues, heaps, heapsort. Chapters 10 and 6.
- Dictionaries ADT. Hashing. Balanced search trees (tentatively, 2-3 trees, 2-3-4 trees, and more generally (a, b)-trees, red-black trees). B-trees. Augmenting a balanced search tree. Chapters 11, 12, 13, 14, and 18.
- Implementation: using Union Find problem and Data Structures. Chapter 21.
- Divide-and-conquer algorithms. Review of recurrences and how to solve them. Master's theorem. Binary search. Mergesort. Quicksort. Median and order statistics. Deterministic linear-time selection. Fast integer multiplication (Karatsuba's algorithm). Fast matrix multiplication (Strassen's algorithm). Closest-pair problem. Chapter 4, 7, 9 and 33.4.
- Randomized algorithms and geometric algorithms (not covered as separate topics).

- Graph algorithms: elementary graph algorithms (breadth-first search, depth-first search, topological sort, connected components, strongly connected components), minimum spanning trees, shortest paths. Some graph algorithms will be presented later in the course as illustrations for different algorithm design paradigms. Chapters 22 and 23.
- Dynamic programming: Rod cutting. Matrix chain product. Longest common subsequence. Optimal binary search trees. Shortest path problems in graphs. Transitive closure. Chapters 15 and 24.
- Greedy algorithms: Activity selection. Huffman coding. Minimum spanning trees. Chapter 16.
- Undecidability and fundamentals of NP-completeness (both very briefly; one lecture). Chapter 34.

Moses Center Statement of Disability

If you are student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities (CSD) at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 3rd floor.

NYU School of Engineering Policies and Procedures on Academic Misconduct

The complete Student Code of Conduct can be found here: `https://www.nyu.edu/registrar/calendars/university\protect\discretionary{\char\hyphenchar\font}{}{}academic-calendar.html#1198`

1. **Introduction:**
   The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.
2. **Definition:**
   Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:
   (a) Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
   (b) Fabrication: including but not limited to, falsifying experimental data and/or citations.
   (c) Plagiarism: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
   (d) Unauthorized collaboration: working together on work meant to be done individually.
   (e) Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.

(f) Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

NYU School of Engineering Policies and Procedures on Excused Absences

– complete policy here https://engineering.nyu.edu/campus-and-community/student-life/office-student-affai policies#chapter-id-30199

1. Introduction: An absence can be excused if you have missed no more than 10 days of school. If an illness or special circumstance has caused you to miss more than two weeks of school, please refer to the section labeled Medical Leave of Absence.
2. Students may request special accommodations for an absence to be excused in the following cases:
   - Medical reasons
   - Death in immediate family
   - Personal qualified emergencies (documentation must be provided)
   - Religious Expression or Practice

Deanna Rayment, deanna.rayment@nyu.edu, is the Coordinator of Student Advocacy, Compliance and Student Affairs and handles excused absences. She is located in 5 MTC, LC240C and can assist you should it become necessary. NYU School of Engineering Academic Calendar – complete list https://www.nyu.edu/registrar/calendars/university-academic-calendar.html#1198 The last day of the final exam period is @@@. Final exam dates for undergraduate courses will not be determined until later in the semester. Final exams for graduate courses will be held on the last day of class during the week of @@@. If you have two final exams at the same time, report the conflict to your professors as soon as possible. Do not make any travel plans until the exam schedule is finalized. Also, please pay attention to notable dates such as Add/Drop, Withdrawal, etc. For confirmation of dates or further information, please contact Susana: sgarcia@nyu.edu