CS6043 Design and Analysis of Algorithms II

Fall Semester 2019

Lectures:	Monday 6:00–8:30pm
Classroom:	RH 304
Course Web site:	`http://cse.poly.edu/cs604/`

Instructor: Professor Yi-Jen Chiang
Office: 370 Jay Street, 1103 (11F)
Office Hours: Monday 4:00–5:00pm
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TA: Shi Shu (Email: shushi@nyu.edu. Office Hours — Time: Thursdays 1:00–3:00pm; Location (tentative for the first few weeks): 370 Jay Street, 8th floor, the lounge area outside of the large conference room 825.).

Catalog Description: Amortized analysis of algorithms. Advanced data structures: binomial heaps, Fibonacci heaps, data structures for disjoint sets, analysis of union by rank with path compression. Graph algorithms: elementary graph algorithms, maximum flow, matching algorithms. Randomized algorithms. Theory of NP-completeness and approach to finding (approximate) solutions to NP-complete problems. Selected additional topics that may vary.

Course Objectives:

• Learn the use of advanced algorithmic design strategies: amortization, randomization, approximation, etc.

• Learn to apply algorithmic design ideas to solve new problems.

• Learn to use rigorous mathematics for algorithm design and analysis: observe, state, and prove structural properties that are used for designing efficient algorithms; prove the correctness and analyze the efficiency of algorithms (running time, space complexity, etc.), in the worst case, expected case, or amortized, etc.

• Learn advanced data structures and their analysis such as binomial heaps, Fibonacci heaps, disjoint-set union-find data structures, skip lists, etc., and be able to apply them.

• Learn the theory of NP-completeness and be able to do NP-completeness proofs.

Prerequisites: CS6033 (Design and Analysis of Algorithms I) or equivalent. Familiarity with basic sorting/searching algorithms and data structures, recurrence relations, and asymptotic notations will be assumed.

Required Textbook: T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, Third Edition, 2009, The MIT Press, ISBN-10: 0262033844, ISBN-13: 978-0262033848.

Grading Distribution: Midterm Exam: 35%, Final Exam: 35%, 4 Homework Sets: 30%.

The full score of each exam/homework is typically **more than 100 points**, and thus the full score of the overall score typically **exceeds 100 points.** The **final grades** are based on the **distribution of the overall scores** of the class.

Homework Sets:

- You will usually have two weeks to complete each set. You may discuss the homework problems with other students currently taking the course, but **solutions must be written individually and independently**, and you should show that you **personally understand everything that you submit.** If a key idea is obtained from another person (other than the instructor) or from another book or paper (other than the course textbook), then the source of that idea should be given.
  Note: Sharing write-up, copying from other(s), copying from the Internet, paying someone to do the work, etc., is cheating. It does not matter who copied from whom. (See also **Policy on Academic Dishonesty** below.)

- Homework solutions are due at the beginning of the class on the due date. Solutions handed in after the due date, but before the solutions are given in TA's help/recitation section (typically less than a week after the due date), will be graded at 50%. After TA's solution help/recitation section, homework submissions will **not** be accepted.

- It is **to your benefit** that you **think hard** and **try to solve homework problems all by yourself** without (or at least before) discussing with others, as **problem-solving** is an important learning process for this course, and it also gives a good preparation for the Midterm and Final Exams.

Midterm and Final Exams: In Class, **Closed Book**, allowing two summary sheets (letter-sized, double-sided — 4 pages in total).

Policy on Academic Dishonesty:
First time: 0 point for the whole homework; second time: F for the course.
See **Student Code of Conduct** at
https://engineering.nyu.edu/sites/default/files/2018-06/code-conduct2-2-16.pdf

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 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 2nd and 3rd floors. *Please do this at the start of the semester.*

Tentative Schedule (subject to change):

I. Advanced Techniques and Data Structures		
1	9/9	Amortized Analysis [Ch 17]
2	9/16	Amortized Analysis [Ch 17]; Binomial Heaps [Ch 19 of the **2nd Edition**]
3	9/23	Binomial Heaps [Ch 19 of the **2nd Edition**] (HW1 given)
4	9/30	Fibonacci Heaps [Ch 19]
5	10/7	Fibonacci Heaps [Ch 19]; Data Structures for Disjoint Sets Union-Find [Ch 21] (HW1 due; HW2 given)
6	10/14	No Class (Fall Recess)
	10/15 Tue	Data Structures for Disjoint Sets Union-Find [Ch 21]
II. NP-Completeness		
7	10/21	NP-Complete Problems and Reduction [Ch 34] (HW2 due)
8	10/28	**Midterm Exam**
9	11/4	NP-Complete Problems and Reduction [Ch 34]
III. Selected Advanced Techniques and Data Structures		
10	11/11	Randomized Algorithms and Data Structures [Lecture Notes] (HW3 given)
IV. Graph Algorithms		
11	11/18	Randomized Algorithms and Data Structures [Lecture Notes]; Maximum Flow and Matching [Ch 26] (HW3 due)
12	11/25	Maximum Flow and Matching [Ch 26] (HW4 given)
V. Approximation Algorithms		
13	12/2	Approximation Algorithms for Optimization Problems [Ch 35]
14	12/9	Approximation Algorithms for Optimization Problems [Ch 35] (HW4 due)
15	12/16	**Final Exam**

Note: You can access Ch 19 of the **2nd Edition of the textbook** by going on-line to the NYU Library (log in to `home.nyu.edu`, and click "Research"; in NYU Libraries, log in and search for "Introduction to Algorithms", select the 2nd Edition of the search results and go to Ch 19).