Course Syllabus

Jump to Today

Instructor: Euiwoong Lee (personal webpage Links to an external site., email: euiwoong@umich.edu)

Teaching assistants: Peter Ly (GSI, pmly@umich.edu), Aditya Singhvi (IA, singhvi@umich.edu).

Prerequisites: EECS 281 (required), EECS 376 (required).

Recommended (but not required): Linear algebra (Math 214, 217, 417, 419, Rob 101).

Meeting time: (Also see the ***Course Calender*** Links to an external site.).

- Lectures: Tuesday and Thursday 12:00 - 1:20 PM at 1303 EECS.

- Discussions 011 (Peter): Friday 09:30 - 10:30 AM at 1130 LBME.

- Discussions 012 (Aditya): Friday 3:30 - 4:30 PM at 1690 BEYSTER. It is okay to go to any section as long as seats are available.

- Office hours: 9:30-11:30 AM on Monday (Peter, BBB Learning Center), 1:30-3:30 PM on Wednesday (Aditya, different rooms), Thursday 2:00-4:00pm (Euiwoong, BBB 3641), 12:00-2:00 PM on Friday (Peter, BBB Learning Center).

Piazza: We will also use Piazza Links to an external site. for questions and discussions.

Grading: Homework 40%. Midterm exam 30%. Final exam 30%.

- The class will operate on a standard 90/80/70/60 scale. We might "curve up". (E.g., if your raw score is 80, you are guaranteed to get some form of B.)

- Participation in lectures/discussions/piazza: Up to 2 points as extra credits.

- A grade of A+ is only awarded for exceptional work at the discretion of the instructor. Some examples of exceptional work in addition to a good score are (1) active participation in lectures/discussions/piazza, (2) quality of HW/exam solutions, and (3) optional problems in HWs.

Homeworks: There will be 6 HWs. Please submit them via Gradescope. Late HWs will not be accepted, but the lowest score will be dropped. One additional drop can be arranged due to special circumstances, with some official documentation explaining them. Collaboration is allowed and encouraged, but everyone must submit their own solution, which should be written up from scratch (and not copy/pasted - there should not be exactly identical text matches). Please list your collaborators in the submission. We recommend writing the solution using LaTeX.

Exams: Both midterm and final are 24-hour take-home exams.

- Midterm: Feb 22 (Thu) 5 pm - Feb 23 (Fri) 5 pm.
- Final: Apr 29 (Mon) 5 pm - Apr 30 (Tue) 5 pm.

Diversity: It is our intention that students from all backgrounds and perspectives will be well served by this course, and that the diversity that students bring to this class will be viewed as an asset. We welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, socioeconomic background, family education level, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. Your suggestions are encouraged and appreciated.

Student Well-Being: Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact the instructor so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being Links to an external site. on the Well-being for U-M Students website. You can also search for additional resources on that website.

Accessibility and Disability: The University of Michigan recognizes disability as an integral part of diversity and is committed to creating an inclusive and equitable educational environment for students with disabilities. Students who are experiencing a disability-related barrier should contact Services for Students with Disabilities https://ssd.umich.edu/ Links to an external site.; 734-763-3000 or ssdoffice@umich.edu). SSD typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. Please turn in our VISA forms by Sep 29 (Fri) to ensure full accommodations.

Topics: The course will consist of the following six units. Each unit will have 3-5 lectures (except the third unit) and one homework based on them.

1. Divide and Conquer / Dynamic Programming

2. Greedy / Graph algorithms and Data structures

3. Randomized algorithms (including Hashing and Streaming)

4. Max-flow Min-cut and Linear programming

5. Approximation algorithms

6. Multiplicative weight update and Online algorithms

However, these topics (especially later ones) are fundamentally connected, and one of the goals of this course is to learn and appreciate these connections yourself! Some examples are:

- Units 2-3: Efficient data structures using randomization
- Units 1-2-4-5-6: How many of the "discrete algorithms" we learned can be simulated by "continuous optimization" via Convex / Linear Programming.

Textbooks: The course will not follow a particular textbook, but the following books contain some materials for each unit.

- For the first two units, most materials (and almost all prerequisites) are covered by ***Introduction to Algorithms*** by Cormen, Leiserson, Rivest, and Stein ("CLRS"). Its e-book can be accessed at the UM library.

Links to an external site. Other useful textbooks include ***Algorithm Design*** by Kleinberg and Tardos ("KT") and ***Algorithms*** by Erickson ("Erickson", free online access Links to an external site.).

- Third unit: ***CLRS***, ***Randomized Algorithms*** by Motwani and Raghavan ("MR"), and ***Foundations of Data Science*** by Blum, Hopcroft, and Kannan ("BMK", available at author's webpage Links to an external site.).

- Fourth unit: ***Understanding and Using Linear Programming*** by Gartner and Matousek ("GM", e-book at the UM library), ***Combinatorial Optimization*** by Schrijver. Additionally, CLRS, KT, and Erickson cover this unit too.

- Fifth unit: ***Approximation Algorithms*** by Vazirani

Links to an external site. and ***The Design of Approximation Algorithms*** by Williamson and Shmoys ("WS") Links to an external site..

- Final unit: Gupta's course notes for his Advanced Algorithms Links to an external site. course.

#	Date	Unit	Topics (tentative)	External Resources	HW
1	Jan 11	Introduction and Divide and Conquer	Fast Fourier transform and convolution	CLRS (3rd edition) Chapter 4	
2	Jan 16	Dynamic Programming	Fully 2-dimensional dynamic programming (matrix chain multiplication, optimal binary search tree)	CLRS 15, Erickson 3	
3	Jan 18	Dynamic Programming	DP for NP-hard problems (Traveling Salesperson Problem, Independent Set)		HW1 out
4	Jan 23	Greedy Algorithms	Minimum Spanning Tree (MST)	CLRS 16, 23, Erickson 4, 7	
5	Jan 25	Greedy Algorithms	Matroid theory		

6	Jan 30	Graph Algorithms and Data Structures	Shortest path (Bellman-Ford, Dijkstra, Seidel)	CLRS 24, 25	Video lecture
7	Feb 1	Graph Algorithms and Data Structures	Data structures (Fibonacci heaps, Splay trees, etc.)	Erickson 8, 9	HW1 due HW2 out Video lecture
8	Feb 6	Randomized algorithms basics	Probability review, Balls and bins, Polynomial identity testing, Perfect/universal hashing	MR 7,8, CLRS 11	
9	Feb 8	Hashing			
10	Feb 13	Streaming Algorithms	Alon-Matias-Szegedy, CountSketch, CountMin	BHK 6	
11	Feb 15	Markov Chain and Random Walk	2SAT via random walk	MR 6	HW2 due
12	Feb 20	More randomized algorithms	Minimum Cut via contraction	MR 1	
13	Feb 22	Midterm Review			HW3 out
			Spring Break		
14	Mar 5	Max-flow Min-cut	Max-flow Min-cut theorem Max-flow algorithms (Ford-Fulkerson, Edmonds-Karp, etc.)	CLRS 26, Erickson 10, 11	
15	Mar 7	Max-flow Min-cut	Bipartite matching		
16	Mar 12	Linear Programming	Introduction to Convex and Linear Programming Polyhedral combinatorics	GM 1-6, Schrijver 5, 9-12, 16-18	

17	Mar 14	Linear Programming			HW3 due
18	Mar 19	Linear Programming			HW4 out
19	Mar 21	Approximation Algorithms	LP-based approximation algorithms (rounding, primal-dual method)	Vazirani 1-3, 12-15	
20	Mar 26	Approximation Algorithms			
21	Mar 28	Approximation Algorithms			
22	Apr 2	Approximation Algorithms	Spectral and Semidefinite Programming-based algorithms	WS 7, 9	HW4 due
23	Apr 4	Approximation Algorithms	Local Search		HW5 out
24	Apr 9	Multiplicative Weight Update (MWU)	MWU basics Applications to Solving Linear Programming	Gupta 13-17	
25	Apr 11	Multiplicative Weight Update (MWU)			
26	Apr 16	Online Algorithms	Ski Rental, Paging, k-Server	Gupta 22, 24	
27	Apr 18	Online Algorithms	Secretaries and Prophets		HW6 out
28	Apr 23	Final Review			HW5 due