

# Boston University, CAS CS 330 - Spring 2023 - Introduction to Analysis of Algorithms Syllabus

## Course Description

Examines the basic principles of algorithm design and analysis; asymptotic analysis; graph algorithms; greedy algorithms; dynamic programming; network flows; polynomial- time reductions; NP-hard and NP-complete problems; This course fulfills a single unit in each of the following BU Hub areas: Quantitative Reasoning II, Critical Thinking.

## Prerequisites

The class assumes **CS 112 and CS 131** (or MA 293). CS majors need to complete **at least one** of their Group B coursework (any two of CS 132/MA242, CS235/MA294 and CS237/MA581) before taking CS 330. If you don't have the prerequisites, you **must** talk to an instructor before continuing with this class.

## Sign up ASAP:

**Piazza** (Q&A, discussion, as well as distribution of lecture notes, homework, additional material, course logistics info):

<https://piazza.com/bu/spring2023/cascs330>

**Gradescope** (Homework submission) :

<https://www.gradescope.com/courses/495780> (entry code: J3GG7D )

**TopHat:** A platform for in-class interaction and questions. There is a per-semester fee for a TopHat account. *If you do not have an account and the fee represents a financial hardship, please let me (the instructor) know via a private Piazza post.*

[Tophat.com](https://tophat.com) Join Code: 182119

## Instructors and Teaching Fellows (reachable on Piazza)

Name	Office Hours ( <b>up to date info on Piazza</b> )
Prof. Dora Erdos	TBD,
TF Harry (Heng-chao) Fu	TBD

TF Patrick Lutz	TBD
TA Jax (Shengyao) Luo	TBD
TA Rahul Razdan	TBD
TA Jack Ruan	TBD
TA Ross Mikulskis	TBD

## Textbook

*Algorithm Design*, by Kleinberg and Tardos. ISBN 0-321-29535-8.

Useful additional resources:

- Cormen, Leiserson, Rivest, and Stein. *Introduction to Algorithms*, 3rd ed. MIT Press.
- J. Erickson. *Algorithms*, 2019. Available from <http://algorithms.wtf/>  
See also the extensive exercises on the website.
- [Mathematics for Computer Science](#) by Eric Lehman, Tom Leighton, and Albert Meyer.  
(Useful background on discrete mathematics.)

## Instructor:

Dora Erdos: email [edori@bu.edu](mailto:edori@bu.edu) , office CDS 910.

Communication related to class material should be conducted through Piazza, for personal questions you can use the “private” post option.)

## Structure:

The class consists of two 75 minute lectures (Tues, Thur) and one 50 minute discussion (Mon) each week. Attendance in lectures is mandatory and will be tracked through TopHat participation (see later section for details). The two sections of the course, A1 and B1, will be treated as one class. The content of the two lectures is identical<sup>1</sup>, assignments will be shared, students can mix-and-match A and B lecture and discussion sections.

The lectures will be taught by professor Erdos, each discussion by one of the TFs or TAs. Every member of the course staff will hold office hours. The purpose of the lectures is to introduce

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<sup>1</sup> If on a given day you can't attend your own lecture section then, as long as there are seats available, you are welcome to attend the other lecture. No need to inform the instructor. For your midterm exam you have to attend the section you are registered for.

concepts, computational and algorithm design principles, analysis. The objective of the discussions is to reinforce the concepts covered in the lecture through problem-solving. The problems discussed are often closely related to that week's homework assignment. The purpose of the office hours is to answer questions on any aspect of the course material and lab or homework problems.

### Communication:

We will be using **Piazza for all discussion** pertaining to the class. You should post your questions about the material, lectures, homework or course logistics here. Piazza is highly preferred over sending the course staff emails. Most often your question and the answer will be just as useful to your fellow students as yourself. We encourage you to respond to questions. The course staff will be monitoring Piazza and chime in as needed. You are encouraged to ask questions about the homework assignments, e.g. clarifications, related material, but **do not post solutions** to the problems. If you think your question is too specific or would reveal too much, then please ask in a private post. See the pinned "Ethics and Etiquette" post on Piazza for further guidance.

Our **Piazza** page:

<https://piazza.com/bu/spring2023/cascs330>

### Lectures

A1 section : Tue, Thur 11 :00 - 12 :15 pm, KCB 101

B1 section : Tue, Thur 12 :30 - 1 :45 pm, KCB 101

**Discussion Labs:** Labs will be an invaluable part of the course involving interactive problem-solving sessions, tips on homework questions, and supplemental material not covered in lecture. We will post lab notes on Piazza in advance -- please read before coming to lab. Lab solutions will be posted after all labs conclude.

**Topics** We will mostly follow the order and content in the textbook. Topics are subject to change. A tentative weekly schedule can be found at the end of this document.

- Asymptotics, data structures, how to describe an algorithm (pseudocode)
- Graphs – data structures, graph traversals, connectivity, DAGs
- Greedy algorithms – scheduling, shortest paths, minimum spanning trees
- Divide-and-conquer – variations on sorting and searching, integer multiplication, closest pair of points
- Dynamic programming – interval scheduling, subsetSum, knapsack, sequence alignment
- Network flow – Ford-Fulkerson, MFMC theorem, applications
- Polynomial time reductions, NP, NP-Complete

**Course atmosphere, diversity and inclusion:** We intend to provide a positive and inclusive atmosphere in classes and on the associated virtual platforms. Students from a wide range of backgrounds and with a diverse set of perspectives are welcome. We ask that students treat each other with thoughtfulness and respect, and do their part to make all their peers feel welcome. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups.

## Grading

The course grade will break down as follows:

**5%** class participation (based on TopHat)

**30%** weekly homework assignments (due Wednesdays, first hw due Wed Febr. 1st).

**30%** in-class midterm exam (in-class, planned for Tuesday, March 21, 2023).

**35%** comprehensive final (during finals week).

Students **must pass both exams** with at least **40% of the grade** to pass the course.

Last day to **drop without a “W”**: **Thur, Febr. 23, 2023**. **With a “W”**: **Fri. March 31, 2023**. Incompletes for this class will be granted based on CAS Policy (mostly only for last minute emergencies).

**Exams:** Both exams will consist of problem solving and short questions about the material. The midterm will be during class time and takes 75 minutes. The final is during the University-assigned final exam slot. The content of the final is cumulative.

*No collaboration whatsoever is permitted on exams, any violations will be reported to the College.*

**Accommodations:** All are welcome in the course. If you require particular accommodations for exams or coursework, please contact the instructor (and forward any relevant documentation from Disability and Access Services) in a timely manner. If you are facing unusual circumstances during the semester, please reach out to us early on so that we can find a good arrangement.

**Attendance and participation:** Your participation grade depends on answering TopHat questions, which requires your presence in class. While our textbook will be very helpful, it is an imperfect substitute for in-class learning, which is the fastest (and easiest) way to learn the material. Some material covered in lecture and lab may not be in our textbooks. You are in all cases responsible to be up to date on the material. Class participation and questions are very much encouraged. *Please ask as many questions in class, labs and on Piazza as you need.* Chances are that your question and answer will be as helpful to your classmates as to you.

**TopHat** is a web-based platform for interactive questions during class. Our goal in using it is to make lectures more interactive, get you thinking actively about the material, and get some feedback on what you are learning. TopHat questions are generally multiple choice. Most of the points (80%) are for participation. The remaining 20% is for correctness. You will get the full 5% of the course grade if you get at least 80% of the possible TopHat points for the semester.

Course TopHat page: [Tophat.com](https://tophat.com) Join Code: 182119

## Homework:

**Homework problems:** There will be weekly homework assignments, 11 total for the semester. Problems will be posted Thursdays and due the following Wednesday evening. Homework problem sets will consist of written problems. They will allow you to practice (a) solving problems using the ideas from class, often in a new way, (b) to assess and analyze the correctness of your solution and (c) communicate your ideas using technical language (precise descriptions, pseudocode, formal claims, proofs). Be aware that this latter is just as important as the two former.

**The two lowest grades** on your homework assignments will be **dropped**.

**Content:** The homework is probably the most useful learning tool in the course—take it seriously, allow yourself time to do it, and have fun! Alumni often describe this course's homework as critical to their success in job interviews.

Limited collaboration on homework is permitted; see below.

**Homework Submission:** Assignments will be due **Wednesdays by 11:59PM ET**, electronically via Gradescope. Solutions to written problems should be *typeset*. Hand-written solutions will not be accepted. We'll provide you with resources on how to get started if you're not familiar yet with typesetting mathematical-algorithmic text.

**Late Policy:** Late assignments will **not** be accepted as we intend to post solutions the next morning. You can use your dropped grades to cover for up to two late assignments. Also, be mindful that sometimes it's ok to submit partial results if you weren't able to fully finish your assignment, don't miss the deadline because of last minute work.

**Regrade Policy:** If, after reviewing the solutions and your answer, you still believe a portion of your homework was graded in error, you may request a regrade, **via Gradescope**, **\*NOT\*** through email. One of the staff will consider your request and adjust your grade if appropriate. Note that when we regrade a problem, your score may go up or down. Regrade requests can be submitted up to one week (7 days) after grades for a given assignment have been posted.

**Workload:** CS 330 is a substantial amount of work. There is a problem set every week as well as two exams to study for. As you likely already know, assignments requiring substantial creativity can take more time than you expect, so plan to finish a day early.

**Personal difficulties:** Unfortunately, it may happen that you find yourself under circumstances that are affecting your ability to perform well in this class. We are here to support you and find the best way to help you in this course. Please reach out, so that we can help.

## **Collaboration, Citation, and Academic Honesty**

**Citation policy:** You can reference anything from the textbook, lecture and discussion notes, information given by the course staff without having to cite it. However, if you make use of any other information, you have to include **proper citation**. If you omit to do this you are committing plagiarism.

You are allowed and encouraged to further your knowledge by finding related material online or in books, but you have to cite it. Your citation may be a url, the title and chapter of a book, or a paper reference.

*Searching explicitly for answers to problems on the Web or from persons not enrolled in the class this current semester is strictly forbidden. (This includes students who took the course in previous semesters, posted solutions, Chegg, GitHub, etc. )*

**Collaboration Policy:** Collaboration on homework is permitted and even encouraged. If you choose to collaborate on some problems, you are allowed to discuss each problem with **at most 3** other students currently enrolled in the class. Before working with others on a problem, you should think about it by yourself for at least 45 minutes.

*You must write up each problem solution by yourself (using your own words) without assistance, even if you collaborate with others to solve the problem.* Identical worded answers, including identical pseudocode, will receive no grade. You must also identify your collaborators clearly on the first page of your assignment. If you did not work with anyone, you should write ``Collaborators: none." It is a violation of this policy to submit a problem solution that you cannot orally explain to the instructors. You may get help on Piazza or in office hours from the instructors for the class for specific problems. You don't need to list them as collaborators .

*No collaboration whatsoever is permitted on exams!*

**Collaboration strategies:** If you do collaborate, use it as an opportunity to practice group work skills: give everyone a chance to speak, listen carefully, acknowledge good suggestions. If you have a tendency to be shy, speak up! If you have the tendency to dominate conversations, make sure to give others the floor. We strongly encourage you to find a small group of classmates that you regularly discuss and review material with. Feel free to post on Piazza to find a study mate.

**Academic Conduct:**

Academic standards and the code of academic conduct are taken very seriously by the University, the College of Arts and Sciences, and the Department of Computer Science. Course participants must adhere to the [CAS Academic Conduct Code](#). Please take the time to review this document if you are unfamiliar with its contents.

If in doubt, our department has an extensive [compilation of examples](#) with regard to Academic Conduct and permissible collaboration. Violations of this policy are handled according to University regulations.

**Tentative schedule:** this schedule is for informational purposes only and is subject, and is likely, to change as we progress through the semester.

week	topic
1	intro, pseudocode
2	asymptotic running time, general graph search, BFS. DFS. queue and stack implementation
3	BFS and DFS pseudocode, graph datastructures: adjacency list, hash table implementation, BFS correctness, graph, connectivity
4	DAGs, greedy intro, interval scheduling
5	Interval partitioning, heaps and priority queues
6	MST
7	Shortest paths, Dijkstra's
8	Spring break
9	Catch up on material, review
10	Midterm, DQ: sort and search, recurrences
11	DQ: Karatsuba, DP: weighted interval scheduling
12	subsetSum, knapsack, sequence alignment
13	Network flow, Ford-Fulkerson, MFMC
14	MFMC, flow applications
15	Flow apps, poly-time reduction
16	P, NP, NP-C
	final exams