CS3000: Algorithms & Data

Summer I 2021

Instructor:	Drew van der Poel (a.vanderpoel@northeastern.edu - 132B Nightingale)
Section 01:	Behrakis 310 M-Th 1:30pm-3:10pm

Office Hours: *(all times Eastern)*:

Instructor - Drew van der Poel, Wednesday 3:30-5:00pm

Teaching Assistant - Kristen Colavita, Tuesday 8-10pm, Thursday 8-10pm
Teaching Assistant - Rishabh Dutta, Sunday 2-4pm, Saturday 2-4pm
Teaching Assistant - Prateek Gulati, Monday 12-1pm, Wednesday 10am-1pm
Teaching Assistant - Zhenxiang (Steven) Guan, Tuesday 9-11am, Saturday 10am-12pm
Teaching Assistant - Anne Lee, Wednesday 6-9pm
Teaching Assistant - Ariana Lozner, Thursday 6-8pm, Saturday 12-1pm
Teaching Assistant - Sameer Marathe, Tuesday 11am-1pm, Thursday 11am-1pm
Teaching Assistant - Amy Min, Sunday 12-3pm, Monday 5-7pm
Teaching Assistant - Tingwei Shi, Sunday 9-11am, Friday 9-11am

Course Pages:

Piazza - https://piazza.com/northeastern/summer2021/cs300040657202140/home
Gradescope - https://www.gradescope.com/courses/266585

Overview: This is an introductory course in algorithms. Although any computer program can be viewed as an implementation of an algorithm for solving a particular computational problem, in this course we focus not on the programs themselves but on the underlying computational problems, and general algorithmic techniques for solving these problems. In this course, we will:

- See a wide range of computational problems arising in different applications
- Learn how to formulate these problems precisely from somewhat informal descriptions
- Learn new algorithmic design techniques used to solve these computational problems
- Learn techniques to prove correctness of algorithms
- Learn techniques to analyze the efficiency of algorithms
- Learn how to transform algorithms to programs

Piazza: We will be using Piazza for class discussion. The system will make it possible to get help quickly and and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I strongly encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

References: Our primary textbook for this course will be

- Algorithm Design by Jon Kleinberg and Éva Tardos

Additional references include the following and are not required for the course

- Algorithms, Etc. by Erickson
- Introduction to Algorithms by Cormen, Leiserson, Rivest, and Stein
- Mathematics for Computer Science by Lehman, Leighton, and Meyer

Homework Policies:

- All homework will be submitted through Gradescope as a PDF by 11:59pm Eastern on the due date.
- All homework solutions must be typeset (preferably in LaTeX). I will provide the source files for the HW assignments to help you get started. See below for some advice on LaTeX. Learning LaTeX can take some time, but is well worth the investment, since most technical publications are written in LaTeX. Great editors exist on most platforms. TeXstudio is a good cross-platform editor. Other professors recommend TexShop for Mac. The not so short introduction to LaTeX is an extremely helpful reference.
- The lowest homework score will be dropped from your grade.
- It is encouraged that you work with your classmates on the homework problems. If you do collaborate, **you must write all solutions by yourself, in your own words, and are strictly forbidden from sharing any written solutions. You must list all of your collaborators on your submission.** The TAs and I reserve the right to ask you explain your solutions.
- No late homework will be accepted. Extensions will be granted only in rare, extreme, and verifiable circumstances.

Grading : Homework (45%), Midterm (20%), Final Exam (25%), Quizzes (10%)

Final grades will be assigned based on the following scale:
A: [93, 100], A-: [90, 93)
B+: [87, 90), B: [82, 87), B-: [80, 82)
C+: [77, 80), C: [72, 77), C-: [70, 72)
D+: [67, 70), D: [62, 67), D-: [60, 62)
F: [0, 60)

Tentative Course Outline: The following high-level course outline is subject to change.

- Week 1 (May 10-May 13) - Introduction and Review; Divide and Conquer
  - Lecture 1: Course Overview, Introduction, Proof by Induction
  - Lecture 2: Stable Matchings
  - Lecture 3: Asymptotic Analysis
  - Lecture 4: Divide and Conquer - overview, Mergesort
- Week 2 (May 17-May 20) - Divide and Conquer; Dynamic Programming
  - Lecture 5 : Karatsuba
  - Lecture 6: Binary Search, Selection
  - Lecture 7: Weighted Interval Scheduling
  - Lecture 8: Knapsack

- Week 3 (May 24-May 27) - Dynamic Programming; Greedy Algorithms
  - Lecture 9: Segmented Least Squares
  - Lecture 10: Interval Scheduling
  - Lecture 11: Huffman Codes
  - Lecture 12: Midterm 1 Review
- Week 4 (May 31-June 3) - Graph Algorithms
  - May 31st - no class (Memorial Day
  - June 1st - Midterm 1
  - Lecture 13: Graph Defintions, Breadth-First Search
  - Lecture 14: Depth-First Search, Bipartiteness, Topological Orderings
- Week 5 (June 7-June 10) - Graph Algorithms
  - Lecture 15: Strongly Connected Components
  - Lecture 16: Dijkstra's I
  - Lecture 17: Dijkstra's II
  - Lecture 18: Bellman-Ford
- Week 6 (June 14-June 17) - Graph Algorithms; Complexity
  - Lecture 19: Minimum Spanning Trees
  - Lecture 20: Network Flow I
  - Lecture 21: Network Flow II
  - Lecture 22: NP-Completeness
- Week 7 (June 21-June 24) - Complexity
  - Lecture 23: Fixed Parameter Tractability I
  - Lecture 24: Fixed Parameter Tractability II
  - Lecture 25: Approximation Algorithms
  - Lecture 26: Final Review

Exam Dates:

	Midterm	Final Exam
Section 01	Tu. June 1, 2021	Mon. June 28, 2021

Classroom Environment: To create and preserve a classroom atmosphere that optimizes teaching and learning, all participants share a responsibility in creating a civil and non-disruptive forum for the discussion of ideas. Students are expected to conduct themselves at all times in a manner that does not disrupt teaching or learning. Your comments to others should be constructive and free from harassing statements. You are encouraged to disagree with other students and the instructor, but such disagreements need to respectful and be based upon facts and documentation (rather than prejudices and personalities). The instructor reserves the right to interrupt conversations that deviate from these expectations. Repeated unprofessional or disrespectful conduct may result in a lower grade or more severe consequences. Part of the learning process in this course is respectful engagement of ideas with others.

Title IX: *Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance.*

Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff.

If you or someone you know has been a survivor of a Prohibited Offense, *confidential* support and guidance can be found through University Health and Counseling Services staff and the Center for Spiritual Dialogue and Service clergy members. By law, those employees are not required to report allegations of sex or gender-based discrimination to the University.

Alleged violations can be reported non-confidentially to the Title IX Coordinator within **The Office for Gender Equity and Compliance** at: titleix@northeastern.edu and/or through **NUPD** (Emergency 617.373.3333; Non-Emergency 617.373.2121). Reporting Prohibited Offenses to NUPD does **NOT** commit the victim/affected party to future legal action.

Faculty members are considered "responsible employees" at Northeastern University, meaning they are required to report all allegations of sex or gender-based discrimination to the Title IX Coordinator.

In case of an emergency, please call 911.

Please visit http://www.northeastern.edu/titleix for a complete list of reporting options and resources both on- and off-campus.

Students With Disabilities: Students who have disabilities who wish to receive academic services and/or accommodations should visit the Disability Resource Center at 20 Dodge Hall or call (617) 373-2675. If you have already done so, please provide your letter from the DRC to me early in the semester so that I can arrange those accommodations.

Classroom Recording: This course, or parts of this course, may be recorded for educational purposes. These recordings will be made available only to students enrolled in the course, instructor of record, and any teaching assistants assigned to the course.

COVID-19 Expectations: The university has put into place a robust plan to make the campus healthy and safe for all — but you must do your part. To summarize:

1. Gatherings on or off campus must conform to healthy practices as outlined by university and Massachusetts state guidance. If you host or attend an inappropriate party or gathering, you run the very real risk of immediate removal from the community.

2. Wear a mask indoors and outdoors as you maintain a 6-foot distance from everyone.

3. Get tested every three days using the COVID-19 Test Scheduler (`Covid19-testing.northeastern.edu`) We may require more frequent testing as the semester progresses. It's quick, easy and will help us to quickly identify and care for anyone who tests positive. I will not be told the identity of anyone who tests positive, and you do not need to share that information with me or anyone else unless you want to. If you receive a positive test result, you will be contacted by a member of the university's telehealth team who will provide you with next steps.

4. Do a Daily Wellness Check (`wellness-check.northeastern.edu`), wash your hands well and regularly, and disinfect high-touch surfaces and spaces.

5. I will be wearing a face covering or mask as I teach and expect that you will do the same in class. If you come to class without a mask, I'll ask you to go and get one on campus. You can get a mask at the Visitor Center or at the Curry Student Center Help Desk. If you refuse to wear a mask in class, I won't be able to continue the class. If you are not sitting six feet apart from your classmate, I'll ask you to do so. We won't be able to eat or drink in class (except water). If you test positive, you will need to enter isolation as directed by the university's telehealth team. I expect that you will not come in-person to class and that you will follow the guidance from the university telehealth team to isolate and get appropriate healthcare if needed.

6. Staying safe is a responsibility that we all must take seriously. Keep in mind the "Protect the Pack" theme. Remember that our individual actions will help everyone stay safe.