CS577 - Introduction to Algorithms 4 Credit – Spring 2023

Section 001
Lecture: TR 9:30 - 10:45 STERLING 1310
Discussions:
DIS-311: W 09:55 - 10:45 ENGR HALL 3024
DIS-312: W 11:00 - 11:50 ENGR HALL 3024
DIS-313: W 12:05 - 12:55 ENGR HALL 3024
DIS-314: W 13:20 - 14:10 ENGR HALL 3024
DIS-315: W 14:25 - 15:15 ENGR HALL 2534
DIS-316: W 15:30 - 16:20 ENGR HALL 2534

Section 002
Lecture: TR 13:00 - 14:15 GRAINGER 1100
Discussions:
DIS-321: W 09:55 - 10:45 ENGR HALL 2534
DIS-322: W 11:00 - 11:50 ENGR HALL 3032
DIS-323: W 12:05 - 12:55 ENGR HALL 2317
DIS-324: W 13:20 - 14:10 ENGR HALL 2534
DIS-325: W 14:25 - 15:15 ENGR HALL 3024
DIS-326: W 15:30 - 16:20 ENGR HALL 3024

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or by appointment.

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Calendar Description

Basic paradigms for the design and analysis of efficient algorithms: greed, divide-and-conquer, dynamic programming, reductions, and the use of randomness. Computational intractability including typical NP-complete problems and ways to deal with them. Enroll Info: None

Specific Learning Outcomes

Students successfully completing this course will be able to:

- Design and analyze efficient algorithms based on the paradigms of divide-and-conquer, dynamic programming, and greed.
- Formulate abstractions of computational problems, and design and analyze efficient reductions between computational problems.

- Know, understand, and apply paradigmatic algorithms and reductions dealing with numbers, strings, graphs, and networks.
- Recognize computational intractability, demonstrate NP-hardness, and understand its repercussions.

Texts

All the texts are optional. *Algorithm Design* by Kleinberg and Tardos should be considered the main text, but, we will also provide references to other texts. As to why, I think Jeff Eriksen says it best in the frontmatter of his online *Algorithms* textbook:

> "Please do not restrict yourself to this or any other single reference. Authors and readers bring their own perspectives to any intellectual material; no instructor "clicks" with every student, or even with every very strong student. Finding the author that most effectively gets their intuition into your head takes some effort, but that effort pays of handsomely in the long run."

- **Kleinberg, and Tardos. *Algorithm Design.* Addison Wesley, 2006.** The main textbook for 577.
- **zyBooks COMP SCI 577: Introduction to Algorithms.** Additional resource with bonus point opportunities. zyBook code: WISCCOMPSCI577RenaultSpring2023.
- **Jeff Erickson. *Algorithms.* jeffe.cs.illinois.edu/teaching/algorithms/** Free online algorithms textbook. A hardcopy, black-and-white version can be purchased from Amazon.
- **Cormen, Leiserson, Rivest, and Stein. *Introduction to Algorithms, 3rd Edition.* MIT Press, 2009.** Now with C-style pseudocode! The classic (presumably because it was the textbook I used in my intro to algorithms course) introduction to algorithms textbook.
- **Sedgewick, and Wayne. *Algorithms, 4th Edition* Pearson, 2011.** Another introduction to algorithms textbook with working Java code.

Format and Procedures

Class Structure

The classes will be a combination of lectures, discussions and exercises. You are encouraged to ask questions throughout the class and to be engaged in the discussions. During the exercises, please feel free to engage with your peers or myself as you work on the problems. Finally, please keep all your devices on silent during the class.

Participation

Lectures: In order to facilitate discussions and to determine participation grades, we will use TopHat in this course. The TopHat questions will be graded on participation not correctness. You will need to register with TopHat. Details can be found at `https://kb.wisc.edu/luwmad/page.php?id=59937`. ***NEW Fall 2022:*** *UW-Madison has licensed Top Hat so there is no charge for UW-Madison students.*

In addition, there will be bonus point opportunity for attending lecture in-person. The in-person attendance will also be done via TopHat.

Once registered, you can join the course at:

- Section 001: `https://app.tophat.com/e/020205`. The course join code is: 020205.

- Section 002: `https://app.tophat.com/e/394523`. The course join code is: 394523.

More information on TopHat can be found at `https://it.wisc.edu/services/top-hat/`. The 80% rule will apply, see below.

Discussions: Attendance will be taken for the discussion participation. For full marks, you must arrive no later than 5 minutes after the scheduled start, stay until the scheduled end, and participate in the discussion. Each discussion carries equal weight. The 80% rule will apply, see below.

Assignment Submissions

You will submit your assignments to Gradescope. They should be in pdf format with the answers written on the assignment subject itself. Registration details for Gradescope will follow once Canvas integration is completed by the department.

You will need to register with Gradescope at `https://www.gradescope.com/`, using your wisc.edu email. *To facilitate the transfer of grades from Gradescope to Canvas,* ***please only register with your wisc.edu email*** *and not your personal email nor your cs.wisc.edu.* The course entry code is: 8NJXGZ.

Code: Some of the assignments will ask you to code a solution to a problem. For these exercises, you can use Java, C, C++, C#, Python, or Rust (other languages may be possible, but first discuss with your instructor). When you submit your code, be sure to include a makefile that runs your program with the command `make run` - a sample makefile will be provided in Canvas. The input to the programs will be read from the console and the solution should be printed out to the console. For assignments requiring code, all the files (source code, makefile, etc) should also be submitted to Gradescope.

Late Submissions: No late submission will count for participation, but we will be happy to provide feedback any late submissions if requested.

Piazza

There will be a specific Piazza board for this section of 577. You can sign up for the Piazza message board at: `https://piazza.com/wisc/spring2023/cs577001and002` with the access code of: 001002.

Course Requirements

TopHat (5%)

During each lecture, there will be some TopHat questions which will be used to calculate a participation grade. Each question in a lecture will have the same weight and be grade based on participation (not correctness). In addition, questions will made available for one week after lecture. The 80% rule will apply, see below.

Discussion Participation (5%)

Attendance will be taken for the discussion participation. For full marks, you must arrive no later than 5 minutes after the scheduled start and stay until the scheduled end. Each discussion carries equal weight. The 80% rule will apply, see below.

Assignments (15%)

There will one assignment per week, starting in week 1, released on Thursday, for a total of 13 assignments (no assignment due during Spring Break, or released on the last week). Each assignment will carry the same weight, and will be due Thursday at 11:59 pm of the next week. The assignments will be graded based on participation rather than correctness. Submitting a blank document will not be sufficient to gain participation points. Rather, each question in the assignment will be graded for participation, giving an overall participation score for the assignment.

In order to get participation points, you must submit an answer that demonstrates to the grader that you made a reasonable attempt to answer the question. Most questions will involve designing algorithms, working through algorithms and writing proofs. Be sure to show your work. If you are unsure how to answer a question, explain what you understand about the question, what approach you believe needs to be taken for the question, and where you are stuck. This will also earn participation credit for those questions. For each assignment, each question or enumerated subquestion with a reasonable attempt to answer will be given a participation grade of 1. No reasonable attempt to answer will be given a participation grade of 0. The 80% rule will apply, see below.

Built-in flexibility: 80% rule

For the scores where the 80% rule applies, if your calculated score is 80% or higher, you will be credited the full points. If it is y% for $y < 80$, you will be credited $\frac{y}{100} \cdot x$ points, where y is your calculated score and x is the total points. I.e., a discussion participation score of 79% would result in 3.95 out of 5 points.

It is important to note that the 80% rule is place to have built-in flexibility for all the students in the case of an unexpected situation, or McBurney flexibility accommodation. For content that uses the 80%, the expectation is that students will still attend and complete 100% of the assigned discussions, classes, and assignments. It does not mean that the expectation is that students should only complete 80% of the assigned discussions, classes, and assignments. Finally, doing less than 80% of the assigned discussions, classes, and assignments risk: altering the knowledge and skills of the course, lowering the academic standards, and fundamental altering the nature of the course.

Quizzes (30%)

There will be 6 quizzes throughout the semester (see below for exact dates). Let a be an array (0 based indexing) containing your quiz scores (out of 1), in order, from highest to lowest. The overall grades for the tests will be calculated as follows:

$$\text{Quizzes (out of 30)} = a[0] \cdot 15 + a[1] \cdot 8 + a[2] \cdot 4 + a[3] \cdot 2 + a[4] \cdot 1 + a[5] \cdot 0$$

These quizzes will be 30 minutes and take place in Canvas as indicated in the schedule below. All quizzes will be on Wednesday and be available from 16:30 to 20:30. The administration of the quizzes will involve proctoring via Honorlock (c.f. `https://kb.wisc.edu/luwmad/page.php?id=103206`). An in-person option will also be made available the same day running from 17:45 - 18:15 that you will need to sign-up for in advance. IMPORTANT NOTE: The time of the in-person quiz may need to be changed due to availability of rooms.

For a given quiz, if you take both a Canvas quiz and an in-person quiz, that is considered academic dishonesty, neither copy will be graded, and the violation will be reported.

Note that the generous quiz aggregation is designed in part to provide built-in flexibility. Due to the logistics of the course, there will be no make-up quizzes, but note that the lowest quiz has a value of 0, and the lowest 3 quizzes have a value of only 3.

Exams (45%)

The final exam will be on May 10, 2022 from 7:45AM to 9:45AM.

Exams will be open book: that is you will be permitted to bring in any *non-electronic* books and notes to the exams.

In the first lecture, as a class, we will decide on one of the following two alternatives for the exams:

1. A single final exam worth 45%. The final exam will be 2 hours and consist of 5 questions each worth 10 points. All questions answered will be graded and the final exam grade will be out of 40, making the maximum possible grade 50/40.

2. A midterm exam worth 20% with 3 questions and duration of 90 minutes, and a final exam worth 25% with 4 questions and a duration of 2 hours. For full marks all questions must be answered correctly.

If option 1 is chosen, the final exam will be comprehensive. If option 2 is chosen, the midterm exam will be on Feb 28 from 17:45 to 19:15 and focus on graphs, greedy, and divide and conquer. While the final exam will focus on dynamic programming, network flow, and intractability, plus another question from graphs, greedy, and divide and conquer.

Bonus Points

There are two opportunities for students to gain bonus points: attending the lectures in-person, and working through the optional zyBook over the semester. Neither is require in order to achieve full marks in the course. There is no 80% rule, or extensions for any of the bonus points.

In-Person Lecture Attendance (up to 5%):

During lecture, we will use the TopHat attendance feature to determine attendance at each lecture. For details on the TopHat attendance works see `https://support.tophat.com/s/article/Student-Attendance`. The in-person attendance will be tracked via this TopHat feature only without exception. Students wishing to earn these bonus marks are responsible for ensuring that they are able to use the TopHat attendance feature.

Each lecture will be equally weighted for the bonus marks. If you attend (as recorded via the TopHat attendance feature) x out of y lectures, you will receive $5 \cdot \frac{x}{y}$ bonus marks.

zyBook (up to 5%):

You can earn up to 5% bonus marks by working through the optional zyBook textbook as follows:

- Earn up to 2% by completing all the participation activities in the zyBook by May 6, 2023 at 11:59 pm. If you complete x out of y participation activities, you will receive $2 \cdot \frac{x}{y}$ bonus marks.

- Earn up to 3% by completing the designated exercises from the zyBook by May 6, 2023 at 11:59 pm. If you complete x out of y designated exercises, you will receive $3 \cdot \frac{x}{y}$ bonus marks. In the zyBook Exercise assignment, you will find the list of exercises to complete. They should be submitted to the Gradescope zyBook Exercise assignment for grading. They will be graded based on participation just like the required homework.

Final Letter Grade

We expect the grades to fit the standard UW grading scheme which is:

A	100% to 90%
AB	$<$ 90% to 85%
B	$<$ 85% to 80%
BC	$<$ 80% to 75%
C	$<$ 75% to 70%
D	$<$ 70% to 60%
F	$<$ 60% to 0%

This should only be considered a very rough guide.
Grades will be scaled so that the median grade is a B (GPA 3.0).

Schedule

(This schedule is subject to change.)

Lecture and Quiz Schedule

Week	Date	Topic	Quizzes
1	Jan 24	Course Introduction, Discrete Review, and Basics of Algorithm Analysis	
2	Jan 31	Graphs, and Greedy	
3	Feb 7	Greedy	Quiz 1 - AA and Graphs
4	Feb 14	Greedy, and Divide & Conquer	
5	Feb 21	Divide & Conquer	Quiz 2 - Greedy
6	Feb 28	Dynamic Programming	
7	Mar 7	Dynamic Programming	Quiz 3 - D&C
8	Mar 14	*Spring Break*	
9	Mar 21	Dynamic Programming and Network Flow	
10	Mar 28	Network Flow	Quiz 4 - DP
11	Apr 4	Network Flow	
12	Apr 11	Intractability	Quiz 5 - NF
13	Apr 18	Intractability and Randomization	
14	Apr 25	Randomization and Approximation	Quiz 6 - Intractability
15	May 2	Randomization and Approximation	

Assignment Schedule

All assignments are due on Thursday at 11:59 pm.

Week	Date	Due	Release
1	Jan 26		1 - Discrete Review
2	Feb 2	1 - Discrete Review	2 - Asymptotic Analysis and Graphs
3	Feb 9	2 - Asymptotic Analysis and Graphs	3 - Greedy
4	Feb 16	3 - Greedy	4 - More Greedy
5	Feb 23	4 - More Greedy	5 - Divide & Conquer
6	Mar 2	5 - Divide & Conquer	6 - More Divide & Conquer
7	Mar 9	6 - More Divide & Conquer	7 - Dynamic Programming
8	Mar 16	*Spring Break*	
9	Mar 23	7 - Dynamic Programming	8 - More Dynamic Programming
10	Mar 30	8 - More Dynamic Programming	9 - Network Flow
11	Apr 6	9 - Network Flow	10 - More Network Flow
12	Apr 13	10 - More Network Flow	11 - Intractability
13	Apr 20	11- Intractability	12 - More Intractability
14	Apr 27	12 -More Intractability	13 - Randomization
15	May 4	13 - Randomization	

University Policies

Rules, Rights and Responsibilities

See http://guide.wisc.edu/undergraduate/#rulesrightsandresponsibilitiestext.

Academic Integrity

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to https://conduct.students.wisc.edu/academic-integrity/.

Accommodations for Students with Disabilities

McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

Diversity and Inclusion

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world."