

CSC-421 Applied Algorithms and Structures, Spring 2022-23

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Class Time, Location (in-person): Mon 5:45PM - 9:00PM, Lewis 1508

Office Hours (Office and Zoom): Tuesday 3:30pm-5pm

Zoom Link: posted on D2L

Course Website: <https://d2l.depaul.edu/>

Course Description

This course covers techniques for designing and analyzing algorithms. Fundamental topics such as running-time analysis and efficiency, and problem-solving techniques (divide-and-conquer, greedy, dynamic programming) will be covered.

Learning Outcome

- Students will be able to use basic algorithmic structures for modeling problems in computer science.
- Students will learn basic techniques for designing and analyzing computer algorithms.
- Students will be exposed to a set of fundamental problems that have applications in several areas of computer science.

Prerequisites

CSC-400 and CSC-403.

Textbook

Many contents of the course will be based on the following textbooks (none of which are required to buy):

[**CLRS**] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. *Introduction to Algorithms*, **3rd Edition**. MIT Press, 2009.

[**JeffE**] Jeff Erickson, *Algorithms*, **1st edition**.

Publicly available and can be downloaded from:

<https://jeffe.cs.illinois.edu/teaching/algorithms/#book>

[**K&T**] Jon Kleinberg and Éva Tardos, *Algorithm design*, **1st edition**

We will use some of the slides made available along with this book (link below):

<https://www.cs.princeton.edu/~wayne/kleinberg-tardos/pearson/>

The slides provided should be standalone and are enough for the purpose of this course. Notice that some slides may also be derived from online materials or are designed on my own. With that being said, reading these books should help you a lot with the learning.

Topics and Corresponding Chapters in Textbooks

Subject	Corresponding Chapters
1. Introduction; Review	[CLRS] Sec 3.2
2. Run-time analysis	[CLRS] Sec 2.1, 2.2, 3.1; [K&T] Sec 2.1, 2.2, 2.4
3. Divide and conquer, sorting	
(a) Solving recursive equation	[CLRS] Sec 4.4, 4.5; [JeffE] Sec 1.7
(b) Binary search, merge sort, quick sort	[CLRS] Sec 2.3, 7
(c) Linear time selection	[CLRS] Sec 9.2, 9.3
(d) Closest point pair	[CLRS] Sec 33.4
(e) Heap and heapsort	[CLRS] Sec 6
4. Dynamic programming	
(a) Introduction	[CLRS] Sec 15.3; [JeffE] Sec 3.4; [K&T] Sec 6.2
(b) Longest increasing subsequence	[JeffE] Sec 3.6 (Second recurrence)
(c) Text segmentation	[JeffE] Sec 3.3
(d) Edit distance	[JeffE] Sec 3.7
(e) Knapsack	[K&T] Sec 6.4
(f) Matrix-chain multiplication	[CLRS] Sec 15.2
5. Greedy algorithms	
(a) Interval scheduling	[CLRS] Sec 16.1; [K&T] Sec 4.1
(b) Interval partitioning	[K&T] Sec 4.1
(c) Scheduling to minimize lateness	[K&T] Sec 4.2
(d) Optimal caching	[K&T] Sec 4.3
(e) Huffman codes	[CLRS] Sec 16.3
6. Elementary graph theory	
(a) Paths/cycles; Connectivity; Trees	[JeffE] Sec 5.2, 5.3
(b) Graph representations	[CLRS] Sec 22.1; [JeffE] Sec 5.4
(c) BFS and DFS	[CLRS] Sec 22.2, 22.3
(d) Topological sort	[CLRS] Sec 22.4; [JeffE] Sec 6.2, 6.3
7. Shortest path algorithms	
(a) Dijkstra's	[CLRS] Sec 24.3
(b) Bellman-Ford	[CLRS] Sec 24.1
(c) Shortest-path algorithm on DAG	[CLRS] Sec 24.2
(d) Floyd-Warshall	[CLRS] Sec 25.2
8. Minimum spanning trees	
(a) A generic algorithm	[CLRS] Sec 23.1
(b) Kruskal's and Prim's algorithm	[CLRS] Sec 23.2
9. NP-completeness	[CLRS] Sec 34; [JeffE] Sec 12; [K&T] Sec 8

Note:

- This is the most exhaustive list of topics and I most probably wouldn't be able to cover them all. An up-to-date topic list will be maintained on D2L.

- Reading corresponding chapters in the textbooks are completely optional. You are only required to follow the slides (considering that slides may have contents that are not based on any of these books). However, some may find that reading books can help a lot with the learning.
- I do not base all materials on a single book because there are many good books on algorithms: each book has its own strength and cannot do best in all aspects. Hence, I believe it's best to combine the strengths of different books:
 - The slides are *largely* based on [CLRS], but I found that, e.g., [K&T] has a much better problem set on greedy algorithms and [JeffE] has a good presentation on solving the edit distance using dynamic programming.
- A certain subject may be discussed in different books (e.g., mergesort is described in all three books), but I only chose ones whose presentations are close to those on slides. You are free to read any other materials on these subjects while keeping in mind that the same subject could be presented in totally different ways (e.g., the description of minimum spanning trees in [JeffE] can be very different from that on slides and can cause confusions for some students).

Grading

- *Assignments – 30%*

There will be around 5 homework assignments. **An email notice will be sent once a homework is posted;** make sure to check your DePaul email.

You will submit your homework through D2L and **only a single file** is allowed for each assignment. The acceptable formats are **pdf** or **word document** (pdf is preferred):

- If you are handwriting your answer on paper, then using a scanning software such as **Adobe Scan** is **strongly** recommended; it makes your writing more recognizable on computer. You will find it more convenient to use Adobe Scan than taking a picture of each page of your answer and combining them to pdf.

Late submissions: Late submissions will **not** be accepted. Please double check your submission to make sure that you submitted the correct file; **no** resubmissions due to submitting the incorrect/incomplete file will be accepted.

Do it on your own: The aim of this course is to develop the *ability* to analyze and design algorithms. This can only be achieved by practices: solving the homework problems *on your own* can therefore greatly benefit you in exams. Also see the 'Academic Integrity and Plagiarism' section for more details.

About providing two answers: If you provide two answers for a problem on homework/exams, **only one of the answers will be graded, and the other one will be ignored.** Being able to determine a correct answer among some choices is part of the learning goals of this course.

- *Midterm Exam—30%*

The midterm exam will be held in Week 6 and will last for 1.5 hours. Without further notice, all topics taught before the midterm will be covered.

In-Class Students. The midterm exam is on May 1, from 5:45 - 7:15 PM, in class (during class hours). No makeup exams will be given. The exam is open book. Electronic devices (including phones, ipads, tablets, etc.) and internet access are **NOT** allowed.

Note: We will not have class after the exam.

Online/ASync Students. You will need to take a proctored exam at an approved testing facility (university, library, etc.) or at CDM (see: <https://www.cdm.depaul.edu/onlinelearning/Pages/Exams.aspx>); **NO** online exams will be given. You will need to register through MyCDM/D2L to take your proctored exam during a time window (3-5 days around the in-class exam including a Saturday) that is specified in the registration system; **NO** exams outside of this time window will be given. The duration of the midterm exam is 1.5 hours. Please register as soon as possible. Please note that you may need to meet the University's vaccination requirements in order to take your proctored exams. The exam is open book. Electronic devices (including phones, ipads, tablets, etc.) and internet access are **NOT** allowed.

- *Final Exam—40%*

Final exam will be held in the final exam week and will last for 2 hours. Without further notice, all topics taught will be covered.

In-Class Students. The final exam is on Jun 5, from 5:45 - 7:45 PM, in class (during class hours). No makeup exams will be given. The exam is open book. Electronic devices (including phones, ipads, tablets, etc.) and internet access are **NOT** allowed.

Online/ASync Students. You will need to take a proctored exam at an approved testing facility (university, library, etc.) or at CDM (see: <https://www.cdm.depaul.edu/onlinelearning/Pages/Exams.aspx>); **NO** online exams will be given. You will need to register through MyCDM/D2L to take your proctored exam during a time window (3-5 days around the in-class exam including a Saturday) that is specified in the registration system; **NO** exams outside of this time window will be given. The duration of the final exam is two hours. Please register as soon as possible. Please note that you may need to meet the University's vaccination requirements in order to take your proctored exams. The exam is open book. Electronic devices (including phones, ipads, tablets, etc.) and internet access are **NOT** allowed.

Academic Integrity and Plagiarism

All the assignments and the exams must be done on **YOUR OWN**. You are strictly prohibited from using any source other than the text and the lecture notes when working on the homework and exam problems. In particular, you are strictly forbidden from acquiring hints and/or solutions from the internet or from any other external resource or person (besides the instructor). Copying is strictly forbidden. Scholastic dishonesty includes acquiring answers from any unauthorized source, working with another person, observing the work of other students during any exam, providing answers when not specifically authorized to do so, and informing any person of the contents of an exam prior to the exam. Disciplinary actions range from grade penalty to expulsion.

This course will be subject to the university's academic integrity policy. All students are expected to abide by the University's Academic Integrity Policy which prohibits cheating and other misconduct in student

coursework. Publicly sharing or posting online any prior or current materials from this course (including exam questions or answers), is considered to be providing unauthorized assistance prohibited by the policy. Both students who share/post and students who access or use such materials are considered to be cheating under the Policy and will be subject to sanctions for violations of Academic Integrity. More information can be found at <https://resources.depaul.edu/teaching-commons/teaching/academic-integrity/Pages/default.aspx>.

Posting work on online sites, such as Hero: All students are expected to abide by the University's Academic Integrity Policy which prohibits cheating and other misconduct in student coursework. Publicly sharing or posting online any prior or current materials from this course (including exam questions or answers), is considered to be providing unauthorized assistance prohibited by the policy. Both students who share/post and students who access or use such materials are considered to be cheating under the Policy and will be subject to sanctions for violations of Academic Integrity.

Attendance and Participation (for in-person students only)

Attendance is not mandatory. Students who miss a lecture are responsible for the material covered in the lecture. However, **I do encourage you to attend the classes as you can ask questions during the lectures, which is good for your learning.** Please also **notice that the teaching (along with the questions/discussions) will be recorded and watched by students taking the online section.**

Changes to Syllabus

This syllabus is subject to change as necessary during the quarter. If a change occurs, it will be thoroughly addressed during class, posted under Announcements in D2L and sent via email.

COVID-19 Health and Safety Precautions

The health and safety of everyone at DePaul depend on the cooperation of all who come to campus. By taking care of yourself, you protect the entire community. DePaul's COVID-19 response plans are based on the latest guidance from the Centers for Disease Control and Prevention, the Chicago Department of Public Health and the university's medical advisor from AMITA Health.

Mandatory protocols must be followed by DePaul students, faculty and staff at all times on both campuses <https://resources.depaul.edu/coronavirus/guidance/health-safety-practices/Pages/default.aspx>.

Respect for Diversity and Inclusion

At DePaul, our mission calls us to explore 'what must be done' in order to respect the inherent dignity and identity of each human person. We value diversity because it is part of our history, our traditions and our future. We see diversity as an asset and a strength that adds to the richness of classroom learning. In my course, I strive to include diverse authors, perspectives and teaching pedagogies. I also encourage open dialogue and spaces for students to express their unique identities and perspectives. I am open to having difficult conversations and I will strive to create an inclusive classroom that values all perspectives. If at any time, the classroom experience does not live up to this expectation, please feel free to contact me via email or during office hours.

Online Course Evaluations

Evaluations are a way for students to provide valuable feedback regarding their instructor and the course. Detailed feedback will enable the instructor to continuously tailor teaching methods and course content to meet the learning goals of the course and the academic needs of the students. They are a requirement of the course and are key to continue to provide you with the highest quality of teaching. The evaluations are anonymous; the instructor and administration do not track who entered what responses. A program is used to check if the student completed the evaluations, but the evaluation is completely separate from the student's identity. Since 100% participation is our goal, students are sent periodic reminders over three weeks. Students do not receive reminders once they complete the evaluation. Please see <https://resources.depaul.edu/teaching-commons/teaching/Pages/online-teaching-evaluations.aspx> for additional information.

Academic Policies

All students are required to manage their class schedules each term in accordance with the deadlines for enrolling and withdrawing as indicated in the University Academic Calendar. Information on enrollment, withdrawal, grading and incompletes can be found at:

<http://www.cdm.depaul.edu/Current%20Students/Pages/PoliciesandProcedures.aspx>

Incomplete Grades

An incomplete grade is a special, temporary grade that may be assigned by an instructor when unforeseeable circumstances prevent a student from completing course requirements by the end of the term and when otherwise the student had a record of satisfactory progress in the course. All incomplete requests must be approved by the instructor of the course and a CDM Associate Dean. Only exceptions cases will receive such approval. Information about the Incomplete Grades policy can be found at <http://www.cdm.depaul.edu/Current%20Students/Pages/Grading-Policies.aspx>

Preferred Name & Gender Pronouns

Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the quarter so that I may make appropriate changes to my records. Please also note that students may choose to identify within the University community with a preferred first name that differs from their legal name and may also update their gender. The preferred first name will appear in University related systems and documents except where the use of the legal name is necessitated or required by University business or legal need. For more information and instructions on how to do so, please see the Student Preferred Name and Gender Policy at <http://policies.depaul.edu/policy/policy.aspx?pid=332>

Students with Disabilities

Students seeking disability-related accommodations are required to register with DePaul's Center for Students with Disabilities (CSD) enabling them to access accommodations and support services to assist with their success. There are two office locations:

- Loop Campus (312) 362-8002
- Lincoln Park Campus (773) 325-1677
- Email: csd@depaul.edu

Students who register with the Center for Students with Disabilities are also invited to contact Dr. Gregory Moorhead, Director of the Center, privately to discuss how he may assist in facilitating the accommodations to be used in a course. This is best done early in the term. The conversation will remain confidential to the extent possible. Please see <https://offices.depaul.edu/student-affairs/about/departments/Pages/csd.aspx> for Services and Contact Information.