

CSCI 3110 - Summer 2019
Design and Analysis of Algorithms I

Instructor:	Christopher Whidden	Class:	TR	2:35-3:55	in DUNN 117
Office:	CS 315	Tutorial:	F	11:35-12:25	in DUNN 117
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Web page:	http://www.cs.dal.ca/~whidden/CSCI3110				and by appointment

This class covers techniques for the design and analysis of efficient algorithms and data structures. Topics include asymptotic analysis, divide and conquer algorithms, greedy algorithms, dynamic programming, data structure design, optimization algorithms, and amortized analysis. The techniques are applied to problems such as sorting, searching, identifying graph structure, and manipulating sets.

There are two prerequisite courses, CSCI 2110: Data Structures and Algorithms and CSCI 2112: Discrete Structures I, and you are expected to know the basic data structures and proof techniques from those courses. There is no real programming in this course. We will design efficient algorithms in high-level pseudocode and then analyze these algorithms to formally prove their correctness and efficiency.

The course is divided into 8 topics. The first one gives a general introduction to algorithm design, motivates it, and highlights a few central questions one can (and should) ask about a problem and an algorithm solving it. Along the way, we will review the mathematical skills you will need in this course and which you should have acquired in CSCI 2112. The next six topics introduce different paradigms for the design of algorithms, more or less in increasing order of difficulty. The final topic revolves around the question whether all problems can be solved efficiently using computers. More precisely, we will provide evidence that certain problems probably cannot be solved efficiently.

Textbook

Introduction to Algorithms (3rd edition) by T. Cormen, C. Leiserson, R. Rivest, and C. Stein
MIT Press (ISBN 9780262033848)

Learning Outcomes

- Extend known algorithms and data structures to solve a closely related problem.
- Recognize problem statements where a solution based on divide and conquer, dynamic programming or greedy approach is appropriate.
- Select the most appropriate proof technique to prove the correctness of a given algorithm.
- Recognize that some problems are unlikely to be efficiently solvable (NP-Hardness).
- Express an algorithm's running time as a recurrence relation and derive a closed form.
- Apply graph exploration approaches as tool to solve a wide range of problems.
- Use standard data structures to efficiently implement graph algorithms.
- Abstract real-world problems into fundamental algorithm, data structure, and graph problems.
- Determine the complexity of an algorithm.
- Estimate the size of an input that an algorithm can process relatively quickly.
- Select and use appropriate abstract data types, data structures, and algorithms to solve moderately complex problems.
- Understand the relevance of different theoretical performance measures: worst-case vs. average case running time.
- Explain the relationship between theoretical analysis and the practical performance of an algorithm.
- Solve simple algorithm design problems.
- Perform an asymptotic analysis of an algorithm's running time.

Class Format and Course Communication

- Content will be delivered via lectures.
- Students must ask the instructor permission before recording class lectures

Midterm and Final Exam Requirements

- Photo ID is required
- Closed book
- You are allowed to bring one and only one cheat sheet of letter size (8.5 by 11 inches), with anything written on both sides. You can also typeset your cheat sheet, but you are not allowed to tape or staple anything onto it.
- No other aids are allowed.

Assignments

Assignments are posted online on Tuesdays and are due at 5:00 PM on the due dates. Submit to the assignment drop box on the second floor of the Goldberg building.

The best 8 of 10 assignment marks are counted.

	Posted	Due
Assignment 1	May 14	May 21
Assignment 2	May 21	May 28
Assignment 3	May 28	June 4
Assignment 4	June 4	June 11
Assignment 5	June 11	June 18
Assignment 6	June 18	June 25
Assignment 7	June 25	July 2
Assignment 8	July 9	July 16
Assignment 9	July 16	July 23
Assignment 10	July 23	July 30

Topics and Tentative Schedule

Introduction	May 7
Fundamentals	May 7, 9
Graph Algorithms	May 14, 16, 21
Greedy Algorithms	May 23, 28, 30
Divide and Conquer	Jun 4, 6, 11, 13
Dynamic Programming	Jun 18, 20, 25, 27
Midterm Review	July 2
Midterm Exam (in-class)	July 4
Data Structures	July 9, 11, 16
Randomization	July 16, 18
NP hardness	July 23, 25, 30
Final Review	July 30
Final Exam	Early August

Tutorials

Tutorials are on Fridays. A TA will show solutions to some practice questions related to recent lectures and current assignments. About one week before each tutorial, these practice questions will be posted on the course web page. The solutions will not be posted so you are encouraged to attend the tutorials and discuss the practice questions with the TA.

Tutorial 1	May 17
Tutorial 2	May 24
Tutorial 3	May 31
Tutorial 4	June 7
Tutorial 5	June 14
Tutorial 6	June 21
Tutorial 7	June 28
No Tutorial	July 5
Tutorial 8	July 12
Tutorial 9	July 19
Tutorial 10	July 26

Evaluation

Assignments	40%	
Mid-Term	20%	July 4 (In-class)
Final	40%	

There will be about 10 assignments but only the best 8 assignments count, each with equal weight. The final exam will be 3 hours long in early August; it is scheduled by the registrar.

If your final exam score is higher than the midterm exam score, your final exam score will be used in place of your midterm exam score. Then the final grade is $A * 40\% + \max(M*20\%+F*40\%, F*60\%)$

The grade conversion scale in Section 17.1 of the Academic Regulations, Undergraduate Calendar will be used to determine the letter grade. Note that as of 2015, a minimum grade of C must be achieved in all required CS courses.

Late Policy

Late assignments are not accepted because they delay posting and discussing solutions and add extra time for marking.

If you are unable to write one or more assignments for valid, documented reasons such as a serious illness then your final exam score can be used to cover the marks for missing course work. Please contact the instructor if this applies to you.

Missed Exams

If you miss an exam, you will be given the opportunity to sit the exam at a later date. You must, however, present a good reason why you were not able to sit the exam at the regular scheduled time. Also, unless there are a large number of students who missed the regularly scheduled exam, make-up exams are oral exams, during which you will be asked to use a whiteboard to show your solutions. A teaching assistant or additional faculty members may be present during any oral exam.

Withdraw Dates

The last day to withdraw without a “W” is June 5th and the last day to withdraw with a “W” is July 5th.

Collaboration

You are allowed (but not required) to form study groups to work on homework assignments, and each group may have up to three students. Students in the same study group must hand in a joint assignment. No form of collaboration, however, will be allowed between students who are in different study groups. Collaboration between different groups will be treated and handled as plagiarism. After each assignment, you are free to start/disband/switch study groups for the next assignment, as long as you follow the above policy.

Responsible Computing Policy

Usage of all computing resources in the Faculty of Computer Science must be within the Dalhousie Acceptable Use Policies (<http://its.dal.ca/policies/>) and the Faculty of Computer Science Responsible Computing Policy. For more information please see https://www.cs.dal.ca/downloads/fcs_policy_local.pdf

Culture of Respect

¹ Every person has a right to respect and safety. We believe inclusiveness is fundamental to education and learning. Misogyny and other disrespectful behaviour in our classrooms, on our campus, on social media, and in our community is unacceptable. As a community, we must stand for equality and hold ourselves to a higher standard.

What we all need to do:

1. Be Ready to Act: This starts with promising yourself to speak up to help prevent it from happening again. Whatever it takes, summon your courage to address the issue. Try to approach the issue with open-ended questions like “Why did you say that?” or “How did you develop that belief?”
2. Identify the Behaviour: Use reflective listening and avoid labeling, name-calling, or assigning blame to the person. Focus the conversation on the behaviour, not on the person. For example, “The comment you just made sounded racist, is that what you intended?” is a better approach than “You’re a racist if you make comments like that.”
3. Appeal to Principles: This can work well if the person is known to you, like a friend, sibling, or co-worker. For example, “I have always thought of you as a fair-minded person, so it shocks me when I hear you say something like that.”
4. Set Limits: You cannot control another person’s actions, but you can control what happens in your space. Do not be afraid to ask someone “Please do not tell racist jokes in my presence anymore” or state “This classroom is not a place where I allow homophobia to occur.” After you have set that expectation, make sure you consistently maintain it.
5. Find or be an Ally: Seek out like-minded people that support your views, and help support others in their challenges. Leading by example can be a powerful way to inspire others to do the same.
6. Be Vigilant: Change can happen slowly, but do not let this deter you. Stay prepared, keep speaking up, and do not let yourself be silenced.

University Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate. <https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=69&chapterid=3457&loaduserredits=False>

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. http://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie’s centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of: a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (NS, NB, PEI, NFLD). http://www.dal.ca/campus_life/student_services/academic-support/accessibility.html

¹Source: Speak Up! © 2005 Southern Poverty Law Center. First Printing. This publication was produced by Teaching Tolerance, a project of the Southern Poverty Law Center. Full ”Speak Up” document found at: <http://www.dal.ca/dept/dalrespect.html>. Revised by Susan Holmes from a document provided April 2015 by Lyndsay Anderson, Manager, Student Dispute Resolution, Dalhousie University, 902.494.4140, lyndsay.anderson@dal.ca www.dal.ca/think.

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-lifepolicies/code-of-student-conduct.html

Diversity and Inclusion - Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). <http://www.dal.ca/cultureofrespect.html>

Recognition of Mikmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mikmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit the office in the McCain Building (room 3037) or contact the programs at elders@dal.ca or 902-494-6803 (leave a message).

Learning and Support Resources

- General Academic Support — Advising http://www.dal.ca/campus_life/student_services/academic-support/advising.html
- Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealing-guide.html>
- Dalhousie University Library <http://libraries.dal.ca/>