DALHOUSIE UNIVERSITY

Faculty of Computer Science

CSCI 2110 Data Structures and Algorithms
Fall 2023

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Course Overview

Welcome to CSCI 2110 – Data Structures and Algorithms, a core course in your second year CS curriculum. We will study, design, implement and analyze a number of data structures such as unordered lists, ordered lists, binary trees, binary search trees, heaps, hash tables and graphs. Algorithms on data structures will include a variety of searching, sorting and graph algorithms. Complexity of algorithms will also be discussed and analyzed. The implementation will be done using object orientated programming with Java.

Course Format

This is an **in-person course** with all lectures held in person in the classroom. Lectures will be live streamed via Collaborate Ultra. You are expected to attend the lectures in person by default and use the remote option only as an exception. Attendance to lectures is important for completing the course successfully. You must not have conflicts during the lecture times since exams and quizzes will be conducted during these times.

Lecture Sessions

Lectures for this course will be on MWF 10.30 – 11.30 AM in the **Kenneth Rowe Building Room 1028 (Potter Auditorium).**

Lab Sessions

Lab Sessions will be held during the time tabled lab time slots and in the lab rooms. Please attend the lab session for which you have signed up.

Attendance

You are **strongly encouraged** to attend all the lecture sessions in person. Use the remote option only occasionally. Short quizzes will be held during the lecture sessions. There will be a 2% bonus for students who attend 70% or more lectures in person.

Lecture Notes

Skeletal lecture notes will be available on Brightspace before the start of each module. Annotated notes will be posted on Brightspace after the completion of the module.

Panopto Recordings

Lectures will not be recorded. Instead, short videos on important concepts will be made available on Panopto on Brightspace. Note: Recordings are not a replacement for live lecture sessions.

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Grading Scheme

Assignments:	20%
Labs:	10%
Short quizzes during lecture sessions:	10%
Test 1:	15%
Test 2:	15%
Final Exam:	30%

Prerequisites

CSCI 1110: Computer Science II

Software

Programming language: Java with an Integrated Development Environment such as Eclipse or NetBeans.

Assignment Details

Assignments are worth **20% of your grade**. **Each assignment will be worth 4%** and will be of approximately equal level of difficulty. Assignments will be posted on Brightspace, and submission is on Brightspace. No collaboration is permitted – you must work on your assignment independently.

There will be **six assignments, one of which is optional** – it means that the best five out of six assignments will be taken for grading. You can choose to do all six assignments, or simply aim to do the any five out of six.

Lab Requirements

Labs are worth **10% of your grade.**
There will be approximately **11 labs through the term,** one each week. **Two of the labs will be dropped**. Labs will be posted on Brightspace on the Sunday of each week and **will be due at 11.59 PM on the Saturday of that week.** You are strongly encouraged to finish most of the lab exercises during the lab time.

Pop Quizzes

There will be eight short pop quizzes held during the lecture sessions. These are worth **10% of your grade**. They are mainly meant to be reflective, and to encourage you to attend the lecture sessions. **Two quizzes will be dropped.** These quizzes will be on Brightspace. Pop Quizzes are open book.

Late Submissions

Assignments are due at 11.59 PM on the day of the submission due date. It is understandable that there may be last minute Internet issues. Hence **late submissions of up to 5 hours will be accepted without late penalty**. Past the five hours grace period, the assignment or the lab will be marked as late. Late assignments will be subject to a penalty of 10% per day up to 5 days. Late assignments which are more than 5 days late will not be accepted.

Labs are due at 11.59 PM on Saturdays. Up to 5 hours of late submission will be accepted without late penalty. Late labs will be subject to a penalty of 10% per day up to 2 days. Labs submitted more than 2 days past the deadline will not be accepted.

Student Declaration of Absence (SDA) – not required.

You have the option to drop one assignment.
You have the option to drop two labs.
You have the option to drop two pop quizzes.
In view of the above flexibility already in the course, there is no need to submit SDAs.

Responsible Use of ChatGPT and Generative AI Tools

You may use ChatGPT and other generative artificial intelligence (AI) tools in a responsible manner, mainly to enhance your understanding, and as a supplement to your learning outcomes. I will not be using any ChatGPT checkers. However, you must acknowledge its use if you used its assistance your assignments and labs.

Tests and the Final Exam are closed book and in person, and will have no access to such tools.

Tests and Exams

Tests and the final exam are <u>closed-book and will be held in person</u>. They will be on Brightspace with Respondus Lockdown Browser.

Test 1 (worth 15% of your grade):
Wednesday, October 11, 6 PM – 7.30 PM
Test 2 (worth 15% of your grade):
Wednesday, November 8, 6 PM – 7.30 PM
Final exam (worth 30% of your grade):
In December, Date Scheduled by Registrar.

To pass the course, you must score a minimum of 50% out of the total weightage for the tests and the final exam. That is, your minimum mark for passing the course is 30 out of 60.

Students with accommodations will take their tests and exams in the Accessibility Centre.

Course Calendar

Important Dates

Sept. 5:	First lecture
Sept.19:	Last day to register
Oct. 4:	Last day to drop course without a "W"
Oct. 11:	TEST 1 (6 – 7.30 PM)
Nov. 2:	Last day to drop course with a "W"
Nov. 8:	TEST 2 (6 – 7.30 PM)
Nov. 13 – 17:	Fall Study Break
Dec. 1:	Last Lecture
Dec. 8 - 19:	Final Exam period

Assignments
A1: Given: Monday, Sept.18, Due: Monday, Oct. 2
A2: Given: Monday, Oct. 2, Due: Monday, Oct. 16
A3: Given: Monday, Oct. 16, Due: Monday, Oct. 30
A4: Given: Monday, Oct. 30, Due: Monday, Nov.13
A5: Given: Monday, Nov.13, Due: Monday, Nov.27
A6: Given: Monday, Nov. 27, Due: Monday, Dec.7

Course Communication

All course information, including announcements, lecture material, labs, assignments, etc. will be posted on Brightspace. Some announcements will be sent to the course mailing list. Please **check Brightspace and your Dal e-mail** daily.

DATA STRUCTURES AND ALGORITHMS
TOPICS AND LEARNING OUTCOMES

BROAD OVERVIEW OF TOPICS

Module 1: Key Concepts in Object-oriented Programming
Traditional programming paradigms, the OOP paradigm, Encapsulation, Inheritance, Polymorphism, Generics

Module 2: Algorithm Time Complexity
What is algorithm complexity?, Big O notation, Deriving Big O given a growth function, Problem solving with Big O, Examples of algorithms with various Big Os., Best case, worst case and average case complexity.

Module 3: Unordered Lists
Definition and examples, Generic set of operations and the big picture of implementation, Linked List Implementation, Complexities of operations Best case, worst case and average case search; smart search methods

Module 4: Ordered Lists
Definition and examples, Binary search algorithm and its complexity, Complexities of operations, Merging ordered lists.

Module 5: Recursion
Concept, recursive definition, writing recursive programs, examples

Module 6: Binary Trees
Definition, Binary Tree Terminology, Strictly binary and complete binary trees, Traversals, Recursive definitions for a binary tree, Binary Tree Class, Application: Huffman coding

Module 7: Binary Search Trees
Definition and Examples, Operations – Search, Insert and Delete, Binary Search Tree Class, Complexity of Binary Search

Module 8: Heaps
Motivation, definition and properties, Operations – Search, Insert and Delete, Heap Class, Heap Applications – Sorting and CPU Process scheduling, Updatable Heaps

Module 9: Hashing
Hashing concept, hash tables and hash functions, Hash Collision, Separate chaining, Linear and Quadratic probing, Hash Functions, Strings as keys, Load Factor, Rehashing , HashMaps, TreeMaps and LinkedHashMaps

Module 10: Graphs
Graph Definitions and Terminology, Applications of graphs, Graph Types, Representation of graphs (Adjacency Matrix Representation, Linked List Representation), Graph Traversals – breadth first, depth first, Topological Sort, Graph Algorithms

LEARNING OUTCOMES

- Select and use appropriate abstract data types, data structures, and algorithms to solve moderately complex problems.
- Select the appropriate data structure to implement a given ADT under a given set of constraints.
- Determine the number of primitive operations of an algorithm in terms of instance size.
- Determine the asymptotic complexity (Big-O) of simple functions such as polynomial, polylogarithmic, and exponential functions.
- Implement a tree data structure and implement depth-first and breadth-first traversals.
- Implement a binary tree data structure and implement pre-order, in-order, and post-order traversals.
- Implement simple iterative and recursive algorithms to solve moderately simple tasks.
- Implement the map, dictionary, and set ADTs using lists, binary search trees, and hash tables.
- Implement the priority-queue ADT using lists and heaps.
- Determine the asymptotic complexity of some simple iterative and recursive algorithms.
- Implement mechanisms to deal with collisions in a hash-table.
- Describe basic concepts in Graph Theory.
- Describe the graph ADT, as well as depth-first and breadth first traversals.
- Implement recursive search and state-space exploration algorithms.
- Implement various graph algorithms

Resources:
No textbook is required for the course.

Lecture notes from the synchronous lecture sessions will be the main study resource. Skeletal lecture notes will be available on Brightspace before the start of each module.
Annotated lecture notes will be available after the completion.

Some useful texts and references are listed below:

1. *Data Structures Outside In with Java* by Sesh Venugopal, Pearson Prentice Hall Publishers ISBN 0-13-198619-8
2. *Data Structures and Problem Solving using JAVA* by Mark Allen Weiss, Addison Wesley, ISBN 0-201-74835-5
3. *Introduction to Java Programming (Comprehensive Version*) by Y.Daniel Liang, Pearson, ISBN 0-13-376131-2

Other references and web sites of interest will also be given as needed during the course.

University and Faculty of Computer Science Policies

Responsible Computing Policy

Usage of all computing resources in the Faculty of Computer Science must be within the Dalhousie Acceptable Use Policies (https://www.dal.ca/dept/university_secretariat/policies/information-management-and-technology/acceptable-use-policy-.html) and the Faculty of Computer Science Responsible Computing Policy. For more information please see https://www.dal.ca/content/dam/dalhousie/pdf/faculty/computerscience/policies-procedures/fcs_policy_local.pdf

Academic Standards

Failure to properly attribute sources in your work will be treated as an academic standards issue and points may be deducted for not following citation requirements. For example, forgetting to quote text taken from other sources, failure to include in-text citations, or a failure to include required information in the citations or references. Please see the resources on proper citation provided by the Dalhousie Writing Center (https://dal.ca.libguides.com/c.php?g=257176&p=5001261).

Please note that if it appears that the error was made with intent to claim other people's work as your own such as a lack of both citations and references, an allegation of plagiarism will be submitted to the Faculty Academic Integrity Officer, which could result in consequences such as a course failure.

Student Health and Wellness

Taking care of your health is important. As a Dalhousie student, you have access to a wide range of resources to support your health and wellbeing. Students looking to access physical or mental health & wellness services at Dalhousie can go to the Student Health & Wellness Centre in the LeMarchant Building. The team includes egistered nurses, doctors, counsellors and a social worker. Visit **dal.ca/studenthealth** to learn more and book an appointment today.

Students also have access to a variety of online mental health resources, including telephone/texting counselling and workshops/training programs. Learn more and access these resources at d**al.ca/mentalhealth**.

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.

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[1] Source: 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.

<u>What we all need to do:</u>
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. A**ppeal 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=117&loaduseredits=False

Territorial Acknowledgement

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

Dalhousie acknowledges the histories, contributions, and legacies of the African Nova Scotia people and communities who have been here for over 400 years.

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." https://www.dal.ca/about-dal/internationalization.html

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. 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. (read more: http://www.dal.ca/dept/university_secretariat/academic-integrity.html)

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion please contact: https://www.dal.ca/campus_life/academic-support/accessibility.html for all courses offered by Dalhousie with the exception of Truro.

Conduct in the Classroom — Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

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). (read more: http://www.dal.ca/cultureofrespect.html)

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. (read more: https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/Code%20of%20Student%20Conduct%20rev%20Sept%202021.pdf)

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. (read more: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html)

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work, and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. (read more: https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/OriginalitySoftwarePolicy.pdf)

Student Use of Course Materials

These course materials are designed for use as part of the CSCI courses at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading material to a commercial third party website) may lead to a violation of Copyright law.

Learning and Support Resources

Please see https://www.dal.ca/campus_life/academic-support.html