University of Saskatchewan

Department of Computer Science
176 Thorvaldson Building
110 Science Place, Saskatoon, SK, S7N 5C9, Canada
Telephine: (306) 966-4886, Facimile: (306) 966-4884

CMPT 280.3-02/04
Winter 2023-2024

Course Syllabus
CMPT 280.3: Intermediate Data Structures and Algorithms

Catalogue Description

Object oriented design of formal abstract data types. This course focuses on data structure design and use in Java. Basic data structures are reviewed in an object oriented context and new data structures and related algorithms are introduced: ordered trees, balanced trees, simple spatial trees; graph representations and searching: path algorithms, depth/breadth first searches, direct and B-tree files; and advanced sorting algorithms. There is emphasis on algorithm analysis in the context of measuring the efficiency of various data structure operations and suitability of data structures to various tasks.

1 Course and Instructor Information

Prerequisite:	CMPT 270
Delivery Method:	In Person
Website:	Canvas https://canvas.usask.ca/courses/67951
Discord:	https://discord.gg/ucFk8GS8va

Lecture Section 02:	MWF, 11:30am-12:20pm STM 140	**Lecture Section 04:**	MWF 1:30pm-2:20pm ESB 18
Instructor Section 02:	Dr. Mark Eramian	**Instructor Section 04:**	Dr. Jason Bowey
Contact:	eramian@cs.usask.ca	**Contact:**	jason.bowey@usask.ca

Tutorial Times:	Consult your timetable for the location and time of your tutorial section.
Help Desk Hours:	To be announced on Canvas

2 Treaty Acknowledgement

I would like to acknowledge that the Saskatoon campus of the University of Saskatchewan is on Treaty Six Territory and the Homeland of the Métis. We pay our respect to the First Nation and Métis ancestors of this place and reaffirm our relationship with one another. I would also like to recognize that some may be attending this course from other traditional Indigenous lands. I ask that you take a moment to make your own Land Acknowledgement to the peoples of those lands. In doing so, we are actively participating in reconciliation as we navigate our time in this course, learning and supporting each other.

3 Learning Outcomes

Upon completion of this course, successful students should be able to:

- compare and contrast the advantages and disadvantages of data in collections, e.g., lists, queues, balanced trees;
- compare and contrast the advantages and disadvantages of different implementations of a graph data structure
- describe and simulate (e.g. on paper) algorithms for operations on collection and graph data structures;
- implement (code) data structures from a formal or informal specification in an object-oriented programming language with attention paid to efficiency of data structure operations;
- select and use appropriate data structures to solve problems with maximum efficiency;
- design new data structures with minimal effort and maximum re-use using the object-oriented concepts of restriction and extension of existing data structures;
- design and implement abstractions of iteration through container data structures and graph data structures;
- write formal specifications for data structures;
- analyze the time complexity of operations on data structures; and
- select from among advanced sorting algorithms the one that is most suitable to a particular data-sorting problem based on the nature of the data to be sorted.

Success in achieving these learning outcomes is less about being able to program data structures and more about understanding how various data structures work, what they are good and bad at, and reasoning about them so you can select and use them effectively to solve problems efficiently. The programming assignments are vehicles for developing an intimate understanding of the data structures that we are studying rather than purely exercises in learning how to program specific data structures.

4 Course Delivery Overview

Activity	**Delivery**
Lectures	Synchronous, in classroom.
Tutorials	In-person tutorials in the classrooms listed in your timetable.
Pre-class Readings	Each week, students will be assigned pre-class readings. Students are expected to complete these prior to the relevant lecture and come to class prepared to participate in in-class examples and discussions. *Pre-class reading assignments have "due dates" that reflect the date you need to have read the material by in order to be prepared for the relevant class.*
Quizzes	Each week there will be graded quizzes to complete on Canvas to serve as a brief check that you are meeting the week's learning objectives. *Quizzes have "due dates" that are* ***recommended completion dates in canvas****, but quizzes be completed for full credit at any time up until the last day of classes even if they are flagged as "late".*
Assignments	Programming assignments will be assigned throughout the term. Students are expected to submit them by the due date for grading. *Assignments are completed outside of class times and* ***must be submitted by the posted due dates****. Late submissions are allowed but carry penalties (see below).*
Midterm Exam	The midterm exam will be an **online exam** delivered through Canvas.
Final Exam	The final exam will be a standard **in-person closed-book invigilated exam** scheduled by the registrar.
Live Help Desk	A mix of in-person and online help sessions. These are drop-in sessions where you can get one-on-one help from an instructor or TA.
Asynchronous Help	Instructors can be contacted by email. Instructors and TAs can be contacted through Canvas Course Dicussions or Discord.
Discord	An optional Discord server will be available. Discord is completely optional (for students and TAs) and its use is not required to complete the course and there is no penalty for not using Discord. Nothing in this course requires participation in the discord and students are not disadvantaged by not using Discord.

5 Required Activities Outside of Class Time

The midterm examination is a synchronous, online examination that will take place outside of normal class time.

6 Student Evaluation

6.1 Grading Scheme

Assignments	20%
Quizzes	5%
Midterm Exam	20%
Final Exam	55%
Total	100%

Assignments and quizzes are not equally weighted. For example, the assignments' 20% of the final mark will be calculated by adding the total marks earned by a student on all assignments, dividing by the total number of marks on each assignment, and multiplying by 20. This means that assignments that have more marks are worth more than assignments with fewer marks. The 5% for quizzes is calculated similarly.

6.2 Criteria That Must Be Met To Pass

All students must be properly registered in order to attend lectures and receive credit for this course. Students must write the final exam. If a student does not write the final exam, the student will receive a grade of at most 49%.

In order to complete the course, the student must pass the final exam. Failing the final exam leads to an incomplete result, even if computed grades would yield an overall passing grade. The incomplete result is recorded as an overall failing grade equal to the lesser of 49% or the student's computed grade, and an annotation INF (incomplete fail).

6.3 Attendance Expectation

Students are expected to attend class but there are no grades for attendance. Materials posted on Canvas are not intended to be a substitute for attending class. Historically, students that attend and participate in class have much greater success.

7 Tentative Assignment Due Dates

Assignments will be mostly weekly. The tentative assignment deadline schedule follows. In the highly unlikely event that this schedule is disrupted so much that an assignment needs to be cancelled, the 20% of the final grade comprised of assignment grades will be calculated exactly as described in the "Grading Scheme" section, above, but treating the cancelled assignment as a grade of "zero out of zero" making the remaining assignments each worth proportionally more.

Assignment	Due Date
1	January 26, 2024, 6:00pm
2	February 2, 2024, 6:00pm
3	February 16, 2024, 6:00pm
4	March 8, 2024, 6:00pm
5	March 15, 2024, 6:00pm
6	March 22, 2024, 6:00pm
7	March 29, 2024, 6:00pm
8	April 5, 2024, 6:00pm

7.1 Midterm Examination Scheduling

Midterm examinations must be written on the date(s) scheduled. The mid-term exam for CMPT 280 will be held as an online exam delivered through Canvas on **Thursday, February 29, 2024, 5:30pm–7:30pm**. More details will be given closer to the date of the exam.

7.2 Final Exam Scheduling

Final examinations may be scheduled at any time during the examination period (April 5–26, 2024). Students should therefore avoid making prior travel, employment, or other commitments for this period. If a student is unable to write an exam through no fault of his or her own for medical or other valid reasons, documentation must be provided and an opportunity to write the missed exam **may** be given. Students are encouraged to review all examination policies and procedures at http://students.usask.ca/academics/exams.php.

The final exam will be three hours in duration and might include multiple choice, short answer, problem-solving, and/or coding questions. More details will be given in the lead-up to the exam period.

8 Textbook Information

8.1 Required Texts

- Required Textbook: M. Eramian, Intermediate Data Structures and Algorithms (Course Readings for CMPT 280), Fifth edition, 2021. **You cannot buy this in the bookstore! This book is available for free on the course website.**

9 Course Topics

The following schedule is approximate. Other topics may be added if time allows. The exact delivery schedule of these topics can be found on Canvas.

Topic	**Details**

Lists and Cursors	• Array-based lists • Singly linked list • Doubly linked lists • Position in lists: Cursors and Iterators
Regression Testing	• Black-box • White-box • Managing expected and unexpected exceptions.
Algorithm Timing Analysis	• Formal defintion • Statement counting approach • Active operation approach • Big-O, Big-Theta notation
Abstract Data Types and Specification	• ADT Defintion (review) • Formal specification of ADTs
Trees	• General Trees • Linked Binary Trees • Arrayed Binary TRrees • Tree Traversals
Dispensers	• Stacks • Queues • Heaps
Non-keyed Dictionaries	• Ordered Binary Trees • AVL Trees
Keyed Dictionaries	• Hash tables • Keyed AVL trees • 2-3 trees • B trees • B+ Trees

Other Trees	• trie trees • k-D trees
Graphs	• Directed and Undirected Graphs • Breadth-first and depth-first search • Shortest Path Algorithms (e.g. Dijkstra's algoirthm)
Efficient Sorting Algorithms	• review of $O(n^2)$ searches • merge sort (in-place array implementation) • quick sort (in-place array implementation) • heap sort • linear sorts: bucket, radix

10 Academic Integrity

The University of Saskatchewan is committed to the highest standards of academic integrity (https://academic-integrity.usask.ca/). Academic misconduct is a serious matter and can result in grade penalties, suspension, and expulsion.

Students are expected to act with academic integrity:

- Students are urged to read the Regulations on Academic Misconduct and to avoid any behaviours that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence.
- Students are encouraged to complete the Academic Integrity Tutorial to understand the fundamental values of academic integrity and how to be a responsible scholar and member of the USask community (tutorial link: https://libguides.usask.ca/AcademicIntegrityTutorial).
- All students are encouraged to be aware of the rules for courses set out in the Academic Courses Policy on Class Delivery, Examinations, and Assessment of Student Learning.
- In cases of uncertainty, students are encouraged to ask their instructors for clarification on academic integrity requirements.

10.1 Collaborative Work

In CMPT 280, **all work** submitted for grading is expected to be an **individual effort**. You may neither possess work from other students (including those not enrolled in this course) nor share your work (rough drafts, finished answers, or graded assignments) with another student at any time during the course **before or after** any assignment is due. Study groups and group discussion are encouraged, but if you plan to employ these then you must adhere to a ***no-recording*** policy:

> Collaboratively, you may discuss and sketch on a non-permanent surface (e.g. white board), but no written-on-paper and no typed-into-computer activities are allowed. Every student

must leave the discussion without a record (no written notes or document, no computer file, no photograph, and no audio/video recording) and must reproduce the result from their own memory. The impermanent surface must be erased.

Offering another's work as your own is academic misconduct, as above. But, one student's possession of other students' work (even after the due date) is also prima facia evidence of academic misconduct on the part of both students, even if one is not registered in this class.

10.2 Use of Outside Resources for Programming Assignments

Programming assignment problems presented in CMPT 280 can be solved by applying the concepts, and algorithms, and data structures presented in official course materials. When solving programming assignment problems, students should limit consultation of outside resources, including both print and internet, unless explicitly allowed. Evidence of excessive use of outside resources may be considered academic misconduct. For example, use of unusual approaches not taught in class may be evidence of excessive consultation especially if their use trivializes or recasts the problem, or circumvents course learning objectives.

Consultation of official Java documentation is excepted. These may be consulted freely when solving programming assignment problems.

Artificial intelligence text generator tools (also known as large language models), such as Chat-GPT and similar tools, are not permitted to be used in any assessments for this course. Any use of such tools will be considered academic misconduct.

Responses to Suspected Academic Misconduct

Students are expected to be familiar with the academic misconduct regulations (https://governance.usask.ca/student-conduct-appeals/academic-misconduct.php#About).

- Definitions appear in Section II of the academic misconduct regulations.
- The academic misconduct regulations apply regardless of type of assessment or presence of supervision during assessment completion.
- Students are advised to ask for clarification as to the specific expectations and rules for assessments in all of their courses.
- Students are urged to avoid any behaviour that could result in suspicions of cheating, plagiarism, misrepresentation of facts. Students should note that posting copyrighted course materials (e.g., notes, questions, assignments or exams) to third party websites or services or other forum or media without permission is an academic or non-academic misconduct offence.

Non-academic offences are dealt with under the Standard of Student Conduct in NonAcademic Matters and Regulations and Procedures for Resolution of Complaints and Appeals.

11 Course Policies

The academic courses policy applies (https://programs.usask.ca/arts-and-science/policies.php).

11.1 Late Programming Assignments

Late assignments are accepted with automatic, non-negotiable late penalties. Late assignments are accepted up to 2 days after the assignment due date, after which they are not accepted. Late penalties will appear on assignment grading rubrics according to the following schedule:

Lateness	**Penalty**
On time	No penalty
Up to 2 hours late	-2%
Up to 6 hours late	-5%
Up to 1 day late	-10%
Up to 2 days late	-25%
More than 2 days late	Not accepted

Late penalties are a percentage of the total marks available on the assignment. **After 2 days have passed from the deadline, submissions will be closed, and assignments will not be accepted.**

11.2 Assignment Extensions

Assignment extensions may be granted on a case-by-case basis, for emergencies, exceptional or unforeseen circumstances, compassionate reasons, or as an approved AES accommodation. Extensions may only be granted by **your** course instructor for the section you are registered in. Students must contact their instructor by email before the deadline for an assignment to request an extension. Students should not expect to be granted an extension for an assignment that is already late.

11.3 Quiz Extensions

Absolutely no extensions will be granted on quizzes. Quizzes may be completed for credit from the date they are released until 11:59pm on the last day of classes, April 5, 2023.

11.4 Missed Assignments

Students are expected to attempt all assignments, and all laboratory exercises. It's better to submit partially completed assignments than to submit nothing at all. An assignment for which nothing is submitted will receive a grade of zero. Make-up assignments will not be offered under any circumstances. If a student misses an assignment due to unavoidable reasons outside of their control, the weight of the assignment might be moved to a different assessment component at the discretion of the course instructor.

11.5 Assignment File Format Policy

Some assignment submissions may require submission in one or more specified file formats. Failure to submit your assignments files in one of the specified acceptable file formats will result in a grade of zero. No special efforts by the instructional team will be made to install software to open submissions that are in a file format other than those listed as acceptable.

11.6 Programming Environment

It is a requirement of this course that you use the Java 1.8 or later. We also fully support use of the IntelliJ IDE. We cannot provide support for any other environments.

11.7 Examination Extensions

Online examinations (if employed) will take place at a specific day and time, or time window, and no extensions will be granted (just like an in-person invigilated exam) beyond the allotted time. Students with approved accommodations for additional examination time from Accessibility and Equity Services (AES) will be allowed a longer time according to their accommodations but be expected to start at the same time or during the same time window as everyone else unless other arrangements are made with the instructor.

11.8 Missed Examinations

1. Midterm exams. Students who have missed a midterm exam must contact their instructor as soon as possible. Arrangements to make up the exam may be arranged with the instructor. Remedies for missed midterm exams will be one of the following at the discretion of the course instructor: writing the exam at a different time (usually only allowed within one day of the scheduled exam date), or have the weight of the midterm moved to the final exam. If a student knows prior to the midterm exam that she/he will not be able to attend, they should let the instructor know before the midterm exam.

2. Final exams. A student who is absent from a final examination through no fault of his or her own, for medical or other valid reasons, may apply to the College of Arts and Science Dean's office. The application must be made within three days of the missed examination along with supporting documentary evidence. Deferred exams are written during the February mid-term break for Term 1 courses and in early June for Term 2 and full year courses. http://students.usask.ca/academics/exams.php

11.9 Grading Concerns

Grading concerns to be handled informally for any submitted assessment must be received within one week of the posting of the graded assessment on Canvas. This deadline does not restrict the timeline for formal reassessments.

Please follow instructions on the course website regarding who to contact about concerns. Should your concern involve a comparison with another's work, both must be submitted for regrading, and we reserve the right to re-grade both your work and the other's work. Furthermore, when re-grading any work, we reserve the right to re-grade the entire work in question, not just selected portions.

11.10 Monitoring of Academic Conduct

The instructors of this course will employ software tools for the detection of plagiarism and non-permitted collaborative work between students.

11.11 Incomplete Course Work and Final Grades

When a student has not completed the required course work, which includes any assignment or examination including the final examination, by the time of submission of the final grades, they may be granted an

extension to permit completion of an assignment, or granted a deferred examination in the case of absence from a final examination.

Extensions past the final examination date for the completion of assignments must be approved by the Department Head, or Dean in non-departmentalized Colleges, and may exceed thirty days only in unusual circumstances. The student must apply to the instructor for such an extension and furnish satisfactory reasons for the deficiency. Deferred final examinations are granted as per College policy.

In the interim, the instructor will submit a computed percentage grade for the class which factors in the incomplete coursework as a zero, along with a grade comment of INF (Incomplete Failure) if a failing grade.

In the case where the student has a passing percentage grade but the instructor has indicated in the course outline that failure to complete the required coursework will result in failure in the course, a final grade of 49% will be submitted along with a grade comment of INF (Incomplete Failure).

If an extension is granted and the required assignment is submitted within the allotted time, or if a deferred examination is granted and written in the case of absence from the final examination, the instructor will submit a revised assigned final percentage grade. The grade change will replace the previous grade and any grade comment of INF (Incomplete Failure) will be removed.

A student can pass a course on the basis of work completed in the course provided that any incomplete course work has not been deemed mandatory by the instructor in the course outline and/or by College regulations for achieving a passing grade. http://policies.usask.ca/policies/academic-affairs/academic-courses.php

For policies governing examinations and grading, students are referred to the **Assessment of Students** section of the University policy *Academic courses: class delivery, examinations, and assessment of student learning*, http://policies.usask.ca/policies/academic-affairs/academic-courses.php.

12 Recordings and Use of Video

Recording of the course lectures by students will only be allowed in certain circumstances. Please see the instructor for information on how to receive approval.

Provided recordings (if any) belong to your instructor, the University, and/or others (like a guest lecturer) depending on the circumstance of each session, and are protected by copyright. Do not download, copy, or share lecture recordings without the explicit permission of the instructor.

More information on class recordings can be found in the Academic Courses Policy https://policies.usask.ca/policies/academic-affairs/academic-courses.php#5ClassRecordings.

13 Copyright

Course materials are provided to you based on your registration in a class, and anything created by your professors and instructors is their intellectual property and cannot be shared without written permission. This includes exams, PowerPoint/PDF lecture slides, code, or other materials. If materials are designated as open education resources (with a creative commons license) you can share and/or use in alignment with the CC license. Additionally, other copyright-protected materials created by textbook publishers and authors may be provided to you based on license terms and educational exceptions in the Canadian Copyright Act (see http://laws-lois.justice.gc.ca/eng/acts/C-42/index.html).

You are responsible for ensuring that any copying or distribution of materials that you engage in is permitted by the University's "Use of Materials Protected By Copyright" Policy. For example, posting others' copyright-protected materials on the open internet is not permitted by this policy unless you have copyright permission or a license to do so. For more copyright information, please visit https:

//library.usask.ca/copyright/students/index.php or contact the University Copyright Coordinator at copyright.coordinator@usask.ca or 306-966-8817.

14 Academic Integrity

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Academic misconduct is a serious matter and can result in grade penalties, suspension, and expulsion. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behaviour that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

For more information on what academic integrity means for students see the Academic Integrity section of the University Library Website at: https://library.usask.ca/academic-integrity.php

You are encouraged to complete the Academic Integrity Tutorial to understand the fundamental values of academic integrity and how to be a responsible scholar and member of the USask community — https://libguides.usask.ca/AcademicIntegrityTutorial.

There are also valuable resources on the Integrity Matters website: https://academic-integrity.usask.ca/|

14.1 Consequences of Academic Misconduct

All students should read and be familiar with the Regulations on Academic Student Misconduct as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals.

- Definitions of academic misconduct appear in Section II of the academic misconduct regulations.
- The academic misconduct regulations apply regardless of type of assessment or presence of supervision during assessment completion.
- Students are advised to ask for clarification if unsure of the specific expectations and rules for assessments in all of their courses.
- Students are urged to avoid any behaviour that could result in suspicions of cheating, plagiarism, misrepresentation of facts. Students should note that posting copyrighted course materials (e.g., notes, questions, assignments or exams) to third party websites or services or other forum or media without permission is an academic or non-academic misconduct offence.

Non-academic offences are dealt with under the Standard of Student Conduct in NonAcademic Matters and Regulations and Procedures for Resolution of Complaints and Appeals.

15 System Outages

System outages (Canvas, labs, network) of 6 hours or longer in the 24 hours before a deadline, automatically grant a 24-hour extension. Shorter outages do not affect the submission deadline, unless they overlap with or the outage ends within the six hours prior to a deadline. Most systems allow resubmission, thus, students are counselled to submit early, and submit regularly as progress is made.

16 Student Supports

16.1 Access and Equity Services (AES) for Students

Access and Equity Services (AES) is available to provide support to students who require accommodations due to disability, family status, and religious observances.

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Access and Equity Services (AES) if they have not already done so. Students who suspect they may have disabilities should contact AES for advice and referrals at any time. Those students who are registered with AES with mental health disabilities and who anticipate that they may have responses to certain course materials or topics, should discuss course content with their instructors prior to course add / drop dates.

Students who require accommodations for pregnancy or substantial parental/family duties should contact AES to discuss their situations and potentially register with that office.

Students who require accommodations due to religious practices that prohibit the writing of exams on religious holidays should contact AES to self-declare and determine which accommodations are appropriate. In general, students who are unable to write an exam due to a religious conflict do not register with AES but instead submit an exam conflict form through their PAWS account to arrange accommodations.

Any student registered with AES, as well as those who require accommodations on religious grounds, may request alternative arrangements for mid-term and final examinations by submitting a request to AES by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by AES.

For more information or advice, visit https://students.usask.ca/health/centres/access-equity-services.php, or contact AES at 306-966-7273 (Voice/TTY 1-306-966-7276) or email aes@usask.ca.

16.2 Academic Help – University Library

Visit the University Library and Learning Hub to find supports for undergraduate and graduate students with first-year experience, study skills, learning strategies, research, writing, math and statistics. Students can attend workshops, access online resources and research guides, book 1-1 appointments or hire a subject tutor through the USask Tutoring Network.

Connect with library staff through the AskUs chat service or visit various library locations on campus.

16.3 Teaching, Learning and Student Experience

The Teaching, Learning and Student Experience unit (TLSE) focuses on providing developmental and support services and programs to students and the university community. For more information, see the sesd web site https://students.usask.ca.

16.4 College Supports

Students in Arts & Science are encouraged to contact the Undergraduate Student Office and/or the Trish Monture Centre for Success with any questions on how to choose a major; understand program requirements; choose courses; develop strategies to improve grades; understand university policies and procedures; overcome personal barriers; initiate pre-career inquiries; and identify career planning resources. Contact information is available at: http://artsandscience.usask.ca/undergraduate/advising/

16.5 Financial Support

Any student who faces unexpected challenges securing their food or housing and believes this may affect their performance in the course is urged to contact Student Central (https://students.usask.ca/student-central.php).

16.6 Gordon Oakes Red Bear Student Centre

The Gordon Oakes Red Bear Student Centre is dedicated to supporting Indigenous student academic and personal success. The centre offers personal, social, cultural and some academic supports to Métis, First Nations, and Inuit students. The centre is also dedicated to intercultural education, brining Aboriginal and non-Aboriginal students together to learn from, with and about one another in a respectful, inclusive and safe environment. Visit https://students.usask.ca/indigenous/index.php or students are encouraged to visit the ASC's website https://students.usask.ca/indigenous/gorbsc.php.

16.7 International Student and Study Abroad Centre

The International Student and Study Abroad Centre (ISSAC) supports student success and facilitates international education experiences at USask and abroad. ISSAC is here to assist all international undergraduate, graduate, exchange, and English as a Second Language students in their transition to the University of Saskatchewan and to life in Canada. ISSAC offers advising and support on matters that affect international students and their families and on matters related to studying abroad as University of Saskatchewan students. Visit https://students.usask.ca/international/issac.php for more information.