CONCORDIA UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

Course Outline
COMP 6651-NN: Algorithm Design Techniques - 4 credits
Winter 2022

1 General Information

Instructor: Dr. B. Jaumard
Office: ER 1027
Email: brigitte.jaumard@concordia.ca

Markers: Quang Anh Nguyen
Office: ER 1015
Email: qu_guye@live.concordia.ca

PODs:
Quang Anh Nguyen (2 groups)
Email: qu_guye@live.concordia.ca
POD 1: Monday 3 - 4:30 pm & Wednesday 3 - 4:30 pm
POD 2: Monday 5 - 6:30 pm & Wednesday 5 - 6:30 pm

Momo Junior Ziazet (1 group)
Email: junior.momoziazet@mail.concordia.ca
POD 3: Monday 5:30 - 7 pm & Wednesday 1 - 2:30 pm

TBD (1 group)
POD 4: Monday 2-4pm & Wednesday 5-7pm

Classes: Friday 5:45pm - 8:15pm - H-937

Office hours: Tuesday 4:00pm - 6:00pm

All the documentation of the course will be made available throughout the Moodle platform, except for the coursepack: to be purchased at the bookstore..

2 Course Description

Mathematical preliminaries; Empirical and theoretical measures of algorithm efficiencies; Optimization techniques and algorithms including greedy algorithms, dynamic programming, and graph algorithms; Amortized analysis; String matching algorithms and tries; Unidimensional and multidimensional search trees; NP-complete problems and approximate solutions; Probabilistic algorithms; Machine learning algorithms.

3 Learning Outcomes

By the end of this course, students should be able to:

- To apply knowledge of computing and mathematics to design algorithms;
- To analyze a problem and identify the computing requirements appropriate for its solution;
- To design, implement, and evaluate an algorithm to meet desired needs;
- To apply mathematical foundations, algorithmic principles, and computer science theory to the modelling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.
- To apply design and development principles in the construction of software systems of varying complexity.

4 Prerequisites

Prerequisite courses: COMP 5361, COMP 5511

You are expected to have taken courses on discrete mathematics and data structures in your undergraduate degree. In particular, it is highly recommended that you brush up on the following topics: sets, relations, functions, logic, proof techniques particularly proofs by induction, graph theory, counting techniques, permutations and combinations, binary search trees, depth first search (DFS) and breadth first search (BFS), stacks and queues, etc. It will be very difficult to follow or appreciate this course without such a proper background preparation.

5 Schedule

Week 1: (Jan. 7, 2022) Introduction and Mathematical Preliminaries (Growth of Functions, Recurrence Relations)

Week 2: (Jan. 14, 2022) Order Statistics (Quiz # 1) (Project: Part I)

Week 3: (Jan. 21, 2022) Graph Algorithms - Part I (Quiz # 2)

Week 4: (Jan. 28, 2022) Greedy Heuristics (Quiz # 3)

Week 5: (Feb. 4, 2022) Dynamic Programming (Quiz # 4)

Week 6: (Feb. 11, 2022) Amortized Complexity (Quiz # 5)

Week 7: (Feb. 18, 2022) NP-Completeness & Approximation/On-line Algorithms (Quiz # 6) (Due date: Project - Part I)

Week 8: (Feb. 25, 2019) Midterm exam (Project: Part II)

Week 9: (March 4, 2019) Spring break

Week 10: (March 14, 2022) Advanced Data Structures: Union-Find, Double-Ended Priority Queues & Dynamic Graph Structures (Quiz # 7)

Week 11: (March 21, 2022) Branch-and-Bound Techniques - Explicit vs. Implicit Enumeration (Quiz # 8)

Week 12: (March 28, 2022) Computational Geometry (Quiz # 9)

Week 13: (April 1, 2022) String Matching & Tries (Quiz # 10) (Due date: Project - Part II, **April 4th, 2022, before midnight**)

Week 13: (April 8, 2022) Graph Algorithms - Part II (Quiz # 11)

6 Course Materials

Textbook:
Cormen, T.H., C.E. Leiserson, R.L. Rivest and C. Stein, *Introduction to Algorithms*, The MIT Press, 3rd Edition, 2009.

Additional References:
M.T. Goodrich and R. Tamassia, Algorithm Design and Applications, Wiley, 2015.
Available at:
`http://canvas.projekti.info/ebooks/Algorithm%20Design%20and%20Applications%5BA4%5D.pdf`

McDowell, G.L., Cracking the Coding Interview: 189 Programming Questions and Solutions, CareerCup, 6th edition, 2015. This additional reference is one possible book among several ones, which contains real interview questions, and gives you hints on how to get prepare for an interview with programming & algorithm design questions.

Acknowledgements: The slides, exercises of the coursepack and questions of the exams are a combination of multiple resources and materials generously made publicly available by:

- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-046j-design-and-analysis-of-algorithms-spring-2015/exams/MIT6_046JS15_quiz1sols.pdf
- https://courses.engr.illinois.edu/cs374/sp2020/B/labs/lab_12_a.pdf
- Finding a Maximum Matching in Non-Bipartite Graphs Alicia Thilani Singham Goodwin 18.304 3/22/2013
- www.cs.princeton.edu/courses/archive/fall12/cos226/lectures/42DirectedGraphs.pdf

7 Course Evaluation Mechanism and Grading

A course pack is available at the Concordia bookstore. It contains a large collection of practice exercises, together with their solutions. It will be the responsibility of the students to work on the exercises of the course pack wisely in order to help them understand and master the techniques presented during the lectures.

There will be a two-step project. Each step will include the design of at least one algorithm, its (their) implementation and evaluation. **Late project submission will not be accepted**. All project materials and reports must be uploaded on Moodle and must be accompanied (each of them) by the *expectations of originality* form (available at https://www.concordia.ca/content/dam/encs/docs/Expectations-of-Originality-Feb14-2012.pdf). Material submitted without that last form will not be graded. Make sure to read the instructions of the *expectations of originality* form before working on your project material/report.

Quizzes (11) will be given to encourage students to work on a regular basis. Quizzes will be given at the end of lectures, during the next 30 minutes (from 8:15pm to 8:45pm).

The midterm will take place during Week 7 (February 18, 2022). It will include the content of the first 6 weeks (with the associated recommended practice exercises from the course pack). It is a closed book exam.

If a student is absent from the Midterm and/or from a Quiz, he/she must produce a written excuse appropriately signed (i.e., by a doctor or an employer) on the appropriate letterhead paper. This letter must be delivered to the instructor as soon as possible but no later than one (1) week after the Exam/Quiz. The Department determines the validity of the absence. If there is no valid excuse, the student will receive a mark of zero for the Exam/Quiz. No make-up quiz and no make-up midterm exam will be offered. In case of the midterm exam, when the absence is valid, the final grade for the course will be based on the marks obtained in the final exam. In the case of the missed quiz, the evaluation will be done with the other quizzes.

The final exam will take place during the examination period at the end of the semester. Students should not make any specific arrangements to leave the city until the final exam date is

posted. It is a closed book exam. One question of the final exam will be related to the project.

To pass the course, the student must achieve at least 50% on average of all course evaluation elements (quizzes, project, exams). In addition, students must obtain a minimum score of 40% on the final exam to pass the course.

Grading: Project 20%, Quizzes 20 %, Midterm 25 %, Final 35 %

Failing grade: Plagiarism, absenteeism, lack of preparation, and lack of regular effort will result in a failing grade.

8 Academic Code of Conduct

Students are strongly advised to acquaint themselves with the University's Academic Code of Conduct (see http://web2.concordia.ca/Legal_Counsel/policies/english/AC/Code.html): Any form of cheating, plagiarism, personation, falsification of a document as well as any other form of dishonest behaviour related to the obtention of academic gain or the avoidance of evaluative exercises committed by a student is an academic offense under this Code (Concordia University Academic Code of Conduct, 2001).

Students should take particular care to cite the sources of your information, ideas, quotations or data; failure to do so results in plagiarism which is defined as the taking of another person's work and presenting it as your own original thought or research idea (Northey and Knight, 1992). The use of unreferenced quotations or data is the most common form of plagiarism, but there are other forms that are equally prohibited. These include the use of another student's paper under your own name, the submission of the same (or a similar) project in two different courses without the permission of both professors, and the purchase of a paper from a commercial '*term paper service*". Presenting someone else's ideas in your own words without reference is also plagiarism.

For further details of the Academic Code of Conduct, including procedures involved in sanctioning students who commit an offence under the Code please visit the Student Advocate Program site: http://advocacy.concordia.ca/student_advocate/advocate.html

9 Student Services

- **Concordia Counseling and Development** offers career services, psychological services, student learning services, etc.
  http://cdev.concordia.ca
- **The Concordia Library Citation and Cycle Guides:**
  http://library.concordia.ca/help/howto/citations.html

- **Advocacy and Support Services:**
  http://supportservices.concordia.ca
- **Student Transition Centre:**
  http://stc.concordia.ca
- **New Student Program:**
  http://newstudent.concordia.ca
- **Office for Students with Disabilities:**
  http://supportservices.concordia.ca/disabilities/
- **The Academic Integrity Website:**
  http://provost.concordia.ca/academixintegrity/

10 Disclaimer

In the event of extraordinary circumstances beyond the University' s control, the content and/or evaluation scheme in this course is subject to change.