**Computing Theory and Scientific Applications**

Department of Computer Science / Lakehead University/ B.Sc. Program

Winter 2024

Instructor Information

Instructor: Xing Tan

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Office Hours: Wed. 2:30pm to 3:30pm, and by appointment

Course Identification

Course Number: COMP-5413

Course Name: Computing Theory and Scientific Applications

Course Location: Zoom/Online

Class Times: Tue./Thu. 11:30pm – 1:00pm

Prerequisites: Requisite with no print text exists

**Course Description/Overview**

This is a graduate course in computing research, covering methods and techniques for reliable and efficient implementations of algorithms for complex problems in Computer Science, and their applications in other branches of science. Topics may include Computational Logics and Reasoning, Foundations in Algorithms Analysis and Computational Complexity, Graph Algorithms (Greedy Algorithms and Dynamic Programming), Linear Programming and Integer Programming (Branch and Bound), Searching and Backtracking, Structural Modelling and Prediction, Sampling.

**Course Learning Objectives**

Upon completing the course, students will be able to:

* Demonstrate a familiarity with major algorithms and numerical methods, and recognize their application limitations.
* Design algorithms to solve problems in Computer Science and related application fields.
* Develop the ability to analyze algorithms and computational complexity, particularly in terms of lower and upper bounds for time and space complexity.
* Synthesize efficient algorithms in scientific applications use-cases.
* Implement numerical algorithms for solving complex problems that cannot be solved easily by analytical mathematics methods.
* Model, simulate, implement, and validate algorithms for applications in sciences and engineering.
* Recognize the application limitations of existing algorithms and systematically develop ideas to solve them.
* Demonstrate personal and group (if any) responsibility and accountability in carrying out the related assignments and term project.

Course Resources

*Course Website(s)*

* On D2L

*Required Course Text*

* Cormen, Leiserson, Rivest, and Stein, Introduction to Algorithms, 4th Edition, MIT Press, 2022.
* Brachman and Levesque. Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
* Russell and Norvig. Artificial Intelligence: A Modern Approach, 4th Edition, Pearson, 2021.

Course Schedule/Outline

Week 1-2: Introduction to Algorithms

- Overview of the course, objectives, and expectations

- Basics of algorithm design and analysis

- Introduction to Cormen et al.'s "Introduction to Algorithms"

- Computational Logics and Reasoning

Week 3-4: Foundations in Algorithms Analysis and Computational Complexity

- Big-O notation and algorithm complexity

- Lower and upper bounds for time and space complexity

- Analyzing and comparing algorithms

- Assignments on algorithm analysis

Week 5-6: Graph Algorithms

- Graph theory fundamentals

- Greedy Algorithms

- Dynamic Programming

- Practical applications and case studies

Week 7-8: Linear Programming and Integer Programming

- Introduction to linear programming

- Integer programming and Branch and Bound method

- Applications in optimization problems

- Problem-solving sessions

Week 9-10: Searching and Backtracking

- Search algorithms and strategies

- Backtracking techniques

- Solving complex problems through search and backtracking

- Implementing search algorithms

Week 11-12: Structural Modeling and Prediction, Sampling

- Structural modeling in computational problems

- Prediction algorithms

- Sampling techniques and their applications

- Group project initiation and progress check

Week 13: Course Review and Project Presentations

- Recap of key concepts

- Review and preparation for the 2nd term test

- Presentation of group projects and their applications

- Closing remarks and feedback

Assignments and Evaluations

Term Tests 60%

* Test One (Feb. 15th, online, 30%)
* Test Two (Apr. 4th, online, 30%)

Course Project 40% (Due Date: Apr. 4th)

***Late Assignments***

Assignments will NOT be accepted. A make-up midterm will NOT be provided. If you miss the assignments or midterm for medical reasons (with valid document provided), the weight will be added to the weight of the final exam. However, you cannot move all weights for assignments and midterm to the final. The final exam is to be held during the university examination period. The exact date is to be announced by the university administration. It is your responsibility to write the exam at the announced time and exam room.

***Assignments***

General Rubric for Assignment Evaluation

 Criteria: Content and Understanding (Out of 100 marks)

 >85 (Excellent): Thoroughly and accurately solves each problem, demonstrating a deep understanding of the concepts. Provides clear explanations with proper formatting. Applies correct logic in program execution and memory hierarchy generalization.

 >75 (Very Good): Mostly accurate solutions with a solid understanding of the concepts. Minor errors or omissions may be present but do not significantly impact the overall quality. Provides reasonable explanations.

 >60 (Satisfactory): Demonstrates a basic understanding of the problems. Solutions may contain significant errors or omissions. Explanations may lack depth or clarity.

 <60 (Needs Improvement): Limited understanding of the concepts. Solutions contain major errors or are incomplete. Explanations are unclear or lacking in detail.

 Criteria: Presentation and Structure (Out of 100 marks)

 >85 (Excellent): Information is presented in a highly organized and clear manner. Structure is easy to follow, and formatting is flawless.

 >75 (Very Good): Well-organized presentation with minimal deviations from clarity. Formatting, grammar, and spelling are mostly correct.

 >60 (Satisfactory): Information is presented with some organization. Structure may lack clarity in some parts. Formatting, grammar, and spelling errors may be noticeable but do not hinder understanding significantly.

 <60 (Needs Improvement): Lack of organization impacts overall clarity. Structure is unclear, and formatting, grammar, and spelling errors are pervasive.

 Criteria: Critical Analysis and Synthesis (Out of 100 marks)

 >85 (Excellent): Demonstrates exceptional critical analysis and synthesis. Integrates multiple perspectives and exhibits a deep understanding of the topics.

 >75 (Very Good): Shows strong critical analysis and synthesis. Integrates multiple perspectives and exhibits a solid understanding of the topics.

 >60 (Satisfactory): Demonstrates basic critical analysis and synthesis. Some integration of perspectives is present, but depth may be lacking.

 <60 (Needs Improvement): Critical analysis and synthesis are limited. Integrates few perspectives, and depth of understanding may be inadequate.

 Criteria: Adherence to Instructions (Out of 100 marks)

 >85 (Excellent): Fully adheres to all instructions provided in the assignment prompt. Includes all required elements and follows specified guidelines accurately.

 >75 (Very Good): Mostly adheres to instructions. May have minor deviations but follows the majority of guidelines accurately.

 >60 (Satisfactory): Adheres to some instructions. May have noticeable deviations but generally follows the main guidelines.

 <60 (Needs Improvement): Deviates significantly from instructions. Fails to follow key guidelines, impacting the overall quality of the assignment.

Course Policies

In this course, regular attendance is expected, and punctuality is emphasized to ensure a focused learning environment. Active participation in class discussions is encouraged, fostering a respectful and collaborative atmosphere. Assignments must be submitted on time, and plagiarism is strictly prohibited. Group work is promoted, with equal contributions expected. Examinations are conducted per the schedule, and any form of cheating results in disciplinary action. Safety regulations must be followed during lab sessions, and students are encouraged to attend office hours for additional assistance. Open communication is essential, with official correspondence conducted through designated channels. Overall, adherence to these policies is crucial for creating a positive and effective learning experience in the course.

Collaboration/Plagiarism Rules

In this course, collaboration on academic exercises is subject to specific rules to maintain academic integrity. While collaboration is encouraged for enhancing learning, individual understanding is crucial for assessments. All submitted work must be the result of individual effort unless explicitly stated otherwise. Collaborative efforts should be limited to discussions and brainstorming; the actual work and writing must be independent. Plagiarism, defined as using someone else's work without proper attribution, is strictly prohibited. This includes but is not limited to copying from peers, online sources, or previous students' submissions. Proper citation and acknowledgment of sources are required. Any violation of these rules will result in severe consequences, ranging from a zero on the assignment to potential course failure or academic disciplinary actions. It is the responsibility of each student to be familiar with and adhere to these rules, ensuring the maintenance of academic honesty and the integrity of the learning process.

University Policies

The instructor has been requested to employ a variety of measures, tools and heuristics to identify possible breaches of academic integrity, and to immediately bring identified cases to the attention of the department's administration for further investigation and consideration of the full range of disciplinary measures. Possible penalties for violating academic honesty policies may include zero on the test or assignment without an option to rewrite, failure in the course, a permanent grade of record, and/or a transcript notation. Subsequent violations may result in suspension or expulsion from the University. By taking this course and participating in its evaluation activities, you confirm that you have read and understood the above and that you will at all times adhere to the academic honesty rules and policies laid by the instructor, the Department and the University. That is, in alignment with the university's Student Code of Conduct (https://www.lakeheadu.ca/students/student-life/student-conduct), collaboration in this course is governed by specific rules to maintain academic integrity. The Student Code of Conduct outlines the expected behavior and ethical standards for all students. It is imperative that students adhere to these standards to foster a fair and respectful learning environment. Additionally, any form of academic misconduct, including plagiarism, is strictly prohibited. The university's policy on Academic Misconduct (link above) provides detailed information on what constitutes academic dishonesty and the consequences for such actions. It is essential for students to be aware of and adhere to these policies to uphold the values of academic honesty.

Furthermore, the university is committed to providing accommodations for students with disabilities to ensure equal access to education. The Accommodation for Students with Disabilities policy (https://www.lakeheadu.ca/students/student-life/student-services/accessibility/resource-faculty-staff/accommodation-information) outlines the process for requesting accommodations and the responsibilities of both students and instructors in this regard. Students with disabilities are encouraged to engage with the relevant university office to facilitate the accommodation process and enhance their learning experience. By understanding and abiding by these policies, students contribute to a positive and inclusive educational environment while upholding the highest standards of academic conduct.

Additional Information

*N/A*

Additional Resource

N/A