MATH 441

Discrete Optimization Problems   *Course Outline 2023W2*

Formulation of real-world optimization problems using techniques such as linear programming, network flows, integer programming, dynamic programming. Solution by appropriate software.

MATH 441 is a project-based course which emphasizes mathematical research, communication, collaboration, computation and reflection. Students will collaborate on a group project and also work independently to create a personal learning portfolio. The group project is an opportunity for students to research a single topic in depth and the learning portfolio is a self-directed project where students demonstrate their individual learning over a range of topics.

Learning Goals

- Formulate well-defined optimization problems based on real-world phenomena
- Describe and contrast algorithms for solving optimization problems
- Describe and contrast the computational complexity of optimization problems
- Use mathematical software to compute solutions of optimization problems
- Communicate solutions of optimization problems to a general mathematical audience

Instructors

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Lectures

Monday/Wednesday/Friday	11–12pm	ANGU 254

Prerequisites

MATH 340 Introduction to Linear Programming is *required*. It will also be *very* helpful if students have completed MATH 200, 210 and 307. See the UBC Course Schedule.

Assessments

Learning Portfolio	50%
Group Project	50%

Students will submit work throughout the semester and receive feedback from instructors. There will be no grades assigned during the semester. Final grades for projects and portfolios will be proposed by students and finalized during interviews with instructors at the end of the semester.

Group Project

- Students form their own groups of 3–4 members and formulate their own problem statement
- Submit proposal and progress report during the semester
- Submit final report at the end of the semester
- All groups are expected to give a short presentation at the end of the semester
- Final report includes a group reflection and grade proposal
- Each group meets with instructors to discuss the project and grade proposal

Learning Portfolio

- Students create artifacts to demonstrate their learning
- Students submit work for feedback during the semester
- Content and format of the portfolio is determined by the student
- Final portfolio includes a reflection and grade proposal
- Each student meets with instructors to discuss the portfolio and grade proposal

Schedule

Week #	Topics
1	**Overview.** Mathematical modelling process, problem formulation, classification of optimization problems, Python and Jupyter.
2,3,4	**Linear Programming.** Simplex method, duality theory, SciPy solvers. Applications: network flows, L1 optimization.
5,6,7	**Combinatorial Optimization.** Integer programming, greedy algorithms, heuristics, dynamic programming, computational complexity. Applications: routing, scheduling, packing, cutting, games.
8,9	**Quadratic Programming.** Formulation, duality theory, interior point methods, CVXPY. Applications: portfolio optimization.
10,11	**Interior Point Methods.** Barrier problem, central path, KKT systems.
12	**Group Project Presentations**

Important Dates

January 8	First lecture
February 19–23	Reading break (no lectures)
March 29	Good Friday (University closed, no lecture)
April 1	Easter Monday (University closed, no lecture)
April 12	Last day of class

- See the UBC Academic Calendar 2023/2024

Student Resources

Science Advising	Health and Wellbeing	Centre for Accessibility
Academic Concession	Academic Integrity	Counselling Services

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the UBC Senate website.