CO 450/650
Fall 2020
Online course

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TBD

Course outline

Combinatorial Optimization is a field that combines techniques from linear programming, combinatorics and algorithms to find the optimal solution of optimization problems over discrete sets. Typically, we are given a finite set and a cost function that assigns a cost to each element of the set and we are interested in finding the minimum cost element of that set in an efficient manner.

Since the set we are interested is usually not given explicitly, but in an implicit and efficient way, checking each element's cost is typically prohibitive. So, while it is hopeless to solve this problem without knowing anything about the structure of our set, in this course we will see a few of the basic discrete optimization problems that we can efficiently solve and develop the tools to understand how we can do so.

Topics will (hopefully) include:

1. Minimum spanning trees
2. Matroids
3. Flows and Cuts
4. Submodular functions
5. Matchings

Prerequisite:

Knowledge of linear programming (simplex, duality, complementary slackness) Knowledge of basic graph theory and algorithm runtime.

Adequate refreshers for these are:

- Chapters 1, Appendix A of the Cook, Cunningham, Pulleyblack, Schrijver (CCPS) book
- Chapters 1-3 of the Korte-Vygen book (KV)

Web Sites:

We will be using two websites for the course:

- **Piazza - https://piazza.com/uwaterloo.ca/fall2020/co450650/home**

  The main website of the course will be the Piazza website.

  Throughout the semester, I will also post in-class topics, readings, and other course materials (handouts, homework, solutions, etc.) on the piazza course web site.

  Besides regular posting of class material, Piazza allows for class discussion and Questions/Answers in a collaborative manner so that everyone has access and can help.

  The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Note that piazza allows for private questions to be asked too if needed. Please only use email to the teaching staff for issues that are unique to you (like an illness, a regrade request, a special circumstance, etc.).

  If you were enrolled in the class at the beginning of the term, you should already be enrolled in the Piazza website. If not, you may sign up directly at the above webpage.

  A note on the site usage: please do not ask questions like "What is the answer to question 1?". I encourage you to ask questions related directly to course content and/or questions like typos/extra assumptions needed in homeworks. Asking for hints is also ok. If in doubt, please use the private question feature in piazza and if the instructor team feels it is appropriate, we will convert it to a public note.

- **D2L - http://learn.uwaterloo.ca**

  The D2L website will be used mostly for its gradebook functionality and for posting course material (videos, pdfs, etc). You should get automatic access to the course website using your WATIam account/password.

Books and Supplementary Material

We will follow the following book as a guide:

(CCPS) Combinatorial Optimization, W. Cook, W. Cunningham, W. Pulleyblank and A. Schrijver. Wiley-Interscience, 1997. https://proxy.lib.uwaterloo.ca/login?url=https://onlinelibrary.wiley.com/doi/book/10.1002/9781118033142

In addition, the following book is also a very helpful additional source:

(KV) Combinatorial Optimization, B. Korte and J. Vygen. Springer, 2012. https://link-springer-com.proxy.lib.uwaterloo.ca/book/10.1007%2F3-540-29297-7

Both books are available in electronic format through the UWaterloo library website (authentication is required with your WatIam credentials).

Grading

Course grades will be calculated according to the following formula:

Lecture participation	15%
Homework	25%
Midterm exam	25%
Final Exam	35%

The grading for CO 450 will typically be done by a subset of the questions for CO 650.

Note on late assignments: Homework assignments handed in late will incur a late penalty of 50% per late day. Please take into account potential technical difficulties when submitting assignments and try to submit assignments well in advance of the deadline. Note that crowdmark allows for updating your submission, that is, if you want to submit something early on and then want to edit it later, you are allowed to do so (up until the deadline).

Homeworks

There will be one homework every 2 weeks (released/due Thursday), with the first one out on September 10, 2020.

Midterm

The midterm will be held on Wednesday, October 21, 2020. It will be a take-home exam, where students will get the exam from crowdmark and will have a limited time to do it on their own and submit their answers. Crowdmark supports the feature of individual timing, so that each person can download the exam at the time they find more convenient (within a 24h window) and their deadline will be adjusted accordingly automatically by Crowdmark.

Lecture participation mark

1. On the Monday of each week, I will release videos covering the material of the week.
2. On those videos, some results will have their proofs skipped (marked with an "S") and others will have details left out - I will explicitly mark this with a green "Show" mark. The results that are skipped you don't need to go over the proofs, but you need to know the results - you may need to apply them in other settings.

3. You are supposed to figure out the details on your own of the "Show" parts after you watch the videos.

4. There will be a weekly synchronous session *(SS)*. It will be held on Mondays, at 1:30pm, Waterloo time.

5. The class will be divided in groups of 2/3 students each.

6. In each (SS), a responsible group will be assigned to show to the whole class the details of the proofs with a "Show" mark for that given week.

7. The group will record a video ($\leq$ 30mins long) showing those detailed proofs and send me the day before the (SS).

8. During the (SS), I will play the video and everyone can ask questions, which will be addressed by someone from the group.

9. A grade of up to 8% will be given for the whole responsible group. I will not evaluate video editing quality, but correctness and clarity in explaining the concepts.

10. A grade of up to 7% will be given for students that attend the (SS) as follows:

    - Attending 1-5 (SS): 1% per (SS) attended
    - Attending 6-8 (SS): 6%
    - Attending 9+ (SS): 7%

11. Attendance will be taken by polls done at the time of the (SS).

12. Students that feel they will be unable to complete the requirements for the lecture participation mark should contact me as soon as possible to make alternative arrangements.

Reviewing: Every student has the right to request a review of their homeworks and exams if they feel that there was a mistake in the correction and/or grading. The request must be done in writing. Students must send an email to both myself and the TA, stating the question to be reviewed and the reason you believe that the correction/grading was incorrect. The deadline for requesting a review is 1 (one) week after the graded work was handed out to the whole class.

Collaboration and acceptable sources of help:

No collaboration is allowed unless otherwise stated. The only acceptable sources of help you may get is myself or the TA, your course notes and the above textbook(s). Any other sources of help (including, but not exclusively, getting help online, talking or consulting with other people by any means, getting access to exams or assessments outside your individualized time window) are not acceptable and consists of cheating, and will yield a mark of 0 in the corresponding assessment and will be reported to the appropriate Associate Dean.

On the INC Mark:

A grade of INC will only be awarded to students who cannot write the final exam for exceptional and justifiable reasons. In addition such students need to be in good standing prior to the final exam. To be in good standing a student must have a passing average in the assignments and the midterm. If you are not in good standing and/or miss the final exam due to a reason considered to be non-justifiable, then you will receive a grade of DNW.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.

[Check `www.uwaterloo.ca/academicintegrity/` for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4,
`http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm`.
When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline,
`http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm`
For typical penalties check Guidelines for the Assessment of Penalties,
`http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm`

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals,
`http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm`.

Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.