CMPUT 675 **Approximation Algorithms** **Fall 2014**

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Course Website: http://webdocs.cs.ualberta.ca/~zacharyf/courses/approx_2014

Lecture: MWF 1:00 - 1:50 pm, CSC B 41
Office Hours: 2:00 - 3:00 pm on Monday and Tuesday

OVERVIEW:
We will study a class of computational problems known as *discrete optimization problems*. You may already know some: the shortest path problem, the traveling salesman problem, the knapsack problem. Although some can be solved in polynomial-time, many are NP-hard.

To cope with this difficulty, we will design polynomial-time algorithms that compute near-optimum solutions to such problems. To measure the quality of these algorithms, we will provide bounds on how far the solutions produced by these algorithms can deviate from the optimum solution. Algorithms with such performance guarantees are called *approximation algorithms*.

Later in the course, we will also explore *inapproximability*: lower bounds on how well we can efficiently approximate certain problems under plausible hypotheses like P $\neq$ NP.

PREREQUISITES: I will assume a basic knowledge of linear algebra and standard graph theory concepts. A background in algorithms at the level of CMPUT 304 is necessary.

GRADING: 5 assignments (12% each), scribe notes (15%) and a final project (25%). The grad cutoffs are A - 80%, B - 70%, C - 60%, D - 50%. Below 50% is a fail.

ASSIGNMENTS: You will have 2 weeks to complete each assignment. You will not be required to code anything at any point in this class.

SCRIBE NOTES: Students will take turns recording scribe notes throughout the semester. They must be typeset in LaTeX and submitted to me by email within 3 days of the lecture. I will post them on the course page after, perhaps, ironing out some kinks. A LaTeX template will be provided on the course page.

FINAL PROJECT: Deliver a presentation on the topic of your choice (it must be related to the course and approved by me). More information will be posted by October 15 on the course page, including a list of suggested topics.

RESOURCES: There is no required textbook. Scribe notes from each lecture will be posted on the course website. Most lecture topics will be taken from the following book, which is available in the bookstore.

The Design of Approximation Algorithms, David P. Williamson and David B. Shmoys, Cambridge University Press, 2011.

http://www.designofapproxalgs.com/

Links to relevant papers will also be posted on the course page.

REPRESENTATIVE EVALUATION MATERIAL: A "calibration assignment" is available on the course page and may be completed immediately. This is entirely optional and does not count toward your final grade. You may submit your answers any time before the 1st assignment is due. I will grade them and provide comments within 3 days of submission. This is to provide an example of how I mark assignments.

CONCEPTS:

- **Classic Techniques**: Greedy, dynamic programming, local search.
- **Mathematical Programming**: Linear programming, duality, structure of extreme points, primal-dual algorithms, iterative techniques, semidefinite programming.
- **Lower Bounds**: Expander graphs, probabilistically checkable proofs, parallel repetition, the linearity test, unique games.
- **Miscellaneous**: Metric embeddings. Others may be added, depending on time.

For the most part, the topics will be presented in an example-oriented manner. Some keywords that describe some problems we will discuss are job scheduling, traveling salesman, network design, facility location, covering and packing, constraint satisfaction, graph cuts, etc.

MISSED ASSIGNMENTS: I intend to post solutions for each assignment shortly after they are due. For this reason, I cannot accept late assignments. A student who cannot complete an assignment due to incapacitating illness, severe domestic affliction or other compelling reasons can apply for a transferral of the weight of the missed term work to other term work. The final project must be completed, so a student who cannot complete this project in time for similar reasons can apply for an extension. Deferral of term work is a privilege and not a right; there is no guarantee that a deferral will be granted. Misrepresentation of Facts to gain a deferral is a serious breach of the Code of Student Behaviour.

ACADEMIC INTEGRITY: The University of Alberta is committed to the highest standards of academic integrity and honesty. 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 Code of Student Behaviour (online at `www.governance.ualberta.ca`) and avoid any behaviour which 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

All forms of dishonesty are unacceptable at the University. Any offence will be reported to the Associate Dean of Science who will determine the disciplinary action to be taken. Cheating, plagiarism and misrepresentation of facts are serious offences. Anyone who engages in these practices will receive at minimum a grade of zero for the exam or paper in question and no opportunity will be given to replace the grade or redistribute the weights.

Policy about course outlines can be found in 23.4(2) of the University Calendar.

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class.