Department of Electrical and Computer Engineering
ECE 7360: Combinatorial Optimization

Syllabus

Instructor: Waleed Meleis, Associate Professor
Email: meleis.comb@westernfog.com
Office: 320 Dana
Mailbox: 409 Dana

CONTENT

An introduction to combinatorial optimization, a field that combines techniques from applied mathematics, operations research and computer science to solve optimization problems over discrete structures. Emphasizes problems that arise in the areas of Electrical and Computer Engineering, including (but not limited to) VLSI, computer aided design, parallel computing, computer architecture, and high performance compiling. Covers the foundations of algorithm analysis, including asymptotic notation and complexity theory, and a range of optimization techniques, including divide and conquer, local optimization, dynamic programming, branch and bound, simulated annealing, genetic algorithms, approximation algorithms, integer and linear programming, and greedy algorithms. Considers the efficient generation of optimal solutions, the development and evaluation of heuristics, and the computation of tight upper and lower bounds.

TOPICS COVERED

1. Analysis of algorithms
2. Complexity theory
3. Greedy algorithms
4. Linear programming
5. Integer programming/Branch and bound
6. Local search (tabu search, simulated annealing, genetic algorithms)
7. Network flow

PREREQUISITES

Students should be familiar with a high-level programming language such as C, C++ or Java and should have some background in algorithm design. It is best to have taken Fundamentals of Computer Engineering first, but that is not essential.

STRUCTURE AND REQUIREMENTS

Written homework will be assigned every few weeks and you will complete a project. The project will be broken up into smaller units that you will complete throughout the semester. There will be several quizzes given during the semester and no final exam.

You are strongly encouraged to attend all lectures, complete all assignments, and regularly do the reading. Your final grade for the class will be based on the following breakdown: 30% homework, 45% quizzes, and 25% research project. A satisfactory score in each area is required.

POLICIES

Homework assignments have fixed due dates. No late submissions will be accepted. Projects also have due dates, but you can have a three-day extension of each project deadline if you are making good progress on that project.

If you miss a quiz, you will not be allowed to retake it. All course requirements must be completed during the semester. No incompletes will be given.

Class attendance is required. If you miss a lecture, you are responsible for all material that was covered, announcements that were made, and handouts that were distributed in class.

If you have a question about the grading of a homework problem you should first contact the teaching assistant directly. If the issue is not resolved to your satisfaction, please contact me.

You should check the class website daily for announcements and other information.

Students are encouraged to work together on homework assignments, but the solutions you turn in must be your own. Copying someone else's work and presenting it as your own, or submitting the same solution as someone else, is not allowed. You must not look at another student's assignment, or allow another student to look at your assignment. Collaboration on the project is allowed.

All students must adhere to Northeastern University's Policy on Academic Integrity. If you violate this policy will receive a lower grade in the course, and may receive an F. You will also be referred to NU's Office of Student Conduct where penalties range from deferred suspension to expulsion from the university.

Exceptions to any course policy may be made if you have a personal emergency that prevents you from participating in the course. In this case you must make arrangements with me as soon as possible, preferably within 24 hours.

READING

Lectures will cover much, but not all, of the required material for the course. There will be reading assignments that accompany each lecture, and you are also responsible for this material. Reading assignments for each lecture topic are listed on the course website.

Most readings are in the coursepack which is on sale in the NU bookstore.

1. E. Aarts and J. Lenstra, *Local Search in Combinatorial Optimization*, Wiley, 1997. 0471948225
2. R. Ahuja, T. Magnanti, and J. Orlinand, *Network Flows: Theory, Algorithms, and Applications*, Prentice Hall, 1993. 013617549X
3. G. Brassard and P. Bratley, *Fundamentals of Algorithmics*, Prentice Hall, 1996. 0133350681
4. W. Cook, W. Cunningham, W. Pulleyblank, and A Schrijver, *Combinatorial Optimization*, Wiley Interscience, 1998. 047155894X
5. T. Cormen, C. Leiserson, R. Rivest, and C. Stein, *Introduction to Algorithms*, McGraw Hill, 1991. 0070131430
6. R. Fourer, D. Gay, and B. Kernighan, *AMPL: A Modeling Language for Mathematical Programming*, Boyd & Fraser, 1993. 0894262327

7. M. Garey and D. Johnson, *Computers and Intractability: A Guide to the Theory of NP Completeness*, Freeman, 1997. 0716710455

8. F. Hillier and G. Lieberman, *Introduction to Mathematical Programming*, McGraw-Hill, 1995. 0079118291

9. E. Lawler, J. Lenstra, A. Rinnooy Kan, and D. Shmoys, *The Traveling Salesman Problem: A Guided Tour of Combinatorial Optimization*, Wiley, 1997. 0471904139

10. C. Papadimitriou and K. Steiglitz, *Combinatorial Optimization: Algorithms and Complexity*, Dover, 1998, 0486402584

11. H. Williams, *Model Building in Mathematical Programming*, Wiley, 1998. 0471941115

POLICY ON ACADEMIC INTEGRITY

Northeastern University is committed to the principles of intellectual honesty and integrity. All members of the Northeastern community are expected to maintain complete honesty in all academic work, presenting only that which is their own work in tests and all other assignments. If you have any questions regarding proper attribution of the work of others, please contact me prior to submitting the work for evaluation.

Academic integrity is important for two reasons. First, independent and original scholarship ensures that students derive the most from their educational experience and the pursuit of knowledge. Second, academic dishonesty violates the most fundamental values of an intellectual community and depreciates the achievements of the entire university community.

Accordingly, Northeastern University views academic dishonesty as one of the most serious offenses that a student can commit while in college. The following is a broad overview of what constitutes academic dishonesty, but is not meant to be an all-encompassing definition.

Cheating: Intentionally using or attempting to use unauthorized materials, information or study aids in any academic exercise.

Plagiarism: Intentionally or knowingly representing the words or ideas of another as ones own in any academic exercise without providing proper documentation of source by way of a footnote, endnote, or intertextual note.

Unauthorized Collaboration: This refers to instances when students, each claiming sole authorship, submit separate reports which are substantially similar to one another. While several students may have the same source material (as in case write-ups), the analysis, interpretation, and reporting of the data must be each individuals.

All members of the Northeastern University community, students, faculty, and staff share the responsibility to bring forward known acts of apparent academic dishonesty. Any member of the academic community who witnesses an act of academic dishonesty should report it to the appropriate faculty member or to the Director of Judicial Affairs. The charge will be investigated and if sufficient evidence is presented, the case will be referred to Northeastern University Student Judicial Hearing Board. If found responsible of an academic dishonesty violation, a minimum sanction of probation will follow. (adapted from NU's Academic Honesty and Integrity Policy)