State University of New York Polytechnic Institute
CS 538: Advanced Algorithms

Instructor:	Dr. Chen-Fu Chiang
Semester:	Spring 2017
Topic:	Introduction to Approximation and Randomized Algorithms for Optimization
Time:	MW 2:00 pm - 3:15 pm
Location:	Kunsela Hall C212
Office Hours:	MW: 3:30 pm - 5:00 pm | TR:10:00 am- 11:30 am | By appointment
Office:	Kunsela C225
Email:	chiangc@sunyit.edu
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Text and References

Required: ISBN-13: 978-3642084690 (Approximation Algorithms by Vazirani)
Optional: ISBN-13: 978-0521195270 (The Design of Approximation Algorithms by Williamson and Shmoys)
Optional: ISBN-13: 978-0521835404 (Probability and Computing: Randomized Algorithms and Probabilistic Analysis by Mitzenmacher and Upfal)

Prerequisites

It is important that you have a foundation on both the theoretical and empirical fronts. You should have taken classes (or their equivalents) in Programming, (Matrix) Linear Algebra, Computational Complexity, and Algorithms.

Course Description

This course is designed to give a graduate-level student a thorough grounding in the formulation of optimization problems that exploits data structures and deploys efficient solution methods for these problems. We will introduce methods of optimization to computer science students, including linear programming, network flow algorithms, online algorithms, randomize algorithms (Markov Chains and Random Walks) and Monte Carlo based algorithms. The goal is to maintain a balance between theory, numerical computation, problem setup for solution by optimization. These general concepts will also be illustrated through applications in statistics, machine learning, AI, computer vision and robotics.

Course Objectives

- Familiarize students with the basic concepts associated with the filed of optimization
- Introduce students specific problem areas of study within optimization and help students develop research skills
- Explore current state-of-the-art approaches and techniques used in research in this field

Course Outcomes

- Identify and describe basic concepts associated with the field of optimization

- Design optimization models and develop the ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- Formulate and approximate solutions for optimization problems and be able to use current techniques, skills, and tools necessary for finding optimal solutions
- Develop the ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.

Topics

- Approximation Algorithms
  - Vertex Cover / Set Cover
  - Steiner Tree
  - Metric TSP Problems
- Rounding Linear Programs
  - Vertex Cover / Set Cover
  - Duality
- Network Flows
- Multi-commodity Flow and Sparsest Cut
- Maximum Matching
  - Bipartite Graphs
- Online Algorithms
  - Ski Problem
  - Bin Packing
- Markov Chains and Random Walk
  - A Randomized Algorithm for 3-SAT
  - Stationary Distributions
  - Random Walks on Undirected Graphs
- The Monte Carlo Method
  - The DNF Counting Problem
    - A Fully Polynomial Randomized Scheme for DNF Counting
  - The Metropolis Algorithm
- Quantum Algorithms
  - Adiabatic Optimization versus Diffusion Monte Carlo Methods
- If time allows, we will explore topics in convex optimization, such as Semidefinite Programming.

Grading (Tentative)
The lecture format will be the basic mechanism used in the course. Computer demonstrations in the classroom will be used whenever appropriate. Assessment of student performance will use a criterion-referenced model which will include written assignments (25%), a midterm examination and a comprehensive final examination (20% each), lecture note scribing (10%) and a project (25%).
Homeworks are with both written and programming parts. Each homework is centered around deepening your understanding of the theoretical concepts. Students are welcome to study together to work out homework solutions. Students can form groups of size up to three for the assignment tasks. The examinations will test your knowledge and problem-solving skills on all preceding lectures and homeworks. Each lecture scribing should be done by two (or three) persons by following the given template written in LaTeX . The final project is consisting in describing and summarizing results from one (or a few) recent research papers. Projects should be done in groups of up to three. We will specify the details of the project topics during the semester.
Late assignment and report will not be accepted unless you have made prior arrangements with me. The acceptable format of your solution will be specified in the assignment. All examinations are closed-book. A typical grading scale will be as follows:

Percent	Grade
93 - 100	A
90 - 92	A-
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
70 - 72	C-
65 - 69	D+
60 - 64	D
Below 60	F

Attendance Policy
Attendance and active class participation are required. Be prepared to participate by asking and answering questions during class meetings. Please send me an email if you know you have to miss a class.

Academic Integrity/Policy
Plagiarism and Cheating of any kind on an examination, quiz, or assignment will result at **least in an F** for that assignment (and may, depending on the severity of the case, lead to an F for the entire course). I will assume for this course that you will adhere to the academic creed of this University and will maintain the highest standards of academic integrity. In other words, **do not** cheat by giving answers to others or taking them from anyone else. The code of academic conduct is detailed in the SUNY Poly student handbook. Make-ups are only given under **extreme circumstances**. I will also adhere to the highest standards of academic integrity, so please do not ask me to change (or expect me to change) your grade illegitimately or to bend or break rules for one person that will not apply to everyone.

Accommodations for Students with Disabilities registered at SUNY Polytechnic Institute
In compliance with the Americans with Disabilities Act of 1990 and with Section 504 of the Rehabilitation Act, SUNY Polytechnic Institute is committed to ensuring educational access and accommodations for all its registered students seeking access to meet course requirements and fully participate in programs or activities. SUNY Poly students with documented disabilities and medical conditions are encouraged

to request these services by registering with the Disability Services Office and discussing your need for accommodations. For information or an appointment contact Suzanne Sprague at the Disability Services Office, located in Utica room B101 Kunsela Hall, in Albany in the Student Services Suite 1602 Nano Fab East, or by phone (315) 792-7170; or e-mail suzanne.sprague@sunyit.edu.