Syllabus MA 598 Topics on optimization algorithms, Spring 2023

Course Information

- **MA59800 137** Topics on optimization algorithms (Convex Optimization)
- **Location & time:** SCHM 114 (REC 114) MWF 9:30 am-10:20 am
- **Instructional Method:** In person. Zoom will be used in case that the instructor cannot be in classroom due to health or other reasons.
- **Course webpage:** https://www.math.purdue.edu/~zhan1966/teaching/598/598_2023S.html

Instructor Contact Information

- **Name of the instructor** Xiangxiong Zhang (feel free to call me X)
- **Office Location** MATH 406
- **Email** zhan1966@purdue.edu
- **Office hours** 1:30pm-3pm on Wed, or other time by appointment.

Course Description

This is a graduate level topics course of convex optimization algorithms for any graduate students interested in modern large scale first order algorithms for convex optimization, with a heavy emphasis on analysis. The course will cover and focus on the following:

Part I: Smooth Optimization

- Global convergence and convergence rates of gradient descent method and Nesterov's accelerated gradient descent method for minimizing functions with Lipschitz continuous gradient under convexity and strong convexity assumptions.
- Standard results for smooth optimization such as local convergence rates of gradient descent and Newton's method, as well as convergence of line search methods for Newton, quasi-Newton and conjugate gradient methods.

Part II: Nonsmooth Optimization

- Global convergence and convergence rates of subgradient method, proximal point method.
- Global convergence and convergence rates of proximal gradient descent, and fast proximal gradient descent.
- Global convergence and convergence rates of popular first order splitting methods including PDHG (primal dual hybrid gradient), ADMM (alternating direction method of muliipliers) and Dougas-Rachford splitting.

Part III: Stochastic Algorithms

- Convergence of stochastic gradient descent and Langevin dynamics.

with selected topics mainly from but not limited to the following reference books.

Reference books

Those with * are available online via Purdue Library:

- Amir Beck, Introduction to Nonlinear Optimization*
- Amir Beck, First Order Methods in Optimization*
- Jorge Nocedal and Stephen J. Wright, Numerical Optimization*
- Yurii Nesterov, Introductory Lectures on Convex Optimization A Basic Course*
- Ernest K. Ryu and Wotao Yin, Large-Scale Convex Optimization: Algorithms & Analyses via Monotone Operators

Learning Resources, Technology & Texts

- Lecture notes and typed up notes will be posted on course webpage.
- Recommended reference books can be found on the course webpage.

Final Report/Presentation

There will be no homework or exams. Instead, during the semester students need to choose from a given list of papers or chapters in books to read and/or code the algorithms. Depending on the schedule of the last few weeks and number of students, a final representation of 15 minutes or a written final report is expected.

Attendance

The class attendance is required and will be strictly enforced. See University Academic Regulations regarding class attendance. More than three unexcused absences from the class will result in an F in the final grade.

Grading Scale

The final grade consists of 60% attendance and 40% of final report/presentation.

A: more than 85%
B: more than 70%
C: more than 60%
D: 50%-60%
F: below 50%

Intellectual Property

Lecture notes, zoom videos, and typed up notes are all copyrighted. Uploading any of these to any forum/website is strictly prohibited.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-

8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered.

Nondiscrimination Statement

A link to Purdue's Nondiscrimination Policy Statement can be found here:
https://www.purdue.edu/purdue/ea_eou_statement.php

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack**.** Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's

control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.