S&DS 431/631 Final project

The S&DS 431/631 Final Project is designed to enhance your understanding of convex optimization theories and methods, beyond regular coursework. This project encourages independent research, practical applications, critical comparison of optimization methods, or deep dives into theoretical milestones in convex optimization. While novel research is welcome, the **primary aim** is to **foster learning and mastery** of **new aspects of optimization not covered in class** or to **gain practical exposure to optimization techniques**.

Topics & Types of Project

Students can choose from various project types, allowing for flexibility based on interest and expertise. Here are the detailed descriptions of each project type:

Type 1: Real-World Application of Optimization Methods

In this project, students are expected to formulate a real-world problem as a convex optimization problem and develop or apply appropriate optimization methods to solve it.

- **Background and Problem Description:** Clearly describe a real-world problem, provide its background, current solutions, and their limitations.
- **Optimization Formulation:** Propose the formulation of the problem (or part of it) as a (convex) optimization problem, defining decision variables, objective function, and constraints and etc.
- **Solution Method:** Detail the algorithm or method used to solve the formulated optimization problem and discuss whether the solution is global or local optimum.
- **Verification:** Verify and interpret the obtained solution in the context of the original real-world problem, ensuring the solution is meaningful and practical.

Examples: Applications of convex (even nonconvex) optimization in Supply Chain Management, Portfolio Optimization, Statistical Estimation, Resource Allocation, Game Theory, and so on.

Type 2: Understanding Specific Optimization Problems or Methods

This project type focuses on a deep understanding of specific optimization problems or a family of optimization methods.

- **Theoretical Understanding:** Investigate the convergence properties, complexity, or other theoretical aspects of the chosen optimization problems or methods.
- **Practical Understanding:** Explore the practical implementation and performance of the chosen optimization problems or methods, possibly comparing various methods.

Examples: A in-depth study of a particular topic that is not covered in class. Understand its theoretical or empirical properties. For example,

- Mirror Descent,
- Frank-Wolfe method
- Alternating direction method of multipliers (ADMM)
- Distributed first-order optimization methods
- Zero-th order optimization
- Minimax optimization with convex-concave objective functions

Type 3: Original Research

This project type allows for the exploration of original research ideas related to optimization.

- Present new findings, methods, or insights in the field of optimization, ensuring the research is thorough and contributions are clear.

Teaming

You may opt to work **independently** or **form a team of two**. Collaborative projects should submit one collective set of deliverables. Independent projects, maintaining quality, will be recognized with higher grades.

Timeline & Deliverables

(1) Project Proposal (1 page, PDF): Due October 26, 11:59 pm (10% of the grade). This due date is not strict though. Feel free to update and modify your project plan. But if you modify the proposal, write an email to the instructor, TF, and ULAs with your updated proposal. In the title of the email, start with a flag `[SDS 431/631 Final Project]` to draw attention.

(2) Project Report (5-20 pages, PDF): Due December 14, 11:59 pm (70% of the grade). It is recommended that you utilize LaTeX for crafting your proposal and final report. Consider using the JMLR style file, available here: https://github.com/JmlrOrg/jmlr-style-file

(3) Final Presentation (Video + Slides): Due December 14, 11:59 pm (Combined weightage: 20% of the grade)

(3a) Video Presentation (Zoom recording, around 20 minutes, MP4).

(3b) Presentation Slides (PDF file)

Note: The Video Presentations and slides will be made available to the entire class. The final project is graded by the instructor (Zhuoran) only.

Submission

The deliverables are submitted separately as follows.

- The Project Proposal, Project Report, Presentation Slides (**all as PDF files**) are submitted on **Gradescope**. Each student should submit his/her project deliverables to Gradescope, even if it is teamwork.
- The Final Presentation is submitted via via email. Each group will email to the instructor, TF, and ULAs, copying the other group member. In the email title, use the flag `[SDDS 431/631 Final Project] [Presentation] Your Name` to highlight. In the email, also send a **PDF version** of the presentation, and **a downloadable link** to the presentation video. The slides and presentation videos will be gathered by the instructor and made available to the whole class.
- In the email submitting the presentation, include a Dropbox/Google Drive link to the MP4 file which contains your presentation video. Make sure the MP4 file is downloadable and keep the link valid for 30 days.
-