SI231B - Matrix Computations, Spring 2022-23

Course Projects

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SI231B projects are meant to be substantial and are, in fact, the most significant part of the final grade in the course. They should contain an overview of a particular problem and some independent work.

1 Specifications

Some specifications for the project:

- The length should be at least 5 single-column pages with 10pt font. Be brief and to the point.
- The project should be written using LaTeX (use an IEEE paper style or similar) and submitted in PDF format (do not use Word!).
- Keep a pdf copy of all the cited references (as you will have to send them to me with the final project).
- The student should read around 8 research papers on the chosen topic and cite at least 8 related papers.
- The project should start with a description of the problem: this should not be a separate overview of each of the papers one after another; instead, it should contain a unified problem formulation, explaining how each of the related papers fits within the general formulation.
- The related papers should be criticized: you should have an opinion on the papers that you read, you should be able to comment on the contribution and difficulty of each paper.
- Independent research: after the problem formulation and overview of the state of the art, the student should try to propose something new that improves on the existing approaches based on the contents learnt from this course.
- No plagiarism or self-plagiarism is allowed. (The student is never allowed to reuse his/her own published papers as the final project.)

2 Structure of the written report

In order to make the evaluation of the project as objective as possible, the written report should strictly adhere to the following structure with the sections (a penalty will be applied if the report is not organized according to the guideline):

1. Introduction: 10% grade
2. Overview of existing work (with unified notation): 20% grade
3. Criticism of the existing work: 20% grade
4. New contribution (if any): 20% grade
5. Numerical results: 10% grade
6. Conclusions: 10% grade

References: 10% grade

3 Schedule and submission

Please follow the deadlines below. They are strict deadlines and there will be penalties for not respecting them. In particular, the final reports late by 1 day will be penalized with 20% of the grade, late by 2 days will be penalized with 40% of the grade, and late by 3 days is most likely a FAIL.

1. *Topic:* By April 30th at 11:59 PM, the student should choose a topic (either inspired on the list of topics below or not, preferably the student will come up with a topic of his/her interest) with a brief plan on what he/she wants to do and email the instructor to get a confirmation.

2. *Final report:* By May 28th at 11:59 PM, submit your final report with all the cited references and codes (optional) with filename YourName.zip to the link: https://epan.shanghaitech.edu.cn/l/2FjEFs.

4 List of topics

Some potential reference topics for the projects include:

- Iteratively Reweighted ℓ_1-Penalized Robust Regression, *Electronic Journal of Statistics*, 2021
- High-Dimensional Quantile Regression: Convolution Smoothing and Concave Regularization, *Journal of the Royal Statistical Society Series B: Statistical Methodology*, 2022
- Communication-Efficient Distributed Statistical Inference, *Journal of the American Statistical Association*, 2019
- DGD^2: A Linearly Convergent Distributed Algorithm For High-dimensional Statistical Recovery, *Neural Information Processing Systems*, 2022
- A Linearly Convergent Proximal Gradient Algorithm for Decentralized Optimization, *Neural Information Processing Systems*, 2019
- DeEPCA: Decentralized Exact PCA with Linear Convergence Rate, *Journal of Machine Learning Research*, 2021
- Optimization-Induced Graph Implicit Nonlinear Diffusion, *International Conference on Machine Learning*, 2022
- A GNN-Guided Predict-and-Search Framework for Mixed-Integer Linear Programming, *International Conference on Learning Representations*, 2023
- Faster Algorithms for High-Dimensional Robust Covariance Estimation, *Conference on Learning Theory*, 2019
- A Proximal Distance Algorithm for Likelihood-Based Sparse Covariance Estimation, *Biometrika*, 2022
- High-dimensional Robust Mean Estimation via Gradient Descent, *International Conference on Machine Learning*, 2020
- Accelerating Ill-Conditioned Low-Rank Matrix Estimation via Scaled Gradient Descent, *Journal of Machine Learning Research*, 2021
- Speeding Up Latent Variable Gaussian Graphical Model Estimation via Nonconvex Optimization, *Neural Information Processing Systems*, 2017
- Sparse Reduced-Rank Regression with Covariance Estimation, *Statistics and Computing*, 2016