IERG 6120 Advanced Topics in Information Engineering I:
Convex and Stochastic Optimization and Applications
Instructions for the Final Project

Grade: 25% of the total score of the class

Important Deadlines:

1. Submission of the proposal for the final project: due October 9, 2024 in class
2. Submission of the project report: due November 27, 2024 in class

Instructions:

The final project is a student-selected research project that applies convex/stochastic optimization techniques to communication, networking, machine learning, or other research problems. The project must contain some "original" research in analysis, experiments or system design. The "originality" does not need to be very high; it is perfectly okay if your project is built upon an existing paper. For example,

- You may generalize an existing theoretical result under a new assumption.
- You may reproduce a simulation and add in new scenarios that could lead to new insights.
- You may design a new network protocol by adapting an existing optimization algorithm, and test it in a new experiment setting.
- Or you may design a completely new project.

Be careful not to propose an overly ambitious project since everything must be done within the semester.

The final project could be a collaborative project with at most two students. If a collaborative project is pursued, the scope of the project is expected to be about twice that of a one-student project, and the works of each student must be clearly stated so that I can grade them separately.

Start early with your project! Think about what you want to do. You are encouraged to discuss with the instructor early about your plans. Think about what you need (any equipments, etc.). Talk to the instructor if you need anything special. Do not wait until the last minute.

Deliverables:

1. A proposal for your final project is due October 9, 2024 in class. Your proposal should be 1-2 pages. Your proposal should provide a detailed description of what you plan to do and why you feel it is an important problem. For example, if it is analytical project, what system you plan to analyze? What aspect you will focus on? What is the methodology you will use for the analysis? If it is a simulation project, what system you plan to simulate? What part of the system you will focus on? Why is it important? What simulation scenarios you plan to run? You should also state what you plan to deliver at

the end of the project. You should include a short list of references that are related to your project. If it is a joint project, you should state the planned division of work. I will give you feedback on your proposal within two weeks.

2. Your project report is due November 27, 2024 in class. Your report should be within 20 pages (single-column, single-space). Your final report should contain: an abstract, an introduction of the problem, an overview of related works, detailed descriptions of the system model, the methodology, and the results, and a conclusion and discussion on future work. If it is a joint project, you should also clearly state the division of work.
If time permits, we will schedule a poster session for the final projects towards the end of the semester. If you build a system, you can even use this opportunity to give a demo. Details of the poster session will be available later.

Grading Criteria:

The final project will be graded according to four criteria:

- Novelty and Significance (25%): is the problem new and of significant value?
- Correctness (25%): is the derivation and/or numerical evaluation correct?
- Technical depth (25%): do the results add significant new knowledge to our understanding of the problem?
- Clarity of presentation (25%): both the written report and the poster presentation.

Suggested Topics:

Suggested topics for the final project could be those listed in the supplemental readings. Additional possible topics of interest for 2023:

1. Reconfigurable intelligent surface (RIS):
    - Jingyuan Zhang and Douglas M. Blough, “Optimizing Coverage with Intelligent Surfaces for Indoor mmWave Networks,” in IEEE INFOCOM 2022.
2. Massive machine-type communications:
    - Yihan Zou, Kwang Taik Kim, Xiaojun Lin, Mung Chiang, Zhi Ding, Risto Wichman and Jyri Hamalainen, “Low-Overhead Joint Beam-Selection and Random-Access Schemes for Massive Internet-of-Things with Non-Uniform Channel and Load,” in IEEE INFOCOM 2020.
3. Information freshness and age of information:
    - Vishrant Tripathi, Eytan Modiano, “Optimizing Age of Information with Correlated Sources,” in ACM MobiHoc 2022.
    - Yihan Zou, Kwang Taik Kim, Xiaojun Lin, and Mung Chiang, “Minimizing Age-of-Information in Heterogeneous Multi-Channel Systems: A New Partial-Index Approach,” in ACM MobiHoc 2021.
4. Satellite networks:

- Yaoying Zhang, Qian Wu, Zeqi Lai and Hewu Li, “Enabling Low-latency-capable Satellite-Ground Topology for Emerging LEO Satellite Networks,” in IEEE INFOCOM 2022

5. Edge networks and edge AI:
    - Chenghao Hu and Baochun Li, “Distributed Inference with Deep Learning Models across Heterogeneous Edge Devices,” in IEEE INFOCOM 2022
6. Federated learning:
    - Juncheng Wang, Min Dong, Ben Liang, Gary Boudreau, Hatem Abou-zeid, “Online Model Updating with Analog Aggregation in Wireless Edge Learning,” in IEEE INFOCOM 2022
    - Menglu Yu, Bo Ji, Hridesh Rajan, Jia Liu, “On Scheduling Ring-All-Reduce Learning Jobs in Multi-Tenant GPU Clusters with Communication Contention,” in ACM MobiHoc 2022
    - Bing Luo, Xiang Li, Shiqiang Wang, Jianwei Huang, Leandros Tassiulas, “Cost-Effective Federated Learning Design”, in IEEE INFOCOM 2021
7. Virtual/augmented reality:
    - Xinyi Yao, Jiangong Chen, Ting He, Jing Yang, Bin Li, “A Scalable Mixed Reality Platform for Remote Collaborative LEGO Design,” in IEEE INFOCOM 2022 (short demo paper, with demo video)
    - Harsh Gupta, Jiangong Chen, Bin Li, R. Srikant, “Online Learning-Based Rate Selection for Wireless Interactive Panoramic Scene Delivery,” in IEEE INFOCOM 2022.
    - Jiangong Chen, Feng Qian, Bin Li, “Enhancing Quality of Experience for Collaborative Virtual Reality with Commodity Mobile Devices,” in IEEE ICDCS 2022.
8. Neural tangent kernel (NTK):
    - Ziwei Ji, Matus Telgarsky, “Polylogarithmic width suffices for gradient descent to achieve arbitrarily small test error with shallow ReLU networks,” in ICLR 2020
9. Smart Grid:
    - Zhang, Ling and Chen, Yize and Zhang, Baosen, “A Convex Neural Network Solver for DCOPF with Generalization Guarantees,” IEEE Transactions on Control of Network Systems, 2022
    - Wenqi Cui, Jiayi Li, Baosen Zhang, “Decentralized Safe Reinforcement Learning for Voltage Control,” https://arxiv.org/abs/2110.01126