**Project Proposal: Due via email on Wednesday, March 24th, 2021.**

**Final Report: Due via email on May TBA, 2021.**
Please submit a complete report in pdf format along with your code and any other supporting documents.

## Project Guidelines

To encourage the important connection between research and classroom education, you have the option to design a final course project based on your own research or research interests that fits into the scope of the topics discussed in the class, instead of taking a final exam. You may work in a group with one other person, or do the project individually. The goal of the project is for you to:

1. Explain an optimization problem arising in analysis and/or control of a dynamical system;
2. Derive and formulate an optimization model that represents the problem, focusing on convex optimization models discussed in class (if your problem is non-convex, you should describe how to use approximations or relaxations that allow utilization of convex optimization techniques);
3. Present an analysis of the properties of your model, develop a solution method, and implement code that solves instances of the problem in CVX*, YALMIP, or your chosen modeling language;
4. Visualize the results of your solution method and code implementation using appropriate plots and other data visualizations;
5. Discuss limitations, special cases, generalizations, variations on the theme, comparisons with alternative approaches, which may also include additional solutions and visualizations.

## Proposal

Your first task is to write a project proposal (by the date above, around 2 pages in length) that clearly describes your problem (with references from the literature as necessary), summarizes your goals and plan of attack, and explains how it fits within the scope of the class. Before Spring Break, we will have individual meetings during class time instead of the normal lecture where we can discuss your project ideas. I'm also happy discuss ideas outside of class at any time before the proposal is due. A good source of projects (if you don't already have an idea coming from your own research) is the research literature on convex optimization in systems and control. If you use a paper from the literature to guide your project, the goal is not to simply recreate the results in the paper, but to use your creativity to explore variations or extensions of the problem.

I will review the proposal quickly after the deadline and provide immediate feedback if I think major modifications are needed for your project to be successful.

## Final Report

If your proposal is accepted, you will submit a final report (by the date above). The main body of your final report should roughly take the form of a long conference or journal paper, which is

typically 6-10 pages, or 10-16 pages for two-person project, (these lengths are rough guides, not hard limits) in single-spaced, double column format at 10 or 11 point font. You are free to structure and format the report as you see fit, but as a rough guide it should contain the following sections:

- Introduction, describing the context, a brief literature review with citations, and some discussion of related work and approaches to the problem
- Model and Problem Formulation, describing in detail the optimization model, along with a discussion of any simplifying assumptions and limitations, how to obtain problem data, etc..
- Model Properties and Problem Solution, describing the application of convex optimization techniques discussed in class. This section can draw heavily from class notes, textbook, and other references, but should demonstrate your own understanding.
- Numerical Experiments, describing your simulation studies and including plots and visualizations for various instances of your problem.
- Conclusions, summarizing what you learned during the project and an outlook for what might be done next, how simplifying assumptions could be removed, how the approach could be generalized, etc.
- Appendices with code, lengthy derivations or mathematical proofs, or other material relevant to the project but not ideally suited for the main text.

I will reserve 20% of the final grade for overall quality and style of the report, including but not limited to grammar, clarity of writing, typesetting and figure quality, creativity of solution and data visualizations, etc.

A few other comments:

- This class focuses on **modeling**, so don't spend too much time on data collection, algorithm design and algorithm parameter tuning, or trying to solve large-scale problem instances.
- A sensible idea is to start by solving a "toy" problem instance first, then work your way up to bigger and/or more realistic instances or your problem. Don't try to solve it all at once.
- For the purposes of this project, it is acceptable to make possibly unrealistic (in the context of your application domain) simplifying assumptions if necessary in order to fit our scope. For example, if your problem has a non-convex objective or constraint, you might linearize, relax, or approximate it in some way. Note that many non-convex problems can be approached using convex optimization techniques using linearization or relaxation.