Final Project

This quarter in MATH 42, you are learning about a wide range of mathematical modeling of real world problems. The learning is in-person and when completing assignments, but you will really experience hands-on work in your project. I would like you to choose wisely a project that fits your interests. One that would be both motivating and technically challenging.

Many fantastic class projects come from students picking either an application area that they're interested in or picking some subfield of data-driven mathematical modeling that they want to explore more. So, pick something that you can get excited and passionate about! Be brave rather than timid and do feel free to propose ambitious things that you're excited about. (Just be sure to ask me for help if you're uncertain how to best get started.)

A very good MATH 42 project will be a publishable or nearly publishable piece of work. Some number of my past students continue working on their projects, submitting their work to a conferences or journals. Thus, for inspiration, you might also look at some recent data-driven mathematical modeling research papers. Finally, looking at class projects from previous quarters from different schools and other data-driven mathematical modeling classes is a good way to get ideas.

Once you have identified a topic of interest, it can be useful to look up existing research on relevant topics by searching related keywords on an academic search engine such as: http://scholar.google.com.. Another important aspect of designing your project is to identify one or several experiments and/or datasets suitable for your topic of interest. If that data needs considerable pre-processing to suit your task, or that you intend to collect the needed data yourself, keep in mind that this is only one part of the expected project work, but can often take considerable time. I still expect a solid methodology and discussion of results, so pace your project accordingly.

Notes on **Replicating results.** Replicating the results in a paper can be a good way to learn. However, we ask that instead of just replicating a paper, also try using the technique on another application, or do some analysis of how each component of the model contributes to final performance.

Project Deliverables

You must submit on Gradescope:

a) The report
b) The Matlab/Python scripts you used to generate the results (I will check your results)
c) Experiments and/ or datasets
d) The powerpoint file of the oral presentation.

The section I am looking to see in the report are as follow:

a) Introduction
b) Methodology
c) Discussion of the results
d) Conclusion
e) Reference

f) Acknowledgments (if any)

Submission: We will be using Gradescope for submission of all parts (proposal and project report) of the project. I'll announce when submissions are open for each part. You should submit on Gradescope ***individually***.

Evaluation: Projects will be evaluated based on:

- The technical quality of the work. (i.e., Does the technical material make sense? Are the things tried reasonable? Are the proposed algorithms or applications clever and interesting? Do the authors convey novel insight about the problem and/or algorithms?)
- (Did the authors choose an interesting or a "real" problem to work on, or only a small "toy" problem? Is this work likely to be useful and/or have impact?)
- The novelty of the work. (Is this project applying a common technique to a well-studied problem, or is the problem or method relatively unexplored?)

In order to highlight these components, it is important you present a solid discussion regarding the learnings from the development of your method and summarizing how your work compares to existing approaches.

Proposal

Deadline: November 10th at 11:59 PM

In the project proposal, you'll pick a project idea to work on early and receive feedback from me or Alex. If your proposed project will be done jointly with a different class' project, you should obtain approval from the other instructor and approval from me. Please come to my office hours to discuss with me if you would like to do a joint project. You should submit your proposals on Gradescope.

In the proposal, below your project title, include the project category. The category can be one of:

- **Computer Graphics**
- **Markov Chains**
- **Leslie Population Models**
- **Graphs (Combinatoric)**
- **Google Rank Page**
- **Cryptography**
- **Euler Angles**
- **Kinematics**
- **Continuum solids/fluid Mechanics**
- **Curves' Fitting**
- **Dynamic systems**
- **Information theory and Applications**
- **Biology,**
- **Social justice,**
- **Epidemiology,**
- **Economics,**
- **Finance,**

- **Sports,**
- **Heat transfers,**
- **Wave propagation,**
- **Chemistry,**
- **Material science,**
- **Machine learning**
- **Data-driven modeling algorithms**
- **Data-driven design**
- **Theories in AI and algorithms development**
- **Others (Please specify!)**

Your project proposal should include the following information:

- What is the problem that you will be investigating? Why is it interesting?
- What are the challenges of this project?
- What dataset are you using? How do you plan to collect it?
- What method or algorithm are you proposing? If there are existing implementations, will you use them and how? How do you plan to improve or modify such implementations?
- What reading will you examine to provide context and background? If relevant, what papers do you refer to?
- How will you evaluate your results? Qualitatively, what kind of results do you expect (e.g. plots or figures)? Quantitatively, what kind of analysis will you use to evaluate and/or compare your results (e.g. what performance metrics or statistical tests)