Final Project

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Overview

For the final project, you will work in a group of two or three to apply mathematical modeling techniques to a problem of your choosing. The goal is to demonstrate that you can use the tools developed in this course — not to conduct original research. A good project takes a real-world question, builds a model, runs computations, and reflects critically on what the model does and doesn't capture.

Techniques developed in class include:

- Markov chains and steady-state analysis
- Population models (e.g., Leslie matrices)
- Monte Carlo simulation
- Network/graph-based models (e.g., PageRank)
- Optimization (linear programming, network flows, integer programming and related methods)

You are encouraged to combine techniques, but depth in one area is more valuable than a superficial survey of many.

To give a sense of the kinds of projects that work well, here are some examples. You are welcome to use one of these directly, or let them inspire something of your own.

- **Inventory management.** Extend the fish tank emporium model with different demand distributions, multiple products, or alternative reorder strategies.
- **Epidemic spread.** Model disease transmission through a population using a Markov chain or Monte Carlo simulation.
- **Sports ranking.** Apply PageRank-style methods to a league schedule to produce a ranking of teams.
- **Species population dynamics.** Use a Leslie matrix model to study an age-structured population, e.g. in a wildlife conservation context.
- **Traffic or supply networks.** Optimize flow on a road or logistics network.

Proposal

Due: Sunday, April 5

Submit a short proposal (roughly one page) that includes:

1. **Group members.** List everyone's name and confirm your group size (2 or 3).
2. **Problem description.** What question or system are you modeling? Give enough context for a reader unfamiliar with the topic to understand why it is interesting.
3. **Modeling approach.** Which technique(s) from class do you plan to use, and why are they appropriate for this problem?
4. **Data or setup.** Do you need external data? If so, where will you get it? If your model is self-contained (e.g., a simulation), describe the setup briefly.

The proposal does not need to be polished — it is a planning document, not a graded deliverable. Its purpose is to let me give you early feedback and confirm that the scope is appropriate.

Final Deliverables

Presentations: Wednesday, April 23 and Thursday, April 24 (in class).

Each group will give a **10-minute presentation** during the last two class meetings. Plan to show your model, your key results, and at least one critical reflection on the model's limitations or assumptions. Slides, a notebook walkthrough, or a live demo are all acceptable formats.

Written report: Due date to be announced.

Submit a written report (as a PDF) that covers:

- **Introduction:** What is the problem and why does it matter?
- **Model:** Describe your modeling choices clearly enough that a classmate could reproduce your work.
- **Results:** Present your main findings with appropriate figures or tables.
- **Discussion:** What do the results mean? What are the limitations of your model? What would you do differently or explore further with more time?

There is no strict page limit. Aim for clarity over length.

A Note on Scope

This is a modeling exercise, not a research project. You do not need to produce new mathematics or novel findings. A project that carefully applies one technique to a well-chosen problem, and reflects honestly on the result, is entirely successful.

If you are unsure whether your topic is appropriate, ask early.