

Final Project – Math 123a

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Basic information: The project can either study a model you develop or a model introduced in a book or a paper. The constraint is that the paper shall deal with a mathematical model using dynamical systems (discrete time, ODE or PDE model). The project can also be solving an **MCM/ICM problem**, in which case the model isn't required to be a dynamical system.

Finding a question of interest. For non-MCM/ICM project, please email a small paragraph [by next Friday April 12](#), describing a real-world question that you would like to study using dynamical systems. Include any relevant papers or references with your submission, or let me know if you need help in finding papers. Here are a few domains of interest:

- chemical reactions
- mechanics of simple toys
- [vampires and zombies](#)
- Economics: supply and Demand, Financial Economics, etc..
- social questions (segregation, rumor spread, etc...)
- Evolutionary biology
- Infectious disease
- Ecology: landscapes, struggle for survival, host-parasite interaction, pollution of lakes,
- Neuroscience: models of single neurons, models of neural networks, firing-rate models, decision making, perceptual bistability
- How the Leopard gets its spots?
- Patterns of visual hallucination and their cortical origin.

In-class Presentation (April 19): Give a group presentation (5-10 minutes) that provides a comprehensive overview of your final project.

- Begin with an introduction to the project's topic and objectives
- If available, present your findings and discuss your results. Otherwise, focus on outlining your methodology, progress to date and future steps.
- Conclude with the significance of the project and potential impacts and limitations.

Final Report (Due May 8th): Submit a written document (8 pages maximum, no minimum) that includes Introduction, Model, Results/Analysis/Summary, Future work/Discussion, and Bibliography. Bibliography is not counted towards the page limit.

The report must be self-contained and readable without reference to the original paper or to additional material.

You are free to add supplements (additional figures, long calculations that do not belong to the report, code, etc.), but the core of the report needs to be readable without supplements. Supplement is excluded from the page count.

Evaluation Criteria:

Clarity of the presentation and report: your report needs to be accessible and easy to read. Please take care of employing precise terms, and when possible simple words and clear expressions. For example, any technical word or concept arising in your model that may not be familiar to everybody, or that was not covered in class, should be defined.

Clear explanation of the problem: What is the applied/theoretical question you are studying? What is the relevance of this question? Why is it important. Was that studied elsewhere?

Clear explanation of the model: the model you are studying should be clearly explained. What are the key assumptions behind the model? What do the variables represent? What are the parameters? Are there parameters that are fixed by observations of the real-world problem associated? What changes did you make to the model (e.g., did you make a change of variables to reduce the number of variables and/or parameters)?

Your analysis of the model (either mathematical or numerical simulations): Show your work on the model: how the material covered in class helps analyze the model and understand the question (e.g., fixed points and their stability, bifurcations, etc). If your project is based on a published paper, please clearly indicate what was done in the original paper and what is your original contribution. If you reproduced parts of the material, please indicate clearly which parts; if you did any calculations that go beyond what is in the paper, please highlight your contribution to the analysis.

Critical discussion: Are the results sound? How do they apply to the real world problem? Are there results non-consistent or surprising? Are there assumptions or hypotheses that you think are not realistic? How would you modify those?