Final Project

MATH 384 • Spring 2024

The final project is your opportunity to use computation to investigate a mathematical topic of interest to you. The goal of this project is to demonstrate a complete process involving reading mathematical ideas, performing computational exploration, collecting observations, and formulating conjectures. This project will result in a computational notebook and a short presentation on the final exam day. You may complete this project either individually or in a group of up to three students.

The following list describes possible topics that serve as starting points for computational investigation. You may also come up with your own topic—if you do, talk with the professor about your topic idea. *Your project must focus on one or more questions that can be answered (at least partially) by computation.*

- Jathan Austin and Emelie Curl (2022) "Exploring Combinatorics and Graph Theory with Simple Blokus" in *The College Mathematics Journal*, 53:4, 273–281, DOI: 10.1080/07468342.2022.2100147.
- Jeffrey D. Blanchard and Marc Chamberland (2023) "Newton's Method Without Division" in *The American Mathematical Monthly*, 130:7, 606–617, DOI: 10.1080/00029890.2022.2093573.
- Karen S. Briggs and Caylee R. Spivey (2023) "When Additive and Multiplicative Inverses are the Same" in *Mathematics Magazine*, 96:3, 299–307, DOI: 10.1080/0025570X.2023.2199700.
- Jacob Brown (2023) "Counting Divisions of a $2 \times n$ Rectangular Grid" in *The College Mathematics Journal*, 54:3, 212–221, DOI: 10.1080/07468342.2023.2201166.
- J. K. Denny (2024) "Schedules and Waitlists and Integer Programs, Oh My!" in *Mathematics Magazine*, 97:1, 50–57, DOI: 10.1080/0025570X.2023.2284419.
- William Q. Erickson (2024) "The Break Buddy Problem" in *Mathematics Magazine*, 97:2, 194–199, DOI: 10.1080/0025570X.2024.2312800.
- Elcio Lebensztayn and Vicenzo Pereira (2024) "On Random Walks with Geometric Lifetimes" in *The American Mathematical Monthly*, 131:2, 131–144, DOI: 10.1080/00029890.2023.2274783.
- Milton F. Maritz (2024) "Extracting Pi from Chaos" *The College Mathematics Journal*, 55:2, 86–99, DOI: 10.1080/07468342.2023.2265282.
- Osvaldo Marrero and Paul C. Pasles (2023) "The Multivariate Probabilistic Josephus Problem" in *The College Mathematics Journal*, 54:5, 446–453, DOI: 10.1080/07468342.2023.2266316.
- Liviu I. Nicolaescu (2023) "Counting Zeros of Random Functions" in *The American Mathematical Monthly*, 130:7, 625–646, DOI: 10.1080/00029890.2023.2206321.
- S. H. Sathish Indika and Lawrence M. Leemis (2024) "Exact Expressions for Trigonometric Functions" in *The College Mathematics Journal*, 55:1, 40–45, DOI: 10.1080/07468342.2023.2241316.

Timeline

- **Week of April 29:** Browse the papers listed above. Decide what topic you would like to explore and who you would like to work with.
- **May 7:** Project topics and teams finalized.
- **May 7–14:** Class time to work on final projects. Check in with the professor regarding progress and questions.
- **Week of May 13:** Finish your project and prepare your presentation.
- **May 16, 9:00am**: Project due. Presentations about what you investigated and discovered.

Deliverables

- **Notebook:** Prepare a computational notebook in a language of your choice. As usual, submit code that runs, and throughly explain your methodology, observations, and conclusions. Your goal should be to communicate your work to another person (e.g., another student at your level who is not in this course).
- **Presentation:** During the final exam period, your group will give a short (5-minutes per person) presentation explaining what you did and what you discovered.
- **Self and peer evaluation:** This brief survey will ask you to reflect on your own contributions and the contributions of your group members to your project.

Grading

This project will be graded on the EMRN scale, as described in the syllabus. To receive a grade of *Meets Expectations*, your project should exhibit the following characteristics:

- You use computation to investigate mathematical questions.
- Your notebook demonstrates understanding of the paper that provided inspiration for your project.
- Your code is appropriate for the given tasks and produces reasonable output.
- Your reasoning is explained using sentences, and your notebook is well-formatted and easy to read.
- Your presentation summarizes your work and your observations.
- No significant gaps or errors are present.

To receive a grade of *Excellent*, your project should further exhibit the following:

- The project involves mathematical depth, demonstrating your ability to apply your mathematical knowledge and computational observations to new questions, thus discovering mathematical ideas for yourselves.
- Exposition is clear and precise, thoroughly explaining your methodology and reasoning. Relevant definitions and assumptions necessary for the for your work are clearly stated and discussed.

- You state at least one original conjecture. This must be a precise mathematical statement based on what you have observed. In your discussion, you clearly distinguish between what is known (i.e., what has been proved) and what is conjectured. Optionally, you may prove something related to your topic.
- Mathematica/Python code is of high quality, demonstrating skillful use of programming constructs.
- Your presentation demonstrates that you have carefully thought and practiced communicating your work.
- The work exhibits creativity and insight.

Note: It is possible that members of the same team may receive different grades, according to their contributions to the project.