Final Project

Math 242

Use computation to investigate some topic or idea. Almost anything is fair game: find one or more questions, statements, or ideas to explore. The process is more important than the topic! You do not need to prove any theorems. You may work alone or in a group of up to three students.

The following list contains some ideas and links to papers that may provide inspiration for your project. However, don't be limited by this list — feel free to come up with your own idea!

- Markov chains and Simulated Annealing
  - Model a board game using Markov chains
  - Bin packing problems – paper by Rao and Iyengar
  - Investigate how adding transitions changes the steady-state distribution – paper by Diaconis and Durrett
  - Solve Sudoku puzzles with simulated annealing – paper on simulated annealing
- Sequences and more: for each of the following, there are many ways to explore, verify, and expand on ideas
  - Fibonacci polynomials – paper by Flórez, McAnally, and Mukherjee
  - Moessner's Theorem – paper by Kozen and Silva
  - Ducci Sequences – paper by Chamberland
  - Collatz Numbers – paper by Lagarias
  - Catalan Numbers – Wikipedia link
- Use SIR models to model the spread of epidemics, rumors, forest fires, or some such thing.
- Mathematical constants: there is plenty to investigate regarding π, e, ϕ, γ, etc. See the Wiki page on Mathematical constants or this paper on spigot algorithms.
- Wheel methods for prime sieves
- Iterated fractal systems such as Barnsley's Fern
- Integer relation algorithms such as PSLQ

Deadlines

- **Friday, May 11**: Choose your topic and group by this day.
- **Wednesday, May 16**: Turn in 1–2 paragraphs describing what you have accomplished, what remains to do, and what questions you have.
- **Final exam period**: Project due; presentations during the final exam period. This deadline is absolutely firm, as the professor cannot accept work after the final exam period.

Deliverables

Notebook: Turn in either a *Mathematica* notebook or HTML/PDF file produced from R Markdown.* As usual, submit code that runs, and explain what your code does. Include the items mentioned in the rubric below. 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, each person/group should give a short presentation explaining what they did and what they observed. Presentation length for a group of n people should be not more than $3n + 1$ minutes.

Grading Rubric

Your project will be graded on a scale of 0 to 4, according to the following rubric.

4. Problems and goals are clearly stated, including relevant definitions or parameters. Computations are complete; code runs and is clearly explained. Conclusions are clearly stated and backed up by sufficient computational evidence. Limitations of the methodology, extensions for future work, and/or conjectures are discussed. Notebook is well-formatted and easy to read. Presentation is well-prepared, including a clear, concise summary of what questions were investigated and what was accomplished in the project.

3. Problems and goals are stated well, though relevant definitions or parameters may be missing. Computations are mostly complete; code runs, but explanation is weak. Conclusions are unclear or not well justified. Insufficient discussion of limitations, extensions, and/or conjectures. Presentation summarizes the questions and investigations, but is unclear or unpolished.

2. Statement of problem or goal is unclear. Computations are incomplete; explanation is ambiguous. Code may produce errors when run. Conclusions are possibly correct, but not justified. Little or no discussion of limitations, extensions, and/or conjectures. Notebook is difficult to read. Presentation is difficult to follow or does not explain the questions and investigations of the project.

1. Serious misunderstanding of the problem or goal. Computation is inadequate for the task at hand. Work is not clearly explained. No discussion of limitations, extensions, and/or conjectures. Notebook is difficult to read. Presentation communicates little about the project and its accomplishments.

0. Notebook is not turned in. Presentation not delivered.

*If you want to use some other language, such as Python, talk with the professor about an appropriate format for submitting your work.