Math 378 - Fall 2024
Project 1 October 1, 2024

Your goal is to investigate the largest cycle and the number of cycles in thee cycle decomposition of randomly generated permutations.

- First, compute data on the sizes of the largest cycle and the number of cycles among all permutations of 1,2,... n as far as possible.
- Second randomly sample large permutations (uniformly, using either a built in Sage method, or your own implementation of Fisher Yates) for various large values.
- Third, randomly sample large permutations using a non-uniform method (the naive transposition approach, one of the riffle shuffle implementations, or come up with a new method)

For each method of generating permutations investigate the distribution of the largest cycles and the number of cycles obtained. Investigate some statistical properties you find interesting. This might include the mean/median/mode/variance/moments/minimum etc. The exact questions are up to you!

On Tuesday October 1st (by midnight) your group should submit:

(1) A **write-up** (about 2-3 pages, double spaced, not counting graphs) which should include:
   - Explanations of the problems you investigated.
   - How you generated the data (don't include the code here, but explain the idea).
   - Precise statements of your conjectures and why you made them. (Include your graphs in the document, along with clear explanations of what is being graphed to justify your conjectures).
   - Your interpretations of the data, including potential explanations of why the patterns and conjectures you've observed might be true.
   - Any "further questions" that your investigation raised of other related problems you think might be interesting to study.

(2) The **data** that you generated, used to make your conjectures. (This can be Excel files, text files, sage objects etc.)

(3) The **code** used to generate your data. (This can be submitted on CoCalc.)

(4) (By classtime) A **presentation** (Powerpoint or beamer) that includes some of the highlights from your write up, along with your graphs. (Aim for 5-10 minutes.)