Math 99r courses are small group tutorial courses with limited enrollment. There is just one Math 99r tutorial for Fall 2024; it is titled **Visualizing Mathematics** and it will be led by Oliver Knill . What follows momentarily is a description of the tutorial. Contact Oliver Knill for additional details.

The tutorial will either consist of two one hour classes or a single 2 hour class later in the afternoon tuesday or thursday.

Visualizing Mathematics: We live in an era where technology enables us to explore, interact with, and experience mathematics in novel ways. Within a remarkably short period, we have witnessed the emergence of powerful computer algebra systems, the development of web technologies for creating interactive laboratories, and advances in printing technologies that enable us to fabricate mathematical models. New photographic techniques, such as panoramic views and drone technologies, have become accessible to consumers in the last decade. Moreover, advancements in large language models, stable diffusion technologies, and proof verification models have entered the mainstream, offering innovative tools for shaping mathematical structures.

In this tutorial, we will introduce several of these developments initially. Students will then delve into the mathematical applications and/or aspects of one of these advances more deeply, culminating in a presentation towards the end of the semester. Ample support will be provided. (The instructor brings several decades of experience in working with, exploring, and programming in each of these areas.)

Prerequisites: Multivariable calculus and linear algebra as taught in Math 21, 22 or a higher numbered course is required, as topics in differential equations or linear algebra come up. Any other math, computer science or applied math or statistics knowledge is helpful but definitely not required.

Possible student exploration topics:

- Animating or building curves and surfaces: 3D printing, visualization, art for documents or on the web
- The mathematics of photography: Different type of cameras systems, panorama photography.
- Computer vision structure: Reconstructing scenes from pictures, 3D scanning, path reconstruction.
- The mathematics of text recognition: Recognizing direction of a text, separating and matching characters.
- Network models and graph visualization: Visualization on the web, types of graph structure.
- Illustrating differential equations: Running differential equations on the browser, building a small lab
- Visualizing partial differential equations: Heat and wave equations on graphs, cellular automata, numerical visualization
- Finite versions of calculus: Discrete Stokes theorem, discrete Taylor theorem
- Discrete differential geometry: Curvature, Gauss-Bonnet, fixed point of maps
- Using intelligent bots to do mathematics: Teaching a bot, learning from a bot, using bots to do literature searches
- Mathematical models in history: Collections of mathematical models, mathematics in art and film.