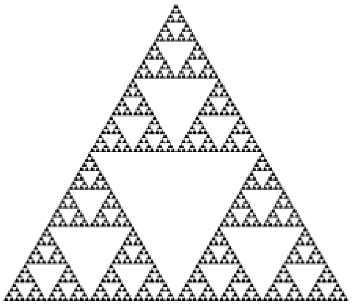
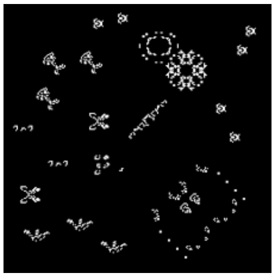
Emergent Complexity and Digital Art

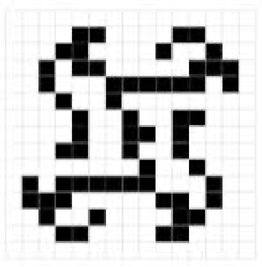
Lead Instructor: Tait Weicht

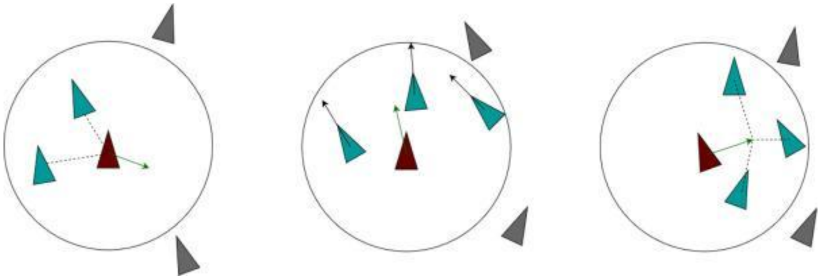
Seminar Description: This seminar will focus on the idea of “emergent complexity”, where surprisingly complex behavior arises from simple rules. Students will be introduced to the ideas behind fractals, cellular automata, and dynamical systems. Students write programs to reproduce the Sierpinski triangle, Barnsley fern and other classic fractals; run iterations of the logistic map and display its behavior in 3 different ways, interact with Langton’s ant and Conway’s Game of Life, simulate the way fireflies synchronize via the Kuramoto model and the way bird flocking together. Work will emphasize student’s creativity with options for how to modify existing models to produce novel behaviors. We will use the Processing programming environment to quickly begin writing programs to draw shapes to the screen and display dynamical simulations.

Prerequisites: MAT 21C or equiv., MAT 22A and ECS 032A or other introductory programming course.









Sources: Peitgen, Jürgensm Saupe’s *Fractals for the Classroom*, Strogatz’s *Non-linear Dynamics and Chaos*, David Lipman’s *Math and Society* e-textbook, coding challenge series by Daniel Shiffman (see his excellent website), Craig Reynold’s original “Boids” article, the Processing coding environment reference page

Format: We will meet once a week on Tuesdays or Thursdays for 1 hour. Each class will consist of a small lecture or introduction to the topic of the week (no more than 30 minutes). Beyond pen and paper exercises, each topic will come with a code-shell that can be opened in Processing. After the introduction, students will pair up to work together to complete exercises either using pen-and-paper or by adding functions to the shell and running the program. We may also try pair programming/live coding, where students suggest doing something and the instructor writes the code to achieve that effect while students follow along. At the end of the course, students will showcase their favorite project with any modifications they made.

Learning Objectives: By the end of this course, students should feel a sense of wonder at the expressivity of mathematics and computer science. Concretely, each week a student will have a small applet that can run a particular simulation or exercise. The ultimate lesson of this course is sometimes we do not know what will happen until we try it!

Schedule:

Meeting 1: Introductions and starting in the Processing environment

Meeting 2: Build Your Own Fractals

Meeting 3: The Logistic Map and Chaos

Meeting 4: Langton’s Ant

Meeting 5: Conway’s Game of Life

Meeting 6: Firefly synchronization and the Kuramoto model

Meeting 7: Flocking dynamics (part 1)

Meeting 8: Flocking dynamics (part 2)

Meeting 9: Individual projects showcase