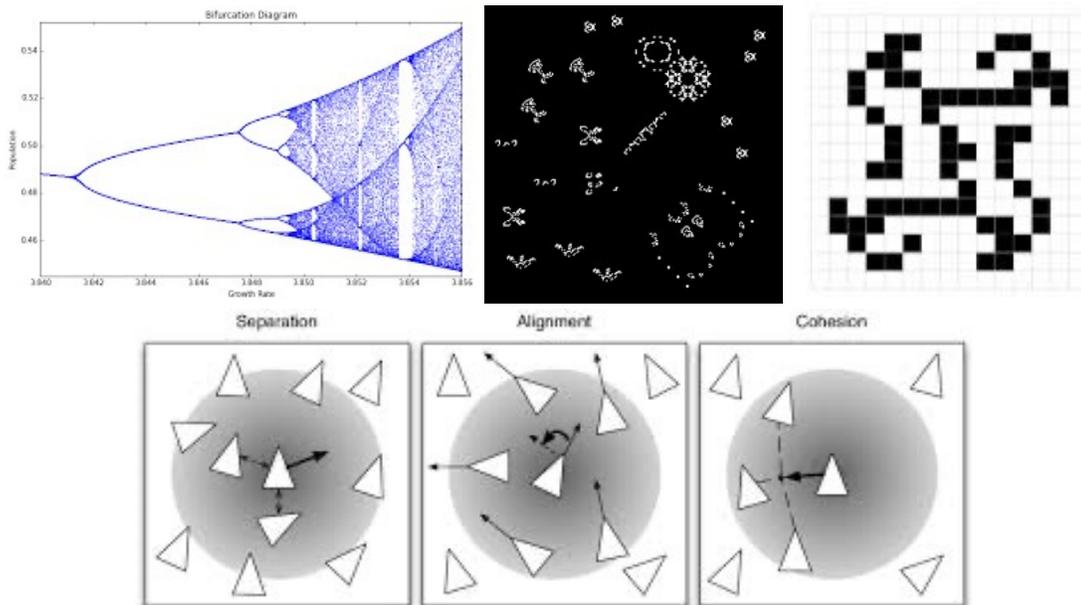


Emergent Complexity and Mathematical Art

Lead: Tait Weicht

Seminar Description: This seminar center around 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. We students write programs to reproduce the Serpinski triangle, Menger carpet and other classic fractals, run 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 glowing via the Kuramoto model and simulate 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.



Sources: Peitgen, Jürgensm Saupe’s *Fractals for the Classroom*, Strogatz’s *Non-linear Dynamics and Chaos*, Craig Reynold’s [Boids](#) article, plus more

Format: We will meet once a week on Tuesdays or Thursdays. Each class will consist of a mini lecture of no more than 30 minutes to introduce concepts. 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 by add to the shell. We may also try pair programming/live-coding, where students suggest doing something and we write the code to achieve that effect while student follow along. At the end of the course, student will showcase their favorite project with any modifications they made.

Learning Objectives: My goal is for students to feel a sense of wonder at the expressivity of mathematics and computer science. The ultimate lesson of this course is sometimes we don't know what will happen until we go and try it! As a byproduct we will also learn some programming for when pen-paper-and-thinking are not enough and some nifty models.

Schedule:

Meeting 1: Introduction and the Processing environment

Meeting 2: Fractals and Iteration

Meeting 3: The Logistic Map

Meeting 4: Langton's Ant

Meeting 5: Conway's Game of Life

Meeting 6: Fireflies and the Kuramoto model

Meeting 7: Flocking dynamics (part 1)

Meeting 8: Flocking dynamics (part 2)

Meeting 9: Individual projects showcase