MAT 200C: Pattern Formation

Media Arts and Technology Program, Spring 2015
University of California, Santa Barbara

Course Description

This offering of MAT 200C will focus on mechanisms of pattern formation. Many complex visual patterns can be generated from surprisingly small amounts of code (< 100 lines), or from simple sets of equations. Some examples include the ubiquitous patterns of the Mandelbrot and Julia set fractals, reaction-diffusion systems, and Conway's Game of Life. We will examine a wide variety of these pattern generation techniques. We will implement these techniques in class, and homework assignments will focus on experimenting with and generating novel patterns. By the end of the class, you will have developed a suite of pattern generation tools.

Tentative Course Topics

- The Mandelbrot and Julia set fractals
- Quaternion Julia sets: fractals in quasi-3D
- Cellular automata and Conway's Game of Life
- Diffusion limited aggregation (DLA) and Laplacian growth
- Reaction-diffusion systems: Turing, Gray-Scott, Meinhardt, FitzHugh-Nagumo, and Barkley
- Newton-Raphson iteration: the fractal structure of polynomial root finding
- Eigenvalues of the Laplacian: can you hear the shape of a drum?
- Divergence-free vector fields: what makes a fluid look like a fluid?
- Finite Differences: Derivatives made easy
- The Wave Equation: Dropping a pebble in a pond
- The Heat Equation: How to heat up a cold room
- Band-Limited Noise: Modeling the variation in the natural world

Instructor:

Theodore Kim, kim@mat.ucsb.edu

Lecture:

Tuesdays and Thursdays, 2-4 PM, Elings 2810 (Systemics Lab)

Prerequisites:

It will be assumed that you have a basic level of programming experience, and you must have a laptop that you can bring to class. You will be provided with a significant amount of basic substrate code so that you can focus on the task of writing pattern formation code. The substrate code will be written in C++ and designed to be run on a Mac, but it should be generic enough to run on Linux and Cygwin with minor modifications. You are free to implement using any language or platform that you want, with the understanding that we will primarily support C++ on the Mac.

Grading Scheme:

- **In-class exercises, 25%:** The first half of each class will be a lecture on some pattern formation algorithm. The second half of each class will be a lab session during which we will implement the actual algorithm. You will post a video of the working algorithm to a shared class Tumblr, `http://mat200c-2015-working.tumblr.com/`. You must sign your post to receive credit.

- **Experimentation, 25%:** In between classes, you will experiment with the pattern formation mechanism developed during lab, and post the most interesting structure you generate to a different class Tumblr `http://mat200c-2015.tumblr.com/`. You must sign your post to receive credit.

- **Final Project 50%:** You will have the opportunity to further explore one of the pattern formation mechanisms from class, or a related topic of your own choosing, as a class project.

- **Freebies:** You will receive **three** freebie credits where you need to turn in neither an in-class exercise nor a post-class experimentation. While you can take these freebies at any time it will be assumed that you will be using these to make time for your final project towards the end of the quarter. It is your responsibility to use these wisely. The freebies are indivisible, so you must use one freebie for the same in-class exercise and experiment.

Textbooks:

There is no required textbook.