

# Math 53 Chaos!: Homework 5

due Fri Nov 2 ... but best if do relevant questions after each lecture

Shorter since only 4 days to do it; the Matlab parts are the most substantial. It is fine to collaborate on code, but tell me who your collaborators are.

Also, this week, tell me your project choice / ideas.

T4.2

T4.3

Compu Expt 4.1: Modify my 1D code `cantorifs.m` to make your code. Then replace the map given by what you deduce in T4.3, and hand in your plot of Sierpinski gasket for the equilateral triangle.

4.2 a,b,c,e.

4.4 (to what other subsets of  $\mathbb{R}$  does this simple argument extend?)

B. (easy) Write a Matlab code to iterate  $P_c(z) = z^2 + c$  (starting from  $z_0 = 0$ ). Find period of the ‘bulb’ within which  $c = -0.470 + 0.587i$  lies. See Resources for links to Devaney’s explanation of Mandelbrot bulb periods. Print out a plot of the attractor in the complex plane  $\mathbb{C}$  to which the orbit settles for this  $c$ . Is this  $c$  in the Mandelbrot set?

C. Prove that for the map  $P_c(z) = z^2 + c$  with  $|c| < 2$ , then if  $z_n$  ever leaves the disc of radius 2 about the origin, it will go to infinity. [Hint: use triangle inequality on the map formula]

Compu Expt 4.3: Write a code which plots the Julia set for the  $c$  value I gave above, on the domain  $|\operatorname{Re} z_0| < 1.5$ ,  $|\operatorname{Im} z_0| < 1.5$ , with some reasonable resolution, such as 0.01, using at least 200 iterations. Print out the Julia set and your code. BONUS: How many arms do the spirals have? How many ‘spikes’ seem to come together where spikes meet? You may need to zoom in to check these. [Hint: you will find iterating all points in a grid *at once* more efficient than what’s suggested, although any method is fine. Given 1D list of grid values  $\mathbf{x}$ , I recommend you use

```
[xx,yy] = meshgrid(x,x);
```

```
zz = xx + 1i*yy;
```

to construct a 2D grid  $\mathbf{zz}$  of complex numbers, which may be iterated simultaneously similarly to if you had one number. Also check the `isnan` command. Bonus if make an efficient code which avoids the slow handling of NaN’s]