Wyatt Newberry

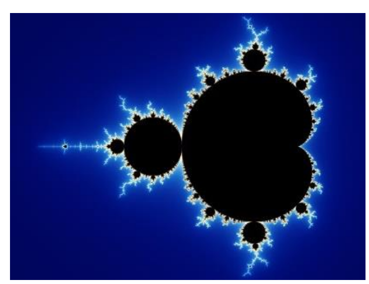
Math 198

October 9, 2015

Pre Proposal

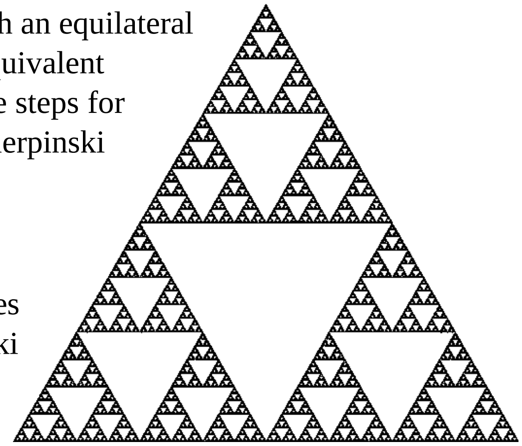
Fractals are a naturally occurring phenomenon that can also be represented by a mathematical set that demonstrates a repeating pattern. Some fractals can also be described as self-similar, where the replication if its pattern is exactly the same at every scale of the fractal. Therefore, if you zoomed in on a picture of the fractal, you would see the originally image endlessly repeated as you continued to zoom in. This property allows fractals to have special properties that aren't seen in standard functions. The term fractal was originally introduced by Benoît Mandelbrot. Mandelbrot is well known for many things, including the Mandelbrot set and the mathematical paper "How Long Is the Coast of Britain?" This paper proposed the paradox that if one were to measure the coastline of Britain with a certain scale of measurement (often explained as a "ruler"), depending on the length of that measurement, the answer is different. Furthermore, as this theoretical ruler becomes infinitely small, the length of the coastline becomes infinitely large, theoretically saying the coastline has no end. Although we know this is in reality incorrect, this is just one example of the power and possible application of fractals.

Mathematically the origin of the fractal began with a French mathematician Gaston Julia. Julia focused on the behavior of recursive functions. This is type of function takes an initial input, then uses the output as input for the function for the next iteration. Julia studied recursive functions with complex parameters (for example: $f(z) = z^2 - .75$). The result was called a function's "Julia set". But, Julia lacked the computational methods of solving these equations as it took too long by hand. Years later, Mandelbrot used varying versions of these equations using computers while he worked at IBM. He noticed an incredible pattern where in each Julia set, certain values for the parameters in the function all "hovered" around similar values before going off to infinity. These graphs demonstrated many interesting patterns, but there were just too many combinations to keep track of. Mandelbrot used results from the Julia sets to make an equation of his own: $f(x) = x^2 + c$, where c is a complex parameter. This resultant set was called the Mandelbrot set. This equation was special for a particular reason: When this equation is plotted on the complex plane, it represents every possible Julia set. Furthermore, this graph is also self-similar, infinitely repeating the same pattern as you zoom in.



So, what does this all have to do with my project? Although I won't be using the Mandelbrot set directly, all of the concepts that apply to the set, and fractals in general, will be directly used in my project. The basis of my project starts at the Sierpinski triangle. The

Sierpinski triangle is a very common fractal example. It begins with an equilateral triangle, and is further subdivided by splitting the triangle into 4 equivalent equilateral triangles and removing the central triangle. Repeat these steps for each of the interior triangles to continue. Here’s an example of a Sierpinski triangle:



Due to this class being all about bringing geometrical figures to higher dimensions, my project idea is to implement the Sierpinski triangle in 3 dimensions. This is also known as the Sierpinski tetrahedron. I’ll be using Javascript/HTML to do this project. I’ll also be using the three.js library to help implement my project. I’ll have to implement a function that recursively draws the tetrahedrons in the proper positions, and terminate after a set number of iterations based on user input. If this project turns out to not be substantial enough, I’ll expand my program to implement other fractal shapes in 3D (possibly Sierpinski cube, hexagon, etc). I also want to implement a camera-like view to rotate the program window and view the fractal from perspectives.