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MATH 210 – 01 – Scientific Computing in Matlab

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1 Setup

A Julia set is a complementary set that consists of iterations of a function. The values of this function play a crucial role in generating a Julia set. Any small deviation can cause drastic changes in the sequence. This is why the behavior of a Julia set is called 'chaotic'. By simply changing the real and imaginary parts of a complex number, one can easily plot various graphs of any Julia set (this property will be discussed more in depth in the "Methods" section). The Julia set is named after the French mathematicians Gaston Julia. He studied complex dynamics during the early 20th century.

Given two complex numbers, c and Z, let's define the following recursive function:

$$Z_{n+1} = {Z_n}^2 + c$$

This function is a dynamical system called a quadratic map. Depending on the values of c and Z_0, the sequence of numbers Z_1, Z_2, Z_3,... (so-called "orbit" of Z_0) tends towards infinity, goes into a periodic loop or dances around the complex plane (this is an example of "chaos"). These starting values, c and Z_0, make up the Julia set of the map, denoted J_c. In this problem, we will write a MATLAB script that visualizes 7 different Julia sets.

2 Methods

The most efficient way to solve this problem is to write a function that will accept various inputs and will plot the corresponding maps. It can be seen in the m-file and .html-file that a function $function[Z, W] = Avagyan - Final - Function(iter, N, zMax, a, b)$ was written. To plot different Julia sets, one would need to input different values for the inputs $iter$, N, $zMax$, a, and b to obtain graphs. However, it is hard to find inputs that will results in beautiful graphs. That's why the entire function was turned into a comment. Instead, specific values of inputs were tested and plotted. The maps will be seen in the "Visual Interpretation" section.

The functions $pcolor$ and $imagesc$ were used to obtain a map. Both of these functions give a view from the top. The function $colormap$ was used to color the fractal map. To iterate the function, a for loop was used. After trial and error, it was decided to plot the variable $W = e^{-|Z|}$ since $pcolor$ and $imagesc$ could have only real input values. The reason why an exponential graph was chosed is because it resulted in more beautiful graphs and worked for all the sets. The function $shading$ with option $flat$ was used to make the graphs more pleasant for the eye.
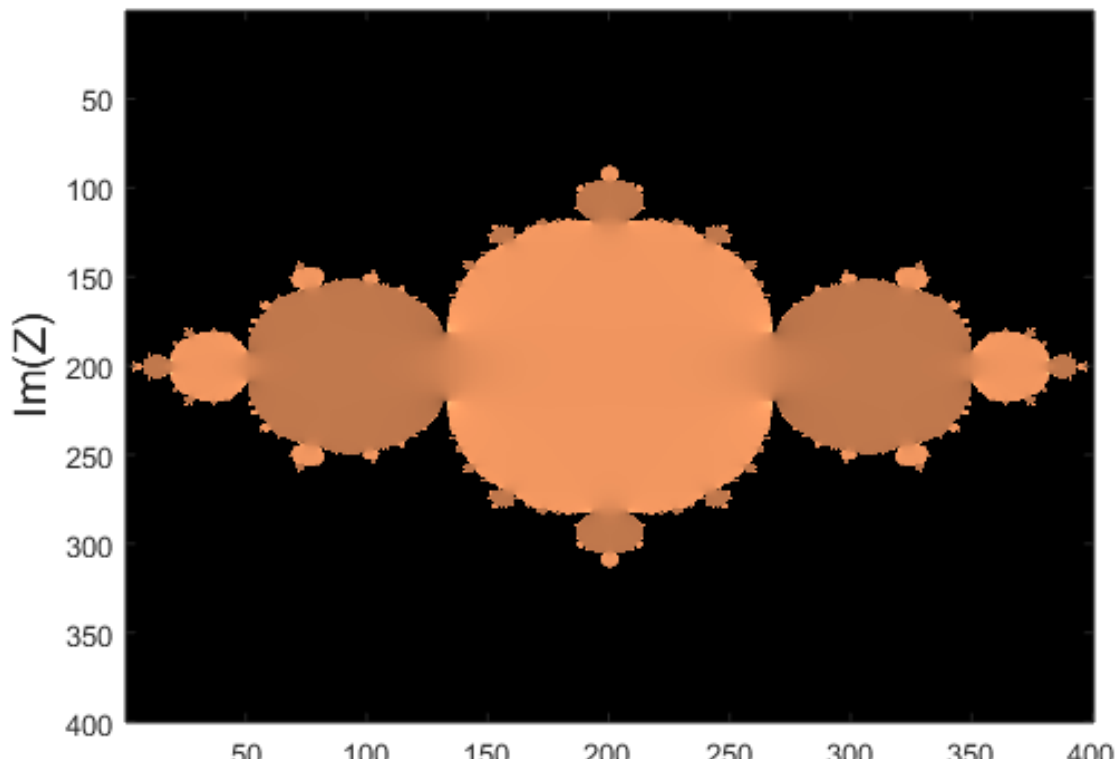
3 Visual Interpretation
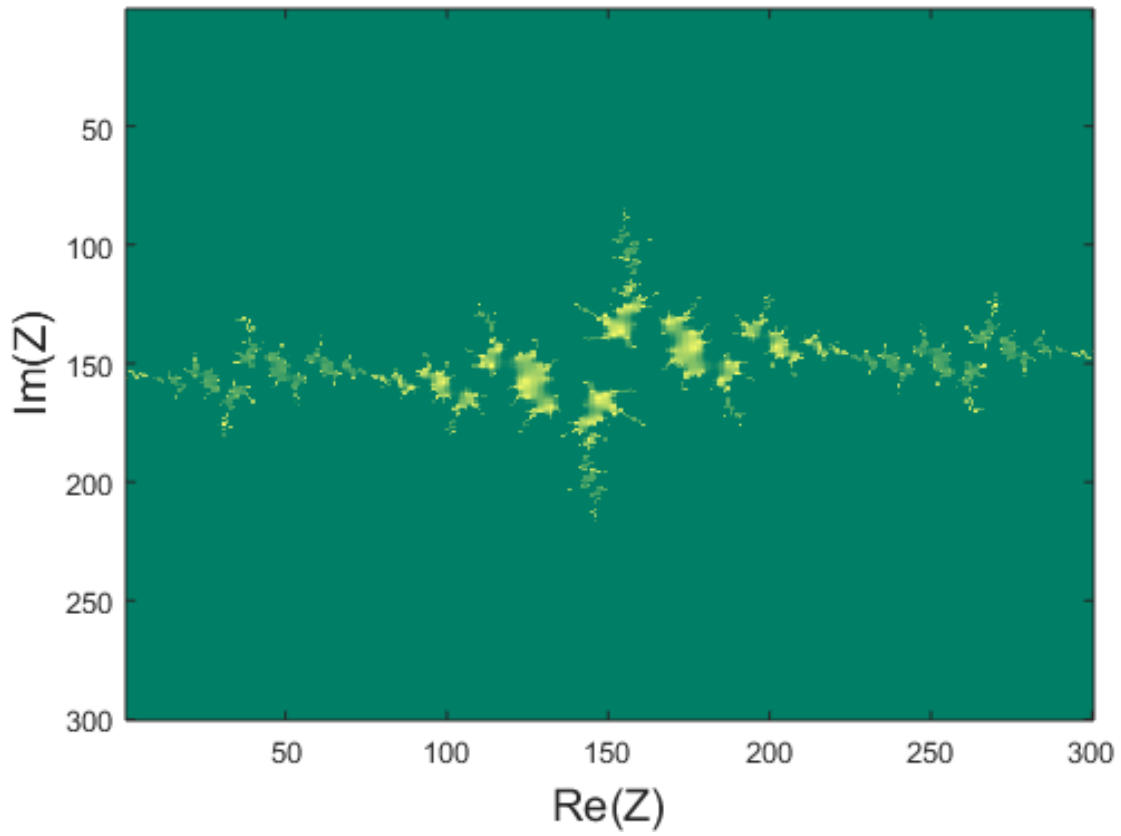
The following maps represent different complex numbers.
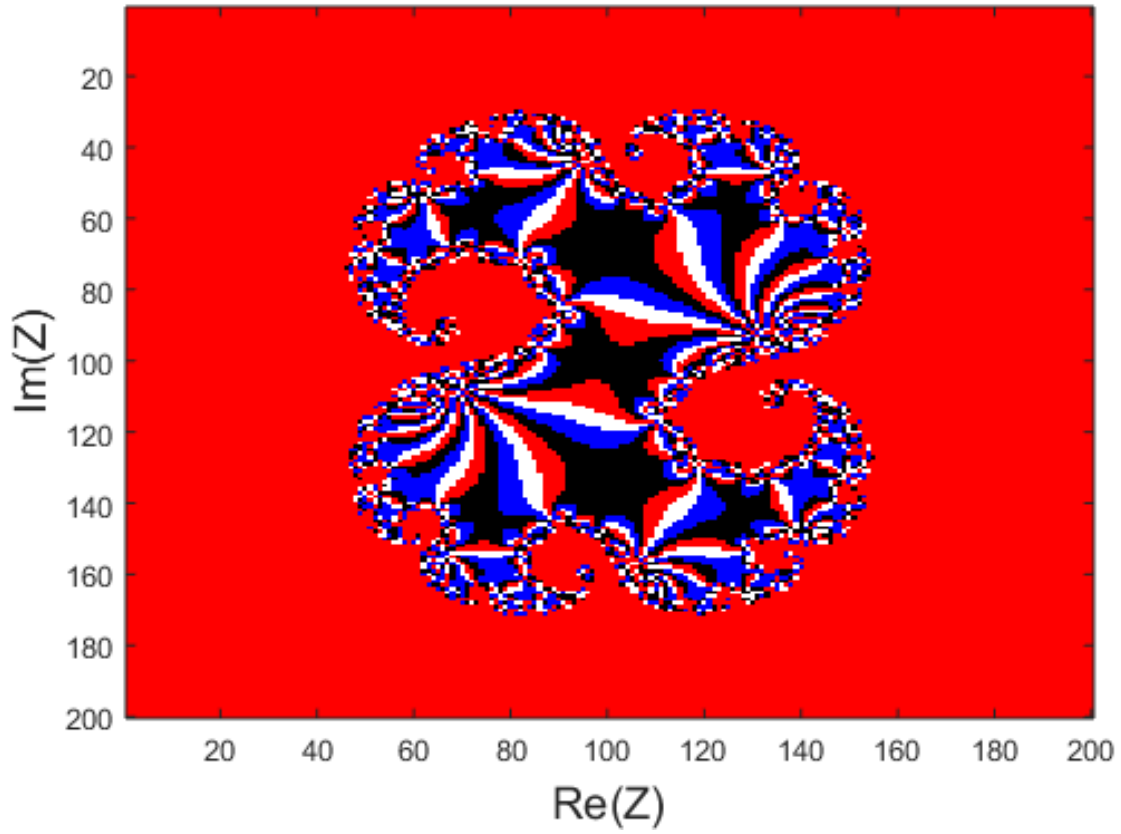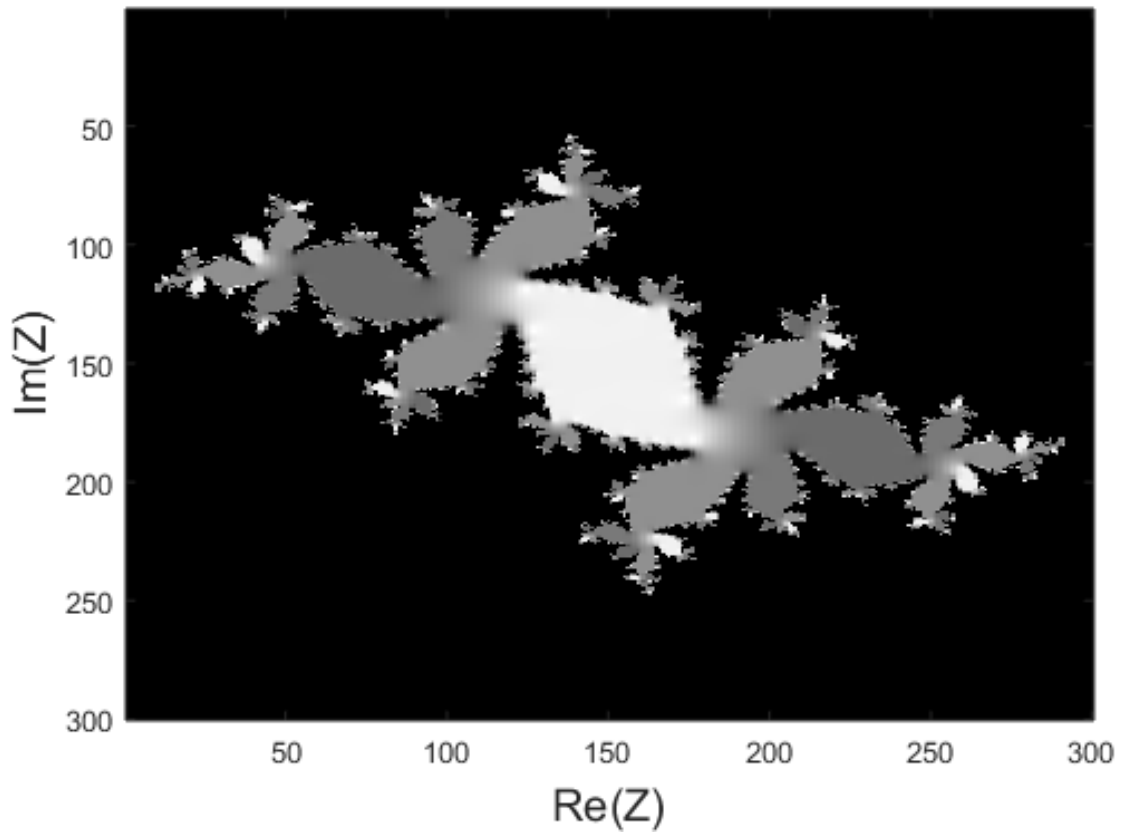
Julia Set Type 1 Prism
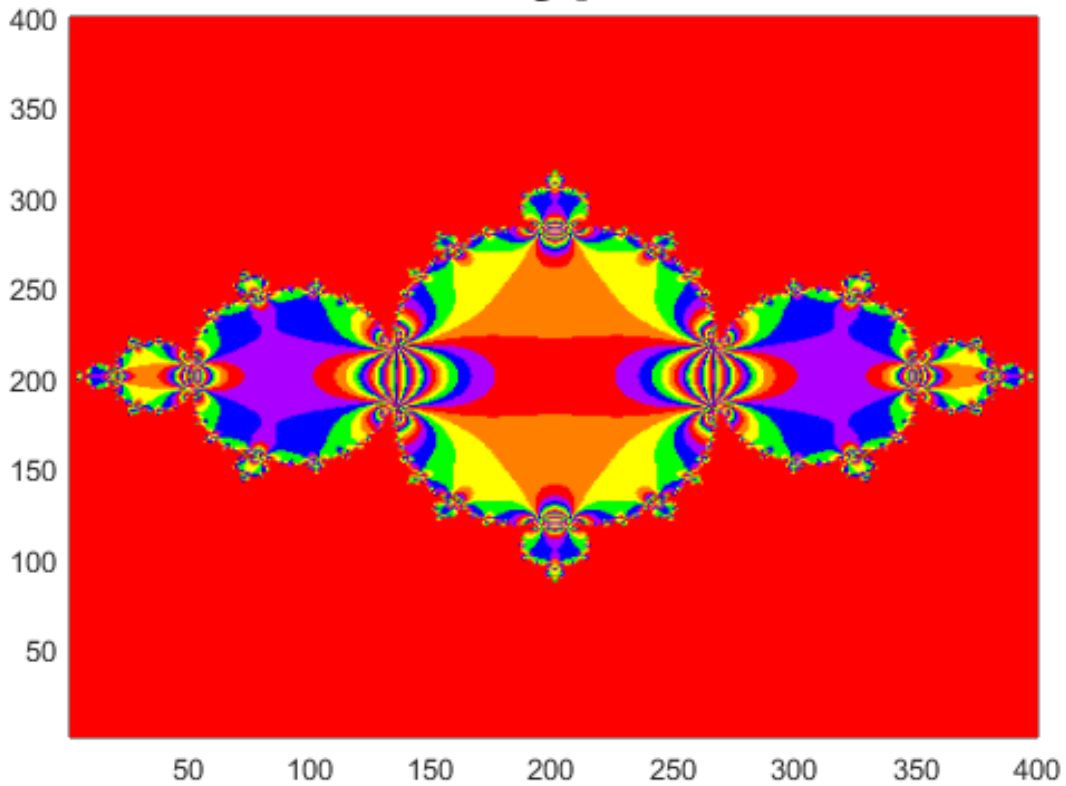
Julia Set Type 1 Copper

Julia Set Type 2
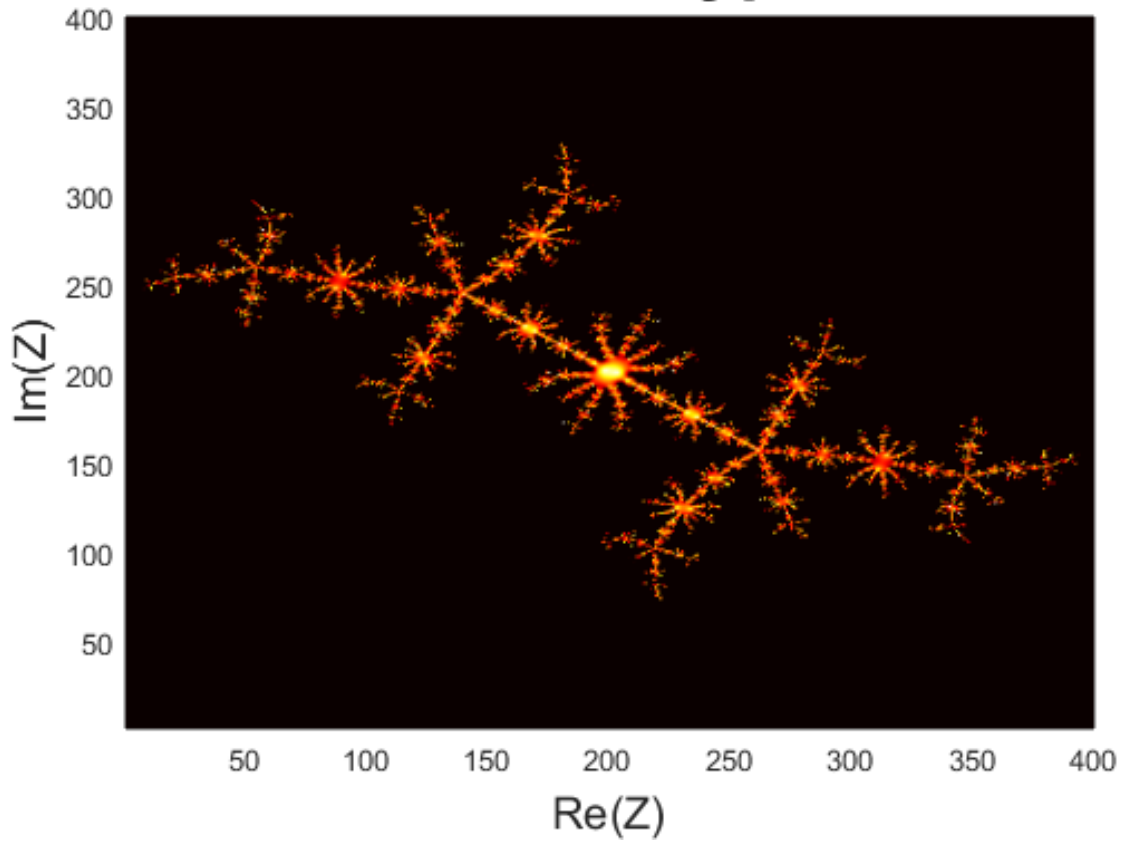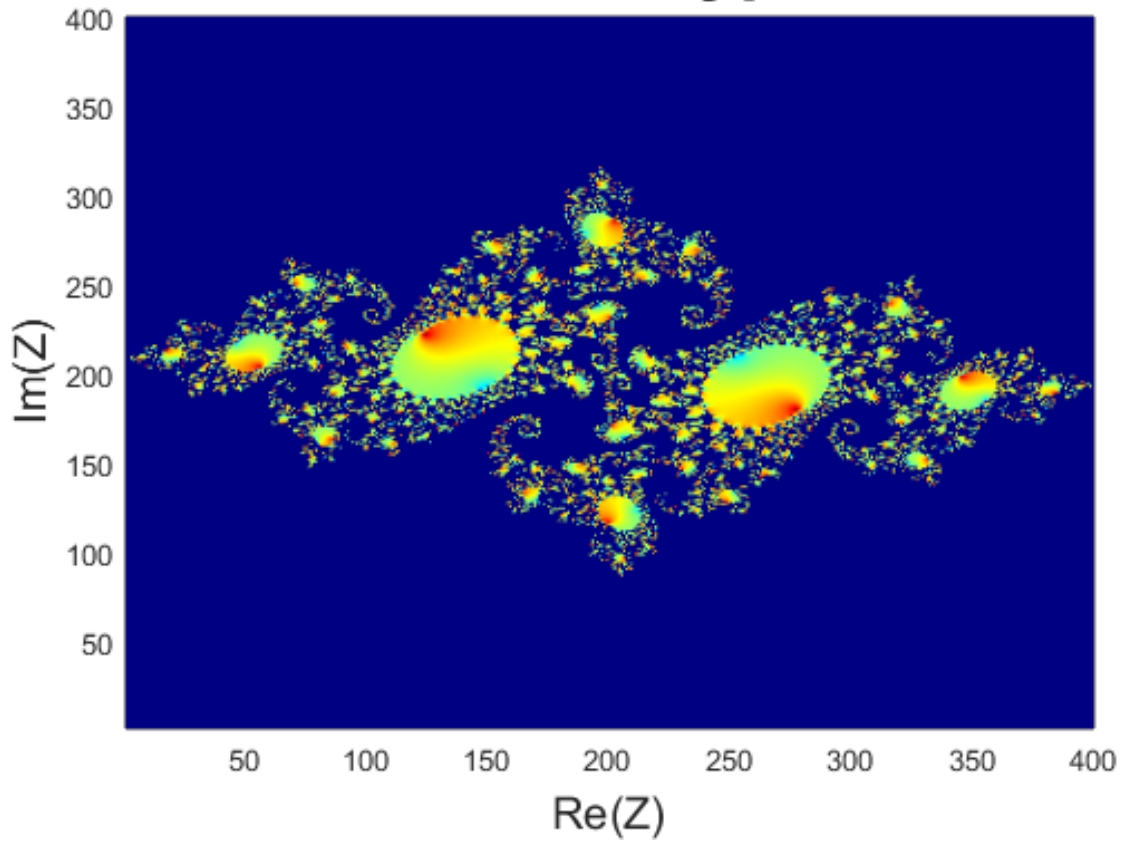
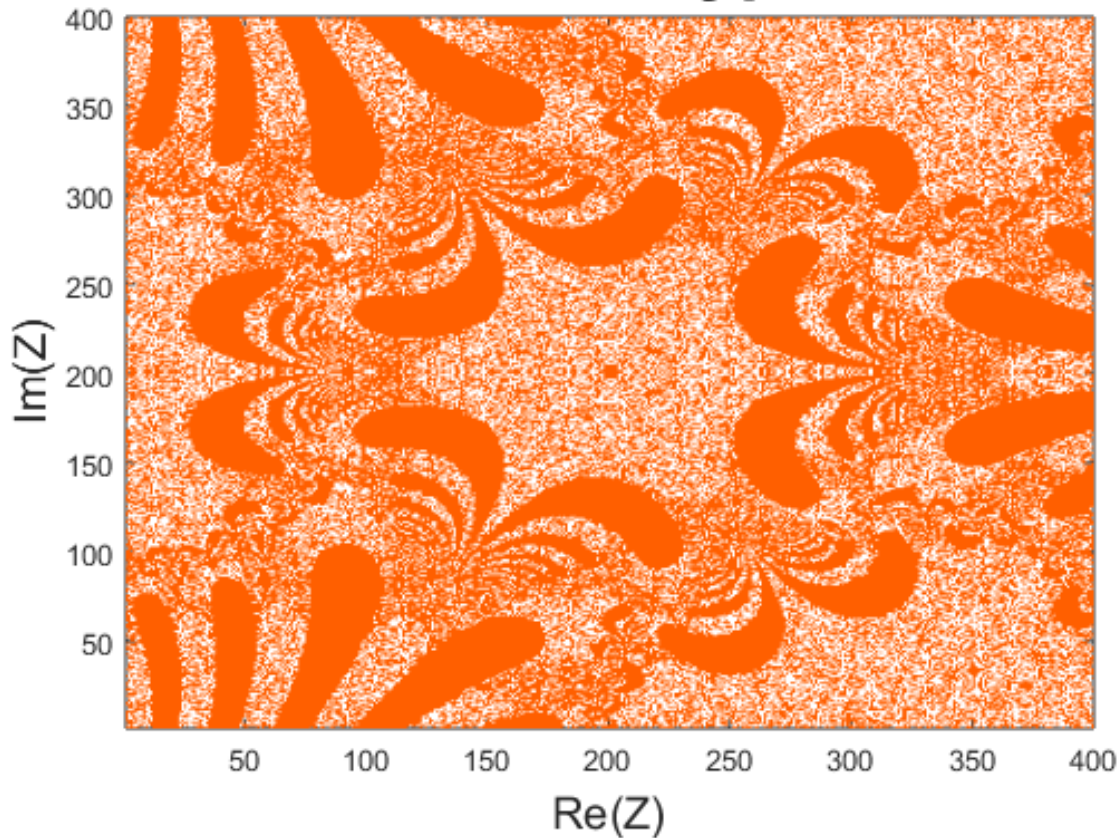Julia Set Type 3

Julia Set Type 4

Julia Set Type 5

Julia Set Type 6

Julia Set Type 7

4   Conclusion

This project not only sparkled my interest in Math but also helped me learn more commands in MATLAB. I played with mapping for about two days.

Since the functions *pcolor* and *imagesc* both need real input variables the command *pcolor(Z)* gave errors. It took me a while to realize that instead a new real variable W depending on Z could be plotted. I got the idea of defining W to be an exponential function from Wikipedia because they showed many examples of Julia sets with exponential functions.

Since Julia sets are infinitely thin, I tried to zoom in my plots which turned out to be a disaster. The image resolution was terrible. I tried to find a way to plot maps with better resolution. However, I did not find an easy way to do so. My future goal is to solve this problem.