Matt McDade
System Simulation Project

Weierstrass Definite Integral Visualization

With only a brief mention during class time, I was intrigued by the Weierstrass Function and its many interesting properties. One of which I couldn't find much information on was the area under the Weierstrass function. To investigate this myself, I would need to learn how to simulate the Weierstrass function with increasing detail, enough so to make a meaningful statement about the definite integral.

I used the Wikipedia article on the Weierstrass Function to learn about the function itself, then went to implement it in Matlab. I chose to make an animating graph, as I like to watch moving lines. This also gave me the opportunity to visualize the area under the Weierstrass function over time as it is calculated using slightly different constants. The constant I chose to vary was b, as it produced the lovely animation on the Wikipedia article.

With my code I was able to produce a similar visualization while tracking the area under the curve throughout modifying this b value from 0 to 5. The final product of this initial code can be seen in Figure 1, and the code can be found attached as *Weierstrass_Varying_b.m* (I would recommend running this code yourself to see the neat animation).

In the definition for the function, there is a second constant, a, that can also vary. In the first code, I left $a = 0.4$. I chose 3 values for this a value and plotted them all next to each other so I could see how this variable changed the function as well. This end product can be seen in Figure 2, with the code attached as *Weierstrass_Varying_a_and_b.m*

Looking at the bottom area graphs for both of these, I noticed that the behavior becomes somewhat chaotic at some point between $b = 1$ and $b = 1.5$. Over time, the area oscillates closer and closer to 0. There are some interesting spikes in the yellow $a = 0.7$ Integral graph that I have associated to a lack of accuracy, as I had to lower the delta to run this graph in a reasonable amount of time. With more time and a more detailed simulation, I'm confident those inconsistent spikes wouldn't be there.

Overall I'm happy with what I learned about the Weierstrass function and that you introduced it to us in the first place. Maybe I'll investigate why the area seems to become chaotic and learn even more about this system.

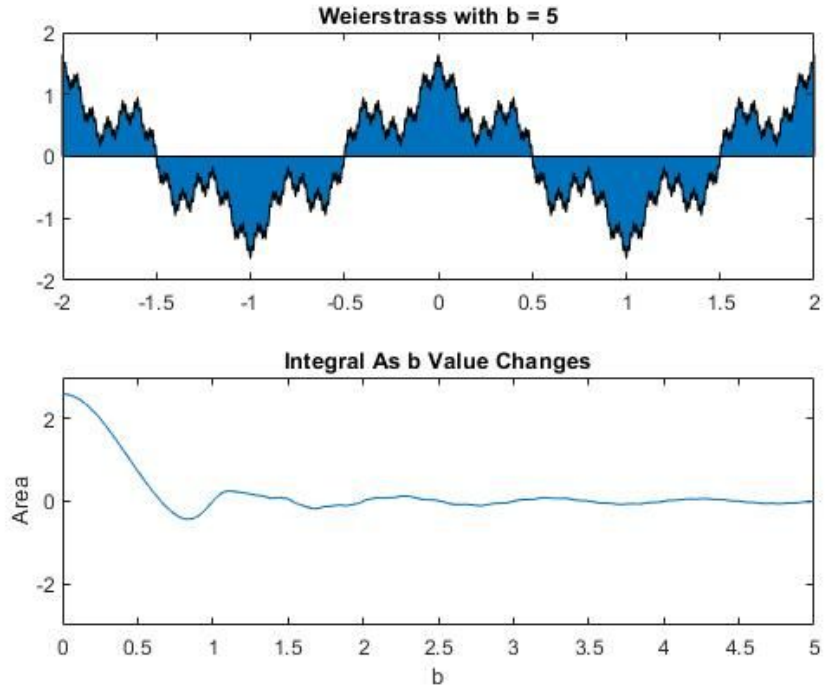

Figure 1: End Result of *Weierstrass_Varying_b.m*

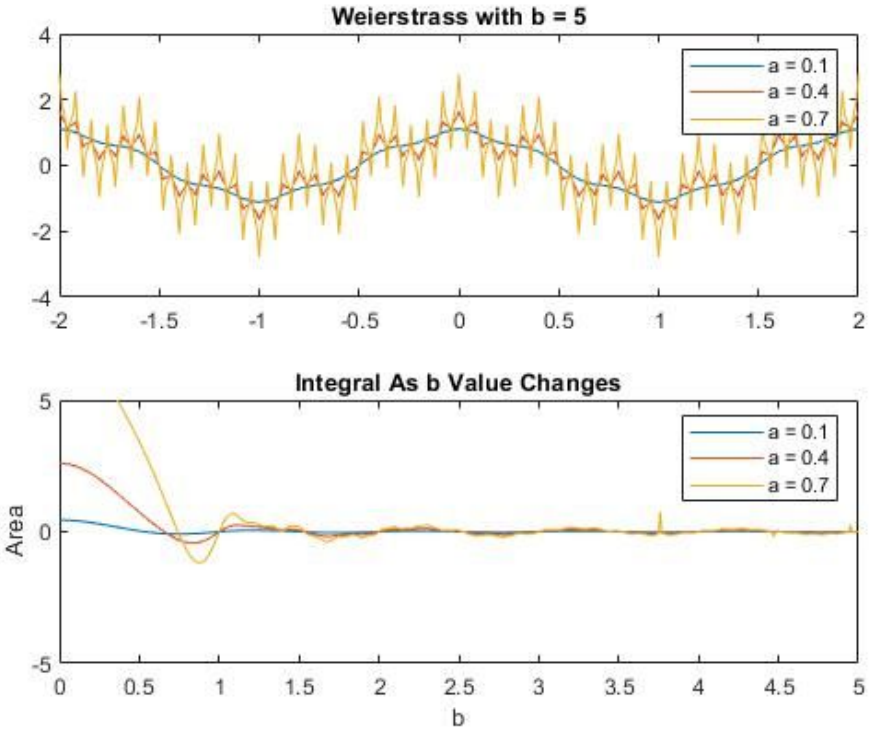

Figure 2: End Result of *Weierstrass_Varying_a_and_b.m*