Lab 5 Report
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Computational Physics

Part 1

Point 1:
The plots for this part are labeled part1point1_x.pdf with x from 0 to 5. For the values of the ratio for which the fixed point is stable, the mapping takes around 30 iterations to reach the correct value and stays there. For the values of the ratio that exhibit chaotic behavior, no convergence is reached but the mapping oscillates between the various fixed points in a cyclic fashion.

Point 2:
The plot for this part is labeled part1point2.pdf. Here the map for ratio = 3.3 oscillates between two values, so the difference between one iteration and the next is always the same and the plot is a straight line. The map for ratio = 3.8 is chaotic, so the differences between one point and the next is not easily predictable and varies wildly, though after 200 iterations a pattern begins to emerge.

Point 3:
The plots are labeled logmap_something.pdf (there are 3 of them). Looking at successively more zommed-in plots (logmap_close, log_branching) makes it evident that the internal structure of the map is repeating.

Point 4:
By looking at the graphs and using the ratio values for the first 4 branches (examine logmap_close to get the last 2 values) I find that the bifurcations happen at ratio = 3, 3.45, 3.544, 3.565. Note that since we start with ratio = 1 the length of the first branch is 2. The average constant (from the 3 values I can compute) is $\delta = 4.56$

Part 2

The various plots outputted by pendulum_simulation.py are saved under FD_x.png. It looks like the plots for F = 1.2, 1.5 are definitely chaotic, while the plot for F = 0.5 is definitely not chaotic. I do not know what to say about the other two plots, they have similar signatures and multiple fixed points, but they are not as varied as the chaotic plots (they are somewhere in between).
When building the large bifurcation plot (part2bifrucation.pdf) I chose to run values of F between 0.5 and 2.5 with spacing of 0.0015 (approximately 1300 different values), The resulting pdf is very large (around 140 Mb), and takes a long time to load, so be careful when opening that everything has loaded in correctly and pieces of the plot are not cut-off.
For the Feigenbaum number, the distances are more difficult to extract since I cannot easily use the tracing feature of the interactive python windows on the finished pdf. But I can estimate the first few values of F where the bifurcation happens, resulting in an estimate of $\delta = 4.77$. This is different than the value obtained in part 1, but that is to be expected since I have to estimate the correct x-values at every step. Given my imprecise methods, it is reasonable that

both values are within about 0.1 of the accepted value of the constant. It is more interesting that the values are so close together given that the two bifurcation diagrams represent totally different mappings, and different physical processes.