ISC Lab 5 Reports

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Abstract

This experiment drew from what we did in the previous lab and added different analytic graphing tools so we could further examine the bifurcations and behavior of the logistic map, such as the Poincare plot, cobweb plot, and bifurcation diagrams. The video mainly explored how chemical reactions could be modeled by simple maps that evolve into dynamical systems upon iterations.

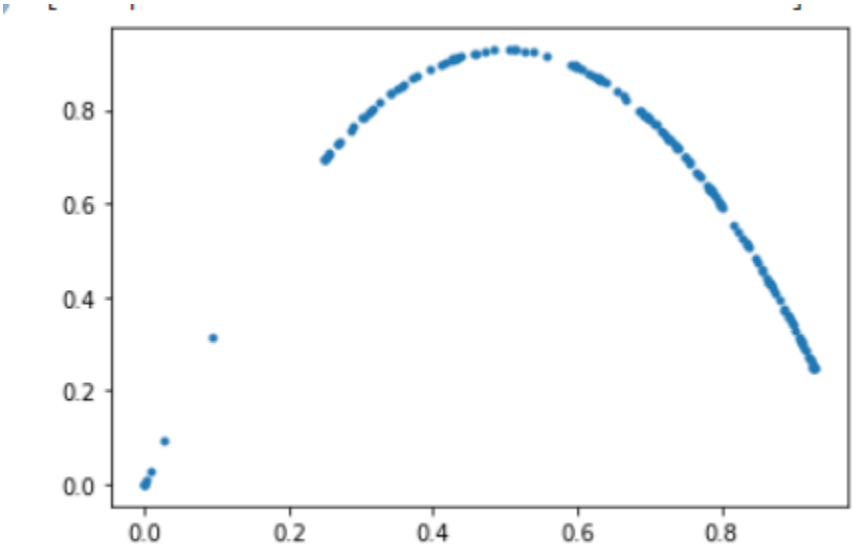
Introduction and Theory

We define the logistic map by

$$x_{n+1} = rx(1-x)$$

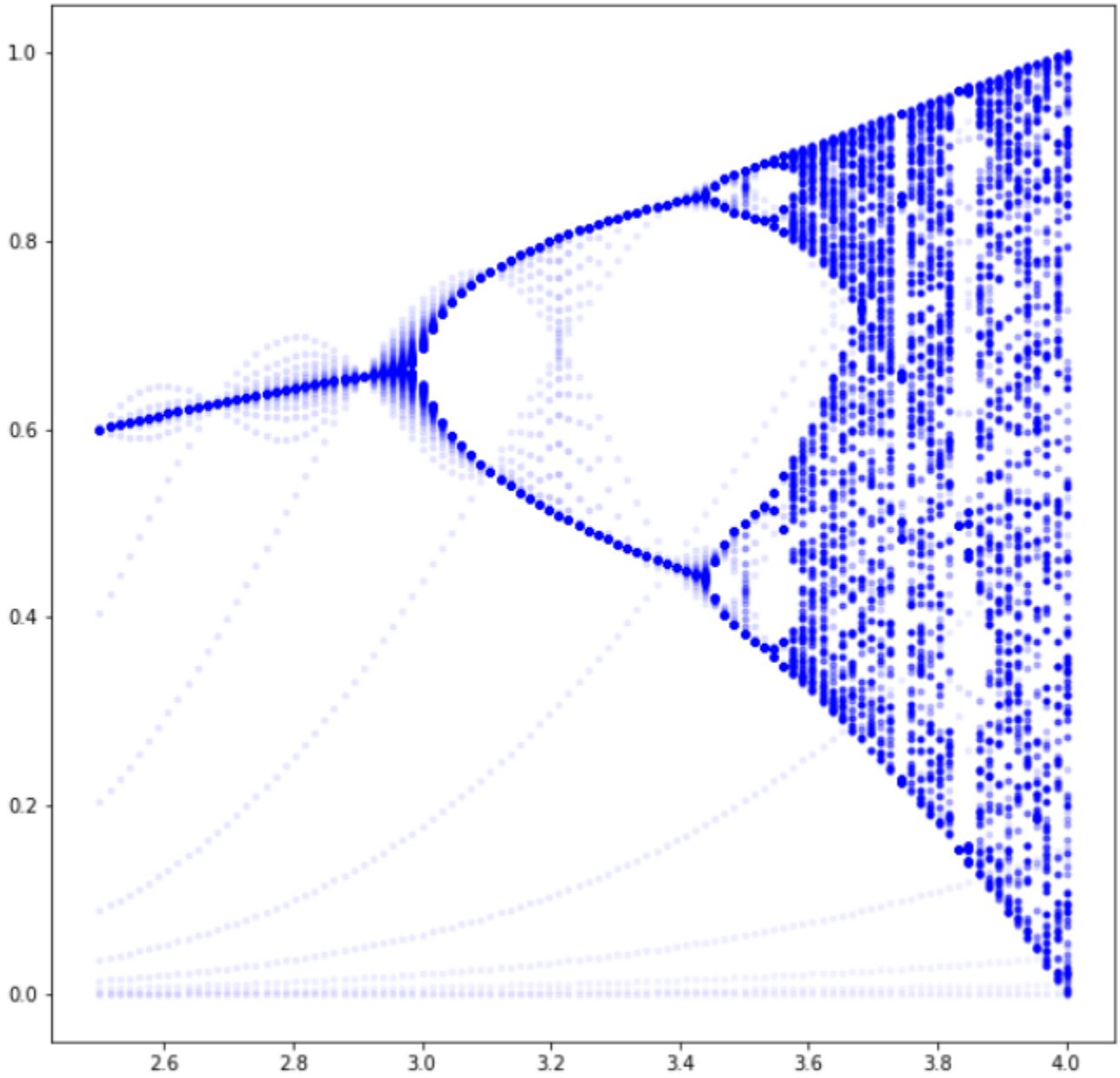
for an initial condition x_0 and a growth rate of r. We first examined the Poincare plot of the map which helps reveal the stretching-and-folding structure of the logistic map and its quadratic characteristics hinted by its formula. The map is obtained by iterating a single initial point and plotting its trajectory through the map. We then plotted the bifurcation diagram, just like the previous lab, which exposed how initial conditions behave differently throughout the map. Thirdly, we looked at the cobweb plots which helped expose which initial conditions would lead to chaos.

Poincare Plot



1 Bifurcation Diagram

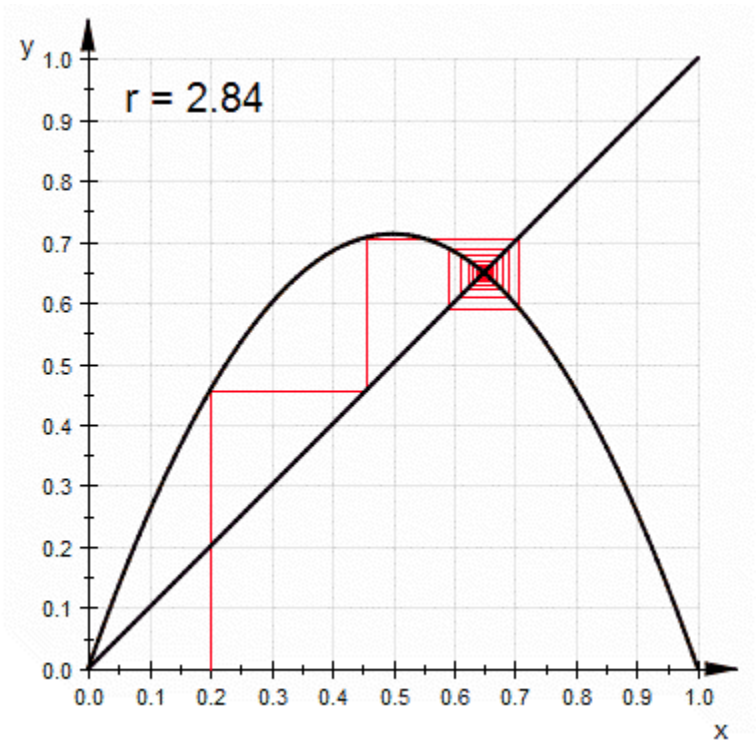
Once again we observe the bifurcation happening at around r= 3 and chaos after around 3.57.



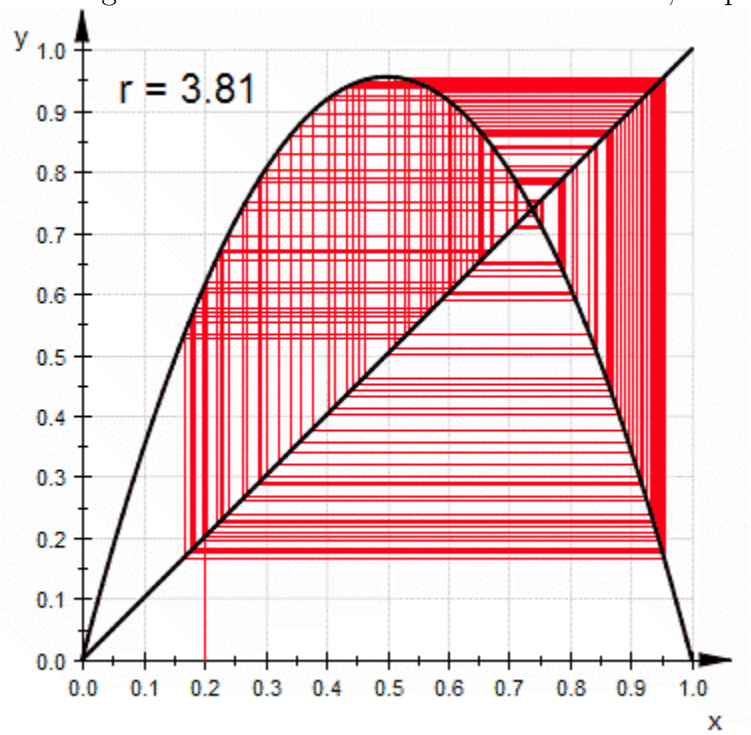
Cobweb Plot

To build this plot we start at our initial point and draw a vertical line connecting that to the 0th iteration of the point. Then draw a horizontal line to the line $y = x$. Draw a new vertical line connecting to the next iteration and repeat for n iterations.

Ffor $r = 2.84$ we obtain a convergence



But for greater values we obtain chaotic behavior, as predicted by the bifurcation diagram



Conclusions

In conclusion, we examined different techniques to explore chaotic behavior and discussed what each revealed about our map.