ELEN 530: Advanced Computer Applications for Engineers

Dynamic Systems and Process Change Over Time

Ashalynn Davis

S01623767

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Introduction:

Dynamic systems and logistic maps (a nonlinear dynamic systems) are used in many fields to evaluate how fixed variables behave over time. Dynamic systems are used fields such as "Electrical, Electronics and Computer Engineering. Dynamical Systems theory describes general patterns found in the solution of systems of nonlinear equations. The theory focuses upon those equations representing the change of process in time."[1]A logistic map model we can model to evaluate its behavior is as follows:

$$x_{i+1} = f(x_i),\ f(x) = rx(1 - x)\ .$$

In our evaluation we will observe the following: the behavior of r over a period of time and how x_{i+1} and x_i interact in regards to r. We will evaluate behaviors and iterations by refering to the bicurations points on the bicuration diagrams, Poincaré, and limited growth model logistic map. Bicuration points are also known as ”attractors” which are points where the system’s behavior ceases even if it is chaotic and unstable

Part 1A:

From evaluating r values, if r has only one bicuration point then $r < 1$. But if $r \in [1, 4]$ there will be several bicuration points.Below are the results from 80 individual timestamps.

1. Khan, Yousuf Ibrahim. “Applications of Dynamical Systems in Engineering." ArXiv.org, 2013, arxiv.org/ftp/arxiv/papers/1304/1304.5251.pdf

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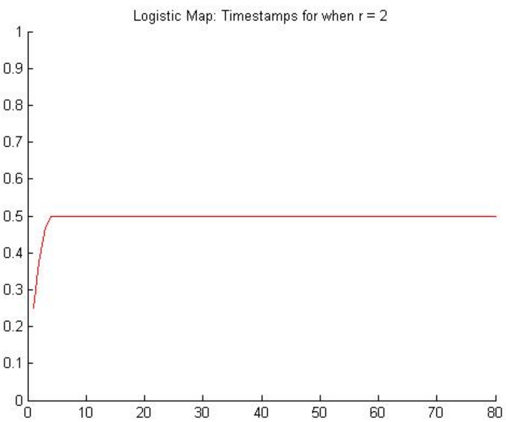

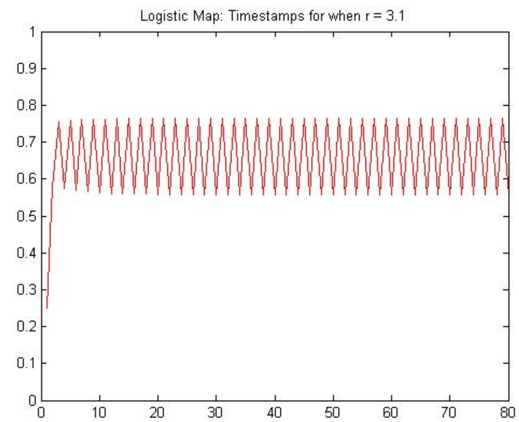

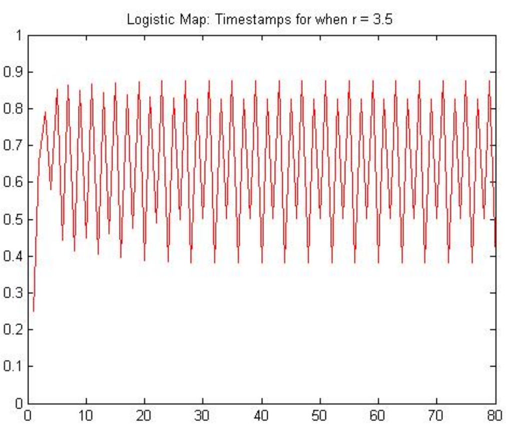

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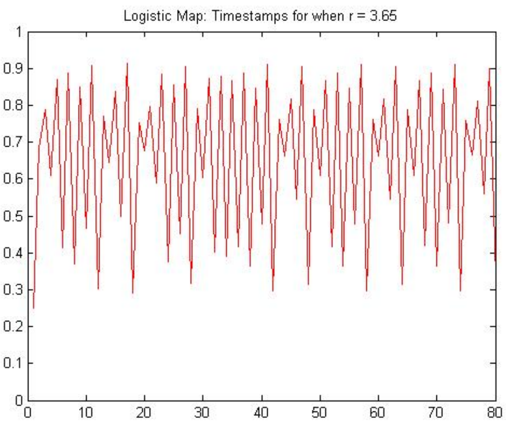

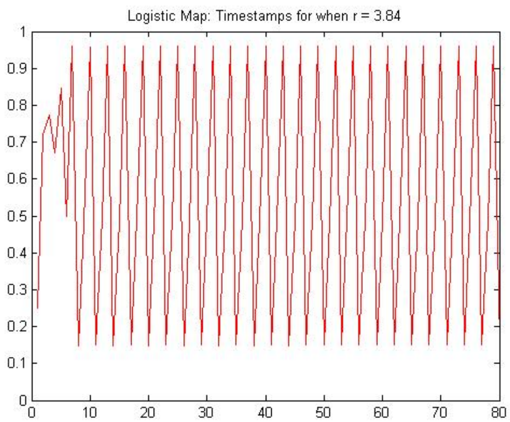

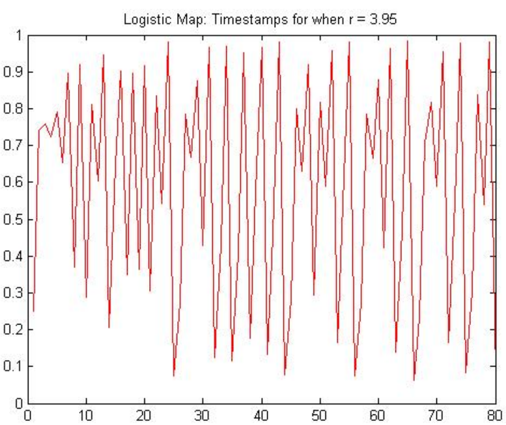

Part 1A (continued) :

In figure 1,the system increases positively when $r = 2$.The system settles flatly after this point; this means there is one attractor point. In figure 2,the system seems to oscillate between 2 points when $r = 3.1$. In figure 3,the system is unstably oscillating in the positive direction when $r = 3.5$; this means there are four attractor points.In figure 4,the system follows no pattern when $r = 3.65$. In figure 5, the system begins in an unstable manner and then begins to oscillate between two points after $1/4$ of the timesteps have passed when $r = 3.84$. In figure 6, the system appear to have several attractor points when $r = 3.95$

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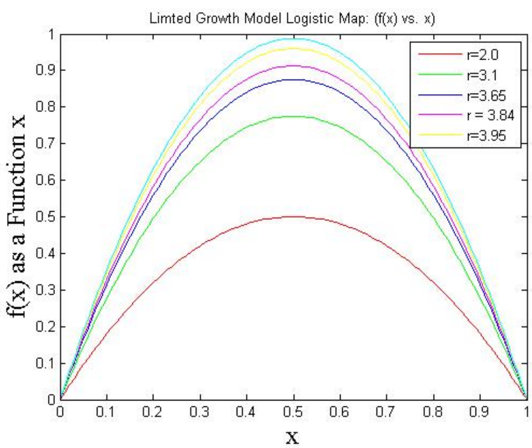
Part 1B :

In figure 7, we show the relationship between x_i and x_{i+1} in regards to the system $x_{i+1} = f(x_i), f(x) = rx(1-x)$ From the results the follow two statements are true about the given system: $x_i < x_{i+1}$ when $x_i < 0.5$ and $x_i > x_{i+1}$ when $x_i > 0.5$.



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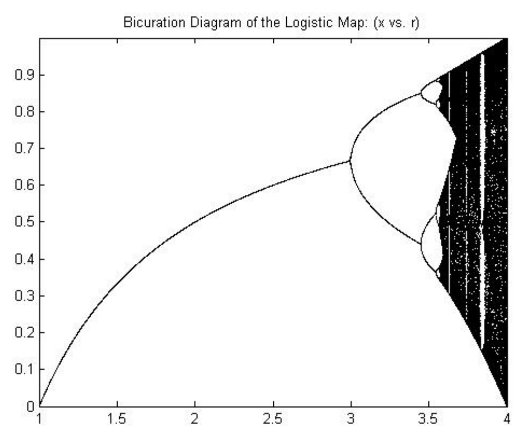
Part 2:

Below is a bicuration diagram of the results found in figure 1-6 in Part 1A. The interval chosen for this diagram is $1.0 < r < 4.0$ because the r values we chose fall in this interval.The diagram shows how chaotic the system is in regards to its logistically map; the diagram shows that the system is unstable in the beginning but eventually calms.



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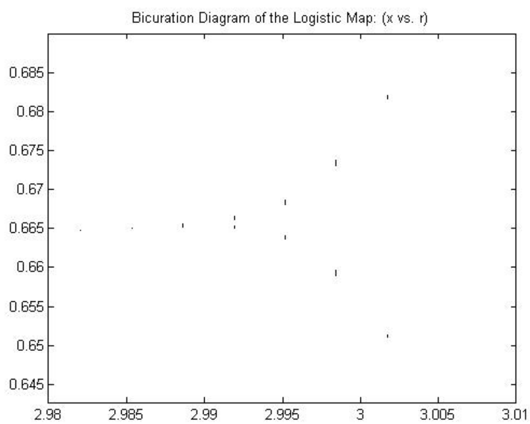
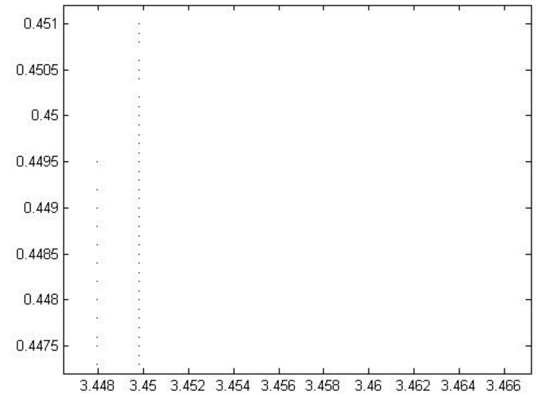
Part 3:

Below is a bicuration diagram of the results found in figuresfrom Part 1A. The interval(s) chosen for figure 8 and figure 9 are $2.98 < r < 3.01$ and $3.448, r < 3.466$ because the r values we are focused on fall in the first bicuration and second bicuration, respectively. After evaluation, the value nearest first bicuration is r=3 and the value nearest the second bicuration is r= 3.45. Only the second.





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Conclusion :

In conclusion, we evaluated the behavior of the dynamic system $x_{i+1} = f(x_i), f(x) = rx(1-x)$,as its x values are compared its preceding value. This system started chatotically and then became stable after time.