Homework 1
Chaotic Dynamics - CSCI 4446

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1 Problem 3

1.1 Chaotic Behaviour

We can see on the Figure 1 that a slight change in initial population ratio (0.2 vs 0.20001) results in different model path as time progresses. Therefore, we conclude that our system is extremely sensitive to initial conditions and is thus chaotic.

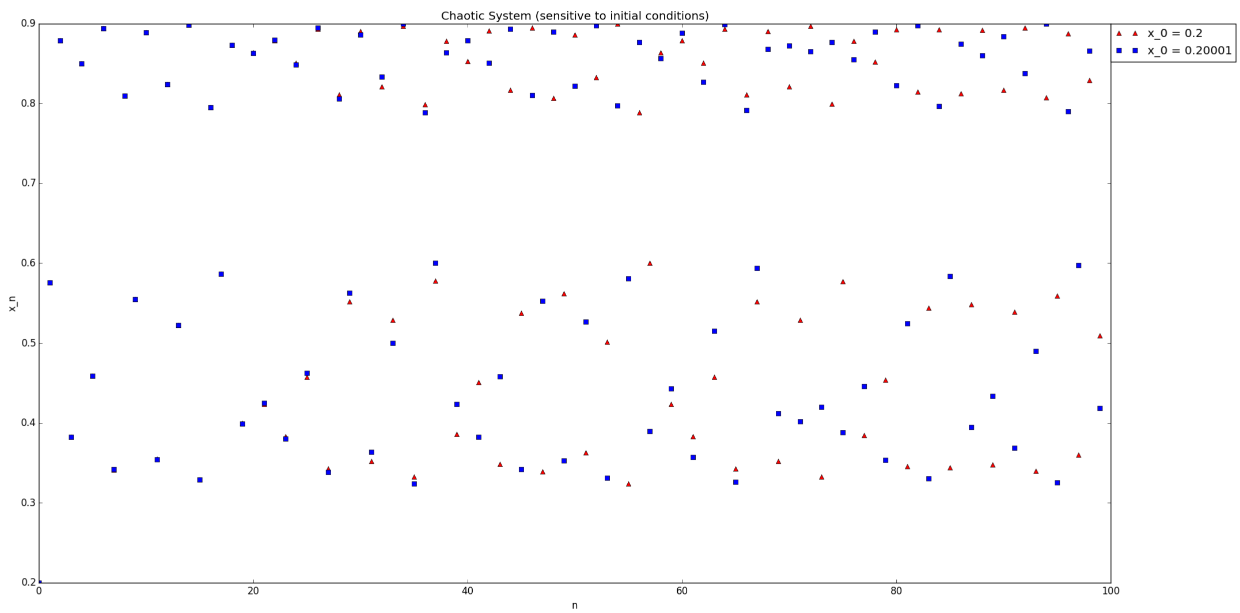

Figure 1: Chaotic Behaviour (R=3.6, n=100, x_0 = 0.2 and 0.20001)

1.2 periodic behaviour

I liked the conditions of $R = 3.83$ because of its interesting oscillating (3-cycle period) behaviour that is very obvious on x_n vs. n graph, but might be confusing on x_{n+1} vs. x_n or x_{n+2} vs. x_n, because those graphs weren't meant to capture a 3 periodic oscillation. However,once we plot x_{n+3} vs. x_n, we clearly see how our line $y = x$ intersects the data points in exactly 3 locations, therefore showing that the system has "converged" to the 3-cycling periodic behaviour.

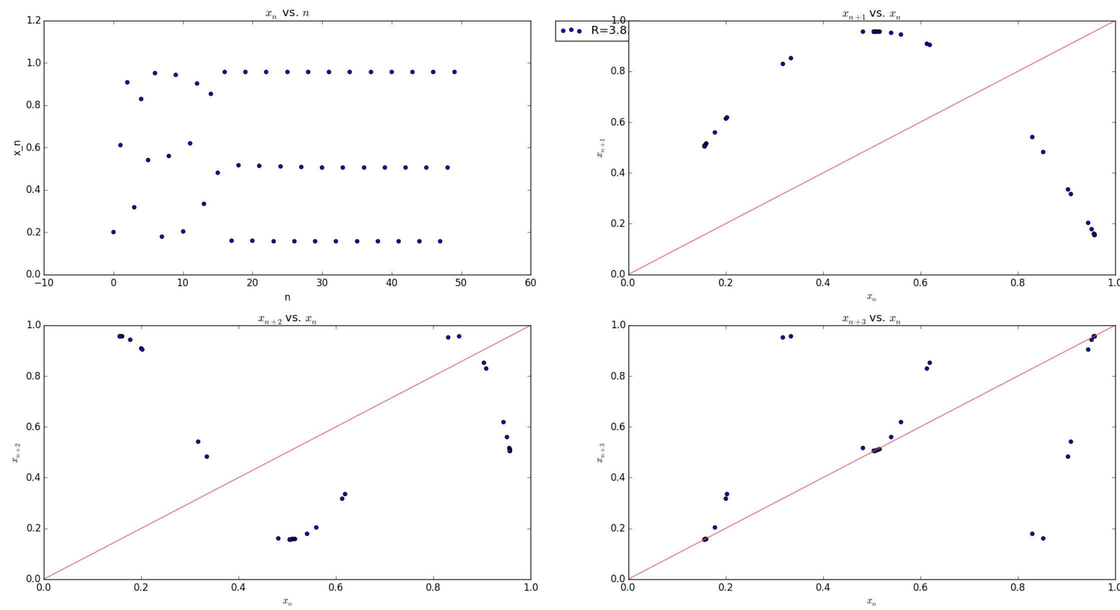

Figure 2: periodic behaviour (R=3.83)

1.3 unstable fixed point

Another condition I found interesting is $R = 3.6$. I tried to set initial condition to that of a 2-cycling oscillation - $x_0 = 0.86955$. Even though a clear 2-cycling behaviour didn't last long, it's interesting to note that the prediction was able to determine behaviour of the system for a brief period.

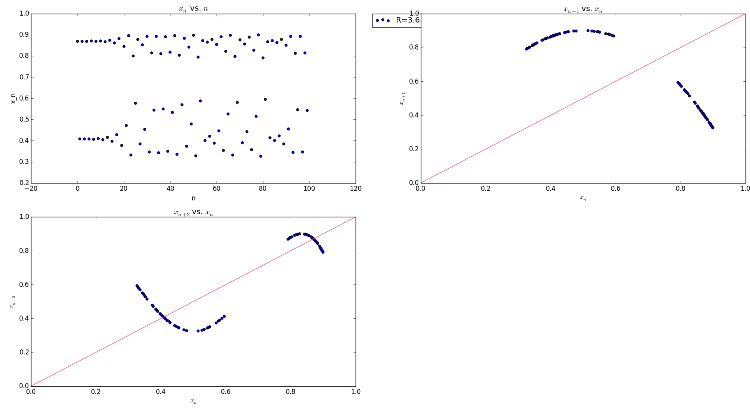

Figure 3: unstable fixed point

We can similarly force a fixed point, but because of the chosen R value, fixed point is unstable.

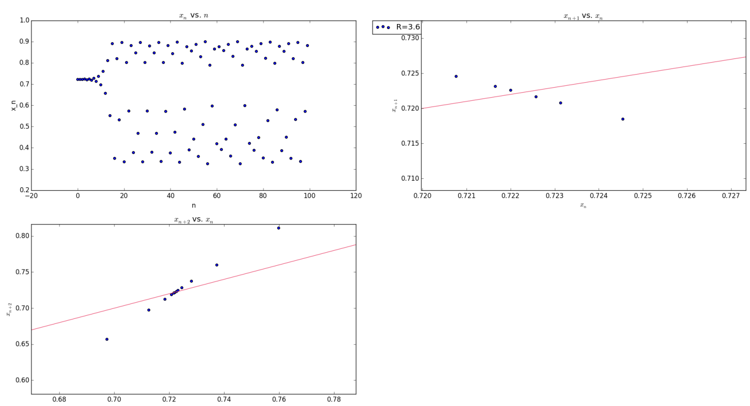

Figure 4: unstable fixed point

1.4 Questions

As we set $R > 4$, the system diverges and at some point, x_0 becomes greater than zero and that ruins our model.

As we choose $R = 2.5$, the system always converges towards the same fixed point as we change initial condition of x_0. Therefore, the system produces a stable fixed point attractor.