PHY100S – The Magic of Physics
Homework #7

This homework assignment is due in the Drop Box for your tutor by 5 PM on Monday March 13.

Question 1

In this question, we will see how simple mathematical structures can lead to chaos. You may want to have a calculator handy although, if you prefer, Excel and many other computer programs can also do the calculations for you.

We will investigate three systems that are somewhat simpler than the *Logistic Map* that is discussed in the course notes.

Exercise 1

This Exercise investigates this system:

$$n_{this} = (n_{previous})^2 + \frac{1}{4}$$

Part A

Start with a value of 0.5. Square it and add 0.25. Write down the result, but don't clear it from your calculator.

Take the number in your calculator, square it, and add 0.25. Write down this result.

What is the pattern?

Part B

Start with a value of 0.4. Square it and add 0.25. Write down the result, but don't clear it from your calculator.

Take the number in your calculator, square it, and add 0.25. Write down this result.

Repeat this a few times.

Can you see a pattern? How does each number that you wrote down compare to the previous one that you wrote down?

If you repeated this many many times the final value would approach the same final value as Part A.[1] In the language of chaos that value is called an *attractor* for this system.

Exercise 2

In this exercise we will investigate this system:

$$n_{this} = (n_{previous})^2 - \frac{3}{4}$$

Again start with a value of 0.4. Square it and subtract 0.75. Write down the result, but don't clear it from your calculator.

Take the number in your calculator, square it, and subtract 0.75. Write down the result.

Repeat a few times.

Can you see a pattern? This system has two *attractors*. What are their approximate values?

Exercise 3

Now we will investigate this system:

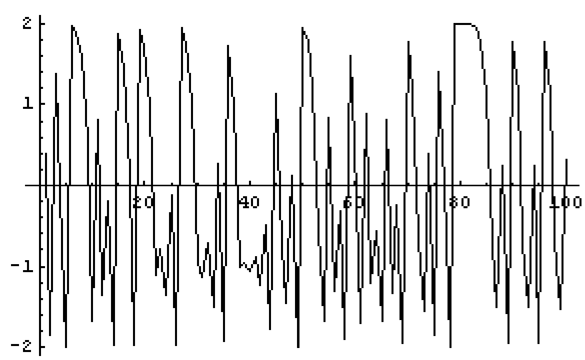
$$n_{this} = (n_{previous})^2 - 2$$

Again start with a value of 0.4. Square it and subtract 2. Write down the result, but don't clear it from your calculator.

Take the number in your calculator, square it, and subtract 2. Write down the result.

Repeat a few times.

You will not be able to see a pattern in this sequence of numbers: the system is chaotic. Here are the results of repeating this calculation 100 times:



[1] After repeating the calculation 5000 times, the result is 0.499801

Question 2

In the Course Notes *Life, Emerging Structures, and the Second Law of Thermodynamics*, there is a Flash animation of the first six generations from Rule 110 after a starting point of a single populated cell. The table below shows that result. Draw the pattern of populated and unpopulated cells for the next two generations. You may use the table for this if you wish.

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							●	●	
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				●	●	●	●	●	
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Question 3

Provide a title, topic, preliminary outline, and preliminary bibliography for the Long Paper that is due on April 3.