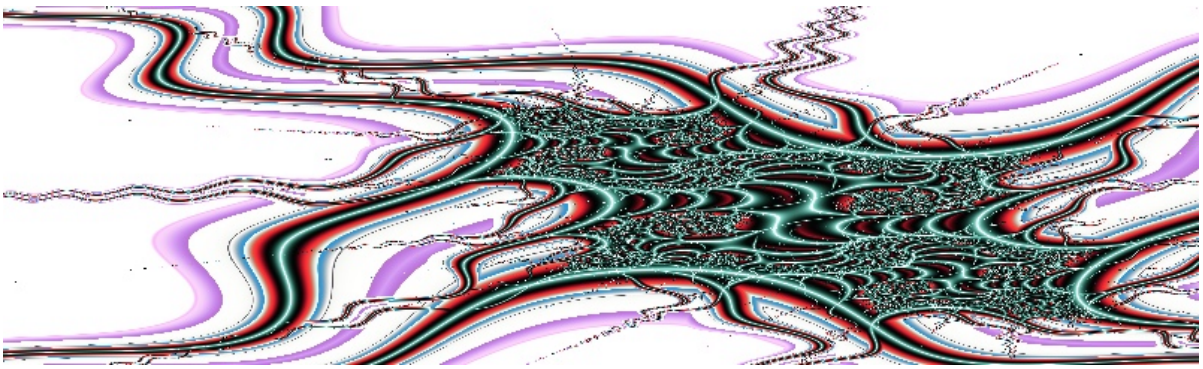

Classroom Chaos 9

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1. What did he say?

The purpose of this exercise is to try to make some sense out of what Wolfram, in discussing one possible source of randomness in physical systems - external noise, is talking about when he claims:

> *"A simple example of this 'homoplectic' behavior occurs in the shift mapping* $x_t = 2x_{t-1} \bmod 1$. *The time sequence of bins, say, above and below 1/2 visited by* x_t *is a direct transcription of the binary-digit sequence of the initial real number* x_0*."*

Begin by setting up the following spreadsheet, which implements the shift map.

	A	B	C
1			
2		0.123	=If(B2 >= 0.5,1,0)
3		=MOD(2*B2,1)	=If(B3 >= 0.5,1,0)

Copy Cells B3 and C2 down through B32 and C32

Create a bar graph of your data in column B. Tile your windows so that the chart and the sheet are both visible.

In cell B2, enter different values (between 0 and 1.0), and take a look at the patterns which emerge.) Experiment and try to find the input values that cause just one bar to appear on the graph. What is the significance of the binary digit stream appearing in column C? Just what is Wolfram talking about?

2. Three of a kind

Once you have figured out what is going on in #1, design a sheet that implements a ternary shift map. Verify that it works correctly. (Choose points that are members of the Middle-Thirds Cantor Set.)

3. The automaton

Manually implement the one-d cellular automaton

$$a_{t+1}^{k} = (a_t^{k-1} + a_t^{k+1}) \mod 2$$

where t = time value and k = column number in the following grid. (Zeroes are not drawn, and ones are indicated by dots.) The starting sequence is indicated. Run your automaton through at least 16 generations. When you have done this by hand, implement the automaton on a spreadsheet, trying different input strings. Is the behavior "autoplectic" or "homoplectic"?