S & S Assignment 6

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1 1. Write down as a difference equation with non-linearity; take a and c as 5 digit prime numbers and plot output for 1000 values.

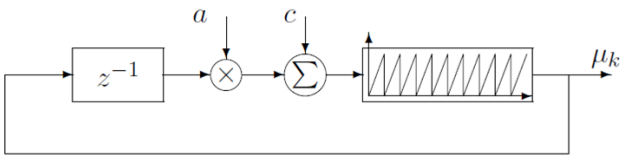


Figure 1: Linear congrential generator (LCG)

Sol:- The non-linear function in the above block diagram is modulo function.

- First input is μ_k.
- When it passes through $\mathbf{z^{-1}}$, it becomes $\mu_{\mathbf{k-1}}$, further mulitiplied with 'a' becomes $\mathbf{a}\mu_{\mathbf{k-1}}$.
- Further added with 'c' results in $\mathbf{a}\mu_{\mathbf{k-1}} + \mathbf{c}$.
- Now the new input to the modulo function is $\mathbf{a}\mu_{\mathbf{k-1}} + \mathbf{c}$. When it is passed through modulo function, the output is $(\mathbf{a}\mu_{\mathbf{k-1}} + \mathbf{c}) \bmod \mathbf{n}$.
- Therefore, the difference equation is

$$\mu_{\mathbf{k}} = (\mathbf{a}\mu_{\mathbf{k-1}} + \mathbf{c}) \bmod \mathbf{n}$$

where 'a' and 'c' are 5 digit prime numbers and

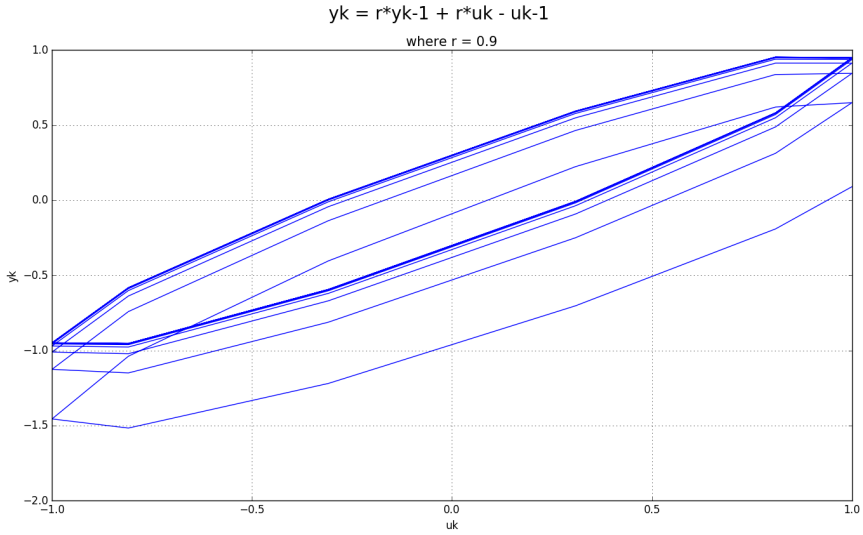
$$k \in [0, 1000]$$

Constraints on the values are:

- $10000 < a < m$
- $10000 < c < m$
- $0 < \mu_{k-1} < m$

Data points:

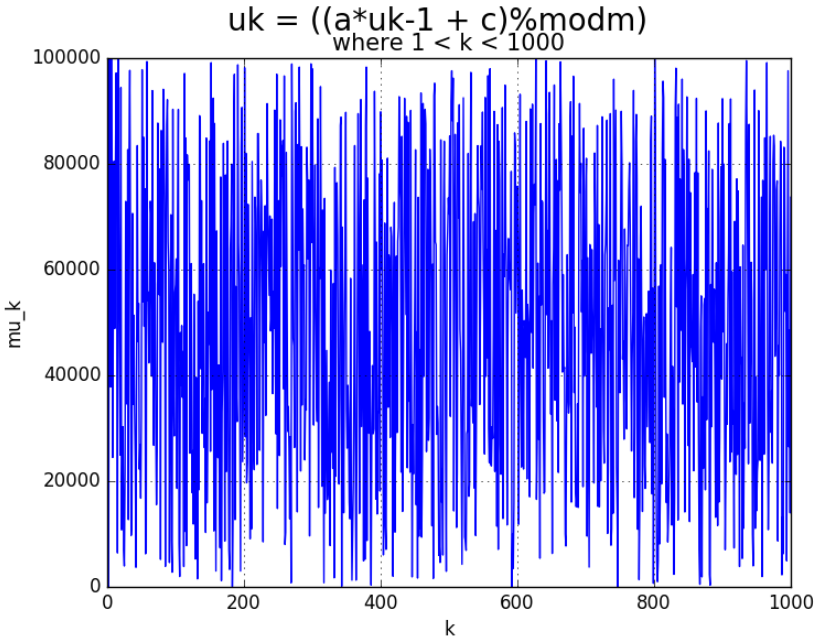
x	**y**
1	0
2	0
3	99997
4	79981
5	37828
6	99886
7	68509
8	24484
9	58666
10	80515
..	..
..	..



2 Use uk as cosine wave with f = 0.1, uk = (cos(2pifk) for 100 values get yk and plot uk and yk for the below difference equation

$$\mathbf{y_k = r.y_{k-1} + r.\mu_{k-1} - \mu_k}$$

u_k	y_k
1.0	0.09
0.809	-0.19
0.309	-0.702
-0.309	-1.219
-0.809	-1.516
-1.0	-1.456
-0.809	-1.038
-0.309	-0.403
0.309	0.223
0.809	0.620
..	..
..	..


uk = ((a*uk-1 + c)%modm)
where 1 < k < 1000
mu_k
k
0
20000
40000
60000
80000
100000
0
200
400
600
800
1000