Computational Physics - Exercise 9

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1 Random Numbers – Rolling Dice

We write a simple portable random number generator, using linear congruences:

$$I_{j+1} = aI_j + c \pmod m \tag{1}$$

For that, we creat an initiation function, that creates a global Variable.

```
def init(initVal):
    global rand
    rand = initVal
```

This variable will now be rewritten over and over again by a number generated by (1):

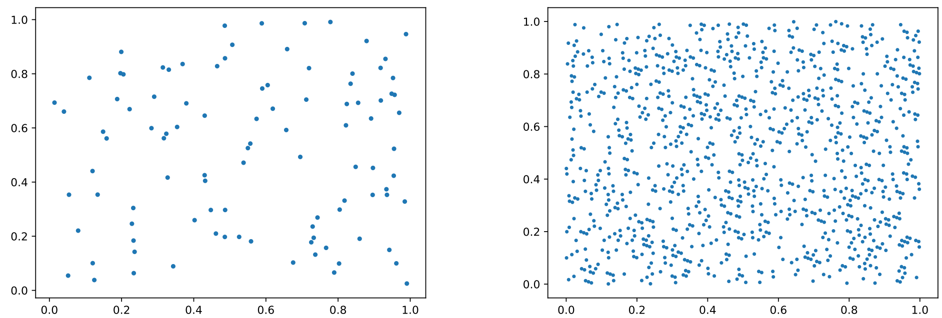
```
def generate_random(a,m,c,initVal):
    global rand
    rand = (a*rand+c)%m
    return rand
```

This function produces homogeneously distributed numbers between 0 and m-1. It can be normalized by $r_i = I_j/(m-1)$, to get homogeneously distributed real numbers between 0 and 1. We try it for example for $a = 106, m = 6075, c = 1283$:

```
Generating random number... a = 106, m = 6075, c = 1283
Random number sequence:
0: 1389
1: 2717
2: 3760
3: 4968
4: 5441
5: 904
6: 5982
7: 3575
8: 3583
9: 4431

Normalizing...
0: 0.22867961804412248
1: 0.4473164306881791
2: 0.6190319394138953
3: 0.8179124135660191
4: 0.8957853144550544
5: 0.14883108330589398
6: 0.9848534738228515
7: 0.5885742509054989
8: 0.5898913401382944
9: 0.7295027988146197
```

A simple way to check 'by eye' that the random number generator really does produce homogeneously distributed numbers, is to create two sequences with different initial values I_0 and J_0. Let $\mathbf{r}$ be a random normalized number sequence generated with $I_0 = 1$ and $\mathbf{s}$ generated with $J_0 = 2$. We plot all pairs (r_i, s_i) of generated numbers in a number plane:



(a) $n = 100$ (b) $n = 1000$

Figure 1: Creating a set of random numbers

Since the eye is quite sensitive to see a good distribution, it can safely be said, that these distributions are indeed what is considered *random*. To see the deterministic character of this random number sequence, we plot I_{j+1} agains I_j for $I_0 = 1,$ and $n = 1000$:

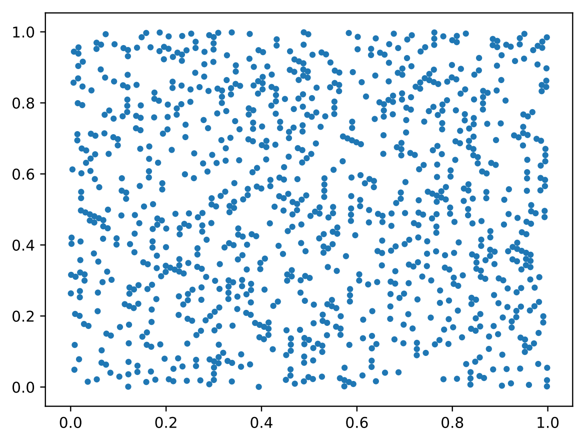


Figure 2: Deterministic Character of random number sequence