

**Mridul Garg**  
**180123028**

## **MA 323 - Monte Carlo Simulation**

### **Assignment - 1**

**Ans 1:**

The sequences generated with input values as:

a = 6  
b = 0  
m = 11

seed = 0 , period = 1 [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
seed = 1 , period = 10 [6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1]  
seed = 2 , period = 10 [1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2]  
seed = 3 , period = 10 [7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3]  
seed = 4 , period = 10 [2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4]  
seed = 5 , period = 10 [8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5]  
seed = 6 , period = 10 [3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6]  
seed = 7 , period = 10 [9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7]  
seed = 8 , period = 10 [4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8]  
seed = 9 , period = 10 [10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9]  
seed = 10 , period = 10 [5, 8, 4, 2, 1, 6, 3, 7, 9, 10, 5, 8, 4, 2, 1, 6, 3, 7, 9, 10]

The sequences generated with input values as:

a = 3  
b = 0  
m = 11

seed = 0 , period = 1 [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
seed = 1 , period = 5 [3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1]  
seed = 2 , period = 5 [6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2]  
seed = 3 , period = 5 [9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3]  
seed = 4 , period = 5 [1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4]  
seed = 5 , period = 5 [4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5]  
seed = 6 , period = 5 [7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6]  
seed = 7 , period = 5 [10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7]  
seed = 8 , period = 5 [2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8]  
seed = 9 , period = 5 [5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9, 5, 4, 1, 3, 9]  
seed = 10 , period = 5 [8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10, 8, 2, 6, 7, 10]

### Observations:

- For sequences generated with **seed = 0**, all  $x_i$  values are 0. Hence, making the period 1. Such sequences are **neither random, nor uniformly distributed**, and there is a clear **pattern of repetition** of values
- For sequences generated with  $a = 6$ , irrespective of the seed ( $\neq 0$ ), all give **Full Period**
- For sequences generated with  $a = 3$ , irrespective of the seed ( $\neq 0$ ), all give **Period = 5**

### Conclusion:

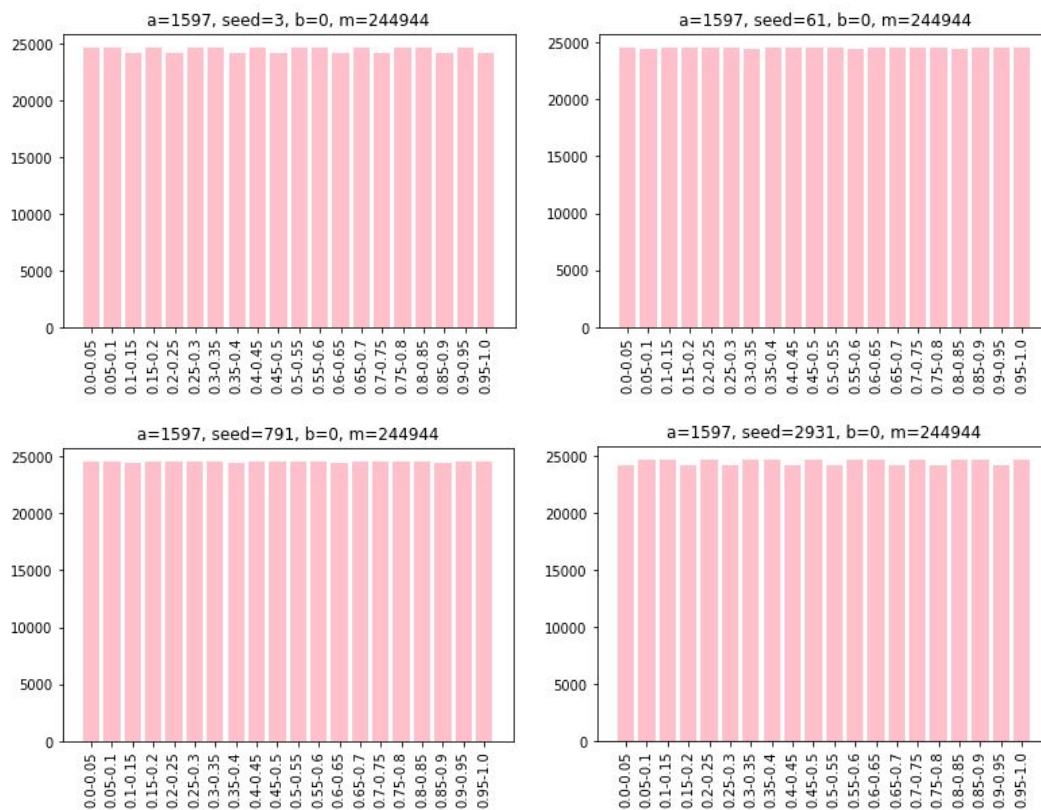
- Sequences generated with seed value not equal to 0 and  $a = 6$  are more uniformly distributed as those generated by  $a = 3$ . Hence the former sequences should be preferred

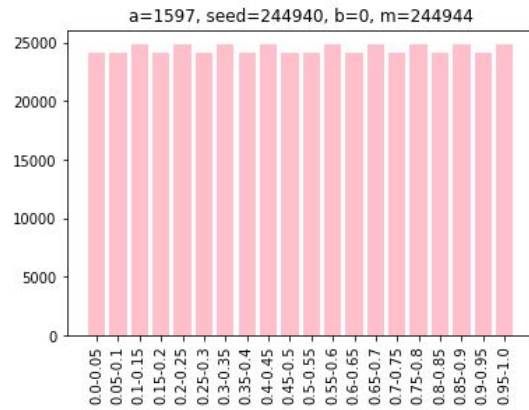
### Ans 2:

All the generated sequences have been tabulated and represented as a bar graph

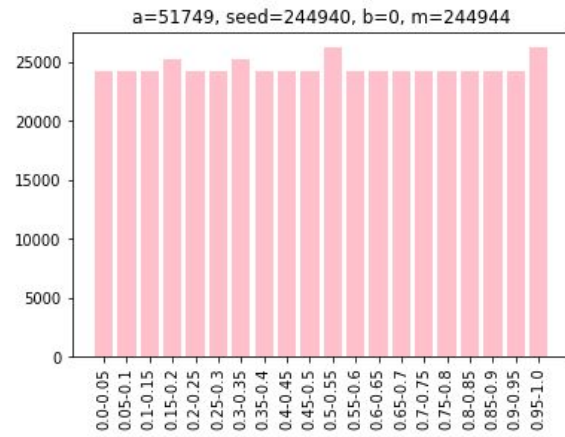
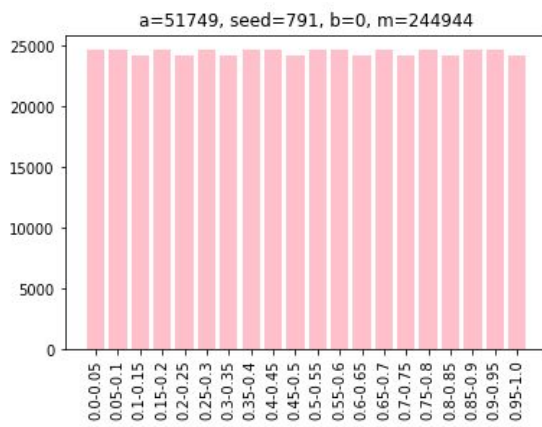
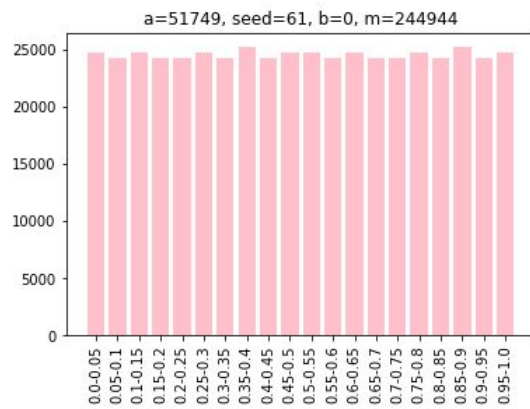
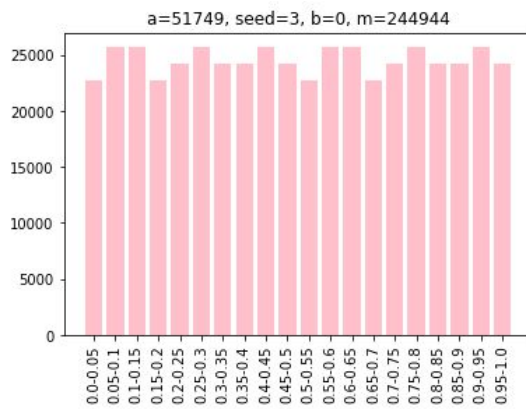
Bar Graphs of values:

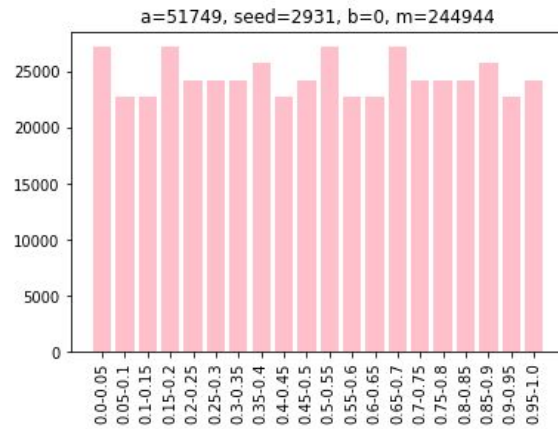
$a = 1597$





Bar Graphs for values:  
a = 51749





### Observations:

- Irrespective of the value of  $a$  or the seed ( $\neq 0$ ), the values of  $u_i$  seem to be uniformly distributed for the given ranges

### Conclusions:

- The sequences generated by  $a = 1597/51749$ ,  $m = 244944$ ,  $b = 0$ , are uniformly distributed irrespective of the value of the seed

### Ans 3:

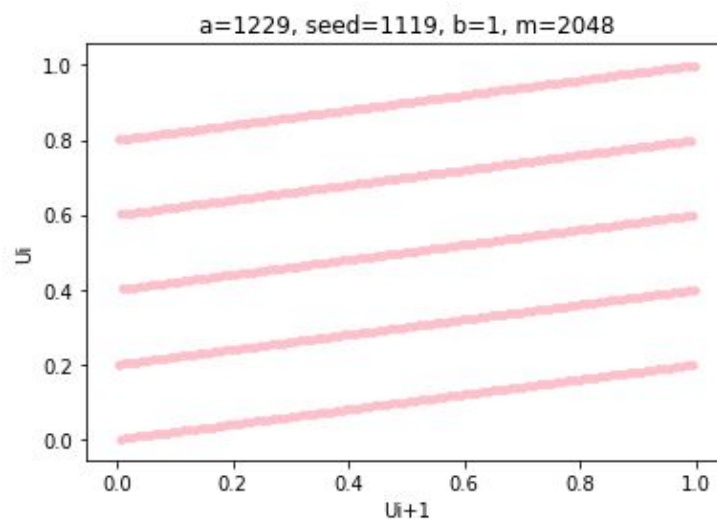
Plotting the generated sequence for the values:

$a = 1229$

$m = 2048$

$b = 1$

seed = 1119



**Observations:**

- The generated sequence, when plotted as  $(U_{i+1}, U_i)$  reveals pattern/ relationship between consecutive values of  $U_i$ .

**Conclusions:**

- $U_i$  generated are not mutually independent