MONTE CARLO STIMULATION LAB 1: REPORT

By: Kabir Yadav
Roll No - 200123027

Ques 1:

X0	a,b,m	numbers	distinct values before repitition
0	6,0,11	(0,)	1
1	6,0,11	(6, 3, 7, 9, 10, 5, 8, 4, 2, 1)	10
2	6,0,11	(1, 6, 3, 7, 9, 10, 5, 8, 4, 2)	10
3	6,0,11	(7, 9, 10, 5, 8, 4, 2, 1, 6, 3)	10
4	6,0,11	(2, 1, 6, 3, 7, 9, 10, 5, 8, 4)	10
5	6,0,11	(8, 4, 2, 1, 6, 3, 7, 9, 10, 5)	10
6	6,0,11	(3, 7, 9, 10, 5, 8, 4, 2, 1, 6)	10
7	6,0,11	(9, 10, 5, 8, 4, 2, 1, 6, 3, 7)	10
8	6,0,11	(4, 2, 1, 6, 3, 7, 9, 10, 5, 8)	10
9	6,0,11	(10, 5, 8, 4, 2, 1, 6, 3, 7, 9)	10
10	6,0,11	(5, 8, 4, 2, 1, 6, 3, 7, 9, 10)	10
0	3,0,11	(0,)	1
1	3,0,11	(3, 9, 5, 4, 1)	5
2	3,0,11	(6, 7, 10, 8, 2)	5
3	3,0,11	(9, 5, 4, 1, 3)	5
4	3,0,11	(1, 3, 9, 5, 4)	5
5	3,0,11	(4, 1, 3, 9, 5)	5
6	3,0,11	(7, 10, 8, 2, 6)	5
7	3,0,11	(10, 8, 2, 6, 7)	5
8	3,0,11	(2, 6, 7, 10, 8)	5
9	3,0,11	(5, 4, 1, 3, 9)	5
10	3,0,11	(8, 2, 6, 7, 10)	5

Observation:

Initially as both x0 and b are zero so we only get one number that is 0, but as
We increase x0 we start to get 10 numbers (period length = m – 1 = 10) for every value of x0 till 10 when (a, b, m) = (6, 0, 11).
For (a, b, m) = (3, 0, 11) but as x0 go beyond 0 we start to get 5 distinct values
before repetition starts. We can also observe that when (a, b, m) = (6, 0, 11) when we go from x0 =1 10 we are getting the same sequence but it starts from different numbers.

Best Choice:

- The largest possible period length of linear congruence generator is m – 1. This value is achieved when a = 6 (full period), while period length for a = 3 is only 5. So the linear congruence generator with a = 6 is preferred over a = 3 as it has higher period length. This is because there will be more randomness in the generated numbers as there are more numbers in the sequence. And x0 (seed) should be a non-zero value, as x0 = 0 has no randomness in it.

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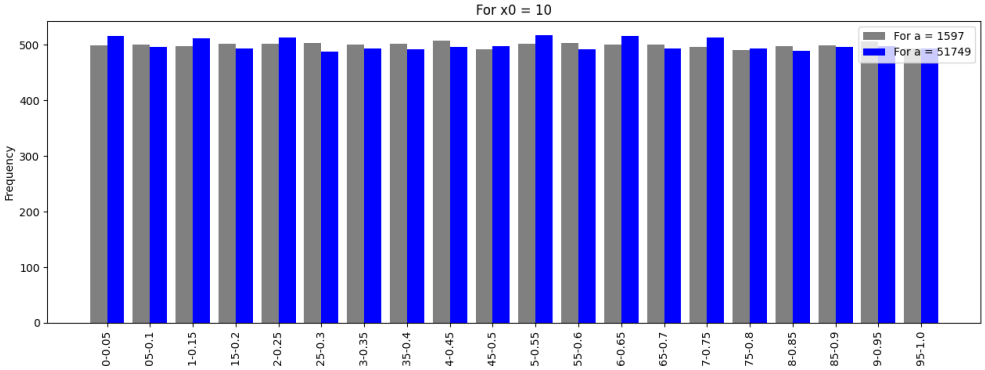
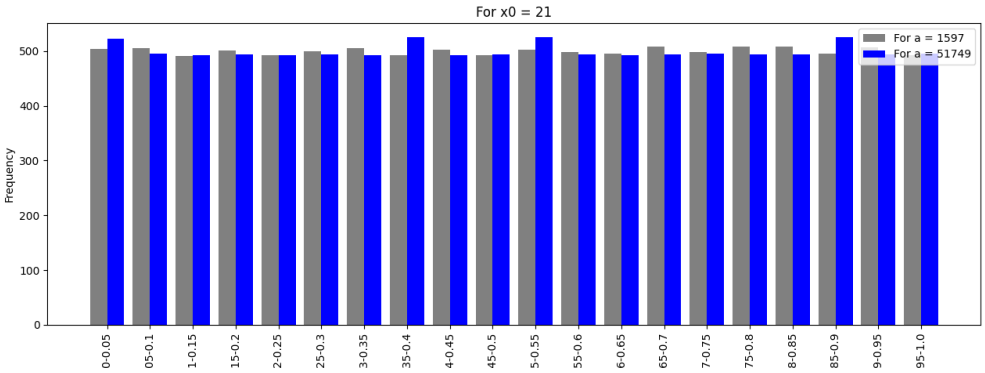
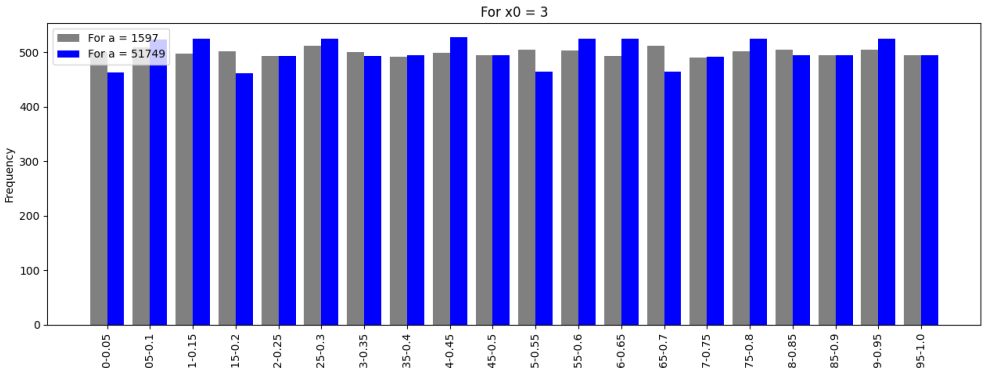
Ques 2:







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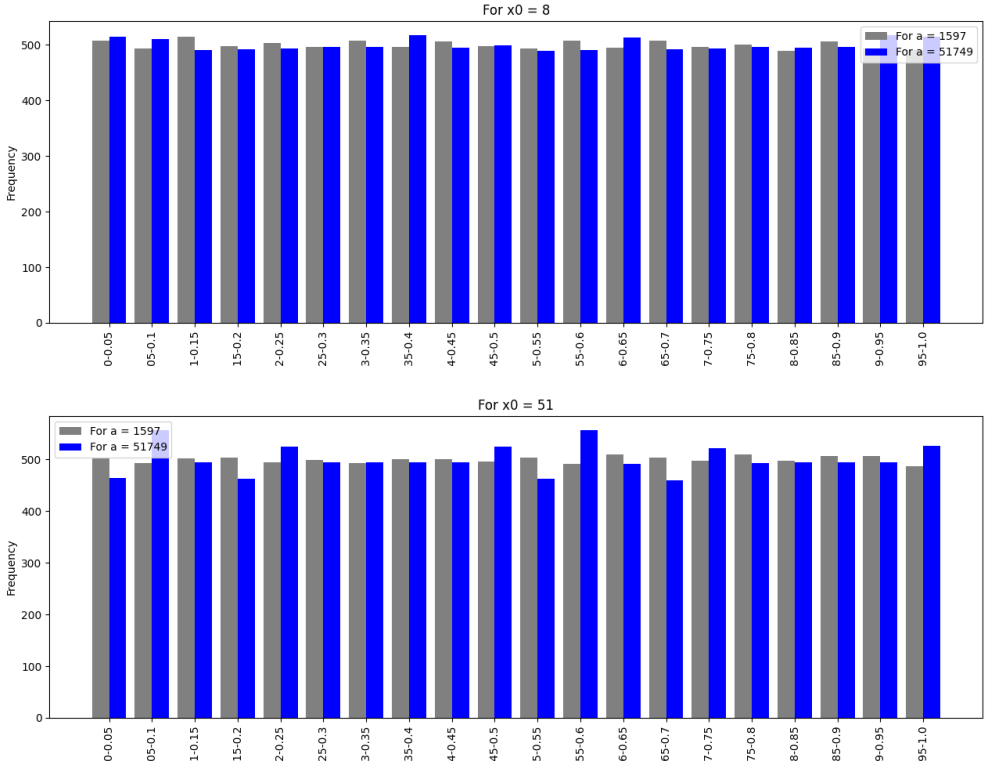

Colu mn1	Colu mn2	Colu mn3	Colu mn4	Colu mn5	Colu mn6	Colu mn7	Colu mn8	Colu mn9	Colu mn10	Colu mn11	Colu mn12
		For (a, b, m) = (1597, 0, 244944)					**For (a, b, m) = (51749, 0, 244944)**				
	Range	FOR x0 = 10	FOR x0 = 21	FOR x0 = 3	FOR x0 = 8	FOR x0 = 51	For x0 = 10	For x0 = 21	For x0 = 3	For x0 = 8	For x0 = 51
0	0.0-0.05	499	504	500	508	502	516	522	463	514	464
1	0.05-0.1	501	505	509	494	493	497	496	523	511	556
2	0.1-0.15	498	491	497	515	502	512	493	524	490	495
3	0.15-0.2	502	501	502	498	504	494	494	462	492	463
4	0.2-0.25	502	493	493	503	495	513	493	493	493	525
5	0.25-0.3	504	500	512	496	499	488	494	525	496	495

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6	0.3-0.35	501	505	500	507	493	493	493	493	497	495
7	0.35-0.4	502	493	491	496	501	492	525	495	517	495
8	0.4-0.45	507	502	499	506	500	496	493	527	495	495
9	0.45-0.5	492	493	494	498	496	498	494	495	499	525
10	0.5-0.55	502	503	505	493	504	517	525	464	489	463
11	0.55-0.6	504	498	503	507	492	492	494	524	491	556
12	0.6-0.65	501	496	493	495	509	516	493	525	513	491
13	0.65-0.7	501	508	511	507	504	493	494	464	492	460
14	0.7-0.75	496	498	490	496	498	513	495	492	493	521
15	0.75-0.8	491	508	502	501	510	493	494	524	496	493
16	0.8-0.85	498	508	505	489	498	489	494	494	495	494
17	0.85-0.9	499	495	495	506	506	496	525	494	496	494
18	0.9-0.95	506	507	504	494	507	498	494	525	517	494
19	0.95-1.0	494	492	495	491	487	494	495	494	514	526

- **Observations:**

1. The numbers are uniformly generated between 0 – 1. The frequency of different numbers lying in same length intervals are almost same. So, the random number generator follows the property of generation of numbers uniformly.

2. For different value of seed (x0), the frequencies are almost identical, and so the nature of bar graphs is same.

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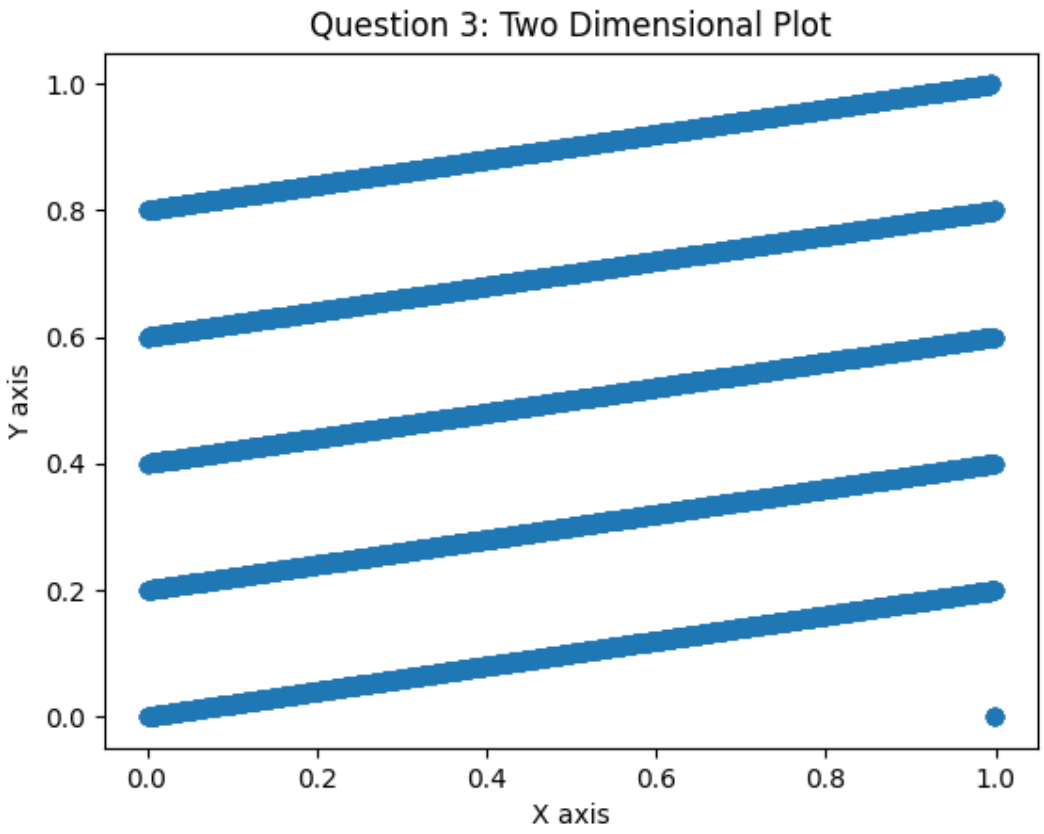
Ques 3:



● Observations:

1. The scatter plot contains 5 almost parallel lines originating at different y – coordinates.

2. There is an outlier present at x = 1.0 (approx.). I believe this is present due to the precision issues while taking modulus in Python code (which is a bit different from the standard notion of modulus operation in other programming languages).

3. I found that this plot helps in what is known as “Spectral Test”. LCGs have a property that when plotted in 2 dimensions, lines will form, on which all possible outputs can be found. The spectral test compares the distance between these planes; the further apart they are, the worse the generator is.