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Constant Multiplier	65539
seed	1505084
alpha	0.1

In this assignment we have generated n random numbers in range [0,1]. Then we have checked how these numbers are distributed using four tests. These are uniformity test, serial test, runs test and correlation test.

Uniformity Test

In uniformity test, we determine how the numbers are uniformly distributed in the range [0,1]. We calculate the value of chi-square.

For doing so, we first split our range [0,1] into k sub ranges. Then we count the number of random values within each sub ranges. Let f_j is the frequency of the generated numbers in j th interval. Then we calculate the value of chi-squared using following equation:

$$\chi^2 = \frac{k}{n}\sum_{j=1}^{k}\left(f_j - \frac{n}{k}\right)^2$$

From the equation we see that if the numbers are uniformly distributed then each f_j should be theoretically closed to the value of n/k. So the smaller the value of chi-squared the more uniform the numbers are. Finally we compare our chi-squared value to a standard value and not reject if it is under a threshold value or reject otherwise. The larger the value of n the more likely the numbers are uniformly distributed.

Our result are presented in table below:

N	K	chi-square	Rejected
20	10	9.0	No
	20	16.0	No
500	10	11.48	No
	20	7.6	No
4000	10	7.75	No
	20	20.29	No

10000	10	7.686	No
	20	16.248	No

Serial Test

In serial test we find d tuple values and determine how uniformly the tuples are distributed in the hyper-cube $[0,1]^d$. To do so, we calculated the value of chi-squared using following equation,

$$\chi^2 = \frac{k^d}{n} \sum_{j1=1}^{k} \sum_{j2=1}^{k} \cdots\cdots \sum_{jd=1}^{k} \left(f_{j1\,j2\,j3\ldots jk} - \frac{n}{k^d} \right)^2$$

Here, it can be mathematically proved that chi-squared is monotonically increasing function of n. So, the larger the value of n, it's more likely to reject the result as the threshold value depends only on k , d and alpha but not on n.

The results of serial test are shown below:

N	D	K	chi-square	Rejected
20	2	4	9.6	No
	2	8	38.4	No
	3	4	27.2	No
	3	8	212.8	No
500	2	4	135.36	Yes
	2	8	159.488	Yes
	3	4	240.192	Yes
	3	8	397.376	No
4000	2	4	1009.496	Yes
	2	8	1032.512	Yes
	3	4	1799.104	Yes
	3	8	1959.536	Yes
10000	2	4	2504.8416	Yes
	2	8	2522.2016	Yes
	3	4	4478.944	Yes
	3	8	4624.5984	Yes

Runs Test

A run of length i is the i consecutive random values which are in non-decreasing order, but the next number is smaller than the last counted number.

We counted the frequency of run. Then calculated the value of R and comparing it with a threshold value to decide to reject or not to reject the result.

The result of run test is shown below:

N	Run	Rejected
20	8.24351347946514	No
500	10.678046510456042	Yes
4000	6.473239543965436	No
10000	1.8915606853112346	No

Correlation Test

In co-relation test, we determine how the random numbers are co-related to each other at lag j. Similar to other tests, we have calculated a value according to theoretical equation then compare it with a threshold value resulting in rejection or not rejection.

The results of Co-Relation Test are shown below:

N	J	|Aj|	Rejected
20	1	0.8464795732462	No
	3	1.0832714941989	No
	5	1.4957769310073	No
500	1	0.7453277276953	No
	3	1.0263570950331	No
	5	1.1668156598648	No
4000	1	1.0205967065011	No
	3	0.1225890989777	No
	5	1.9335156819592	Yes
10000	1	0.7085102013131	No
	3	0.8053560852765	No
	5	0.4886590610643	No