Ucchwas Talukder
Roll : 1505109

# In this assignment, you will create a linear congruential generator and perform four
empirical tests on the generated random numbers. You will calculate the values for
n = 20, 500, 4000 and 10000. For each n, perform 10 tests in total:
(1) Uniformity test at k = 10 and k = 20
(2) Serial test using d = 2; 3 and k = 4; 8
(3) Run length test
(4) Correlation test with j =1, 3 and 5.
The value of α for all tests will be 0.1 .

n= 20

Uniformity test

k= 10 chi-squared : 18.0 ppf: 14.683656573259837

Accepted.

k= 20 chi-squared : 22.0 ppf: 27.203571029356844

Accepted.

...................................

Serial test

d = 2 k = 4 chi-squared: 16.0 ppf: 22.307129581578693

Accepted.

d = 2 k = 8 chi-squared: 51.2 ppf: 77.74538483569489

Accepted.

d = 3 k = 4 chi-squared: 27.200000000000003 ppf: 77.74538483569489

Accepted.

d = 3 k = 8 chi-squared: 161.60000000000002 ppf: 552.3739332206293

Accepted.

...................................

Run test

R: 233.8335134794666 ppf: 10.644640675668422

Rejected.

...................................

Corelation test

j = 1

|Aj| : 2.9539945546175557 ppf: 1.6448536269514722

Rejected.

j = 3

|Aj| : 0.878534745301487 ppf: 1.6448536269514722

Accepted.

j = 5

|Aj| : 3.22268499482288 ppf: 1.6448536269514722

Rejected.

....................................

n= 500

Uniformity test

k= 10 chi-squared : 59.32 ppf: 14.683656573259837

Rejected.

k= 20 chi-squared : 15.84 ppf: 27.203571029356844

Accepted.

....................................

Serial test

d = 2 k = 4 chi-squared: 129.92000000000002 ppf: 22.307129581578693

Rejected.

d = 2 k = 8 chi-squared: 155.648 ppf: 77.74538483569489

Rejected.

d = 3 k = 4 chi-squared: 241.984 ppf: 77.74538483569489

Rejected.

d = 3 k = 8 chi-squared: 393.28000000000003 ppf: 552.3739332206293

Accepted.

…………………………………

Run test

R: 31.823319526329286 ppf: 10.644640675668422

Rejected.

…………………………………

Corelation test

j = 1

|Aj| : 18.50396611811111 ppf: 1.6448536269514722

Rejected.

j = 3

|Aj| : 10.84940742063786 ppf: 1.6448536269514722

Rejected.

j = 5

|Aj| : 7.400563699315755 ppf: 1.6448536269514722

Rejected.

…………………………………

n= 4000

Uniformity test

k= 10 chi-squared : 406.935 ppf: 14.683656573259837

Rejected.

k= 20 chi-squared : 19.740000000000002 ppf: 27.203571029356844

Accepted.

...................................

Serial test

d = 2 k = 4 chi-squared: 1014.048 ppf: 22.307129581578693

Rejected.

d = 2 k = 8 chi-squared: 1048.544 ppf: 77.74538483569489

Rejected.

d = 3 k = 4 chi-squared: 1799.904 ppf: 77.74538483569489

Rejected.

d = 3 k = 8 chi-squared: 1956.72 ppf: 552.3739332206293

Rejected.

...................................

Run test

R: 67.3283609725362 ppf: 10.644640675668422

Rejected.

...................................

Corelation test

j = 1

|Aj| : 52.49417897753739 ppf: 1.6448536269514722

Rejected.

j = 3

|Aj| : 30.21555249294933 ppf: 1.6448536269514722

Rejected.

j = 5

|Aj| : 30.21555249294933 ppf: 1.6448536269514722

Rejected.

.....................................

n= 10000

Uniformity test

k= 10 chi-squared : 1007.45 ppf: 14.683656573259837

Rejected.

k= 20 chi-squared : 18.240000000000002 ppf: 27.203571029356844

Accepted.

.....................................

Serial test

d = 2 k = 4 chi-squared: 2511.0368000000003 ppf: 22.307129581578693

Rejected.

d = 2 k = 8 chi-squared: 2542.5408 ppf: 77.74538483569489

Rejected.

d = 3 k = 4 chi-squared: 4465.1552 ppf: 77.74538483569489

Rejected.

d = 3 k = 8 chi-squared: 4626.7488 ppf: 552.3739332206293

Rejected.

.....................................

Run test

R: 39.77813433610483 ppf: 10.644640675668422

Accepted.

.....................................

Corelation test

j = 1

|Aj| : 83.32871271635636 ppf: 1.6448536269514722

Rejected.

j =  3

|Aj| :  47.875411910710696 ppf:  1.6448536269514722

Rejected.

j =  5

|Aj| :  36.835194294425484 ppf:  1.6448536269514722

Rejectted.

# Reasoning:

**UNIFORMITY TEST**

In Uniformity test, we will check this hypothesis, H0 = Ui's are IID random variables. So we check if the generated random numbers are uniformly distributed. So with smaller n, the null Hypothesis is rejected. As the number of generated pseudo number increases, it becomes more probable of them to be IID random variables.

**SERIAL TEST**

We will check whether d-tuples are uniformly distributed on the dimensional unit hypercube [0; 1] d . In this test, we will check this hypothesis, H0 = Ui's are IID random variables. So with smaller dimension,d and interval,k, the null Hypothesis is not rejected. But if we increase the dimension and intervals, that hypothesis will get rejected (This does not depend on the number of generated random variables).

**RUNS TEST**

We will evaluate the independence assumption of the random number generator in this test and we will check this hypothesis, H0 = Ui's are IID random variables. So we check if the generated random numbers are independent or not. So with smaller n, the null Hypothesis is rejected. As the number of generated pseudo number increases, it becomes more probable of them to be IID random variables.

**CORRELATION TEST**

In this test you will directly assess whether the generated $U_i$'s exhibit discernible correlation at lag j.In this test, we will check this hypothesis, H0 = $U_i$'s have zero lag j correlation. As there is less correlation between at lag j, the hypothesis is never rejected. Also with bigger n, the correlation becomes smaller and at bigger lag j, the correlation gets bigger.