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CSC 579 – ASSIGNMENT 2

The tests were conducted in MATLAB version R2015b.

Frequency Test (Monobit Test)

In a true random sequence, the number of 1's and 0's should be about the same. The Frequency test checks whether this is correct or not.

The procedure followed is described below.
A sequence of random numbers was generated from a pdf distribution. The first 5 elements of the sequence was removed to prevent any outlier interference. The test was carried out on the remaining 995 elements. Each of the elements is converted to a binary string representation. The number of 1's and 0's is calculated for each string using the find command. The test statistic $S_{obs}$is computed using the given formula S = abs(number of 0's – number of 1's)/sqrt(length of string). The length of the string in this case will be 995*15 as each number is representated with 15 literals. The final p-value is calculated using the inbuilt function erfc. The entire process is shown in the snapshot below.

```
>> for i = 1:995
str = dec2bin(round(r(i) * 2^15),15);
NumberOfZeros = NumberOfZeros + (length(find(str=='0')));
NumberOfOnes = NumberOfOnes + (length(find(str=='1')));
end
>> Sn = abs(NumberOfZeros - NumberOfOnes)

Sn =

    11

>> Sn = NumberOfZeros - NumberOfOnes

Sn =

    11

>> Sobs = abs(Sn)/sqrt(i*15)

Sobs =

    0.0900

>> p = erfc(Sobs/sqrt(2))

p =

    0.9283
```

Fig 1 – Frequency Test

p is the p-value of the hypothesis test which measures how compatible the data is to the null hypothesis. The p-value ranges from 0 to 1.

Runstest

The runstest is used to decide if a data set is from a random process.

A probability distribution was created using the makedist command specifying the parameter as Uniform thereby creating a Uniform Distribution.

1000 random numbers were sampled from this distribution and the runstest was carried out on them. A snapshot of the output is shown below.

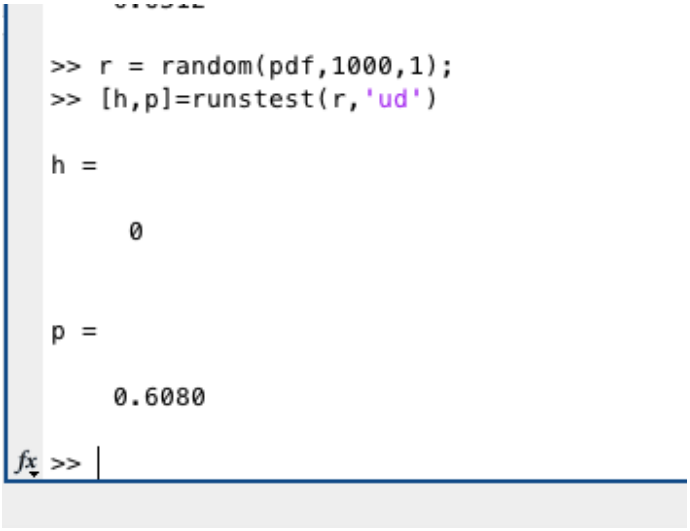

Fig 2 – Runstest for a Uniform Distribution

The runstest(x,'ud') returns a test decision based on the number of runs up or down.
The result h is 1 if the test rejects the null hypothesis at the 5% significance level, or 0 otherwise.
p is the p-value of the hypothesis test which measures how compatible the data is to the null hypothesis.

Chi Square Test

The chi-square goodness of fit test test checks whether a sequence of pseudo-random numbers in [0,1] are uniformly distributed.

In MATLAB however, the chi2gof function works only for a normal distribution. To accommodate this requirement, the previously generated uniform distribution was first sorted. The first 5 elements was then removed from the distribution to prevent any outlier interference to the test. After the outlier removal, the distribution was converted to a normal distribution. The chi-square goodness of fit test was then run on these numbers and a snapshot of the results are shown below.

```
>> [h,p]=chi2gof(y)

h =

     0


p =

    0.7520
```

Fig 3 – Chi Square Test for a Normal Distribution

chi2gof returns the test decision for the null hypothesis that the data vector y comes from a normal distribution.
h is 1 if the test rejects the null hypothesis at the 5% significance level, and 0 otherwise.
p is the p-value of the hypothesis test which measures how compatible the data is to the null hypothesis.