Assignment 5

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Contents

1 Report on Question 1

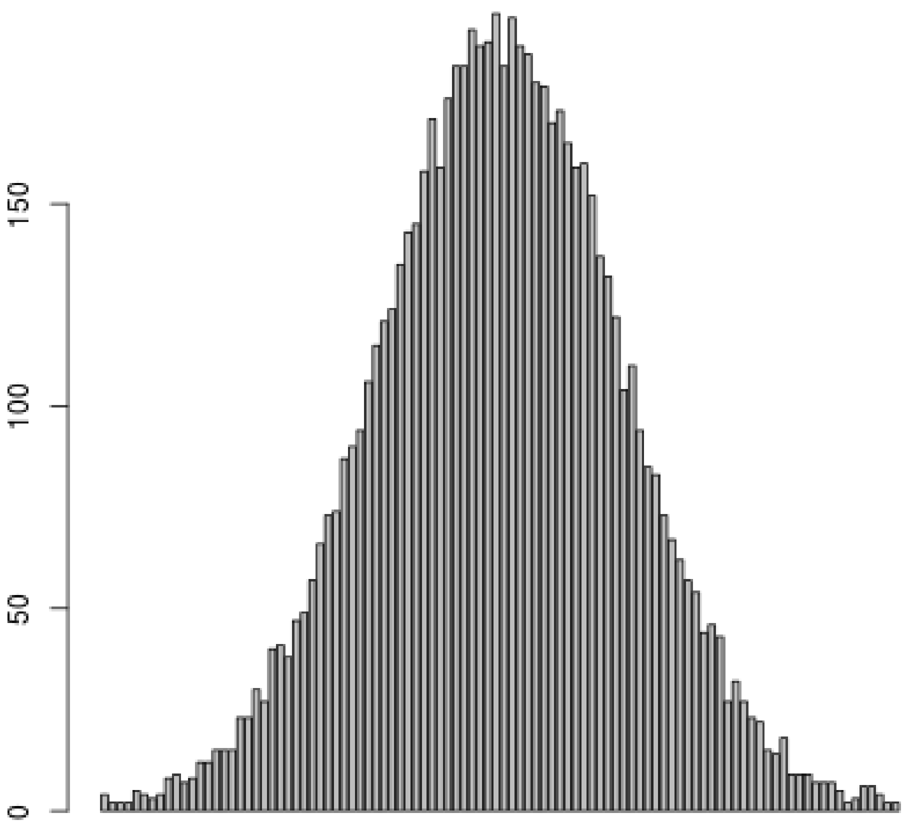
We are asked to generate 1000 standard normal variates using standard Double-exponential distribution by acceptance-rejection method.
$f(x)$ is the pdf of standard normal
$g(x)$ is the pdf of standard Double exponential distribution
$\frac{f(x)}{g(x)} \leq c$ Here c comes out to be 1.3159
The R language code for the above question is as follows:

```
f<-function(x)
{
        return (exp(-x*x/2)*(1/(2*pi))^(1/2));
}
g<-function(x)
{
        return (exp(-abs(x))/2);
}
h<-function(x)
{
        if(x>=0.5)
                return (-log(2*(1-x)))
        else
                return (log(2*x))
}
c<-sqrt(2*exp(1)/pi);
m<-2^13;
a<-113;
b<-83;
x<-4;
y<-91;
count<-0.0;
```

```
sum<-0.0;
sqsum<-0.0;
freq<-array(0,100);
for(i in 1:10000)
{
        x<-(a*x+b)%%m;
        u<-as.double(x)/m;
        y<-(a*y+b+80)%%m;
        v<-as.double(y)/m;
        Y<-h(v);
        if(c*g(Y)*u<=f(Y))
        {
                if(v>=0.00001)
                {
                        count<-count+1;
                        sum<-sum+Y;
                        freq[Y*15+51]<-freq[Y*15+51]+1;
                }
        }
}
mean<-sum/10000;
for(i in 1:100)
        sqsum<-sqsum+freq[i]*(mean-(as.double(i-51)/15))^2;
var<-sqsum/10000;
cat("Mean : ",mean,"\n");
cat("Standard Deviation : ",sqrt(var),"\n");
cat("Observed Acceptance probability : ",(count/10000),"\n");
cat("Theoritical Acceptance probability : ",(1/c),"\n");
png("plot1.png")
barplot(freq);
dev.off()
```

1.1 Observations

The generated standard normal variates are plotted and the graph is as follows:



The theoretically calculated acceptance probability is 1/c which is 0.7601735 and the simulated acceptance probability is 0.7614.They are approximately equal.So the generated random numbers are correct

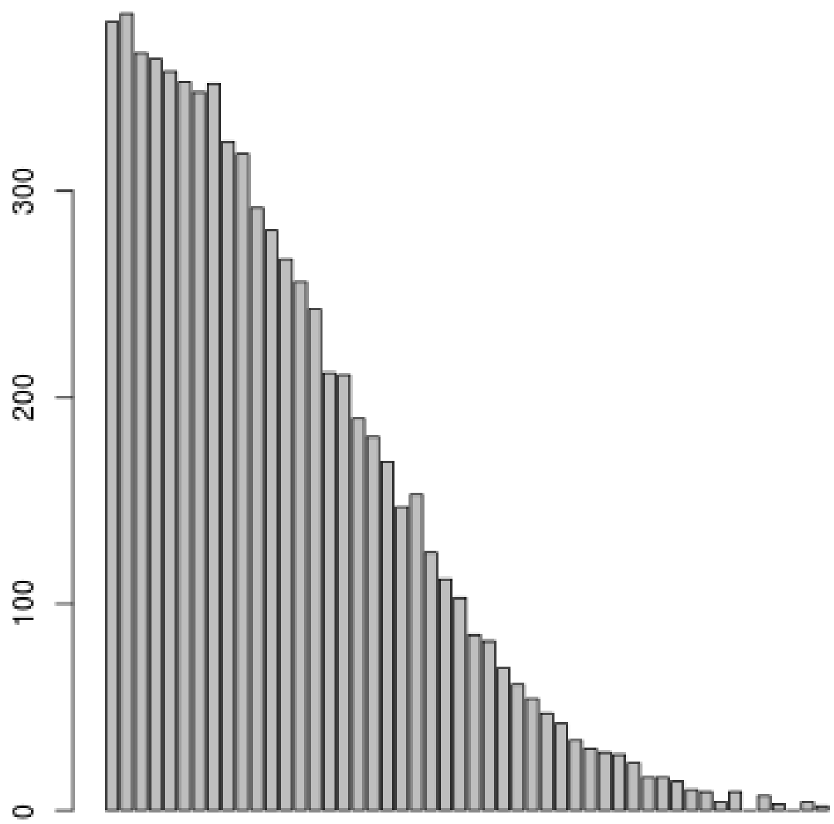
2 Report on Question 2

We are asked to generate random numbers from half-standard normal distribution using exponential distribution with mean 1 by acceptance rejection method . The R language code for this question is as follows:

```
f<-function(x)
{
        return (exp(-x*x/2)*(2/pi)^(1/2));
}
g<-function(x)
{
        return (exp(-x));
}
h<-function(x)
{
        return (-log(1-x))
}
c<-1.4;
m<-2^13;
a<-113;
b<-83;
x<-4;
y<-91;
freq<-array(0,50);
for(i in 1:10000)
{
        x<-(a*x+b)%%m;
        u<-as.double(x)/m;
        y<-(a*y+b+80)%%m;
        v<-as.double(y)/m;
        Y<-h(v);
        if(c*g(Y)*u<=f(Y))
                freq[Y*15+1]<-freq[Y*15+1]+1;
}
png("plot2.png")
barplot(freq);
dev.off()
```

2.1 Observations

The generated random numbers are plotted and the plot is as follows:



3 Report on Question 3

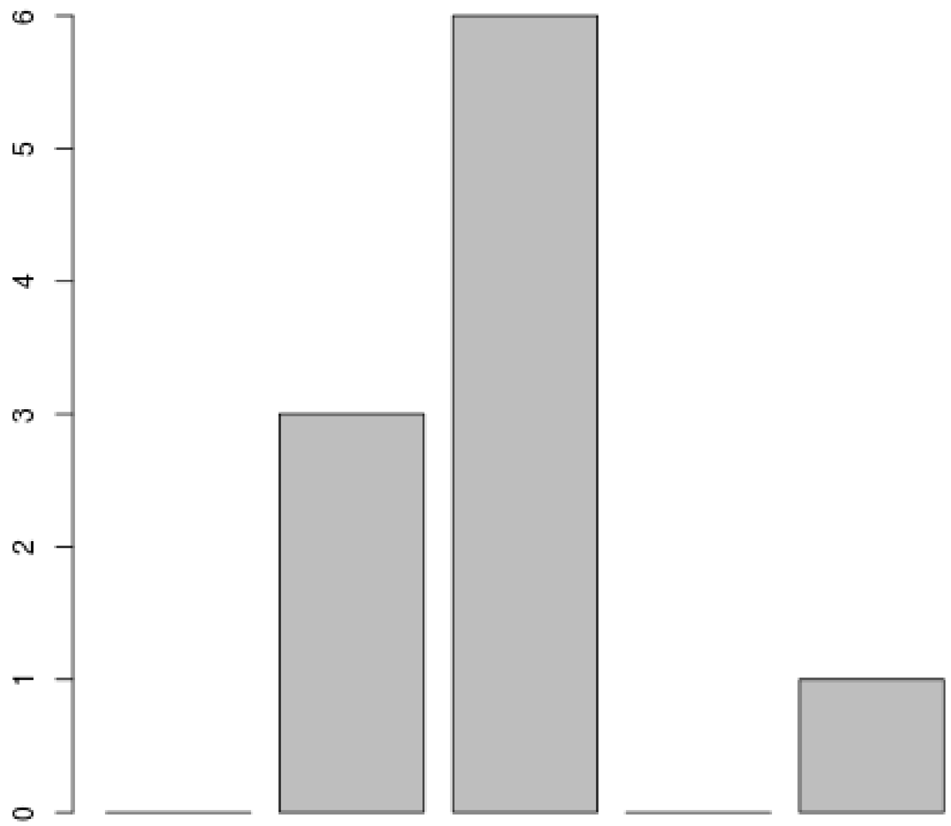
3.1 part a

We are asked to use inverse transform method of generating random numbers from discrete distribution defined on finite number of points. The R language code for this question is as follows:

```
m<-2^13;
a<-113;
b<-91;
x<-70;
p<-c(0.05,0.25,0.45,0.15,0.10);
c<-cumsum(p);
sum<-0;
sqsum<-0;
freq<-array(0,5);
for(i in 1:10)
{
        x<-(a*x+b)%%m;
        u<-as.double(x)/m;
        for(j in 1:5)
                if(u<c[j])
                {
                        freq[j]<-freq[j]+1;
                        sum<-sum+j;
                        break;
                }
}
mean<-as.double(sum)/10;
for(i in 1:5)
        sqsum<-sqsum+freq[i]*(mean-i)^2;
var<-as.double(sqsum)/10;
cat("Mean : ",mean,"\n");
cat("Variance : ",var,"\n");
png("plot3a.png");
barplot(freq);
dev.off();
```

3.1.1 Observations

Mean of generated numbers = 2.9
Variance of generated numbers = 0.69
The random numbers generated are plotted as follows:



3.2 part b

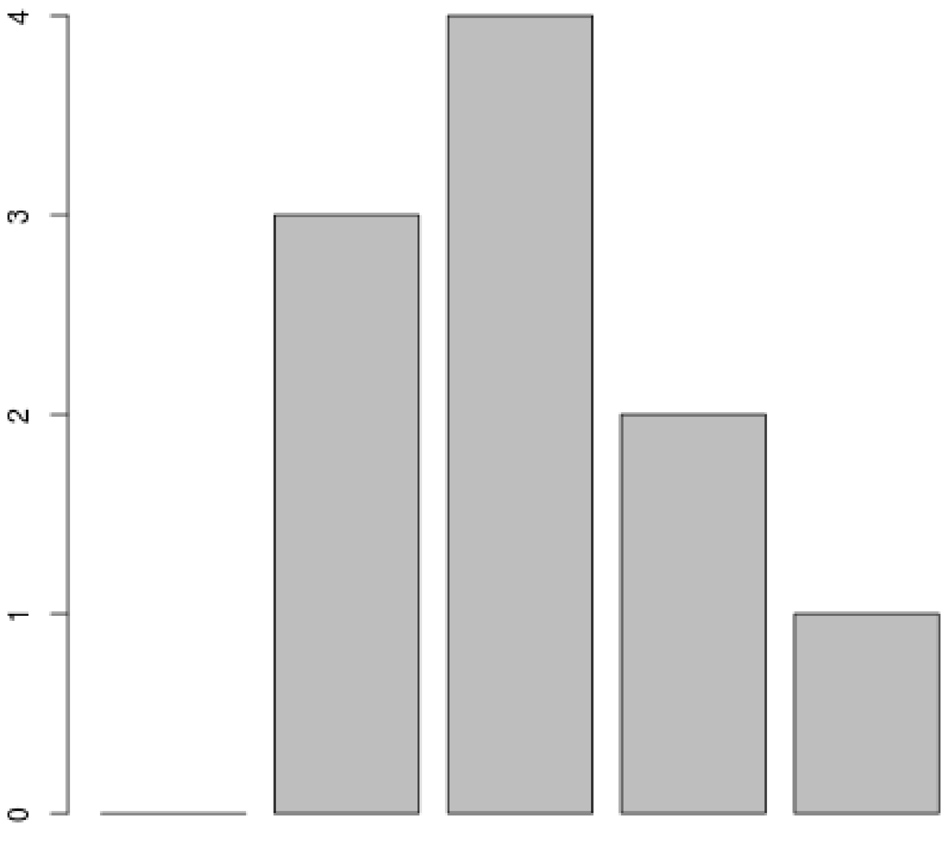
We are asked to use acceptance rejection principle to generate the random numbers. The R language code for this question is as follows:

```
f<-function(x)
{
        p<-c(0.05,0.25,0.45,0.15,0.10)
        return (p[x])
}
m<-2^13
a<-113
b<-83
```

```
x<-50
y<-60
cg<-0.5
sum<-0
sqsum<-0
count<-0
freq<-array(0,5)
while(count!=10)
{
        x<-(a*x+b)%%m
        u<-as.double(x)/m
        y<-(a*y+b+80)%%m
        v<-as.double(y)/m
        Y<-as.integer(v*5)+1
        if(cg*u<f(Y))
        {
                freq[Y]<-freq[Y]+1
                sum<-sum+Y
                count<-count+1
        }
}
mean<-as.double(sum)/10
for(i in 1:5)
        sqsum<-sqsum+freq[i]*(mean-i)^2;
var<-as.double(sqsum)/10
cat("Mean : ",mean,"\n")
cat("Variance : ",var,"\n")
png("plot3b.png")
barplot(freq)
dev.off()
```

3.2.1 Observations

Mean of generated numbers is 3.1
Variance of generated numbers is 0.89
The random numbers generated are plotted as follows:


0
1
2
3
4