Assignment-3

Abheek Ghosh
140123047

February 6, 2016

1 Question 1

Code for C++

```
#include <iostream>
#include <iomanip>
#include <cmath>
#include <cstdlib>

#define RANGE 100

using namespace std;

class LCG {
private:
long a, b, m, x, q, r;
public:
LCG() {
a = 1103515245;
b = 12345;
m = 2147483648;
q=m/a;
r=m%a;
x = std::rand()/32768;
}
long base_generator() {
long k=x/q;
x = (a * (x - (k * q))) - (k * r);
x = (x + b) % m;
while(x<0) x+=m;
return x;
}
double generate() {
return (double)base_generator()/m;
```

```
31 }
32 void set_all(long sa, long sb, long sm, long sx) {
33 a = sa;
34 b = sb;
35 m = sm;
36 q=m/a;
37 r=m%a;
38 x = sx;
39 }
40 void set_x(long sx) {
41 x = sx;
42 }
43 };
44
45 double inv_exp_cdf(double x, double lamda) {
46 return (-log(x)/lamda);
47 }
48
49 int main() {
50 int n = 5000, Density[RANGE];
51 double given_mean = 5;
52 double lamda = 1/given_mean;
53 double mean=5, emax = 0, emin = 1.79769e+30, x;
54 LCG lcg;
55
56 for(int i = 0; i < RANGE; ++i) {
57 Density[i] = 0;
58 }
59
60 for(int i = 0; i < n; ++i) {
61 x = inv_exp_cdf(lcg.generate(), lamda);
62 // cout<<x<<" ";
63 mean = ((mean * i) + x)/(i+1);
64 if(emin > x)
65 emin = x;
66 if(emax < x)
67 emax = x;
68 if(x*5 <= RANGE) {
69 Density[(int)(x*5)]++;
70 }
71 }
72 cout<<"#Mean = "<<mean<<endl;
73 cout<<"#Minimum = "<<emin<<endl;
74 cout<<"#Maximum = "<<emax<<endl;
75 for(int i = 0; i < RANGE; ++i) {
76 if(i%5==0)
77 cout<<i/5<<" "<<Density[i]<<endl;
78 else
```

```
79 cout<<". "<<Density[i]<<endl;
80 }
81 return 0;
82 }
```

Code for R

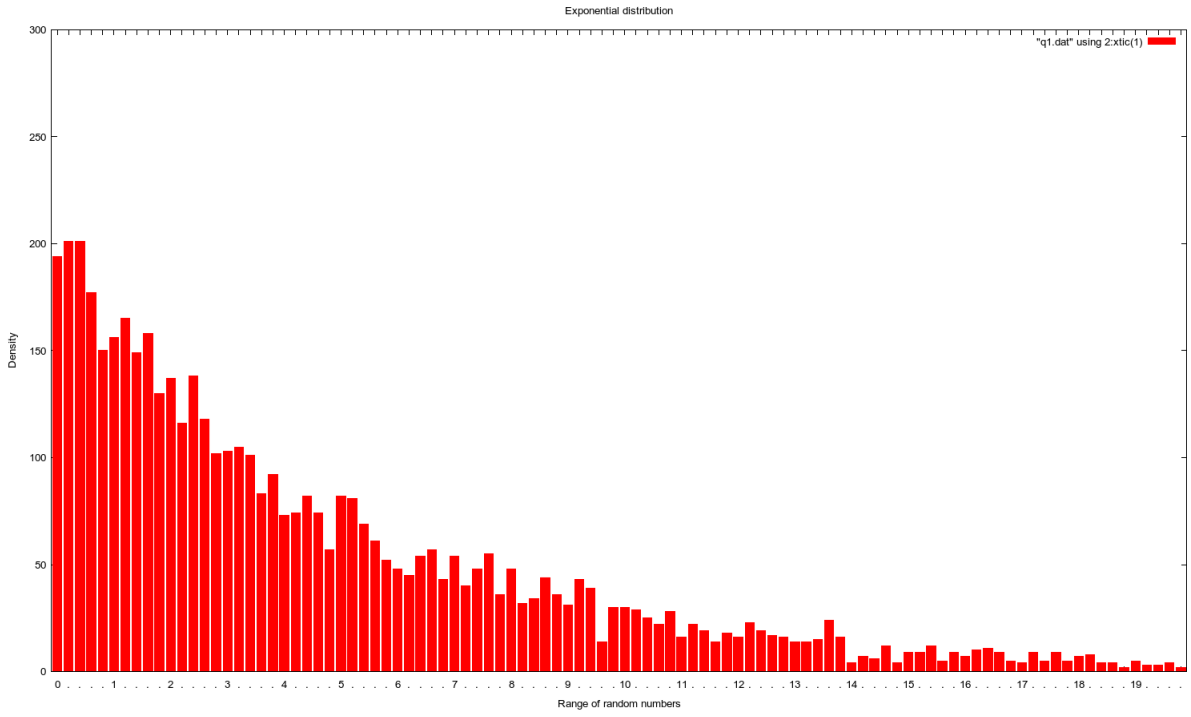
```
1 rd <- runif(5000)
2 rd <- -log(rd)*5
3 cat("Mean = ", mean(rd), "\n")
4 cat("Minimum = ", min(rd), "\n")
5 cat("Maximum = ", max(rd), "\n")
6 hist(rd, main="Exponential distribution with mean = 5", xlab="Range of random numbers", ylab="
      Density")
7 dev.copy(png,"plot1.png");
8 dev.off ();
9 rm(list = ls())
```

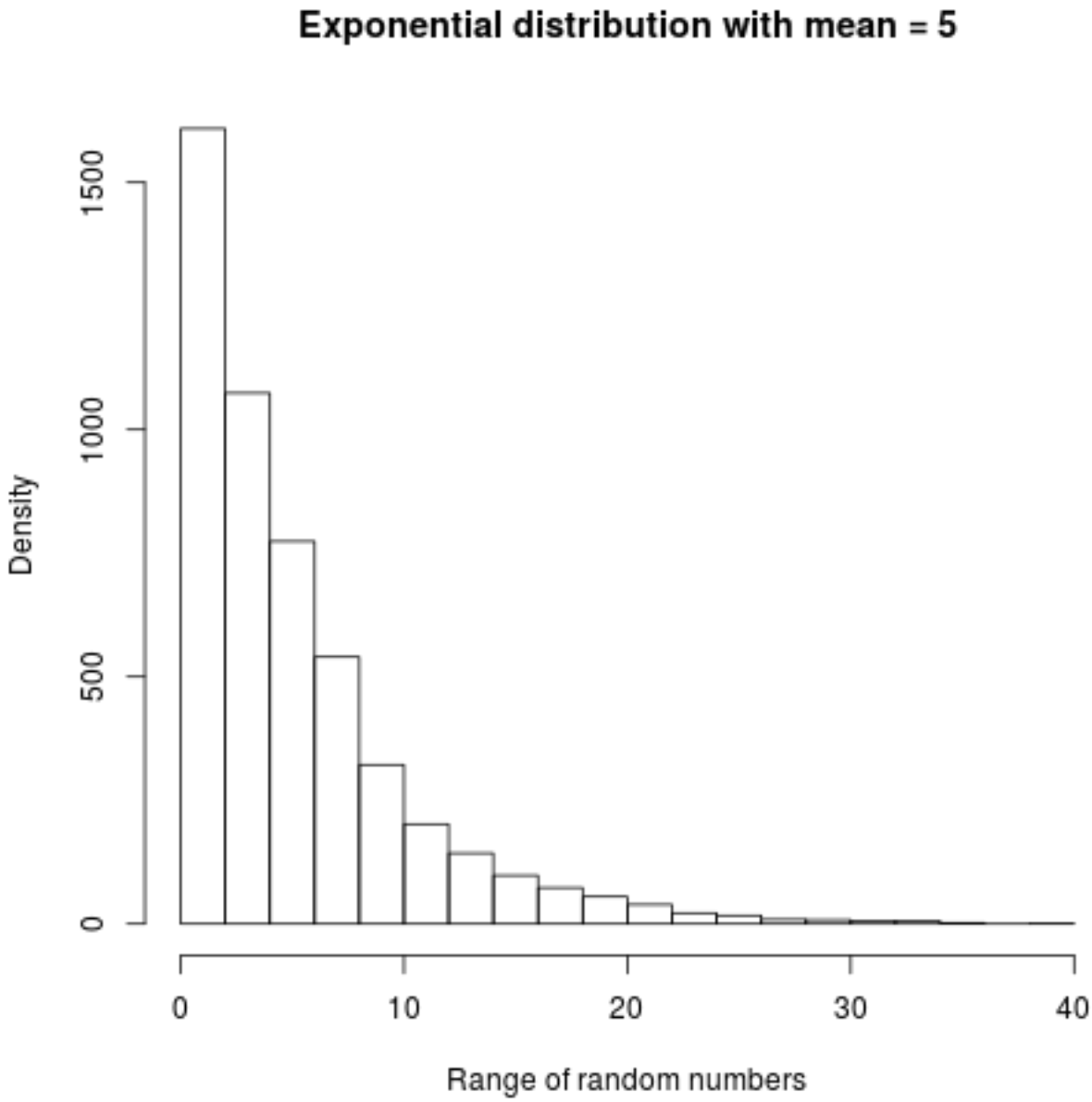
Simulate 5000 sample of exponential with mean 5. Draw the histogram and calculate the mean, maximum and minimum.

Mean = 4.993371

Minimum = 0.0003285686

Maximum = 39.08356




Exponential distribution with mean = 5
Density
0
500
1000
1500
0
10
20
30
40
Range of random numbers

2 Question 2

Code for C++

```
#include <iostream>
#include <iomanip>
#include <cmath>
#include <cstdlib>

#define RANGE 90

using namespace std;

class LCG {
private:
long a, b, m, x, q, r;
public:
LCG() {
a = 1103515245;
b = 12345;
m = 2147483648;
q=m/a;
r=m%a;
x = std::rand()/32768;
}
long base_generator() {
long k=x/q;
x = (a * (x - (k * q))) - (k * r);
x = (x + b) % m;
while(x<0) x+=m;
return x;
}
double generate() {
return (double)base_generator()/m;
}
void set_all(long sa, long sb, long sm, long sx) {
a = sa;
b = sb;
m = sm;
q=m/a;
r=m%a;
x = sx;
}
void set_x(long sx) {
x = sx;
}
};

```

```
45 double inv_exp_cdf(double x, double lamda) {
46 return (-log(x)/lamda);
47 }
48
49 int main() {
50 int n = 5000, Density[RANGE];
51 double lamda = 5;
52 double mean=5, emax = 0, emin = 1.79769e+30, x;
53 LCG lcg;
54
55 for(int i = 0; i < RANGE; ++i) {
56 Density[i] = 0;
57 }
58
59 for(int i = 0; i < n; ++i) {
60 x = 0;
61 for(int j=0; j<5; ++j) {
62 x += inv_exp_cdf(lcg.generate(), lamda);
63 }
64 // cout<<x<<" ";
65 mean = ((mean * i) + x)/(i+1);
66 if(emin > x)
67 emin = x;
68 if(emax < x)
69 emax = x;
70 if(x*30 <= RANGE) {
71 Density[(int)(x*30)]++;
72 }
73 }
74 cout<<"Mean = "<<mean<<endl;
75 cout<<"Minimum = "<<emin<<endl;
76 cout<<"Maximum = "<<emax<<endl;
77 for(int i = 0; i < RANGE; ++i) {
78 if(i%30==0)
79 cout<<i/30<<" "<<Density[i]<<endl;
80 else
81 cout<<". "<<Density[i]<<endl;
82 }
83 return 0;
84 }
```

Code for R

```
1 rd1 <- runif(5000)
2 rd2 <- runif(5000)
3 rd3 <- runif(5000)
4 rd4 <- runif(5000)
5 rd5 <- runif(5000)
```

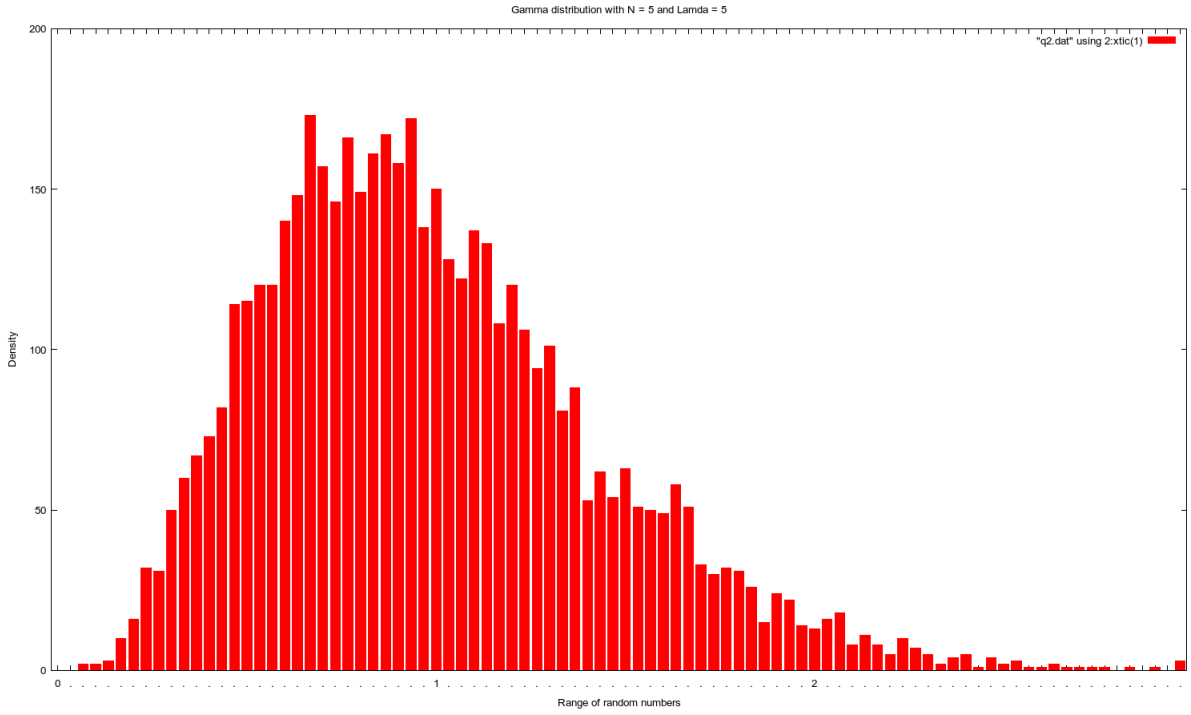
```
6
7  rd <- -(log(rd1) + log(rd2) + log(rd3) + log(rd4) + log(rd5))/5
8  cat("Mean = ", mean(rd), "\n")
9  cat("Minimum = ", min(rd), "\n")
10 cat("Maximum = ", max(rd), "\n")
11 hist(rd, main="Gamma distribution with N = 5 and Lamda = 5", xlab="Range of random numbers",
       ylab="Density")
12 dev.copy(png,"plot2.png");
13 dev.off ();
14 rm(list = ls())
```

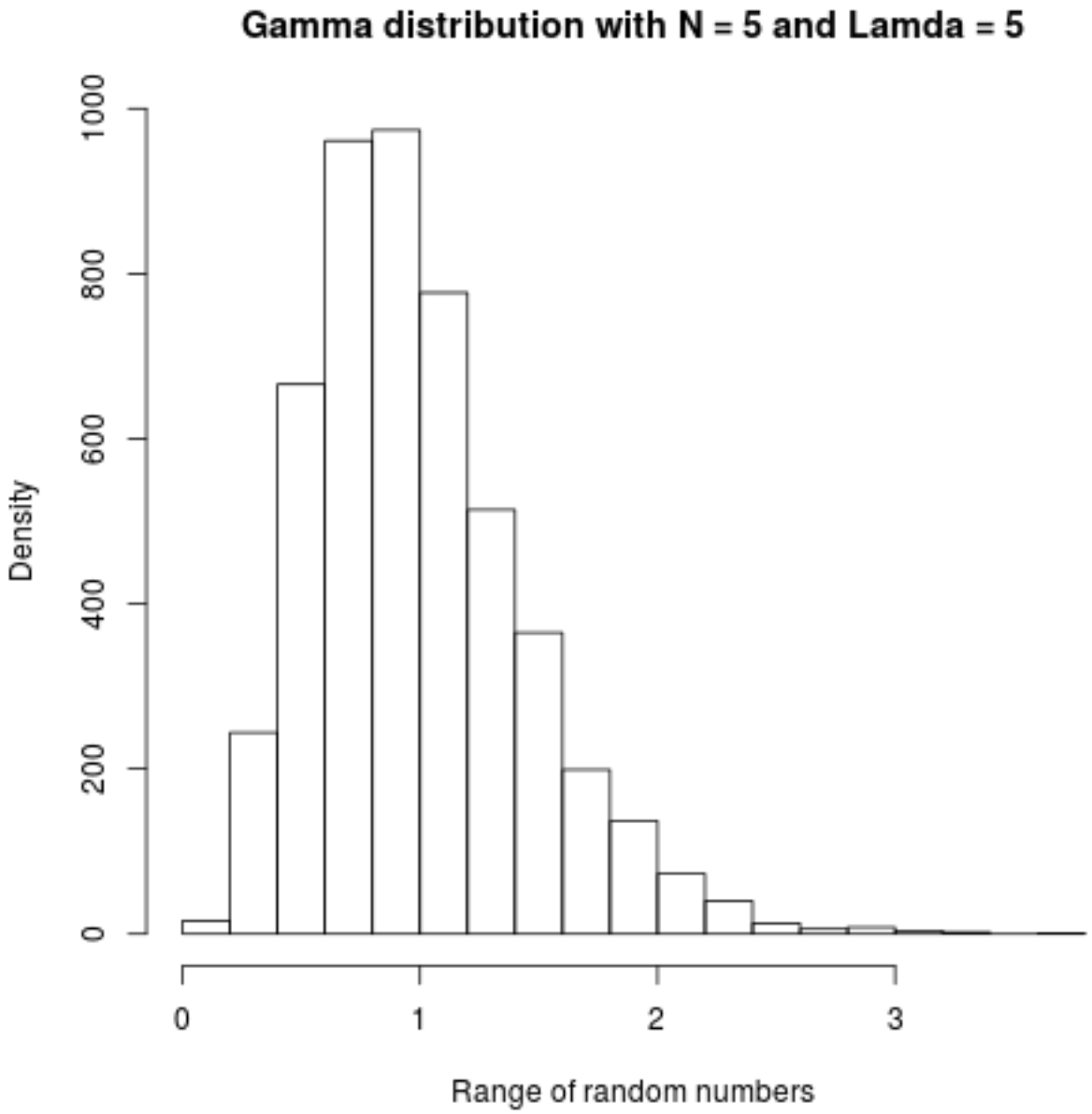
Generate 5000 sample from Gamma with parameter $n = 5$ and $\lambda = 5$. Draw the histogram and the calculate the mean, maximum and minimum.

Mean = 0.9943813

Minimum = 0.07742613

Maximum = 3.659501




Gamma distribution with N = 5 and Lamda = 5
Density
0
200
400
600
800
1000
0
1
2
3
Range of random numbers

3 Question 3

Code for R

```
#c <- 2.109376
rd1 <- runif(50000) #Taking g(x) as uniform dist rd1 is c*g(x)
rd2 <- runif(50000, 0, 2.109375)
fx <- 20 * rd1 * (1 - rd1)^3

rd <- rd1[rd2 < fx]

cat("Mean = ", mean(rd), "\n")
cat("Minimum = ", min(rd), "\n")
cat("Maximum = ", max(rd), "\n")
hist(rd, main="Distribution with f(x) = 20x(1-x)^3", xlab="Range of random numbers", ylab="
    Density")
dev.copy(png,"plot3.png");
dev.off ();
rm(list = ls())
```

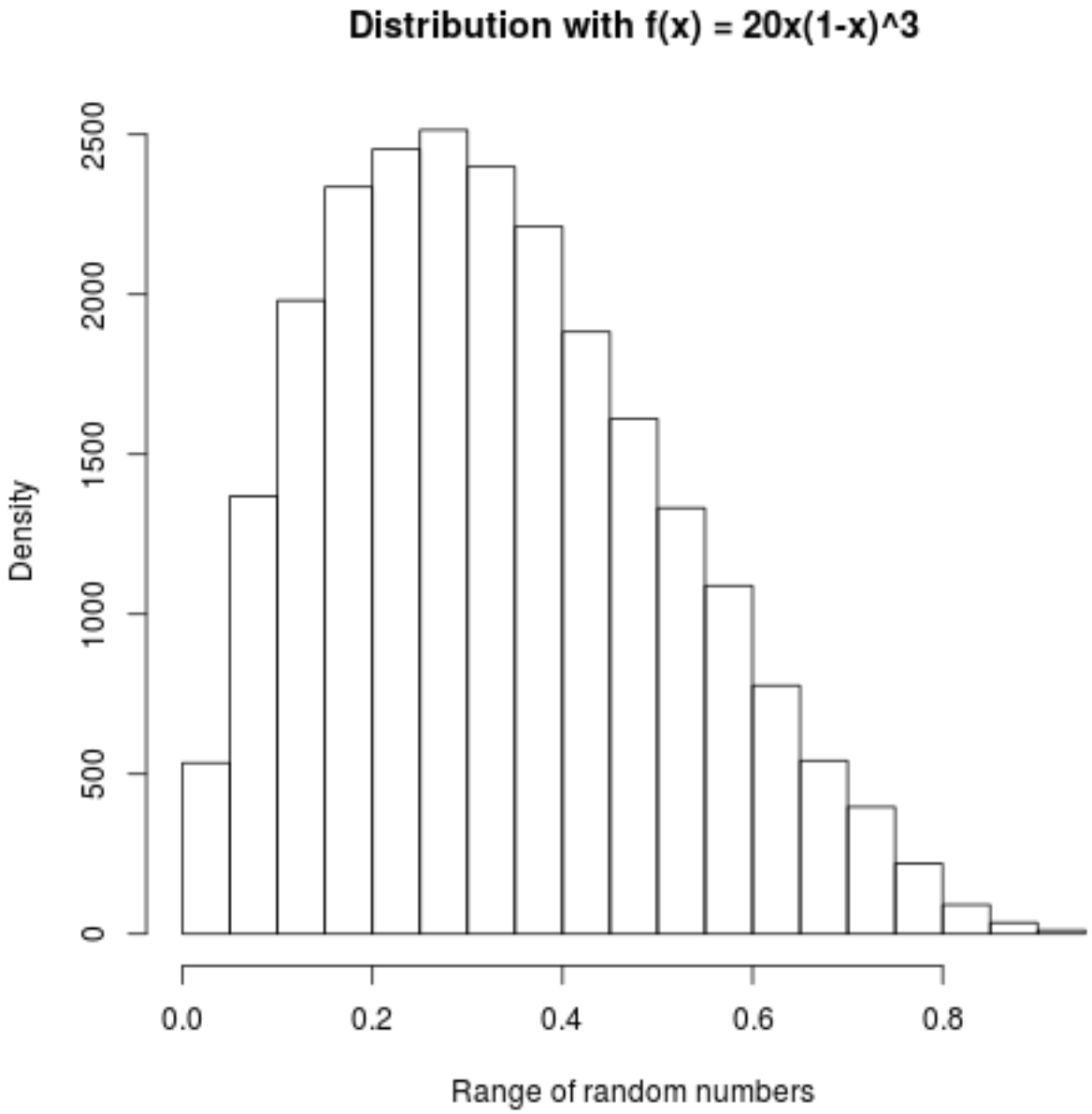
Given in the question, density function:

$$f(x) = 20x(1-x)^3 \quad 0 < x < 1$$

Mean = 0.3389358

Minimum = 0.00600503

Maximum = 0.9436907


Distribution with f(x) = 20x(1-x)^3
Density
0
500
1000
1500
2000
2500
0.0
0.2
0.4
0.6
0.8
Range of random numbers