ELECENG 3TQ3 Project 1

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Task 1

The code & variable for Task 1

```
%%Task 1
clc;
clear;

N=100;
L=25;
times=0;
theoreticalvalue=0.05;
X = L * rand(N,1);

for i=1:N
    if(X(i,1)>0.1*L&&X(i,1)<0.15*L)
    times=times+1;
    end

end
times%The experimental times result
experimentalvalue=times/100%The experimental value result
difference=(times/100)-theoreticalvalue;
difference %The difference between the experimental result and the theoretical value



M=100;
m=zeros(M,1);
average=0;
var=0;

for j=1:M
    times=0;
    X=L*rand(N,1);
    for i=1:N
        if(X(i,1)>0.1*L&&X(i,1)<0.15*L)
            times=times+1;
        end
    end
    m(j,1)= times;
    average = average+(1/M)*(m(j,1)/N-0.05); %The average error
    var = var+((1/M)*(m(j,1)/N-0.05)^(2)); %The Variance
end
 average %The average error
 var %The Variance
```

The output for Task1

```
times =

     9


experimentalvalue =

    0.0900


difference =

    0.0400


average =

   -0.0025


var =

   5.2100e-04
```

The difference between the experimental result and the theoretical value is that the theoretical value is smaller than the experimental value because compared to the theoretical value the experimental value of the number of samples is too small.

Task 2

The code & output for Task 2

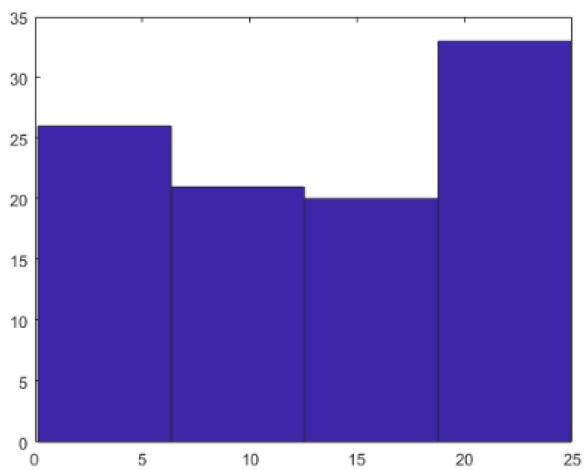
```
%%Task 2
%a
N=1000;
M=100;
L=25;
m=zeros(M,1);
average=0;
var=0;

for j=1:M
    times=0;
    X=L*rand(N,1);
    for i=1:N
        if(X(i,1)>0.1*L&&X(i,1)<0.15*L)
            times=times+1;
        end
    end
    m(j,1)= times;
    average = average+(1/M)*(m(j,1)/N-0.05); %The average error
    var = var+((1/M)*(m(j,1)/N-0.05)^(2)); %The Variance
end
 average %The average error

average = -4.8000e-04

 var %The Variance

var = 5.7020e-05

%b
N=10000;
M=100;
L=25;
m=zeros(M,1);
average=0;
var=0;

for j=1:M
    times=0;
    X=L*rand(N,1);
    for i=1:N
        if(X(i,1)>0.1*L&&X(i,1)<0.15*L)
            times=times+1;
        end
    end
    m(j,1)= times;
    average = average+(1/M)*(m(j,1)/N-0.05); %The average error
    var = var+((1/M)*(m(j,1)/N-0.05)^(2)); %The Variance
end
 average %The average error

average = -5.6000e-05

 var %The Variance

var = 4.7140e-06
```

Given many trials for each N, we can see that the absolute value of both the Average Error and Variance are decreasing after we increase the number of experiments N to 1000 and 10000. The reason for that is the error between the experimental tests and the theoretical cases should be smaller as more experiments are involved. Thus, it is better to take more samples to make the simulation closer to the theoretical case.

Task 3

The code & output for Task 3

```
%%Task 3
%Q1
N=100;
L=25;
X = L * rand(N,1);
hist(X,4);
```




```
p=hist(X,4);
p
```

```
p = 1×4
    26    21    20    33
```

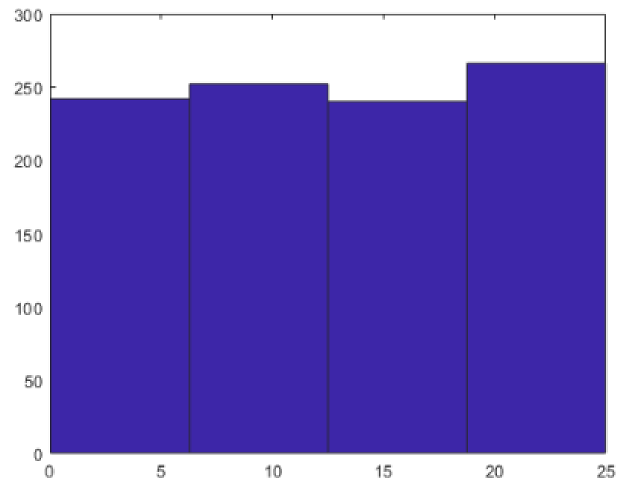
```
mean(p)
```

```
ans = 25
```

```
clear var
var(p)
```

```
ans = 35.3333
```

```
%%Task 3
%Q2
N=1000;
L=25;
X = L * rand(N,1);
hist(X,4);
```




```
p=hist(X,4);
p
```

```
p = 1×4
    242    252    240    266
```

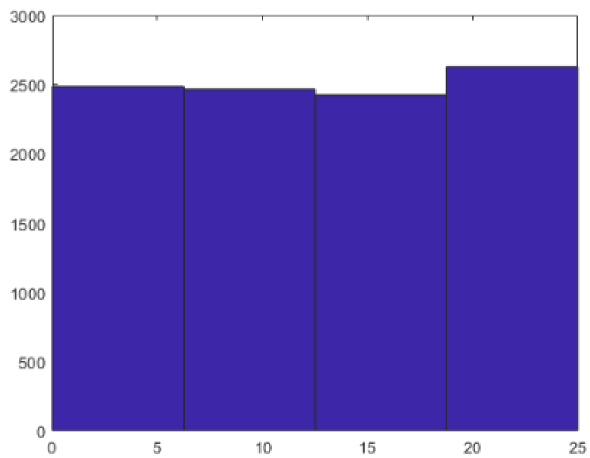
```
mean(p)
```

```
ans = 250
```

```
clear var
var(p)
```

```
ans = 141.3333
```

```
%%Task 3
%Q3
N=10000;
L=25;
X = L * rand(N,1);
hist(X,4);
```




```
p=hist(X,4);
p
```

```
p = 1×4
      2484      2467      2423      2626
```

```
mean(p)
```

```
ans = 2500
```

```
clear var
var(p)
```

```
ans = 7.7167e+03
```

We can obtain that the average is increasing with the same ratio from 25 to 250 to 2500 as we rise the number of experiments by 10 times each time. In addition, we can tell from the results that variance increases as the number of experiments increases. The reason for that is because when you increase the number of experiments N, you are still dividing them into four intervals which cause the rise of the absolute value. Thus, both the mean and the variance are increasing.

Task 4

The code & output for Task 4

```
%%Task4
N=100;
L=10;
X=L*rand(N,1);
Y=L*rand(N,1);
Z=X+Y;
P1=hist(X,10);
P2=hist(Y,10);
P3=hist(Z,10);
D1=var(P1);
D2=var(P2);
D3=var(P3);
D1
D2
D3
D3/D2
D3/D1
```

```
D1 = 10.2222
D2 = 8.6667
D3 = 19.1111
ans = 2.2051
ans = 1.8696
```

From the experiment above, we can notice that D3 is always bigger than D1, which means that the ratio between D3 and D1 is always bigger than 1. Additionly, it is also obvious that D3 is always bigger than D2, which means that the ratio between D3 and D2 is always bigger than 1. The reason for that is because there was Z=X+Y at the beginning of the code. Z has a larger range of N compared to the other two, so we would obtain a greater variance for Z compared to X and Y