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Probability and Statistics (UCS410)

Experiment 4

(Mathematical Expectation, Moments and Functions of Random Variables)

1. The probability distribution of X, the number of imperfections per 10 meters of a synthetic fabric in continuous rolls of uniform width, is given as

x	0	1	2	3	4
$p(x)$	0.41	0.37	0.16	0.05	0.01

Find the average number of imperfections per 10 meters of this fabric.

(Try functions **sum( )**, **weighted.mean( )**, c(a **%*%** b) to find expected value/mean.

Code:-

```
#Q1
x<-c(0,1,2,3,4)
p<-c(0.41,0.37,0.16,0.05,0.01)
z1<-sum(x*p)
z2<-weighted.mean(x,p)
z3<-c(x%*%p)
z1
z2
z3
```

INPUT:-

```
#Q1
x<-c(0,1,2,3,4)
p<-c(0.41,0.37,0.16,0.05,0.01)
z1<-sum(x*p)
z2<-weighted.mean(x,p)
z3<-c(x%*%p)
z1
z2
z3
```

OUTPUT:-

```
> #Q1
> x<-c(0,1,2,3,4)
> p<-c(0.41,0.37,0.16,0.05,0.01)
> z1<-sum(x*p)
> z2<-weighted.mean(x,p)
> z3<-c(x%*%p)
> z1
[1] 0.88
> z2
[1] 0.88
> z3
[1] 0.88
```

2. The time T, in days, required for the completion of a contracted project is a random variable with probability density function $f(t) = 0.1\ e^{(-0.1t)}$ for $t > 0$ and 0 otherwise. Find the expected value of T.
Use function **integrate( )** to find the expected value of continuous random variable T.

Code:-

```
#Q2
f1<-function(t){
  t*0.1*(exp(-0.1*t))
}
ans<-integrate(f1,0,Inf)
ans$value
```

INPUT:-

```
#Q2
f1<-function(t){
  t*0.1*(exp(-0.1*t))
}
ans<-integrate(f1,0,Inf)
ans$value
```

OUTPUT:-

```
> #Q2
> f1<-function(t){
+   t*0.1*(exp(-0.1*t))
+ }
> ans<-integrate(f1,0,Inf)
> ans$value
[1] 10
```

3. A bookstore purchases three copies of a book at \$6.00 each and sells them for \$12.00 each. Unsold copies are returned for \$2.00 each. Let X = {number of copies sold} and Y = {net revenue}. If the probability mass function of X is

x	0	1	2	3
$p(x)$	0.1	0.2	0.2	0.5

Find the expected value of Y.

Code:-

```
#Q3
x<-c(0,1,2,3)
p<-c(0.1,0.2,0.2,0.5)
b<-sum(x*p)
m<-10*b-12
m
```

INPUT:-

```
#Q3
x<-c(0,1,2,3)
p<-c(0.1,0.2,0.2,0.5)
b<-sum(x*p)
m<-10*b-12
m
```

OUTPUT:-

```
> x<-c(0,1,2,3)
> p<-c(0.1,0.2,0.2,0.5)
> b<-sum(x*p)
> m<-10*b-12
> m
[1] 9
```

4. Find the first and second moments about the origin of the random variable X with probability density function $f(x) = 0.5e^{-|x|}$, $1 < x < 10$ and 0 otherwise. Further use the results to find Mean and Variance.
(kth moment = $E(X^k)$, Mean = first moment and Variance = second moment – Mean^2.

Code:-

```
#Q4
F1=function(x){
  x*x*0.5*exp(-abs(x))
}
F2=function(x){
  0.5*(exp(-abs(x)*(x^2)))
}

G<-integrate(F1,lower=0,upper=10)
H<-integrate(F2,lower=0,upper=10)
```

print(G$value)
print(H$value-(G$value^2))

INPUT:-

```
#Q4
F1=function(x){
  x*x*0.5*exp(-abs(x))
}
F2=function(x){
  0.5*(exp(-abs(x)*(x^2)))
}

G<-integrate(F1,lower=0,upper=10)
H<-integrate(F2,lower=0,upper=10)
print(G$value)
print(H$value-(G$value^2))
```

OUTPUT:-

```
> #Q4
> F1=function(x){
+   x*x*0.5*exp(-abs(x))
+ }
> F2=function(x){
+   0.5*(exp(-abs(x)*(x^2)))
+ }
>
> G<-integrate(F1,lower=0,upper=10)
> H<-integrate(F2,lower=0,upper=10)
> print(G$value)
[1] 0.9972306
> print(H$value-(G$value^2))
[1] -0.5479791
>
```

5. Let X be a geometric random variable with probability distribution

$$f(x) = \frac{3}{4}\left(\frac{1}{4}\right)^{x-1}, \quad x = 1,2,3,\ldots$$

Write a function to find the probability distribution of the random variable $Y = X^2$ and find probability of Y for X = 3. Further, use it to find the expected value and variance of Y for X = 1,2,3,4,5.

CODE:-

#Q5

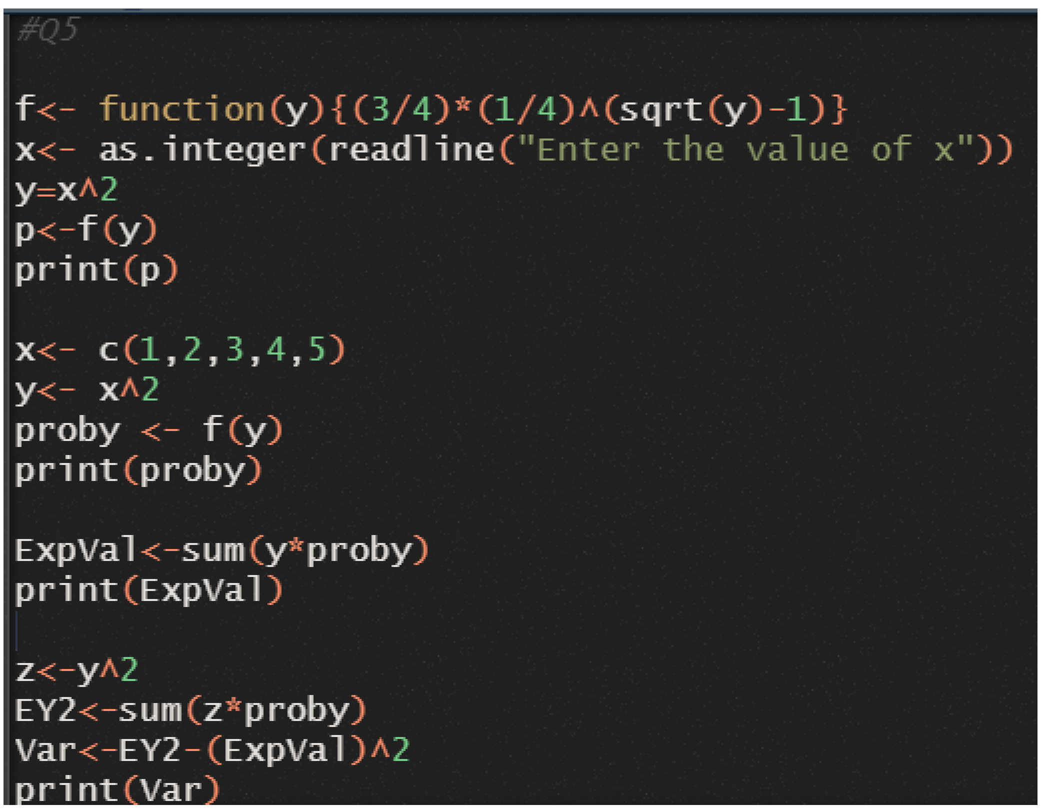
```
f<- function(y){(3/4)*(1/4)^(sqrt(y)-1)}
x<- as.integer(readline("Enter the value of x"))
y=x^2
p<-f(y)
print(p)

x<- c(1,2,3,4,5)
y<- x^2
proby <- f(y)
print(proby)

ExpVal<-sum(y*proby)
print(ExpVal)

z<-y^2
EY2<-sum(z*proby)
Var<-EY2-(ExpVal)^2
print(Var)
```

INPUT:-



```
#Q5

f<- function(y){(3/4)*(1/4)^(sqrt(y)-1)}
x<- as.integer(readline("Enter the value of x"))
y=x^2
p<-f(y)
print(p)

x<- c(1,2,3,4,5)
y<- x^2
proby <- f(y)
print(proby)

ExpVal<-sum(y*proby)
print(ExpVal)

z<-y^2
EY2<-sum(z*proby)
Var<-EY2-(ExpVal)^2
print(Var)
```

OUTPUT:-

```
> #Q5
>
> f<- function(y){(3/4)*(1/4)^(sqrt(y)-1)}
> x<- as.integer(readline("Enter the value of x"))
Enter the value of xy=x^2
Warning message:
NAs introduced by coercion
> p<-f(y)
> print(p)
[1] 0.750000000 0.187500000 0.046875000 0.011718750 0.002929688
>
> x<- c(1,2,3,4,5)
> y<- x^2
> proby <- f(y)
> print(proby)
[1] 0.750000000 0.187500000 0.046875000 0.011718750 0.002929688
>
> ExpVal<-sum(y*proby)
> print(ExpVal)
[1] 2.182617
>
> z<-y^2
> EY2<-sum(z*proby)
> Var<-EY2-(ExpVal)^2
> print(Var)
[1] 7.614112
>
```