Probability and Statistics (UCS410)
Experiment 6
(Joint probability mass and density functions)

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COE-6

(Q1) The joint probability density of two random variables X and Y is

f(x, y) =	**2(2x + 3y)/5;**	**$0 \leq x, y \leq 1$**
	0;	**elsewhere**

Then write a R-code to

(i) Check that it is a joint density function or not? (Use integral2())

```
library ("pracma")

#Question 1 (i)
func = function(x,y) (2*(2*x+3*y)/5)
inter =integral2(func,xmin=0,xmax=1,ymin=0,ymax=1)
inter
inter$Q  #to get absolute value of integration without error
```

Output-

```
> library ("pracma")
> #Question 1 (i)
> func = function(x,y) (2*(2*x+3*y)/5)
> inter =integral2(func,xmin=0,xmax=1,ymin=0,ymax=1)
> inter
$Q
[1] 1
```

(ii) Find marginal distribution g(x) at x = 1

```
#Question 1 (ii)
func1 = function(y) (2*(2+3*y)/5)
inter1= integrate(func1, lower=0, upper=1)
inter1
inter1$value #Absolute value
```

Output-

```
> #Question 1 (ii)
> func1 = function(y) (2*(2+3*y)/5)
> inter1= integrate(func1, lower=0, upper=1)
> inter1
1.4 with absolute error < 1.6e-14
```

(iii) Find the marginal distribution h(y) at y = 0

```
#Question 1 (iii)
func2 = function(x) (2*(2*x)/5)
inter2= integrate(func2, lower=0, upper=1)
inter2
inter2$value #Absolute value
```

Output-

```
> #Question 1 (iii)
> func2 = function(x) (2*(2*x)/5)
> inter2= integrate(func2, lower=0, upper=1)
> inter2
0.4 with absolute error < 4.4e-15
> inter2$value #Absolute value
[1] 0.4
```

(iv) Find the expected value of g(x, y) = xy

```
#Question 1 (iv)
func3 = function(x,y) (2*(2*x+3*y)/5)*x*y
mean1 = integral2(func3,xmin=0,xmax=1,ymin=0,ymax=1)
mean1
```

Output-

```
> #Question 1 (iv)
> func3 = function(x,y) (2*(2*x+3*y)/5)*x*y
> mean1 = integral2(func3,xmin=0,xmax=1,ymin=0,ymax=1)
> mean1
$Q
[1] 0.3333333

$error
[1] 8.673617e-17
```

(2) The joint probability mass function of two random variables X and Y is

$f(x, y) = \{(x + y)/30;\ x = 0, 1, 2, 3;\ y = 0, 1, 2\}$

Then write a R-code to

(i) Display the joint mass function in rectangular (matrix) form.

```
#Question 2 (i)
func1=function(x,y) (x+y)/30
x=c(0:3)
y=c(0:2)
m1=matrix(c(func1(0,0:2),func1(1,0:2),func1(2,0:2),func1(3,0:2)),nrow=4,ncol=3,byrow=TRUE)
m1
```

Output-

```
> #Question 2 (i)
> func1=function(x,y) (x+y)/30
> x=c(0:3)
> y=c(0:2)
> m1=matrix(c(func1(0,0:2),func1(1,0:2),func1(2,0:2),func1(3,0:2)),nrow=4,ncol=3,byrow=TRUE)
> m1
           [,1]       [,2]       [,3]
[1,] 0.00000000 0.03333333 0.06666667
[2,] 0.03333333 0.06666667 0.10000000
[3,] 0.06666667 0.10000000 0.13333333
[4,] 0.10000000 0.13333333 0.16666667
```

(ii) Check that it is joint mass function or not? (use: Sum())

```
#Question 2 (ii)
sum(m1) #if sum=1, so it is joint mass function
```

Output-

```
> #Question 2 (ii)
> sum(m1) #if sum=1, so it is joint mass function
[1] 1
```

(iii) Find the marginal distribution g(x) for x = 0, 1, 2, 3. (Use:apply())

```
#Question 2 (iii)
r=apply(m1,1,sum) #row-wise addition
r
```

Output-

```
> #Question 2 (iii)
> r=apply(m1,1,sum) #row-wise addition
> r
[1] 0.1 0.2 0.3 0.4
```

(iv) Find the marginal distribution h(y) for y = 0, 1, 2. (Use:apply())

```
#Question 2 (iv)
c=apply(m1,2,sum) #column-wise addition
c
```

Output-

```
> #Question 2 (iv)
> c=apply(m1,2,sum) #column-wise addition
> c
[1] 0.2000000 0.3333333 0.4666667
```

(v) Find the conditional probability at x = 0 given y = 1.

```
#Question 2 (v)
func1(0,1)/c[1]
```

Output-

```
> #Question 2 (v)
> func1(0,1)/c[1]
[1] 0.1666667
```

(vi) Find E(x), E(y), E(xy), V ar(x), V ar(y), Cov(x, y) and its correlation coefficient.

```
#Question 2 (vi)
meanx= sum(x*r)
meanx

meany=sum(y*c)
meany

func2=function(x,y) ((x+y)/30)*x*y
x=c(0:3)
y=c(0:2)
m2=matrix(c(func2(0,0:2),func2(1,0:2),func2(2,0:2),func2(3,0:2)),nrow=4,ncol=3,byrow=TRUE)
m2
meanxy=sum(m2)
meanxy

varx=sum(x^2*r)-meanx^2
varx

vary=sum(y^2*c)-meany^2
vary

covariance = (meanxy)-(meanx*meany)
covariance

correlation=covariance/(sqrt(varx)*sqrt(vary))
correlation
```

Output-

```
> #Question 2 (vi)
> meanx= sum(x*r)
> meanx
[1] 2
> meany=sum(y*c)
> meany
[1] 1.266667
> func2=function(x,y) ((x+y)/30)*x*y
> x=c(0:3)
> y=c(0:2)
> m2=matrix(c(func2(0,0:2),func2(1,0:2),func2(2,0:2),func2(3,0:2)),nrow=4,ncol=3,byrow=TRUE)
> m2
     [,1]       [,2]      [,3]
[1,]    0 0.00000000 0.0000000
[2,]    0 0.06666667 0.2000000
[3,]    0 0.20000000 0.5333333
[4,]    0 0.40000000 1.0000000
> meanxy=sum(m2)
> meanxy
[1] 2.4
> varx=sum(x^2*r)-meanx^2
> varx
[1] 1
> vary=sum(y^2*c)-meany^2
> vary
[1] 0.5955556
> covariance = (meanxy)-(meanx*meany)
> covariance
[1] -0.1333333
> correlation=covariance/(sqrt(varx)*sqrt(vary))
> correlation
[1] -0.1727737
```