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Probability and Statistics(UCS410) Exp. sheet 06 (Joint probability mass and density functions)

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(1)

The joint probability density of two random variables *X* and *Y* is

$$f(x,y) = \begin{cases} 2(2x+3y)/5; & 0 \le x, y \le 1 \\ 0; & elsewhere \end{cases}$$

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

```
library(pracma)
f<-function(x,y){
  2*(2*x+3*y)/5
}
res<-integral2(f,xmin=0,xmax=1,ymin=0,ymax=1)
print(res$Q)

f1<-function(y)
{
  f(1,y)
}
gx<-integral(f1,0,1)
```

```
Console   Terminal   Background Jobs
R 4.2.1 · ~/
> library(pracma)
> f<-function(x,y){
+   2*(2*x+3*y)/5
+ }
> res<-integral2(f,xmin=0,xmax=1,ymin=0,ymax=1)
> print(res$Q)
[1] 1
>
```

(ii) find marginal distribution $g(x)$ at $x = 1$.

```
print(res$Q)

f1<-function(y)
{
  f(1,y)
}
gx<-integral(f1,0,1)
print(gx)

f2<-function(x)
{
  f(x,0)
```

8:1 f1(y)

Console Terminal Background Jobs

R 4.2.1 · ~/

```
> f1<-function(y)
+ {
+   f(1,y)
+ }
> gx<-integral(f1,0,1)
> print(gx)
[1] 1.4
>
```

(iii) find the marginal distribution $h(y)$ at $y = 0$.

Source on Save

```
print(gx)

f2<-function(x)
{
  f(x,0)
}
hy<-integral(f2,0,1)
print(hy)

f3<-function(x,y)
{
  x*y*f(x,y)
```

15:1 f2(x)

Console Terminal Background Jobs

R 4.2.1 · ~/

```
> f2<-function(x)
+ {
+   f(x,0)
+ }
> hy<-integral(f2,0,1)
> print(hy)
[1] 0.4
>
```

(iv) find the expected value of $g(x, y) = xy$.

```
f3<-function(x,y)
{
  x*y*f(x,y)
}
ret<-integral2(f3,0,1,0,1)
print(ret$Q)

q2<-function(x,y)
```

22:1 f3(x, y)

Console Terminal Background Jobs

R 4.2.1 · ~/

```
> f3<-function(x,y)
+ {
+   x*y*f(x,y)
+ }
> ret<-integral2(f3,0,1,0,1)
> print(ret$Q)
[1] 0.3333333
>
```

(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.

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

```
28
29  q2<-function(x,y)
30  {
31    (x+y)/30
32  }
33  x<-c(0:3)
34  y<-c(0:2)
35  M<-matrix(c(q2(0,0:2),q2(1,0:2),q2(2,0:2),q2(3,0:2)),4,3,byrow=TRUE)
36  M
37
38  sum(M)
```

29:1 q2(x, y)

Console | Terminal | Background Jobs

R 4.2.1 · ~/

```
> q2<-function(x,y)
+ {
+   (x+y)/30
+ }
> x<-c(0:3)
> y<-c(0:2)
> M<-matrix(c(q2(0,0:2),q2(1,0:2),q2(2,0:2),q2(3,0:2)),4,3,byrow=TRUE)
> M
           [,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
>
> sum(M)
[1] 1
>
```

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

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

```
39
40  gx<-apply(M,1,sum)
41  gx
42
43  hy<-apply(M,2,sum)
44  hy
45
46  conp<-M[1,2]/hy[2]
47  conp
48
49  Ex<-sum(x*gx)
50  Ex
```

40:1 (Top Level)

Console Terminal Background Jobs

R 4.2.1 · ~/

```
> gx<-apply(M,1,sum)
> gx
[1] 0.1 0.2 0.3 0.4
>
> hy<-apply(M,2,sum)
> hy
[1] 0.2000000 0.3333333 0.4666667
>
```

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

```
45
46  conp<-M[1,2]/hy[2]
47  conp
48
```

46:1 (Top Level)

Console Terminal Background Jobs

R 4.2.1 · ~/

```
> conp<-M[1,2]/hy[2]
> conp
[1] 0.1
>
```

(vi) find $E(x)$, $E(y)$, $E(xy)$, $Var(x)$, $Var(y)$, $Cov(x, y)$ and its correlation coefficient.

```
48
49  Ex<-sum(x*gx)
50  Ex
51
52  Ey<-sum(y*hy)
53  Ey
54
55  Exx<-sum(x*x*gx)
56  Eyy<-sum(y*y*hy)
57
58  Vx<-Exx-Ex^2
59  Vy<-Eyy-Ey^2
60  Vx
61  Vy
62
63  Exy<-sum(x*y*M[x,y])
64  Exy
65
66  cov<-Exy-(Ex*Ey)
67  cov
68
69  corr<-cov/((Vx^0.5)*(Vy^0.5))
70  corr
```

70:5 (Top Level)

Console Terminal Background Jobs

R 4.2.1 · ~/

```
> Ex<-sum(x*gx)
> Ex
[1] 2
>
> Ey<-sum(y*hy)
> Ey
[1] 1.266667
>
> Exx<-sum(x*x*gx)
> Eyy<-sum(y*y*hy)
>
> Vx<-Exx-Ex^2
> Vy<-Eyy-Ey^2
> Vx
[1] 1
> Vy
[1] 0.5955556
>
> Exy<-sum(x*y*M[x,y])
Warning messages:
1: In x * y :
  longer object length is not a multiple of shorter object length
2: In x * y * M[x, y] :
  longer object length is not a multiple of shorter object length
> Exy
[1] 0.4
>
>
> cov<-Exy-(Ex*Ey)
> cov
[1] -2.133333
>
> corr<-cov/((Vx^0.5)*(Vy^0.5))
> corr
[1] -2.764379
>
```

```
>
> cov<-Exy-(Ex*Ey)
> cov
[1] -2.133333
>
> corr<-cov/((Vx^0.5)*(Vy^0.5))
> corr
[1] -2.764379
>
```