

R Textbook Companion for  
Fundamentals of Mathematical Statistics  
by S.C. Gupta, V.K. Kapoor<sup>1</sup>

Created by  
Meet Bhatnagar  
B.Tech.  
Computer Science and Engineering  
VELLORE INSTITUTE OF TECHNOLOGY  
Cross-Checked by  
R TBC Team

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# Book Description

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R numbering policy used in this document and the relation to the above book.

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means an R code whose theory is explained in Section 2.3 of the book.

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# Chapter 2

## Descriptive Measures

R code Exa 2.1 Arithmetic Mean

```
1 #PAGE NUMBER--2.8
2 #Example number--2.1
3
4 #Part (a)
5 x=c(1,2,3,4,5,6,7)
6 f=c(5,9,12,17,14,10,6)           # frequency
7 fx=f*x
8 a=data.frame(x,y,fx)
9 a
10 mean=(sum(fx))/sum(y)
11 mean
12
13
14
15 #Part (b)
16 Marks=c("0-10","10-20","20-30","30-40","40-50","
17         50-60")
18 mid=c((0+10)/2,(10+20)/2,(20+30)/2,(30+40)/2,(40+50)
19       /2,(50+60)/2)             # mid values
20 f=c(12,18,27,20,17,6)           # frequency
21 fx=f*mid
```

```

20 b=data.frame(Marks,mid,f,fx)
21 b
22 mean=(sum(fx))/sum(f)
23 mean

```

---

### R code Exa 2.2 Mean

```

1 #PAGE NUMBER--2.10
2 #Example number--2.2
3
4 A=28
5 h=8
6 Class_Interval=c("0-8","8-16","16-24","24-32","32-40",
  "","40-48")
7 mid=c((0+8)/2,(8+16)/2,(16+24)/2,(24+32)/2,(32+40)/
  2,(40+48)/2)
8 f=c(8,7,16,24,15,7) # frequency
9 d=(mid-A)/h
10 fd=f*d
11 a=data.frame(Class_Interval,mid,f,d,fd)
12 a
13 mean=A + h* sum(fd)/sum(f)
14 mean

```

---

### R code Exa 2.3 Percentage Male Female Employees

```

1 #PAGE NUMBER--2.11
2 #Example number--2.3
3
4 x1=5200
5 x2=4200
6 x=5000

```

```

7 #we know that combined mean——> x=(a1*x1+a2*x2)/(a1
  +a2)
8 #we will find the ratio of a1/a2
9 #let us name it as ——> a
10 a=(x-x2)/(x1-x)
11 #by comparing a numerator and denominator we get a1
    =800 and a2=200
12 a1=x-x2;a1
13 a2=x1-x;a2
14 m.p=a1*100/(a1+a2)
15 f.p=a2*100/(a1+a2)
16 sprintf("Percentage of male employee: %s",m.p)
17 sprintf("Percentage of female employee: %s",f.p)

```

---

#### R code Exa 2.4 Age Limits

```

1 #PAGE NUMBER--2.12
2 #Example number--2.4
3
4 Age_Group=c("20-25","25-30","30-35","35-40","40-45",
  "45-50","50-55","55-60","60-65")
5 n_o_p=c(30,160,210,180,145,105,70,60,40) #
  Number of persons
6 data.frame(Age_Group,n_o_p)
7
8 N=1000
9
10 # Part(i)
11 a=15/100*N
12 sprintf("Number of persons to be retrenched from the
  lower group: %d", a)
13 sprintf("30 people from 20-25 age group")
14 sprintf("%d people from 25-30 age group", a-30)
15
16 # Part(ii)

```

```

17 b=45/100*N
18 sprintf("Number of persons to be absorbed in other
    branches: %d", b)
19 Age_Group1=c("25-30","30-35","35-40","40-45")
20 n_o_p1=c(160-120,210,180,b-(40+210+180))
21 data.frame(Age_Group1,n_o_p1)
22
23 # Part( iii )
24 c=10/100*N
25 sprintf("Number of persons to retire: %d", c)
26
27 Age_Group2=c("40-45","45-50","50-55")
28 n_o_p2=c(145-20,105,70) # Number of
    persons
29 data.frame(Age_Group2,n_o_p2)
30
31 A=47.5
32 h=5
33 mid=c((40+45)/2,(45+50)/2,(50+55)/2)
34 d=(mid-A)/h;d
35 fd=n_o_p2*d
36 data.frame(Age_Group2,mid,n_o_p2,d,fd)
37 mean=A + h* sum(fd)/sum(n_o_p2)
38 round(mean)

```

---

## R code Exa 2.6 Median

```

1 #PAGE NUMBER--2.15
2 #Example number--2.6
3
4 x=c(1,2,3,4,5,6,7,8,9)
5 f=c(8,10,11,16,20,25,15,9,6)
6 cf=cumsum(f)
7 data.frame(x,f,cf)
8 sum(f)/2

```

```

9  sprintf("Cumulative frequency just greater than 60
    is 65")
10 sprintf("So, Median = 5")

```

---

### R code Exa 2.7 Median Wages

```

1  #PAGE NUMBER--2.16
2  #Example number--2.7
3
4  Wages=c("2000-3000", "3000-4000", "4000-5000", "
    5000-6000", "6000-7000")
5  n_o_e=c(3,5,20,10,5)           # Number of
    employees
6  cf=cumsum(n_o_e)
7  data.frame(Wages,n_o_e,cf)
8
9  sum(n_o_e)/2
10 sprintf("Cumulative frequency just greater than 21.5
    is 28")
11 sprintf("So, the median class is 4000-5000")
12
13 median= 4000 + 1000/20*(21.5-8)
14 median

```

---

### R code Exa 2.8 Median Hours Of Work

```

1  #PAGE NUMBER--2.17
2  #Example number--2.8
3
4  Wages_hours=c("Below 3.005", "3.005-4.505", "
    4.505-6.005", "6.005-7.505", "7.505-9.005", "9.005
    Above")
5  f=c(0.05*3000,580,0.3*3000,500,0.2*3000,3000-2730)

```

```

6 cf=cumsum(f)
7 data.frame(Wages_hours,f,cf)
8
9 sum(f)/2
10 sprintf("Cumulative frequency just greater than 1500
           is 1630")
11 sprintf("So, the median class is 4.505-6.005")
12
13 median= 4.505 + 1.5/900*(1500-730)
14 round(median,2)

```

---

#### R code Exa 2.9 Incomplete Frequency

```

1 #PAGE NUMBER--2.17
2 #Example number--2.9
3
4 variable=c("10-20","20-30","30-40","40-50","50-60","
            60-70","70-80")
5 f=c(12,30,NA,65,NA,25,18)
6 data.frame(variable,f)
7
8 # Let frequency of 30-40 be f1
9 # Let frequency of 50-60 be f1
10 # sum of f1+f2= q
11 q=229-(12+30+65+25+18)
12 #Solving the equation——> 46=40+(114.5-12-30-f1)/65
    *10
13 f1=round(solve(10,335))
14 f1
15 f2=q-f1
16 f2

```

---

#### R code Exa 2.12 Mode



```

1 #PAGE NUMBER--2.21
2 #Example number--2.12
3
4 Class_Interval=c("0-10","10-20","20-30","30-40","
    40-50","50-60","60-70","70-80")
5 f=c(5,8,7,12,28,20,10,10)
6 data.frame(Class_Interval,f)
7
8 a=max(f)
9 sprintf("Maximum frequency: %d",a)
10 sprintf("Modal class is 40-50")
11 Mode= 40 + 10*(28-12)/(2*28-12-20)
12 round(Mode,2)

```

---

#### R code Exa 2.15 Geometric mean

```

1 #PAGE NUMBER--2.25
2 #Example number--2.15
3
4 # G'=(x1 '*x2*....xn)^1/n
5 # G'=(x1*x2*....xn)^(1/n) * (x1'/x1)^(1/n)
6 # G'=G* (x1'/x1)^(1/n)
7
8 G=16.2
9 n=10
10 x1=12.9
11 x_1=21.9
12 c_G.M=G*(x_1/x1)^(1/10) # Corrected G.M
13 c_G.M

```

---

#### R code Exa 2.17 Average Speed

```

1 #PAGE NUMBER--2.27

```

```

2 #Example number--2.17
3
4 #Average speed
5
6 avg.s=function(){
7     #let the distance between home and college is x
        kms.
8     x=1
9     #speed from home to college
10    a=x/10
11    #speed from college to home
12    b=x/15
13    AverageSpeed=2*x/(a+b)
14    sprintf("Your average speed is: %s",AverageSpeed
        )
15 }
16 avg.s()

```

---

#### R code Exa 2.18 Average Price

```

1 #PAGE NUMBER--2.27
2 #Example number--2.18
3
4 #Part (a)
5 #Average price
6 avg.p=function(){
7     #Number of varieties of milk
8     n=4
9     #Prices of milk sold at different varieties
10    a=c(8,10,12,15)
11    #Average price
12    AveragePrice=1/((1/n)*(1/a[n-3]+1/a[n-2]+1/a[n
        -1]+1/a[n]))
13    sprintf("Your average price is: %s",AveragePrice
        )

```

```

14 }
15 avg.p()
16
17
18 #Part (b)
19 quality=c("A","B","C")
20 p.p.p=c(1.00,1.50,2.00) #price per pencil
21 m.s=c(50,30,20) #money spent
22 fr.distr=data.frame(quality,p.p.p,m.s)
23 fr.distr
24 n.e=sum(m.s) #net value
25 p.p= sum(m.s / p.p.p) #number of pencils
    purchased
26 Averagep.p.p = n.e/p.p #Average price per pencil
27 Averagep.p.p

```

---

#### R code Exa 2.19 Average Speed

```

1 #PAGE NUMBER--2.28
2 #Example number--2.19
3
4 speed=c(60,25,350,25)
5 distance=c(900,3000,400,15)
6 wx=round(distance/speed,2)
7 data.frame(speed,distance,wx)
8
9 avg.sp= sum(distance)/sum(wx) #Average Speed
10
11 #Answer is little varying as of rounding off
12
13 avg.sp

```

---

#### R code Exa 2.20 Number Of Tosses Required

```

1 #PAGE NUMBER--2.29
2 #Example number--2.20
3
4 x=seq(0,8,1)
5 f=c(1,9,26,59,72,52,29,7,1)
6 cf=cumsum(f)
7 data.frame(x,f,cf)
8
9 sum(f)/2
10 sprintf("Cumulative frequency just greater than 128
    is 167")
11 sprintf("So, Median = 4")
12
13 Q1=sum(f)/4;Q1
14 sprintf("Cumulative frequency just greater than 64
    is 95")
15 sprintf("So, Q1 = 3")
16 Q3=3*sum(f)/4;Q3
17 sprintf("Cumulative frequency just greater than 192
    is 219")
18 sprintf("So, Q3 = 5")
19 D4=4*sum(f)/10;D4
20 sprintf("Cumulative frequency just greater than
    102.4 is 167")
21 sprintf("So, D4 = 4")
22 P27=27*sum(f)/100;P27
23 sprintf("Cumulative frequency just greater than
    69.12 is 95")
24 sprintf("So, P27 = 3")

```

---

#### **R code Exa 2.21** Lower Quartile Marks

```

1 #PAGE NUMBER--2.29
2 #Example number--2.21
3

```

```

4 m_m_t=c(0,10,20,30,40,50)           # marks more
   than
5 n_o_c=c(500,460,400,200,100,30)     # number of
   candidates
6 Class_interval=c("0-10","10-20","20-30","30-40","
   40-50","50 Above")
7 f=c(500-460,460-400,400-200,200-100,100-30,30)
8 cf=cumsum(f)
9 data.frame(m_m_t,n_o_c,Class_interval,f,cf)
10
11 sum(f)/4
12 sprintf("Cumulative frequency just greater than 125
   is 300")
13 sprintf("So, the corresponding class is 20-30")
14 Q1= 20 + 10/200*(125-100)
15 Q1
16
17 3*sum(f)/10
18 sprintf("Cumulative frequency just greater than 150
   is 300")
19 sprintf("So, the corresponding class is 20-30")
20 D3= 20 + 10/200*(150-100)
21 D3

```

---

### R code Exa 2.23 Cumulative Frequency Curve

```

1 #PAGE NUMBER--2.31
2 #Example number--2.23
3
4 m.g=c("0-10","10-20","20-30","30-40","40-50","50-60"
   ,"60-70") #Marks Group
5 f=c(4,8,11,15,12,6,3)
6 l.c.f=cumsum(f) #
   Less than cumulative frequency
7 m.c.f=rev(cumsum(rev(f)))

```

```

8 data.distr=data.frame(m.g,f,l.c.f,m.c.f)
      #More than cumulative frequency
9 data.distr
10 #For lower quartile (Q1)
11 N=sum(f)
12 Q1=20+10/11*(N/4-l.c.f[2])
13 Q1
14 #For middle quartile (Q2)
15 Q2=30+10/15*(N/2-l.c.f[3])
      #Median
16 Q2
17 #For upper quartile (Q3)
18 Q3=40+10/12*(3*N/4-l.c.f[4])
19 Q3
20 x=seq(10,70,10)
21 plot(x,l.c.f,xlab="MARKS",ylab="No. of Students",
      main="Cumulative frequency curve",col="red")
22 sp=spline(x,l.c.f,n=20)
23 plot(x,m.c.f,xlab="MARKS",ylab="No. of Students",
      main="Cumulative frequency curve",col="red")
24 spl=spline(x,m.c.f,n=20)
25 lines(spl,col="blue")
26 lines(sp,col="green")
27 locator()

```

---

#### R code Exa 2.24 Quartile Deviation And Mean Deviation From Mean

```

1 #PAGE NUMBER--2.33
2 #Example number--2.24
3
4 marks=c("0-10","10-20","20-30","30-40","40-50","
      50-60","60-70")
5 n.o.s=c(6,5,8,15,7,6,3)
6 mid=seq(5,65,10)
7 d=(mid-35)/10

```

```

8 fd=n.o.s*d
9 mean=35+10*(sum(fd))/sum(n.o.s)
10 l.c.f=cumsum(n.o.s)
11 a=abs(mid-mean)
12 b=n.o.s*a
13 fr.distr=data.frame(marks,mid,n.o.s,d,fd,a,b,l.c.f)
14 fr.distr
15
16 #Part (i)
17 N=sum(n.o.s)
18 Q1=20+10*(N/4-11)/8
19 Q1          #Q1 is deviated because they have taken
               N/4=12.75 which is 12.5
20 Q3=40+10/7*(3*N/4-34)
21 Q3          #Q3 is deviated because they have taken
               N/4=12.75 which is 12.5
22
23 QD=(Q3-Q1)/2
24 sprintf("Quartile Deviation is : %s",QD)
25
26 #Part (ii)
27 MD=sum(b)/N
28 MD

```

---

### R code Exa 2.26 Mean and Standard deviation

```

1 #PAGE NUMBER--2.38
2 #Example number--2.26
3
4 A=55
5 h=10
6 Age_group=c("20-30","30-40","40-50","50-60","60-70",
              "70-80","80-90")
7 mid=c((20+30)/2,(30+40)/2,(40+50)/2,(50+60)/
        2,(60+70)/2,(70+80)/2,(80+90)/2)

```

```

8 f=c(3,61,132,153,140,51,2)
9 d=(mid-A)/h
10 fd=f*d
11 fd2=fd*d
12
13 mean= A + h*sum(fd)/sum(f)
14 mean
15
16 s.d=sqrt(100*(765/542-0.028^2))
17 s.d                                     # Standard Deviation

```

---

#### R code Exa 2.27 Corrected Mean And Standard Deviation

```

1 #PAGE NUMBER--2.39
2 #Example number--2.27
3
4 n=200
5 mean=40
6 s.d=15
7
8 s_x=n*mean
9 s_x                                     # sum of xi
10 s_x2=n*(15^2+1600)
11 s_x2                                   # sum of xi^2
12
13 c_s_x= s_x-34-53+43+35
14 corrected_mean=c_s_x/n
15 corrected_mean
16
17 c_s_x2= s_x2-34^2-53^2+43^2+35^2
18 corrected_s.d= sqrt(c_s_x2/n - corrected_mean^2)
19 corrected_s.d                         # corrected Standard
    deviation

```

---



## R code Exa 2.28 Original Frequency Distribution

```
1 #PAGE NUMBER--2.39
2 #Example number--2.28
3
4 d=seq(-4,3,1)
5 f=c(2,5,7,13,21,16,8,3)
6 fd=f*d
7 fd2=fd*d
8 data.frame(fd,fd2)
9
10 mean=21.9
11 s.d2=63.9725
12 h=round(sqrt(solve(193/75-(-9/75)^2,s.d2)))
13 h
14 A= 21.9 + 9*5/75
15 A
16
17 # Mid value=(x1+x2)/2=A
18 # Magnitude of class= x1-x2=h
19 a=matrix(c(1,-1,1,1),nrow=2,ncol=2)
20 b=matrix(c(A*2,h),nrow=2,ncol=1)
21 t=solve(a,b)
22 t
23 x1=t[1,1];x1
24 x2=t[2,1];x2
25
26 # So the classes obtained
27 class_interval=c("0-5","5-10","10-15","15-20","20-25",
28   "25-30","30-35","35-40")
29 mid=c((0+5)/2,(5+10)/2,(10+15)/2,(15+20)/2,(20+25)/
30   2,(25+30)/2,(30+35)/2,(35+40)/2)
31 data.frame(d,mid,class_interval,f)
```

---

**R code Exa 2.29** Standard Deviation Of Second Group

```
1 #PAGE NUMBER--2.40
2 #Example number--2.29
3
4 N=250
5 n1=100
6 x1=15
7 s.d1=3
8 n2=250-n1
9 mean=15.6
10 s.d=sqrt(13.44)
11
12 x2=solve(150,N*mean-1500)
13 x2
14 d1=x1-mean;d1
15 d2=x2-mean;d2
16 s.d2=sqrt(solve(150,N*13.44-n1*9.36-n2*0.16))
17 s.d2
```

---

**R code Exa 2.34** Wages By Firm A And B

```
1 #PAGE NUMBER--2.44
2 #Example number--2.34
3
4 # Part(i)
5 # Firm A:
6 n1=500                                # Number of wagers
7 x1=186                                # Average daily wage
8 t_w_p1=n1*x1                          # Total wages paid
9 t_w_p1
10
```

```

11 # Firm B:
12 n2=600                                # Number of wagers
13 x2=175                                # Average daily wage
14 t_w_p2=n2*x2                          # Total wages paid
15 t_w_p2
16
17 sprintf("Firm B has larger wage bill")
18
19 # Part(ii)
20 s.d1=sqrt(81)                          # Standard Deviation of
    A
21 s.d2=sqrt(100)                         # Standard Deviation of B
22 c.vA=100*s.d1/x1
23 c.vA
24 c.vB=100*s.d2/x2
25 c.vB
26
27 sprintf("Firm B has greater variability in
    individual wages")
28
29 # Part(iii)
30 a_d_w= (n1*x1 + n2*x2)/(n1 + n2)       # Average
    daily wages
31 a_d_w
32 d1=x1-a_d_w
33 d2=x2-a_d_w
34 c.v= 1/(n1 + n2) * (n1*(81+d1^2) + n2*(100+d2^2))
35 c.v

```

---

### R code Exa 2.35 Moments About Mean Origin Particular Point

```

1 #PAGE NUMBER--2.48
2 #Example number--2.35
3
4 A=4

```

```

5 U1=-1.5
6 U2=17
7 U3=-30; U4=108
8 u2= U2-U1^2; u2
9 u3= U3-3*U2*U1+2*U1^3; u3
10 u4= U4-4*U3*U1+6*U2*U1^2 -3*U1^4; u4
11
12 b1=u3^2/u2^3
13 b1
14 b2=u4/u2^2
15 b2
16 mean= A + U1
17 mean
18
19 # Taking A=0, we get the first moment about origin
20 U1=2.5
21 U2= u2+U1^2; U2
22 U3= u3+3*u2*U1+U1^3; U3
23 U4= u4+4*u3*U1+6*u2*U1^2+U1^4; U4
24
25 # Taking A=2, we get the first moment about x=2
26 U1=2.5-2
27 U2= u2+U1^2; U2
28 U3= u3+3*u2*U1+U1^3; U3
29 U4= u4+4*u3*U1+6*u2*U1^2+U1^4; U4

```

---

### R code Exa 2.36 First Four Moments

```

1 #PAGE NUMBER--2.49
2 #Example number--2.36
3
4 x=seq(0,8,1)
5 f=c(1,8,28,56,70,56,28,8,1)
6 d=x-4
7 fd=f*d

```

```

8 fd2=fd*d
9 fd3=fd2*d
10 fd4=fd3*d
11 data.frame(x,f,d,fd,fd2,fd3,fd4)
12
13 # Moments about point x=4
14 U1=sum(fd)/sum(f); U1
15 U2=sum(fd2)/sum(f); U2
16 U3=sum(fd3)/sum(f); U3
17 U4=sum(fd4)/sum(f); U4
18
19 # Moments about mean
20 u1=0
21 u2= U2-U1^2; u2
22 u3= U3-3*U2*U1+2*U1^3; u3
23 u4= U4-4*U3*U1+6*U2*U1^2 -3*U1^4; u4
24
25 b1=u3^2/u2^3
26 b1
27 b2=u4/u2^2
28 b2

```

---

#### R code Exa 2.40 Corrected Frequency Constants

```

1 #PAGE NUMBER--2.51
2 #Example number--2.40
3
4 N=250
5 x=54
6 s.d=3
7 b1=0; b2=3
8
9 #Wrong observation--> 64 and 50          Correct
   observation--> 62 and 52
10 #Part (i)

```

```

11 ux=N*x
12 cx=ux - (64+50) + (62+52)
13 cx
14 cm=cx/N # Corrected mean
15 cm
16
17 # Part (ii)
18 ux2=N*s.d^2; ux2
19 cx2=ux2 - ((64-54)^2+(50-54)^2)+((62-54)^2+(52-54)^2)
    ; cx2
20 cs.d=round(sqrt(cx2/N),2) # Corrected Standard
    Deviation
21 cs.d
22
23 # Part (iii)
24 u3=b1*u2^3; u3
25 ux3=N*u3; ux3
26 cx3=0 - ((64-54)^3+(50-54)^3)+((62-54)^3+(52-54)^3);
    cx3 # Answer here is wrong
27 cu3=cx3/N; cu3
28 cb1=(cu3)^2/(cx2/N)^3; round(cb1)
29
30 # Part (iv)
31 u4=b2*9^2
32 ux4= N*u4; ux4
33 cx4= ux4 - ((64-54)^4+(50-54)^4)+((62-54)^4+(52-54)^4); cx4
34 cu4=cx4/N; cu4
35 cb2= cu4/(cx2/N)^2; cb2

```

---

#### R code Exa 2.42 First Four Moments About Origin

```

1 #PAGE NUMBER--2.55
2 #Example number--2.42
3

```

```

4 mean=10
5 u2=16
6 s.d=sqrt(16)
7 y1=1
8 b1=4
9
10 # First four moments about origin
11 U1=mean
12 U2=u2 + U1^2; U2
13 u3=s.d^3; u3
14 U3= u3 + 3*U2*U1 -2*U1^3; U3
15 u4= b1*u2^2; u4          # here we have to take value
    of b1, written wrong in book
16
17 U4= u4 + 4*U3*U1 - 6*U2*U1^2 + 3*U1^4; U4  # plus,
    minus signs are not correct in the book
18
19 sprintf("The distribution is leptokurtic")

```

---

#### R code Exa 2.43 First Four Moments About Mean Of The Distribution

```

1 #PAGE NUMBER--2.56
2 #Example number--2.43
3
4 A=135
5 h=10
6 Scores=c("50-60","60-70","70-80","80-90","90-100","
    100-110","110-120","120-130",
7 "130-140","140-150","150-160","160-170","170-180","
    180-190","190-200",
8 "200-210","210-220","220-230")
9 f=c(1,0,0,1,1,2,1,0,4,4,2,5,10,11,4,1,1,2)
10 mid=c((50+60)/2,(60+70)/2,(70+80)/2,(80+90)/
    2,(90+100)/2,(100+110)/2,
11 (110+120)/2,(120+130)/2,(130+140)/2,(140+150)/

```

```

        2,(150+160)/2,(160+170)/2,
12  (170+180)/2,(180+190)/2,(190+200)/2,(200+210)/
        2,(210+220)/2,(220+230)/2)
13  d=(mid-A)/h
14  fd=f*d
15  fd2=fd*d
16  fd3=fd2*d
17  fd4=fd3*d
18  data.frame(Scores,mid,f,d,fd,fd2,fd3,fd4)
19
20  # Raw Moments of variable d about origin
21  U1=sum(fd)/sum(f); U1
22  U2=sum(fd2)/sum(f); U2
23  U3=sum(fd3)/sum(f); U3
24  U4=sum(fd4)/sum(f); U4
25
26  # Central Moments of variable X
27  u2= (U2-U1^2)*h^2; u2
28  u3= (U3-3*U2*U1+2*U1^3)*h^3; u3
29  u4= (U4-4*U3*U1+6*U2*U1^2 -3*U1^4)*h^4; u4
30
31  # Sheppard's Corrections for Moments
32
33  u2b=u2-h^2/12; u2b
34  u3b=u3; u3b
35  u4b=u4 - h^2/2*u2 + 7/240*h^4; u4b
36
37  # Moment coefficient of skewness
38  y1= u3/(u2)^(3/2); y1
39
40  # Moment coefficient of kurtosis
41  b2= u4/u2^2; b2
42
43  sprintf("The distribution is leptokurtic")

```

---



# Chapter 3

## Probability I

**R code Exa 3.2** Two Unbiased Dice

```
1 #Page number--3.7
2 #Example number--3.2
3 #LOAD PACKAGE-->prob
4
5 s=rolldie(2)
6 s
7
8 #Part (a)
9 subset(s,X1==X2)
10 p=nrow(subset(s,X1==X2))/nrow(s)
11 sprintf("Probability that the two dice show the same
    number: %f",p)
12
13 #Part (b)
14 subset(s,X1==6)
15 p=nrow(subset(s,X1==6))/nrow(s)
16 sprintf("Probability that the first die show 6: %f",
    p)
17
18 #Part (c)
19 subset(s,X1+X2==8)
```

```

20 p=nrow(subset(s,X1+X2==8))/nrow(s)
21 sprintf("Probability that the total of numbers on
    the die is 8: %f",p)
22
23 #Part (d)
24 subset(s,X1+X2>8)
25 p=nrow(subset(s,X1+X2>8))/nrow(s)
26 sprintf("Probability that the total of numbers on
    the die is more than 8: %f",p)
27
28 #Part (e)
29 subset(s,X1+X2==13)
30 p=nrow(subset(s,X1+X2==13))/nrow(s)
31 sprintf("Probability : %f",p)
32 sprintf("This is an impossible event")
33
34 #Part (f)
35 sprintf("This is a certain event.")
36 sprintf("Probability : 1")

```

---

### R code Exa 3.3 Probability That Odd Digit Selected

```

1 #Page number--3.8
2 #Example number--3.3
3
4 # Part(a)
5 N=5*4
6 sprintf("Total number of cases: %d",N)
7 #Part(i)
8 # there are 12 cases-->(1,2),(1,3),(1,4),(1,5)
    ,(3,1),(3,2),(3,4),(3,5),(5,1),(5,2),(5,3),(5,4)
9 a=12/20
10 sprintf("Probability that the first digit drawn is
    odd: %f",a)
11 #Part(ii)

```

```

12 # there are 12 cases --->(2,1),(3,1),(4,1),(5,1)
    ,(1,3),(2,3),(4,3),(5,3),(1,5),(2,5),(3,5),(4,5)
13 b=12/20
14 sprintf("Probability that the second digit drawn is
    odd: %f",b)
15 #Part(iii)
16 # there are 6 cases --->(1,3),(1,5),(3,1),(3,5),(5,1)
    ,(5,3)
17 c=6/20
18 sprintf("Probability that the first and second digit
    drawn are odd: %f",c)
19
20 # Part(b)
21 n=25
22 #Number which are multiple of 5-----> 5,10,15,20,25
23 d.f.c= 5+3          # Distinct favourable cases
24 d=d.f.c/n
25 sprintf("Required Probability: %f",d)
26
27 #Number which are multiple of 3----->
    3,6,9,12,15,18,21,24
28 d.f.c= 8+3-1        # Distinct favourable cases
29 e=d.f.c/n
30 sprintf("Required Probability: %f",e)

```

---

#### R code Exa 3.4 Four Cards Drawn At Random

```

1 #Page number--3.9
2 #Example number--3.4
3
4 #Preparing Combination function
5 comb=function(n,r){
6     return (factorial(n)/(factorial(r)*factorial(n-r
7         )))

```

```

8
9 s=cards()
10
11 #Part (i)
12 subset(s, rank=="K" | rank=="J" | rank=="Q" | rank=="A")
13 #there are 4 King, 4 Jack, 4 Queen, 4 Ace ----> we
    need to select one from each
14 #total there are 52 cards
15 p=(comb(4,1)*comb(4,1)*comb(4,1)*comb(4,1))/comb
    (52,4)
16 sprintf("Probability: %f",p)
17
18 #Part (ii)
19 subset(s, rank=="K" | rank=="Q" )
20 #there are 4 kings, 4 queens ----> we need to select
    two from each
21 #total there are 52 cards
22 p=(comb(4,2)*comb(4,2))/comb(52,4)
23 sprintf("Probability: %f",p)
24
25 #Part (iii)
26 #There are 26 black cards and 26 red cards ----> we
    need to select two from each
27 #total there are 52 cards
28 p=(comb(26,2)*comb(26,2))/comb(52,4)
29 sprintf("Probability: %f",p)
30
31 #Part (iv)
32 subset(s, suit=="Diamond" | suit=="Heart" )
33 #there are 13 heart, 13 diamonds ----> we need to
    select two from each
34 #total there are 52 cards
35 p=(comb(13,2)*comb(13,2))/comb(52,4)
36 sprintf("Probability: %f",p)
37
38 #Part (v)
39 #4 cards can be from each suit

```

```

40 #total 52 cards
41 p=(comb(13,1)*comb(13,1)*comb(13,1)*comb(13,1))/comb
    (52,4)
42 sprintf("Probability: %f",p)

```

---

#### R code Exa 3.24 Probability That Letter Chosen

```

1 #Page number--3.36
2 #Example number--3.24
3
4 letters
5
6 n=length(letters)
7
8 #Part (i)
9 #Probability that the letter choosen is vowel
10 n1=length(c("a","e","i","o","u"))
11 p=n1/n
12 sprintf("Probability: %f",p)
13
14 #Part (ii)
15 #Probability that the letter preceeds m and is vowel
16 n2=length(c("a","e","i"))
17 p=n2/n
18 sprintf("Probability: %f",p)
19
20 #Part (iii)
21 #Probability that the letter follows m and is vowel
22 n3=length(c("o","u"))
23 p=n3/n
24 sprintf("Probability: %f",p)

```

---

#### R code Exa 3.29 Probability That Odd Number Appear

```

1 #Page number--3.38
2 #Example number--3.29
3
4 #Probability of rolling die=P(n)
5 #P(n) is proportional to n
6 #P(n)=kn
7 #We know that-----> P(1)+P(2)+P(3)+P(4)+P(5)+P(6)=1
8 #k(1+2+3+4+5+6)=1
9 k=solve(21,1)
10 #We need to find probability of an odd number
    appearing on top
11 #P(1)+P(3)+(5)
12 p=1*k+3*k+5*k
13 sprintf("Probability : %f",p)

```

---

### R code Exa 3.30 Probability

```

1 #Page number--3.39
2 #Example number--3.30
3 #LOAD PACKAGE---prob
4
5 s=rolldie(2)
6
7 #S denotes sum of faces of two die
8
9 #Part (a)
10 subset(s,X1+X2>8)
11 #Sample Space
12 #S=9----->(3,6),(6,3),(4,5),(5,4)
13 #S=10----->(4,6),(6,4),(5,5)
14 #S=11----->(5,6),(6,5)
15 #S=12----->(6,6)
16 p=nrow(subset(s,X1+X2==9))/nrow(s)+nrow(subset(s,X1+
    X2==10))/nrow(s)+nrow(subset(s,X1+X2==11))/nrow(s)
    +nrow(subset(s,X1+X2==12))/nrow(s)

```

```

17 sprintf(" Probability that sum greater than 8: %f",p)
18
19 #Part (b)
20 subset(s,X1+X2==7 | X1+X2==11)
21 #Sample Space
22 #S=7----->(1,6),(6,1),(2,5),(5,2),(3,4),(4,3)
23 #S=11----->(5,6),(6,5)
24 p1=nrow(subset(s,X1+X2==7))/nrow(s)+nrow(subset(s,X1
    +X2==11))/nrow(s)
25 sprintf(" Required Probability : %f",1-p1)

```

---

### R code Exa 3.37 Probability

```

1 #Page number--3.41
2 #Example number--3.37
3 #LOAD PACKAGE-->prob
4
5 s=cards()
6 s
7
8 #A= Probability that the card drawn is king
9 #B= Probability that the card drawn is heart
10 #C= Probability that the card drawn is red card
11 A=nrow(subset(s,rank=="K"))/nrow(s)
12 B=nrow(subset(s,suit=="Heart"))/nrow(s)
13 C=(nrow(s)/2)/nrow(s) #Total red cards
    =26(i.e. half of deck)
14 #D=Probability that the card drawn is king of hearts
15 #E=Probability that the card drawn is heart
16 #F=Probability that the card drawn is red king
17 #G=Probability that the card drawn is king of hearts
18 D=1/nrow(s)
19 E=13/nrow(s)
20 F=2/nrow(s)
21 G=1/nrow(s)

```

22 #P=Probability that the card drawn is KING OR HEART  
OR RED CARD  
23  $P=A+B+\textcolor{red}{C}-\textcolor{red}{D}-E-F+G$   
24 P

---



# Chapter 4

## Probability II

**R code Exa 4.1** Factories Production

```
1 #Page number--4.6
2 #Example number--4.1
3
4 #There are 3 factories-->X,Y,Z
5 #Product produced respectively--->3n,n,n
6 #Where n is constant , let suppose n=1
7 n=1
8 #E1,E2,E3 denotes event to the item produced in X,Y,
   Z
9 #A be the event that item is deffective
10 PE1=3*n/(3*n+n+n)
11 PE2=n/(5*n)
12 PE3=n/(5*n)
13 #GIVEN----->P(A|E1)=P(A|E3)=0.03 AND P(A|E2)
   =0.05
14 P.AE1=0.03 #P(A|E1)
15 P.AE3=0.03 #P(A|E3)
16 P.AE2=0.05 #P(A|E2)
17
18 #Part (i)
19 PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
```

```

20 PA
21 sprintf("The required probability is: %f ",PA)
22
23
24 #Part (ii)
25 #Using bayes rule
26 P.E1A=(PE1*P.AE1)/PA #P(E1|A)
27 P.E2A=(PE2*P.AE2)/PA #P(E2|A)
28 P.E3A=(PE3*P.AE3)/PA #P(E3|A)
29 sprintf("The required probabilities are: %f ,%f ,%f"
        ,P.E1A,P.E2A,P.E3A)

```

---

#### R code Exa 4.2 Probability

```

1 #Page number--4.7
2 #Example number--4.2
3
4 #A----->Introduction to co-education
5 #E1,E2,E3----->Chatterji ,Ayangar ,Singh selected as
   principal
6
7 PE1=4/9
8 PE2=2/9
9 PE3=3/9
10 P.AE1=0.3 #P(A|E1)
11 P.AE2=0.5 #P(A|E2)
12 P.AE3=0.8 #P(A|E3)
13
14 #Part (i)
15 PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
16 sprintf("The required probability is: %f ",PA)
17
18 #Part (ii)
19 #Using bayes rule
20 P.E3A=(PE3*P.AE3)/PA #P(E3|A)

```

```
21 sprintf("The required probability is: %f ",P.E3A)
```

---

**R code Exa 4.3** Probability of X Y Z Becoming Managers

```
1 #Page number--4.7
2 #Example number--4.3
3
4 #X,Y,Z-->managers
5 #E1,E2,E3-->Are the events of becoming X,Y,Z
  managers
6
7 PE1=4/9
8 PE2=2/9
9 PE3=1/3
10 P.AE1=0.3 #P(A|E1)
11 P.AE2=0.5 #P(A|E2)
12 P.AE3=0.8 #P(A|E3)
13
14 #Part (i)
15 PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
16 PA
17 sprintf("The probability that Bonus scheme is
  introduced: %f ",PA)
18
19 #Part (ii)
20 #Using bayes rule
21 P.E1A=(PE1*P.AE1)/PA #P(E1|A)
22 sprintf("The probability that X will be manager: %f
  ",P.E1A)
```

---

**R code Exa 4.4** Probability By Machines I And II And III

```
1 #Page number--4.8
```

```

2 #Example number--4.4
3
4 #A----->Output is defective
5 #E1,E2,E3----->Output produced by machines I,II,III
6
7 PE1=3000/10000
8 PE2=2500/10000
9 PE3=4500/10000
10 P.AE1=0.01                                #P(A|E1)
11 P.AE2=0.012                                #P(A|E2)
12 P.AE3=0.02                                #P(A|E3)
13
14 PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
15 PA
16 sprintf("The probability that output is defective:
    %f ",PA)
17
18
19 #Using bayes rule
20 P.E1A=(PE1*P.AE1)/PA                      #P(E1|A)
21 P.E2A=(PE2*P.AE2)/PA                      #P(E2|A)
22 P.E3A=(PE3*P.AE3)/PA                      #P(E3|A)
23 sprintf("The probabilities of machine I,II,III are:
    %f ,%f ,%f",P.E1A,P.E2A,P.E3A)

```

---

#### **R code Exa 4.9** Vessel Containing Balls

```

1 #Page number--4.11
2 #Example number--4.9
3
4 #E----->Drawing a white ball from second
    vessel
5 #E1,E2,E3,E4----->Transfer of (0,4),(1,3),(2,2)
    ,(3,1) white and black balls
6

```

```

7 PE1=choose(5,4)/choose(8,4)
8 PE2=choose(3,1)*choose(5,3)/choose(8,4)
9 PE3=choose(3,2)*choose(5,2)/choose(8,4)
10 PE4=choose(3,3)*choose(5,1)/choose(8,4)
11 P.EE1=0 #P(E|E1)
12 P.EE2=1/4 #P(E|E2)
13 P.EE3=2/4 #P(E|E3)
14 P.EE4=3/4 #P(E|E4)
15
16 PE=PE1*P.EE1+PE2*P.EE2+PE3*P.EE3+PE4*P.EE4
17
18 #Using bayes rule
19 P.E4E=(PE4*P.EE4)/PE #P(E4|E)
20 sprintf("The required probability is: %f ",P.E4E)

```

---

#### R code Exa 4.10 Probability That Answer Is Correct

```

1 #Page number--4.11
2 #Example number--4.10
3
4 #E----->They get same answer
5 #E1----->Both A and B solve correctly
6 #E2----->Exactly one of them solves correctly
7 #E3----->No one solves correctly
8
9
10 PE1=1/6*1/8
11 PE2=1/6*7/8+5/6*1/8
12 PE3=5/6*7/8
13
14 P.EE1=1 #P(E|E1)
15 P.EE2=0 #P(E|E2)
16 P.EE3=1/525 #P(E|E3)
17
18 PE=PE1*P.EE1+PE2*P.EE2+PE3*P.EE3

```

```

19
20 #Using bayes rule
21 P.E1E=(PE1*P.EE1)/PE #P(E1|E)
22 sprintf("The required probability is: %f ",P.E1E)

```

---

#### R code Exa 4.16 Probability That A Wrote Plus

```

1 #Page number--4.15
2 #Example number--4.16
3
4 #E----->The referee observes plus sign
5 #E1,E2----->Wrote plus or minus sign
6 #E3,E4----->Plus signed not changed, Plus sign
   was changed exactly twice
7
8 PE1=1/3
9 PE2=1-PE1
10
11 #A1,A2,A3----->B,C,D change sign on slip
12 PA1=2/3;PA2=2/3;PA3=2/3
13 PA1b=1/3;PA2b=1/3;PA3b=1/3 #P(Ai) bar
14
15 PE3=(1/3)^3
16 PE4=PA1*PA2*PA3b+PA1*PA2b*PA3+PA1b*PA2*PA3
17
18 P.EE1=PE3+PE4 #P(E|E1)
19 sprintf("The required probability is: %f ",P.EE1)
20
21 #E5,E6----->Minus sign change once, Minus sign
   change thrice
22 PE5=PA1*PA2b*PA3b+PA1b*PA2*PA3b+PA1b*PA2b*PA3
23 PE6=PA1*PA2*PA3
24 P.EE2=PE5+PE6 #P(E|E2)
25 sprintf("The required probability is: %f ",P.EE2)
26

```

```

27 P.E1E=(PE1*P.EE1)/(PE1*P.EE1+PE2*P.EE2)
    #P(E1|E)
28 sprintf("The FINAL probability is: %f ",P.E1E)

```

---

### R code Exa 4.18 Probability Of Drawing White Ball

```

1 #Page number--4.17
2 #Example number--4.18
3
4 #E----->Event of drawing a white ball from
    the second urn in the fiest draw
5 #E0,E1,E2,E3,E4----->Drawing of (0,4),(1,3),(2,2)
    ,(3,1),(4,0) white and black balls
6
7 PE0=choose(5,4)/choose(10,4)
8 PE1=choose(5,1)*choose(5,3)/choose(10,4)
9 PE2=choose(5,2)*choose(5,2)/choose(10,4)
10 PE3=choose(5,3)*choose(5,1)/choose(10,4)
11 PE4=choose(5,4)/choose(10,4)
12 P.EE0=0                                #P(E|E0)
13 P.EE1=1/4                                #P(E|E1)
14 P.EE2=2/4                                #P(E|E2)
15 P.EE3=3/4                                #P(E|E3)
16 P.EE4=4/4                                #P(E|E4)
17
18 #C----->Future event
19
20 P.CE0E=0                                #P(C|intersection(E0
    ,E))
21 P.CE1E=0                                #P(C|intersection(E1
    ,E))
22 P.CE2E=1/3                                #P(C|intersection(E2
    ,E))
23 P.CE3E=2/3                                #P(C|intersection(E3
    ,E))

```

```

24 P.CE4E=3/3                                     #P(C| intersection (E4
    ,E))
25
26 P.CE=(PE0*P.EE0*P.CE0E+PE1*P.EE1*P.CE1E+PE2*P.EE2*P.
    CE2E+PE3*P.EE3*P.CE3E+PE4*P.EE4*P.CE4E)/(PE0*P.
    EE0+PE1*P.EE1+PE2*P.EE2+PE3*P.EE3+PE4*P.EE4)
27 sprintf("The required probability is: %f ",P.CE)

```

---

#### R code Exa 4.20 Die A And B

```

1 #Page number--4.19
2 #Example number--4.20
3
4 #A----->Getting a red face in each of 1st n
    throws
5 #E1,E2,E3----->Event that Die A is used, Die B is
    used, Getting a red face
6
7 #Part (i)
8 P.E3E1=4/6                                     #P(E3|E1)
9 P.E3E2=2/6                                     #P(E3|E2)
10
11 PE1=1/2; PE2=1/2
12
13 PE3=PE1*P.E3E1+PE2*P.E3E2
14 sprintf("The probability of getting a red face in
    any throw: %f ",PE3)
15
16 #Part (ii)
17 #Using the Law Of Succession
18 sprintf("The probability of getting a red face at
    the 3rd throw when 1st two gave red faces: %f ",
    (1/2+1)/(1/2+2))

```

---



# Chapter 5

## Random Variables And Distribution Functions

R code Exa 5.1 Random Variable X

```
1 #Page number--5.6
2 #Example number--5.1
3
4 # Constructing Quadratic Formula
5 result <- function(a,b,c){
6   if(delta(a,b,c) > 0){ # first case D>0
7     x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
8     x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
9     result = c(x_1,x_2)
10  }
11  else if(delta(a,b,c) == 0){ # second case D=0
12    x = -b/(2*a)
13  }
14  else {"There are no real roots."} # third case D<0
15 }
16
17 # Constructing delta
18 delta<-function(a,b,c){
19   b^2-4*a*c
```

```

20 }
21
22 #Values of X
23 x=c(0,1,2,3,4,5,6,7)
24 #Respective probabilities
25 px=c("0","k","2k","2k","3k","k^2","2k^2","7k^2+k")
26
27 data.frame(x,px)
28
29 #Part(i)
30 #We know that total probability =1
31 #k+2k+2k+3k+k^2+2k^2+7k^2+k=1----->We get
    10*k^2+9*k-1=0
32 a=result(10,9,-1)
33 a
34 #Since, k cannot be negative
35 k=a[1]
36 k
37 #Substituting values of k in p(x), we get
38 px=c(0,k,2*k,2*k,3*k,k^2,2*k^2,7*k^2+k)
39
40 b=data.frame(x,px)
41 b
42
43 #Part (ii)
44 #Evaluate P(X<6)
45 PX6=sum(b[1:6,2])
46 sprintf("The probability X<6 is: %f",PX6)
47 sprintf("The probability X>=6 is: %f",1-PX6)
48 POX5=sum(b[2:5,2])
49 sprintf("The probability 0<X<5 is: %f",POX5)
50
51 #Part (iii)
52 #BY trail we get a=4
53
54 #Part (iv)
55 #Cumulative probability function
56 FX=c(sum(b[1,2]),sum(b[1:2,2]),sum(b[1:3,2]),sum(b

```

```

    [1:4,2]),sum(b[1:5,2]),sum(b[1:6,2]),sum(b
    [1:7,2]),sum(b[1:8,2]))
57 data.frame(x,FX)

```

---

### R code Exa 5.2 Probability

```

1 #Page number--5.7
2 #Example number--5.2
3
4 x=c(1,2,3,4,5)
5 px=c()
6 i=1
7 while(i<=5){
8     px[i]=i/15
9     i=i+1
10 }
11 a=data.frame(x,px)
12 a
13
14 #Part (i)
15 PX12=sum(a[1:2,2])
16 sprintf("The probability X=1 or X=2 is: %f",PX12)
17
18 #Part (ii)
19 P=a[2,2]/(1-a[1,2])
20 sprintf("The required probability is: %f",P)

```

---

### R code Exa 5.3 Distribution Function Of X

```

1 #Page number--5.7
2 #Example number--5.3
3 #LOAD PACKAGE-->prob
4

```

```

5 s=rolldie(2)
6 s
7 X=c(1,2,3,4,5,6,7,8,9,10,11,12)
8 a=0
9 for(i in 1:12){
10     a[i]=nrow(subset(s,X1+X2==i))/nrow(s)
11 }
12 #Probability chart
13 plot(X,a,type="h",xlim=c(0,12),ylim=c(0,0.17),ylab="
    Prob.",xlab="Sum of two faces")
14
15 #Cumulative probability distribution
16 FX=c(sum(a[1]),sum(a[1:2]),sum(a[1:3]),sum(a[1:4]),
    sum(a[1:5]),sum(a[1:6]),sum(a[1:7]),sum(a[1:8]),
    sum(a[1:9]),sum(a[1:10]),sum(a[1:11]),sum(a
    [1:12]))
17 data.frame(X,FX)

```

---

#### R code Exa 5.4 Probability Function

```

1 #Page number--5.8
2 #Example number--5.4
3 #LOAD PACKAGE-->prob
4
5 s=tosscoin(3)
6 s
7 #For number of heads
8 X=c(3,2,2,1,2,1,1,0)
9 #For number of head runs
10 Y=c(1,1,0,0,1,0,0,0)
11 #For length of head runs
12 Z=c(3,2,0,0,2,0,0,0)
13 U=X+Y
14 V=X*Y
15 data.frame(X,Y,Z,U,V)

```

```

16
17 #Part (i)
18 #Probability distribution of X
19 P3=1/8;P2=3/8;P1=3/8;P0=1/8
20 x=seq(0,3,1)
21 px=c(P3,P2,P1,P0)
22 plot(x,px,type="h",xlim=c(0,3),ylim=c(0,0.4),ylab="
    Prob.",xlab="Number of heads")
23 points(0:3,px,pch=16,cex=2)
24
25 #Part (ii)
26 #Probability distribution of Y
27 P1=3/8;P0=5/8
28 y=seq(0,1,1)
29 py=c(P1,P0)
30 plot(y,py,type="h",xlim=c(0,1),ylim=c(0,0.7),ylab="
    Prob.",xlab="Number of heads runs")
31 points(0:1,py,pch=16,cex=2)
32
33 #Part (iii)
34 #Probability distribution of Z
35 P3=1/8;P2=2/8;P1=0;P0=5/8
36 z=seq(0,3,1)
37 pz=c(P0,P1,P2,P3)
38 plot(z,pz,type="h",xlim=c(0,3),ylim=c(0,0.7),ylab="
    Prob.")
39 points(0:3,pz,pch=16,cex=2)
40
41 #Part (iv)
42 #Probability distribution of U
43 P4=1/8;P3=2/8;P2=1/8;P1=3/8;P0=1/8
44 u=seq(0,4,1)
45 pu=c(P2,P1,P0,P3,P4)
46 plot(u,pu,type="h",xlim=c(0,4),ylim=c(0,0.4),ylab="
    Prob.")
47 points(0:4,pu,pch=16,cex=2)
48
49 #Part (v)

```

```

50 #Probability distribution of V
51 P3=1/8;P2=2/8;P1=0;P0=5/8
52 v=seq(0,3,1)
53 pv=c(P0,P1,P2,P3)
54 plot(v,pv,type="h",xlim=c(0,3),ylim=c(0,0.7),ylab="
    Prob.")
55 points(0:3,pv,pch=16,cex=2)

```

---

### R code Exa 5.5 Probability Density Function

```

1 #Page number--5.13
2 #Example number--5.5
3
4 # Constructing Quadratic Formula
5 result <- function(a,b,c){
6     if(delta(a,b,c) > 0){ # first case D>0
7         x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
8         x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
9         result = c(x_1,x_2)
10    }
11    else if(delta(a,b,c) == 0){ # second case D=0
12        x = -b/(2*a)
13    }
14    else {"There are no real roots."} # third case D<0
15 }
16
17 # Constructing delta
18 delta<-function(a,b,c){
19     b^2-4*a*c
20 }
21
22 #Part (i)
23 #Checking f(x) is p.d.f or not
24 integrand=function(x) {6*x*(1-x)}
25 a=integrate(integrand,lower=0,upper=1)

```

```

26 a
27 sprintf("f(x) is p.d.f")
28
29 #Part (ii)
30 #Determining b
31 #integrand=function(x) {6*x*(1-x)}
32 #integrate(integrand,lower=0,upper=b) = integrate(
    integrand,lower=b,upper=1)
33 #Solving above integral we get quadratic equation
    ----->(2*b-1)(2*b^2-2*b-1)=0
34 b=result(2,-2,-1)
35 b
36 #Other solution of b
37 b=1/2
38 #Since, probability cannot be negative or greater
    than 1
39 sprintf("The onle real value of b: %f", b)

```

---

### R code Exa 5.12 Relative Frequency Density

```

1 #Page number--5.17
2 #Example number--5.12
3 #LOADED PACKAGE-->cubature
4 # Constructing Quadratic Formula
5 result <- function(a,b,c){
6     if(delta(a,b,c) > 0){ # first case D>0
7         x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
8         x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
9         result = c(x_1,x_2)
10    }
11    else if(delta(a,b,c) == 0){ # second case D=0
12        x = -b/(2*a)
13    }
14    else {"There are no real roots."} # third case D<0
15 }

```

```

16
17 # Constructing delta
18 delta<-function(a,b,c){
19     b^2-4*a*c
20 }
21
22
23 #Total probability = 1
24 integrand=function(x){x*(2-x)}
25 a=integrate(integrand,lower=0,upper=2)
26 a
27 y0=1/1.333
28
29 u1d=(3*2^2)/(3*4) #Mean
30 u2d=(3*2^3)/(4*5)
31 u3d=(3*2^4)/(5*6)
32 u4d=(3*2^5)/(6*7)
33 #Variance
34 #u2=u2d-u1d^2
35 u2=6/5-1
36 #u3=u3d-3*u2d*u1d+2*u1d^3
37 u3=8/5-3*6/5*1+2
38 #u4=u4d-4*u3d*u1d+6*u2d*u1d^2-3*u1d^4
39 u4=16/7-4*8/5*1+6*6/5*1-3*1
40 beta1=u3^2/u2^3
41 beta1
42 beta2=u4/u2^2
43 beta2
44 #Since beta1 =0, symmetrical distribution
45 #Mean deviation about mean
46 integrand=function(x){3/4*(1-x)*x*(2-x)}
47 f1=integrate(integrand,lower=0,upper=1)
48 f1
49 integrand=function(x){3/4*(x-1)*x*(2-x)}
50 f2=integrate(integrand,lower=1,upper=2)
51 f2
52 #Mean deviation abt mean=f1+f2
53 M=0.1875+0.1875

```



```

54
55 #Harmonic Mean
56 integrand=function(x){3/4*(2-x)}
57 a=integrate(integrand,lower=0,upper=2)
58 a
59 H.M=3/2
60
61 #Median
62 #integrand=function(x){3/4*x*(2-x)}
63 #integrate(integrand,lower=0,upper=M)=1/2
64 #Solving above integral we get quadratic equation
    ----->(M-1)*(M^2-2*M-2)=0
65 b=result(1,-2,-2)
66 b
67 #Other solution of b
68 b=1
69 #Since, M lying in [0,2]
70 sprintf("The median is: %f", b)

```

---

### R code Exa 5.13 Standard Deviation And Mean Deviation

```

1 #Page number--5.18
2 #Example number--5.13
3
4 #Mean
5 integrand=function(x){x*(3+2*x)/18}
6 a1=integrate(integrand,lower=2,upper=4)
7 a1
8 u1d=83/27
9
10 integrand=function(x){x^2*(3+2*x)/18}
11 a2=integrate(integrand,lower=2,upper=4)
12 a1
13 u2d=88/9
14

```

```

15 #Variance
16 v=u2d-u1d^2
17
18 #Standard Deviation
19 s.d=sqrt(v)
20
21 #Mean Deviation
22 integrand=function(x){(83/27-x)*(3+2*x)/18}
23 f1=integrate(integrand,lower=2,upper=83/27)
24 f1
25 integrand=function(x){(x-83/27)*(3+2*x)/18}
26 f2=integrate(integrand,lower=83/27,upper=4)
27 f2
28 #Mean deviation=f1+f2
29 M.D=0.247264+0.247264

```

---

#### R code Exa 5.19 Probability Density Function

```

1 #Page number--5.21
2 #Example number--5.19
3
4 #Part (i)
5 integrand=function(x){100/x^2}
6 a=integrate(integrand,lower=100,upper=150)
7 a
8 #Probability that tubes be replaced in first 150 hrs
9
10
11 p=(1/3)^3
12
13 #Part (ii)
14 #Probability that none of tubes be replaced in first
15     150 hrs.
16
17 p=(1-1/3)^3
18
19 #Part (iii)

```

```

16 #Probability that tube last more than 150 but less
    than 200 hrs.
17 integrand=function(x){100/x^2}
18 a1=integrate(integrand,lower=150,upper=200)
19 a1
20 integrand=function(x){100/x^2}
21 a2=integrate(integrand,lower=150,upper=Inf)
22 a2
23 #a1=0.1666667   a2=0.6666667
24 p=0.1666667/0.6666667
25
26 #Part (iv)
27 #Maximum number of tubes
28 n=log(0.5)/log(0.6667)
29 n

```

---

#### R code Exa 5.22 Probability That Tyres Will Last

```

1 #Page number--5.24
2 #Example number--5.22
3
4 #Part (i)
5 #P(X<=10)
6 integrand=function(x){1/20*exp(-x/20)}
7 a=integrate(integrand,lower=0,upper=10)
8 a
9
10 #Part (ii)
11 #P(16<=X<=24)
12 integrand=function(x){1/20*exp(-x/20)}
13 a1=integrate(integrand,lower=16,upper=24)
14 a1
15
16 #Part (iii)
17 #P(X>=30)

```

```

18 integrand=function(x){1/20*exp(-x/20)}
19 a3=integrate(integrand,lower=30,upper=Inf)
20 a3

```

---

### R code Exa 5.24 Probability Density Function

```

1 #Page number--5.27
2 #Example number--5.24
3 #LOAD PACKAGE-->polygonom
4
5 #Part (i)
6 integrand=function(x){6*x*(1-x)}
7 a=integrate(integrand,lower=0,upper=1)
8 a
9 sprintf("The function p.d.f")
10
11 #Part (ii)
12 #The expression is
13 #0, if x<=0
14 #(3*x^2-2*x^3), if 0<x<1
15 #1, if x>1
16
17 #Part (iii)
18 integrand=function(x){6*x*(1-x)}
19 a1=integrate(integrand,lower=1/3,upper=1/2)
20 a1
21 integrand=function(x){6*x*(1-x)}
22 a2=integrate(integrand,lower=1/3,upper=2/3)
23 a2
24 #a1=0.2407407      a2=0.4814815
25 p=0.2407407/0.4814815
26 p                  #Answer may vary because of
                      rounding off values
27
28 #Part (iv)

```

```

29 #integrand=function(x){6*x*(1-x)}
30 #integrate(integrand,lower=0,upper=k)=integrate(
    integrand,lower=k,upper=1)
31 #Solving above integral we get cubic equation----->4
    k^3-6k^2+1=0
32 options(digits=16)
33 library(polynom)
34 p=polynomial(c(4,-6,0,1))
35 solve(p)
36 sprintf("The only admissible value of k=1/2")

```

---

# Chapter 6

## Mathematical Expectations

**R code Exa 6.1** Laws of Expectation

```
1 #Page number --6.11
2 #Example number --6.1
3
4 x=c(-3,6,9)
5 px=c(1/6,1/2,1/3)
6 a=data.frame(x,px)
7 a
8 #E(X)
9 EX=sum(a[,1]*a[,2])
10 EX
11 #E(X^2)
12 EX2=sum((a[,1])^2*a[,2])
13 EX2
14 #E(2X+1)^2=4*E(X^2)+4*E(X)+1
15 EX3=4*EX2+4*EX+1
16 EX3
```

---

**R code Exa 6.2** Expectations Results

```

1 #Page number--6.11
2 #Example number--6.2
3 #LOAD PACKAGE-->prob
4
5 s=rolldie(2,makespace=TRUE)
6 s
7
8 #Part (a)
9 #E(X)
10 EX=sum(1/6*seq(1,6,,))
11 EX
12
13 #Part (b)
14 #Probability distribution on basis on sum of two
    faces of die
15 x=c(seq(2,12,1))
16 px=c(1/36,2/36,3/36,4/36,5/36,6/36,5/36,4/36,3/36,2/
    36,1/36)
17 a=data.frame(x,px)
18 a
19 EX=sum(a[1:11,1]*a[1:11,2])
20 EX

```

---

### R code Exa 6.3 Expected Value Of X

```

1 #Page number--6.12
2 #Example number--6.3
3 #LOAD PACKAGE-->prob
4
5 s=tosscoin(4)
6 s
7
8 n.o.h=c(4,3,3,3,3,2,2,2,2,2,2,1,1,1,1,0)
9 data.frame(s,n.o.h)
10 PX0=1/6;PX1=4/16;PX2=6/16;PX3=4/16;PX4=1/16

```

```

11
12 #Probability Distribution
13 x=c(0,1,2,3,4)
14 px=c(PX0,PX1,PX2,PX3,PX4)
15 data.frame(x,px)
16 EX=sum(x*px)
17 EX

```

---

#### R code Exa 6.4 Urn Example

```

1 #Page number--6.13
2 #Example number--6.4
3
4 PX0=choose(3,2)/choose(10,2)
5 PX1=choose(7,1)*choose(3,1)/choose(10,2)
6 PX2=choose(7,2)/choose(10,2)
7
8 x=c(0,1,2)
9 px=c(PX0,PX1,PX2)
10 #Probability Distribution
11 a=data.frame(x,px)
12 a
13 EX=sum(x*px)
14 EX

```

---

#### R code Exa 6.5 Expectation Of Player

```

1 #Page number--6.13
2 #Example number--6.5
3
4 Event=c("Lucky number","Special lucky no.," "Other
      numbers")

```



```

5 Favourable=c("5,10,15","0",
  1,2,3,4,6,7,8,9,11,12,13,14,16,17,18,19")
6 px=c(3/20,1/20,16/20)
7 Player_Gain=c((20-10)*px[1],(50-10)*px[2],-10*px[3])
8 a=data.frame(Event,Favourable,px,Player_Gain)
9 a
10 EX=sum(a[,4])
11 EX
12 if(EX!=0){print("Game is not fair")}

```

---

#### R code Exa 6.29 Joint Distribution Of Y And X1

```

1 #Page number--6.36
2 #Example number--6.29
3 #LOAD PACKAGE-->prob
4
5 s=rolldie(2)
6 s
7
8 x=c(1,2,3,4,5,6)
9 y1=c(1/36,0,0,0,0,0)
10 y2=c(1/36,2/36,0,0,0,0)
11 y3=c(1/36,1/36,3/36,0,0,0)
12 y4=c(1/36,1/36,1/36,4/36,0,0)
13 y5=c(1/36,1/36,1/36,1/36,5/36,0)
14 y6=c(1/36,1/36,1/36,1/36,1/36,6/36)
15 Marginal_Totals_y=c(1/36,3/36,5/36,7/36,9/36,11/36)
16 Marginal_Totals_x=c(6/36,6/36,6/36,6/36,6/36,6/36)
17 a=data.frame(y1,y2,y3,y4,y5,y6,Marginal_Totals_x,
  Marginal_Totals_y)
18 a
19
20 EY=1*1/36+2*3/36+3*5/36+4*7/36+5*9/36+6*11/36
21 EY
22 EY2=1^2*1/36+2^2*3/36+3^2*5/36+4^2*7/36+5^2*9/36+6^2

```

```

      *11/36
23 EY2
24 VY=EY2-EY^2
25 VY
26 EX1=6/36*(1+2+3+4+5+6)
27 EX1
28 EX1Y=(1*1/36+2*1/36+3*1/36+4*1/36+5*1/36+6*1/36)+(4*
      2/36+6*1/36+8*1/36+10*1/36+12*1/36)+(9*3/36+12*1/
      36+15*1/36+18*1/36)+(16*4/36+20*1/36+24*1/36)+(25
      *5/36+30*1/36)+36*6/36
29 EX1Y
30 COV=EX1Y-EX1*EY
31 COV

```

---

### R code Exa 6.30 Joint Probability Distribution

```

1 #Page number--6.37
2 #Example number--6.30
3
4 #Part (i)
5 EY=-1*2+0*6+1*2
6 EY
7 EX=-1*2+0*4+1*4
8 EX
9
10 #Part (ii)
11 EXY=-1*-1*0+0*-1*1+1*-1*1+0*-1*2+0*0*2+0*1*2+1*-1*
      0+1*0*1+1*1*1
12 EXY
13 COV=EXY-EX*EY
14 COV
15
16 #Part (iii)
17 EY2=-1^2*0.2+0*0.6+1^2*0.2
18 EY2

```

```

19 VY=EY2-EY^2
20 VY
21 EX2=-1^2*0.2+0*0.4+1^2*0.4
22 EX2
23 VX=EX2-EX^2
24 VX
25
26 #Part (iv)
27 PXY=0.2/0.6 #P(X=-1|Y=0)
28 PXY=0.2/0.6 #P(X=0|Y=0)
29 PXY=0.2/0.6 #P(X=1|Y=0)
30
31 #Part (v)
32 EYX=-1*0+0*2+1*0
33 EYX2=1*0+0*2+0
34 VYX=EYX2-EYX^2
35 VYX

```

---

## Chapter 7

# Generating Functions And Law Of Large Numbers

**R code Exa 7.12** Probability Of Getting 80 to 120 Sixes

```
1 #Page number--7.31
2 #Example number--7.12
3
4 #S be total number of successes
5 n=600          #Number of times die thrown
6 p=1/6;q=5/6
7 ES=n*p
8 VS=n*p*q
9
10 #Using Chebychev's inequality
11 #P{|S-ES|<k*s.d}>=1-1/k^2      #s.d-->Standard
    deviation
12 #P{100-k*sqrt(500/6)<S<100+k*sqrt(500/6)}>=1-1/k^2
13 #comparing lower limit with 80
14 k=solve(sqrt(500/6),20)
15 k
16 #P{80<=S<=120}
17 P=1-1/k^2
18 sprintf("Probabilities of getting 80 to 120 sixes: %
```

f",P)

---

**R code Exa 7.13** Use Chebychev Inequality

```
1 #Page number--7.32
2 #Example number--7.13
3
4 #By proof of Bernoulli's law of large numbers
5 #P{|X/n-p|<e}<=1-1/(4*n*e^2)
6 p=0.5
7 #X/n lie between 0.4 and 0.6
8 e=0.1
9 #We want the probability to be atleast 0.9
10 n=solve(0.1,1/0.04)
11 sprintf("Required number of tosses: %f",n)
```

---

**R code Exa 7.14** How Large Is Sample

```
1 #Page number--7.32
2 #Example number--7.14
3
4 #Part (i)
5 n=solve(0.05,1/(4*0.02**2))
6 sprintf("The true proportions: %f",n)
7
8 #Part (ii)
9 n=solve(0.05,0.16/0.02^2)
10 n
```

---

**R code Exa 7.17** Discrete Variate With Density

```

1 #Page number--7.17
2 #Example number--7.33
3
4 x=c(-1,0,1)
5 px=c(1/8,6/8,1/8)
6 data.frame(x,px)
7 EX=sum(x*px)
8 EX                                     #Mean
9 EX2=sum(abs(x*px))
10 EX2
11 VarX=EX2-(EX)^2
12 VarX                                 #Variance
13 s.d=sqrt(VarX)                       #Standard Deviation
14 s.d
15 P=1-px[2]
16 P
17 px[2]

```

---

### R code Exa 7.18 Two Unbiased Dice

```

1 #Page number--7.34
2 #Example number--7.18
3 #Load Package---->prob
4
5 s=rolldie(2)
6 s
7
8 #From above table we find that
9 X=c(seq(2,12,1))
10 cases=c("(1,1)","(1,2),(2,1)","(1,3),(3,1),(2,2)","(1,4),(4,1),(2,3),(3,2)","(1,5),(5,1),(2,4),(4,2),(3,3)","(1,6),(6,1),(2,5),(5,2),(3,4),(4,3)","(2,6),(6,2),(3,5),(5,3),(4,4)","(3,6),(6,3),(4,5),(5,4)","(4,6),(6,4),(5,5)","(5,6),(6,5)","(6,6)"
)

```

```

11 prob=c(1/36,2/36,3/36,4/36,5/36,6/36,5/36,4/36,3/
      36,2/36,1/36)
12 a=data.frame(X,cases,prob)
13 a
14 EX=sum(X*prob)
15 EX
16 EX2=sum(X^2*prob)
17 EX2
18 VarX=EX2-EX^2
19 VarX
20 #By Chebychev's inequality
21 P=(35/6)/9
22 P
23 #Actual Probability
24 P1=1-(4+5+6+5+4)/36
25 P1

```

---

#### R code Exa 7.19 Chebychev Inequality

```

1 #Page number--7.34
2 #Example number--7.19
3
4 EX=(1+2+3+4+5+6)/6
5 EX
6 EX2=(1^2+2^2+3^2+4^2+5^2+6^2)/6
7 EX2
8 VarX=EX2-EX^2
9 VarX
10 #By Chebychev's inequality
11 k=2.5
12 #P{|X-u|>2.5}<T
13 T=VarX/k^2
14 T
15 #But since the number lies outside the limits
16 #It cannot lie outside the limits of 1 and 6

```

17 #Actual probability = 0

---



## Chapter 8

# Special Discrete Probability Distributions

**R code Exa 8.1** Probability Of Getting At Least 7 Heads

```
1 #Page number--8.5
2 #Example number--8.1
3
4 #Probability of getting head
5 p=1/2
6 #Probability of not getting head
7 q=1/2
8 #Probability of getting x heads
9 #P=choose(10,x)*(1/2)^10
10 #Probability of getting atleast 7 heads
11 P=(choose(10,7)+choose(10,8)+choose(10,9)+choose
    (10,10))*(1/2)^10
12 P
```

---

**R code Exa 8.2** A And B Play A Game

```

1 #Page number--8.5
2 #Example number--8.2
3 n=5
4 #Probability A wins the game
5 p=3/5
6 q=1-p
7 #Probability of getting A wins
8 #P=choose(5,x)*(3/5)^x*(2/5)^(5-x)
9 #Probability of getting 3 wins
10 P=(choose(5,3)*2**2+choose(5,4)*3*2+1*3^2*1)*3^3/5^5
11 P

```

---

#### R code Exa 8.3 Chances Of Having The Claim Accepted Or Rejected

```

1 #Page number--8.6
2 #Example number--8.3
3 n=6
4 #Probability of correct distinction between coffee
5 p=3/4
6 q=1-p
7 #Probability of getting x correct distinction
  between coffee
8 #P=choose(6,x)*(3/4)^x*(1/4)^(6-x)
9 #Probability of getting atleast 5 correct
  distinction between coffee
10 P=choose(6,5)*(3/4)**5*(1/4)+choose(6,6)*(3/4)^6
11 P
12 #Probability that the claim is rejected
13 Q=1-P
14 Q

```

---

#### R code Exa 8.4 Probability That Student Secures Distinction

```

1 #Page number--8.6
2 #Example number--8.4
3 n=8
4 #Probability of getting answer correct
5 p=1/3
6 q=1-p
7 #Probability of getting x answer correct
8 #P=choose(8,x)*(1/3)^x*(2/3)^(8-x)
9 #Probability of getting 6 answer correct
10 P=choose(8,6)*(1/3)^6*(2/3)^2+choose(8,7)*(1/3)^7*(2
    /3)+choose(8,8)*(1/3)^8
11 P

```

---

#### R code Exa 8.6 Probability

```

1 #Page number--8.7
2 #Example number--8.6
3 n=10
4 #Probability that old machine need adjustment
5 p1=1/11
6 q1=1-p
7 #Probability that new machine need adjustment
8 p2=1/21
9 q2=1-p
10 #Probability that x old machine need adjustment
11 #P=choose(3,x)*(1/11)^x*(10/11)^(3-x)
12 #Probability that x new machine need adjustment
13 #P=choose(7,x)*(1/21)^x*(20/21)^(7-x)
14
15 #Part (i)
16 #Probability that 2 old machine and no new machine
    need adjustment
17 P=choose(3,2)*(1/11)^2*(10/11)*(20/21)^7
18 P
19

```

```

20 #Part (ii)
21 #Probability that no old machine and 2 new machine
    need adjustment
22 Q=(10/11)^3*choose(7,2)*(1/21)^2*(20/21)^5
23 Q

```

---

### R code Exa 8.7 Probability Man Hitting A Target

```

1 #Page number--8.8
2 #Example number--8.7
3
4 #Probability of hitting target
5 p=1/4
6 q=1-p
7 #Probability that x hits in 7 shots
8 #P=choose(7,x)*(1/4)^x*(3/4)^(7-x)
9
10 #Part (i)
11 #Probability of hitting atleast 2 hits
12 P=1-(choose(7,0)*(1/4)^0*(3/4)^(7-0)+choose(7,1)*(1/4)
    ^1*(3/4)^(7-1))
13 P
14
15 #Part (ii)
16 #Probability of atleast 1 hit in n shots
17 p=solve(log(3/4),log(1/3))
18 p
19 round(p)
20 sprintf("The required number of shots: %d",round(p))

```

---

### R code Exa 8.9 Find Parameter P

```

1 #Page number--8.9

```

```

2 #Example number--8.9
3
4 n=5
5 p1=0.4096
6 p2=0.2048
7 #Probability distribution
8 #P=choose(5,x)*(p)^x*(1-p)^(5-x)
9 #p1=choose(5,1)*(p)^1*(1-p)^(5-1)
10 #p2=choose(5,2)*(p)^x*(1-p)^(5-2)
11 #The ratio of p1 and p2
12 sprintf("The parameter p is: %f",solve(5,1))

```

---

#### R code Exa 8.10 P For Binomial Variate X

```

1 #Page number--8.9
2 #Example number--8.10
3
4 # Constructing Quadratic Formula
5 result <- function(a,b,c){
6   if(delta(a,b,c) > 0){ # first case D>0
7     x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
8     x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
9     result = c(x_1,x_2)
10  }
11  else if(delta(a,b,c) == 0){ # second case D=0
12    x = -b/(2*a)
13  }
14  else {"There are no real roots."} # third case D<0
15 }
16
17 # Constructing delta
18 delta<-function(a,b,c){
19   b^2-4*a*c
20 }
21

```

```

22 #Probability Distribution
23 #P=choose(6,x)*(p)^x*(1-p)^6-x
24 #9*P(X=4)=P(X=2)
25 #Solving above equation
26 #We get quadratic equation ---->8*p^2+2*p-1=0
27 a=result(8,2,-1)
28 a
29 #Probability cannot be negative
30 sprintf("p : %f",a[1])

```

---

#### R code Exa 8.12 Probability

```

1 #Page number --8.11
2 #Example number --8.12
3
4 # Mean
5 M=4
6
7 #Variance
8 Var=4/3
9
10 q=Var/M
11 p=1-q
12 n=M/p
13
14 # P(X>=1) = 1 - P(X=0)
15 P=1-q^6
16 P

```

---

#### R code Exa 8.21 Fit Binomial Distribution

```

1 #Page number --8.19
2 #Example number --8.21

```

```

3
4 n=5
5 N=4096
6 #Probability of success throw 4,5,6
7 p=1/2
8 q=1-p
9 #Probability distribution
10 #P=choose(12,x)*(1/2)^x*(1/2)^(12-x)
11 #f(x)=choose(12,x)
12 success=c(0,1,2,3,4,5,6,7,8,9,10,11,12)
13 Expected_Frequency=c()
14 for(i in success){
15     Expected_Frequency[i+1]=choose(12,i)
16 }
17 data.frame(success,Expected_Frequency)
18 Total=sum(Expected_Frequency)
19 Total

```

---

### R code Exa 8.22 Fit A Binomial Distribution

```

1 #Page number --8.20
2 #Example number --8.22
3
4 n=7
5 N=128
6 #CASE 1: When the coin is unbiased
7 p=1/2
8 q=p
9 x=c(seq(0,7,1))
10 f=c(7,6,19,35,30,23,7,1)
11 fx=f*x
12 #a=(n-x)/(x+1)
13 a=c()
14 for(i in x){
15     a[i+1]=(n-i)/(i+1)

```

```

16 }
17 #b=(n-x)/(x+1)*p/q
18 b=c()
19 for(i in x){
20     b[i+1]=(n-i)/(i+1)*p/q
21 }
22 Expected_Frequency=c(1,1*7,7*3,21*5/3,35*1,35*3/5,21
    *1/3,7*1/7)
23 data.frame(x,f,fx,a,b,Expected_Frequency)
24
25 #CASE 2: When nature of coin is not known
26 mean=433/128
27 p=mean/n
28 q=1-p
29 p/q
30 x=c(seq(0,7,1))
31 #a=(n-x)/(x+1)
32 a=c()
33 for(i in x){
34     a[i+1]=(n-i)/(i+1)
35 }
36 #b=(n-x)/(x+1)*p/q
37 b=c()
38 for(i in x){
39     b[i+1]=(n-i)/(i+1)*p/q
40 }
41 Expected_Frequency=c(1.2593,1.259*6.546,2.805*
    8.243,1.558*23.129,0.935*36.05,.5611*33.715,.3117
    *18.918,.1336*5.897)
42 data.frame(x,f,fx,a,b,Expected_Frequency,round(
    Expected_Frequency))
43
44 #Part (iii)
45 f=c(128*.0625*.1663,8.591,128*.283,128*.184,128*
    .260,128*.146,128*.043,128*.0056)
46 data.frame(x,f,round(f))
47 Total=sum(round(f))
48 Total                                     #Note that total is

```



**R code Exa 8.33** Proportion Of Days

```
1 #Page number--8.35
2 #Example number--8.33
3
4 #For poisson distribution
5 #Part (i)
6 a=dpois(0,1.5)
7 sprintf("Proportion of days on which neither car is
   used: %f",a)
8
9 #Part (ii)
10 b=ppois(2,1.5,lower=FALSE)
11 sprintf("Proportion on which some demand is refused:
   %f",b)
```

---

**R code Exa 8.34** Probability That More Than 3 Collect Policy In A Year

```
1 #Page number--8.35
2 #Example number--8.34
3
4 n=4000
5 #Probability of loss of both eyes
6 p=10/100000
7 #For poisson distribution
8 lambda=n*p
9 a=ppois(3,lambda,lower=FALSE)
10 sprintf("Probability that more than 3 will collect
   the policy: %f",a)
```

---

**R code Exa 8.37** Random Sample Of 5 Page With No Error

```
1 #Page number--8.37
2 #Example number--8.37
3
4 lambda=390/520
5 lambda
6 #For poisson distribution
7 a=dpois(0,lambda)
8 sprintf("Sample of 5 pages with no error: %f",a^5)
```

---

**R code Exa 8.41** Probability That X Have More Than On Value

```
1 #Page number--8.38
2 #Example number--8.41
3
4 lambda=2
5 #For poisson distribution
6 a=dpois(1,lambda)
7 b=dpois(2,lambda)
8 sprintf("Required probability: %f",a+b)
```

---

**R code Exa 8.55** Fit A Poisson Distribution

```
1 #Page number--8.46
2 #Example number--8.55
3
4 n_m_p=c(0,1,2,3,4)           #Number of mistakes per
    page
```

```

5 n_o_p=c(109,65,22,3,1)          #Number of pages
6 data.frame(n_m_p,n_o_p)
7
8 #Poisson distribution parameter
9 lambda=sum(n_m_p*n_o_p)/200
10 lambda
11 Expected_Frequency=c()
12 a=c()
13 for(i in n_m_p){
14     a[i+1]=dpois(i,lambda)
15 }
16 for(i in n_m_p){
17     Expected_Frequency[i+1]=200*a[i+1]
18 }
19 data.frame(n_m_p,Expected_Frequency,round(Expected_
    Frequency))

```

---

#### R code Exa 8.56 Errors In 1000 Pages

```

1 #Page number--8.46
2 #Example number--8.56
3
4 lambda=2/5
5 n_o_e=c(0,1,2,3,4)          #Number of errors
6 prob=c()
7 for(i in n_o_e){
8     prob[i+1]=dpois(i,lambda)
9 }
10 Expected_Frequency=c()
11 for(i in n_o_e){
12     Expected_Frequency[i+1]=1000*prob[i+1]
13 }
14 data.frame(n_o_e,prob,Expected_Frequency,round(
    Expected_Frequency))

```

---

### R code Exa 8.57 Fit A Poisson Distribution

```
1 #Page number--8.47
2 #Example number--8.57
3
4 n_o_d=c(0,1,2,3,4,5,6,7,8)           #Number of
   doddens
5 o_f=c(56,156,132,92,37,22,4,0,1)     #Observed
   frequency
6 data.frame(n_o_d,o_f)
7 Mean=sum(n_o_d*o_f)/500
8 lambda=Mean
9 a=c()
10 for(i in n_o_d){
11     a[i+1]=lambda/(i+1)
12 }
13 prob=c()
14 for(i in n_o_d){
15     prob[i+1]=dpois(i,lambda)
16 }
17 Expected_Frequency=c()
18 for(i in n_o_d){
19     Expected_Frequency[i+1]=500*prob[i+1]
20 }
21 data.frame(n_o_d,a,prob,Expected_Frequency,round(
   Expected_Frequency))
```

---

### R code Exa 8.63 Fit A Negative Binomial Distribution

```
1 #Page number--8.54
2 #Example number--8.63
3
```

```

4  n_o_c=c(0,1,2,3,4,5)           #Number of cells
5  f=c(213,128,37,18,3,1)        #frequency
6  Mean=sum(n_o_c*f)/400
7  u2=sum(f*n_o_c^2)/400
8  u2
9  Var=u2-Mean^2
10 p=0.6825/0.8117
11 q=1-p
12 r=round(p*0.6825/q)
13 a=c(p^4,0.5738*0.5,2.5*0.1592*0.2869,2*0.1592*
      0.1142,7/4*0.1592*0.0364,8/5*0.1592*0.0101)
14 Expected_Frequency=c()
15 for(i in n_o_c){
16     Expected_Frequency[i+1]=400*a[i+1]
17 }
18 round(Expected_Frequency)

```

---

## Chapter 9

# Special Continuous Probability Distributions

R code Exa 9.1 Equation Of Normal Curve

```
1 #Page number--9.14
2 #Example number--9.1
3 #Load Package-->cubature
4
5 library(cubature)
6 N=1000
7 u=79.945
8 s.d=5.545
9 class=c("Below 60","60-65","65-70","70-75","75-80","
      80-85","85-90","90-95","95-100","100 and over")
10 l_c_b=c(-Inf,60,65,70,75,80,85,90,95,100)
11 z=c()
12 for(i in c(seq(1,10,1))){
13     z[i]=(l_c_b[i]-u)/s.d
14 }
15 z
16 #Equation of normal curve
17 #f(x)=1000/sqrt(2*pi)*exp(-1/2*((x-u)/s.d)^2)
18 oZ=c()
```

```

19 for(i in c(seq(1,10,1))){
20     # define the integrated function
21     f <- function(x){exp(-x^2/2)}
22     a=adaptIntegrate(f, lowerLimit =-Inf, upperLimit
        =z[i])
23     oZ[i]=1/sqrt(2*pi)*a$integral
24 }
25 oZ
26 deltaZ=c
        (0.000112,0.002914,0.031044,0.147870,0.322050,0.319300,0.144072,0
        NA)
27 Expected_Frequency=c()
28 for(i in c(seq(1,10,1))){
29     Expected_Frequency[i]=N*deltaZ[i]
30 }
31
32 data.frame(class,l_c_b,z,oZ,deltaZ,Expected_
        Frequency,round(Expected_Frequency))
33 Total=sum(round(Expected_Frequency[1:9]))
34 Total

```

---

### R code Exa 9.3 Probability

```

1 #Page number--9.15
2 #Example number--9.3
3
4 Mean=12
5 s.d=4                      #Standard Deviation
6
7 #Part (i)
8 pnorm(Inf,12,4)-pnorm(20,12,4)
9 x=seq(0,30,length=200)
10 y=dnorm(x,12,4)
11 plot(x,y,type="l")
12 x=seq(20,25,length=100)

```

```

13 y=dnorm(x,12,4)
14 polygon(c(20,x,25),c(0,y,0),col="red")
15
16 #Part (ii)
17 p=1-(pnorm(Inf,12,4)-pnorm(20,12,4))
18 p
19
20 #Part (iii)
21 pnorm(12,12,4)-pnorm(0,12,4)
22 x=seq(0,30,length=200)
23 y=dnorm(x,12,4)
24 plot(x,y,type="l")
25 x=seq(0,12,length=100)
26 y=dnorm(x,12,4)
27 polygon(c(0,x,12),c(0,y,0),col="red")
28
29 #Part (a)
30 #Taking value of z1 from Normal Tables
31 z1=0.71
32 a=12+4*z1
33 a
34 #Part (b)
35 #Taking value of z1 from Normal Tables
36 z1=0.67
37 x1=12+4*z1
38 x1
39 x0=12-4*z1
40 x0

```

---

#### R code Exa 9.4 X Is A Normal Variate

```

1 #Page number--9.16
2 #Example number--9.4
3
4 Mean=30

```



```

5  s.d=5                                #Standard Deviation
6
7  #Part (i)
8  pnorm(40,30,5)-pnorm(26,30,5)
9  x=seq(0,60,length=200)
10 y=dnorm(x,30,5)
11 plot(x,y,type="l")
12 x=seq(26,40,length=100)
13 y=dnorm(x,30,5)
14 polygon(c(26,x,40),c(0,y,0),col="red")
15
16 #Part (ii)
17 pnorm(Inf,30,5)-pnorm(45,30,5)
18 x=seq(0,50,length=200)
19 y=dnorm(x,30,5)
20 plot(x,y,type="l")
21 x=seq(45,50,length=100)
22 y=dnorm(x,30,5)
23 polygon(c(45,x,50),c(0,y,0),col="red")
24
25 #Part (iii)
26 #P(|X-30|>5)=1-P(|X-30|<=5)
27 P=1-2*0.3413
28 P

```

---

#### R code Exa 9.5 Batch Of 1000 Plots

```

1  #Page number--9.17
2  #Example number--9.5
3
4  Mean=662
5  s.d=32                                #Standard Deviation
6
7  #Part (i)
8  P1=pnorm(Inf,662,4)-pnorm(700,662,32)

```

```

9  sprintf("Probability that plots has a yield over 700
      kilos : %f",P1)
10 #Batch off 1000 plots
11 sprintf("Expected number of plots with yield over
      700 kilos: %f",as.integer(1000*P1))
12
13 #Part (ii)
14 P2=pnorm(650,662,32)
15 sprintf("Probability that plots has a yield less
      than 650 kilos : %f",P2)
16 #Batch off 1000 plots
17 sprintf("Expected number of plots with yield less
      than 650 kilos: %f",as.integer(1000*P2))
18 #Answer vary due to rounding of values
19
20 #Part (iii)
21 #P(X>x1)=100/1000
22 p=100/1000
23 z1=1.28                      #From Normal Table
24 x1=662+32*z1
25 sprintf("Best 100 plots have yield: %f kilos",x1)

```

---

#### R code Exa 9.7 Number Of Lamps

```

1 #Page number--9.18
2 #Example number--9.7
3
4 Mean=1000
5 s.d=200                      #Standard Deviation
6
7 #Part (i)
8 P1=pnorm(800,1000,200)
9 sprintf("Probability that bulb fail in less than 800
      hrs.: %f",P1)
10 #Total number of bulbs=10000

```

```

11 sprintf("Expected number of bulb fail in less than
    800 hrs.: %f",round(10000*P1))
12
13 #Part(ii)
14 P2=pnorm(1200,1000,200)-pnorm(800,1000,200)
15 sprintf("Expected number of bulb fail in 800-1200hrs
    .: %f",as.integer(10000*P2))
16 x=seq(0,2000,length=200)
17 y=dnorm(x,1000,200)
18 plot(x,y,type="l")
19 x=seq(800,1200,length=100)
20 y=dnorm(x,1000,200)
21 polygon(c(800,x,1200),c(0,y,0),col="red")
22 #Part (a)
23 #Taking value of z1 from Normal Tables
24 z1=1.28
25 x1=1000-200*z1
26 x1
27 #Part (b)
28 #Taking value of z1 from Normal Tables
29 z2=1.28
30 x2=1000+200*z1
31 x2

```

---

### R code Exa 9.8 Probability Of Marks

```

1 #Page number--9.20
2 #Example number--9.8
3
4 Mean=65
5 s.d=5                #Standard Deviation
6
7 P1=pnorm(Inf,65,5)-pnorm(70,65,5)
8 sprintf("Probability that marks are over 70: %f",P1)
9 #3 students selected at random, exactly 2 will get

```

```

    more than 70
10 choose(3,2)*P1^2*(1-P1)

```

---

#### R code Exa 9.9 Probability

```

1 #Page number --9.20
2 #Example number --9.9
3
4 #Part (a)
5 Y1=log(1.202)
6 Y2=log(7.92)
7 #For Y1=0.08
8 z1=(0.08-4)/2
9 #For Y2=7.92
10 z2=(7.92-4)/2
11 #P(0.08<Y<7.92)
12 p=2*0.4750
13 sprintf("Required Probability: %f",p)
14
15 #Part (b)
16 y1=log(1.202)
17 y2=log(83180000)
18 #U=log(X)-log(Y)
19 #P(0.08<U<7.92)
20 p=2*0.4750
21 sprintf("Required Probability: %f",p)

```

---

#### R code Exa 9.12 Mean And Standard Deviation Of The Distribution

```

1 #Page number --9.22
2 #Example number --9.12
3
4 #P(X<25)=0.1003

```

```

5  p1=0.1003
6  #P(X<70)=0.8997
7  p2=0.8997
8  #When X=25, Z=(25-u)/s.d=-z1
9  #When X=70, Z=(70-u)/s.d=z2
10
11 #P(0<Z<z2)=0.3997
12 z2=1.28          #From Normal Table
13
14 #P(0<Z<z1)=0.5-0.1003=0.3997
15 z1=1.28          #From Normal Table
16
17 #Solving two variables equation
18 a=matrix(c(1,1,-1.28,1.28),nrow=2,ncol=2)
19 b=matrix(c(25,70),nrow=2,ncol=1)
20 c=solve(a,b)
21 c
22 sprintf("The mean: %f Kg",c[1,1])
23 sprintf("The standard deviation: %f Kg",c[2,1])

```

---

### R code Exa 9.13 Mean And Standard Deviation

```

1  #Page number--9.23
2  #Example number--9.13
3
4  #P(X<75)=0.58
5  #P(X>80)=0.04
6  #When X=75, Z=(75-u)/s.d=z1
7  #When X=80, Z=(80-u)/s.d=z2
8
9  #P(0<Z<z2)=1.75
10 z2=1.75          #From Normal Table
11
12 #P(0<Z<z1)=0.20
13 z1=0.20          #From Normal Table

```

```

14
15 #Solving two variables equation
16 a=matrix(c(1,1,z1,z2),nrow=2,ncol=2)
17 b=matrix(c(75,80),nrow=2,ncol=1)
18 c=solve(a,b)
19 c
20 sprintf("The mean: %f ",c[1,1])
21 sprintf("The standard deviation: %f ",c[2,1])

```

---

#### R code Exa 9.14 Percentage Of Students Placed In Second Division

```

1 #Page number --9.24
2 #Example number --9.14
3
4 #P(X<30)=0.10
5 #P(X>80)=0.05
6 #When X=30, Z=(30-u)/s.d==z1
7 #When X=80, Z=(80-u)/s.d=z2
8
9 #P(0<Z<z2)=0.5-0.05
10 z2=0.45 #From Normal Table
11
12 #P(0<Z<z1)=0.50-0.10
13 z1=0.40 #From Normal Table
14
15
16 #Solving two variables equation
17 a=matrix(c(1,1,-1.28,1.64),nrow=2,ncol=2)
18 b=matrix(c(30,80),nrow=2,ncol=1)
19 c=solve(a,b)
20 c
21 sprintf("The mean: %f ",c[1,1])
22 sprintf("The standard deviation: %f ",c[2,1])
23
24 #P(45<X<60)

```

```

25 a=pnorm(60,c[1,1],c[2,1])-pnorm(45,c[1,1],c[2,1])
26 a
27 sprintf("%d percent candidates got second division
    in examination",round(a*100))

```

---

### R code Exa 9.15 Probability Of the Defectives In The Sample

```

1 #Page number--9.25
2 #Example number--9.15
3
4 n=100          # Total items
5 p=0.4
6 q=0.6
7 u=n*p          # Mean
8 s.d=sqrt(n*p*q) # Standard Deviation
9
10 #Normal Distribution
11 #Part (i)
12 #P(43.5<X<100.5)
13 a=pnorm(100.5,u,s.d)-pnorm(43.5,u,s.d)
14 a
15
16 #Part (ii)
17 #P(X=44)----->P(43.5<X<44.5)
18 b=pnorm(44.5,u,s.d)-pnorm(43.5,u,s.d)
19 b
20
21 #Binomial Distribution
22 #P(X>=44)
23 sum(dbinom(44:100,100,0.4))
24 #P(X=44)
25 dbinom(44,100,0.4)
26
27 sprintf("We can see that both Normal and Binomial
    Distribution are close to each other")

```

---

**R code Exa 9.21** Probability

```
1 #Page number--9.31
2 #Example number--9.21
3 #Load Package-->cubature
4
5 library(cubature)
6
7 mean=1
8 variance=4/3
9 #mean=(a+b)/2=1
10 #b+a=2
11 #variance=(b-a)^2/12=4/3
12 #b-a=4
13
14 #Solving two variables equation
15 x=matrix(c(1,-1,1,1),nrow=2,ncol=2)
16 y=matrix(c(2,4),nrow=2,ncol=1)
17 z=solve(x,y)
18 z
19
20 p=1/4          # -1<x<3
21
22 # define the integrated function
23 f <- function(x){p}
24 a=adaptIntegrate(f, lowerLimit =-1, upperLimit =0)
25 a
```

---

**R code Exa 9.22** Probability

```
1 #Page number--9.31
```



```

2 #Example number --9.22
3 #Load Package-->cubature
4
5 library(cubature)
6
7 #P(X>=20)
8
9 fx=1/30          # 0<x<30
10 # define the integrated function
11 f <- function(x){fx}
12 a=adaptIntegrate(f, lowerLimit =20, upperLimit =30)
13 a
14 sprintf("Probability that he has to wait at least 20
    min: %f",a$integral)

```

---

# Chapter 10

## Correlation

**R code Exa 10.1** Correlation Coefficient

```
1 #Page number --10.7
2 #Example number --10.1
3
4 X=c(65,66,67,67,68,69,70,72)
5 Y=c(67,68,65,68,72,72,69,71)
6 meanX=sum(X)/length(X)
7 meanX
8 meanY=sum(Y)/length(Y)
9 meanY
10 U=X-meanX
11 V=Y-meanY
12 data.frame(X,Y,U,V,U^2,V^2,U*V)
13 u=sum(U)/length(U)
14 v=sum(V)/length(V)
15 covUV=(sum(U*V)-u*v)/length(Y)
16 s.dU=sqrt(1/length(Y)*(sum(U^2)-u^2))
17 s.dV=sqrt(1/length(Y)*(sum(V^2)-v^2))
18 rUV=covUV/(s.dU*s.dV)
19 rUV
```

---

### R code Exa 10.2 Correct Value Of Correlation Coefficient

```
1 #Page number --10.8
2 #Example number --10.2
3
4 n=25
5 CsX=125-6-8+8+6           #Corrected sum of X
6 CsY=100-14-6+12+8         #Corrected sum of Y
7 CsX2=650-6^2-8^2+8^2+6^2   #Corrected sum of X^2
8 CsY2=460-14^2-6^2+12^2+8^2 #Corrected sum of Y^2
9 CsXY=508-6*14-8*6+8*12+6*8 #Corrected sum of XY
10 meanX=CsX/n
11 meanY=CsY/n
12 covXY=1/n*CsXY-meanX*meanY
13 s.dX=sqrt(1/n*CsX2-meanX^2)
14 s.dY=sqrt(1/n*CsY2-meanY^2)
15 rXY=covXY/(s.dX*s.dY)
16 round(rXY,2)
```

---

### R code Exa 10.14 Correlation Coefficient

```
1 #Page number --10.18
2 #Example number --10.14
3
4 n=100
5 v=c(-2,-1,0,1,2,3)
6 g=c(8,19,35,22,10,6)
7 a=v^2*g
8 uf=c(-19,0,31,56)
9 u2f=c(19,0,31,112)
10 suvf=c(9,0,13,30)
11 meanU=sum(uf)/n
```

```

12 meanV=sum(v*g)/n
13 covUV=1/n*sum(suvf)-meanU*meanV
14 s.dU=sqrt(1/n*sum(u2f)-meanU^2)
15 s.dU
16 s.dV=sqrt(1/n*sum(a)-meanV^2)
17 s.dV
18 rUV=covUV/(s.dU*s.dV)
19 rUV

```

---

### R code Exa 10.15 Correlation Coefficient Between X And Y

```

1 #Page number --10.20
2 #Example number --10.15
3
4 X=c(-1,1)
5 Y=c(0,1)
6 X1=c(1/8,2/8)
7 X2=c(3/8,2/8)
8 gy=X1+X2
9 px=c(3/8,5/8)
10 data.frame(Y,X1,X2,gy)
11
12 EX=sum(X*px);EX
13 EX2=sum(X^2*px);EX2
14 varX=EX2-EX^2
15 varX
16
17 EY=sum(Y*gy);EY
18 EY2=sum(Y^2*gy);EY2
19 varY=EY2-EY^2
20 varY
21
22 EXY=0*-1*1/8+0*1*3/8+1*-1*2/8+1*1*2/8
23 EXY
24 covXY=EXY-EX*EY

```

```

25 rXY=covXY/sqrt(varX*varY)
26 rXY

```

---

### R code Exa 10.17 Rank Correlation Coefficient

```

1 #Page number --10.25
2 #Example number --10.17
3
4 n=16
5 r_i_m=c(seq(1,16,1))                                     #
6 r_i_p=c(1,10,3,4,5,7,2,6,8,11,15,9,14,12,16,13)
7 #Ranks in physics
8 d = r_i_m-r_i_p
9 data.frame(r_i_m,r_i_p,d,d^2)
10 #Rank correlation coefficient
11 p=1-(6*sum(d^2))/(n*(n^2-1))
12 p

```

---

### R code Exa 10.18 Rank Correlation Between 3 Judges

```

1 #Page number --10.25
2 #Example number --10.18
3
4 n=10
5 a=c(1,6,5,10,3,2,4,9,7,8)
6 b=c(3,5,8,4,7,10,2,1,6,9)
7 c=c(6,4,9,8,1,2,3,10,5,7)
8 d1=a-b
9 d2=a-c
10 d3=b-c
11 data.frame(a,b,c,d1,d2,d3,d1^2,d2^2,d3^2)

```

```

12
13 #Rank correlation coefficient
14 Pab=1-(6*sum(d1^2))/(n*(n^2-1))
15 Pab
16 Pac=1-(6*sum(d2^2))/(n*(n^2-1))
17 Pac
18 Pbc=1-(6*sum(d3^2))/(n*(n^2-1))
19 Pbc

```

---

### R code Exa 10.19 Rank Correlation Coefficient

```

1 #Page number --10.26
2 #Example number --10.19
3
4 X=c(68,64,75,50,64,80,75,40,55,64)
5 Y=c(62,58,68,45,81,60,68,48,50,70)
6 RankX=c(4,6,2.5,9,6,1,2.5,10,8,6)
7 RankY=c(5,7,3.5,10,1,6,3.5,9,8,2)
8 d=RankX-RankY
9 data.frame(X,Y,RankX,RankY,d,d^2)
10
11 #Total correction
12 Correction=2*(4-1)/12+3*(9-1)/12
13
14 p=1-(6*(sum(d^2)+Correction+1/2))/(n*(n^2-1))
15 p

```

---

# Chapter 11

## Linear And Curvilinear Regression

R code Exa 11.1 Equations Of Two Lines Of Regression

```
1 #Page number--11.9
2 #Example number--11.1
3
4 X=c(65,66,67,67,68,69,70,72)
5 Y=c(67,68,65,68,72,72,69,71)
6 #Equation of line regressiono of Y on X
7 b=lm(Y~X)
8 a=summary(b)$coefficients[1,1]
9 a      # Intercept
10 c=summary(b)$coefficients[2,1]
11 c      # Slope
12 #From the above, we can get the equation of Y on X
13 #Equation-->Y=c*X+a----->Y=0.66*X+23.66
14
15 #Equation of line regressiono of X on Y
16 e=lm(X~Y)
17 f=summary(e)$coefficients[1,1]
18 f      # Intercept
19 g=summary(e)$coefficients[2,1]
```

```

20 g          # Slope
21 #From the above , we can get the equation of X on Y
22 #Equation——>X=g*Y+f————>X=0.545*Y+30.36
23
24 #Calculating the value
25 x=0.545*70+30.36
26 x          # Answer little vary due to rounding off

```

---

### R code Exa 11.2 Record An Analysis On Correlation Data

```

1 #Page number—11.10
2 #Example number—11.2
3
4 a=matrix(c(8,40,-10,-18),nrow=2,ncol=2)
5 b=matrix(c(-66,214),nrow=2,ncol=1)
6 r=solve(a,b)
7 r
8 x=r[1,1]
9 y=r[2,1]
10 byx=8/10          #Regression coefficient of Y
    on X
11 bxy=18/40         #Regression coefficient of X
    on Y
12 z=sqrt(byx*bxy)
13 z
14 s.dy=solve(1/5,4/5)
15 s.dy              #Standard deviation of Y

```

---

### R code Exa 11.3 Correlation Coefficient

```

1 #Page number—11.11
2 #Example number—11.3
3

```



```

4 kolkata=c(65,2.5)
5 mumbai=c(67,3.5)
6 type=c("Average Price","Standard Deviation")
7 q=data.frame(type,kolkata,mumbai)
8 q
9
10 x=q[1,2]; x
11 s.dx=q[2,2]; s.dx                      #Standard deviation
    of x
12 y=q[1,3]; y
13 s.dy=q[2,3]; s.dy                      #Standard
    deviation of y
14
15 slope=0.8*3.5/2.5
16 intercept=67+0.8*65*3.5/2.5
17 #From the above, we can get the equation of Y on X
18 #Equation—>Y=slope*X+intercept
19
20 #Calculating the value
21 Y=67+0.8*3.5/2.5*(70-65)
22 Y

```

---

### R code Exa 11.6 Coefficient Of Regression And Regression Equation

```

1 #Page number—11.14
2 #Example number—11.6
3
4 obs=c(seq(1,10,1))
5 X=c(1,1,2,2,3,3,4,5,6,7)
6 Y=c(2,7,7,10,8,12,10,14,11,14)
7 data.frame(obs,X,Y,X^2,X^3,X^4,X*Y,X^2*Y)
8
9 a=matrix(c(10,34,154,34,154,820,154,820,4774),nrow
    =3,ncol=3)
10 b=matrix(c(95,377,1849),nrow=3,ncol=1)

```

```

11 t=solve(a,b)
12 t
13 #From the above, we can get the equation
14 #Equation—> Y= 1.80 + 3.48*X - 0.2689*X^2

```

---

### R code Exa 11.7 Fit Exponential Curve

```

1 #Page number—11.15
2 #Example number—11.7
3
4 obs=c(seq(1,8,1))
5 X=c(1,2,3,4,5,6,7,8)
6 Y=c(1.0,1.2,1.8,2.5,3.6,4.7,6.6,9.1)
7 U=log(Y)
8 data.frame(obs,X,Y,U,X*U,X^2)
9
10 a=matrix(c(8,36,36,204),nrow=2,ncol=2)
11 b=matrix(c(3.7393,22.7385),nrow=2,ncol=1)
12 t=solve(a,b)
13 t
14 #Taking antilog
15 b=0.1408
16 d=0.6821
17
18 #Equation—> Y= 0.6821* (1.38)^X

```

---

# Chapter 12

## Additional Topics On Correlation And Regression

**R code Exa 12.7** Partial And Multiple Correlation Coefficient

```
1 #Page number --12.31
2 #Example number --12.7
3
4 r12=0.77
5 r13=0.72
6 r23=0.52
7
8 r12.3=(r12-r13*r23)/sqrt((1-r13^2)*(1-r23^2))
9 r12.3
10 R1.23=sqrt((r12^2+r13^2-2*r12*r13*r23)/(1-r23^2))
11 R1.23
```

---

**R code Exa 12.8** Distribution

```
1 #Page number --12.32
2 #Example number --12.8
```

```

3
4 s.d1=2
5 s.d2=3
6 s.d3=3
7 r12=0.7
8 r21=0.7
9 r13=0.5
10 r31=0.5
11 r23=0.5
12 r32=0.5
13
14 #Part (i)
15 r23.1=(r23-r21*r31)/sqrt((1-r21^2)*(1-r31^2))
16 r23.1
17 #Part (ii)
18 R1.23=sqrt((r12^2+r13^2-2*r12*r13*r23)/(1-r23^2))
19 R1.23
20 #Part (iii)
21 r12.3=0.6
22 r13.2=0.2425
23 s.d1.3=2*sqrt(1-r13^2);s.d1.3
24 s.d2.3=3*sqrt(1-r23^2);s.d2.3
25 s.d1.2=2*sqrt(1-r12^2);s.d1.2
26 s.d3.2=3*sqrt(1-r23^2);s.d3.2
27 b12.3=r12.3*s.d1.3/s.d2.3;b12.3
28 b13.2=r13.2*s.d1.2/s.d3.2;b13.2
29
30 #Part (iv)
31 w=matrix(c(1,r12,r13,r12,1,r23,r13,r23,1),nrow=3,
           ncol=3)
32 det(w)
33 w1=matrix(c(1,r23,r23,1),nrow=2,ncol=2)
34 det(w1)
35 s.d1.23=2*sqrt(det(w)/det(w1));s.d1.23

```

---

### R code Exa 12.9 Regression Equation

```
1 #Page number--12.33
2 #Example number--12.9
3
4 r12=0.8
5 r21=0.8
6 r13=-0.4
7 r31=-0.4
8 r23=-0.56
9 r32=-0.56
10
11 w=matrix(c(1,r12,r13,r12,1,r23,r13,r23,1),nrow=3,
           ncol=3)
12 det(w)
13 w11=matrix(c(1,r23,r23,1),nrow=2,ncol=2)
14 det(w11)
15 w12=matrix(c(r21,r31,r23,1),nrow=2,ncol=2)
16 det(w12)*-1
17 w13=r23*r12-r13
18 w13
19
20 #Required equation
21 #0.686/4.42*(X1-28.02)-0.576/1.10*(X2-4.91)-0.048/85
    *(X3-594)
```

---

# Chapter 13

## Theory Of Attributes

**R code Exa 13.2** Finding Frequencies

```
1 #Page number --13.5
2 #Example number --13.2
3
4 ABi=738;AjC=225;Aji=1196
5 kBC=204;kBi=1762;kjC=171;
6 kji=21842
7 ABC=149
8
9 A=ABC+ABi+AjC+Aji;A
10 B=ABC+ABi+kBC+kBi;B
11 C=ABC+AjC+kBC+kjC;C
12 AB=ABC+Aji;AB           # Answer is wrong in
    the example
13 AC=ABC+AjC;AC
14 BC=ABC+kBC;BC
15
16 N=ABC+ABi+AjC+Aji+kBC+kBi+kjC+kji;N
```

---

**R code Exa 13.11** Find if A And B Are Independent Or Positively Associated Or Negatively Associated

```
1 #Page number --13.13
2 #Example number --13.11
3
4 #Part (i)
5 N=1000
6 A=470; B=620; AB=320
7 k=AB-A*B/N
8 if (k>0) print("A and B are positively associated")
9
10 #Part (ii)
11 A=490; AB=294; i=570; iB=380
12 N=A+i
13 B=AB+iB
14 k=AB-A*B/N
15 if (k<0) print("A and B are negatively associated")
16
17 #Part (iii)
18 AB=256; iB=768; Aj=48; ij=144
19 A=AB+Aj
20 B=AB+iB
21 N=AB+Aj+iB+ij
22 k=AB-A*B/N
23 if (k<0) print("A and B are independent")
```

---

**R code Exa 13.12** Heredity In A Family

```
1 #Page number --13.14
2 #Example number --13.12
3
4 #A:: Dark eye-colour of father
5 #B:: Dark eye-colour of son
6
```

```

7 AB=50;Aj=79;iB=89;ij=782
8
9 Q=(AB*ij-Aj*iB)/(AB*ij+Aj*iB)           #Yule 's
    Coefficient of Association
10 Q
11
12 A=AB+Aj;A
13 B=AB+iB;B
14 i=iB+ij;i
15 j=Aj+ij;j
16 N=A+i
17 N
18 AB0=A*B/N;round(AB0)
19 Aj0=A*j/N;round(Aj0)
20 iB0=i*B/N;round(iB0)
21 ij0=i*j/N;round(ij0)

```

---

### R code Exa 13.14 Coefficient Of Association

```

1 #Page number--13.15
2 #Example number--13.14
3
4 #A:: Boys
5 #i:: Girls
6 #B:: Successful candidates
7 #j:: Failed candidates
8
9 N=800
10 Aj=80;iB=260
11 AB=380;ij=80
12 Attributes=c("B","j")
13 A=c(380,80)
14 i=c(260,80)
15 Total=c(A[1]+i[1],A[2]+i[2])
16 data.frame(Attributes,A,i,Total)

```



```

17
18 Q=(AB*ij-Aj*iB)/(AB*ij+Aj*iB)           #Yule's
      Coefficient of Association
19 Q
20
21 sprintf("The coefficient shows positive association
      of a low degree between success and failure")

```

---

### R code Exa 13.15 Coefficient Of Association

```

1 #Page number--13.15
2 #Example number--13.15
3
4 #A:: Majority
5 #i:: Minority
6 #B:: Regular players
7 #j:: Not Regular players
8
9 i=250+200+150
10 sprintf("No. of minority students: %d",i)
11 A=120+100+80
12 sprintf("No. of major students: %d",A)
13 iB=200+150+90
14 sprintf("No. of minor regular players: %d",iB)
15 AB=48+30+12
16 sprintf("No. of major regular players: %d",AB)
17
18 Aj=A-AB;Aj
19 ij=i-iB;ij
20
21 Q=(AB*ij-Aj*iB)/(AB*ij+Aj*iB)           #Yule's
      Coefficient of Association
22 Q

```

---

# Chapter 14

## Large Sample Theory

**R code Exa 14.1** Limits Between Which Probability 3 Or 4 Lies

```
1 #Page number --14.12
2 #Example number --14.1
3
4 n=9000
5 X=3240
6
7 #H0::That die is unbiased
8 #Probability of success
9 P=1/6+1/6
10 Q=1-P
11 #H1::That die is biased
12
13 Z=(X-n*P)/sqrt(n*P*Q)
14
15 #Probability limits
16 p=3240/9000;q=1-p
17 ll=p-3*sqrt(p*q/n)
18 ul=p+3*sqrt(p*q/n)
19 sprintf("Probability of getting 3 or 4 certainly
    lies between %f and %f",round(ll,3),round(ul,3))
```

---

#### R code Exa 14.2 Percentage Of Bad Pineapples

```
1 #Page number --14.13
2 #Example number --14.2
3
4 n=500
5 X=65
6 p=X/n          #Proportion on Number of bad
   pineapples
7 q=1-p
8 #S.E of proportion
9 s.e=sqrt(p*q/n)
10 #Probability limits
11 ll=p-3*sqrt(p*q/n)
12 ul=p+3*sqrt(p*q/n)
13 sprintf("Percentage of bad pineapples in the
   consignment between %f and %f",round(ll,3),round(
   ul,3))
```

---

#### R code Exa 14.4 Rice And Wheat Eaters

```
1 #Page number --14.13
2 #Example number --14.4
3
4 n=1000
5 X=540
6 p=X/n          # Sample proportion of rice
   eaters
7 #H0::Wheat and rice are equally popular
8 # Population proportion of rice eaters in
   Maharashtra
9 P=0.5
```

```

10 Q=1-P
11
12 Z=(p-P)/sqrt(P*Q/n)
13
14 #At 1% level of significance
15 if(Z<2.532)
16 sprintf("Hence, H0 hypothesis accepted")
17 sprintf("Rice and wheat are equally popular in
    Maharashtra State")

```

---

#### R code Exa 14.6 Number Of Observations

```

1 #Page number--14.14
2 #Example number--14.6
3
4 P=0.95
5 p=40/200
6 q=1-p
7 n=p*q*3.8416/0.0025
8 round(n)

```

---

#### R code Exa 14.7 Test For Significance For Difference Of Proportions

```

1 #Page number--14.16
2 #Example number--14.7
3
4 #H1: P1!=P2 (two tailed test)
5 n1=400
6 n2=600
7 X1=200; X2=325
8 p1=X1/n1
9 p2=X2/n2
10

```

```

11 p=(n1*p1+n2*p2)/(n1+n2)
12 q=1-p
13
14 z=abs((p1-p2)/sqrt(p*q*(1/n1+1/n2)))
15 z
16 if(z<1.96) print("Mean and women do not differ on
    flyover proposal")

```

---

#### R code Exa 14.10 Test For Significance For Difference Of Proportions

```

1 #Page number --14.19
2 #Example number --14.10
3
4 n1=1000;p1=800/1000;q1=1-p1
5 n2=1200;p2=800/1200;q2=1-p2
6
7 #H0: P1=P2
8 #H1: P1>P2 (Right-tailed test)
9
10 p=(n1*p1+n2*p2)/(n1+n2);p
11 q=1-p
12
13 z=abs((p1-p2)/sqrt(p*q*(1/n1+1/n2)))
14 z
15 if(z>1.96) print("H0 hypothesis is rejected")
16 sprintf("There is significant decrease in consupcion
    of tea after increase in excise duty")

```

---

#### R code Exa 14.15 Proportion Of Failures

```

1 #Page number --14.22
2 #Example number --14.15
3

```

```

4  n1=400;p1=300/400;q1=1-p1
5  n2=500;p2=300/500;q2=1-p2
6
7  #H0: P1=P2
8  #H1: P1!=P2 (two tailed test)
9
10 p=(n1*p1+n2*p2)/(n1+n2);p
11 q=1-p
12 s.e.p1p2=sqrt(p*q*1/(n1+n2)*500/400)
13 s.e.p1p2
14 z=(p-p1)/s.e.p1p2
15 abs(z)      # Answer is wrong in the book
16 sprintf("H0 is rejected")

```

---

#### R code Exa 14.18 Arithmetic Mean And Standard Deviation

```

1  #Page number--14.26
2  #Example number--14.18
3
4  #H0: u=30.5
5  #H1: u<30.5 (Left-tailed test)
6
7  AgeLastBirthday=c("16-20","21-25","26-30","31-35","
8    36-40")
9  f=c(12,22,20,30,16)
10 midx=c((16+20)/2,(25+21)/2,(26+30)/2,(31+35)/
11    2,(36+40)/2)
12 d=(midx-28)/5
13 a=f*d
14 b=f*d^2
15 data.frame(AgeLastBirthday,f,midx,d,a,b)
16
17 u=30.5
18 x=28+5*16/100
19 s=5*sqrt(164/100-(16/100)^2)

```

```

18
19 z=abs((x-u)/sqrt(s^2/100))
20 z
21 if(z>1.645) print("Reject H0 hypothesis")

```

---

#### R code Exa 14.26 Food Expenditure Of Two Populations

```

1 #Page number--14.31
2 #Example number--14.26
3
4 n1=400;n2=400
5 x1=250;x2=220
6 s.d1=40;s.d2=55
7
8 #H0::u1=u2
9 #H1::u1!=u2 (two tailed test)
10
11 z=abs((x1-x2)/sqrt(40^2/400+55^2/400))
12 z
13 if(z>3) print("H0 rejected")
14 sprintf("Expenditure of two population of shoppers
    in market A and B differ significantly")

```

---

#### R code Exa 14.28 Difference In Average Weights Of Items

```

1 #Page number--14.32
2 #Example number--14.28
3
4 n1=250;n2=400
5 x1=120;x2=124
6 s.d1=12;s.d2=14
7 s.e.x1x2=sqrt(s.d1^2/n1+s.d2^2/n2)
8 s.e.x1x2

```

```

9
10 #H0::u1=u2
11 #H1::u1!=u2 (two tailed test)
12
13 z=(x1-x2)/s.e.x1x2
14 z
15 if(z>3) print("H0 rejected")
16 sprintf("There is significant difference between
    sample means")
17
18 #|u1-u2| limits
19 ll=abs(x1-x2)-2.58*s.e.x1x2          #lower limit
20 ul=abs(x1-x2)+2.58*s.e.x1x2        #upper limit
21 sprintf("|u1-u2| varies between %f and %f",ll,ul)

```

---

#### R code Exa 14.30 Relating Heights Of Country A And Country B

```

1 #Page number--14.34
2 #Example number--14.30
3
4 n1=1000;n2=1200
5 x1=67.42;x2=67.25
6 s.d1=2.58;s.d2=2.5
7
8 #Part (i)
9 #H0::u1=u2
10 #H1::u1!=u2 (two tailed test)
11
12 z=abs((x1-x2)/sqrt(s.d1^2/n1+s.d2^2/n2))
13 z
14 if(z<1.96) print("H0 accepted")
15 sprintf("There is no significant difference between
    sample means")
16
17 #Part (ii)

```



```
18 s.e.s1s2=sqrt(s.d1^2/(2*n1)+s.d2^2/(2*n2))
19 s.e.s1s2
20 z=(s.d1-s.d2)/s.e.s1s2
21 z
22 if(z<1.96) print("H0 accepted")
23 sprintf("The sample standard deviation do not differ
    significantly")
```

---

# Chapter 15

## Exact Sampling Distributions I

**R code Exa 15.9** Precision Of Instrument

```
1 #Page number --15.25
2 #Example number --15.9
3
4 X=c(2.5,2.3,2.4,2.3,2.5,2.7,2.5,2.6,2.6,2.7,2.5)
5 m=sum(X)/length(X) # Mean
6 a=round(X-m,2)
7 b=a^2
8 data.frame(X,m,a,b)
9
10 #Null Hypothesis
11 H0=0.16
12 #Alternative Hypothesis
13 #H1>0.16
14 x=sum(b)/H0
15 x
16
17 sprintf("H0 may be accepted")
18 sprintf("The data are consistent with the hypothesis
    that the precision of the instrument is 0.16")
```

---

### R code Exa 15.12 Digits And Frequency In Telephone Directory

```
1 #Page number--15.27
2 #Example number--15.12
3
4 digits=c(seq(0,9,1))
5 f=c(1026,1107,997,966,1075,933,1107,972,964,853)
   # Observed Frequency
6 m=sum(f)/length(f)                                     #
   Mean
7 e=rep(m,10)                                           # Expected
   Frequency
8 a=(f-e)^2
9 b=round(a/e,3)
10 data.frame(digits,f,e,a,b)
11
12 #H0 is null hypothesis
13 x=sum(b)
14 x
15
16 sprintf("H0 may be rejected")
17 sprintf("The digits are not uniformly distributed in
   the directory")
```

---

### R code Exa 15.14 Survey Of 800 Families

```
1 #Page number--15.29
2 #Example number--15.14
3
4 #Probability of male birth
5 p=1/2
6 #Probability of female birth
```

```

7 q=1/2
8 n_m_b=c(seq(0,4,1))
9 f=c(32,178,290,236,64)           # Number of
    families
10 e=c()
11 for (i in n_m_b){
12     e[i+1]=800*choose(4,i)*p^4    # Frequency of
    male birth
13 }
14 a=(f-e)^2
15 b=round(a/e,3)
16 data.frame(n_m_b,f,e,a,b)
17
18 #H0 is null hypothesis
19 x=sum(b)
20 x
21
22 sprintf("H0 may be rejected")
23 sprintf("Male and female births are not equally
    probable")

```

---

#### R code Exa 15.15 Fit a Poisson Distribution

```

1 #Page number--15.30
2 #Example number--15.15
3
4 x=c(seq(0,6,1))
5 f=c(275,72,30,7,5,2,1)           # Observed Frequency
6 m=sum(f*x)/sum(f)                 #Mean
7 # Expected Frequency
8 e=c(242.1,0.482*242.1,0.241*116.69,0.482/3*
    28.12,0.482/4*4.51,0.482/5*0.544,0.482/6*0.052)
9 a=(f-e)^2
10 b=round(a/e,3)
11 data.frame(x,f,e,a,b)

```

```

12
13 x=sum(b)
14 x                # Aswer here is wrong in the book
15
16 sprintf("Poisson distribution is not good to fit to
    the given data")

```

---

#### R code Exa 15.18 8000 Graduates

```

1 #Page number--15.34
2 #Example number--15.18
3
4 Class=c("Male employed","Male unemployed","Female
    employed","Female unemployed")
5 f=c(1480,5720,120,680)                #
    Observed Frequency
6 e=c(7200*1600/8000,7200-1440,1600-1440,6400-5760)
    # Expected Frequency
7 a=(f-e)^2
8 b=round(a/e,2)
9 data.frame(Class,f,e,b)
10
11 #H0 is null hypothesis
12 x=sum(b)
13 x
14
15 sprintf("H0 may be rejected")
16 sprintf("Appointment is based on the basis of sex")

```

---

#### R code Exa 15.20 Two Researchers

```

1 #Page number--15.36
2 #Example number--15.20

```

```

3
4 E86=126*200/300
5 E60=93*200/300
6 E44=69*200/300
7
8 Researcher=c("X","Y")
9 bavg=c(E86,126-E86)           # Below Average
10 avg=c(E60,93-E60)           # Average
11 aavg=c(E44,69-E44)          # Above Average
12 genius=c(200-192,12-8)
13 data.frame(Researcher,bavg,avg,aavg,genius)
14
15 f=c(86,60,44,10,40,33,25,2)
16 e=c(84,62,46,8,42,31,23,4)
17 a=(f-e)^2
18 b=round(a/e,3)
19 data.frame(f,e,a,b)
20
21 x=sum(b[1:6])
22 x
23 sprintf("No difference in sampling techniques used
    by two researchers")

```

---

# Chapter 16

## Exact Sampling Distributions II

**R code Exa 16.6** Sales Of Soap Bars Advertising Campaign

```
1 #Page number --16.13
2 #Example number --16.6
3
4 n=22
5 x=153.7
6 s=17.2
7 u=146.3
8
9 #H0:: Null Hypothesis -----> the advertising
   campaign is successful
10 #H1:: Alternative Hypothesis ---> u>146.3 (Right tail)
11
12 t=(x-u)/sqrt(s^2/(n-1))
13 t      # Answer of value of t is wrong
14 sprintf("H0 is rejected")
```

---

### R code Exa 16.7 Sample Of 10 Boys IQ

```
1 #Page number --16.14
2 #Example number --16.7
3
4 n=10
5 u=100
6 #H0:: Null Hypothesis -----> mean IQ of 100 in the
   population u=100
7 #H1:: Alternative Hypothesis ---->u!=100
8
9 x=c(70,120,110,101,88,83,95,98,107,100)
10 m=sum(x)/n                      #Mean
11 m
12 a=x-m
13 b=a^2
14 data.frame(x,a,b)
15 s2=sum(b)/9
16 s2
17 t=abs((m-u)/sqrt(s2/n))
18 t
19 sprintf("H0 is accepted")
```

---

### R code Exa 16.10 Gain In Weights By Diet A And B

```
1 #Page number --16.18
2 #Example number --16.10
3
4 n1=12
5 n2=15
6 #H0:: Null Hypothesis -----> No significant
   difference in mean of weight in diet A and B
7 #H1:: Alternative Hypothesis ---->ux!=uy (two-tailed)
8
9 #Diet A
```



```

10 x1=c(25,32,30,34,24,14,32,24,30,31,35,25)
11 m1=sum(x1)/n1           # Mean
12 m1
13 a1=x1-m1
14 b1=a1^2
15 data.frame(x1,a1,b1)
16
17 #Diet B
18 x2=c(44,34,22,10,47,31,40,30,32,35,18,21,35,29,22)
19 m2=sum(x2)/n2           # Mean
20 m2
21 a2=x2-m2
22 b2=a2^2
23 data.frame(x2,a2,b2)
24
25 s2=(sum(b2)+sum(b1))/(n1+n2-2)
26 t=abs((m1-m2)/sqrt(s2*(1/n1+1/n2)))
27 t
28
29 sprintf("H0 is accepted")
30 sprintf("Two diets do not differ significantly ")

```

---

#### R code Exa 16.12 Heights Of Sailors And Soldiers

```

1 #Page number --16.20
2 #Example number --16.12
3
4 # SAILORS
5 X=c(63,65,68,69,71,72)
6 A=68
7 d=X-A
8 a=sum(d^2)
9 data.frame(X,d,d^2)
10
11 # SOLDIERS

```

```

12 Y=c(61,62,65,66,69,69,70,71,72,73)
13 B=66
14 D=Y-B
15 b=sum(D^2)
16 data.frame(Y,D,D^2)
17
18 mx=A + sum(d)/6;mx           # Mean
19 p=a-(sum(d))^2/6;p
20
21 my=B + sum(D)/10;my         # Mean
22 q=b-(sum(D))^2/10;q
23
24 S2=(1/(6+10-2))*(p+q)
25 S2
26
27 t=(mx-my)/sqrt(S2*(1/6+1/10))
28 t
29
30 sprintf("Null hypothesis can be retained")
31 sprintf("The sailors are on the average taller than
    the soilders.")

```

---

**R code Exa 16.15** Increase In Weights Of Animals By Food A And Food B

```

1 #Page number--16.22
2 #Example number--16.15
3
4 # Part (i)
5 # Food A
6 X=c(49,53,51,52,47,50,52,53)
7 A=50
8 d=X-A
9 a=sum(d^2)
10 data.frame(X,d,d^2)

```

```

11
12 # Food B
13 Y=c(52,55,52,53,50,54,54,53)
14 B=52
15 D=Y-B
16 b=sum(D^2)
17 data.frame(Y,D,D^2)
18
19 mx=A + sum(d)/8;mx           # Mean
20 p=a-(sum(d))^2/8;p
21
22 my=B + sum(D)/8;my          # Mean
23 q=b-(sum(D))^2/8;q
24
25 S2=(1/(8+8-2))*(p+q)
26 S2
27
28 t=(mx-my)/sqrt(S2*(1/8+1/8))
29 t
30
31 sprintf("Null hypothesis rejected")
32 sprintf("Food B is superior to Food A")
33
34 # Part (ii)
35 X
36 Y
37 d=X-Y
38 data.frame(X,Y,d,d^2)
39
40 n=length(X)
41 md=sum(d)/n
42 md
43 S2=1/(n-1)*(sum(d^2)-(sum(d))^2/n)
44 S2
45
46 t= abs(md/sqrt(S2/n))
47 round(t,3)
48

```

```
49 sprintf("Food B is superior to Food A")
```

---

**R code Exa 16.18** Random Sample Of 625 Pairs Of Observations

```
1 #Page number --16.25
2 #Example number --16.18
3
4 #H0:: Null Hypothesis ----->p=0
5 #H0:: The value of r=0.2 is not significant
6
7 r=0.2
8 n=625
9 t=r*sqrt(n-2)/sqrt(1-r^2)
10 t
11
12 sprintf("Null hypothesis is rejected")
13 sprintf("The sample correlation is significant of
    correlation in the population.")
14
15 #95% confidence limits
16 ll=r - 1.96*(1-r^2)/sqrt(n)           # lower
    limit
17 ll
18 ul=r + 1.96*(1-r^2)/sqrt(n)           # upper limit
19 ul
20
21 #99% confidence limits
22 ll=r - 2.58*(1-r^2)/sqrt(n)           # lower
    limit
23 round(ll,3)
24 ul=r + 2.58*(1-r^2)/sqrt(n)           # upper limit
25 ul
```

---

### R code Exa 16.26 F Test

```
1 #Page number --16.38
2 #Example number --16.26
3
4 n1=8
5 n2=10
6 dx=84.4
7 dy=102.6
8 SX2=dx/(n1-1); SX2
9 SY2=dy/(n2-1); SY2
10
11 F=SX2/SY2
12 F
13
14 if(F<3.29) print("H0 may be accepted")
```

---

### R code Exa 16.27 F Test And T Test

```
1 #Page number --16.38
2 #Example number --16.27
3
4 n1=10
5 n2=12
6 mx=15
7 my=14
8 dx=90
9 dy=108
10
11 # F-Test
12 SX2=dx/(n1-1); SX2
13 SY2=dy/(n2-1); SY2
14
15 F=SX2/SY2
16 F
```

```
17
18 if(F<2.90) print("H0 of equality of populatin may be
    accepted")
19
20 # T-Test
21 S2=1/(n1+n2-2)*(dx+dy)
22 S2
23 t=(mx-my)/sqrt(S2*(1/n1+1/n2))
24 t
25
26 sprintf("Samples have been drawn from the same
    normal population")
```

---

# Chapter 20

## Some Additional Topics

**R code Exa 20.1** Fit A Straight Line

```
1 #Page number -- 20.8
2 #Example number -- 20.1
3
4 x=seq(0,4,1)
5 e=x-2
6 y=c(1,1.8,3.3,4.5,6.3)
7 q=e
8 y0=y*e
9 data.frame(x,e,y,q,y0)
10
11 b0=sum(y)/length(x)
12 b0
13 b1=sum(y0)/sum(e^2)
14 b1
15 #WE get the following equation
16 # y = 1.33*x + 0.72
```

---

**R code Exa 20.2** Fit A Second Degree Parabola

```

1 #Page number --20.9
2 #Example number --20.2
3
4 x=seq(0.5,3,0.5)
5 e=4*x-7
6 y=c(72,110,158,214,290,380)
7 q=e
8 q2=c(5,-1,-4,-4,-1,5)
9 y0=y*q
10 y1=y*q2
11 data.frame(x,e,y,q,q2,y0,y1)
12
13 b0=sum(y)/length(x)
14 b0
15 b1=sum(y0)/sum(e^2)
16 b1
17 b2=sum(y1)/sum(q2^2)
18 b2
19
20 #WE get the following equation
21 #  $y = 106.32x^2 - 128.04x + 83.08$ 

```

---