R Textbook Companion for
Fundamentals of Mathematical Statistics
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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.

Contents

List of R Codes

9

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","
      50−60")
17 mid=c((0+10)/2,(10+20)/2,(20+30)/2,(30+40)/2,(40+50)
      /2,(50+60)/2)         # mid values
18 f=c(12,18,27,20,17,6)                # frequency
19 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 frequence 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 frequence 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  frequence  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  frequence: %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  varities  of  milk
 8      n=4
 9      #Prices  of  milk  sold  at  different  varities
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 frequence just greater than 128
        is 167")
11  sprintf("So, Median = 4")
12
13  Q1=sum(f)/4;Q1
14  sprintf("Cumulative frequence just greater than 64
        is 95")
15  sprintf("So, Q1 = 3")
16  Q3=3*sum(f)/4;Q3
17  sprintf("Cumulative frequence just greater than 192
        is 219")
18  sprintf("So, Q3 = 5")
19  D4=4*sum(f)/10;D4
20  sprintf("Cumulative frequence just greater than
        102.4 is 167")
21  sprintf("So, D4 = 4")
22  P27=27*sum(f)/100;P27
23  sprintf("Cumulative frequence 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
```

19

```
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 frequence 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 frequence 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  xiˆ2
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
     ","25-30","30-35","35-40")
28 mid=c((0+5)/2,(5+10)/2,(10+15)/2,(15+20)/2,(20+25)/
     2,(25+30)/2,(30+35)/2,(35+40)/2)
29 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 + C - 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
```

42

```
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  deffective :
       %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 sovles correctly
 7  #E3−−−−−−−>No one sovles 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))
```

46

```
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  P0X5=sum(b[2:5,2])
49  sprintf("The probability 0<X<5 is: %f",P0X5)
50
51  #Part(iii)
52  #BY trail we get a=4
53
54  #Part (iv)
55  #Cummulative probability function
56  FX=c(sum(b[1,2]),sum(b[1:2,2]),sum(b[1:3,2]),sum(b
```

49

```
      [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 #Cummulative 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)
```

```r
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  }
```

```r
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  #Varience
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  p=(1/3)^3
10
11  #Part (ii)
12  #Probability that none of tubes be replaced in first
        150 hrs.
13  p=(1-1/3)^3
14
15  #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−−−−>ploynom
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[1:3,1]*a[1:3,2])
10 EX
11 #E(X^2)
12 EX2=sum((a[1:3,1])^2*a[1:3,2])
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[1:3,4])
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
```

65

```
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

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```
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  unbaised
 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)
```

```r
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
```

wrong in the book

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

```r
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

```r
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

```r
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  #Poission 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
```

```r
 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 -1200 hrs
        .:  %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
```

90

```
       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
```

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```
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))                              #
       Ranks  in  math
6  r_i_p=c(1,10,3,4,5,7,2,6,8,11,15,9,14,12,16,13)
       #Ranks  in  physics
7  d = r_i_m-r_i_p
8  data.frame(r_i_m,r_i_p,d,d^2)
9
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  ( i i )
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  ( i i i )
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  coeficient  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 baised
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
```

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```
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 consuption
        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","
       36−40")
 8  f=c(12,22,20,30,16)
 9  midx=c((16+20)/2,(25+21)/2,(26+30)/2,(31+35)/
       2,(36+40)/2)
10  d=(midx-28)/5
11  a=f*d
12  b=f*d^2
13  data.frame(AgeLastBirthday,f,midx,d,a,b)
14
15  u=30.5
16  x=28+5*16/100
17  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

```r
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

```r
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)
```

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```r
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

```r
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 = 106.32*x^2 − 128.04*x + 83.08
```