

R Textbook Companion for
Schaum's Outline Series - Theory and
Problems of Statistics
by Murray R. Spiegel¹

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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Chapter 1

Variables And Graphs

R code Exa 1.1.3 rounding off the numbers

```
1 #page=8
2 a<-round(48.6,digits=0)
3 a
4 b<-round(136.5,digits=0)
5 b
6 c<-round(2.484,digits=2)
7 c
8 d<-round(0.0435,digits=3)
9 d
10 e<-round(4.50001,digits=0)
11 e
12 f<-round(143.95,digits=0)
13 f
14 g<-round(368,digits=-2)
15 g
16 h<-round(24448,digits=-3)
17 h
18 library(plyr)
19 i<-round_any(5.56500,5.56,f=floor)
20 i
21 j<-round(5.56501,digits=2)
```

R code Exa 1.1.4 Adding the numbers

```
1 #page=8
2 x<-c(4.35,8.65,2.95,12.45,6.65,7.55,9.75)
3 sum(x)
4 len=length(x)
5 s1=0
6 s2=0
7 library(plyr)
8 len=length(x)
9 for ( i in 1:len)
10 {
11   if (i%%2!=0)
12   {
13     a=round_any(x[i], 0.1, ceiling)
14     s1=s1+a
15   }
16   else
17   {
18     b=round_any(x[i], 0.1, floor)
19     s2=s2+b
20   }
21 }
22 s3=s1+s2
23 s3
24
25 s4=0
26 for( i in 1:len)
27 {
28   c=round_any(x[i], 0.1, ceiling)
29   s4=s4+c
30 }
31 s4
```

R code Exa 1.1.5 Without using powers of 10

```
1 #PAGE=9
2 a=4.823*10^7
3 cat(a)
4 b=8.4*10^(-6)
5 ran2 <- c(b)
6 options("scipen"=100)
7 cat(ran2)
8 c=3.8*10^(-4)
9 cat(c)
10 d=1.86*10^5
11 cat(d)
12 e=300*10^8
13 cat(e)
14 f=70000*10^(-10)
15 cat(f)
```

R code Exa 1.1.6 Significant figures

```
1 #PAGE=9
2 sigfigs <- function(x){
3   orig_scipen <- getOption("scipen")
4   options(scipen = 999)
5   on.exit(options(scipen = orig_scipen))
6
7   x <- as.character(x)
8   x <- sub("\\\\.", "", x)
9   x <- gsub("(^0+|0+$)", "", x)
10  nchar(x)
11 }
```

```

12
13 a <- 149.8
14 sigfigs(a)
15
16 b<-149.80
17 sigfigs(b)+1
18
19 c<-0.0028
20 sigfigs(c)
21
22 d1=1
23 d=0.00280
24 sigfigs(d)+d1
25
26 e1=1
27 e=1.00280
28 sigfigs(e)+e1
29
30 f=9
31 sigfigs(f)
32
33 g<-1/0
34 g
35
36 h1=1
37 h=4*10^3
38 sigfigs(h)+h1
39
40 i1=2
41 i=7.58400*10^(-5)
42 sigfigs(i)+i1
43 #”The answer may vary due to difference in
    representation.”

```

R code Exa 1.1.7 Maximum Error

```

1 #PAGE=9
2 sigfigs <- function(x){
3   orig_scipen <- getOption("scipen")
4   options(scipen = 999)
5   on.exit(options(scipen = orig_scipen))
6
7   x <- as.character(x)
8   x <- sub("\\\\.", "", x)
9   x <- gsub("(^0+|0+$)", "", x)
10  nchar(x)
11 }
12 a=73.854
13 a1=a+0.0005
14 a2=a-0.0005
15 a1
16 a2
17 cat(sigfigs(a2)-1)
18
19 b=0.09800
20 b1=b-0.000005
21 b2=b+0.000005
22 cat(sigfigs(b2)-1)
23
24 c=3.867*10^8
25 c1=c-0.0005*10^8
26 c2=c+0.0005*10^8
27 cat(sigfigs(c2)-1)

```

R code Exa 1.1.8 Scientific Notation

```

1 #page=9
2 a<-24380000
3 b<-0.000009851
4 c<-7300000000
5 d<-0.00018400

```



```
6 formatC(a,format='e',digits=3)
7 formatC(b,format='e',digits=3)
8 formatC(c,format='e',digits=4)
9 formatC(d,format='e',digits=4)
```

R code Exa 1.1.9 Product of numbers

```
1 #PAGE=9
2
3 sigdigs<-function(a) {
4   d<-0
5   while(signif(a,digits=d) != a) {
6     d<-d+1
7     next
8   }
9   return(d)
10 }
11 cat(5.74*3.8)
12 a=sigdigs(5.74)
13 b=sigdigs(3.8)
14 a1=5.74-5/10^a
15 a2=5.74+5/10^a
16
17 b1=3.8-5/10^b
18 b2=3.8+5/10^b
19
20 cat(a1*b1)
21 cat(a2*b2)
```

R code Exa 1.1.10 Addition

```
1 #page=10
2 a<-c(4.19355,15.28,5.9561,12.3,8.472)
```

```
3 sum(a)
4 x=round(a,digits=2)
5 a=sum(x)
```

R code Exa 1.1.11 Scientific Figures

```
1 #page=10
2 a<-475000000
3 b<-12684000
4 c<-1372410
5 d<-a+b-c
6 d
7 e=round(a,digits=-5)
8 e
9 f=round(b,digits=-5)
10 f
11 g=round(c,digits=-5)
12 g
13 h<-e+f-g
14 h
```

R code Exa 1.1.12 Performing indicated operations

```
1 #PAGE=11
2 A<-48.0*943
3 round(A,digits=-2)
4 b<-8.35/98
5 round(b,digits=3)
6 c<-28*4193*182
7 formatC(c,format='e',digits=1)
8 d<-(526.7*0.001280)/0.000034921
9 formatC(d,format='e',digits=3)
10 e<-((1.47562-1.47322)*4895.36)/0.000159180
```

```

11 formatC(e, format='e', digits=2)
12 f<-(4.38**2)/5+(5.482**2)/6
13 round(f, digits=2)
14 g<-3.1416*sqrt(71.35)
15 round(g, digits=2)
16 h<-sqrt(128.5-89.24)
17 round(h, digits=2)

```

R code Exa 1.1.13 Evaluating

```

1 #page=11
2 x<-3
3 y<--5
4 a<-4
5 b<--7
6 z<-2*x-3*y
7 z
8 z<-4*y-8*x+28
9 z
10 z<-(a*x+b*y)/(b*x-a*y)
11 z
12 z<-x**2-3*x*y-2*y**2
13 z
14 z<-2*(x+3*y)-4*(3*x-2*y)
15 z
16 z<-(x**2-y**2)/(a**2-b**2+1)
17 z
18 z<-sqrt(2*x*x-y*y-3*a*a+4*b*b+3)
19 z
20 z<-sqrt(6*a*a/x+2*b*b/y)
21 z
22 round(z, digits=2)

```

R code Exa 1.1.15 tonnes of potatoes and straw

```
1 #PAGE=13
2 y=c(1975:1985)
3 a=c(200,185,225,250,240,195,210,225,250,230,235)
4 b=c(75,90,100,85,80,100,110,105,95,110,100)
5
6 a1=which(y==1981)
7 a2=a[a1]
8 a2
9
10 b1=which(y==1978)
11 b1=b[b1]
12 b1
13 b2=which(y==1984)
14 b2=b[b2]
15 b2
16
17 c1=which(a==225)
18 c1=y[c1]
19 c1
20
21 d1=which(y==1979)
22 d1=a[d1]
23 d1
24
25 e1=which(y==1983)
26 e1=b[e1]
27 e1
28
29 f1=which(a==210)
30 f1=b[f1]
31 f1
32
33 g1=y
34 g1
```

R code Exa 1.1.16 Determining the variables

```
1 #PAGE=13
2 x=c(3,-2,1.5)
3 y1=2*x-3
4 cat(y1)
5
6 x=c(-2,-1,0,1,2,3,4)
7 y2=2*x-3
8 y3 <- matrix(c(x,y2),ncol=7,byrow=TRUE)
9 colnames(y3) <- c(" "," "," "," "," "," "," ")
10 rownames(y3) <- c("X","Y")
11 y3 <- as.table(y3)
12 y3
13
14 x=2.4
15 cat(2*x-3)
16 x=0.8
17 cat(2*x-3)
18
19 y=15
20 cat((y+3)/2)
```

R code Exa 1.1.17 Finding corresponding z value

```
1 #PAGE=14
2 X<-2
3 Y<-5
4 Z=16+4*X-3*Y
5 Z
6 X<-3
7 Y<-7
```

```
8 Z=16+4*X-3*Y
9 Z
10 X<- -4
11 Y<-2
12 Z=16+4*X-3*Y
13 Z
```

R code Exa 1.1.18 Locate values on X axis

```
1 #PAGE=14
2 x=c(4,-3,2.5,-4.3,0.4)
3 y=c(0,0,0,0,0)
4 plot(x,y,xaxt="n")
5 axis(1, at = seq(-5, 5, by = 1), las=2)
```

R code Exa 1.1.19 Ball bearing in millimeters

```
1 #PAGE=14
2 x=4.58
3 x1=x-0.005
4 x2=x+0.005
5 x=c(x1,x2)
6 y=c(0,0)
7 plot(x,y,type='l',xlim=c(4.54,4.59))
```

R code Exa 1.1.20 Rectangular coordinate

```
1 #PAGE=15
2 x=c(5,2,-3,1,3,-2.5,0,4)
3 y=c(2,5,1,-3,-4,-4.8,-2.5,0)
```

```

4 plot(x, y, xlim=c(-6, 6), ylim=c(-6, 6))
5 abline(h=0)
6 abline(v=0)

```

R code Exa 1.1.21 Graph the equation

```

1 #PAGE=15
2 x=c(-3,-2,-1,0,1,2,3,4)
3 y=2*x-3
4 plot(x, y,type='b', xlim=c(-6, 6), ylim=c(-6, 6))
5 abline(h=0)
6 abline(v=0)

```

R code Exa 1.1.22 Graph the equation

```

1 #PAGE=16
2 x=c(-3,-2,-1,0,1,2,3,4,5)
3 y=x^2-2*x-8
4 plot(x, y,type='b', xlim=c(-9, 9), ylim=c(-9, 9))
5 abline(h=0)
6 abline(v=0)

```

R code Exa 1.1.23 US population graph

```

1 #PAGE=16
2 y=c
   (1860,1870,1880,1890,1900,1910,1920,1930,1940,1950,1960,1970,1980)
3 p=c
   (31.4,39.8,50.2,62.9,76,92,105.7,122.8,131.7,151.1,179.3,203.3,22

```

```
4 plot(y,p,type='b',xlab='Year',ylab='Population of  
the U.S.( millions)')
```

R code Exa 1.1.24 bar graph and line graph

```
1 #PAGE=17
2 a=c(1975:1985)
3 b=c(200,185,225,250,240,195,210,225,250,230,235)
4 c=c(75,90,100,85,80,100,110,105,95,110,100)
5
6 plot(a, ylim=range( b, c), col='black',xlab = 'Year'
      ,ylab='Number of Tonnes')
7 lines(b,type = 'b')
8 lines(c,type='b')
9
10 v=c(c,b)
11
12 library(ggplot2)
13
14 df2 <- data.frame(supp=rep(c("Potatoes", "Straw"),
      each=11),Year=a,Number_of_Tonnes=v)
15 df2
16
17 ggplot(data=df2, aes(x=Year, y=Number_of_Tonnes,
      fill=supp)) +
18   geom_bar(stat="identity")
19 ggplot(data=df2, aes(x=Year, y=Number_of_Tonnes,
      fill=supp)) +
20   geom_bar(stat="identity", position=position_dodge
      ())
```

R code Exa 1.1.25 Potatoes and straw


```

1 #PAGE=18
2 a=c(1975:1985)
3 b=c(200,185,225,250,240,195,210,225,250,230,235)
4 c=c(75,90,100,85,80,100,110,105,95,110,100)
5
6 s1=b+c
7 a1=b/s1
8 a1=a1*100
9 a1=round(a1,1)
10 a2=100-a1
11
12 y1 <- matrix(c(a,a1,a2),ncol=11,byrow=TRUE)
13 colnames(y1) <- c(" "," "," "," "," "," "," "," "," "," "," ")
14 rownames(y1) <- c("Year","Percentage potatoes","
    Percentage straw")
15 y1 <- as.table(y1)
16 y1

```

R code Exa 1.1.26 Line graph

```

1 #PAGE=18
2 a=c(1975:1985)
3 b=c(200,185,225,250,240,195,210,225,250,230,235)
4 c=c(75,90,100,85,80,100,110,105,95,110,100)
5
6 plot(a,b,type = 'b',ylim=range(0,250),xlab = 'Year',
    ylab='Number of Tonnes')

```

R code Exa 1.1.27 Continents and area

```

1 #page 21

```

```

2 continent<-c('Africa','Asia','Europe','North America
  ','Oceanic','South America','U.S.S.R')
3
4 area<-c(30.3,26.9,4.9,24.3,8.5,17.9,20.5)
5
6 barplot(area,ylab="continent",xlab="Area ",names.arg
  =c("AFRICA","ASIA","EUROPE","N.A","OCEANIC","S.A"
    ,"U.S.S.R"),horiz =TRUE)
7
8 pie(area,label=as.character(continent),border="black
  ",clockwise=TRUE)

```

R code Exa 1.1.28 Simple pendulum

```

1 #PAGE=22
2 L=c(101,162,222,338,420,534,667,745,866,1000)
3 T=c
  (0.64,0.81,0.95,1.17,1.30,1.47,1.65,1.74,1.87,2.01)
4 plot(L,T,type='b',xlim=c(100,1000),ylim=c(0.1,2.0))
5
6 b=(0.81-0.64)/(162-101)*400+0.15
7 b=round(b,2)
8 cat(b,'seconds')

```

R code Exa 1.1.29 Solving equations

```

1 #PAGE=23
2 a=solve(4,28)
3 cat(a)
4
5 b=solve(5,24-4)
6 cat(b)

```

```

7
8 c=solve(-8,16)
9 cat(c)
10
11 d=solve(1,10)
12 cat(d)

```

R code Exa 1.1.30 Solving simultaneous equations

```

1 #PAGE=23
2 A <- matrix(data=c(3, -2, 5, 7), nrow=2, ncol=2,
  byrow=TRUE)
3 b <- matrix(data=c(11, 39), nrow=2, ncol=1, byrow=
  FALSE)
4 round(solve(A, b), 2)
5
6 A <- matrix(data=c( 5, 14,7,3), nrow=2, ncol=2,
  byrow=TRUE)
7 b <- matrix(data=c(78, -7), nrow=2, ncol=1, byrow=
  FALSE)
8 round(solve(A, b), 2)
9
10 A <- matrix(data=c(3,2,5,7,-3,2,5,1,-4), nrow=3,
  ncol=3, byrow=TRUE)
11 b <- matrix(data=c(15,52,2), nrow=3, ncol=1, byrow=
  FALSE)
12 round(solve(A, b), 3)

```

R code Exa 1.1.33 Rearranging the numbers

```

1 #PAGE=24
2 x=c(3.42,-0.6,-2.1,1.45,-3)
3 a=sort(x)

```

```

4 a
5 b=sort(x,decreasing = TRUE)
6 b
7 #”The answer may vary due to difference in
  representation.”

```

R code Exa 1.1.34 Corresponding Inequality

```

1 #PAGE=25
2 a1=2
3 a2=6
4 a3=a2/a1
5 cat('X <',a3)
6
7 b1=3
8 b2=-8
9 b3=4
10 b4=(b3-b2)/b1
11 cat('X >=', b4)
12
13 c1=6
14 c2=-4
15 c3=-2
16 c4=(c1-c3)/(-c2)
17 cat('X >', c4)
18
19 d1=-3
20 d2=3
21 d3=2
22 d4=5
23 d5=(d1*d3)+d4
24 d6=(d2*d3)+d4
25 cat(d5, '< X <',d6)
26
27 e1=-1

```

```

28 e2=7
29 e3=5
30 e4=3
31 e5=2
32 e6=((e1*e3)-e4)/e5*(-1)
33 e7=((e2*e3)-e4)/e5*(-1)
34 cat(e7, '<= X <=', e6)

```

R code Exa 1.1.35 Common logarithm

```

1 #PAGE=25
2 y=c
   (57,57.4,5.63,35.63,982.5,7824,186000,0.71,0.7314,0.0325,0.0071,0

3 a=log(y,base=10)
4 c=floor(a)
5 c[8]=c[8]+10
6 c[9]=c[9]+10
7 c[10]=c[10]+10
8 c[11]=c[11]+10
9 c[12]=c[12]+10
10 cat(c[1],c[2],c[3],c[4],c[5],c[6],c[7],c[8],'- 10 ',c
      [9],'- 10 ',c[10],'- 10 ',c[11],'- 10 ',c[12],'- 10 '
      )

```

R code Exa 1.1.36 Logarithms

```

1 #PAGE=25
2 a=87.2
3 a=log(a,base=10)
4 a=round(a,digits = 4)
5 a
6

```

```

7  b=37300
8  b=log(b,base=10)
9  b=round(b,digits = 4)
10 b
11
12 c=753
13 c=log(c,base=10)
14 c=round(c,digits = 4)
15 c
16
17 d=9.21
18 d=log(d,base=10)
19 d=round(d,digits = 4)
20 d
21
22 e=54.5
23 e=log(e,base=10)
24 e=round(e,digits = 4)
25 e
26
27 f=0.382
28 f=log(f,base=10)
29 f=round(f,digits = 4)
30 f=10+f
31 cat(f, '-10')
32
33 g=0.00159
34 g=log(g,base=10)
35 g=round(g,digits = 4)
36 g=10+g
37 cat(g, '-10')
38
39 h=0.0753
40 h=log(h,base=10)
41 h=round(h,digits = 4)
42 h=10+h
43 cat(h, '-10')
44

```

```

45 i=0.000827
46 i=log(i,base=10)
47 i=round(i,digits = 4)
48 i=10+i
49 cat(i, '-10 ')
50
51 j=0.0503
52 j=log(j,base=10)
53 j=round(j,digits = 4)
54 j=10+j
55 cat(j, '-10 ')
56
57 k=4.638
58 k=log(k,base=10)
59 k=round(k,digits = 4)
60 k
61
62 l=6.753
63 l=log(l,base=10)
64 l=round(l,digits = 4)
65 l
66
67 m=183.2
68 m=log(m,base=10)
69 m=round(m,digits = 4)
70 m
71
72 n=43.15
73 n=log(n,base=10)
74 n=round(n,digits = 4)
75 n
76
77 o=876400
78 o=log(o,base=10)
79 o=round(o,digits = 4)
80 o
81
82 p=0.2548

```

```

83 p=log(p,base=10)
84 p=round(p,digits = 4)
85 p=10+p
86 cat(p, '-10 ')
87
88 q=0.04372
89 q=log(q,base=10)
90 q=round(q,digits = 4)
91 q=10+q
92 cat(q, '-10 ')
93
94 r=0.009848
95 r=log(r,base=10)
96 r=round(r,digits = 4)
97 r=10+r
98 cat(r, '-10 ')
99
100 s=0.0001788
101 s=log(s,base=10)
102 s=round(s,digits = 4)
103 s=10+s
104 cat(s, '-10 ')

```

R code Exa 1.1.37 Antilogarithms

```

1 #PAGE=26
2 c2=9.9058
3 c3=10
4 c5=c2-c3
5 c5=(10**c5)
6 c5=round(c5,4)
7 c5=c5*10^2
8 cat(c5)
9
10 c2=7.8531

```



```

11 c3=10
12 c5=c2-c3
13 c5=(10**c5)
14 c5=round(c5,6)
15 c5
16 c5=c5*10^6
17 cat(c5)
18
19 c2=8.1875
20 c3=10
21 c5=c2-c3
22 c5=(10**c5)
23 c5=round(c5,4)
24 c5=c5*10^4
25 cat(c5)
26
27
28
29 c2=10.4997
30 c3=10
31 c5=c2-c3
32 c5=(10**c5)
33 c5=round(c5,2)
34 cat(c5)
35
36 c2=6.9360
37 c3=10
38 c5=c2-c3
39 c5=(10**c5)
40 c5=round(c5,6)
41 c5=c5*10^8
42 cat(c5)
43
44
45 c2=7.8657
46 c3=10
47 c5=c2-c3
48 c5=(10**c5)

```

```

49 c5=round(c5,5)
50 cat(c5)
51
52
53 c2=9.8267
54 c3=10
55 c5=c2-c3
56 c5=(10**c5)
57 c5=round(c5,4)
58 cat(c5)
59
60 c2=8.3927
61 c3=10
62 c5=c2-c3
63 c5=(10**c5)
64 c5=round(c5,4)
65 cat(c5)
66
67 c2=9.3842
68 c3=10
69 c5=c2-c3
70 c5=(10**c5)
71 c5=round(c5,4)
72 cat(c5)
73
74 c2=8.6715
75 c3=10
76 c5=c2-c3
77 c5=(10**c5)
78 c5=round(c5,6)
79 c5=c5*100^2
80 cat(c5)
81
82
83 c2=6.1853
84 c3=10
85 c5=c2-c3
86 c5=(10**c5)

```

```

87  c5=round(c5,10)
88  c5=c5*100^4
89  c5=round(c5,2)
90  cat(c5)
91
92  c2=10.9245
93  c3=10
94  c5=c2-c3
95  c5=(10**c5)
96  c5=round(c5,3)
97  cat(c5)
98
99  c2=9.6089
100 c3=10
101 c5=c2-c3
102 c5=(10**c5)
103 c5=round(c5,4)
104 cat(c5)
105
106 c2=8.8907
107 c3=10
108 c5=c2-c3
109 c5=(10**c5)
110 c5=round(c5,6)
111 cat(c5)
112
113 c2=9.2000
114 c3=10
115 c5=c2-c3
116 c5=(10**c5)
117 c5=round(c5,4)
118 c5=c5*100
119 cat(c5)
120
121
122 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 1.1.38 Calculating logarithms

```
1 #PAGE=27
2 a=3.81
3 b=43.4
4 a=log(a,base=10)
5 b=log(b,base=10)
6 c=b+a
7 c=round(c,digits = 4)
8 c=10**c
9 c=round(c,digits = 1)
10 c
```

R code Exa 1.1.39 Calculating logarithms

```
1 #PAGE=27
2 a=73.42
3 b=0.004620
4 d=0.5143
5 a=log(a,base=10)
6 b=log(b,base=10)
7 b=10+b
8 d=log(d,base=10)
9 d=10+d
10 c=b+a+d
11 e=10*2
12 c=round(c,digits = 4)
13 c=10**c
14 c=round(c,digits = 1)
15 c2=10**e
16 c1=c/c2
17 c1=round(c1,digits = 4)
```

```
18 c1
19 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 1.1.40 Calculating logarithms

```
1 #PAGE=27
2 a=784.6
3 b=0.0431
4 c=28.23
5 a=log(a,base=10)
6 b=log(b,base=10)
7 b=10+b
8 c=log(c,base=10)
9 d=a+b-c
10 f=10
11 p=d-f
12 p=round(p,digits = 4)
13 p=10**p
14 p=round(p,digits = 3)
15 p
```

R code Exa 1.1.41 Calculating logarithms

```
1 #PAGE=28
2 a=5.395
3 b=8
4 c=log(a,base=10)
5 c=c*b
6 c=round(c,digits = 3)
7 c=10**c
8 c=round(c,digits = -2)
9 c
```

R code Exa 1.1.42 Calculating logarithms

```
1 #PAGE=28
2 a=387.2
3 b=log(a,base=10)
4 b=b/2
5 b=round(b,digits = 3)
6 b
7 c=10**b
8 c=round(c,digits = 2)
9 c
```

R code Exa 1.1.43 Calculating logarithms

```
1 #PAGE=28
2 a=0.08317
3 n=5
4 a1=log(a,base=10)
5 a1=10+a1
6 a1=round(a1,digits = 2)
7 a1=a1+40
8 a1=a1/n
9 a1
10 c=10**a1
11 c
12 d=-10
13 c1=10**d
14 c2=c*c1
15 c2=round(c2,digits = 4)
16 c2
```

R code Exa 1.1.44 Calculating logarithms

```
1 #PAGE=28
2 a=0.003654
3 b=18.37
4 c=8.724
5 d=743.8
6
7 a1=log(a,base=10)
8 a1=10+a1
9 a1=a1+10
10 a1=round(a1,digits = 4)
11 a1=a1/2
12
13 b1=log(b,base=10)
14 b1=3*b1
15 b1=round(b1,digits = 4)
16
17 e=a1+b1
18
19 c1=log(c,base=10)
20 c1=4*c1
21 c1=round(c1,digits = 4)
22
23 d1=log(d,base=10)
24 d1=d1/4
25
26 f=c1+d1
27
28 g=e-f
29
30 p=10**g
31 q=-10
32 q=10**q
```

```
33 p1=p*q
34 p1=round(p1,digits = 5)
35 p1
```

R code Exa 1.1.45 Calculating logarithms

```
1 #PAGE=28
2 a=874.3
3 b=0.03816
4 c=28.53
5 d=1.754
6 e=0.007352
7 a=log(a,base=10)
8 b=log(b,base=10)
9 b=10+b
10 c=log(c,base=10)
11 c=c*3
12 f=a+b+c
13 d=log(d,base=10)
14 d=d*4
15 e=log(e,base=10)
16 e=10+e
17 g=d+e
18 p=f-g
19 p=p/2
20 p=round(p,digits = 4)
21 p1=10**p
22 p1=round(p1,digits = 0)
23 p1
24 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 1.3 Scientific notation


```
1 #PAGE=2
2 a=10
3 b=1
4 c=2
5 d=5
6 e=8
7
8 print(a**b)
9 print(a**c)
10 print(a**d)
11 print(a**e)
```

R code Exa 1.4 Scientific notation

```
1 #PAGE=2
2
3 a=10
4 b=-1
5 c=-2
6 d=-5
7 e=0
8
9 print(a**e)
10 print(a**b)
11 print(a**c)
12 print(a**d)
```

R code Exa 1.5 Scientific notation

```
1 #PAGE=2
2
3 a=864000000
4 formatC(a, format="e")
```

```
5
6 b=0.00003416
7 formatC(b,format="e")
```

R code Exa 1.6 Scientific notation

```
1 #PAGE=2
2 a=10**3
3 b=10**2
4 c=a*b
5 formatC(c,format="e")
6
7 a=10**6
8 b=10**4
9 c=a/b
10 formatC(c,format="e")
```

R code Exa 1.7 Scientific notation

```
1 #PAGE=2
2 a=4000000
3 b=0.0000000002
4 c=a*b
5 formatC(c,format="e")
```

R code Exa 1.8 Scientific notation

```
1 #PAGE=3
2 a=((0.006)*(80000))/(0.04)
3 print(a)
```

R code Exa 1.9 Significant figures

```
1 #PAGE=3
2
3 sigdigs<-function(a) {
4   d<-0
5   while(signif(a,digits=d) != a) {
6     d<-d+1
7     next
8   }
9   return(d)
10 }
11 sigdigs(1.67)
```

R code Exa 1.10 Significant figures

```
1 #PAGE=3
2 x=4.5300
3 x_new2 <- paste0(round(x, 4), "00")
4 x_new2
5 a=nchar(x_new2)
6
7 matched_commas <- gregexpr(".",x_new2 , fixed = TRUE
8 )
9 n_commas <- length(matched_commas[[1]])
10 n_commas
11 ans=a-n_commas
12 cat(ans)
```

R code Exa 1.11 Significant figures

```
1 #PAGE=3
2
3 sigdigs<-function(a) {
4   d<-0
5   while(signif(a,digits=d) != a) {
6     d<-d+1
7     next
8   }
9   return(d)
10 }
11 sigdigs(0.0018)
```

R code Exa 1.12 Significant figures

```
1 #PAGE=3
2
3 sigdigs<-function(a) {
4   d<-0
5   while(signif(a,digits=d) != a) {
6     d<-d+1
7     next
8   }
9   return(d)
10 }
11 a=sigdigs(0.001800)*2
12 cat(a)
```

R code Exa 1.13 Computation

```
1 #PAGE=3
2 a=73.24
```

```
3 b=4.52
4 c=a*b
5 round(c,0)
```

R code Exa 1.14 Computation

```
1 #PAGE=3
2 a=1.648
3 b=0.023
4 c=a/b
5 round(c,0)
```

R code Exa 1.15 Computation

```
1 #PAGE=3
2 a=38.7
3 b=sqrt(a)
4 round(b,2)
```

R code Exa 1.16 Computation

```
1 #PAGE=3
2 a=8.416
3 b=50
4 c=a*b
5 print(c)
```

R code Exa 1.17 Computation

```
1 #PAGE=3
2 a=3.16
3 b=2.7
4 c=a+b
5 round(c,1)
```

R code Exa 1.18 Computation

```
1 #PAGE=3
2 a=83.42
3 b=72
4 c=a-b
5 ans=round(c,0)
6 cat(ans)
```

R code Exa 1.19 Computation

```
1 #PAGE=3
2 a=47.816
3 b=25
4 c=a-b
5 print(c)
```

R code Exa 1.22 Solution to equation

```
1 #PAGE=5
2 a=9
3 b=3
```

```
4 c=2
5 d=a-b
6 solve(c,d)
```

R code Exa 1.31 Logarithm

```
1 #PAGE=6
2 a=2.36
3 b=log10(a)
4 round(b,4)
```

R code Exa 1.32 Logarithm

```
1 #PAGE=6
2 a=2.36
3 b=a*10
4 c=b*10
5 d=c*10
6
7 a=log10(a)
8 round(a,4)
9 b=log10(b)
10 round(b,4)
11 c=log10(c)
12 round(c,4)
13 d=log10(d)
14 round(d,4)
```

R code Exa 1.33 Logarithm

```
1 #PAGE=6
2 a=2.36
3 b=a/10
4 c=b/10
5
6 a=log10(a)
7 round(a,4)
8 b=log10(b)
9 round(b,4)
10 c=log10(c)
11 round(c,4)
```

R code Exa 1.34 Logarithm

```
1 #PAGE=6
2 x=c(2360,236,23.6,2.36)
3 y=log10(x)
4 round(y,4)
```

R code Exa 1.35 Logarithm

```
1 #PAGE=7
2 log(0.236)
3 log(0.0236)
4 log(0.00236)
5 a=log10(0.236)
6 a=round(a,0)
7 a
8 b=log10(0.0236)
9 b=round(b,0)
10 b
11 c=log10(0.00236)
12 c=round(c,0)
```



```

13  c
14
15  c2=9.3729
16  c3=10
17  c5=c2-c3
18  c5=(10**c5)
19  round(c5,4)
20
21  c2=8.3729
22  c3=10
23  c5=c2-c3
24  c5=(10**c5)
25  round(c5,4)
26
27  c2=7.3729
28  c3=10
29  c5=c2-c3
30  c5=(10**c5)
31  round(c5,5)

```

R code Exa 1.36 Antilogarithms

```

1  #PAGE=7
2  c2=8.6284
3  c3=10
4  c5=c2-c3
5  c5=(10**c5)
6  round(c5,4)
7
8  c6=3.6284
9  c6=10**c6
10 c6=round(c6,0)
11 cat(c6)
12
13 c7=5.6284

```

```
14 c7=10**c7
15 c7=round(c7,-2)
16 cat(c7)
```

Chapter 2

Frequency Distributions

R code Exa 2.2.1 arrange the numbers

```
1 #PAGE=41
2 c=c(17,45,38,27,6,48,11,57,34,22)
3 a=sort(c)
4 a
5 b=sort(c, decreasing = TRUE)
6 b
7
8 r=max(c)-min(c)
9 r
```

R code Exa 2.2.2 Final grades

```
1 #PAGE=41
2 n=c(68,84,75,82,68,90,62,88,76,93,
3     73,79,88,73,60,93,71,59,85,75,
4     61,65,75,87,74,62,95,78,63,72,
5     66,78,82,75,94,77,69,74,68,60,
6     96,78,89,61,75,95,60,79,83,71,
```

```

7      79,62,67,97,78,85,76,65,71,75,
8      65,80,73,57,88,78,62,76,53,74,
9      86,67,73,81,72,63,76,75,85,77)
10 a=max(n)
11 a
12 b=min(n)
13 b
14 c=a-b
15 c
16 d= head(sort(n,decreasing = TRUE),5)
17 d
18 e=head(sort(n),5)
19 e
20 f=(sort(n,TRUE)[10])
21 f
22 g=length(n[n >= 75])
23 g
24 h=length(n[n < 85])
25 h
26 i1=length(n[n > 65 & n<=85])
27 i=i1/length(n)
28 i=i*100
29 i=round(i,1)
30 i
31 j1=0:100
32 j=setdiff(j1,n)
33 j

```

R code Exa 2.2.3 Frequency distribution

```

1 #PAGE=42
2 a=c(250,260,270,280,290,300,310)
3 b=c
  (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

```

```

4  n=c(8,10,16,14,10,5,2)
5  n1=sum(n)
6
7  a1=a[6]
8  cat('$',a1)
9
10 b1=b[4]
11 cat('$',b1)
12
13 c1=(a[3]+b[3])/2
14 c1=round(c1,digits = 0)
15 cat('$',c1)
16
17 d1=(a[5]+b[4])/2
18 cat('$',d1)
19 d2=(a[6]+b[5])/2
20 cat('$',d2)
21
22 e1=b[5]-b[4]
23 cat('$',e1)
24
25 s=which(a==270)
26 f=n[s]
27 f
28
29 g=f/n1
30 g=g*100
31 g=round(g,digits = 1)
32 cat(g,'%')
33
34 h=which.max(n)
35 h1=a[h]
36 h2=b[h]
37 cat('$',h1,'- $',h2)
38
39 n2=n[1]+n[2]+n[3]
40 i=n2/n1
41 i=i*100

```

```

42 i=round(i,digits = 1)
43 cat(i, '%')
44
45 j1=which(a==290)
46 j2=which(a==260)
47 j=0
48 for(i in j2:j1)
49 {
50     j=j+n[i]
51 }
52 j=j/n1
53 j=j*100
54 j=round(j,digits = 1)
55 cat(j, '%')

```

R code Exa 2.2.4 Frequency distribution

```

1 #PAGE=43
2 x=c(128,137,146,155,164,173,182)
3 a=x[2]-x[1]
4 cat(a, 's')
5
6 a1=(x[1]+x[2])/2
7 a2=(x[2]+x[3])/2
8 a3=(x[3]+x[4])/2
9 a4=(x[4]+x[5])/2
10 a5=(x[5]+x[6])/2
11 a6=(x[6]+x[7])/2
12 a0=a1-a
13 a7=a6+a
14 b=c(a0,a1,a2,a3,a4,a5,a6,a7)
15 cat(b, 's')
16
17 b1=b-0.5
18 b2=b+0.5

```

```

19 cat(b2[1], '-', b1[2])
20 cat(b2[2], '-', b1[3])
21 cat(b2[3], '-', b1[4])
22 cat(b2[4], '-', b1[5])
23 cat(b2[5], '-', b1[6])
24 cat(b2[6], '-', b1[7])
25 cat(b2[7], '-', b1[8])

```

R code Exa 2.2.5 Graphical Representation

```

1 #PAGE=44
2 set.seed(0815)
3 x=c(128,137,146,155,164,173,182)
4 a=x[2]-x[1]
5
6 a1=(x[1]+x[2])/2
7 a2=(x[2]+x[3])/2
8 a3=(x[3]+x[4])/2
9 a4=(x[4]+x[5])/2
10 a5=(x[5]+x[6])/2
11 a6=(x[6]+x[7])/2
12 a0=a1-a
13 a7=a6+a
14 b=c(a0,a1,a2,a3,a4,a5,a6,a7)
15 b
16 b1=b-0.5
17 b2=b+0.5
18 b1
19 b2
20 df <- data.frame(x =b,
21                   F =runif(b),
22                   L =runif(b1),
23                   U =runif(b2))
24 df
25 x11()

```

```

26 require(ggplot2)
27 ggplot(df, aes(x = x, y = F)) +
28   geom_point(size = 4) +
29   geom_errorbar(aes(ymax = 0.75, ymin = 0.25))
30 #The answer may vary due to difference in
    representation.

```

R code Exa 2.2.6 150 measurements

```

1  #PAGE=44
2  n=150
3  s=51.8
4  l=74.4
5  r=l-s
6  r1=r/5
7  r2=r/20
8  r1=round(r1,1)
9  r2=round(r2,1)
10 a=seq.int(r2+1,r1)
11 a=round(a,0)
12 a1=a-0.1
13 a11=seq.int(51,74,by=a[1])
14 a12=a11+a1[1]
15 n1=length(a11)
16 for (i in 1:n1){
17   cat(a11[i],'- ',a12[i])
18   cat("\n")
19 }
20
21 b11=seq.int(51,74,by=a[2])
22 b12=b11+a1[2]
23 b12
24 n1=length(b11)
25 for (i in 1:n1){
26   cat(b11[i],'- ',b12[i])

```



```

27     cat("\n")
28 }
29
30 c11=seq.int(51,74,by=a[3])
31 c12=c11+a1[3]
32 n1=length(c11)
33 for (i in 1:n1){
34     cat(c11[i],'- ',c12[i])
35     cat("\n")
36 }
37
38 a21=a11-0.05
39 a22=a12+0.05
40 n1=length(a21)
41 for (i in 1:n1){
42     cat(a21[i],'- ',a22[i])
43     cat("\n")
44 }
45
46 b21=b11-0.05
47 b22=b12+0.05
48 n1=length(b21)
49 for (i in 1:n1){
50     cat(b21[i],'- ',b22[i])
51     cat("\n")
52 }
53
54 c21=c11-0.05
55 c22=c12+0.05
56 n1=length(c21)
57 for (i in 1:n1){
58     cat(c21[i],'- ',c22[i])
59     cat("\n")
60 }
61
62 aa=(a11+a12)/2
63 cat(aa)
64 bb=(b11+b12)/2

```

```
65 cat(bb)
66 cc=(c11+c12)/2
67 cat(cc)
```

R code Exa 2.2.8 Frequency distribution

```
1 #PAGE=45
2 c<-c(138,164,150,132,144,125,149,157,
3      146,158,140,147,136,148,152,144,
4      168,126,138,176,163,119,154,165,
5      146,173,142,147,135,153,140,135,
6      161,145,135,142,150,156,145,128)
7 c
8
9 b1=seq(117,182,by=5)
10 table2.7=cut(c,b1)
11 Frequency=table(table2.7)
12 a1=cbind(Frequency)
13 a1
14
15 b1=seq(117,182,by=9)
16 table2.7=cut(c,b1)
17 Frequency=table(table2.7)
18 a1=cbind(Frequency)
19 a1
```

R code Exa 2.2.9 histogram and frequency polygon

```
1 #PAGE=46
2 c<-c(138,164,150,132,144,125,149,157,
3      146,158,140,147,136,148,152,144,
4      168,126,138,176,163,119,154,165,
5      146,173,142,147,135,153,140,135,
```

```

6      161,145,135,142,150,156,145,128)
7  b1=seq(118,182,by=8)
8  table2.7=cut(c,b1)
9  a=table(table2.7)
10 a1=cbind(a)
11 a1
12 l=length(a1)
13 f=a1[0:l]
14 f=c(f,0)
15 hist(c, breaks=8,xlab = 'Time(seconds)',ylab='
    Frequency ')
16 plot(b1,f,type='l',xlim=c(110,180),ylim=c(0,12),xlab
    ='Time(seconds)',ylab='Frequency ')
17 #”The answer may vary due to difference in
    representation.”

```

R code Exa 2.2.10 relative frequency

```

1  #PAGE=46
2  a=c(250,260,270,280,290,300,310)
3  b=c
    (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

4  c=c(a,b)
5  n=c(8,10,16,14,10,5,2)
6  n1=sum(n)
7  n1
8  n2=(n/n1)*100
9  n2=round(n2,digits = 1)
10 n2
11
12 n3=(b+a)/2
13 n3=n3-200
14 n3=round(n3,digits = 0)
15 n4=rep(n3,n)

```

```

16 h=hist(n4,xlab='Wages')
17 h
18
19 mp=c(min(h$mids) - (h$mids[2] - h$mids[1]), h$mids,
      max(h$mids) + (h$mids[2] -h$mids[1]))
20 mp
21 freq = c(0, h$counts, 0)
22 freq
23 lines(mp, freq, type = "b", pch = 20, col = "red",
      lwd = 3)
24
25
26 n4=rep(n3,n2)
27 h=hist(n4,ylab='Relative Frequency',xlab='Wages')
28 mp=c(min(h$mids) - (h$mids[2] - h$mids[1]), h$mids,
      max(h$mids) + (h$mids[2] -h$mids[1]))
29 mp
30 freq = c(0, h$counts, 0)
31 freq
32 lines(mp, freq, type = "b", pch = 20, col = "red",
      lwd = 3)

```

R code Exa 2.2.12 P and R company

```

1 #PAGE=48
2 a=c
      (250,250,250,250,250,250,250,250,260,260,260,260,260,260,260,260,2
3      270,270,270,270,270,270,270,270,270,270,270,270,270,270,270,270,
4      280,280,280,280,280,280,280,280,280,280,280,280,290,290,290,290,
5      290,290,290,290,300,300,300,300,300,310,310)
6 a=c(a,285.34,316.83,335.78,356.21,374.5)
7 a

```

```

8
9  b1=seq(249,380,by=10)
10 table2.7=cut(a,b1)
11 Frequency=table(table2.7)
12 a1=cbind(Frequency)
13 a1
14
15 b1=seq(249,390,by=20)
16 table2.7=cut(a,b1)
17 Frequency=table(table2.7)
18 a1=cbind(Frequency)
19 a1

```

R code Exa 2.2.13 Histogram for frequency distribution

```

1  #PAGE=49
2  a=c(250,260,270,280,290,300,320)
3  b=c
      (259.99,269.99,279.99,289.99,299.99,319.99,379.99)

4  f=c(8,10,16,15,10,8,3)
5  f[8]=3
6  f[9]=3
7  f[10]=3
8
9  c=(a+b)/2
10 c=round(c,digits = 0)
11 c[7]=320
12 c[8]=330
13 c[9]=340
14 c[10]=350
15 c
16 n4=rep(c,f)
17 n4
18 hist(n4,xlab='Wages')

```

R code Exa 2.2.14 cumulative frequency

```
1 #PAGE=49
2 a=c(250,260,270,280,290,300,310,320)
3 n=c(8,10,16,14,10,5,2)
4 t=table(n)
5 s=0
6 c=0
7 for (x in n) {
8   s=s+x
9   c=c(c,s)
10 }
11 s1=c/s
12 s1=s1*100
13 s1=round(s1,1)
14 w=c('Less than $250.00 ', 'Less than $260.00 ', 'Less
      than $270.00 ', 'Less than $280.00 ', 'Less than $
      290.00 ', 'Less than $300.00 ', 'Less than $310.00 ',
      'Less than $320.00 ')
15 class.df<- data.frame(w,c,s1)
16 colnames(class.df) <- c('Wages', 'Cumulative
      Frequency', 'Percentage Cumulative Distribution')
17 class.df
18
19 w=c(250,260,270,280,290,300,310,320)
20 plot(w,c,type='b',xlab='Wages (in dollars)',ylab='
      Cumulative Frequency')
21 plot(w,s1,type='b',xlab='Wages (in dollars)',ylab='
      Percentage Cumulative Frequency')
```

R code Exa 2.2.15 Frequency distribution

```

1  #PAGE=50
2  a=c(250,260,270,280,290,300,310)
3  b=c
      (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

4  c=c(a,320)
5  c
6  n=c(8,10,16,14,10,5,2)
7  n=c(n,0)
8  n1=sum(n)
9  n4=rep(c,n)
10 n4
11 d0=n[7]
12 d1=n[7]+n[6]
13 d2=d1+n[5]
14 d3=n[4]+d2
15 d4=n[3]+d3
16 d5=n[2]+d4
17 d6=n[1]+d5
18
19 d=c(0,d0,d1,d2,d3,d4,d5,d6)
20 d=rev(d)
21 d
22 c
23 e=c('or more','or more','or more','or more','or more
      ','or more','or more','or more')
24 y <- matrix(c(c,e,d),ncol=3,byrow=FALSE)
25 colnames(y) <- c("Wages"," ","or more cf")
26 rownames(y) <- c(" "," "," "," "," "," "," "," "," ")
27 y <- as.table(y)
28 y
29
30 n4=rep(c,d)
31 n4
32
33 plot(table(n4),type='c',xlab = 'WAGES',ylab='CF')

```

R code Exa 2.2.16 Ogive estimation

```
1 #PAGE=51
2 w=c(250,260,270,280,290,300,310,320)
3 f=c(65,57,47,31,17,7,2,0)
4
5 a1=approx(w,f,288)
6 a1=round(a1$y,0)
7 a2=f[1]-a1
8 cat(a2)
9
10 b=approx(w,f,296)
11 b
12
13 c1=approx(w,f,275)
14 c2=approx(w,f,263)
15 c2$y-c1$y
```

R code Exa 2.2.17 five pennies were tossed 1000 times

```
1 #PAGE=51
2 n=c(0:5)
3 a=1000
4 f=c(38,144,342,287,164,25)
5 c=rep(n,f)
6 plot(table(c))
7 n1=sum(f)
8 d<-seq(0,6,by=1)
9 f=c(0,f)
10 e1=f[1]+f[2]
11 e2=e1+f[3]
12 e3=e2+f[4]
```



```

13 e4=e3+f [5]
14 e5=e4+f [6]
15 e6=e5+f [7]
16 e7=e6+f [8]
17 e=c(0,e1,e2,e3,e4,e5,e6)
18 e
19
20 g=e/10
21 g
22 n=c(n,6)
23 h=c('Less than','Less than','Less than','Less than',
      'Less than','Less than','Less than')
24 y <- matrix(c(h,n,e,g),ncol=4,byrow=FALSE)
25 colnames(y) <- c(" ","No.of heads","No.of tosses","
      percentage no.of tosses")
26 rownames(y) <- c(" "," "," "," "," "," "," "," ")
27 y <- as.table(y)
28 y
29
30
31 plot(n,g,type='l',xlab='Number of heads',ylab='
      Percentage of tosses')

```

R code Exa 2.2.18 100 male students at XYZ college

```

1 #PAGE=53
2 w1=c(60,63,66,69,72)
3 w2=w1+2
4 n=c(5,18,42,27,8)
5 t=sum(n)
6
7 a1=(w1+w2)/2
8 a=a1[1]-3
9 b=a1[length(a1)]+3
10 for (x in a1) {

```

```

11     a=c(a,x)
12 }
13
14 c=c(a,b)
15 n=c(0,n,0)
16 c1=c+1.5
17
18 smoothingSpline = smooth.spline(c, n, spar=0.35)
19 plot(c,n,type='o',xlab='Weight(kg)',ylab='Relative
    Frequency(in percentage)')
20 lines(smoothingSpline)
21
22 n=c(5,18,42,27,8)
23 c=0
24 s=0
25 for (x in n) {
26     s=s+x
27     c=c(c,s)
28 }
29
30 s1=c/s
31 s1=s1*100
32 s1=round(s1,1)
33 c1=c1[1:length(c1)-1]
34
35 smoothingSpline = smooth.spline(c1, s1, spar=0.35)
36 plot(c1,s1,type='o',xlab='Weight(kg)',ylab='
    Cumulative Frequency(in percent)')
37 lines(smoothingSpline)
38
39 a=65
40 b=70
41 a=a-0.5
42 b=b+0.5
43 c=82
44 d=18
45 e=c-d
46 m=e*1546/100

```

```
47 m=round(m,0)
48 m
49 cat(e, '%')
```

Chapter 3

The Mean Median Mode And Other Measures Of Central Tendency

R code Exa 3.3.4 Calculating the given variables

```
1 #PAGE=64
2 x=c(2,-5,4,-8)
3 y=c(-3,-8,10,6)
4 a=sum(x)
5 a
6 b=sum(y)
7 b
8 c=x*y
9 c=sum(c)
10 c
11 d=x**2
12 d=sum(d)
13 d
14 e=y**2
15 e=sum(e)
16 e
17 f=a*b
```

```
18 f
19 g=y**2
20 g=x*g
21 g=sum(g)
22 g
23 h=d-e
24 h
```

R code Exa 3.3.5 Calculating the given equation

```
1 #PAGE=64
2 s1=-4
3 s2=10
4 f=6
5 a=2*s1+f*3
6 a
7
8 b=s2-s1
9 b
10
11 c=s2-10*s1+25*f
12 c
```

R code Exa 3.3.6 mean of grades of student

```
1 #page=65
2 x=c(84,91,72,68,87,78)
3 mean(x)
```

R code Exa 3.3.7 mean of diameter of cylinders

```

1 #PAGE=65
2 a=c
   (38.8,40.9,39.2,39.7,40.2,39.5,40.3,39.2,39.8,40.6)

3 x=mean(a)
4 x=round(x,digits = 1)
5 cat(x,'mm')

```

R code Exa 3.3.8 annual salaries of four men

```

1 #PAFE=65
2 salary=c(15000,16000,16500,40000)
3 a=mean(salary)
4 cat('$',a)

```

R code Exa 3.3.9 arithmetic mean of a set of numbers

```

1 #PAGE=65
2 x=c(5,3,6,5,4,5,2,8,6,5,4,8,3,4,5,4,8,2,5,4)
3 mean(x)

```

R code Exa 3.3.10 arithmetic mean of numbers

```

1 #PAGE=65
2 x=c(4,5,6,7)
3 a=c(20,40,30,10)
4 weighted.mean(x,a)

```

R code Exa 3.3.11 Average grade for four subjects and their respective credits

```
1 #page=66
2 grades=c(82,86,90,70)
3 credits=c(3,5,3,1)
4 a=weighted.mean(grades,credits)
5 a=round(a,digits=0)
6 a
```

R code Exa 3.3.12 Mean of earning of employees

```
1 #PAGE=66
2 emp=c(60,20)
3 earn=c(7,4)
4 a=weighted.mean(earn,emp)
5 cat('$',a)
```

R code Exa 3.3.13 mean weight of all the students

```
1 #PAGE=66
2 students=c(15,20,10,18)
3 weights=c(74,67,70,63)
4 a=weighted.mean(weights,students)
5 cat(a,'kg')
```

R code Exa 3.3.14 Mean annual income of two groups

```
1 #PAGE=67
2 x=c(1,12)
```

```

3 y=c(9000,15000)
4 a=weighted.mean(y,x)
5 a=round(a,digits=-2)
6 cat('$ ',a)

```

R code Exa 3.3.15 Mean weight of students at XYZ university

```

1 #PAGE=67
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 len=length(w)
14 f=c(5,18,42,27,8)
15 a=sum(f)
16 b=0
17 for(i in 1:len)
18 {
19   b=b+w[i]*f[i]
20 }
21 x=b/a
22 cat(x, 'kg ')

```

R code Exa 3.3.19 guessed and arithmetic mean

```

1 #69

```



```

2 guessed_mean<-9
3 data<-c(5,8,11,9,12,6,14,10)
4 len=length(data)
5 temp=0
6 sum=0
7 for (i in 1:len )
8 {
9   temp[i]<-data[i]-guessed_mean
10  print(temp[i])
11  sum<-temp[i]+sum
12 }
13 sum<-sum/len
14 sample_mean=sum+guessed_mean
15 sample_mean
16
17 guessed_mean_2<-20
18 sum=0
19 temp=0
20 for (i in 1:len )
21 {
22   temp[i]<-data[i]-guessed_mean_2
23   print(temp[i])
24   sum<-temp[i]+sum
25 }
26 sum<-sum/len
27 sample_mean=sum+guessed_mean_2
28 sample_mean

```

R code Exa 3.3.20 Mean weight of students at XYZ university using different method

```

1 #PAGE=69
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)

```

```

5  w2=mean(w2)
6  w3=c(66,68)
7  w3=mean(w3)
8  w4=c(69,71)
9  w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 a=median(w)
14 b=w-a
15 f=c(5,18,42,27,8)
16 c=sum(f)
17 x=b*f
18 y=sum(x)
19 result=a+y/c
20 cat(result,'kg')

```

R code Exa 3.3.22 Mean weight of all the students of XYZ university

```

1  #PAGE=70
2  w1=c(60,62)
3  w1=mean(w1)
4  w2=c(63,65)
5  w2=mean(w2)
6  w3=c(66,68)
7  w3=mean(w3)
8  w4=c(69,71)
9  w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 w
14 f=c(5,18,42,27,8)
15 p=sum(f)
16 p

```

```

17 a=median(w)
18 a
19 b=w-a
20 b
21 c=3
22 b=b/c
23 b
24 d=f*b
25 d
26 e=sum(d)
27 e
28 x=a+(c*e)/p
29 cat(x, 'kg')

```

R code Exa 3.3.23 mean weekly wage

```

1 #PAGE=70
2 w1=c(250,259.99)
3 w1=round(mean(w1),digits = 0)
4 w2=c(260,269.99)
5 w2=round(mean(w2),digits = 0)
6 w3=c(270,279.99)
7 w3=round(mean(w3),digits = 0)
8 w4=c(280,289.99)
9 w4=round(mean(w4),digits = 0)
10 w5=c(290,299.99)
11 w5=round(mean(w5),digits = 0)
12 w6=c(300,309.99)
13 w6=round(mean(w6),digits = 0)
14 w7=c(310,319.99)
15 w7=round(mean(w7),digits = 0)
16 w=c(w1,w2,w3,w4,w5,w6,w7)
17 f=c(8,10,16,14,10,5,2)
18 a=sum(f)
19 x=f*w

```

```

20 b=sum(x)
21 m1=b/a
22 m1=round(m1,digits=2)
23 cat('$ ',m1)
24
25
26 m=which.max(f)
27 z=w[m]
28 c=10
29 w=w-z
30 w=w/c
31 e=w*f
32 e=sum(e)
33 m2=z+(c*e)/a
34 m2=round(m2,digits=2)
35 cat('$ ',m2)

```

R code Exa 3.3.24 mean wage of employees

```

1 #PAGE=71
2 w1=c(250,259.99)
3 w1=round(mean(w1),digits = 0)
4 w2=c(260,269.99)
5 w2=round(mean(w2),digits = 0)
6 w3=c(270,279.99)
7 w3=round(mean(w3),digits = 0)
8 w4=c(280,289.99)
9 w4=round(mean(w4),digits = 0)
10 w5=c(290,299.99)
11 w5=round(mean(w5),digits = 0)
12 w6=c(300,319.99)
13 w6=round(mean(w6),digits = 0)
14 w7=c(320,379.99)
15 w7=round(mean(w7),digits = 0)
16 w=c(w1,w2,w3,w4,w5,w6,w7)

```

```
17
18 f=c(8,10,16,15,10,8,3)
19 a=sum(f)
20
21 b=w*f
22 e=sum(b)
23 x=e/a
24 cat('$ ',x)
```

R code Exa 3.3.25 median of grades

```
1 #PAGE=71
2 x=c(84,91,72,68,87,78)
3 median(x)
```

R code Exa 3.3.26 hourly wages of five employees

```
1 #PAGE=71
2 x=c(4.52,5.96,5.28,11.20,5.75)
3 a=median(x)
4 cat('$ ',a)
5 b=mean(x)
6 cat('$ ',b)
```

R code Exa 3.3.27 Numbers in an array

```
1 #PAGE=72
2 a=85
3 b=150
4
```

```

5 c<-ifelse(a%%2==0, floor(a/2+1), floor(a/2))
6 c=c+1
7 cat(c)
8
9 d1<-ifelse(b%%2==0, floor(b/2+1), floor(b/2))
10 d2=d1-1
11 cat(d2, 'th ', d1, 'th ')

```

R code Exa 3.3.28 40 male students solving a problem

```

1 #PAGE=72
2 t1=c(118,127,136,145,154,163,172)
3 t2=c(126,135,144,153,162,171,180)
4 f=c(3,5,9,12,5,4,2)
5 s1=sum(f)
6
7 n=4
8 a=0.5
9 a1=t1[n]-a
10 a2=t2[n]+a
11
12 a=a1+(a2-a1)/n
13 a=round(a,1)
14 cat(a, 's ')
15
16 m=c
    (119,125,126,128,132,135,135,135,136,138,138,140,140,142,142,144,
17
18 m1=median(m)
19 cat(m1, 's ')

```

R code Exa 3.3.29 Histogram and Ogive

```

1 #PAGE=73
2 t1=c(118,127,136,145,154,163,172)
3 t2=c(126,135,144,153,162,171,180)
4 t=(t1+t2)/2
5 f=c(3,5,9,12,5,4,2)
6
7 m=c
      (119,125,126,128,132,135,135,135,136,138,138,140,140,142,142,144,
8
9 x11()
10 hist(m,xlab='Time(seconds ',ylab='Frequency ')
11 abline(v = median(m),
12         col = "red",
13         lwd = 2)
14
15 t1=t1-0.5
16 c1=cumsum(f)
17 x11()
18 plot(t1,c1,type='b',xlab='Time(seconds ',ylab='
      Cumulative Relative Frequency(%) ')
19 abline(v = median(t1),
20         col = "red",
21         lwd = 2)
22
23 m2=median(t1)
24 n2=9/4
25 n1=m2+n2
26 cat(n1,'s ')

```

R code Exa 3.3.30 P and R Company

```

1 #PAGE=74
2 n=65
3 n=n/2

```

```

4
5 f2=c(8,10,16,14,10,5,2)
6 s=c(f2[1],f2[2],f2[3])
7 s1=sum(s)
8 l=c(250,260,270,280,290,300,310)
9 f=c
    (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

10
11 l1=length(s)
12 m=(l[l1]+f[l1-1])/2
13
14 f1=f2[l1-1]
15 s2=f2[1]+f2[2]
16
17 m1=m+((n-s2)/s[l1])*f1
18 m1=round(m1,2)
19 cat('$',m1)

```

R code Exa 3.3.31 mean median and mode

```

1 #PAGE=74
2 a1=c(3,5,2,6,5,9,5,2,8,6)
3 m1=mean(a1)
4 m2=median(a1)
5 getmode <- function(v) {
6   uniqv <- unique(v)
7   uniqv[which.max(tabulate(match(v, uniqv)))]
8 }
9 result <- getmode(a1)
10 cat(m1)
11 cat(m2)
12 cat(result)
13
14 b1=c(51.6,48.7,50.3,49.5,48.9)

```



```

15 m1=mean(b1)
16 m2=median(b1)
17 getmode <- function(v) {
18   uniqv <- unique(v)
19   uniqv[which.max(tabulate(match(v, uniqv)))]
20 }
21 result <- getmode(b1)
22 cat(m1)
23 cat(m2)

```

R code Exa 3.3.33 modal wage of employees

```

1 #PAGE=75
2 l=269.995
3 f=c(8,10,16,14,10,5,2)
4 f=sort(f,decreasing = TRUE)
5 d2=f[1]-f[2]
6 d1=f[1]-f[3]
7 c=10
8 mode=l+(d1*c)/(d1+d2)
9 mode=round(mode,digits = 2)
10 cat('$',mode)

```

R code Exa 3.3.34 Empirical formula

```

1 #PAGE=75
2 m1=279.77
3 m2=279.06
4 m=m1-3*(m1-m2)
5 cat('$',m)

```

R code Exa 3.3.35 geometric mean and arithmetic mean

```
1 #PAGE=75
2 x=c(3,5,6,6,7,10,12)
3 a=1
4 len=length(x)
5 for(i in 1:len)
6 {
7   a=a*x[i]
8 }
9 a=a**(1/7)
10 a=round(a,digits = 2)
11 a
12
13 b=mean(x)
14 b
```

R code Exa 3.3.37 milk prices to bread prices

```
1 #PAGE=76
2 x=c(3,2)
3 a=mean(x)
4 a
5 y=1/x
6 y=round(y,digits = 3)
7 b=mean(y)
8 b=round(b,digits=3)
9 b
10 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 3.3.38 bacterial increase percentage

```

1 #PAGE=77
2 a=1000
3 b=4000
4 c=3
5 r=(b/a)**(1/c)-1
6 r=r*100
7 r=round(r,digits = 1)
8 r

```

R code Exa 3.3.39 harmonic mean

```

1 #PAGE=77
2 x=c(3,5,6,6,7,10,12)
3 len=length(x)
4 y=1/x
5 y=sum(y)
6 y=y*1/len
7 z=1/y
8 z=round(z,digits = 2)
9 z

```

R code Exa 3.3.40 average oil cost

```

1 #PAGE=78
2 a=4000
3 x=c(0.2,0.23,0.26,0.31)
4 y=a*x
5 z=sum(y)
6 b=z/(4*a)
7 cat('$',b,'/litre ')
8
9 t=4
10 c=sum(1/x)

```

```
11 h=t/c
12 h=round(h,digits = 2)
13 cat('$',h,'/litre ')
```

R code Exa 3.3.41 average speed for a trip

```
1 #PAGE=78
2 a=45
3 b=90
4 d=90
5 c=d/a
6 f=d/b
7 e=2*d
8 avg=e/(c+f)
9 cat(avg,'km/h ')
```

R code Exa 3.3.42 quadratic mean

```
1 #PAGE=79
2 x=c(3,5,6,6,7,10,12)
3 len=length(x)
4 y=x**2
5 y=sum(y)
6 y=y/len
7 z=y^(1/2)
8 z=round(z,digits=2)
9 z
```

R code Exa 3.3.44 Quartiles q1 q2 and q3

```

1  #PAGE=79
2  a=c(250,260,270,280,290,300,310)
3  b=c
    (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

4  n=c(8,10,16,14,10,5,2)
5
6  n1=65
7  n2=4
8  n3=n1/n2
9  n4=2
10 n5=n1/n4
11 n6=(3*n1)/n2
12 d=10
13
14 l=length(n)
15 n7=n3-(n[1])
16 n8=n5-(n[1]+n[2])
17 n9=n6-(n[1]+n[2]+n[3]+n[4])
18
19 c1=(a[2]+b[1])/2
20 c2=(a[3]+b[2])/2
21 c3=(a[5]+b[4])/2
22
23 q1=c1+(n7/n[2])*d
24 q2=c2+(n8/n[3])*d
25 q3=c3+(n9/n[5])*d
26
27
28 q1=round(q1,2)
29 q2=round(q2,2)
30 q3=round(q3,2)
31
32 cat('$ ',q1)
33 cat('$ ',q2)
34 cat('$ ',q3)
35
36 a=c(250,260,270,280,290,300,310)

```

```

37  b=c
    (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

38  n=c(8,10,16,14,10,5,2)
39  n0=65
40
41  n1=(a[1]+249.99)/2+(n0/10)*(d/n[1])
42  cat('$',n1)
43  n2=(a[2]+b[1])/2+5*(d/n[2])
44  n2=round(n2,0)
45  cat('$',n2)
46  n3=((a[3]+b[2])/2)+(1.5*d/n[3])
47  n3=round(n3,2)
48  cat('$',n3)
49
50  n4=(a[3]+b[2])/2+(8)*(d/n[3])
51  n4=round(n4,2)
52  cat('$',n4)
53  n6=(a[3]+b[2])/2+(14.5)*(d/n[3])
54  n6=round(n6,2)
55  cat('$',n6)
56
57  n7=(a[3]+b[4])/2+(5)*(d/n[4])
58  n7=round(n7,2)
59  cat('$',n7)
60
61  n8=(a[3]+b[4])/2+(11.5)*(d/n[4])
62  n8=round(n8,2)
63  cat('$',n8)
64
65  n9=(a[4]+b[5])/2+(4)*(d/n[5])
66  n9=round(n9,0)
67  cat('$',n9)
68
69  n10=(a[5]+b[6])/2+(0.5)*(d/n[6])
70  n10=round(n10,0)
71  cat('$',n10)
72

```

73 #The answer may vary due to difference in
representation.

R code Exa 3.3.45 Percentiles for the distribution

```
1 #PAGE=80
2 a=c(250,260,270,280,290,300,310)
3 b=c
  (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

4 n=c(8,10,16,14,10,5,2)
5
6 n1=65
7 c1=(a[3]+b[2])/2
8 d=10
9 a1=35
10 a1=(a1*n1)/100
11 a1=a1-(n[1]+n[2])
12 a1=a1/n[3]
13 a1=a1*d
14 a1=c1+a1
15 a1=round(a1,2)
16 cat('$ ',a1)
17
18 c2=(a[4]+b[3])/2
19 e=5/n[4]
20 b1=c2+e*d
21 b1=round(b1,2)
22 cat('$ ',b1)
```

R code Exa 3.3.46 Percentage Ogive

```
1 #PAGE=80
```

```

2 a=c(250,260,270,280,290,300,310)
3 b=c
    (259.99,269.99,279.99,289.99,299.99,309.99,319.99)

4 n=c(8,10,16,14,10,5,2)
5
6 c1=cumsum(n)
7 c1
8 c2=c1/65*100
9
10 x11()
11 plot(a,c2,type='b',xlab='Wages( dollars) ',ylab='
    Cumulative Relative Frequency(%) ')
12 abline(h = quantile(a,c(0.25,0.5 ,0.75)),v =
    quantile(a,c(0.25,0.5 ,0.75)),
13         col = "red",
14         lwd = 2)
15
16 #”The answer may vary due to difference in
    representation.”

```

R code Exa 3.4 arithmetic mean

```

1 #page=59
2 x=c(8,3,5,12,10)
3 mean(x)

```

R code Exa 3.5 Arithmetic Mean

```

1 #PAGE=59
2 x=c(5,8,6,2)
3 f=c(3,2,4,1)
4 len=length(x)

```



```

5 a=0
6 for(i in 1:len)
7 {
8   a=x[i]*f[i]+a
9 }
10 a=a/sum(f)
11 a

```

R code Exa 3.6 weighted mean

```

1 #page=59
2 a=70
3 b=90
4 c=85
5 d=3
6 e=1
7 f=1
8 x=(a*e+b*f+c*d)/(e+f+d)
9 x

```

R code Exa 3.7 deviation and mean

```

1 #page=59
2 x=c(8,3,5,12,10)
3 len=length(x)
4 y=mean(x)
5 z=x-y
6 z
7 a=sum(z)
8 x=round(a,digits=0)
9 x

```

R code Exa 3.8 median

```
1 #PAGE=60
2 x=c(3,4,4,5,6,8,8,8,10)
3 median(x)
```

R code Exa 3.9 median

```
1 #PAGE=60
2 x=c(5,5,7,9,11,12,15,18)
3 median(x)
```

R code Exa 3.10 mode

```
1 #page=61
2 x=c(2,2,5,7,9,9,9,10,10,11,12,18)
3 mode <- function(v) {
4   uniqv <- unique(v)
5   uniqv[which.max(tabulate(match(v, uniqv)))]
6 }
7
8 a=mode(x)
9 a
```

R code Exa 3.11 mode

```

1 #PAGE=61
2 x=c(3,5,8,10,12,15)
3 Mode = function(x){
4   ta = table(x)
5   tam = max(ta)
6   if (all(ta == tam))
7     mod = NA
8   else
9     if(is.numeric(x))
10      mod = as.numeric(names(ta)[ta == tam])
11   else
12     mod = names(ta)[ta == tam]
13   return(mod)
14 }
15 Mode(x)

```

R code Exa 3.12 bimodal

```

1 #PAGE=61
2 x=c(2,3,4,4,4,5,5,7,7,7,9)
3
4 Mode = function(x){
5   ta = table(x)
6   tam = max(ta)
7   if (all(ta == tam))
8     mod = NA
9   else
10    if(is.numeric(x))
11     mod = as.numeric(names(ta)[ta == tam])
12   else
13     mod = names(ta)[ta == tam]
14   return(mod)
15 }
16 Mode(x)

```

R code Exa 3.13 Geometric mean

```
1 #PAGE=62
2 x=c(2,4,8)
3 len=length(x)
4 a=1
5 for(i in 1:len)
6 {
7   a=a*x[i]
8 }
9 print(a)
10 a=a^(1/3)
11 a
```

R code Exa 3.14 harmonic mean

```
1 #PAGE=62
2 x=c(2,4,8)
3 a=sum(1/x)
4 a
5 len=length(x)
6 h=len/a
7 h=round(h,digits=2)
8 h
```

R code Exa 3.15 arithmetic geometric and harmonic mean

```
1 #page=62
2 x=c(2,4,8)
```

```

3 a=mean(x)
4 a=round(a,digits = 2)
5 a
6
7 len=length(x)
8 b=1
9 for(i in 1:len)
10 {
11     b=b*x[i]
12 }
13 print(b)
14 b=b^(1/3)
15 b
16
17 a=sum(1/x)
18 a
19 len=length(x)
20 h=len/a
21 h=round(h,digits=2)
22 h

```

R code Exa 3.16 RMS

```

1 #PAGE=63
2 x=c(1,3,4,5,7)
3 x=x**2
4 x
5 y=sum(x)
6 len=length(x)
7 a=y/len
8 a=sqrt(a)
9 a=round(a,digits = 2)
10 a

```

Chapter 4

The Standard Deviation And Other Measures Of Dispersion

R code Exa 4.1 Range of a set of numbers

```
1 #PAGE=87
2 x=c(2,3,3,5,5,5,8,10,12)
3 a=max(x)
4 b=min(x)
5 c=a-b
6 c
```

R code Exa 4.2 mean deviation of a set of numbers

```
1 #PAGE=87
2 x=c(2,3,6,8,11)
3 len=length(x)
4 y=mean(x)
5 b=0
6 for(i in 1:5)
7 {
```

```
8     a=abs(x[i]-y)
9     b=b+a
10 }
11 b=b/len
12 b
```

R code Exa 4.4.1 Range of a set of numbers

```
1 #PAGE=92
2 x=c(12,6,7,3,15,10,18,5)
3 m=max(x)
4 n=min(x)
5 a=m-n
6 a
7
8 y=c(9,3,8,8,9,8,9,18)
9 m=max(y)
10 n=min(y)
11 b=m-n
12 b
13
14
15 x1=c(12,6,7,15,10,5)
16 m=max(x1)
17 n=min(x1)
18 a1=m-n
19 a1
20
21
22 y1=c(9,8,8,9,8,9)
23 m=max(y1)
24 n=min(y1)
25 b1=m-n
26 b1
```

R code Exa 4.4.2 Range of weights of students

```
1 #PAGE=92
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 a=max(w)
14 b=min(w)
15 c=a-b
16 cat(c, 'kg ')
17
18 a=60-0.5
19 b=74+0.5
20 c=b-a
21 cat(c, 'kg ')
```

R code Exa 4.4.3 Mean deviation of a set of numbers

```
1 #PAGE=92
2 x=c(12,6,7,3,15,10,18,5)
3 len=length(x)
4 y=mean(x)
5 y
6 b=0
```



```

7  for(i in 1:len)
8  {
9    a=abs(x[i]-y)
10   print(a)
11   b=b+a
12 }
13 b=b/len
14 b
15
16 x=c(9,3,8,8,9,8,9,18)
17 len=length(x)
18 y=mean(x)
19 y
20 b=0
21 for(i in 1:len)
22 {
23   a=abs(x[i]-y)
24   print(a)
25   b=b+a
26 }
27 b=b/len
28 b

```

R code Exa 4.4.4 mean deviation of weights of students of XYZ college

```

1  #PAGE=93
2  w1=c(60,62)
3  w1=mean(w1)
4  w2=c(63,65)
5  w2=mean(w2)
6  w3=c(66,68)
7  w3=mean(w3)
8  w4=c(69,71)
9  w4=mean(w4)
10 w5=c(72,74)

```

```

11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 f=c(5,18,42,27,8)
14 s=sum(f)
15 y=w*f
16 s2=sum(y)
17 m=s2/s
18 x=abs(w-m)
19 z=x*f
20 a=sum(z)
21 md=a/s
22 cat(md,'kg')
23 #"The answer may slightly vary due to rounding off
    values."

```

R code Exa 4.4.5 Percentage of Students weights

```

1 #PAGE=93
2 a1=65.19
3 a2=69.71
4 a=(a1+a2)/2
5 b1=2.26
6 c1=a+b1
7 c2=a-b1
8 ans=42+(65.5-c2)*18/3+(c1-68.5)*27/3
9 ans=round(ans,0)
10 cat(ans)
11
12 a1=62.93
13 a2=71.97
14 a=(a1+a2)/2
15 b=2*b1
16 c1=a+b
17 c2=a-b
18 ans=18-(c2-62.5)*18/3+42+27+(c1-71.5)*8/3

```

```

19 ans=round(ans,0)
20 cat(ans)
21
22 a1=60.67
23 a2=74.23
24 a=(a1+a2)/2
25 b=b1*3
26 c1=a+b
27 c2=a-b
28 ans=5-(c2-59.5)*5/3+18+42+27+(74.5-c1)*8/3
29 ans=round(ans,0)
30 cat(ans)
31 #”The answer provided in the textbook is wrong.”

```

R code Exa 4.4.6 Semi interquartile range

```

1 #PAGE=94
2 q1=65.5+(2*3)/42
3 q3=68.5+(10*3)/27
4 q=(q3-q1)/2
5 q2=(q3+q1)/2
6 q2=round(q2,2)
7 q=round(q,2)
8 cat(q2, '+', q, 'kg ')
9 cat(q2, '-', q, 'kg ')

```

R code Exa 4.4.7 Semi interquartile range for wages

```

1 #PAGE=94
2 q1=268.25
3 q2=290.75
4 q11=(q2-q1)/2
5 cat('$ ', q11)

```

```

6 q22=(q1+q2)/2
7 cat('$ ',q22)
8
9 cat(q11, '+ ',q22, 'kg ')

```

R code Exa 4.4.8 Weights of students at XYZ University

```

1 #PAGE=94
2 a=62.5
3 b=68.5
4 c=3
5 d=5/18
6 e=25/27
7
8 p1=a+d*c
9 p1=round(p1,2)
10 cat(p1, 'kg ')
11
12 p2=b+e*c
13 p2=round(p2,2)
14 cat(p2, 'kg ')
15
16 q1=p2-p1
17 cat(q1, 'kg ')
18
19 q2=p2+p1
20 cat(q2, 'kg ')
21
22 q3=q1/2
23 q3=round(q3,2)
24 cat(q3, 'kg ')
25
26 q4=q2/2
27 q4=round(q4,2)
28 cat(q4, 'kg ')

```

29

```
30 cat(q4, ' + ', q3, ' kg ')
```

R code Exa 4.4.9 standard deviation for each set of numbers

```
1 #PAGE=94
2 f=c(12,6,7,3,15,10,18,5)
3 n=length(f)
4 s=sum(f)/n
5 s1=f-s
6 s1=s1**2
7 s2=sum(s1)
8 ans=sqrt(s2/n)
9 ans=round(ans,2)
10 cat(ans)
11
12 f=c(9,3,8,8,9,8,9,18)
13 n=length(f)
14 s=sum(f)/n
15 s1=f-s
16 s1=s1**2
17 s2=sum(s1)
18 ans=sqrt(s2/n)
19 ans=round(ans,2)
20 cat(ans)
```

R code Exa 4.4.10 variance of a set of numbers

```
1 #PAGE=95
2 a=4.87
3 ans=round(a*a,2)
4 cat(ans)
5
```

```
6 a=3.87
7 ans=round(a*a,0)
8 cat(ans)
```

R code Exa 4.4.11 Standard deviation of weights of 100 male students

```
1 #PAGE=95
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 f=c(5,18,42,27,8)
14 s=sum(f)
15 y=w*f
16 s2=sum(y)
17 m=s2/s
18 x=abs(w-m)
19 x=x**2
20 z=x*f
21 a=sum(z)
22 sd=sqrt(a/s)
23 sd=round(sd,digits = 2)
24 cat(sd,'kg')
```

R code Exa 4.4.12 standard deviation of a set of numbers

```

1 #PAGE=95
2 x=c(12,6,7,3,15,10,18,5)
3 y=mean(x)
4 y=y**2
5 z=x**2
6 z=mean(z)
7 s=sqrt(z-y)
8 s=round(s,digits = 2)
9 s

```

R code Exa 4.4.14 standard deviation of a set of data

```

1 #PAGE=97
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 f=c(5,18,42,27,8)
14 s=sum(f)
15 y=w*f
16 s2=sum(y)
17 m=s2/s
18 x=w**2
19 a=f*x
20 b=sum(a)
21 c=b/s
22 m=m**2
23 z=sqrt(c-m)

```

```
24 z=round(z,digits=2)
25 cat(z, 'kg ')
```

R code Exa 4.4.17 Standard deviation of weights of students of XYZ university

```
1 #PAGE=98
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 a=median(w)
14 f=c(5,18,42,27,8)
15 s=sum(f)
16 d=w-a
17 fd=d*f
18 e=sum(fd)
19 d=d**2
20 fd2=f*d
21 h=sum(fd2)
22 h=h/s
23 e=(e/s)**2
24 s=sqrt(h-e)
25 s=round(s,digits=2)
26 cat(s, 'kg ')
27
28
29 w=c(w1,w2,w3,w4,w5)
```



```

30 f=c(5,18,42,27,8)
31 s=sum(f)
32 d=(w-a)/3
33 fu=f*d
34 e=sum(fu)
35 fu2=f*d**2
36 h=sum(fu2)
37 s1=h/s-(e/s)**2
38 s1=sqrt(s1)
39 s1=3*s1
40 s1=round(s1,digits = 2)
41 cat(s1,'kg')

```

R code Exa 4.4.18 mean and standard deviation for wage distribution

```

1 #PAGE=99
2 w1=c(250,259.99)
3 w1=mean(w1)
4 w1=round(w1,digits=0)
5
6 w2=c(260,269.99)
7 w2=mean(w2)
8 w2=round(w2,digits=0)
9
10 w3=c(270,279.99)
11 w3=mean(w3)
12 w3=round(w3,digits=0)
13
14 w4=c(280,289.99)
15 w4=mean(w4)
16 w4=round(w4,digits=0)
17
18 w5=c(290,299.99)
19 w5=mean(w5)
20 w5=round(w5,digits=0)

```

```

21
22 w6=c(300,309.99)
23 w6=mean(w6)
24 w6=round(w6,digits=0)
25
26 w7=c(310,319.99)
27 w7=mean(w7)
28 w7=round(w7,digits=0)
29
30 w=c(w1,w2,w3,w4,w5,w6,w7)
31
32 f=c(8,10,16,14,10,5,2)
33 b=which.max(f)
34 a=w[b]
35 d=10
36 u=w-a
37 u=u/d
38
39 c=sum(f)
40 fu=f*u
41 e=sum(fu)
42 fu2=f*u**2
43 f=sum(fu2)
44
45 x=a+(d*e)/c
46 x=round(x,digits = 2)
47 cat('$ ',x)
48
49 m=f/c-(e/c)**2
50 m=sqrt(m)
51 m=m*10
52 m=round(m,digits = 2)
53 cat('$ ',m)

```

R code Exa 4.4.19 IQ of elementary school students

```

1 #PAGE=99
2 x=c
   (70,74,78,82,86,90,94,98,102,106,110,114,118,122,126)

3 f=c(4,9,16,28,45,66,85,72,54,38,27,18,11,5,2)
4 s=sum(f)
5 b=which.max(f)
6 a=x[b]
7 u=x-a
8 d=4
9 u=u/d
10 fu=f*u
11 s1=sum(fu)
12 fu2=f*u**2
13 s2=sum(fu2)
14
15
16 m=a+d*(s1/s)
17 m=round(m,digits=2)
18 m
19
20
21 n=(s2/s)-(s1/s)**2
22 n=sqrt(n)*d
23 n=round(n,digits=2)
24 n

```

R code Exa 4.4.20 Charlies Check

```

1 #PAGE=100
2 f=236
3 n=480
4 a=f+n
5 print(a)
6

```

```

7
8 fu=3404
9 b=fu+f*2+n
10 print(b)

```

R code Exa 4.4.21 standard deviation of data

```

1 #PAGE=100
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 a=median(w)
14 f=c(5,18,42,27,8)
15 s=sum(f)
16 d=w-a
17 fd=d*f
18 e=sum(fd)
19 d=d**2
20 fd2=f*d
21 h=sum(fd2)
22 h=h/s
23 e=(e/s)**2
24 s=sqrt(h-e)
25 s=round(s,digits=2)
26 s=s**2
27
28 c=3

```

```

29 c=c**2
30 cv=s-c/12
31 cv=sqrt(cv)
32 cv=round(cv,digits = 2)
33 cat(cv,'kg')
34
35
36 w1=c(250,259.99)
37 w1=mean(w1)
38 w1=round(w1,digits=0)
39
40 w2=c(260,269.99)
41 w2=mean(w2)
42 w2=round(w2,digits=0)
43
44 w3=c(270,279.99)
45 w3=mean(w3)
46 w3=round(w3,digits=0)
47
48 w4=c(280,289.99)
49 w4=mean(w4)
50 w4=round(w4,digits=0)
51
52 w5=c(290,299.99)
53 w5=mean(w5)
54 w5=round(w5,digits=0)
55
56 w6=c(300,309.99)
57 w6=mean(w6)
58 w6=round(w6,digits=0)
59
60 w7=c(310,319.99)
61 w7=mean(w7)
62 w7=round(w7,digits=0)
63
64 w=c(w1,w2,w3,w4,w5,w6,w7)
65
66 f=c(8,10,16,14,10,5,2)

```

```

67 b=which.max(f)
68 a=w[b]
69 d=10
70 u=w-a
71 u=u/d
72
73 c=sum(f)
74 fu=f*u
75 e=sum(fu)
76 fu2=f*u**2
77 f=sum(fu2)
78
79 x=a+(d*e)/c
80 x=round(x,digits = 2)
81
82 m=f/c-(e/c)**2
83 m=sqrt(m)
84 m=m*10
85 m=round(m,digits = 2)
86 m=m**2
87 d=d**2
88 cv=m-d/12
89 cv=sqrt(cv)
90 cv=round(cv,digits=2)
91 cat('$ ',cv)
92
93
94 x=c
    (70,74,78,82,86,90,94,98,102,106,110,114,118,122,126)

95 f=c(4,9,16,28,45,66,85,72,54,38,27,18,11,5,2)
96 s=sum(f)
97 b=which.max(f)
98 a=x[b]
99 u=x-a
100 d=4
101 u=u/d
102 fu=f*u

```

```

103 s1=sum(fu)
104 fu2=f*u**2
105 s2=sum(fu2)
106
107 m=a+d*(s1/s)
108 m=round(m,digits=2)
109
110 n=(s2/s)-(s1/s)**2
111 n=sqrt(n)*d
112 n=round(n,digits=2)
113
114 d=d**2
115 n=n**2
116 n=round(n,digits=2)
117 cv=n-d/12
118 cv=sqrt(cv)
119 cv=round(cv,digits=2)
120 cv

```

R code Exa 4.4.22 second frequency distribution

```

1 #PAGE=101
2 x1=c(118,126)
3 x1=mean(x1)
4 x2=c(127,135)
5 x2=mean(x2)
6 x3=c(136,144)
7 x3=mean(x3)
8 x4=c(145,153)
9 x4=mean(x4)
10 x5=c(154,162)
11 x5=mean(x5)
12 x6=c(163,171)
13 x6=mean(x6)
14 x7=c(172,180)

```

```

15 x7=mean(x7)
16 x=c(x1,x2,x3,x4,x5,x6,x7)
17 f=c(3,5,9,12,5,4,2)
18 b=which.max(f)
19 a=x[b]
20 c=9
21 u=(x-a)
22 u=u/c
23 n=sum(f)
24 fu=f*u
25 m1=sum(fu)
26 fu2=f*u**2
27 m2=sum(fu2)
28
29 y=a+c*m1/n
30 y=round(y,digits = 0)
31 cat(y,'s')
32
33
34 s=(m2/n-(m1/n)**2)
35 s=sqrt(s)
36 s=s*c
37 s=round(s,digits = 1)
38 cat(s,'s')
39
40 s=s^2
41 c=c^2
42 cv=s-c/12
43 cv=round(cv,digits=0)
44 csd=sqrt(cv)
45 csd=round(csd,digits=1)
46 cat(csd,'s')
47
48 x=c
    (138,164,150,132,144,125,149,157,146,158,140,147,136,148,152,144,
49 len=length(x)
50 a=150

```



```

51 x=x-a
52 x
53 d=sum(x)
54 x=x**2
55 d2=sum(x)
56 s=d2/len-(d/len)**2
57 s=sqrt(s)
58 s=round(s,digits = 1)
59 cat(s,'s')

```

R code Exa 4.4.23 Distribution of weights of students at XYZ University

```

1 #PAGE=102
2 m=2.92
3
4 a1=2.26
5 a=a1/m
6 a=round(a,2)
7 cat(a)
8
9 b1=1.98
10 b=b1/m
11 b=round(b,2)
12 cat(b)

```

R code Exa 4.4.24 Percentage of Students IQ

```

1 #PAGE=102
2 a3=95.97+10.47
3 a4=95.97-10.47
4 n=4
5 a6=88
6 a7=104

```

```

7  a5=((a6-a4)/n)*45+66+85+72+54+((a3-a7)/n)*38
8  m1=a5/480
9  m1=round(m1,1)
10 cat(m1*100,'%')
11
12 b1=95.97+2*10.47
13 b2=95.97-2*10.47
14 b1=round(b1,1)
15 b2=round(b2,1)
16 b3=76
17 b4=116
18 b5=((b3-b2)/4)*9+16+28+45+66+85+72+54+38+27+18+((b1-
    b4)/4)*11
19 m2=b5/480
20 m2=round(m2,2)
21 cat(m2*100,'%')
22
23 c1=95.97+3*10.47
24 c2=95.97-3*10.47
25 c1=round(c1,1)
26 c2=round(c2,1)
27 c3=128
28 c4=480
29 c5=c4-((c3-c1)/4)*2
30 c5
31 c6=c5/c4
32 c6=round(c6,3)
33 cat(c6*100,'%')
34 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 4.4.25 Mean and variance of single and combined sets

```

1 #page 103
2 x<-c(2,5,8,11,14)

```

```

3 y<-c(2,8,14)
4 a<-mean(x)
5 print(a)
6 b<-mean(y)
7 print(b)
8
9 l1<-length(x)
10 l2<-length(y)
11 sum=0
12 for (i in 1:l1)
13 {
14     sum<-sum+(x[i]-a)*(x[i]-a)
15 }
16 var1<-sum/l1
17 var1
18 sum=0
19 for (i in 1:l2)
20 {
21     sum<-sum+(y[i]-b)*(y[i]-b)
22 }
23 }
24 var2<-sum/l2
25 var2
26
27
28 z<-c(x,y)
29 z
30 m<-mean(z)
31 m
32
33 len<-length(z)
34 sum=0
35 for (i in 1:len)
36 {
37     sum<-sum+(z[i]-m)*(z[i]-m)
38 }
39 var<-sum/len
40 var

```

R code Exa 4.4.26 Set work problem

```
1 #PAGE=103
2 s1=c(2,5,8,11,14)
3 s2=c(10,16,22)
4 l1=length(s1)
5 l2=length(s2)
6
7 m2=mean(s1)
8 a1=0
9 a1=((s1-m2)**2)+a1
10 a1=sum(a1)/l1
11 cat(a1)
12
13 m3=mean(s2)
14 a2=0
15 a2=((s2-m3)**2)+a2
16 a2=sum(a2)/l2
17 cat(a2)
18
19 m1=(sum(s1)+sum(s2))/(l1+l2)
20 cat(m1)
21
22 s3=c(s1,s2)
23 s=0
24 s=((s3-m1)**2)+s
25 s=sum(s)/(l1+l2)
26 cat(s)
27
28 e=(a1*l1+a2*l2)/(l1+l2)
29 cat(e)
```

R code Exa 4.4.28 Television tubes A and B

```
1 #PAGE=104
2 x1=1495
3 x2=1875
4 s1=280
5 s2=310
6
7 y <- if(s1 < s2) print(s1)
8 y
9
10 a=s1/x1
11 a=round(a,3)
12 cat(a*100, '%')
13
14 b=s2/x2
15 b=round(b,3)
16 cat(b*100, '%')
17 #”The answer may vary due to difference in
    representation.”
```

R code Exa 4.4.29 Coefficients of variance

```
1 #PAGE=104
2 s1=2.92
3 s2=2.79
4 s3=67.45
5 a1=s1/s3
6 a1=round(a1,3)
7 cat(a1*100, '%')
8
9 a2=s2/s3
10 a2=round(a2,3)
11 cat(a2*100, '%')
12
```

```

13 m1=15.6
14 m2=15.33
15 m3=79.77
16 b1=m1/m3
17 b1=round(b1,3)
18 cat(b1*100,'%')
19
20 b2=m2/m3
21 b2=round(b2,3)
22 cat(b2*100,'%')

```

R code Exa 4.4.30 Measure of relative dispersion

```

1 #PAGE=104
2 q3=69.611
3 q1=65.64
4 v=(q3-q1)/(q3+q1)
5 v=round(v,3)
6 v=v*100
7 cat(v,'%')

```

R code Exa 4.4.31 Higher relative standing

```

1 #PAGE=105
2 a=84
3 b=76
4 s=10
5 z=(a-b)/s
6 z
7
8 c=90
9 d=82
10 s1=16

```

```

11 z1=(c-d)/s1
12 z1
13
14 if(z1 < z) print(TRUE)
15 #”The answer may vary due to difference in
    representation.”

```

R code Exa 4.4.32 Converting the IQs into standard scores

```

1 #PAGE=105
2 x=c
    (70,74,78,82,86,90,94,98,102,106,110,114,118,122,126)

3 f=c(4,9,16,28,45,66,85,72,54,38,27,18,11,5,2)
4 a1=x[1]-4
5 a2=x[15]+4
6 x1=c(a1,x,a2)
7 m=96
8 s=10.5
9 x2=x1-m
10
11 z=x2/s
12 z=round(z,2)
13
14 a1=0
15 a2=0
16 f=c(a1,f,a2)
17 f1=sum(f)
18 f1
19
20 rf=f/f1
21 rf=round(rf,3)
22 rf=rf*100
23 rf1=sum(rf)
24 rf1=round(rf1,0)

```

```

25 rf1
26
27 y5 <- matrix(c(x1,x2,z,f,rf),nrow = 17,byrow=FALSE)
28 rownames(y5) <- c(" "," "," "," "," "," "," "," "," "," "," "," "," "," "," "," ")
      " "," "," "," "," "," "," "," "," "," "," "," "," "," ")
29 colnames(y5) <- c("IQ(X)","X-X BAR","z",'Frequency',
      'Relative Frequency')
30 y5 <- as.table(y5)
31 y5
32
33 x11()
34 plot(z,rf,type='l',xlab=" ",ylab='Relative Frequency
      ')

```

Chapter 5

Moments Skewness And Kurtosis

R code Exa 5.5.1 moments

```
1 #PAGE=113
2 x<-c(2,3,7,8,10)
3 len=length(x)
4 sum<-0
5 first=0
6 for (i in 1:len)
7 {
8   sum=sum+x[i]
9 }
10 first=sum/len
11 first
12 sum=0
13 for (i in 1:len)
14 {
15   sum=sum+x[i]**2
16 }
17 second=sum/len
18 second
19
```

```

20 sum=0
21 for (i in 1:len)
22 {
23     sum=sum+x[i]**3
24 }
25 third=sum/len
26 third
27
28 sum=0
29 for (i in 1:len)
30 {
31     sum=sum+x[i]**4
32 }
33 four=sum/len
34 four

```

R code Exa 5.5.2 moments about the mean

```

1 #PAGE=113
2 x=c(2,3,7,8,10)
3 len=length(x)
4 a=mean(x)
5 a
6 m1=x-a
7 m1=sum(m1)/len
8 m1
9 m2=(x-a)**2
10 m2=sum(m2)/len
11 m2
12 m3=(x-a)**3
13 m3=sum(m3)/len
14 m3
15 m4=(x-a)**4
16 m4=sum(m4)/len
17 m4

```

R code Exa 5.5.3 moments about the origin

```
1 #PAGE=114
2 x=c(2,3,7,8,10)
3 len=length(x)
4
5 m1=x-4
6 m1=sum(m1)/len
7 m1
8 m2=(x-4)**2
9 m2=sum(m2)/len
10 m2
11 m3=(x-4)**3
12 m3=sum(m3)/len
13 m3
14 m4=(x-4)**4
15 m4=sum(m4)/len
16 m4
```

R code Exa 5.5.4 relation between moments

```
1 #PAGE=114
2 x=c(2,3,7,8,10)
3 len=length(x)
4 a=mean(x)
5 m1=x-a
6 m1=sum(m1)/len
7 m2=(x-a)**2
8 m2=sum(m2)/len
9 m3=(x-a)**3
10 m3=sum(m3)/len
```

```

11 m4=(x-a)**4
12 m4=sum(m4)/len
13
14 m11=x-4
15 m11=sum(m11)/len
16 m22=(x-4)**2
17 m22=sum(m22)/len
18 m33=(x-4)**3
19 m33=sum(m33)/len
20 m44=(x-4)**4
21 m44=sum(m44)/len
22
23 a=m22-m11**2
24 a
25
26 b=m33-3*m11*m22+2*m11**3
27 b
28
29 c=m44-4*m11*m33+6*m11**2*m22-3*m11**4
30 c

```

R code Exa 5.5.6 first four moments about the weight

```

1 #PAGE=115
2 w1=c(60,62)
3 w1=mean(w1)
4 w2=c(63,65)
5 w2=mean(w2)
6 w3=c(66,68)
7 w3=mean(w3)
8 w4=c(69,71)
9 w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)

```

```

13 f=c(5,18,42,27,8)
14 n=sum(f)
15 b=which.max(f)
16 a=w[b]
17 w=w-a
18 d=3
19 w=w/d
20 fu=f*w
21 e=sum(fu)
22 fu2=f*w**2
23 g=sum(fu2)
24 fu3=f*w**3
25 h=sum(fu3)
26 fu4=f*w**4
27 i=sum(fu4)
28
29 m1=d*(e/n)
30 m1
31
32 m2=d**2*(g/n)
33 m2
34
35 m3=d**3*(h/n)
36 m3
37
38 m4=d**4*(i/n)
39 m4
40
41 x=c(w1,w2,w3,w4,w5)
42 z=mean(x)
43 m11=(x-z)
44 m11=m11/2
45 m11=sum(m11)
46 m11
47
48
49 m22=m2-m1**2
50 m22

```

```

51
52 m33=m3-3*m1*m2+2*m1**3
53 m33=round(m33,digits = 4)
54 m33
55
56 m44=m4-4*m1*m3+6*m1**2*m2-3*m1**4
57 m44

```

R code Exa 5.5.7 Moments for distribution

```

1 #PAGE=115
2 x=c
   (70,74,78,82,86,90,94,98,102,106,110,114,118,122,126)

3 f=c(4,9,16,28,45,66,85,72,54,38,27,18,11,5,2)
4 s=sum(f)
5 b=which.max(f)
6 a=x[b]
7 u=x-a
8 d=4
9 u=u/d
10 fu=f*u
11 s1=sum(fu)
12
13 fu2=f*u**2
14 s2=sum(fu2)
15
16 fu3=f*u**3
17 s3=sum(fu3)
18
19 fu4=f*u**4
20 s4=sum(fu4)
21
22 N=sum(f)
23

```

```

24 a1=d*s1/N
25 a1=round(a1,4)
26 a1
27
28 b1=(d**2)*(s2)/N
29 b1
30
31 c1=(d**3)*(s3)/N
32 c1
33
34 d1=(d**4)*(s4)/N
35 d1
36
37 e1=a1-a1**1
38 e1
39
40 f1=b1-a1**2
41 f1
42
43 g1=c1-3*a1*b1+2*a1**3
44 g1
45
46 h1=d1-4*c1*a1+6*(a1**2)*b1-3*a1**4
47 h1
48
49 i1=a+d*s1/N
50 i1=round(i1,2)
51 i1
52
53 j1=sqrt(f1)
54 j1=round(j1,2)
55 j1
56
57 k1=a**2+2*a*a1+b1
58 k1
59
60 l1=a**3+3*a**2*a1+3*a*b1+c1
61 l1=round(l1,-2)

```

```
62 11
63 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 5.5.8 Charlies check

```
1 #PAGE=116
2 x=c
    (70,74,78,82,86,90,94,98,102,106,110,114,118,122,126)

3 x
4 f=c(4,9,16,28,45,66,85,72,54,38,27,18,11,5,2)
5 f
6 s=sum(f)
7 s
8 b=which.max(f)
9 a=x[b]
10 a
11 u=x-a
12 d=4
13 u=u/d
14 u
15 fu=f*u
16 fu
17 s1=sum(fu)
18 s1
19 fu2=f*u**2
20 fu2
21 s2=sum(fu2)
22 s2
23 fu3=f*u**3
24 fu3
25 s3=sum(fu3)
26 s3
27 fu4=f*u**4
```



```
28 fu4
29 s4=sum(fu4)
30 s4
31
32 u=u+1
33 u
34
35 f1=f*u
36 f1
37 y1=sum(f1)
38 y1
39 s1=s1+s
40 s1
41
42 f2=f*u**2
43 f2
44 y2=sum(f2)
45 y2
46 s2=s2+s
47 s2
48
49 f3=f*u**3
50 f3
51 y3=sum(f3)
52 y3
53 s3=s3+s
54 s3
55
56 f4=f*u**4
57 f4
58 y4=sum(f4)
59 y4
60 s4=s4+s
61 s4
```

R code Exa 5.5.9 Sheppards correction

```
1 #PAGE=117
2 m1=8.5275
3 c=3
4 l=12
5 m2=m1-(c**2)/l
6 m2
7 m3=199.3759
8 m4=m3-(c**2*m1)/2+(7*c**4)/240
9 m4
10
11
12 m3=109.5988
13 c=4
14 l=12
15 m5=m3-(c**2)/l
16 m5
17 m6=35627.2853
18 m7=m6-(c**2*m3)/2+(7*c**4)/240
19 m7
```

R code Exa 5.5.10 Pearsons

```
1 #PAGE=118
2 m1=279.76
3 m2=279.06
4 m3=277.5
5 s=15.6
6 a=(m1-m3)/s
7 a=round(a,digits = 2)
8 a
9
10 b=3*(m1-m2)/s
11 b=round(b,digits = 2)
```

12 b

R code Exa 5.5.11 Quartile and percentile

```
1 #PAGE=118
2 q1=268.25
3 q2=279.06
4 q3=290.75
5 d1=258.12
6 d2=301
7
8 a=(q3-2*q2+q1)/(q3-q1)
9 a=round(a,digits = 4)
10 a
11
12 b=(d2-2*q2+d1)/(d2-d1)
13 b=round(b,digits = 4)
14 b
```

R code Exa 5.5.12 Coefficient of skewness

```
1 #PAGE=118
2 m1=8.5275
3 m2=-2.6932
4 a=(m2)/sqrt(m1**3)
5 a=round(a,digits = 2)
6 a
7
8 g=7.7775
9 b=m2/sqrt(g**3)
10 b=round(b,digits = 2)
11 b
12
```

```

13 m3=202.8158
14 m4=109.5988
15 c=m3/(sqrt(m4)**3)
16 c=round(c,digits = 2)
17 c
18
19 h=108.2655
20 d=m3/(sqrt(h)**3)
21 d=round(d,digits = 2)
22 d

```

R code Exa 5.5.13 Coefficient of kurtosis

```

1 #PAGE=119
2 m4=199.3759
3 m2=8.5275
4 m3=163.3646
5 m1=7.7775
6
7 a=m4/(m2**2)
8 a=round(a,digits = 2)
9 a
10
11 b=m3/(m1**2)
12 b=round(b,digits = 2)
13 b
14
15 a1=35627.2853
16 a2=109.5988
17 a3=34757.9616
18 a4=108.2655
19
20 c=a1/(a2**2)
21 c=round(c,digits = 2)
22 c

```

```
23
24 d=a3/(a4**2)
25 d=round(d,digits = 2)
26 d
```

R code Exa 5.5.14 Percentile coefficient of Kurtosis

```
1 #PAGE=119
2 q3=290.75
3 q2=268.25
4 q=(q3-q2)/2
5 cat('$ ',q)
6
7 p1=301
8 p2=258.12
9 p=p1-p2
10 cat('$ ',p)
11
12 k=q/p
13 k=round(k,digits = 2)
14 k
```

Chapter 6

Elementary Probability Theory

R code Exa 6.1 Events and probability

```
1 #PAGE=122
2 a=c(3,4)
3 b=c(1:6)
4 l1=length(a)
5 l2=length(b)
6 l=l1/l2
7 p=1-l
8 cat(p)
```

R code Exa 6.2 Tossing a coin

```
1 #PAGE=122
2 a=529
3 b=1000
4 c=a/b
5 cat(c)
6
7 d=493
```

```
8 e=(a+d)
9 f=e/(2*b)
10 cat(f)
```

R code Exa 6.3 E1 and E2 events

```
1 #PAGE=123
2 p1=1/2
3 p2=1/2
4 p=p1*p2
5 cat(p)
```

R code Exa 6.4 Probability that A and B will be alive

```
1 #PAGE=123
2 n=20
3 p=0.7
4 q=0.5
5 a=p*q
6 cat(a)
```

R code Exa 6.5 White and black balls

```
1 #PAGE=123
2 w=3
3 b=2
4 t=w+b
5 a=b/t
6 b=(b-1)/(t-1)
7 p=a*b
8 cat(p)
```

R code Exa 6.6 Pair of fair dice

```
1 #PAGE=124
2 p1=4/52
3 p2=4/52
4 p=p1+p2
5 cat(p)
```

R code Exa 6.6.1 dice and coin and cards

```
1 #PAGE=128
2 a1=c(1,3,5)
3 n1=6
4 a=length(a1)/n1
5 a
6
7 b1=c(1,2,3)
8 b2=c(0,b1)
9 l1=length(b1)
10 l2=length(b2)
11 l=l1/l2
12 l
13
14 n=6
15 q=52
16 p=n/q
17 p
18
19 n=6
20 c=c(c(1,6),c(2,5),c(3,4),c(4,3),c(5,2),c(6,1))
21 l=length(c)
```



```
22 l=1 / 2
23 p=1 / (1*n)
24 p
25
26 n3=100
27 h=56
28 h1=n3-h
29 p=h1 / n3
30 p
```

R code Exa 6.6.3 red white and blue balls

```
1 #PAGE=129
2 r=6
3 w=4
4 bb=5
5 x=r+w+bb
6 a=r / x
7 a
8 b=w / x
9 b
10 c=bb / x
11 c
12 d=1-a
13 d
14 e=(r+w) / (x)
15 e
```

R code Exa 6.6.4 fair dice tossed twice

```
1 #PAGE=129
2 l1=(1:6)
3 l2=(1:6)
```

```

4 e1=c(4,5,6)
5 e2=c(1,2,3,4)
6 len=length(e1)
7 len2=length(e2)
8 m1=length(l1)
9 m2=length(l2)
10 m=m1*m2
11 len1=len*len2
12 p=len1/m
13 p

```

R code Exa 6.6.5 Deck of 52 cards

```

1 #PAGE=130
2 n=52
3 n1=4
4 n2=4
5 p=(n1/n)*(n2/n)
6 cat(p)
7
8 b=(n1)*(n2-1)/(n*(n-1))
9 cat(b)

```

R code Exa 6.6.6 three balls drawn from a box

```

1 #PAGE=130
2 r=6
3 w=4
4 b=5
5 x=r+w+b
6 y=(r-1)+w+b
7 z=(r-1)+(w-1)+b
8

```

```

9  x1=r/x
10 x2=w/y
11 x3=b/z
12
13
14 a=r/x
15 bb=w/x
16 c=b/x
17
18 a1=a*bb*c
19 a1
20
21 b1=x1*x2*x3
22 b1

```

R code Exa 6.6.7 Two tosses of a fair dice

```

1  #PAGE=130
2  n=4
3  e1=n+1
4  e2=n+1
5  e=e1+e2+1
6  n1=n2=6
7  a=e/(n1*n2)
8  a

```

R code Exa 6.6.8 white and black balls

```

1  #PAGE=131
2  w1=4
3  b1=2
4  w2=3
5  b2=5

```

```

6  x1=w1+b1
7  x2=w2+b2
8
9  a1=(w1/x1)*(w2/x2)
10 a1
11
12 bb2=(b1/x1)*(b2/x2)
13 bb2
14
15 c=(w1/x1)*(b2/x2)+(b1/x1)*(w2/x2)
16 c

```

R code Exa 6.6.9 games of chess

```

1  #PAGE=131
2  a=6
3  b=4
4  t=2
5  n=3
6  g=a+b+t
7  a1=a/g
8  b1=b/g
9  t1=t/g
10
11 p1=a1**n
12 p1
13
14 p2=t1*(1-t1)*t1+(1-t1)*t1*t1+t1*t1*(1-t1)
15 p2
16
17 p3=a1*b1*a1+b1*a1*b1
18 p3
19
20 p4=1-(1-b1)**n
21 p4

```

R code Exa 6.6.10 probability of girls and boys

```
1 #PAGE=132
2 x=c(0:3)
3 n1=3
4 p=1/2
5 q=1-p
6 p1=(p**n1)
7 p1
8 p2=(q**n1)
9 p2
10 c=p1*3
11 c
12 d=p2*3
13 d
14
15 p=c(p1,c,d,p2)
16 p
17 y<- matrix(c(x,p),ncol=4,byrow=TRUE)
18 colnames(y) <- c(" "," "," "," ")
19 rownames(y) <- c('Numbers of boys','Probability')
20 y <- as.table(y)
21 y
```

R code Exa 6.6.11 Graph of distribution

```
1 #PAGE=133
2 x=c(0:3)
3 n1=3
4 p=1/2
5 q=1-p
```

```

6  p1=(p**n1)
7  p1
8  p2=(q**n1)
9  p2
10 c=p1*3
11 c
12 d=p2*3
13 d
14
15 p=c(p1,c,d,p2)
16 p
17 y<- matrix(c(x,p),ncol=4,byrow=TRUE)
18 colnames(y) <- c(" "," "," "," ")
19 rownames(y) <- c('Numbers of boys','Probability')
20 y <- as.table(y)
21 y
22 barplot(p,xlab='Number of Boys',ylab='p(X)')

```

R code Exa 6.6.12 Continuous Random Variable

```

1  #PAGE=133
2  x=c(0:4)
3  x1=0
4  p1=1/2-x1
5  p1
6  h=2
7  h1=h**2
8  h1
9  x2=4
10 x=x2/h
11 x
12
13 a=(1-(1/x))/h1
14 a
15 a1=p1-h1*a

```

```
16 a1
17
18 x3=1
19 x4=2
20 p3=p1**3
21 p3
22
23 p4=p1-p3
24 p5=p1**2
25
26 b=p1*(p4+p5)
27 b
```

R code Exa 6.6.13 man purchases a raffle ticket

```
1 #PAGE=134
2 w1=5000
3 w2=2000
4 p1=0.001
5 p2=0.003
6 fair_price=w1*p1+w2*p2
7 cat('$ ',fair_price)
```

R code Exa 6.6.14 business venture

```
1 #PAGE=134
2 p1=300
3 p2=100
4 p11=0.6
5 p22=0.4
6 ex=p1*p11-p2*p22
7 cat('$ ',ex)
```

R code Exa 6.6.15 probability distribution

```
1 #page 134
2 x<-c(8,12,16,20,24)
3 p<-c(1/8,1/6,3/8,1/4,1/12)
4 E1=0
5 len<-length(x)
6 for( i in 1:len)
7 {
8   E1=E1+x[i]*p[i]
9 }
10 cat(E1)
11
12 E2=0
13 for (i in 1:len)
14 {
15   E2=E2+x[i]**2*p[i]
16 }
17 cat(E2)
18
19 E3=0
20 for (i in 1:len)
21 {
22   E3=E3+(E1-x[i])**2*p[i]
23 }
24 cat(E3)
```

R code Exa 6.6.16 white and black balls

```
1 #PAGE=134
2 w=2
3 b=3
```



```

4 e=10
5 n=4
6 x=w+b
7 pa=w/x
8 pa
9
10 a=e*pa
11 a
12
13 pab=(b/x)*(w/(x-1))
14 pab
15
16 b=e*pab
17 b
18
19 pabc=(b/x)*(w/(x-1))*((n-2)/(x-2))
20 pabc
21
22 c=pabc*e
23 c
24
25 pd=(b/x)*(w/(x-1))*((n-2)/(x-2))*((n-3)/(x-3))
26 pd
27
28 d=e*pd
29 d

```

R code Exa 6.6.17 5 different marbles

```

1 #PAGE=135
2 a=5
3 factorial(a)

```

R code Exa 6.6.18 benches and seats

```
1 #PAGE=135
2 a=10
3 b=4
4 x=factorial(a)
5 z=factorial(a-b)
6 ans=x/z
7 ans
```

R code Exa 6.6.19 permutation

```
1 #PAGE=135
2 a1=8
3 a2=3
4 a=factorial(a1)/(factorial(a1-a2))
5 a
6
7 b1=6
8 b2=4
9 b=factorial(b1)/(factorial(b1-b2))
10 b
11
12 c1=15
13 c2=1
14 c=factorial(c1)/(factorial(c1-c2))
15 c
16
17 d1=3
18 d2=3
19 d=factorial(d1)/(factorial(d1-d2))
20 d
```

R code Exa 6.6.20 Men and women

```
1 #PAGE=135
2 m=5
3 w=4
4 p1=factorial(m)
5 p2=factorial(w)
6 p=p1*p2
7 p
```

R code Exa 6.6.21 Allowed and not allowed repetitions

```
1 #PAGE=136
2 x=(0:9)
3 t2=length(x)-1
4 h=length(x)
5 t1=length(x)
6 o=length(x)
7 a=t2*h*t1*o
8 a
9
10 t3=length(x)-1
11 h1=length(x)-1
12 t4=h1-1
13 o1=t4-1
14 b=t3*h1*t4*o1
15 b
16
17 t5=length(x)-1
18 h2=t5-1
19 t6=h2-1
20 o2=1
21 c=t5*h2*t6*o2
22 c
```

R code Exa 6.6.22 Mathematics physics and chemistry

```
1 #PAGE=136
2 m=4
3 p=6
4 c=2
5 n=3
6 p1=factorial(m)
7 p2=factorial(p)
8 p3=factorial(c)
9 p4=factorial(n)
10
11 a=p1*p2*p3*p4
12 a
13
14 m1=1
15 x=m1+p+c
16 p5=factorial(x)
17
18 b=p5*p1
19 b
```

R code Exa 6.6.23 red white and blue marbles

```
1 #PAGE=136
2 r=5
3 w=2
4 b=3
5 x=r+w+b
6
7 a1=factorial(r)
8 a2=factorial(w)
```

```
9 a3=factorial(b)
10 a4=factorial(x)
11
12 a=a4/(a2*a3*a1)
13 a
```

R code Exa 6.6.24 people and round table

```
1 #PAGE=137
2 x=7
3 a=factorial(x-1)
4 a
5
6 y=2
7 b=factorial(x-y)*factorial(y)
8 b=a-b
9 b
```

R code Exa 6.6.25 objects into groups

```
1 #PAGE=137
2 o=10
3 x=4
4 y=6
5
6 a=factorial(o)
7 b=factorial(x)
8 c=factorial(y)
9
10 m=a/(b*c)
11 m
```

R code Exa 6.6.26 Evaluation

```
1 #PAGE=137
2 x1=7
3 y1=4
4 a=factorial(x1)/(factorial(y1)*factorial(x1-y1))
5 a
6
7 x2=6
8 y2=5
9 b=factorial(x2)/(factorial(y2)*factorial(x2-y2))
10 b
11
12 x3=4
13 y3=4
14 c=factorial(x3)/(factorial(y3)*factorial(x3-y3))
15 c
```

R code Exa 6.6.27 committee of people

```
1 #PAGE=138
2 a=9
3 b=5
4 x=factorial(a)/(factorial(b)*factorial(a-b))
5 x
```

R code Exa 6.6.28 Mathematics and Physics

```
1 #PAGE=138
```

```

2 m=5
3 p=7
4 m1=2
5 p1=3
6
7 f1=factorial(m)/(factorial(m1)*factorial(m-m1))
8 f2=factorial(p)/(factorial(p1)*factorial(p-p1))
9 a=f1*f2
10 a
11
12 p2=p-1
13 p3=p1-1
14 f3=factorial(m)/(factorial(m1)*factorial(m-m1))
15 f4=factorial(p2)/(factorial(p3)*factorial(p2-p3))
16 b=f3*f4
17 b
18
19 m2=3
20 f5=factorial(m2)/(factorial(m1)*factorial(m2-m1))
21 f6=factorial(p)/(factorial(p1)*factorial(p-p1))
22 c=f5*f6
23 c

```

R code Exa 6.6.29 Girls and flowers

```

1 #PAGE=138
2 x=c(1:5)
3 y=5
4 sum=0
5 for (i in 1:5)
6 {
7   a=factorial(y)/(factorial(i)*factorial(y-i))
8   sum=sum+a
9 }
10 print(sum)

```

R code Exa 6.6.30 consonants and vowels

```
1 #PAGE=139
2 c=7
3 v=5
4 c1=4
5 v1=3
6 f1=factorial(c)/(factorial(c1)*factorial(c-c1))
7 f2=factorial(v)/(factorial(v1)*factorial(v-v1))
8 p=factorial(c)
9 a=f1*f2*p
10 a
```

R code Exa 6.6.31 Evaluate 50 factorial

```
1 #PAGE=139
2 n=50
3 e=2.718
4 pi=3.14
5 a2=n*(-1)
6 a1=sqrt(2*pi*n)
7 a1=a1*(n**n)*(e**a2)
8 a1
9
10 b=log(2*n,10)/2+log(pi,10)/2+n*log(n,10)-n*log(e,10)
11 b=round(b,0)
12 b
13 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 6.6.32 Box of red white and blue balls

```
1 #PAGE=139
2 r=8
3 w=3
4 b=9
5 x=r+w+b
6
7 a1=r/x
8 a2=(r-1)/(x-1)
9 a3=(r-2)/(x-2)
10 a=a1*a2*a3
11 a
12
13 b1=w/x
14 b2=(w-1)/(x-1)
15 b3=(w-2)/(x-2)
16 b=b1*b2*b3
17 b
18
19 r1=2
20 w1=1
21 x1=r1+w1
22 f1=factorial(r)/(factorial(r1)*factorial(r-r1))
23 f2=factorial(w)/(factorial(w1)*factorial(w-w1))
24 f3=factorial(x)/(factorial(x1)*factorial(x-x1))
25 c=(f1*f2)/f3
26 c
27
28 x2=x-w
29 f4=factorial(x2)/(factorial(w)*factorial(x2-w))
30 f5=factorial(x)/(factorial(w)*factorial(x-w))
31 p1=f4/f5
32 d=1-p1
33 d
34
35 o=1
36 b=9
```

```

37 f6=factorial(r)/(factorial(o)*factorial(r-o))
38 f7=factorial(w)/(factorial(o)*factorial(w-o))
39 f8=factorial(b)/(factorial(o)*factorial(b-o))
40 f9=factorial(x)/(factorial(w)*factorial(x-w))
41 e=(f6*f7*f8)/f9
42 e
43
44 f1=factorial(w)
45 f=e/f1
46 f

```

R code Exa 6.6.33 pack of cards

```

1 #PAGE=140
2 c=52
3 n=5
4 a1=4
5 x=c-a1
6 a2=n-a1
7 f1=factorial(x)/(factorial(a2)*factorial(x-a2))
8 f2=factorial(c)/(factorial(n)*factorial(c-n))
9 f3=factorial(a1)/(factorial(a1)*factorial(a1-a1))
10 a=(f3*f1)/f2
11 a
12
13 b1=1
14 f4=factorial(a1)/(factorial(b1)*factorial(a1-b1))
15 b=(f3*f4)/f2
16 b
17
18 a2=a1-1
19 a3=a1-2
20 f5=factorial(a1)/(factorial(a2)*factorial(a1-a2))
21 f6=factorial(a1)/(factorial(a3)*factorial(a1-a3))
22 c=(f5*f6)/f2

```

```

23  c
24
25  b1=1
26  f7=factorial(a1)/(factorial(b1)*factorial(a1-b1))
27  d=(f7**n)/f2
28  d
29
30  g=4
31  h=3
32  c=52
33  f8=factorial(c/4)/(factorial(a2)*factorial(c/4-a2))
34  f9=factorial(c/4)/(factorial(a3)*factorial(c/4-a3))
35  e=(g*f8*h*f9)/f2
36  e
37
38
39  f10=factorial(x)/(factorial(n)*factorial(x-n))
40  f=f10/f2
41  f=1-f
42  f

```

R code Exa 6.6.34 tossing a fair die

```

1  #PAGE=141
2  n=5
3  r=3
4  a=1/6
5  b=1-a
6  f1=factorial(n)/(factorial(r)*factorial(n-r))
7  x=a**r
8  y=b**(n-r)
9  p=x*y*f1
10 p

```

R code Exa 6.6.35 Machine and bolts

```
1 #PAGE=141
2 t=10
3 x=0.2
4 y=0.8
5 a1=2
6 f1=factorial(t)/(factorial(a1)*factorial(t-a1))
7 a=f1*(x**a1)*(y**(t-a1))
8 a=round(a,digits=4)
9 a
10
11 m=0
12 n=1
13 f2=factorial(t)/(factorial(m)*factorial(t-m))
14 f3=factorial(t)/(factorial(n)*factorial(t-n))
15 p1=f2*(x**m)*(y**(t-m))
16 p2=f3*(x**n)*(y**(t-n))
17 b=1-p1-p2
18 b=round(b,digits=4)
19 b
20
21 s=0
22 for(i in 6:10)
23 {
24   f4=factorial(t)/(factorial(i)*factorial(t-i))*(x**
      i)*(y**(t-i))
25   s=s+f4
26 }
27 c=round(s,digits=5)
28 c
```

R code Exa 6.6.36 Defective bolts

```
1 #PAGE=141
2 t=10
3 x=0.2
4 y=0.8
5 a1=2
6 f1=factorial(t)/(factorial(a1)*factorial(t-a1))
7 a=f1*(x**a1)*(y**(t-a1))
8 a=round(a,digits=4)
9 a
10
11 m=0
12 n=1
13 f2=factorial(t)/(factorial(m)*factorial(t-m))
14 f3=factorial(t)/(factorial(n)*factorial(t-n))
15 p1=f2*(x**m)*(y**(t-m))
16 p2=f3*(x**n)*(y**(t-n))
17 b=1-p1-p2
18 b=round(b,digits=4)
19 b
20
21 s=0
22 for(i in 6:10)
23 {
24   f4=factorial(t)/(factorial(i)*factorial(t-i))*(x**
25     i)*(y**(t-i))
26   s=s+f4
27 }
28 c=round(s,digits=5)
29 c
30
31 N=1000
32 a=a*N
33 a
34
35 b=b*N
```

```

36 b=round(b,digits=0)
37 b
38
39 c=c*N
40 c=round(c,digits = 0)
41 c

```

R code Exa 6.6.37 Sample space

```

1 #PAGE=142
2 x=0
3 y=0
4 for(i in 1:6)
5 {
6   for(j in 1:6)
7   {
8     c=c(i,j);
9     print(c);
10    if(sum(c)==7) x<-x+1
11    if(sum(c)==11) y<-y+1
12  }
13 }
14 pa=x/(6*6)
15 pb=y/(6*6)
16 p=pa+pb
17 cat(p)

```

R code Exa 6.6.39 Algebra physics and statistics

```

1 #PAGE=144
2 t=500
3 a=329
4 p=186

```

```

5 s=295
6 a_p=83
7 a_s=217
8 p_s=63
9
10 a1=t-(a+p+s-a_p-a_s-p_s)
11 a1
12
13 t1=a_s-a1
14 t2=a-a_s
15 b=t2
16 b
17
18 c=p-a_p
19 c
20
21 d=s-p_s
22 d
23
24 m1=a-a_p-a_s+a1
25 s1=s-a_s-p_s+a1
26 n1=a_s-a1
27 e=m1+s1+n1
28 e
29
30 f=a-a_p-a_s+a1
31 f

```

R code Exa 6.7 Drawing an ace and a spade

```

1 #PAGE=124
2 e1=4
3 e2=13
4 e3=1
5 e4=52

```

```
6 p=e1/e4+e2/e4-e3/e4
7 cat(p)
```

R code Exa 6.8 Pair of fair dice

```
1 #PAGE=124
2 total_outcoms=36
3 list=list()
4 list[[1]]<-c(1,4)
5 list[[2]]<-c(4,1)
6 list[[3]]<-c(2,3)
7 list[[4]]<-c(3,2)
8 favourable_outcomes=length(list)
9 n=900
10 probability=favourable_outcomes/total_outcoms
11 ans=probability*n
12 ans
```

R code Exa 6.9 Probability of a man winning

```
1 #PAGE=125
2 p=10
3 p1=1/5
4 r=p*p1
5 cat('$',r)
```

R code Exa 6.10 3 Candidates

```
1 #PAGE=126
2 n=3
```



```

3 m=5
4 a=factorial(m)
5 cat(a)
6 b=factorial(m-1)
7 c=factorial(n)
8 d=b*c
9 cat(d)

```

R code Exa 6.12 Number of permutations of letters

```

1 #PAGE=127
2 n='statistics'
3 m=nchar(n)
4 library(stringr)
5 a=str_count(n, "s")
6 b=str_count(n, "t")
7 c=str_count(n, "a")
8 d=str_count(n, "i")
9 e=str_count(n, "c")
10
11 v1=factorial(m)
12 v2=factorial(a)
13 v3=factorial(b)
14 v4=factorial(c)
15 v5=factorial(d)
16 v6=factorial(e)
17
18 ans=v1/(v2*v3*v4*v5*v6)
19 cat(ans)

```

R code Exa 6.13 Number of combinations

```

1 #PAGE=127

```

```
2 library(combinat)
3 a=combn(letters[1:3],2)
4 len1=dim(a)[2]
5 len2=dim(a)[1]
6 ans=(len1*len2)/factorial(len2)
7 cat(ans)
```

Chapter 7

The Binomial Normal And Poisson Distributions

R code Exa 7.1 fair coin

```
1 #PAGE=150
2 x=6
3 y=2
4 f1=factorial(x)/(factorial(y)*factorial(x-y))
5 a=(1/2)**y
6 b=(1/2)**(x-y)
7 c=f1*a*b
8 c
```

R code Exa 7.2 tossing a fair coin

```
1 #PAGE=150
2 x=6
3 y=4
4 f1=factorial(x)/(factorial(y)*factorial(x-y))
5 a=(1/2)**y
```

```

6  b=(1/2)**(x-y)
7  c=f1*a*b
8
9  y=y+1
10 f1=factorial(x)/(factorial(y)*factorial(x-y))
11 a=(1/2)**y
12 b=(1/2)**(x-y)
13 d=f1*a*b
14
15 y=y+1
16 f1=factorial(x)/(factorial(y)*factorial(x-y))
17 a=(1/2)**y
18 b=(1/2)**(x-y)
19 e=f1*a*b
20
21 f=c+d+e
22 f

```

R code Exa 7.4 standard deviation

```

1  #PAGE=150
2  t=100
3  p=1/2
4  q=1-1/2
5  s=sqrt(t*p*q)
6  s

```

R code Exa 7.5 fair die toss

```

1  #PAGE=153
2  t=12
3  n=2
4  s=t/n

```

```

5 a=factorial(t)/(factorial(n)**s)
6 b=(1/s)**(2*6)
7 c=a*b
8 c=round(c,digits=5)
9 c

```

R code Exa 7.7.1 Evaluate

```

1 #PAGE=154
2 t=5
3 a=factorial(t)
4 a
5
6 t2=6
7 t3=2
8 t4=4
9 b=factorial(t2)/(factorial(t3)*factorial(t4))
10 b
11
12 t5=8
13 t6=3
14 c=factorial(t5)/(factorial(t6)*factorial(t5-t6))
15 c
16
17 t7=7
18 t8=5
19 d=factorial(t7)/(factorial(t8)*factorial(t7-t8))
20 d
21
22 t9=4
23 t10=4
24 e=factorial(t9)/(factorial(t10)*factorial(t9-t10))
25 e
26
27 t11=4

```

```

28 t12=0
29 f=factorial(t11)/(factorial(t12)*factorial(t11-t12))
30 f

```

R code Exa 7.7.2 tossing a coin three times

```

1 #PAGE=154
2 t1=3
3 t2=t1
4 a=factorial(t1)/(factorial(t2)*factorial(t1-t2))
5 a=a*(1/2)**t1*(1/2)**(t1-t2)
6 a
7
8 t1=3
9 t2=t1-1
10 b=factorial(t1)/(factorial(t2)*factorial(t1-t2))
11 b=b*(1/2)**t2*(1/2)**(t1-t2)
12 b
13
14 t1=3
15 t2=t1-2
16 c=factorial(t1)/(factorial(t2)*factorial(t1-t2))
17 c=c*(1/2)**t2*(1/2)**(t1-t2)
18 c
19
20 t1=3
21 t2=t1-3
22 d=factorial(t1)/(factorial(t2)*factorial(t1-t2))
23 d=d*(1/2)**t2*(1/2)**(t1-t2)
24 d

```

R code Exa 7.7.3 five tosses of a fair die

```

1  #PAGE=155
2  t=5
3  d=3
4  p=1/6
5  q=5/6
6
7  n1=0
8  a1=factorial(t)/(factorial(n1)*factorial(t-n1))
9  a2=(p)**(n1)
10 a3=q**t
11 a=a1*a2*a3
12 a
13
14 t1=t-1
15 n2=n1+1
16 b1=factorial(t)/(factorial(n2)*factorial(t-n2))
17 b2=(p)**(n2)
18 b3=q**t1
19 b=b1*b2*b3
20 b
21
22 t2=t1-1
23 n3=n2+1
24 c1=factorial(t)/(factorial(n3)*factorial(t-n3))
25 c2=(p)**(n3)
26 c3=q**t2
27 c=c1*c2*c3
28 c
29
30 t3=t2-1
31 n4=n3+1
32 d1=factorial(t)/(factorial(n4)*factorial(t-n4))
33 d2=(p)**(n4)
34 d3=q**t3
35 d=d1*d2*d3
36 d
37
38 t4=t3-1

```

```

39 n5=n4+1
40 e1=factorial(t)/(factorial(n5)*factorial(t-n5))
41 e2=(p)**(n5)
42 e3=q**t4
43 e=e1*e2*e3
44 e
45
46 t5=t4-1
47 n6=n5+1
48 f1=factorial(t)/(factorial(n6)*factorial(t-n6))
49 f2=(p)**(n6)
50 f3=q**t5
51 f=f1*f2*f3
52 f

```

R code Exa 7.7.5 family of 4 children

```

1 #PAGE=156
2 c=4
3 p=1/2
4 q=1-p
5 s=0
6 for(i in 1:4)
7 {
8   f1=factorial(c)/(factorial(i)*factorial(c-i))
9   a1=(p**i)*(q**(c-i))
10  a=f1*a1
11  s=s+a
12 }
13 print(s)
14
15 b=1-p**4-q**4
16 b

```

R code Exa 7.7.6 2000 families with 4 children

```
1 #PAGE=156
2 n=2000
3 c=4
4 a=n*15/c^2
5 cat(a)
6 b=n*3/8
7 cat(b)
8 nn=1/4+3/8
9 c=n*nn
10 cat(c)
11 c=4
12 d=n/c^2
13 cat(d)
```

R code Exa 7.7.7 bolts produced by a machine

```
1 #PAGE=156
2 p=0.2
3 q=1-p
4 c=4
5
6 a1=1
7 a2=c-a1
8 f1=factorial(c)/(factorial(a1)*factorial(c-a1))
9 p1=p**a1
10 q1=q**a2
11 a=f1*p1*q1
12 a
13
14 b1=0
```

```

15 b2=c-b1
16 f1=factorial(c)/(factorial(b1)*factorial(c-b1))
17 p1=p**b1
18 q1=q**b2
19 b=f1*p1*q1
20 b
21
22 c1=2
23 c2=c-c1
24 f1=factorial(c)/(factorial(c1)*factorial(c-c1))
25 p1=p**c1
26 q1=q**c2
27 c3=f1*p1*q1
28 c3
29 c=a+b++c3
30 c

```

R code Exa 7.7.8 college student graduation probability

```

1 #PAGE=157
2 m1=0.4
3 m2=1-m1
4 n=5
5 a1=m1^(n-5)*m2^n
6 cat(a1)
7 round(a1,2)
8
9
10 c=n-4
11 d=4
12 b1=m1^c*m2^d
13 b1=factorial(n)/(factorial(d)*factorial(c))*b1
14 cat(b1)
15 round(b1,2)
16

```

```

17
18 c1=1-a1
19 cat(c1)
20 round(c1,2)
21
22 c=n
23 d=n-5
24 b1=m1^c*m2^d
25 b1=factorial(n)/(factorial(d)*factorial(c))*b1
26 cat(b1)
27 round(b1,2)

```

R code Exa 7.7.9 pair of dice

```

1 #PAGE=157
2 c=6
3 p=1/9
4 q=8/9
5
6 a1=2
7 a2=c-a1
8 f1=factorial(c)/(factorial(a1)*factorial(c-a1))
9 p1=p**a1
10 q1=q**a2
11 a=f1*p1*q1
12 a
13
14 b1=0
15 b2=c-b1
16 f1=factorial(c)/(factorial(b1)*factorial(c-b1))
17 p1=p**b1
18 q1=q**b2
19 b=f1*p1*q1
20
21 c1=1

```

```

22 c2=c-c1
23 f1=factorial(c)/(factorial(c1)*factorial(c-c1))
24 p1=p**c1
25 q1=q**c2
26 c=f1*p1*q1
27
28 d=b+c
29 b=1-d
30 b

```

R code Exa 7.7.12 Defective bolts

```

1 #PAGE=158
2 d=0.1
3 q=1-d
4 t=400
5
6 a=d*t
7 a
8
9 b=q*d*t
10 b=sqrt(b)
11 b

```

R code Exa 7.7.13 skewness and kurtosis

```

1 #PAGE=158
2 p=0.1
3 q=1-p
4 t=400
5
6 a=(q-p)/sqrt(t*p*q)
7 a=round(a,digits=3)

```

```
8 a
9
10 b=3+(1-6*p*q)/(t*p*q)
11 b=round(b,digits = 2)
12 b
```

R code Exa 7.7.14 final examination in mathematics

```
1 #PAGE=159
2 m=72
3 s=15
4
5 a1=60
6 a=(a1-m)/s
7 a
8
9 b1=93
10 b=(b1-m)/s
11 b
12
13 c1=72
14 c=(c1-m)/s
15 c
```

R code Exa 7.7.15 grades corresponding to standard scores

```
1 #PAGE=159
2 m=72
3 s=15
4
5 a1=-1
6 a=m+a1*s
7 a
```

```
8
9 b1=1.6
10 b=m+b1*s
11 b
```

R code Exa 7.7.16 Examination in English

```
1 #PAGE=159
2 s1=0.8
3 s2=-0.4
4 g1=88
5 g2=64
6
7 a <- matrix(c(1,1,s2,s1),nrow=2,ncol=2)
8 b <- matrix(c(64,88),nrow=2,ncol=1)
9
10 solve(a,b)
```

R code Exa 7.7.17 Area under normal curve

```
1 #PAGE=159
2 z1=0
3 z2=1.2
4 a1=pnorm(z2,0,1)
5 a2=pnorm(z1,0,1)
6 a=a1-a2
7 a=round(a,4)
8 cat(a)
9
10 z1=-0.68
11 z2=0
12 a1=pnorm(z2,0,1)
13 a2=pnorm(z1,0,1)
```

```

14 a=a1-a2
15 b=round(a,4)
16 cat(b)
17
18 z1=-0.46
19 z2=0
20 a1=pnorm(z2,0,1)
21 a2=pnorm(z1,0,1)
22 a3=a1-a2
23 z3=2.21
24 a4=pnorm(z3,0,1)
25 a5=a4-a2
26 a5=round(a5,4)
27 cat(a5)
28
29 z1=0.81
30 z2=1.94
31 a1=pnorm(z2,0,1)
32 a2=pnorm(z1,0,1)
33 a3=a1-a2
34 a3=round(a3,4)
35 cat(a3)
36
37 z1=-0.6
38 z2=0
39 a1=pnorm(z2,0,1)
40 a2=pnorm(z1,0,1)
41 a3=a1-a2
42 e=a1-a3
43 e=round(e,4)
44 cat(e)
45
46
47 z1=-1.28
48 z2=0
49 a1=pnorm(z2,0,1)
50 a2=pnorm(z1,0,1)
51 a3=a1-a2

```

```

52 a3=a3+a1
53 a3=round(a3,4)
54 cat(a3)
55
56 z1=-1.44
57 z2=0
58 z3=2.05
59 a1=pnorm(z1,0,1)
60 a2=pnorm(z2,0,1)
61 a3=pnorm(z3,0,1)
62 a4=a3-a2
63 a5=a2-a1
64 a4=round(a4,4)
65 a5=round(a5,4)
66 g=1-a4-a5
67 cat(g)
68
69
70 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 7.7.18 Determining z value

```

1 #PAGE=160
2 z1=0
3 b=pnorm(z1)
4 c=0.377
5 a=b+c
6 a=qnorm(a)
7 a=round(a,2)
8 cat('+-',a)
9
10
11 z2=0
12 a1=pnorm(z2,0,1)

```



```

13 e=0.8621
14 a2=e
15 e=qnorm(e)
16 e=round(e,2)
17 cat(e)
18
19
20
21 z1=-1.5
22 z2=0
23 a1=pnorm(z2,0,1)
24 a2=pnorm(z1,0,1)
25 a3=a1-a2
26 a5=0.0217
27 a4=a5+a2
28 a6=qnorm(a4)
29 a6=round(a6,2)
30 cat(a6)
31 a7=a5-a2
32 a7=(a7*(-1))
33 a8=qnorm(a7)
34 a8=round(a8,2)
35 cat(a8)

```

R code Exa 7.7.19 Ordinate of the normal curve

```

1 #PAGE=161
2 z1=0.84
3 z1=dnorm(z1)
4 z1=round(z1,4)
5 cat(z1)
6
7 z2=-1.27
8 z2=dnorm(z2)
9 z2=round(z2,4)

```

```
10 cat(z2)
11
12 z3=-0.05
13 z3=dnorm(z3)
14 z3=round(z3,4)
15 cat(z3)
```

R code Exa 7.7.20 500 male students and problem solving

```
1 #PAGE=161
2 n=500
3 t=151
4 s=15
5 a1=120
6 a2=155
7 a3=0.5
8 a1=a1-a3
9 a2=a2+a3
10 a3=(a1-t)/s
11 a4=(a2-t)/s
12
13 z1=a3
14 z2=0
15 a1=pnorm(z2,0,1)
16 a2=pnorm(z1,0,1)
17 a3=a1-a2
18 z3=a4
19 a4=pnorm(z3,0,1)
20 a5=a4-a2
21 a5=round(a5,4)
22 a5=a5*n
23 cat(a5)
24
25
26 b1=185
```

```

27 b2=0.5
28 b3=b1+b2
29 b3=(b3-t)/s
30 z1=b3
31 z2=0
32 a1=pnorm(z2,0,1)
33 a2=pnorm(z1,0,1)
34 a3=a1-a2
35 a3=a1+a3
36 a3=a3=a3*n
37 a3=round(a3,0)
38 cat(a3)

```

R code Exa 7.7.21 500 students

```

1 #PAGE=162
2 n=128
3 m=0.5
4 a1=n-m
5 a1
6 t=500
7 t1=151
8 v=15
9 a2=(a1-t1)/v
10 a2=round(a2,2)
11 a2
12
13
14 z1=a2
15 z2=0
16 a1=pnorm(z2,0,1)
17 a2=pnorm(z1,0,1)
18 a3=a1-a2
19 e=a1-a3
20 e=round(e,4)

```

```

21 e
22 e=t*e
23 e=round(e,0)
24 cat(e)
25
26
27 b1=n+m
28 b1=(b1-t1)/v
29 b2=n-m
30 b2=(b2-t1)/v
31 b2=round(b2,2)
32
33 z1=b2
34 z2=0
35 a1=pnorm(z2,0,1)
36 a2=pnorm(z1,0,1)
37 a3=a1-a2
38 z3=b1
39 a4=pnorm(z3,0,1)
40 a5=a4-a2
41 a5=round(a5,4)
42 a5
43 a5=a5*t
44 a5=round(a5,0)
45 cat(a5)
46
47
48 c1=n+m
49 c1=(c1-t1)/v
50 c1=round(c1,2)
51 z1=c1
52 z2=0
53 a1=pnorm(z2,0,1)
54 a2=pnorm(z1,0,1)
55 a3=a1-a2
56 e=a1-a3
57 e=round(e,4)
58 e

```

```
59 e=e*t
60 e=round(e,0)
61 cat(e)
```

R code Exa 7.7.22 Quiz in Biology

```
1 #PAGE=163
2 g=c(0:10)
3 n=10
4 m=6.7
5 sd=1.2
6 d=0.5
7
8 a=6
9 a1=a-d
10 a2=a+d
11 a3=(a1-m)/sd
12 a4=(a2-m)/sd
13 a4=round(a4,2)
14 z1=a3
15 z2=a4
16 a1=pnorm(z2,0,1)
17 a2=pnorm(z1,0,1)
18 a3=a1-a2
19 a3=round(a3,4)
20 a3=a3*100
21 a3=round(a3,0)
22 cat(a3, '%')
23
24
25 z1=10/100
26 e=qnorm(z1)
27 x=(e*sd)+m
28 x=round(x,0)
29 cat(x)
```

```

30
31 e=e*(-1)
32 x=(e*sd)+m
33 x=round(x,0)
34 cat(x)

```

R code Exa 7.7.23 Sample of 200 washers

```

1 #PAGE=164
2 s=200
3 m=5.02
4 sd=0.05
5 d1=4.96
6 d2=5.08
7 s1=(d1-m)/sd
8 s2=(d2-m)/sd
9
10 z1=s2
11 z2=0
12 a1=pnorm(z2,0,1)
13 a2=pnorm(z1,0,1)
14 a3=-a1+a2
15 e=round(a3,4)
16 e=e*2
17 e=e*100
18 e=round(e,0)
19 cat(e, '%')
20 f=100-e
21 cat(f, '%')

```

R code Exa 7.7.24 10 tosses of fair coin

```

1 #PAGE=164

```

```

2  a=3
3  b=6
4  n=10
5  p1=factorial(n)/(factorial(a)*factorial(n-a))
6  p1=p1*((1/2)**a)*((1/2)**(n-a))
7
8  a=a+1
9  p2=factorial(n)/(factorial(a)*factorial(n-a))
10 p2=p2*((1/2)**a)*((1/2)**(n-a))
11
12 a=a+1
13 p3=factorial(n)/(factorial(a)*factorial(n-a))
14 p3=p3*((1/2)**a)*((1/2)**(n-a))
15
16 a=a+1
17 p4=factorial(n)/(factorial(a)*factorial(n-a))
18 p4=p4*((1/2)**a)*((1/2)**(n-a))
19
20 p=p1+p2+p3+p4
21 p=round(p,4)
22 p
23
24 p=1/2
25 q=1-p
26 s=sqrt(n*p*q)
27 s=round(s,2)
28
29 u=n/2
30 a=3
31 b=6
32 d=0.5
33 a=a-d
34 b=b+d
35 c1=(a-u)/s
36 c2=(b-u)/s
37 c1=round(c1,2)
38 c2=round(c2,2)
39

```

```

40
41
42 z1=c1
43 z2=0
44 z3=c2
45 a1=pnorm(z1,0,1)
46 a2=pnorm(z2,0,1)
47 a3=pnorm(z3,0,1)
48 a4=a3-a2
49 a5=a2-a1
50 g=a4+a5
51 g=round(g,4)
52 cat(g)
53
54 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 7.7.25 fair coin

```

1 #PAGE=165
2 n=500
3 p=1/2
4 q=1-p
5 d=250
6 u=sqrt(n*p*q)
7 u=round(u,digits=2)
8
9
10 x=10
11 a1=d+x+p
12 a2=d-x-p
13
14 s1=(d-a2)/u
15 s1=round(s1,digits = 2)
16 s1=pnorm(s1,mean=0)

```



```

17
18 s2=(d-a1)/u
19 s2=round(s2,digits = 2)
20 s2=pnorm(s2,mean=0)
21
22 s=s1-s2
23 s=round(s,digits=4)
24 s
25
26 x=30
27 b1=d+x+p
28 b2=d-x-p
29
30 s1=(d-b2)/u
31 s1=round(s1,digits = 2)
32 s1=pnorm(s1,mean=0)
33
34 s2=(d-b1)/u
35 s2=round(s2,digits = 2)
36 s2=pnorm(s2,mean=0)
37
38 s=s1-s2
39 s=round(s,digits=4)
40 s
41 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 7.7.26 Die tossed 120 times

```

1 #PAGE=166
2 n=120
3 m=4
4 d=0.5
5 d1=0
6 d2=18

```

```

7  d1=d1-d
8  d2=d2+d
9
10 p=1/6
11 q=1-p
12 u=n*p
13 s=sqrt(n*p*q)
14 s=round(s,2)
15 a1=(d1-u)/s
16 b1=(d2-u)/s
17 b1=round(b1,2)
18
19
20 z1=a1
21 z2=0
22 z3=b1
23 a1=pnorm(z1,0,1)
24 a2=pnorm(z2,0,1)
25 a3=pnorm(z3,0,1)
26 a4=a3-a2
27 a5=a2-a1
28 g=a4+a5
29 cat(g)
30
31
32 n=120
33 m=4
34 d=0.5
35 d1=0
36 d2=14
37 d1=d1-d
38 d2=d2+d
39
40 p=1/6
41 q=1-p
42 u=n*p
43 s=sqrt(n*p*q)
44 s=round(s,2)

```

```

45 a1=(d1-u)/s
46 b1=(d2-u)/s
47 b1=round(b1,2)
48
49
50 z1=a1
51 z2=0
52 z3=b1
53 a1=pnorm(z1,0,1)
54 a2=pnorm(z2,0,1)
55 a3=pnorm(z3,0,1)
56 a4=a3-a2
57 a5=a2-a1
58 g=a4+a5
59 g=round(g,4)
60 cat(g)

```

R code Exa 7.7.27 tools from a manufacturing process

```

1 #PAGE=166
2 p=0.1
3 t=10
4 n=2
5 f1=factorial(t)/(factorial(n)*factorial(t-n))
6 a1=(p)**n
7 b1=(1-p)**(t-n)
8 a=f1*a1*b1
9 a=round(a,digits=4)
10 a
11 a=round(a,digits=2)
12 a
13
14 e=2.718
15 l=t*p
16 p1=(1**n*e**(-l))/factorial(n)

```

```
17 p1=round(p1,digits=2)
18 p1
```

R code Exa 7.7.28 bad reaction from injection

```
1 #PAGE=167
2 n=2000
3 p=0.001
4 x1=3
5 e=2.718
6
7 l=n*p
8 a=(1**x1*e**(-1))/factorial(x1)
9 a=round(a,digits = 3)
10 a
11
12 b=0
13 for(i in 0:2)
14 {
15   s=(1**i*e**(-1))/factorial(i)
16   b=b+s
17 }
18
19 b=1-b
20 b=round(b,digits=3)
21 b
```

R code Exa 7.7.29 poisson distribution

```
1 #PAGE=167
2 l=0.72
3 e=2.718
4 x1=0
```

```

5 b=(1**x1*e**(-1))/factorial(x1)
6 b=round(b,digits=4)
7 b
8
9 x2=1
10 c=(1**x2*e**(-1))/factorial(x2)
11 c=round(c,digits=4)
12 c
13
14 x3=2
15 d=(1**x3*e**(-1))/factorial(x3)
16 d=round(d,digits=4)
17 d
18
19 x4=3
20 f=(1**x4*e**(-1))/factorial(x4)
21 f=round(f,digits=4)
22 f

```

R code Exa 7.7.30 red white and blue balls

```

1 #PAGE=168
2 r=5
3 w=4
4 b=3
5 x=r+w+b
6 r1=3
7 w1=2
8 b1=1
9 x2=r1+w1+b1
10 p=(factorial(x2))/(factorial(r1)*factorial(w1)*
    factorial(b1))*((r/x)**r1)*((w/x)**w1)*((b/x)**b1
    )
11 p

```

R code Exa 7.7.31 Binomial Distribution

```
1 #PAGE=168
2 n=c(0:5)
3 t=c(38,144,342,287,164,25)
4 s=sum(t)
5 s1=n*t
6 s1=sum(s1)
7 a=s1/s
8 cat(a)
9 b=5
10 b1=a/b
11 cat(b1)
12
13 c=n[1]
14 p1=(factorial(b)/(factorial(c)*factorial(b-c)))*(b1*
      *c)*((1-b1)**(b-c))
15 p1=round(p1,4)
16
17 c=n[2]
18 p2=(factorial(b)/(factorial(c)*factorial(b-c)))*(b1*
      *c)*((1-b1)**(b-c))
19 p2=round(p2,4)
20
21 c=n[3]
22 p3=(factorial(b)/(factorial(c)*factorial(b-c)))*(b1*
      *c)*((1-b1)**(b-c))
23 p3=round(p3,4)
24
25 c=n[4]
26 p4=(factorial(b)/(factorial(c)*factorial(b-c)))*(b1*
      *c)*((1-b1)**(b-c))
27 p4=round(p4,4)
28
```

```

29 c=n[5]
30 p5=(factorial(b)/(factorial(c)*factorial(b-c)))*(b1*
    *c)*((1-b1)**(b-c))
31 p5=round(p5,4)
32
33 c=n[6]
34 p6=(factorial(b)/(factorial(c)*factorial(b-c)))*(b1*
    *c)*((1-b1)**(b-c))
35 p6=round(p6,4)
36
37 p=c(p1,p2,p3,p4,p5,p6)
38 pf=p*1000
39 pf1=round(pf,0)
40 t=c(38,144,342,287,164,25)
41
42 y <- matrix(c(n,p,pf,t),nrow=6,byrow=FALSE)
43 colnames(y) <- c("Number of heads","Pr(X heads)","
    Expected Frequency","Observed Frequency")
44 rownames(y) <- c(" "," "," "," "," "," ")
45 y <- as.table(y)
46 y

```

R code Exa 7.7.32 Probability graph

```

1 #PAGE=169
2 w2=c(62,65,68,71,74)
3 d=0.5
4 w2=w2+d
5 f=c(5,18,42,27,8)
6 f0=f[1]
7 f1=f0+f[2]
8 f2=f1+f[3]
9 f3=f2+f[4]
10 f4=f3+f[5]
11 f=c(f0,f1,f2,f3,f4)

```

```
12
13 plot(w2,f,xlab = 'Weight(kg)',ylab = 'Relative
    cumulative frequency')
```

R code Exa 7.7.33 Normal curve of data

```
1 #PAGE=169
2 w1=c(60,63,66,69,72)
3 w2=c(62,65,68,71,74)
4 d=0.5
5 w3=w1-d
6 w3[6]=w3[5]+d*6
7 w3
8 f=c(5,18,42,27,8)
9 x=67.45
10 s=2.92
11 z=(w3-x)/s
12 zz=round(z,digits = 2)
13 zz
14 z1=0
15 a1=pnorm(z1)
16 a2=pnorm(zz)
17 z=-a2+a1
18 z=round(z,4)
19 z=abs(z)
20 z
21
22 l1=z[1]-z[2]
23 l2=z[2]-z[3]
24 l3=z[3]+z[4]
25 l4=z[4]-z[5]
26 l5=z[5]-z[6]
27 l=c(l1,l2,l3,l4,l5)
28 l=abs(l)
29 exp=l*100
```



```

30
31 l=round(l,4)
32 exp=round(exp,2)
33 w11=c(w1[1], '-', w2[1])
34 w12=c(w1[2], '-', w2[2])
35 w13=c(w1[3], '-', w2[3])
36 w14=c(w1[4], '-', w2[4])
37 w15=c(w1[5], '-', w2[5])
38
39 wid=c(w11, w12, w13, w14, w15, '-')
40 w1=c(w1, '-')
41 w2=c(w2, '-')
42 exp=c(exp, '-')
43 l=c(l, '-')
44 f=c(f, '-')
45 y <- matrix(c(w1, w2, w3, zz, z, l, exp, f), ncol=8, byrow=
  FALSE)
46 colnames(y) <- c(" Weight1", "Weight2", "X", "z", "Area
  under normal curve", " Area for each class", "
  Expected Frequency", "Observed Frequency")
47 rownames(y) <- c(" ", " ", " ", " ", " ", " ", " ", " ")
48 y <- as.table(y)
49 y

```

R code Exa 7.7.34 Automobile Accidents

```

1 #PAGE=170
2 x=c(0,1,2,3,4)
3 f=c(21,18,7,3,1)
4 s=sum(f)
5 a=sum(f*x)/s
6 cat(a)
7
8 c=x[1]
9 p1=(a^c)*(2.718)**(-0.9)/factorial(c)

```

```

10 p1=round(p1,4)
11 c=x[2]
12 p2=((a^c)*(2.718)**(-0.9))/factorial(c)
13 p2=round(p2,4)
14 c=x[3]
15 p3=((a^c)*(2.718)**(-0.9))/factorial(c)
16 p3=round(p3,4)
17 c=x[4]
18 p4=((a^c)*(2.718)**(-0.9))/factorial(c)
19 p4=round(p4,4)
20 c=x[5]
21 p5=((a^c)*(2.718)**(-0.9))/factorial(c)
22 p5=round(p5,4)
23 pr=c(p1,p2,p3,p4,p5)
24
25 t=50
26 exp=t*pr
27 exp=round(exp,0)
28
29
30 y <- matrix(c(x,pr,exp,f),ncol=4,byrow=FALSE)
31 colnames(y) <- c("Number of Accidents","Pr(X)","
    Expected number of days","Actual number of days")
32 rownames(y) <- c(" "," "," "," ")
33 y <- as.table(y)
34 y

```

Chapter 8

Elementary Sampling Theory

R code Exa 8.8.1 population of sample

```
1 #PAGE=179
2 f=c(2,3,6,8,11)
3 a=mean(f)
4 cat(a)
5
6 b1=sum((f-a)**2)/5
7 b=sqrt(b1)
8 b=round(b,2)
9 cat(b)
10
11 a1=c(2,2)
12 a1=mean(a1)
13 a2=c(2,3)
14 a2=mean(a2)
15 a3=c(2,6)
16 a3=mean(a3)
17 a4=c(2,8)
18 a4=mean(a4)
19 a5=c(2,11)
20 a5=mean(a5)
21
```

```
22 b1=c(3,2)
23 b1=mean(b1)
24 b2=c(3,3)
25 b2=mean(b2)
26 b3=c(3,6)
27 b3=mean(b3)
28 b4=c(3,8)
29 b4=mean(b4)
30 b5=c(3,11)
31 b5=mean(b5)
32
33 c1=c(6,2)
34 c1=mean(c1)
35 c2=c(6,3)
36 c2=mean(c2)
37 c3=c(6,6)
38 c3=mean(c3)
39 c4=c(6,8)
40 c4=mean(c4)
41 c5=c(6,11)
42 c5=mean(c5)
43
44 d1=c(8,2)
45 d1=mean(d1)
46 d2=c(8,3)
47 d2=mean(d2)
48 d3=c(8,6)
49 d3=mean(d3)
50 d4=c(8,8)
51 d4=mean(d4)
52 d5=c(8,11)
53 d5=mean(d5)
54
55 e1=c(11,2)
56 e1=mean(e1)
57 e2=c(11,3)
58 e2=mean(e2)
59 e3=c(11,6)
```

```

60 e3=mean(e3)
61 e4=c(11,8)
62 e4=mean(e4)
63 e5=c(11,11)
64 e5=mean(e5)
65
66 c=c(a1,a2,a3,a4,a5,b1,b2,b3,b4,b5,c1,c2,c3,c4,c5,d1,
      d2,d3,d4,d5,e1,e2,e3,e4,e5)
67 c1=sum(c)
68 c2=sum(c)/length(c)
69 cat(c2)
70
71 m1=sum((c-c2)**2)
72 m1=m1/25
73 d=sqrt(m1)
74 d=round(d,2)
75 cat(d)

```

R code Exa 8.8.2 sampling without replacement

```

1 #PAGE=180
2 f=c(2,3,6,8,11)
3 a=mean(f)
4 cat(a)
5
6 b1=sum((f-a)**2)/5
7 b=sqrt(b1)
8 b=round(b,2)
9 cat(b)
10
11 a2=c(2,3)
12 a2=mean(a2)
13 a3=c(2,6)
14 a3=mean(a3)
15 a4=c(2,8)

```

```

16 a4=mean(a4)
17 a5=c(2,11)
18 a5=mean(a5)
19 b3=c(3,6)
20 b3=mean(b3)
21 b4=c(3,8)
22 b4=mean(b4)
23 b5=c(3,11)
24 b5=mean(b5)
25 c4=c(6,8)
26 c4=mean(c4)
27 c5=c(6,11)
28 c5=mean(c5)
29 d5=c(8,11)
30 d5=mean(d5)
31 cc=c(a2,a3,a4,a5,b3,b4,b5,c4,c5,d5)
32
33 cc1=sum(cc)/length(cc)
34 cat(cc1)
35
36 d1=sum((cc-cc1)**2)/length(cc)
37 d=sqrt(d1)
38 d=round(d,2)
39 cat(d)

```

R code Exa 8.8.3 weights of 3000 male students

```

1 #PAGE=180
2 n=3000
3 m=66
4 sd=3
5 s=25
6 a1=m
7 a1
8 a2=sd/sqrt(s)

```

```

9  a2
10
11  b1=m
12  b1
13  b2=(sd/sqrt(s))*(sqrt((n-s)/(n-1)))
14  b2=round(b2,digits=1)
15  b2

```

R code Exa 8.8.4 mean of samples

```

1  #PAGE=181
2  n=3000
3  m=66
4  sd=3
5  s=25
6  s=25
7  a1=m
8  a1
9  a2=sd/sqrt(s)
10 a2
11 x=64.8
12 y=66.3
13 a3=(x-a1)/a2
14 a3
15 a4=(y-a1)/a2
16 a4
17 z1=pnorm(a3,lower.tail = F)
18 z2=pnorm(a4,lower.tail = F)
19 z=z1-z2
20 z=round(z,digits = 4)
21 z
22
23 x=seq(-4,4,length=200)
24 y=1/sqrt(2*pi)*exp(-x^2/2)
25 plot(x,y,type="l",lwd=2,col="black")

```

```

26 x=seq(a3,a4,length=200)
27 y=dnorm(x)
28 polygon(c(a3,x,a4),c(0,y,0),col="gray")
29
30 c=64.4
31 a5=(c-a1)/a2
32 a5=round(a5,digits = 2)
33 a5
34 z3=pnorm(a5,lower.tail = T)
35 z3=round(z3,digits = 4)
36 z3
37
38 x=seq(-4,4,length=200)
39 y=1/sqrt(2*pi)*exp(-x^2/2)
40 plot(x,y,type="l",lwd=2,col="black")
41 x=seq(-4,a5,length=200)
42 y=dnorm(x)
43 polygon(c(-4,x,a5),c(0,y,0),col="gray")

```

R code Exa 8.8.5 500 ball bearings

```

1 #PAGE=181
2 w=5.02
3 sd=0.3
4 n=100
5 a1=496
6 a2=500
7 a3=510
8
9 s=(sd/sqrt(n))*(sqrt((a2-n)/(a2-1)))
10 s=round(s,digits = 3)
11
12
13 x1=((a1/n-w)/s)
14 x1=round(x1,digits = 2)

```



```

15 x1
16
17 x2=((a2/n-w)/s)
18 x2=round(x2,digits = 2)
19 x2
20
21 c1=pnorm(x1,lower.tail = F)
22 c2=pnorm(x2,lower.tail = F)
23 c=c1-c2
24 c=round(c,digits = 4)
25 c
26 x=seq(-4,4,length=200)
27 y=1/sqrt(2*pi)*exp(-x^2/2)
28 plot(x,y,type="l",lwd=2,col="black")
29 x=seq(x1,x2,length=200)
30 y=dnorm(x)
31 polygon(c(x1,x,x2),c(0,y,0),col="gray")
32
33 x3=((a3/n-w)/s)
34 x3=round(x3,digits = 2)
35 x3
36 c3=pnorm(x3,lower.tail = F)
37 c3=round(c3,digits = 4)
38 c3
39
40 x=seq(-4,4,length=200)
41 y=1/sqrt(2*pi)*exp(-x^2/2)
42 plot(x,y,type="l",lwd=2,col="black")
43 x=seq(x3,4,length=200)
44 y=dnorm(x)
45 polygon(c(x3,x,4),c(0,y,0),col="gray")

```

R code Exa 8.8.6 Random samples of students

1 [#PAGE=182](#)

```

2  w1=c(60,63,66,69,72)
3  w2=c(62,65,68,71,74)
4  f=c(5,18,42,27,8)
5  m=(w1+w2)/2
6  a=mean(m)
7
8
9  s1=sample(0:100,4)
10 s1=toString(s1)
11 s2=sample(0:100,4)
12 s2=toString(s2)
13 s3=sample(0:100,4)
14 s3=toString(s3)
15 s4=sample(0:100,4)
16 s4=toString(s4)
17 s5=sample(0:100,4)
18 s5=toString(s5)
19 s6=sample(0:100,4)
20 s6=toString(s6)
21 s7=sample(0:100,4)
22 s7=toString(s7)
23 s8=sample(0:100,4)
24 s8=toString(s8)
25 s9=sample(0:100,4)
26 s9=toString(s9)
27 s10=sample(0:100,4)
28 s10=toString(s10)
29 s11=sample(0:100,4)
30 s11=toString(s11)
31 s12=sample(0:100,4)
32 s12=toString(s12)
33 s13=sample(0:100,4)
34 s13=toString(s13)
35 s14=sample(0:100,4)
36 s14=toString(s14)
37 s15=sample(0:100,4)
38 s15=toString(s15)
39 s16=sample(0:100,4)

```

```

40 s16=toString(s16)
41 s17=sample(0:100,4)
42 s17=toString(s17)
43 s18=sample(0:100,4)
44 s18=toString(s18)
45 s19=sample(0:100,4)
46 s19=toString(s19)
47 s20=sample(0:100,4)
48 s20=toString(s20)
49 s21=sample(0:100,4)
50 s21=toString(s21)
51 s22=sample(0:100,4)
52 s22=toString(s22)
53 s23=sample(0:100,4)
54 s23=toString(s23)
55 s24=sample(0:100,4)
56 s24=toString(s24)
57 s25=sample(0:100,4)
58 s25=toString(s25)
59 s26=sample(0:100,4)
60 s26=toString(s26)
61 s27=sample(0:100,4)
62 s27=toString(s27)
63 s28=sample(0:100,4)
64 s28=toString(s28)
65 s29=sample(0:100,4)
66 s29=toString(s29)
67 s30=sample(0:100,4)
68 s30=toString(s30)
69 s=c(s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,s13,s14,
      s15,s16,s17,s18,s19,s20,s21,s22,s23,s24,s25,s26,
      s27,s28,s29,s30)
70
71 c1=sample(m,4)
72 c2=sample(m,4)
73 c3=sample(m,4)
74 c4=sample(m,4)
75 c5=sample(m,4)

```

```

76 c6=sample(m,4)
77 c7=sample(m,4)
78 c8=sample(m,4)
79 c9=sample(m,4)
80 c10=sample(m,4)
81 c11=sample(m,4)
82 c12=sample(m,4)
83 c13=sample(m,4)
84 c14=sample(m,4)
85 c15=sample(m,4)
86 c16=sample(m,4)
87 c17=sample(m,4)
88 c18=sample(m,4)
89 c19=sample(m,4)
90 c20=sample(m,4)
91 c21=sample(m,4)
92 c22=sample(m,4)
93 c23=sample(m,4)
94 c24=sample(m,4)
95 c25=sample(m,4)
96 c26=sample(m,4)
97 c27=sample(m,4)
98 c28=sample(m,4)
99 c29=sample(m,4)
100 c30=sample(m,4)
101
102 c=c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,
      c15,c16,c17,c18,c19,c20,c21,c22,c23,c24,c25,c26,
      c27,c28,c29,c30)
103
104 h1=mean(c1)
105 h2=mean(c2)
106 h3=mean(c3)
107 h4=mean(c4)
108 h5=mean(c5)
109 h6=mean(c6)
110 h7=mean(c7)
111 h8=mean(c8)

```

```

112 h9=mean(c9)
113 h10=mean(c10)
114 h11=mean(c11)
115 h12=mean(c12)
116 h13=mean(c13)
117 h14=mean(c14)
118 h15=mean(c15)
119 h16=mean(c16)
120 h17=mean(c17)
121 h18=mean(c18)
122 h19=mean(c19)
123 h20=mean(c20)
124 h21=mean(c21)
125 h22=mean(c22)
126 h23=mean(c23)
127 h24=mean(c24)
128 h25=mean(c25)
129 h26=mean(c26)
130 h27=mean(c27)
131 h28=mean(c28)
132 h29=mean(c29)
133 h30=mean(c30)
134
135 h=c(h1,h2,h3,h4,h5,h6,h7,h8,h9,h10,h11,h12,h13,h14,
      h15,h16,h17,h18,h19,h20,h21,h22,h23,h24,h25,h26,
      h27,h28,h29,h30)
136
137
138 c1=toString(c1)
139 c2=toString(c2)
140 c3=toString(c3)
141 c4=toString(c4)
142 c5=toString(c5)
143 c6=toString(c6)
144 c7=toString(c7)
145 c8=toString(c8)
146 c9=toString(c9)
147 c10=toString(c10)

```

```

148 c11=toString(c11)
149 c12=toString(c12)
150 c13=toString(c13)
151 c14=toString(c14)
152 c15=toString(c15)
153 c16=toString(c16)
154 c17=toString(c17)
155 c18=toString(c18)
156 c19=toString(c19)
157 c20=toString(c20)
158 c21=toString(c21)
159 c22=toString(c22)
160 c23=toString(c23)
161 c24=toString(c24)
162 c25=toString(c25)
163 c26=toString(c26)
164 c27=toString(c27)
165 c28=toString(c28)
166 c29=toString(c29)
167 c30=toString(c20)
168
169 c=c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,
      c15,c16,c17,c18,c19,c20,c21,c22,c23,c24,c25,c26,
      c27,c28,c29,c30)
170
171
172 y <- matrix(c(s,c,h),nrow=30,ncol=3,byrow=FALSE)
173 colnames(y) <- c("Sample Number drawn","
      Corresponding Weight","Mean Weight")
174 rownames(y) <- c("1. ","2. ","3. ","4. ","5. ","6. "
      ,"7. ","8. ","9. ","10. ","11. ","12. ","13. ","
      14. ","15. ","16. ","17. ","18. ","19. ","20. ","
      21. ","22. ","23. ","24. ","25. ","26. ","27. ","
      28. ","29. ","30. ")
175 y <- as.table(y)
176 y
177
178

```

```

179
180 c=0.75
181 fu=23
182 n=30
183 fu2=123
184
185 m1=a+(c*fu)/n
186 m1=round(m1,2)
187 cat(m1, 'kg ')
188
189 sd=c*sqrt(fu2/n-(fu/n)**2)
190 sd=round(sd,2)
191 cat(sd, 'kg ')
192
193 s1=2.92
194 n=4
195 c=s1/sqrt(n)
196 cat(c, 'kg ')

```

R code Exa 8.8.7 120 tosses of a fair coin

```

1 #PAGE=184
2 t=120
3 a1=40/100
4 a2=60/100
5 p=1/2
6 q=1-p
7 d=0.5
8 t1=t*a1
9 t2=t*a2
10
11 t1=t1-d
12 t2=t2+d
13 u=t*p
14 s=sqrt(t*p*q)

```

```

15  z1=(t1-t/2)/s
16  z2=(t2-t/2)/s
17
18  z1=pnorm(z1)
19  z2=pnorm(0)
20  z=2*(z2-z1)
21  z=round(z,4)
22  cat(z)
23
24
25  n1=5/8
26  u1=p
27  sp=sqrt((p*q)/t)
28  n2=1/(2*t)
29  b=(n1-n2-u1)/sp
30  b=round(b,2)
31  cat(b)
32
33  z1=pnorm(b)
34  z1=round(z1,4)
35  z1=1-z1
36  cat(z1)

```

R code Exa 8.8.8 Group of 500 people

```

1  #PAGE=185
2  t=120
3  a1=40/100
4  a2=60/100
5  p=1/2
6  q=1-p
7  d=0.5
8  t1=t*a1
9  t2=t*a2
10 N=500

```



```

11
12 t1=t1-d
13 t2=t2+d
14 u=t*p
15 s=sqrt(t*p*q)
16 z1=(t1-t/2)/s
17 z2=(t2-t/2)/s
18
19 z1=pnorm(z1)
20 z2=pnorm(0)
21 z=2*(z2-z1)
22 z=round(z,4)
23 z=z*N
24 z=round(z,0)
25 z4=N-z
26 cat(z)
27 cat(z4)
28
29
30 n1=5/8
31 u1=p
32 sp=sqrt((p*q)/t)
33 n2=1/(2*t)
34 b=(n1-n2-u1)/sp
35 b=round(b,2)
36 cat(b)
37
38 z1=pnorm(b)
39 z1=round(z1,4)
40 z1=1-z1
41 z1=N*z1
42 cat(z1)

```

R code Exa 8.8.9 Machine and tools

```

1 #page 185
2 u=p=2/100
3 no_of_tools=n=400
4 v1<-sqrt((p*(1-p))/n)
5 v1
6 x<-1/(2*n)
7 x
8 a<-3/100
9 a
10 z_value=(a-x-u)/v1
11 z_value
12 p1<-pnorm(-abs(z_value))
13 p<-round(p1,digits=4)
14 p
15
16 u=p=2/100
17 no_of_tools=n=400
18 v1<-sqrt((p*(1-p))/n)
19 v1
20 x<-1/(2*n)
21 x
22 b<-2/100
23 z_value_2<-(b+x-u)/v1
24 z_value_2<-round(z_value_2,digits=2)
25 z_value_2
26 p2<-pnorm(abs(z_value_2))
27 p<-round(p2,digits=4)
28 p

```

R code Exa 8.8.10 Election returns

```

1 #PAGE=186
2 p=0.46
3 q=1-p
4

```

```

5 a1=200
6 s=sqrt(p*q/a1)
7 s=round(s,digits = 4)
8
9 m=1/(2*a1)
10 n=0.5
11
12 s1=m+n
13
14 s2=(s1-p)/s
15 s2=round(s2,digits = 2)
16 a=pnorm(s2,mean=0,sd=1,lower.tail=F)
17 a=round(a,digits=4)
18 a
19
20 b1=1000
21 c=sqrt(p*q/b1)
22 c=round(c,digits = 4)
23
24 c1=(s1-p)/c
25 c1=round(c1,digits=2)
26 b=pnorm(c1,mean=0,sd=1,lower.tail=F)
27 b=round(b,digits=4)
28 b

```

R code Exa 8.8.11 Elements of the population

```

1 #PAGE=186
2 u1=c(3,7,8)
3 u2=c(2,4)
4 m1=mean(u1)
5 m1
6 m2=mean(u2)
7 m2
8

```

```

 9  u4=u1-u2[2]
10  u4
11  u3=u1-u2[1]
12  u3
13  u=c(u3,u4)
14  u
15  x=matrix(u,ncol=2,nrow=3)
16  v=t(x)
17  v
18  c=mean(v)
19  c
20
21  d1=(u1[1]-m1)**2
22  d2=(u1[2]-m1)**2
23  d3=(u1[3]-m1)**2
24  d=(d1+d2+d3)/3
25  d=sqrt(d)
26  d
27
28  e1=(u2[1]-m2)**2
29  e2=(u2[2]-m2)**2
30  e=(e1+e2)/2
31  e
32
33  f1=(u[1]-c)**2
34  f2=(u[2]-c)**2
35  f3=(u[3]-c)**2
36  f4=(u[4]-c)**2
37  f5=(u[5]-c)**2
38  f6=(u[6]-c)**2
39  f=(f1+f2+f3+f4+f5+f6)/length(u)
40  f=sqrt(f)
41  f

```

R code Exa 8.8.12 Electric light bulbs

```

1 #PAGE=187
2 l1=1400
3 s1=200
4 l2=1200
5 s2=100
6 n=125
7 l=l1-l2
8 s=sqrt((s1**2+s2**2)/n)
9
10
11 a1=160
12 a2=(a1-s1)/s
13 a=pnorm(a2,mean=0,sd=1,lower.tail=F)
14 a=round(a,digits=4)
15 a
16
17 b1=250
18 b2=(b1-s1)/s
19 b=pnorm(b2,mean=0,sd=1,lower.tail=F)
20 b=round(b,digits=4)
21 b

```

R code Exa 8.8.13 Ball bearing

```

1 #PAGE=188
2 m1=0.5
3 m2=0.5
4 s1=0.02
5 s2=s1
6 n1=1000
7 n2=n1
8 m=m1-m2
9 s=(s1**2)/n1+(s2**2)/n2
10 s=sqrt(s)
11 s=round(s,6)

```

```

12 cat(s)
13 a=2
14 a1=a/n1
15 a2=-a1
16 a3=(a1-0)/s
17 a4=(a2-0)/s
18 a3=round(a3,2)
19 a4=round(a4,2)
20 cat(a3)
21 cat(a4)
22 ans=2*(m1-0.4871)
23 cat(ans)

```

R code Exa 8.8.14 heads and tails

```

1 #PAGE=188
2 p=1/2
3 q=1/2
4 a=50
5 b=50
6 t=5
7 m=a-b
8 s=sqrt((2*p*q)/a)
9 t1=t-p
10 p=t1/a
11
12 p1=(p-m)/s
13 x=pnorm(p1,lower.tail = F)
14 x=round(x,digits = 4)
15 x
16 y=1-x
17 y

```

R code Exa 8.8.15 Two distances with different standard deviation

```
1 #PAGE=188
2 u1=273
3 u2=156
4 s1=1.6
5 s2=0.8
6 a1=u1+u2
7 cat(a1, 'mm')
8 a2=sqrt(s1**2+s2**2)
9 a2=round(a2,digits = 1)
10 cat(a2, 'mm')
11
12 b1=u1-u2
13 cat(b1, 'mm')
14 b2=sqrt(s1**2+s2**2)
15 b2=round(b2,digits = 1)
16 cat(b2, 'mm')
```

R code Exa 8.8.16 Electric light bulb

```
1 #PAGE=189
2 u1=u2=u3=1500
3 u=u1+u2+u3
4 s1=s2=s3=150
5 s=sqrt(s1**2*3)
6 s=round(s,digits = 0)
7 s
8 a1=5000
9 a2=(a1-u)/s
10 a2=round(a2,digits = 2)
11 a2
12 a=pnorm(a2,lower.tail=F)
13 a=round(a,digits=4)
14 a
```

```

15
16 b1=4200
17 b2=(b1-u)/s
18 b2=round(b2,digits = 2)
19 b2
20 b=pnorm(b2,lower.tail = T)
21 b=round(b,digits = 4)
22 b

```

R code Exa 8.8.17 Mean and Standard deviation

```

1 #PAGE=189
2 c=c
   (0,0.25,4,9,20.25,0.25,0,2.25,6.25,16,4,2.25,0,1,6.25,9,6.25,1,0,

3 u=sum(c)/length(c)
4 cat(u)
5
6 c1=(c-u)**2
7 c1=sum(c1)
8 c2=c1/length(c)
9 c2=sqrt(c2)
10 c2=round(c2,2)
11 cat(c2)
12 #”The answer provided in the textbook is wrong.”

```

R code Exa 8.8.18 Sampling without replacement

```

1 #PAGE=190
2 c=c
   (0,0.25,4,9,20.25,0.25,0,2.25,6.25,16,4,2.25,0,1,6.25,9,6.25,1,0,

3

```



```

4 m2 <- matrix(c, 5, 5)
5   lower.tri(m2)
6   m2[lower.tri(m2)] <- NA
7
8 c1=m2[upper.tri(m2)]
9
10 u=sum(c1)/length(c1)
11 cat(u)
12
13
14 c11=(c1-u)**2
15 c11=sum(c11)
16 c2=c11/length(c1)
17 c2=sqrt(c2)
18 c2=round(c2,2)
19 cat(c2)

```

R code Exa 8.8.19 Sampling distribution of standard deviation

```

1 #PAGE=190
2 s=200
3 n=5
4 u=n
5 cat(u, 'kg ')
6
7 s1=n/sqrt(2*s)
8 cat(s1, 'kg ')

```

R code Exa 8.8.20 Percentage of the samples

```

1 #PAGE=190
2 s=200
3 n=5

```

```
4  s1=0.25
5  a1=5.5
6  z=(a1-n)/s1
7  z1=pnorm(z)
8  z2=pnorm(0)
9  z3=z2-z1
10 z3=z2+z3
11 z3=round(z3,4)
12 cat(z3)
13 z3=z3*100
14 z3=round(z3,1)
15 cat(z3, '%')
16
17
18 b1=4.4
19 z4=(b1-n)/s1
20 z1=pnorm(z4)
21 z2=pnorm(0)
22 z3=z2-z1
23 z3=round(z3,4)
24 z3=0.5-z3
25 cat(z3)
26 z3=z3*100
27 z3=round(z3,1)
28 cat(z3, '%')
```

Chapter 9

Statistical Estimation Theory

R code Exa 9.9.2 sample of five measurements

```
1 #PAGE=197
2 x=c(63.3,63.7,63.6,63.2,63.7)
3 a=mean(x)
4 cat(a, 'mm')
5 len=length(x)
6
7 b=(x-a)**2
8 b=sum(b)
9 b=b/(len-1)
10 cat(b, 'mm^2 ')
11 s=sqrt(b)
12 s=round(s,digits=2)
13 cat(s, 'mm')
```

R code Exa 9.9.3 random sample of weights of students

```
1 #PAGE=198
2 w1=c(60,62)
```

```

3  w1=mean(w1)
4  w2=c(63,65)
5  w2=mean(w2)
6  w3=c(66,68)
7  w3=mean(w3)
8  w4=c(69,71)
9  w4=mean(w4)
10 w5=c(72,74)
11 w5=mean(w5)
12 w=c(w1,w2,w3,w4,w5)
13 f=c(5,18,42,27,8)
14 p=sum(f)
15 a=median(w)
16 b=w-a
17 c=3
18 b=b/c
19 d=f*b
20 e=sum(d)
21 x=a+(c*e)/p
22 cat(x,'kg')
23
24 w=c(w1,w2,w3,w4,w5)
25 a=median(w)
26 f=c(5,18,42,27,8)
27 s=sum(f)
28 d=w-a
29 fd=d*f
30 e=sum(fd)
31 d=d**2
32 fd2=f*d
33 h=sum(fd2)
34 h=h/s
35 e=(e/s)**2
36 s=(h-e)
37
38 n=100
39 s2=(n*s)/(n-1)
40 s2

```

```
41 s3=sqrt(s2)
42 s3=round(s3,digits = 2)
43 cat(s3, 'kg')
```

R code Exa 9.9.4 unbiased and efficient estimate

```
1 #PAGE=198
2 x=c(63.3,63.7,63.6,63.2,63.7)
3 a=sort(x)
4 a=median(x)
5 cat(a, 'mm')
```

R code Exa 9.9.5 XYZ university students

```
1 #PAGE=198
2 a=1-0.95
3 a1=qnorm(a/2,lower.tail=FALSE)
4 a1=round(a1,2)
5 x=67.45
6 s=2.93
7 n=100
8 s1=x+a1*s/sqrt(n)
9 s2=x-a1*s/sqrt(n)
10 s1=round(s1,2)
11 s2=round(s2,2)
12 cat(s2, 'kg -', s1, 'kg')
13
14 b=1-0.99
15 a1=qnorm(b/2,lower.tail=FALSE)
16 a1=round(a1,2)
17 x=67.45
18 s=2.93
19 n=100
```

```

20 s1=x+a1*s/sqrt(n)
21 s2=x-a1*s/sqrt(n)
22 s1=round(s1,2)
23 s2=round(s2,2)
24 cat(s2, 'kg -', s1, 'kg ')
25
26 m=1546
27 np=sqrt((m-n)/(m-1))
28 np=round(np,3)
29 b=1-np
30 a1=qnorm(b/2, lower.tail=FALSE)
31 a1=round(a1,2)
32 x=67.45
33 s=2.93
34 n=100
35 s1=x+a1*s/sqrt(n)
36 s2=x-a1*s/sqrt(n)
37 s1=round(s1,2)
38 s2=round(s2,2)
39 cat(s2, 'kg -', s1, 'kg ')

```

R code Exa 9.9.6 Measurements of the diameter of a a random sample

```

1 #PAGE=199
2 n=200
3 m=8.24
4 s=0.42
5 a1=95
6 a1=1-(100-a1)/200
7 a1=qnorm(a1)
8 a1=round(a1,digits = 2)
9
10 b1=99
11 b1=1-(100-b1)/200
12 b1=qnorm(b1)

```

```

13 b1=round(b1,digits = 2)
14
15 l1=m-a1*(s/sqrt(n))
16 l1=round(l1,digits = 2)
17 u1=m+a1*(s/sqrt(n))
18 u1=round(u1,digits = 2)
19 cat(l1, '-', u1, 'kg ')
20
21 l2=m-b1*(s/sqrt(n))
22 l2=round(l2,digits = 2)
23 u2=m+b1*(s/sqrt(n))
24 u2=round(u2,digits = 2)
25 cat(l2, '-', u2, 'kg ')

```

R code Exa 9.9.7 confidence limits for the mean diameters

```

1 #PAGE=199
2 n=200
3 m=8.24
4 s=0.42
5 a1=98
6 a1=1-(100-a1)/200
7 a1=qnorm(a1)
8 a1=round(a1,digits = 2)
9 a1
10 b1=90
11 b1=1-(100-b1)/200
12 b1=qnorm(b1)
13 b1=round(b1,digits = 2)
14 b1
15 c1=99.73
16 c1=1-(100-c1)/200
17 c1=qnorm(c1)
18 c1=round(c1,digits = 2)
19 c1

```

```

20 l1=m-a1*(s/sqrt(n))
21 l1=round(l1,digits = 2)
22 u1=m+a1*(s/sqrt(n))
23 u1=round(u1,digits = 2)
24 cat(l1, '-', u1, 'mm')
25
26 l2=m-b1*(s/sqrt(n))
27 l2=round(l2,digits = 2)
28 u2=m+b1*(s/sqrt(n))
29 u2=round(u2,digits = 2)
30 cat(l2, '-', u2, 'mm')
31
32 l2=m-c1*(s/sqrt(n))
33 l2=round(l2,digits = 2)
34 u2=m+c1*(s/sqrt(n))
35 u2=round(u2,digits = 2)
36 cat(l2, '-', u2, 'mm')

```

R code Exa 9.9.8 measuring reaction time

```

1 #PAGE=200
2 s=0.05
3 e=0.01
4
5 a1=95
6 a1=1-(100-a1)/200
7 a1=qnorm(a1)
8 a1=round(a1,digits = 2)
9 n1=(a1*s/e)**2
10 n1
11
12 b1=99
13 b1=1-(100-b1)/200
14 b1=qnorm(b1)
15 b1=round(b1,digits = 2)

```



```

16 n2=(b1*s/e)**2
17 n2=round(n2,digits = 1)
18 n2

```

R code Exa 9.9.9 Random sample of 50 mathematics grades

```

1 #PAGE=200
2 m=50
3 t=200
4 n=75
5 s=10
6
7 a1=95
8 a1=1-(100-a1)/200
9 a1=qnorm(a1)
10 a1=round(a1,digits = 2)
11
12 a2=n+a1*(s/sqrt(m))*sqrt((t-m)/(t-1))
13 a3=n-a1*(s/sqrt(m))*sqrt((t-m)/(t-1))
14
15 cat(a3, '-', a2)
16
17
18 b1=(s/sqrt(m))*sqrt((t-m)/(t-1))
19 b1=round(b1,digits = 2)
20 b1
21
22 c=1
23 z=c/b1
24 z=round(z,digits = 2)
25 z=pnorm(1-z/2,lower.tail = FALSE)
26 z=round(z,digits = 2)
27 d1=z*2
28 d1=d1*100
29 d1

```

30 #”The answer may slightly vary due to rounding off
values.”

R code Exa 9.9.10 sample poll of 100 voters

```
1 #PAGE=200
2 n=100
3 p=55/100
4 q=1-p
5 a=95/100
6 a1=(1-a)/2
7 a2=qnorm(a1,lower.tail=FALSE)
8 a2=round(a2,digits = 2)
9 c1=a2*sqrt((p*q)/n)
10 c1=round(c1,digits = 1)
11 c2=p+c1
12 c3=p-c1
13 cat(c2, '-', c3)
14
15 b=99/100
16 a1=(1-b)/2
17 a2=qnorm(a1,lower.tail=FALSE)
18 a2=round(a2,digits = 2)
19 c1=a2*sqrt((p*q)/n)
20 c1=round(c1,digits = 2)
21 c2=p+c1
22 c3=p-c1
23 cat(c2, '-', c3)
24
25 c=99.73/100
26 a1=(1-c)/2
27 a2=qnorm(a1,lower.tail=FALSE)
28 a2=round(a2,digits = 2)
29 c1=a2*sqrt((p*q)/n)
30 c1=round(c1,digits = 2)
```

```
31 c2=p+c1
32 c3=p-c1
33 cat(c2, '-', c3)
```

R code Exa 9.9.11 sample of voters

```
1 #PAGE=201
2 n=100
3 p=55/100
4 q=1-p
5 a=95/100
6 a1=(1-a)/2
7 a2=qnorm(a1, lower.tail=FALSE)
8 a2=round(a2,digits = 2)
9 n=(0.5*a2/0.05)**2
10 n=round(n,1)
11 n
12 ans=round(n,0)
13 cat(ans+1)
14
15
16 b=99.73/100
17 b1=(1-b)/2
18 b2=qnorm(b1, lower.tail=FALSE)
19 b2=round(b2,digits = 2)
20 n=(0.5*b2/0.05)**2
21 n=round(n,1)
22 n
23 ans=round(n,0)
24 cat(ans+1)
```

R code Exa 9.9.12 Confidence limits

```

1 #PAGE=201
2 b=1-0.9973
3 a1=qnorm(b/2,lower.tail=FALSE)
4 a1=round(a1,2)
5 a1
6 p=0.55
7 n=100
8 z=a1**2
9
10 p1=p+(z/(2*n))+a1*sqrt((p*(1-p)/n)+(z/(4*n**2)))
11 p2=1+(z/n)
12 p3=p1/p2
13 p3=round(p3,2)
14 cat(p3)
15
16
17 p1=p+(z/(2*n))-a1*sqrt((p*(1-p)/n)+(z/(4*n**2)))
18 p2=1+(z/n)
19 p3=p1/p2
20 p3=round(p3,1)
21 cat(p3)

```

R code Exa 9.9.13 40 tosses of coin

```

1 #PAGE=202
2 t=40
3 aa=24
4 p1=aa/t
5
6 b=1-0.95
7 a1=qnorm(b/2,lower.tail=FALSE)
8 a1=round(a1,2)
9 a1
10 p=p1
11 n=t

```

```

12 z=a1**2
13
14 p1=p+(z/(2*n))+a1*sqrt((p*(1-p)/n)+(z/(4*n**2)))
15 p2=1+(z/n)
16 p3=p1/p2
17 p3=round(p3,2)
18
19 p1=p+(z/(2*n))-a1*sqrt((p*(1-p)/n)+(z/(4*n**2)))
20 p2=1+(z/n)
21 p4=p1/p2
22 p4=round(p4,2)
23
24 cat(p4,p3)
25
26
27 t=40
28 aa=24
29 p1=aa/t
30
31 b=1-0.9973
32 a1=qnorm(b/2,lower.tail=FALSE)
33 a1=round(a1,2)
34 a1
35 p=p1
36 n=t
37 z=a1**2
38
39 p1=p+(z/(2*n))+a1*sqrt((p*(1-p)/n)+(z/(4*n**2)))
40 p2=1+(z/n)
41 p3=p1/p2
42 p3=round(p3,2)
43
44 p1=p+(z/(2*n))-a1*sqrt((p*(1-p)/n)+(z/(4*n**2)))
45 p2=1+(z/n)
46 p4=p1/p2
47 p4=round(p4,2)
48
49 cat(p4,p3)

```

R code Exa 9.9.14 sample of 150 and 200 light bulbs

```
1 #PAGE=202
2 xa=1400
3 xb=1200
4 s1=120
5 s2=80
6 n1=150
7 n2=100
8 b=1-0.95
9 a1=qnorm(b/2,lower.tail=FALSE)
10 a1=round(a1,2)
11 a1
12 an1=xa-xb+a1*sqrt((s1**2/n1)+(s2**2/n2))
13 an1=round(an1,0)
14 an2=xa-xb-a1*sqrt((s1**2/n1)+(s2**2/n2))
15 an2=round(an2,0)
16
17 cat(an2,an1,'h')
18
19 b=1-0.99
20 a1=qnorm(b/2,lower.tail=FALSE)
21 a1=round(a1,2)
22 a1
23 an1=xa-xb+a1*sqrt((s1**2/n1)+(s2**2/n2))
24 an1=round(an1,0)
25 an2=xa-xb-a1*sqrt((s1**2/n1)+(s2**2/n2))
26 an2=round(an2,0)
27
28 cat(an2,an1,'h')
```

R code Exa 9.9.15 random sample of adults and teenagers

```

1 #PAGE=202
2 a=400
3 t=600
4 a1=100
5 t1=300
6 p1=a1/a
7 q1=1-p1
8 p2=t1/t
9 q2=1-p2
10 z=95/100
11 z1=(1-z)/2
12 z2=qnorm(z1,lower.tail=FALSE)
13 z2=round(z2,digits = 2)
14 k=z*sqrt((p1*q1)/t+(p2*q2)/a)
15 k=round(k,digits = 2)
16 m1=p2-p1-k
17 m1
18 m2=p2-p1+k
19 m2
20
21 z3=99/100
22 z1=(1-z3)/2
23 z2=qnorm(z1,lower.tail=FALSE)
24 z2=round(z2,digits = 2)
25 k=z*sqrt((p1*q1)/t+(p2*q2)/a)
26 k=round(k,digits = 2)
27 n1=p2-p1-k
28 n1
29 n2=p2-p1+k
30 n2

```

R code Exa 9.9.16 Electromotive force of batteries

```

1 #PAGE=203
2 m1=m2=m3=m4=45.1

```

```

3  s1=s2=s3=s4=0.04
4  m=m1*4
5  s=sqrt(4*s1**2)
6  s
7  b=1-0.95
8  a1=qnorm(b/2,lower.tail=FALSE)
9  a1=round(a1,2)
10 a1
11 a2=m+a1*s
12 a2=round(a2,2)
13 a3=m-a1*s
14 a3=round(a3,2)
15 cat(a3,a2,'V')
16
17 b=1-0.99
18 a1=qnorm(b/2,lower.tail=FALSE)
19 a1=round(a1,2)
20 a1
21 a2=m+a1*s
22 a2=round(a2,2)
23 a3=m-a1*s
24 a3=round(a3,2)
25 cat(a3,a2,'V')
26
27 b=1-0.9973
28 a1=qnorm(b/2,lower.tail=FALSE)
29 a1=round(a1,2)
30 a1
31 a2=m+a1*s
32 a2=round(a2,2)
33 a3=m-a1*s
34 a3=round(a3,2)
35 cat(a3,a2,'V')
36
37 b=1-0.5
38 a1=qnorm(b/2,lower.tail=FALSE)
39 a1=round(a1,2)
40 a1

```



```

41 a2=m+a1*s
42 a2=round(a2,2)
43 a3=m-a1*s
44 a3=round(a3,2)
45 cat(a3,a2,'V')

```

R code Exa 9.9.17 standard deviation of light bulbs

```

1 #PAGE=203
2 s=200
3 sd=100
4 z=95/100
5 z1=(1-z)/2
6 z1=qnorm(z1,lower.tail=FALSE)
7 z1=round(z1,digits = 2)
8
9 a2=sd-(z1*sd)/(sqrt(2*s))
10 a1=sd+(z1*sd)/(sqrt(2*s))
11 cat(a2,a1,'h')
12
13 z=99/100
14 z1=(1-z)/2
15 z1=qnorm(z1,lower.tail=FALSE)
16 z1=round(z1,digits = 2)
17
18 a4=sd-(z1*sd)/(sqrt(2*s))
19 a3=sd+(z1*sd)/(sqrt(2*s))
20 cat(a4,a3,'h')

```

R code Exa 9.9.18 Sample of light bulbs

```

1 #PAGE=203
2 s=200

```

```

3 sd=100
4 z=99.73/100
5 z1=(1-z)/2
6 z1=qnorm(z1,lower.tail=FALSE)
7 z1=round(z1,digits = 2)
8 k=z1*sd
9 k
10 a1=5
11 n1=(k/a1)**2/2
12 n1
13
14 a2=10
15 n2=(k/a2)**2/2
16 n2

```

R code Exa 9.9.19 Probable error and confidence limits

```

1 #PAGE=204
2 v=50
3 m=18.2
4 sd=0.5
5
6 z=50/100
7 z4=(1-z)/2
8 z4=qnorm(z4,lower.tail=FALSE)
9 z4=round(z4,digits = 4)
10
11 a=(0.6745*sd)/sqrt(v-1)
12 a=round(a,digits = 3)
13 cat(a,'V')
14
15 m=round(m,digits = 0)
16 m2=m+a
17 m1=m-a
18 cat(m1,m2)

```

```
19 #”The answer may vary due to difference in
    representation.”
```

R code Exa 9.9.20 Probable error and confidence limits for a measurement

```
1 #PAGE=204
2 m=216.480
3 e=0.272
4 z=95/100
5 z1=(1-z)/2
6 z1=qnorm(z1,lower.tail=FALSE)
7 z1=round(z1,digits = 2)
8 k=e/0.6745
9 x1=m+z1*k
10 x2=m-z1*k
11 cat(x2,x1,'kg')
12 #”The answer may vary due to difference in
    representation.”
```

Chapter 10

Statistical Decision Theory

R code Exa 10.10.1 Probability of getting heads and tails

```
1  #PAGE=210
2  h1=40
3  h2=60
4  m=(h1+h2)/2
5  n=100
6  p=1/2
7  q=1-p
8  u=n*p
9  s=sqrt(n*p*q)
10 h1=h1-0.5
11 h2=h2+0.5
12 c1=(h1-m)/s
13 c2=(h2-m)/s
14 a1=pnorm(c1,lower.tail = F)
15 a2=pnorm(c2,lower.tail = F)
16 a=a1-a2
17
18 a=round(a,digits = 4)
19 a=abs(a)
20 a
21 #” The answer may slightly vary due to rounding off
```

values.”

R code Exa 10.10.2 Hypothesis testing

```
1 #PAGE=211
2 n=100
3 a=40
4 b=60
5
6
7 m=1.9642
8 m1=1-m
9 cat(m1)
10
11 d=0.5
12 a1=a-d
13 b1=b+d
14
15 z1=(a1-n/2)/5
16 z2=z1*(-1)
17
18
19 z.rg <- c(z1, z2)
20
21
22 cuts <- sort(sort(c(z.rg, -3.5, 3.5))) # c(-3.5,
    3.5) will be the xlim of the plot
23 x.sq <- seq(cuts[1], cuts[4], len=200)
24 alpha <- c(.001, .01, .05)
25 z <- c(qnorm(alpha/2), 0, abs(qnorm(alpha/2)))
26
27
28 plot(x.sq, dnorm(x.sq), type="l", xlab="z-score",
    ylab=" ", xaxt="n")
29 z <- c(qnorm(alpha/2), 0, abs(qnorm(alpha/2)))
```

```

30 axis(1, z, round(z, 2))
31 abline(h=0)
32
33 polygon(c(cuts[2], cuts[2], x.sq[x.sq > cuts[2] & x.
    sq < cuts[3]], cuts[3], cuts[3])),
34       c(0, dnorm(cuts[2]), dnorm(x.sq[x.sq > cuts
    [2] & x.sq < cuts[3]]), dnorm(cuts[3]),
    0),
35       col="lightgrey", border=1)
36
37 polygon(c(cuts[3], cuts[3], x.sq[x.sq > cuts[3]],
    cuts[4], cuts[4])),
38       c(0, dnorm(cuts[3]), dnorm(x.sq[x.sq > cuts
    [3]]), dnorm(cuts[4]), 0),
39       col="#4da6ff", border=1)
40 polygon(c(cuts[1], cuts[1], x.sq[x.sq < cuts[2]],
    cuts[2], cuts[2])),
41       c(0, dnorm(cuts[1]), dnorm(x.sq[x.sq < cuts
    [2]]), dnorm(cuts[2]), 0),
42       col="#4da6ff", border=4)
43
44 arrows(z.rg, rep(dnorm(z.rg), length(z.rg)), z.rg,
    rep(dnorm(0)*.666, length(z.rg)),
45       length=0, lty=2, col=4)
46 sapply(z.rg, function(x) text(x, dnorm(0)*.666 +
    .02, bquote(italic("z=")~.(x)), col=4))

```

R code Exa 10.10.3 Hypothesis test of a fair coin

```

1 #PAGE=211
2 n=64
3 a=0.05
4 a1=a/2
5 z1=qnorm(a1,lower.tail=FALSE)
6 z1=round(z1,digits = 2)

```

```

7
8  z2=qnorm(a1,lower.tail=TRUE)
9  z2=round(z2,digits = 2)
10
11 x=pnorm(0)
12 z=x-a/2
13
14 p=1/2
15 q=1-p
16
17 u=n*p
18 s=sqrt(n*p*q)
19
20 x1=z1*s+u
21 x2=z2*s+u
22
23 cat(x2,x1)
24
25 b=0.01
26 b1=b/2
27 z3=qnorm(b1,lower.tail=FALSE)
28 z3=round(z3,digits = 2)
29
30 z4=qnorm(b1,lower.tail=TRUE)
31 z4=round(z4,digits = 2)
32
33 x=pnorm(0)
34 z=x-b/2
35
36 p=1/2
37 q=1-p
38
39 u=n*p
40 s=sqrt(n*p*q)
41
42 x3=z3*s+u
43 x3=round(x3,digits = 0)
44 x4=z4*s+u

```

```

45 x4=round(x4,digits = 0)
46
47 cat(x4,x3)

```

R code Exa 10.10.5 An experiment on extrasensory perception

```

1 #PAGE=213
2 n=50
3 p=1/2
4 q=1-p
5 c=32
6 u=p*n
7 s=sqrt(n*p*q)
8 a=0.05
9 a1=p-a
10 z=1.645
11 x=n/2
12 y=(c-x)/s
13 y=round(y,digits = 2)
14 y
15 c1=c-p
16 y=(c1-x)/s
17 y=round(y,digits = 2)
18 y
19
20 b=0.01
21 b1=p-b
22 z2=qnorm(b,lower.tail = FALSE)
23 z2=round(z2,digits = 2)
24 z2
25
26 if(z2>y) x <- TRUE
27 x
28 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.6 Manufacturer of a patent medicine

```
1 #PAGE=214
2 p=90/100
3 q=1-p
4 t=8
5 n=200
6 r=160
7 b=0.01
8 b1=p-b
9 z2=qnorm(b,lower.tail = FALSE)
10 z2=round(z2,digits = 2)
11 z2
12 z3=qnorm(b,lower.tail = TRUE)
13 z3=round(z3,digits = 2)
14 z3
15 u=n*p
16 s=sqrt(n*p*q)
17 x=(r-u)/s
18 x=round(x,digits = 2)
19 x
20 if(z3>x) y <- TRUE
21 y
22 #”The answer may vary due to difference in
    representation.”
```

R code Exa 10.10.7 Fluorescent light bulbs

```
1 #PAGE=214
2 u=1600
3 a=0.05
```

```

4 a=a/2
5 z1=qnorm(a,lower.tail = FALSE)
6 z1=round(z1,digits = 3)
7 z1
8 z2=qnorm(a,lower.tail = TRUE)
9 z2=round(z2,digits = 3)
10 z2
11 l=100
12 c=1570
13 s=120
14 s1=s/(sqrt(1))
15 x=(c-u)/s1
16 x
17 if (x>z1||x<z2) k<-FALSE
18 k
19
20 b1=0.01
21 b1=b1/2
22 z3=qnorm(b1,lower.tail=FALSE)
23 z3=round(z3,digits = 2)
24 z3
25 z4=qnorm(b1,lower.tail=TRUE)
26 z4=round(z4,digits = 2)
27 z4
28 if (x<z3||x>z4) l<-TRUE
29 l

```

R code Exa 10.10.8 hypothesis and alternative hypothesis

```

1 #PAGE=215
2 u=1600
3 a=0.05
4 z1=qnorm(a,lower.tail = FALSE)
5 z1=round(z1,digits = 3)
6 z1

```

```

7  z2=qnorm(a,lower.tail = TRUE)
8  z2=round(z2,digits = 3)
9  z2
10 l=100
11 c=1570
12 s=120
13 s1=s/(sqrt(1))
14 x=(c-u)/s1
15 x
16 if (x>z1||x<z2) k<-FALSE
17 k
18
19 b1=0.01
20 z3=qnorm(b1,lower.tail=FALSE)
21 z3=round(z3,digits = 2)
22 z3
23 z4=qnorm(b1,lower.tail=TRUE)
24 z4=round(z4,digits = 2)
25 z4
26 if (x>z1||x<z2) l<-FALSE
27 l

```

R code Exa 10.10.9 Breaking strengths of cables

```

1  #PAGE=215
2  u=1800
3  a=0.05
4  l=50
5  c=1850
6  s=100
7  s1=s/(sqrt(1))
8  x=(c-u)/s1
9  x
10
11 b1=0.01

```

```

12 z3=qnorm(b1,lower.tail=FALSE)
13 z3=round(z3,digits = 2)
14 z3
15 z4=qnorm(b1,lower.tail=TRUE)
16 z4=round(z4,digits = 2)
17 z4
18 if (x>z3||x<z4) l<-TRUE
19 l

```

R code Exa 10.10.10 Accepting hypothesis

```

1 #PAGE=216
2 p=0.7
3 q=1-p
4 n=100
5 h1=40
6 h2=60
7 h1=h1-0.5
8 h2=h2+0.5
9 u=n*p
10 s=sqrt(n*p*q)
11 s1=(h2-p*n)/s
12 s2=(h1-p*n)/s
13 s1=round(s1,digits = 2)
14 s2=round(s2,digits = 2)
15 a=pnorm(s1)
16 b=pnorm(s2)
17 c=a-b
18 c=round(c,digits = 4)
19 c

```

R code Exa 10.10.11 Work problem

```

1  #PAGE=216
2  p=0.6
3  q=1-p
4  n=100
5  h1=40
6  h2=60
7  h1=h1-0.5
8  h2=h2+0.5
9  u=n*p
10 s=sqrt(n*p*q)
11 s1=(h2-p*n)/s
12 s2=(h1-p*n)/s
13 s1=round(s1,digits = 2)
14 s2=round(s2,digits = 2)
15 a=pnorm(s1)
16 b=pnorm(s2)
17 c=a-b
18 c=round(c,digits = 2)
19 c
20
21 p=0.8
22 q=1-p
23 n=100
24 h1=40
25 h2=60
26 h1=h1-0.5
27 h2=h2+0.5
28 u=n*p
29 s=sqrt(n*p*q)
30 s1=(h2-p*n)/s
31 s2=(h1-p*n)/s
32 s1=round(s1,digits = 2)
33 s2=round(s2,digits = 2)
34 a=pnorm(s1)
35 b=pnorm(s2)
36 c=a-b
37 c=round(c,digits = 4)
38 c

```

```

39
40 p=0.4
41 q=1-p
42 n=100
43 h1=40
44 h2=60
45 h1=h1-0.5
46 h2=h2+0.5
47 u=n*p
48 s=sqrt(n*p*q)
49 s1=(h2-p*n)/s
50 s2=(h1-p*n)/s
51 s1=round(s1,digits = 2)
52 s2=round(s2,digits = 2)
53 a=pnorm(s1)
54 b=pnorm(s2)
55 c=a-b
56 c=round(c,digits = 2)
57 c
58 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 10.10.12 Graph of results

```

1 #PAGE=217
2 p=c(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9)
3 b=c(0,0,0.0192,0.504,0.9642,0.504,0.0192,0,0)
4
5 plot(p,b,type = 'l')
6
7 c=1-b
8 plot(p,c,type = 'l')

```

R code Exa 10.10.13 Rope manufacturing company

```
1 #PAGE=217
2 u=300
3 s=24
4 a=0.01
5 n=600
6 z=2.33
7 t=64
8 b=s/sqrt(t)
9 c=b*z+u
10 c=round(c,0)
11 cat(c, 'N')
12
13 u2=310
14 u1=(c-u2)/3
15 z1=pnorm(u1)
16 z1=round(z1,4)
17 cat(z1)
```

R code Exa 10.10.14 OC and power curve

```
1 #PAGE=219
2 a=307
3 a1=290
4 u1=(a-a1)/3
5 z1=pnorm(u1)
6 z1=round(z1,4)
7 cat(z1)
8
9
10 a2=295
11 u2=(a-a2)/3
12 z2=pnorm(u2)
13 z2=round(z2,4)
```

```

14  cat(z2)
15
16
17  a3=300
18  u3=(a-a3)/3
19  z3=pnorm(u3)
20  z3=round(z3,2)
21  cat(z3)
22
23  a7=305
24  u7=(a-a7)/3
25  z7=pnorm(u7)
26  z7=round(z7,3)
27  cat(z7)
28
29
30  a4=310
31  u4=(a-a4)/3
32  z4=pnorm(u4)
33  z4=round(z4,4)
34  cat(z4)
35
36  a5=315
37  u5=(a-a5)/3
38  z5=pnorm(u5)
39  z5=round(z5,4)
40  cat(z5)
41
42  a6=320
43  u6=(a-a6)/3
44  z6=pnorm(u6)
45  z6=round(z6,4)
46  cat(z6)
47
48
49
50  u=c(a1,a2,a3,a7,a4,a5,a6)
51  b=c(z1,z2,z3,z7,z4,z5,z6)

```



```

52
53 plot(u,b,type = 'l')
54
55 c=1-b
56 plot(u,c,type = 'l')

```

R code Exa 10.10.15 To test hypothesis that a coin is fair

```

1 #PAGE=219
2 p=0.5
3 a1=0.05
4 q=1-p
5 a2=0.6
6 a3=1-a2
7
8 b1=sqrt(a2*a3)
9 b1=round(b1,2)
10 b2=sqrt(p*q)
11
12 z1=1.96
13 z2=-1.645
14 c1=b2*z1
15 c2=b1*z2
16
17 n=((c1-c2)/(a2-p))**2
18 n=round(n,0)
19 cat(n)
20
21 x=a2*n+c2*sqrt(n)
22 x=round(x,0)
23 cat(x)
24
25 np=n*p
26 x1=x-np
27 cat(x1)

```

```
28
29 m1=np+x1
30 m2=np-x1
31 cat(m2,m1)
```

R code Exa 10.10.16 Ball bearing machine is constructed

```
1 #PAGE=220
2 u=5.74
3 s=0.08
4 n=6
5 z=99.73
6
7 a1=u-(3*s)/sqrt(n)
8 a1=round(a1,2)
9
10 a2=u+(3*s)/sqrt(n)
11 a2=round(a2,2)
12
13 cat(a1,'mm',a2,'mm')
14
15 a=runif(14,min=a1,max=a2)
16
17 library(ggplot2)
18
19 a=runif(20,min=a1,max=a2)
20
21
22 set.seed(2017)
23 date <- seq(from = as.Date("2017-12-04"), to = as.
      Date("2017-12-08"),
24           by = "days")
25 date=rep(date,4)
26
27 dat <- data.frame(date, a)
```

```

28
29 ggplot(dat, aes(x = date, y = a)) +
30   geom_point() +
31   scale_x_date(date_breaks = "day", date_labels = "%
      a") +
32   theme_bw()+ labs(x=' ',y='Sample Mean(mm)')
33
34 # The answer may vary due to difference in
      representation.

```

R code Exa 10.10.17 Examination of two classes

```

1 #PAGE=221
2 c1=40
3 c2=50
4 m1=74
5 s1=8
6 m2=78
7 s2=7
8 s=sqrt((s1**2/c1)+(s2**2/c2))
9 s=round(s,digits = 3)
10 z=(m1-m2)/s
11 z=round(z,digits = 2)
12 z
13 a=0.05
14 a=a/2
15 z1=qnorm(a,lower.tail = FALSE)
16 z1=round(z1,digits = 3)
17 z1
18
19 z2=qnorm(a,lower.tail = TRUE)
20 z2=round(z2,digits = 3)
21 z2
22 if (z1<z||z2>z) k<-FALSE
23 k

```

```

24
25 b=0.01
26 b=b/2
27 z1=qnorm(b,lower.tail = FALSE)
28 z1=round(z1,digits = 2)
29 z1
30
31 z2=qnorm(b,lower.tail = TRUE)
32 z2=round(z2,digits = 2)
33 z2
34 if (z1<z || z2>z) k<-TRUE
35 k
36 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.18 Male students and college athletics

```

1 #PAGE=222
2 n1=50
3 m1=68.2
4 s1=2.5
5 n2=50
6 m2=67.5
7 s2=2.8
8 s=sqrt((s1**2/n1)+(s2**2/n2))
9 s=round(s,digits = 2)
10 z=(m1-m2)/s
11 z=round(z,digits = 2)
12 a=0.05
13 x=qnorm(a,lower.tail = FALSE)
14 x=round(x,digits = 3)
15 x
16 if (x>z) k<-TRUE
17 k
18 b=0.1

```

```

19 y=qnorm(b,lower.tail = FALSE)
20 y=round(y,digits = 2)
21 y
22 if (y<z) k<-FALSE
23 k
24 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.19 sample of two groups

```

1 #PAGE=222
2 n1=50
3 m1=68.2
4 s1=2.5
5 n2=50
6 m2=67.5
7 s2=2.8
8
9 s3=sqrt(s1**2+s2**2)
10 s3=round(s3,digits = 2)
11 k=0.7
12 a=0.05
13 x=qnorm(a,lower.tail = FALSE)
14 x=round(x,digits = 3)
15
16 n=(x*s3)/k
17 n=n**2
18 n=round(n,digits = 0)
19 d=n-n1
20 d
21
22 b=0.01
23 y=qnorm(b,lower.tail = FALSE)
24 y=round(y,digits = 3)
25 n=(y*s3)/k

```

```

26 n=n**2
27 n=n+1
28 d=n-n1
29 d=round(d,digits = 0)
30 d
31 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 10.10.20 two groups A and B

```

1 #PAGE=223
2 n1=75
3 n2=65
4 n=100
5 p=(n1+n2)/(2*n)
6 q=1-p
7 s=sqrt(p*q*(1/n+1/n))
8 s=round(s,digits = 4)
9 p1=n1/n
10 p2=n2/n
11 z=(p1-p2)/s
12 z=round(z,digits = 2)
13 a=0.01
14 x=qnorm(a,lower.tail = FALSE)
15 x=round(x,digits = 2)
16
17 if (x>z) k<-FALSE
18 k
19
20 b=0.05
21 y=qnorm(b,lower.tail = FALSE)
22 y=round(y,digits = 2)
23 if (y>z) l<-FALSE
24 l
25

```

```

26 c=0.1
27 y1=qnorm(c,lower.tail = FALSE)
28 y1=round(y1,digits = 2)
29 if (x>z) L<-TRUE
30 L
31
32 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.21 Groups of people cured

```

1 #PAGE=224
2 n=300
3 a=225
4 b=195
5 p=(a+b)/(2*n)
6 q=1-p
7 s=sqrt(p*q*(1/n+1/n))
8 s=round(s,digits = 4)
9 z=a/100-b/100
10 z=z/s
11 a=0.01
12 x=qnorm(a,lower.tail = FALSE)
13 x=round(x,digits = 2)
14 if (x<z) k<-FALSE
15 k
16 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.22 A sample poll from district A and B

```

1 #PAGE=224
2 n1=300

```

```

3 n2=200
4 p1=0.56
5 q1=0.48
6 p=(p1*n1+q1*n2)/(n1+n2)
7 q=1-p
8 s=sqrt((p*q*(1/n1+1/n2)))
9 s=round(s,digits = 4)
10 z=(p1-q1)/s
11 z=round(z,digits = 2)
12 z
13 a=0.05
14 a1=a/2
15 z1=qnorm(a1,lower.tail = FALSE)
16 z1=round(z1,digits = 2)
17 z1
18 z2=qnorm(a1,lower.tail = TRUE)
19 z2=round(z2,digits = 2)
20 z2
21
22 if (z2<z||z1>z) k<-TRUE
23 k
24
25 a=0.05
26 z3=qnorm(a,lower.tail = FALSE)
27 z3=round(z3,digits = 2)
28 z3
29 z4=qnorm(a,lower.tail = TRUE)
30 z4=round(z4,digits = 2)
31 z4
32
33
34 if (z4>z||z3<z) k<-FALSE
35 k
36 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.23 An instructor and short quiz

```
1 #PAGE=224
2 n=10
3 p=1/2
4 q=1-p
5 a=7
6 s=0
7 for (i in a:n)
8 {
9   x=factorial(n)/(factorial(i)*factorial(n-i))
10  y=x*p**i*q**(n-i)
11  s=s+y
12 }
13 s=round(s,digits = 4)
14 s
```

R code Exa 10.10.24 Probability of accepting the hypothesis

```
1 #PAGE=225
2 n=10
3 p=0.7
4 q=1-p
5 a=7
6 s=0
7 for (i in a:n)
8 {
9   x=factorial(n)/(factorial(i)*factorial(n-i))
10  y=x*p**i*q**(n-i)
11  s=s+y
12 }
13 s=round(s,digits = 4)
```

```
14 s=1-s
15 s
```

R code Exa 10.10.25 Probability of accepting the hypothesis

```
1 #PAGE=225
2 n=10
3 p1=0.6
4 q1=1-p1
5 a=7
6 s=0
7 for (i in a:n)
8 {
9   x=factorial(n)/(factorial(i)*factorial(n-i))
10  y=x*p1**i*q1**(n-i)
11  s=s+y
12 }
13 s1=round(s,digits = 3)
14 s1=1-s1
15 s1
16
17 n=10
18 p2=0.8
19 q2=1-p2
20 a=7
21 s=0
22 for (i in a:n)
23 {
24   x=factorial(n)/(factorial(i)*factorial(n-i))
25   y=x*p2**i*q2**(n-i)
26   s=s+y
27 }
28 s2=round(s,digits = 3)
29 s2=1-s2
30 s2
```

```

31
32 n=10
33 p3=0.9
34 q3=1-p3
35 a=7
36 s=0
37 for (i in a:n)
38 {
39     x=factorial(n)/(factorial(i)*factorial(n-i))
40     y=x*p3**i*q3**(n-i)
41     s=s+y
42 }
43 s3=round(s,digits = 3)
44 s3=1-s3
45 s3
46
47 n=10
48 p4=0.4
49 q4=1-p4
50 a=7
51 s=0
52 for (i in a:n)
53 {
54     x=factorial(n)/(factorial(i)*factorial(n-i))
55     y=x*p4**i*q4**(n-i)
56     s=s+y
57 }
58 s4=round(s,digits = 3)
59 s4=1-s4
60 s4
61
62 n=10
63 p5=0.3
64 q5=1-p5
65 a=7
66 s=0
67 for (i in a:n)
68 {

```

```

69     x=factorial(n)/(factorial(i)*factorial(n-i))
70     y=x*p5**i*q5**(n-i)
71     s=s+y
72 }
73 s5=round(s,digits = 3)
74 s5=1-s5
75 s5
76
77 n=10
78 p6=0.2
79 q6=1-p6
80 a=7
81 s=0
82 for (i in a:n)
83 {
84     x=factorial(n)/(factorial(i)*factorial(n-i))
85     y=x*p6**i*q6**(n-i)
86     s=s+y
87 }
88 s6=round(s,digits = 3)
89 s6=1-s6
90 s6
91
92 n=10
93 p7=0.1
94 q7=1-p7
95 a=7
96 s=0
97 for (i in a:n)
98 {
99     x=factorial(n)/(factorial(i)*factorial(n-i))
100    y=x*p7**i*q7**(n-i)
101    s=s+y
102 }
103 s7=round(s,digits = 4)
104 s7=1-s7
105 s7
106

```

```

107
108 n=10
109 p8=0.7
110 q8=1-p8
111 a=7
112 s=0
113 for (i in a:n)
114 {
115     x=factorial(n)/(factorial(i)*factorial(n-i))
116     y=x*p8**i*q8**(n-i)
117     s=s+y
118 }
119 s8=round(s,digits = 3)
120 s8=1-s8
121 s8
122
123
124 n=10
125 p9=0.5
126 q9=1-p9
127 a=7
128 s=0
129 for (i in a:n)
130 {
131     x=factorial(n)/(factorial(i)*factorial(n-i))
132     y=x*p9**i*q9**(n-i)
133     s=s+y
134 }
135 s9=round(s,digits = 3)
136 s9=1-s9
137 s9
138
139
140 s=c(s7,s6,s5,s4,s9,s1,s8,s2,s3)
141 p=c(p7,p6,p5,p4,p9,p1,p8,p2,p3)
142
143 y <- matrix(c(p,s),ncol=9,byrow=TRUE)
144 colnames(y) <- c(" ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ")

```

```

    )
145 rownames(y) <- c("p","B")
146 y <- as.table(y)
147 y

```

R code Exa 10.10.26 Graph of B and P

```

1 #PAGE=225
2 p=c(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9)
3 b=c
    (1,0.999,0.989,0.945,0.828,0.618,0.35,0.121,0.013)

4
5 plot(p,b,type='l')

```

R code Exa 10.10.27 Coin tossed 6 times

```

1 #PAGE=225
2 n1=6
3 a=0.05
4 b=0.01
5 p=1/2
6 q=1-p
7
8 m=(p**n1)
9 n=c(0:6)
10
11
12 a1=factorial(n1)/(factorial(n1-n[1])*factorial(n[1]))
    )
13 a2=factorial(n1)/(factorial(n1-n[2])*factorial(n[2]))
    )

```

```

14 a3=factorial(n1)/(factorial(n1-n[3])*factorial(n[3])
    )
15 a4=factorial(n1)/(factorial(n1-n[4])*factorial(n[4])
    )
16 a5=factorial(n1)/(factorial(n1-n[5])*factorial(n[5])
    )
17 a6=factorial(n1)/(factorial(n1-n[6])*factorial(n[6])
    )
18 a7=factorial(n1)/(factorial(n1-n[7])*factorial(n[7])
    )
19
20 a1=a1*m
21 a2=a2*m
22 a3=a3*m
23 a4=a4*m
24 a5=a5*m
25 a6=a6*m
26 a7=a7*m
27
28 b1=a1
29 b1=round(b1,5)
30 b2=a1+a2
31 b2=round(b2,4)
32 cat(b1)
33 cat(b2)
34 if (b1<a) print(FALSE)
35 if (b2>a) print(FALSE)
36 if (b2>b) print(TRUE)
37
38
39 c1=a1+a7
40 cat(c1)
41
42 if (c1<a) print(FALSE)
43 if (c1<a) print(TRUE)
44 #”The answer may vary due to difference in
    representation.”

```

R code Exa 10.10.28 coin comes up heads five times

```
1 #PAGE=226
2 n=6
3 p=1/64
4 a=0.05
5 x0=1*p
6 x1=(factorial(n)/(factorial(1)*factorial(n-1)))*p
7 x2=(factorial(n)/(factorial(2)*factorial(n-2)))*p
8 x3=(factorial(n)/(factorial(3)*factorial(n-3)))*p
9 x4=(factorial(n)/(factorial(4)*factorial(n-4)))*p
10 x5=(factorial(n)/(factorial(5)*factorial(n-5)))*p
11 x6=(factorial(n)/(factorial(6)*factorial(n-6)))*p
12 x=c(x0,x1,x2,x3,x4,x5,x6)
13
14 n1=c(0,1,2,3,4,5,6)
15
16 p1=x5+x6
17 p1=round(p1,digits = 4)
18 p1
19
20 p2=x0+x1+x5+x6
21 p2=round(p2,digits = 4)
22 p2
```

Chapter 11

Small Sampling Theory

R code Exa 11.11.1 t distribution

```
1 #PAGE=234
2 f=9
3 a11=0.05
4 a1=1-a11
5 a=qt(a1,df=f)
6 a=round(a,digits = 2)
7 a
8
9 b11=0.05
10 b1=b11/2
11 a1=1-b1
12 b=qt(a1,df=f)
13 b=round(b,digits = 2)
14 b
15
16 c11=0.99
17 a1=1-c11
18 a1=a1/2
19 a=qt(a1,df=f)
20 c=round(a,digits = 2)
21 c=abs(c)
```

```

22 c
23
24 d11=0.99
25 a1=1-d11
26 a=qt(a1,df=f)
27 d=round(a,digits = 2)
28 d
29 d=abs(d)
30 d
31
32 e11=0.9
33 a1=1-e11
34 a=qt(a1,df=f)
35 e=round(a,digits = 2)
36 e=abs(e)
37 e

```

R code Exa 11.11.2 sample of 10 measurements

```

1 #PAGE=235
2 a=16
3 x1=0.05
4 x1=1-x1
5 x=qt(x1,df=a)
6 x=round(x,digits = 2)
7 x
8
9 b=27
10 x1=0.05
11 x1=1-x1
12 x=qt(x1,df=b)
13 x=round(x,digits = 2)
14 x
15
16 c=200

```

```

17 x1=0.05
18 x1=1-x1
19 x=qt(x1,df=c)
20 x=round(x,digits = 2)
21 x
22 ##"The answer may slightly vary due to rounding off
    values."

```

R code Exa 11.11.3 two tailed test

```

1 #PAGE=235
2 n=95/100
3 n=1-n
4 n=n/2
5
6 a=9
7 x1=n
8 x1=1-x1
9 x=qt(x1,df=a)
10 x=round(x,digits = 2)
11 cat('-',x,'+',x)
12
13 b=20
14 x1=n
15 x1=1-x1
16 x=qt(x1,df=b)
17 x=round(x,digits = 2)
18 cat('-',x,'+',x)
19
20 c=30
21 x1=n
22 x1=1-x1
23 x=qt(x1,df=c)
24 x=round(x,digits = 2)
25 cat('-',x,'+',x)

```

```

26
27 d=60
28 x1=n
29 x1=1-x1
30 x=qt(x1,df=d)
31 x=round(x,digits = 2)
32 cat('-',x,'+',x)
33 #”The answer may vary due to difference in
    representation.”

```

R code Exa 11.11.4 sample of 10 diameter measurements

```

1 #PAGE=235
2 n=10
3 m=43.8
4 s=0.6
5 f=n-1
6
7 a11=0.95
8 a1=1-a11
9 a1=a1/2
10 a=qt(a1,df=f)
11 a=round(a,digits = 2)
12 a=abs(a)
13
14 x1=m+a*s/sqrt(n-1)
15 x1=round(x1,digits = 2)
16 x2=m-a*s/sqrt(n-1)
17 x2=round(x2,digits = 2)
18 cat(x2,'mm',x1,'mm')
19
20 b11=0.99
21 b1=1-b11
22 b1=b1/2
23 b=qt(b1,df=f)

```

```

24 b=round(b,digits = 2)
25 b=abs(b)
26
27 x1=m+b*s/sqrt(n-1)
28 x1=round(x1,digits = 2)
29 x2=m-b*s/sqrt(n-1)
30 x2=round(x2,digits = 2)
31 cat(x2, 'mm',x1, 'mm')

```

R code Exa 11.11.5 Large sampling theory

```

1 #PAGE=235
2 a=95/100
3 a=1-a
4 a=a/2
5 a=qnorm(a,lower.tail = FALSE)
6 a=round(a,digits = 2)
7
8
9 m=43.8
10 n=10
11 s=0.6
12 x1=m+a*s/sqrt(n)
13 x1=round(x1,digits = 2)
14 x2=m-a*s/sqrt(n)
15 x2=round(x2,digits = 2)
16 cat(x2, 'mm',x1, 'mm')
17
18 b=99/100
19 b=1-b
20 b=b/2
21 b=qnorm(b,lower.tail = FALSE)
22 b=round(b,digits = 2)
23
24 m=43.8

```

```

25 n=10
26 s=0.6
27 x3=m+b*s/sqrt(n)
28 x3=round(x3,digits = 2)
29 x4=m-b*s/sqrt(n)
30 x4=round(x4,digits = 2)
31 cat(x4, 'mm', x3, 'mm')

```

R code Exa 11.11.6 machine and washers

```

1 #PAGE=236
2 x=0.53
3 u=0.5
4 s=0.03
5 n=10
6 t=(x-u)*sqrt(n-1)/s
7 t
8
9 n=0.05
10 n=n/2
11
12 a=9
13 x1=n
14 x1=1-x1
15 x=qt(x1,df=a)
16 x=round(x,digits = 2)
17 x2=-x
18 cat('-',x, '+',x)
19
20 if (x<t || x2>t) l<-FALSE
21 l
22
23 n=0.01
24 n=n/2
25

```

```

26 a=9
27 x1=n
28 x1=1-x1
29 x=qt(x1,df=a)
30 x=round(x,digits = 2)
31 x2=-x
32 cat('-',x,'+',x)
33 if (x>t || x2<t) l<-TRUE
34 l

```

R code Exa 11.11.7 Test of the breaking strengths

```

1 #PAGE=236
2 x=7750
3 u=8000
4 s=145
5 N=6
6 t=(x-u)*sqrt(N-1)/s
7 t=round(t,2)
8 t
9
10 n=0.05
11 a=N-1
12 x1=n
13 x1=1-x1
14 x=qt(x1,df=a)
15 x=round(x,digits = 2)
16 x2=-x
17 cat('-',x,'+',x)
18
19 if (x<t || x2>t) l<-FALSE
20 l
21
22 n=0.01
23 a=N-1

```

```

24 x1=n
25 x1=1-x1
26 x=qt(x1,df=a)
27 x=round(x,digits = 2)
28 x2=-x
29 cat('-',x,'+',x)
30 if (x>t || x2<t) l<-TRUE
31 l

```

R code Exa 11.11.8 intelligence quotients

```

1 #PAGE=237
2 n1=16
3 m1=107
4 s1=10
5 n2=14
6 m2=112
7 s2=8
8 n=2
9 s=sqrt((n1*s1**2+n2*s2**2)/(n1+n2-n))
10 s=round(s,digits = 2)
11 t=(m2-m1)/(s*sqrt(1/n1+1/n2))
12 t=round(t,digits = 2)
13
14 a=0.01
15 a=a/2
16 f=n1+n2-n
17 a=qt(a,df=f)
18 a=round(a,digits = 2)
19 a
20 a1=a*(-1)
21 a1
22
23 if(t>a || t<a1) k<-TRUE
24 k

```



```

25
26
27 b=0.05
28 b=b/2
29 f=n1+n2-n
30 b=qt(b,df=f)
31 b=round(b,digits = 2)
32 b
33 b1=b*(-1)
34 b1
35
36 if(t>b || t<b1) l<-TRUE
37 l
38 #”The answer may vary due to difference in
    representation.”

```

R code Exa 11.11.9 Agricultural station

```

1 #PAGE=237
2 n=24
3 n1=n/2
4 n2=n-n1
5 m1=4.8
6 s1=0.4
7 m2=5.1
8 s2=0.36
9 a=1/100
10 n3=2
11 s=sqrt((n1*s1**2+n2*s2**2)/(n1+n2-n3))
12 s=round(s,digits = 3)
13
14 t=(m2-m1)/(s*sqrt(1/n1+1/n2))
15 t=round(t,digits = 2)
16 t
17

```

```

18 a=1/100
19 f=n1+n2-n3
20 a=qt(a,df=f)
21 a=round(a,digits = 2)
22 a
23 a1=a*(-1)
24 a1
25
26 if(t<a1||t>a) k<-TRUE
27 k
28
29 b=5/100
30 f=n1+n2-n3
31 b=qt(b,df=f)
32 b=round(b,digits = 2)
33 b
34 b1=b*(-1)
35 b1
36
37 if(t<b1||t>b) l<-FALSE
38 l
39 #”The answer may vary due to difference in
    representation.”

```

R code Exa 11.11.10 chi square test

```

1 #PAGE=238
2 f=5
3 a=0.05
4 a=1-a
5 a=qchisq(a,df=f)
6 a=round(a,digits = 1)
7 a
8
9 b1=0.05

```

```

10 b1=b1/2
11 b1=1-b1
12 b1=qchisq(b1,df=f)
13 b1=round(b1,digits = 1)
14
15 b2=0.05
16 b2=b2/2
17 b2=qchisq(b2,df=f)
18 b2=round(b2,digits = 3)
19 cat(b2,b1)
20
21 c=0.1
22 c=qchisq(c,df=f)
23 c=round(c,digits = 2)
24 c
25
26 d=0.01
27 d=1-d
28 d=qchisq(d,df=f)
29 d=round(d,digits = 1)
30 d

```

R code Exa 11.11.11 critical values

```

1 #PAGE=239
2 a11=0.05
3 a1=15
4
5 a=1-a11
6 a=qchisq(a,df=a1)
7 a=round(a,digits = 1)
8 a
9
10 b1=21
11 a=1-a11

```

```
12 a=qchisq(a,df=b1)
13 b=round(a,digits = 1)
14 b
15
16 c1=50
17 a=1-a11
18 a=qchisq(a,df=c1)
19 c=round(a,digits = 1)
20 c
```

R code Exa 11.11.12 median values and degree of freedom

```
1 #PAGE=239
2 a11=0.5
3
4 a1=9
5 a=1-a11
6 a=qchisq(a,df=a1)
7 a=round(a,digits = 2)
8 a
9
10 b1=28
11 a=1-a11
12 a=qchisq(a,df=b1)
13 b=round(a,digits = 1)
14 b
15
16 c1=40
17 a=1-a11
18 a=qchisq(a,df=c1)
19 c=round(a,digits = 1)
20 c
```

R code Exa 11.11.13 standard deviation of weights

```
1 #PAGE=239
2 n=16
3 n1=1000
4 s=2.4
5 f=n-1
6
7 a1=95/100
8 a2=1-a1
9 a2=a2/2
10
11 a=a1+a2
12 a=qchisq(a,df=f)
13 a3=round(a,digits = 1)
14 a=qchisq(a2,df=f)
15 a4=round(a,digits = 2)
16
17 a5=sqrt(a3)
18 a5=round(a5,digits = 2)
19 a6=sqrt(a4)
20 a6=round(a6,digits = 2)
21
22 x1=s*sqrt(n)/a5
23 x1=round(x1,digits = 2)
24 x2=s*sqrt(n)/a6
25 cat(x1, 'kg ',x2, 'kg ')
26
27
28 b1=99/100
29 b2=1-b1
30 b2=b2/2
31
32 b=b1+b2
33 b=qchisq(b,df=f)
34 b3=round(b,digits = 1)
35 b=qchisq(b2,df=f)
36 b4=round(b,digits = 2)
```

```

37
38 b5=sqrt(b3)
39 b5=round(b5,digits = 2)
40 b6=sqrt(b4)
41 b6=round(b6,digits = 2)
42
43 x1=s*sqrt(n)/b5
44 x1=round(x1,digits = 2)
45 x2=s*sqrt(n)/b6
46 x2=round(x2,digits = 2)
47 cat(x1, 'kg ',x2, 'kg ')

```

R code Exa 11.11.14 degree of freedom

```

1 #PAGE=239
2 f=50
3 a1=95/100
4 a1=1-a1
5 a=qnorm(a1,lower.tail = FALSE)
6 a=round(a,digits = 2)
7
8
9 x1=a+sqrt(2*f-1)
10 x1=x1**2
11 x1=x1/2
12 x1=round(x1,digits = 1)
13 x1
14
15 b=100
16 x2=a+sqrt(2*b-1)
17 x2=x2**2
18 x2=x2/2
19 x2=round(x2,digits = 1)
20 x2

```

R code Exa 11.11.15 standard deviation of the lifetimes of sample of electric bulbs

```
1 #PAGE=240
2 v=200
3 x1=0.025
4 x1=1-x1
5 x=qt(x1,df=199)
6 x=round(x,digits = 2)
7 x2=-x
8 x2
9 xx1=((sqrt(2*(v-1)-1)+x)^2)/2
10 xx1=round(xx1,0)
11 xx1
12
13 xx2=((sqrt(2*(v-1)-1)+x2)^2)/2
14 xx2=round(xx2,0)
15 xx2
16 xx1=sqrt(xx1)
17 xx2=sqrt(xx2)
18 c1=100*sqrt(v)/xx1
19 c2=100*sqrt(v)/xx2
20 c1=round(c1,1)
21 c2=round(c2,1)
22 cat(c1,'h',c2,'h')
23
24 v=200
25 x1=0.005
26 x1=1-x1
27 x=qt(x1,df=199)
28 x=round(x,digits = 2)
29 x2=-x
30 x2
31 xx1=((sqrt(2*(v-1)-1)+x)^2)/2
```

```

32 xx1=round(xx1,0)
33 xx1
34
35 xx2=((sqrt(2*(v-1)-1)+x2)^2)/2
36 xx2=round(xx2,0)
37 xx2
38 xx1=sqrt(xx1)
39 xx2=sqrt(xx2)
40 c1=100*sqrt(v)/xx1
41 c2=100*sqrt(v)/xx2
42 c1=round(c1,1)
43 c2=round(c2,1)
44 cat(c1, 'h ', c2, 'h ')
45
46 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 11.11.17 standard deviation of weights

```

1  #PAGE=240
2  w=2
3  s1=12.5
4  n=20
5  f=n-1
6  s2=16
7  x=(n*s2**2)/(s1**2)
8  x=round(x,digits = 1)
9  x
10
11 a=0.05
12 a=1-a
13 a=qchisq(a,df=f)
14 a=round(a,digits = 1)
15 a
16 if(a<x) k<-FALSE

```



```

17 k
18
19 b=0.01
20 b=1-b
21 b=qchisq(b,df=f)
22 b=round(b,digits = 1)
23 b
24 if(b>x) l<-TRUE
25 l
26 #”The answer may vary due to difference in
    representation.”

```

R code Exa 11.11.18 two sample of sizes 9 and 12

```

1 #PAGE=241
2 n1=9
3 n2=12
4 v1=16
5 v2=25
6 sv1=20
7 sv2=8
8
9 k1=(n1*sv1)/((n1-1)*v1)
10 k2=(n2*sv2)/((n2-1)*v2)
11 k=k1/k2
12 k=round(k,digits = 2)
13 k
14 f1=n1-1
15 f2=n2-1
16 a=0.05
17 a1=qchisq(a,df=f1)
18
19 if(a<k) l<-TRUE
20 l
21 b=0.01

```

```

22 b1=qchisq(b,df=f2)
23 b2=qchisq(b,df=f1)
24 b=b1+b2
25 b=round(b,digits = 2)
26 b
27 if(b>k) l<-FALSE
28 l
29 #”The answer may vary due to difference in
    representation.”

```

R code Exa 11.11.19 two sample of sizes 8 and 10

```

1 #PAGE=241
2 n1=8
3 n2=10
4 v1=20
5 v2=36
6 k1=n1/((n1-1)*v1)
7 k2=n2/((n2-1)*v2)
8 k=k1/k2
9 k=round(k,digits = 2)
10 k
11 f1=n1-1
12 f2=n2-1
13 f=k*2
14 f

```

Chapter 12

The Chi Square Test

R code Exa 12.12.1 200 tosses of a coin

```
1 #PAGE=249
2 n=200
3 n1=115
4 n2=85
5 e1=n/2
6 e2=n-e1
7 x=((n1-e1)**2)/e1+((n2-e2)**2)/e2
8 x
9 k=2
10 f=k-1
11 a=0.05
12 a=1-a
13 a=qchisq(a,df=f)
14 a=round(a,digits = 2)
15 a
16
17 if(a<x) l<-FALSE
18 l
19
20 b=0.01
21 b=1-b
```

```

22 b=qchisq(b,df=f)
23 b=round(b,digits = 2)
24 b
25
26 if(b>x) L<-TRUE
27 L
28 #”The answer may vary due to difference in
    representation.”

```

R code Exa 12.12.2 Yates correction

```

1 #PAGE=249
2 n=200
3 n1=115
4 n2=85
5 e1=n/2
6 e2=n-e1
7 x=(abs(n1-e1)-0.5)**2/e1+(abs(n2-e2)-0.5)**2/e2
8 x
9 k=2
10 f=k-1
11
12 a=0.05
13 a=1-a
14 a=qchisq(a,df=f)
15 a=round(a,digits = 2)
16 a
17
18 if(a<x) l<-FALSE
19 l
20
21 b=0.01
22 b=1-b
23 b=qchisq(b,df=f)
24 b=round(b,digits = 2)

```

```
25 b
26
27 if (b>x) L<-TRUE
28 L
```

R code Exa 12.12.3 Normal approximation

```
1 #PAGE=249
2 n=200
3 p=0.5
4 q=1-p
5 u=n*p
6 s=sqrt(n*p*q)
7 s=round(s,2)
8 h=115
9 su=(h-100)/s
10 su=round(su,2)
11 su
12
13 b=1-0.95
14 a1=qnorm(b/2,lower.tail=FALSE)
15 a1=round(a1,2)
16 a1
17 a2=-a1
18 if (a2>su || a1<su) l<-FALSE
19 l
20
21 b=1-0.99
22 a1=qnorm(b/2,lower.tail=FALSE)
23 a1=round(a1,2)
24 a1
25 a2=-a1
26 if (a2<su || a1>su) l<-TRUE
27 l
28 #” The answer may vary due to difference in
```

representation.”

R code Exa 12.12.4 Observed and Expected frequency

```
1 #PAGE=250
2 k=6
3 o=c(25,17,15,23,24,16)
4 f=20
5 s=sum((o-f)**2)/f
6 s
7
8 x=0.95
9 x=qchisq(x,df=k-1)
10 x=round(x,digits = 1)
11 x
12 if (s<x) l<-TRUE
13 l
14
15 x=0.05
16 x=qchisq(x,df=k-1)
17 x=round(x,digits = 2)
18 x
19 if (s>x) l<-FALSE
20 l
```

R code Exa 12.12.5 Random numbers

```
1 #PAGE=250
2 d=c(0,1,2,3,4,5,6,7,8,9)
3 o=c(17,31,29,18,14,20,35,30,20,36)
4 e=25
5 s=0
6 l=length(d)
```

```

7  for (i in 1:l)
8  {
9    x=((o[i]-e)**2)/e
10   s=s+x
11  }
12  s=round(s,digits = 1)
13  s
14  f=1-1
15  x=0.99
16  x=qchisq(x,df=f)
17  x=round(x,digits = 1)
18  x
19  if(x<s) k<-TRUE
20  k
21  #"The answer may vary due to difference in
    representation."

```

R code Exa 12.12.6 Experiments with peas

```

1  #PAGE=251
2  n1=315
3  n2=108
4  n3=101
5  n4=32
6  n=n1+n2+n3+n4
7  k1=9
8  k2=3
9  k3=3
10 k4=1
11 x=k1+k2+k3+k4
12 x1=(k1*n)/x
13 x2=(k2*n)/x
14 x3=(k3*n)/x
15 x4=(k4*n)/x
16 y=c(x1,x2,x3,x4)

```

```

17 z=c(n1,n2,n3,n4)
18 s=0
19 l=length(y)
20 for(i in 1:l)
21 {
22   v=((z[i]-y[i])**2)/y[i])
23   s=s+v
24 }
25 s=round(s,digits = 2)
26 s
27 f=1-1
28 a=0.01
29 a=1-a
30 a=qchisq(a,df=f)
31 a=round(a,digits = 1)
32 a
33 if(s<a) k<-TRUE
34 k
35
36 b=0.05
37 b=1-b
38 b=qchisq(b,df=f)
39 b=round(b,digits = 2)
40 b
41 if(s<b) k<-TRUE
42 k
43 #”The answer may vary due to difference in
    representation.”

```

R code Exa 12.12.7 Large number of marbles

```

1 #PAGE=251
2 n=12
3 r=2
4 o=5

```



```

5 y=4
6 g=1
7 c2=r+g
8 c1=o+y
9 n1=n/2
10 n2=n-n1
11 x=((c2-n1)**2)/n1+((c1-n2)**2)/n2
12 x
13 t=2
14 f=t-1
15 a=0.95
16 a=qchisq(a,df=f)
17 a=round(a,digits = 2)
18 a
19 if(a>x) k<-TRUE
20 k
21 #”The answer may vary due to difference in
    representation.”

```

R code Exa 12.12.8 360 tosses of a pair of dice

```

1 #PAGE=252
2 t=360
3 n1=74
4 n2=24
5 m1=t/6
6 m2=t/(6*3)
7 x1=((n1-m1)^2)/m1+((n2-m2)^2)/m2
8 x1=round(x1,2)
9 x1
10
11 v=2-1
12 x=0.95
13 x=qchisq(x,df=v)
14 x=round(x,digits = 2)

```

```

15 x=sqrt(x)
16 x=x^2
17 x
18 if (x<x1) l<-FALSE
19 l
20
21 x2=((n1-m1-0.5)^2)/m1+((n2-m2-0.5)^2)/m2
22 x2

```

R code Exa 12.12.9 survey of 320 families

```

1 #PAGE=252
2 x=320
3 f=c(18,56,110,88,40,8)
4 p=1/2
5 q=1-p
6 l=length(f)
7 t=l-1
8 p1=p**t
9 p2=5*(p**(t-1))*q**1
10 p3=10*(p**(t-2))*q**2
11 p4=10*(p**(t-3))*q**3
12 p5=5*(p**(t-4))*q**4
13 p6=(p**(t-5))*q**5
14
15 k=c(p1,p2,p3,p4,p5,p6)
16 k=k*x
17 s=0
18 for(i in 1:l)
19 {
20   m=((f[i]-k[i])**2)/k[i]
21   s=s+m
22 }
23 s=round(s,digits = 0)
24 s

```

```

25 a=0.95
26 a=qchisq(a,df=t)
27 a=round(a,digits = 1)
28 a
29 if(a<s) k1<-FALSE
30 k1
31
32 a1=0.99
33 a1=qchisq(a1,df=t)
34 a1=round(a1,digits = 1)
35 a1
36 if(a1>s) k2<-TRUE
37 k2
38 #”The answer may vary due to difference in
    representation.”

```

R code Exa 12.12.11 verification

```

1 #PAGE=253
2 n1=315
3 n2=108
4 n3=101
5 n4=32
6 n=n1+n2+n3+n4
7 k1=9
8 k2=3
9 k3=3
10 k4=1
11 x=k1+k2+k3+k4
12 x1=(k1*n)/x
13 x2=(k2*n)/x
14 x3=(k3*n)/x
15 x4=(k4*n)/x
16 y=c(x1,x2,x3,x4)
17 z=c(n1,n2,n3,n4)

```

```

18 z=z^2
19 l=z/y
20 l=sum(l)
21 l=l-n
22 l=round(l,digits = 2)
23 l

```

R code Exa 12.12.12 goodness of fit

```

1 #PAGE=253
2 f=c(38,144,342,287,164,25)
3 e=c(33.2,161.9,316.2,308.7,150.7,29.4)
4 x=(f-e)**2
5 x=x/e
6 x=sum(x)
7 l=length(f)
8 m=1
9 f=l-1-m
10
11 a=0.95
12 a=qchisq(a,df=f)
13 a=round(a,digits = 2)
14 a
15
16 if(x<a) k2<-TRUE
17 k2
18
19
20 b=0.05
21 b=qchisq(b,df=f)
22 b=round(b,digits = 3)
23 b
24
25 if(x>b) k<-FALSE
26 k

```

```
27 #”The answer may vary due to difference in
    representation.”
```

R code Exa 12.12.13 Goodness of fit

```
1 #PAGE=254
2 f=c(5,18,42,27,8)
3 e=c(4.13,20.68,38.92,27.71,7.43)
4 x=(f-e)
5 x=x^2
6 x=x/e
7 x=sum(x)
8
9 l=length(f)
10 m=2
11 f=l-1-m
12 a=0.95
13 a=qchisq(a,df=f)
14 a=round(a,digits =2 )
15 a
16
17 if(a>x) k<-TRUE
18 k
19
20 a1=0.05
21 a1=qchisq(a1,df=f)
22 a1=round(a1,digits =3 )
23 a1
24
25 if(a1<x) k1<-FALSE
26 k1
27 #”The answer may vary due to difference in
    representation.”
```

R code Exa 12.12.14 chi square test

```
1 #PAGE=254
2 n1=100
3 n2=100
4 a1=75
5 b1=65
6 a2=n1-a1
7 b2=n2-b1
8
9 x1=70
10 x2=n1-x1
11 y1=70
12 y2=n2-y1
13
14 x=((a1-x1)**2)/x1+((b1-y1)**2)/y1+((a2-x2)**2)/x2+((
    b2-y2)**2)/y2
15 x=round(x,digits = 2)
16 x
17
18 a=0.05
19 a=1-a
20 a=qchisq(a,df=1)
21 a
22 if(a>x) k<-FALSE
23 k
24
25 a1=0.01
26 a1=1-a1
27 a1=qchisq(a1,df=1)
28 a1
29 if(a1>x) k<-FALSE
30 k
31 #”The answer may vary due to difference in
```

representation.”

R code Exa 12.12.15 Yates correction

```
1 #PAGE=255
2 n=c(75,65,25,35)
3 a=70
4 b=30
5 c=0.5
6 x=((abs(n[1]-a)-c)^2)/a+((abs(n[2]-a)-c)^2)/a+((abs(n[3]-b)-c)^2)/b+((abs(n[4]-b)-c)^2)/b
7 x=round(x,2)
8 x
```

R code Exa 12.12.16 Students passed and failed

```
1 #PAGE=255
2 x1=50
3 x2=5
4 y1=47
5 y2=14
6 z1=56
7 z2=8
8 t1=27*100/180
9 t2=100-t1
10 t11=55
11 t22=61
12 t33=64
13 x11=(t11*t1)/100
14 x12=(t22*t1)/100
15 x13=(t33*t1)/100
16 x21=(t11*t2)/100
17 x22=(t22*t2)/100
```

```

18 x23=(t33*t2)/100
19 a1=((x1-x21)**2)/x21
20 a2=((y1-x22)**2)/x22
21 a3=((z1-x23)**2)/x23
22 a4=((x2-x11)**2)/x11
23 a5=((y2-x12)**2)/x12
24 a6=((z2-x13)**2)/x13
25 a=c(a1,a2,a3,a4,a5,a6)
26 a=sum(a)
27 a
28 h=2
29 k=3
30 f=(h-1)*(k-1)
31 m1=0.95
32 m1=qchisq(m1,df=f)
33 m1=round(m1,digits = 2)
34 m1
35
36 if(a<m1)k1<-TRUE
37 k1
38
39 m2=0.9
40 m2=qchisq(m2,df=f)
41 m2=round(m2,digits = 2)
42 m2
43
44 if(a>m2)k2<-FALSE
45 k2
46 #”The answer may vary due to difference in
    representation.”

```

R code Exa 12.12.17 Computing the value

```

1 #PAGE=256
2 a1=50

```



```

3  a2=47
4  a3=56
5  b1=5
6  b2=14
7  b3=8
8  n11=a1+a2+a3
9  n22=b1+b2+b3
10 n1=a1+b1
11 n2=a2+b2
12 n3=a3+b3
13 n=n11+n22
14 x1=((a1**2)/n1+(a2**2)/n2+(a3**2)/n3)*n/n11
15 x2=((b1**2)/n1+(b2**2)/n2+(b3**2)/n3)*n/n22
16 x=x1+x2-n
17 x=round(x,digits = 2)
18 x

```

R code Exa 12.12.19 Contingency table

```

1  #PAGE=257
2  a1=75
3  a2=25
4  b1=65
5  b2=35
6  n1=140
7  n2=60
8  n11=100
9  n22=100
10 n=n1+n2
11 x=(n*(a1*b2-a2*b1)**2)/(n1*n2*n11*n22)
12 x=round(x,digits = 2)
13 x
14
15 x1=n*(((a1*b2-a2*b1)-n/2)**2)/(n1*n2*n11*n22)
16 x1=round(x1,digits = 2)

```

17 x1

R code Exa 12.12.21 coefficient of contingency

```
1 #PAGE=258
2 n1=100
3 n2=100
4 a1=75
5 b1=65
6 a2=n1-a1
7 b2=n2-b1
8
9 x1=70
10 x2=n1-x1
11 y1=70
12 y2=n2-y1
13
14 x=((a1-x1)**2)/x1+((b1-y1)**2)/y1+((a2-x2)**2)/x2+((
    b2-y2)**2)/y2
15 x=round(x,digits = 2)
16 x
17
18 c=sqrt(x/(x+n1+n2))
19 c=round(c,digits = 4)
20 c
```

R code Exa 12.12.22 Maximum Value of coefficient

```
1 #PAGE=258
2 a=100
3 b=100
4 t1=100
5 t2=100
```

```

6 t3=100
7 t4=100
8 t=200
9 n=t/4
10
11 x=((a-n)**2)/n+((0-n)**2)/n+((0-n)**2)/n+((b-n)**2)/
    n
12 x
13
14 c=sqrt(x/(x+t))
15 c=round(c,digits = 4)
16 c

```

R code Exa 12.12.23 Correlation coefficient

```

1 #PAGE=259
2 n1=100
3 n2=100
4 a1=75
5 b1=65
6 a2=n1-a1
7 b2=n2-b1
8
9 x1=70
10 x2=n1-x1
11 y1=70
12 y2=n2-y1
13
14 x=((a1-x1)**2)/x1+((b1-y1)**2)/y1+((a2-x2)**2)/x2+((
    b2-y2)**2)/y2
15 x=round(x,digits = 2)
16
17 k=2
18 r=sqrt(x/((n1+n2)*(k-1)))
19 r=round(r,digits = 4)

```

```

20 r
21
22 x4=((abs(a1-x1)-0.5)**2)/x1+((abs(b1-y1)-0.5)**2)/y1
      +((abs(a2-x2)-0.5)**2)/x2+((abs(b2-y2)-0.5)**2)/
      y2
23 x4=round(x4,digits = 2)
24
25 a=sqrt(x4/(n1+n2))
26 a=round(a,digits = 4)
27 a

```

R code Exa 12.12.25 Hypothesis test

```

1 #PAGE=259
2 x=c(2.37,2.86,3.54)
3 f=c(1,1,1)
4 x=sum(x)
5 x
6 f=sum(f)
7
8 a=0.95
9 a=qchisq(a,df=f)
10 a=round(a,digits = 2)
11 a
12
13 if(x>a) k<-TRUE
14 k
15
16 #”The answer may vary due to difference in
    representation.”

```

Chapter 13

Curve Fitting And The Method Of Least Squares

R code Exa 13.13.1 Straight line

```
1 #PAGE=269
2 x=c(2,3,5,7,9,10)
3 y=c(1,3,7,11,15,17)
4 plot(x,y,ylim =c(0,16))
5 lines(x,y,col="grey")
```

R code Exa 13.13.2 The increase in Y corresponding to a unit increase in X

```
1 #PAGE=269
2 a=4
3 y=2*a-3
4 y
5
6 b=15
7 x=(b*2)-3
```

```

8 x
9
10 c=0
11 y=2*c-3
12 y
13
14 d=7.5
15 x=(d+3)/2
16 x
17
18 e=0
19 x=(e+3)/2
20 x

```

R code Exa 13.13.3 Equation of a straight line

```

1 #PAGE=270
2 x1=2
3 x2=4
4 y1=-3
5 y2=5
6 m=(y2-y1)/(x2-x1)
7 c=m*x1-y1
8 cat('Y + ', -y1, ' = ', m, ' ( X - ', x1, ' ) ')

```

R code Exa 13.13.5 Slope equation and intercepts

```

1 #PAGE=272
2 x1=1
3 y1=5
4 x2=4
5 y2=-1
6 m=(y2-y1)/(x2-x1)

```

```

7  cat(m)
8
9  b1=y1-m
10 b2=-y2*m
11 cat('Y =',b1,'-',-b2,'X')
12
13 c1=0
14 y=b1+m*c1
15 cat(y)
16
17 c2=0
18 x=(b1+c2)/(-m)
19 cat(x)

```

R code Exa 13.13.7 Equation of line slope

```

1  #PAGE=272
2  m=-4
3  y=16
4  cat('Y =',y,'-',-m,'X')

```

R code Exa 13.13.8 Straight line

```

1  #PAGE=273
2  x=c(1,3,4,6,8,9,11,14)
3  y=c(1,2,4,4,5,7,8,9)
4  plot(x,y)
5
6  a=7.5
7  b=12
8  c=(a-1)/(b-0)
9  c
10 abline(1,c)

```

R code Exa 13.13.9 Comparing and Estimation

```
1 #PAGE=273
2 a=0.542
3 x1=1
4 y1=1+a*x1
5 y1=round(y1,digits = 1)
6
7 x2=3
8 y2=1+a*x2
9 y2=round(y2,digits = 1)
10
11 x3=4
12 y3=1+a*x3
13 y3=round(y3,digits = 1)
14
15 x4=6
16 y4=1+a*x4
17 y4=round(y4,digits = 1)
18
19 x5=8
20 y5=1+a*x5
21 y5=round(y5,digits = 1)
22
23 x6=9
24 y6=1+a*x6
25 y6=round(y6,digits = 1)
26
27 x7=11
28 y7=1+a*x7
29 y7=round(y7,digits = 1)
30
31 x8=14
32 y8=1+a*x8
```



```

33 y8=round(y8,digits = 1)
34
35 x=c(x1,x2,x3,x4,x5,x6,x7,x8)
36 y=c(1,2,4,4,5,7,8,9)
37 y1=c(y1,y2,y3,y4,y5,y6,y7,y8)
38
39 y<- matrix(c(x,y,y1),ncol=8,byrow=TRUE)
40 colnames(y) <- c(" "," "," "," "," "," "," "," ")
41 rownames(y) <- c("X","Y","Yest")
42 y<- as.table(y)
43 y

```

R code Exa 13.13.10 Length and Breadth

```

1 #PAGE=274
2 x=c(70,63,72,60,66,70,74,65,62,67,65,68)
3 y=c(155,150,180,135,156,168,178,160,132,145,139,152)
4
5 plot(x,y)
6 lm(y~x)
7 abline(lm(y~x),col='green',lwd=2)
8
9
10 x1=60
11 y1=130
12 x2=72
13 y2=170
14 c1=(y2-y1)/(x2-x1)
15 c2=y1-c1*x1
16 cat('Y =',c1,'X -',(-1)*c2)
17
18 x1=63
19 y1=c1*x1+c2
20 cat(y1,'mm')
21

```

```

22 y2=168
23 x2=(y2-c2)/c1
24 cat(x2, 'mm')

```

R code Exa 13.13.11 dependent and independent variables

```

1 #PAGE=275
2 x1=c(1,3,4,6,8,9,11,14)
3 y1=c(1,2,4,4,5,7,8,9)
4 x2=x1^2
5 xy=x1*y1
6 y2=y1^2
7 l=length(x1)
8
9 x1=sum(x1)
10 x2=sum(x2)
11 y1=sum(y1)
12 y2=sum(y2)
13 xy=sum(xy)
14
15
16 a0=((y1*x2)-(x1*xy))/(1*x2-x1**2)
17 a0=round(a0,digits = 3)
18
19 a1=((1*xy)-(x1*y1))/(1*x2-x1**2)
20 a1=round(a1,digits = 3)
21 cat('Y =',a0,'+',a1,'X')
22
23 b0=((x1*y2)-(y1*xy))/(1*y2-y1**2)
24 b0=round(b0,digits = 3)
25
26 b1=((1*xy)-(x1*y1))/(1*y2-y1**2)
27 b1=round(b1,digits = 3)
28 cat('X =',b0,'+',b1,'Y')

```

R code Exa 13.13.12 Graph of two lines

```
1 #PAGE=276
2 t=0:16
3 z=0.667*t+0.333
4 w=0.545+0.636*t
5
6 plot(t,z, type="l", col="green", lwd=5, xlab="
   Breadth", ylab="Length")
7 lines(t, w, col="red", lwd=2)
```

R code Exa 13.13.13 least squares lines

```
1 #PAGE=276
2 a=-7
3 b=11
4 c=2
5 d=-3
6 e=6
7 f=-1
8
9 A <- matrix(data=c(a,b,c,d), nrow=2, ncol=2, byrow=
   TRUE)
10 b <- matrix(data=c(e,f), nrow=2, ncol=1, byrow=FALSE
   )
11 round(solve(A, b), 2)
12
13 x=12
14 y=0.545+0.636*x
15 y=round(y,1)
16 cat(y)
17
```

```
18 y1=3
19 x1=-0.5+1.5*y1
20 cat(x1)
```

R code Exa 13.13.17 Fit a least squares lines

```
1 #PAGE=279
2 x=c(70,63,72,60,66,70,74,65,62,67,65,68)
3 y=c(155,150,180,135,156,168,178,160,132,145,139,152)
4 x1=mean(x)
5 y1=mean(y)
6 s1=sum(x)
7 s2=sum(y)
8 x2=x-x1
9 x2=round(x2,1)
10 y2=y-y1
11 y2=round(y2,1)
12 xy=x2*y2
13 x3=x2**2
14 y3=y2**2
15 sxy=sum(xy)
16 sx3=sum(x3)
17 sy3=sum(y3)
18
19
20 a1=sxy/sx3
21 a1=round(a1,2)
22 a2=a1*x1-y1
23 a2=round(a2,0)
24 cat('Y =',a1,'X -',a2)
25
26 a1=sxy/sy3
27 a1=round(a1,2)
28 a2=-a1*y1+x1
29 a2=round(a2,0)
```

```
30 cat('X =', a1, 'Y +', a2)
```

R code Exa 13.13.18 Graphs of two lines

```
1 #PAGE=281
2
3 t=60:76
4 z=3.22*t-60.9
5 w=(t-31)/0.232
6
7 plot(t,z, type="l", col="green", lwd=5, xlab="
   Breadth", ylab="Length")
8 lines(t, w, col="red", lwd=2)
9
10 x1=63
11 y1=x1*3.22-60.9
12 y1=round(y1,digits = 0)
13 cat(y1, 'mm')
14
15 y2=168
16 x2=31+0.232*y2
17 x2=round(x2,digits = 0)
18 cat(x2, 'mm')
```

R code Exa 13.13.19 Medical care in United States

```
1 #PAGE=281
2 y1=c(1976:1984)
3 y=c
   (184.7,202.4,219.4,239.7,265.9,294.5,328.7,357.3,378)
4
5 plot(y1,y,type='b')
```

```

6
7 x=(0:8)
8 s1=sum(x)
9 m1=mean(x)
10 s2=sum(y)
11 m2=mean(y)
12
13 x1=x-m1
14 y1=y-m2
15 x2=x1^2
16 xy=x1*y1
17 s3=sum(x2)
18 s4=sum(xy)
19
20 a=s4/s3
21 a=round(a,2)
22 m1
23 b=-m1*a+m2
24 b=round(b,1)
25 cat('Y =',b,'+',a,'X')
26
27 x=9
28 ans1=b+a*x
29 cat(ans1)
30
31 x=-1
32 ans2=b+a*x
33 cat(ans2)

```

R code Exa 13.13.20 Farm Employment of the United States

```

1 #PAGE=284
2
3 yr=c
  (1935,1940,1945,1950,1955,1960,1965,1970,1975,1980)

```

```

4 y=c(12.7,11,10,9.9,8.4,7.1,5.6,4.5,4.3,3.7)
5 x=c(0,1,2,3,4,5,6,7,8,9)
6 y1=mean(y)
7 x1=mean(x)
8 x2=x-x1
9 y2=y-y1
10 y2=round(y2,digits = 1)
11 x3=x2**2
12 x3=sum(x3)
13 xy=x2*y2
14 xy=sum(xy)
15 xy=round(xy,digits = 1)
16
17 c1=xy/x3
18 c1=round(c1,digits = 2)
19 c2=c1*(-1*x1)+y1
20 c2=round(c2,digits = 1)
21
22 t=1935:1980
23 z=c1*t-c2
24
25 plot(yr,y, type="l", col="green", lwd=5, xlab="index
    ", ylab="year",xlim = c(1935,1980))
26 lines(t, z, col="red", lwd=2)
27
28 c1=c1*(-1)
29 cat('Y =',c2,'-',c1,'X')
30
31 a=which(x==0)
32 a=yr[a]
33 b=1990
34 c=b-a
35 c=c/5
36 c
37 c2=c2-0.1
38 yc1=c2-(c1*c)
39 cat(yc1,'million ')

```

```

40 d=2000
41 e=d-a
42 e=e/5
43 e
44 yc=c2-c1*e
45 cat(yc, 'million ')

```

R code Exa 13.13.21 Thermodynamic principles

```

1 #PAGE=286
2 v=c(54.3,61.8,72.4,88.7,118.6,194)
3 p=c(61.2,49.5,37.6,28.4,19.2,10.1)
4
5 x=log10(v)
6 x=round(x,4)
7
8 y=log10(p)
9 y=round(y,4)
10
11 sx=sum(x)
12 sy=sum(y)
13
14 x2=x^2
15 x2=round(x2,4)
16
17 xy=x*y
18 xy=round(xy,4)
19
20 sx2=sum(x2)
21 sxy=sum(xy)
22
23 n=length(v)
24 a=(sy*sx2-sx*sxy)/(n*sx2-sx**2)
25 a=round(a,2)
26

```



```

27 a1=(n*sxy-sx*sy)/(n*sx2-sx**2)
28 a1=round(a1,2)
29
30
31 c=10^a
32 y=-1*a1
33 c=round(c,-3)
34 am=formatC(c,format="e")
35 cat(am)
36 cat(y)
37
38 cat('PV^1.4 =',c)
39
40 v1=100
41 v2=log10(v1)
42
43 p1=a+a1*v2
44 p2=10^p1
45 p2=round(p2,1)
46 cat(p2)

```

R code Exa 13.13.22 Plotting the data

```

1 #PAGE=287
2 v=c(54.3,61.8,72.4,88.7,118.6,194)
3 p=c(61.2,49.5,37.6,28.4,19.2,10.1)
4 v1=log10(v)
5 p1=log10(p)
6
7 plot(v,p,xlim = c(10,300),ylim = c(10,100),xlab = '
  Volume V',ylab='Pressure P')
8 a=lm(p~v)
9 abline(a)
10
11 b=lm(v~p)

```

```

12 c=coef(b)[2]
13 c1=c+1
14 c1=round(c1,1)
15
16 v=100
17 p=25
18 p=log10(25)
19 q=log10(100)
20 a3=p-q*c1
21 a3=round(a3,2)
22
23 ans=10**a3
24 ans=round(ans,-3)
25 cat(ans)

```

R code Exa 13.13.23 Population of United States

```

1 #PAGE=288
2 y1=c(1880:1980)
3 y=c
   (50.2,62.9,76,92,105.7,122.8,131.7,151.1,179.3,203.3,226.5)

4 x=c(-5:5)
5 s1=sum(x)
6 s2=sum(y)
7 x2=sum(x^2)
8 x3=sum(x^3)
9 x4=sum(x^4)
10 xy=sum(x*y)
11 x2y=sum(x^2*y)
12
13 a1=xy/x2
14 a1=round(a1,2)
15 a1
16

```

```

17 A <- matrix(data=c(11,x2,x2,x4), nrow=2, ncol=2,
               byrow=TRUE)
18 b <- matrix(data=c(s2,x2y), nrow=2, ncol=1, byrow=
               FALSE)
19 c=round(solve(A, b), 2)
20
21 c
22 a=c[1,1]
23 b=c[2,1]
24 cat('Y =',a,'+',a1,'X +',b,'X^2 ')
25
26 yy=c
    (1880,1890,1900,1910,1920,1930,1940,1950,1960,1970,1980)

27 y=c
    (50.2,62.9,76,92,105.7,122.8,131.7,151.1,179.3,203.3,226.5)

28 x=c(-5:5)
29
30 p=a+a1*x+b*x^2
31 p=round(p,1)
32 p
33
34 y1 <- matrix(c(yy,p,y),ncol=11,byrow=TRUE)
35 colnames(y1) <- c
    (1880,1890,1900,1910,1920,1930,1940,1950,1960,1970,1980)

36 rownames(y1) <- c("Year","Trend Value","Actual Value
    ")
37 y1 <- as.table(y1)
38 y1

```

Chapter 14

Correlation Theory

R code Exa 14.14.1 Least Squares Regression

```
1 #PAGE=301
2 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4
5 plot(x,y,ylim=c(62,72),xlim=c(62,72))
6
7 x2=x**2
8 y2=y**2
9 xy=x*y
10
11 n1=sum(x)
12 n2=sum(y)
13 n3=sum(x2)
14 n4=sum(y2)
15 n5=sum(xy)
16
17 l=length(x)
18
19 c=matrix(c(1,n1,n1,n3),nrow=2,ncol=2)
20
21 d=matrix(c(n2,n5),nrow=2,ncol=1)
```

```

22
23 e=solve(c,d)
24 a0=e[2]
25 a0=round(a0,digits = 3)
26 a1=e[1]
27 a1=round(a1,digits = 2)
28 cat('Y =',a1,'+',a0,'X')
29
30
31 f=matrix(c(1,n2,n2,n4),nrow=2,ncol=2)
32
33 g=matrix(c(n1,n5),nrow=2,ncol=1)
34
35 h=solve(f,g)
36 a3=h[2]
37 a3=round(a3,digits = 3)
38 a2=h[1]
39 a2=round(a2,digits = 2)
40 cat('X =',a2,'+',a3,'Y')
41
42
43
44
45
46 t=62:72
47 z=a0*t+a1
48 w=(t-a2)/a3
49
50 plot(t,z, type="l", col="green", lwd=5, xlab="
    Breadth", ylab="Length")
51 lines(t, w, col="red", lwd=2)

```

R code Exa 14.14.2 Regression lines

1 [#PAGE=303](#)

```

2 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4 s1=sum(x)
5 m1=mean(x)
6 s2=sum(y)
7 m2=mean(y)
8 m1=round(m1,1)
9 m2=round(m2,1)
10
11 x1=x-m1
12 y1=y-m2
13 x2=x1^2
14 xy=x1*y1
15 y2=y1^2
16 s3=sum(x2)
17 s4=sum(xy)
18 s5=sum(y2)
19
20 a1=s4/s3
21 a1=round(a1,3)
22 a=s4/s5
23 a=round(a,1)
24 cat('Y -',m2,'=',a1,'( X -',m1,') ')
25
26 cat('X -',m1,'=',a,'( Y -',m2,') ')

```

R code Exa 14.14.5 Computing Standard error

```

1 #PAGE=305
2 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4 yest=35.82+0.476*x
5 yest=round(yest,2)
6 a=y-yest
7 a1=a^2

```

```

8  s1=sum(a1)/12
9  s1=round(s1,3)
10 cat(s1)
11 ans=sqrt(s1)
12 ans=round(ans,2)
13 cat(ans,'kg')
14
15 y2=38.92
16 a=0.476
17 xy=40.34
18 ans2=y2-a*xy
19 ans2=ans2/length(x)
20 ans2=round(ans2,3)
21 ans2
22 ans2=sqrt(ans2)
23 ans2=round(ans2,2)
24 cat(ans2,'kg')

```

R code Exa 14.14.6 Regression line

```

1  #PAGE=305
2  x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3  y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4  a1=35.82
5  a2=0.476
6
7
8  a3=a1+1.28
9  a4=a1-1.28
10
11 plot(x,y)
12 abline(a1,a2)
13 abline(a3,a2)
14 abline(a4,a2)
15

```

```

16 n=3
17 b1=(length(x)-n)
18 b=b1/length(x)
19 cat(b*100, '%')

```

R code Exa 14.14.8 Total variation explained variation and unexplained variation

```

1 #PAGE=306
2
3 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
4 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
5
6 l=length(x)
7 a1=mean(x)
8 a2=mean(y)
9 s1=sum(x)
10 s2=sum(y)
11 x1=x-a1
12 y1=y-a2
13 x2=x1**2
14 xy=x1*y1
15 y2=y1**2
16
17 s3=sum(x2)
18 s4=sum(xy)
19 s5=sum(y2)
20
21 s3=round(s3,digits = 2)
22 s4=round(s4,digits = 2)
23 s5=round(s5,digits = 2)
24
25 a=sum(y2)
26 a=round(a,digits = 2)
27 a

```



```

28
29 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
30 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
31 yest=35.82+0.476*x
32 yest=round(yest,digits = 2)
33 y1=y-yest
34 y1=y1**2
35 y1=sum(y1)
36 y1=round(y1,digits = 2)
37 y1
38
39 m=mean(y)
40 y2=(yest-m)**2
41 y2=sum(y2)
42 y2=round(y2,digits = 2)
43 y2

```

R code Exa 14.14.9 Coefficient of determination and correlation

```

1 #PAGE=307
2
3 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
4 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
5
6 l=length(x)
7 a1=mean(x)
8 a2=mean(y)
9 s1=sum(x)
10 s2=sum(y)
11 x1=x-a1
12 y1=y-a2
13 x2=x1**2
14 xy=x1*y1
15 y2=y1**2
16

```

```

17 s3=sum(x2)
18 s4=sum(xy)
19 s5=sum(y2)
20
21 s3=round(s3,digits = 2)
22 s4=round(s4,digits = 2)
23 s5=round(s5,digits = 2)
24
25 a=sum(y2)
26 a=round(a,digits = 2)
27
28 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
29 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
30 yest=35.82+0.476*x
31 yest=round(yest,digits = 2)
32 y1=y-yest
33 y1=y1**2
34 y1=sum(y1)
35 y1=round(y1,digits = 2)
36
37 m=mean(y)
38 y2=(yest-m)**2
39 y2=sum(y2)
40 y2=round(y2,digits = 2)
41
42 a1=y2/a
43 a1=round(a1,digits = 4)
44 a1
45
46 b1=sqrt(a1)
47 b1=round(b1,digits = 4)
48 b1

```

R code Exa 14.14.11 Coefficient of linear correlation

```

1 #PAGE=308
2 x=c(1,3,4,6,8,9,11,14)
3 y=c(1,2,4,4,5,7,8,9)
4 m1=mean(x)
5 m1=ceiling(m1)
6 m2=mean(y)
7 x1=x-m1
8 y1=y-m2
9 xy=x1*y1
10 x2=x1**2
11 y2=y1**2
12
13 s1=sum(x1)
14 s2=sum(y2)
15 s3=sum(x2)
16 s4=sum(y2)
17 s5=sum(xy)
18
19 r=s5/(sqrt(s3*s2))
20 r=round(r,digits = 3)
21 r

```

R code Exa 14.14.12 standard variation variance and covariance

```

1 #PAGE=308
2 x=c(1,3,4,6,8,9,11,14)
3 y=c(1,2,4,4,5,7,8,9)
4 m1=mean(x)
5 m1=ceiling(m1)
6 m2=mean(y)
7 x1=x-m1
8 y1=y-m2
9 xy=x1*y1
10 x2=x1**2
11 y2=y1**2

```

```

12
13 s1=sum(x1)
14 s2=sum(y2)
15 s3=sum(x2)
16 s4=sum(y2)
17 s5=sum(xy)
18
19 r=s5/(sqrt(s3*s2))
20 r=round(r,digits = 3)
21
22 l=length(x)
23
24 a=sqrt(s3/l)
25 a=round(a,digits = 2)
26 a
27
28 b=sqrt(s4/l)
29 b=round(b,digits = 2)
30 b
31
32 c=a**2
33 c=round(c,digits = 1)
34 c
35
36 d=b**2
37 d=round(d,digits = 0)
38 d
39
40 e=s5/l
41 e

```

R code Exa 14.14.13 verification

```

1 #PAGE=309
2

```

```

3  x=c(1,3,4,6,8,9,11,14)
4  y=c(1,2,4,4,5,7,8,9)
5  m1=mean(x)
6  m1=ceiling(m1)
7  m2=mean(y)
8  x1=x-m1
9  y1=y-m2
10 xy=x1*y1
11 x2=x1**2
12 y2=y1**2
13
14 s1=sum(x1)
15 s2=sum(y2)
16 s3=sum(x2)
17 s4=sum(y2)
18 s5=sum(xy)
19
20 r=s5/(sqrt(s3*s2))
21 r=round(r,digits = 3)
22
23 l=length(x)
24
25 a=sqrt(s3/l)
26 a=round(a,digits = 2)
27
28 b=sqrt(s4/l)
29 b=round(b,digits = 2)
30
31 c=a**2
32 c=round(c,digits = 1)
33
34 d=b**2
35 d=round(d,digits = 0)
36
37 e=s5/l
38
39 a1=e/(a*b)
40 a1=round(a1,digits = 3)

```

41 a1

R code Exa 14.14.14 Product moment formula

```
1 #PAGE=309
2 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4
5 m1=mean(x)
6 m2=mean(y)
7
8 x1=x-m1
9 y1=y-m2
10
11 x2=x1**2
12 y2=y1**2
13 xy=x1*y1
14
15 n1=sum(x)
16 n1=round(n1,digits = 2)
17 n2=sum(y)
18 n2=round(n2,digits = 2)
19 n3=sum(x2)
20 n3=round(n3,digits = 2)
21 n4=sum(y2)
22 n4=round(n4,digits = 2)
23 n5=sum(xy)
24 n5=round(n5,digits = 2)
25
26 r=n5/(sqrt(n3*n4))
27 r=round(r,digits = 4)
28 r
29 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 14.14.16 Linear correlation coefficient

```
1 #PAGE=309
2 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4
5 plot(x,y,ylim=c(62,72),xlim=c(62,72))
6
7 x2=x**2
8 y2=y**2
9 xy=x*y
10
11 n1=sum(x)
12 n2=sum(y)
13 n3=sum(x2)
14 n4=sum(y2)
15 n5=sum(xy)
16
17 l=length(x)
18
19 a=(l*n5-n1*n2)
20 b=(sqrt((l*n3-n1**2)*(l*n4-n2**2)))
21 a=a/b
22 a=round(a,digits = 4)
23 a
```

R code Exa 14.14.17 Frequency distributions

```
1 #PAGE=310
2 t=100
3 a=c
  (0,0,0,2,4,4,10,0,0,1,4,6,5,16,0,0,5,10,8,1,24,1,4,9,5,2,0,21,3,6
```

```

4
5 y<- matrix(c(a),ncol=7,byrow=TRUE)
6 colnames(y) <- c("40-49","50-59","60-69","70-79","
    80-89","90-99","total")
7 rownames(y) <- c("90-99","80-89","70-79","60-69","
    50-59","40-49","total")
8 y <- as.table(y)
9 y
10
11 a=y[2,4]
12 a
13
14 b=y[7,c(1,2,3)]
15 b=sum(b)
16 b=b/t*100
17 cat(b,'%')
18
19 c=y[c(1,2,3),c(1,2,3,4)]
20 c=sum(c)
21 c
22
23 d=y[c(5,6),c(1,2)]
24 d=sum(d)
25 d=t-d
26 d=d/t*100
27 cat(d,'%')

```

R code Exa 14.14.19 Coefficient of linear correlation

```

1 #PAGE=311
2 x=c(44.5,54.5,64.5,74.5,84.5,94.5)
3 y1=c(94.5,84.5,74.5,64.5,54.5,44.5)
4 ux=c(-2,-1,0,1,2,3)
5 uy=c(2,1,0,-1,-2,-3)

```



```

6
7  a=c
      (0,0,0,2,4,4,0,0,1,4,6,5,0,0,5,10,8,1,1,4,9,5,2,0,3,6,6,2,0,0,3,5

8  y<- matrix(c(a),ncol=6,byrow=TRUE)
9  colnames(y) <- c(x)
10 rownames(y) <- c(y1)
11 y <- as.table(y)
12 y
13
14 a1=y[1,c(4,5,6)]
15 fy1=sum(a1)
16
17 a2=y[2,c(3,4,5,6)]
18 fy2=sum(a2)
19
20 a3=y[3,c(3,4,5,6)]
21 fy3=sum(a3)
22
23 a4=y[4,c(1,2,3,4,5)]
24 fy4=sum(a4)
25
26 a5=y[5,c(1,2,3,4)]
27 fy5=sum(a5)
28
29 a6=y[6,c(1,2,3)]
30 fy6=sum(a6)
31
32 fy=c(fy1,fy2,fy3,fy4,fy5,fy6)
33 fuy=uy*fy
34 fuy2=(uy**2)*fy
35
36
37 b1=y[c(4,5,6),1]
38 b1=sum(b1)
39
40 b2=y[c(4,5,6),2]
41 b2=sum(b2)

```

```

42
43 b3=y[c(2,3,4,5,6),3]
44 b3=sum(b3)
45
46 b4=y[c(1,2,3,4,5),4]
47 b4=sum(b4)
48
49 b5=y[c(1,2,3,4),5]
50 b5=sum(b5)
51
52 b6=y[c(1,2,3),6]
53 b6=sum(b6)
54
55 fx=c(b1,b2,b3,b4,b5,b6)
56 fux=ux*fx
57 fux2=(ux**2)*fx
58
59 n1=sum(fy)
60 n2=sum(fx)
61 n3=sum(fux)
62 n4=sum(fuy)
63 n5=sum(fux2)
64 n6=sum(fuy2)
65
66 c1=4+16+24
67 c2=4+12+15
68 c3=0
69 c4=2+4-5-4
70 c5=12+12-4
71 c6=18+15
72 r=c(c1,c2,c3,c4,c5,c6)
73
74 r1=2+12+18
75 r2=4+12+15
76 r3=0
77 r4=4+4-5-4
78 r5=16+12-4
79 r6=24+15

```

```

80 c=c(r1,r2,r3,r4,r5,r6)
81
82 c1=sum(c)
83 c3=c2=10
84
85 r1=(n1*c1-n3*n4)
86 r2=sqrt((n1*n5-n3^2)*(n1*n6-n4^2))
87 r=r1/r2
88 r=round(r,digits = 4)
89 r

```

R code Exa 14.14.20 Computing and Verify

```

1 #PAGE=312
2 x=c(44.5,54.5,64.5,74.5,84.5,94.5)
3 y1=c(94.5,84.5,74.5,64.5,54.5,44.5)
4 ux=c(-2,-1,0,1,2,3)
5 uy=c(2,1,0,-1,-2,-3)
6
7 a=c
    (0,0,0,2,4,4,0,0,1,4,6,5,0,0,5,10,8,1,1,4,9,5,2,0,3,6,6,2,0,0,3,5

8 y<- matrix(c(a),ncol=6,byrow=TRUE)
9 colnames(y) <- c(x)
10 rownames(y) <- c(y1)
11 y <- as.table(y)
12 y
13
14 a1=y[1,c(4,5,6)]
15 fy1=sum(a1)
16
17 a2=y[2,c(3,4,5,6)]
18 fy2=sum(a2)
19
20 a3=y[3,c(3,4,5,6)]

```

```

21  fy3=sum(a3)
22
23  a4=y[4,c(1,2,3,4,5)]
24  fy4=sum(a4)
25
26  a5=y[5,c(1,2,3,4)]
27  fy5=sum(a5)
28
29  a6=y[6,c(1,2,3)]
30  fy6=sum(a6)
31
32  fy=c(fy1,fy2,fy3,fy4,fy5,fy6)
33  fuy=uy*fy
34  fuy2=(uy**2)*fy
35
36
37  b1=y[c(4,5,6),1]
38  b1=sum(b1)
39
40  b2=y[c(4,5,6),2]
41  b2=sum(b2)
42
43  b3=y[c(2,3,4,5,6),3]
44  b3=sum(b3)
45
46  b4=y[c(1,2,3,4,5),4]
47  b4=sum(b4)
48
49  b5=y[c(1,2,3,4),5]
50  b5=sum(b5)
51
52  b6=y[c(1,2,3),6]
53  b6=sum(b6)
54
55  fx=c(b1,b2,b3,b4,b5,b6)
56  fux=ux*fx
57  fux2=(ux**2)*fx
58

```

```

59 n1=sum(fy)
60 n2=sum(fx)
61 n3=sum(fux)
62 n4=sum(fuy)
63 n5=sum(fux2)
64 n6=sum(fuy2)
65
66 c1=4+16+24
67 c2=4+12+15
68 c3=0
69 c4=2+4-5-4
70 c5=12+12-4
71 c6=18+15
72 r=c(c1,c2,c3,c4,c5,c6)
73
74 r1=2+12+18
75 r2=4+12+15
76 r3=0
77 r4=4+4-5-4
78 r5=16+12-4
79 r6=24+15
80 c=c(r1,r2,r3,r4,r5,r6)
81
82 c1=sum(c)
83 c3=c2=10
84
85 a=c2*(sqrt(n5/n1-(n3/n1)**2))
86 a=round(a,digits = 3)
87 a
88
89 b=c3*(sqrt(n6/n1-(n4/n1)**2))
90 b=round(b,digits = 3)
91 b
92
93 c=c2*c3*(c1/n1-(n3/n1)*(n4/n1))
94 c
95
96 r=c/(a*b)

```

```
97 r=round(r,digits = 4)
98 r
```

R code Exa 14.14.23 Linear correlation coefficient

```
1 #PAGE=313
2 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
4
5 x2=x**2
6 y2=y**2
7 xy=x*y
8
9 n1=sum(x)
10 n2=sum(y)
11 n3=sum(x2)
12 n4=sum(y2)
13 n5=sum(xy)
14
15 l=length(x)
16
17 c=matrix(c(1,n1,n1,n3),nrow=2,ncol=2)
18
19 d=matrix(c(n2,n5),nrow=2,ncol=1)
20
21 e=solve(c,d)
22 a0=e[2]
23 a0=round(a0,digits = 3)
24 a1=e[1]
25 a1=round(a1,digits = 2)
26
27 f=matrix(c(1,n2,n2,n4),nrow=2,ncol=2)
28
29 g=matrix(c(n1,n5),nrow=2,ncol=1)
30
```

```

31 h=solve(f,g)
32 a3=h[2]
33 a3=round(a3,digits = 3)
34 a2=h[1]
35 a2=round(a2,digits = 2)
36
37 a1=a0
38 b1=a3
39 r=a1*b1
40 r=sqrt(r)
41 r=round(r,digits = 4)
42 r
43 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 14.14.24 Equation of regression lines

```

1 #PAGE=314
2 a=64.5
3 b=74.5
4 c=10
5 n=100
6 ux=64
7 uy=-55
8
9 x=a+c*ux/n
10 y=b+c*uy/n
11 sx=13.966
12 sy=14.925
13 r=0.7686
14
15 a1=r*sy/sx
16 a1=round(a1,3)
17 a2=r*sx/sy
18 a2=round(a2,3)

```

```

19 cat('Y -',x,'=',a1,'( x -',x,') ')
20 cat('Y -',y,'=',a2,'( x -',y,') ')

```

R code Exa 14.14.25 Standard errors

```

1 #PAGE=314
2
3 x=c(44.5,54.5,64.5,74.5,84.5,94.5)
4 y1=c(94.5,84.5,74.5,64.5,54.5,44.5)
5 ux=c(-2,-1,0,1,2,3)
6 uy=c(2,1,0,-1,-2,-3)
7
8 a=c
      (0,0,0,2,4,4,0,0,1,4,6,5,0,0,5,10,8,1,1,4,9,5,2,0,3,6,6,2,0,0,3,5

9 y<- matrix(c(a),ncol=6,byrow=TRUE)
10 colnames(y) <- c(x)
11 rownames(y) <- c(y1)
12 y <- as.table(y)
13 y
14
15 a1=y[1,c(4,5,6)]
16 fy1=sum(a1)
17
18 a2=y[2,c(3,4,5,6)]
19 fy2=sum(a2)
20
21 a3=y[3,c(3,4,5,6)]
22 fy3=sum(a3)
23
24 a4=y[4,c(1,2,3,4,5)]
25 fy4=sum(a4)
26
27 a5=y[5,c(1,2,3,4)]
28 fy5=sum(a5)

```



```

29
30 a6=y[6,c(1,2,3)]
31 fy6=sum(a6)
32
33 fy=c(fy1,fy2,fy3,fy4,fy5,fy6)
34 fuy=uy*fy
35 fuy2=(uy**2)*fy
36
37
38 b1=y[c(4,5,6),1]
39 b1=sum(b1)
40
41 b2=y[c(4,5,6),2]
42 b2=sum(b2)
43
44 b3=y[c(2,3,4,5,6),3]
45 b3=sum(b3)
46
47 b4=y[c(1,2,3,4,5),4]
48 b4=sum(b4)
49
50 b5=y[c(1,2,3,4),5]
51 b5=sum(b5)
52
53 b6=y[c(1,2,3),6]
54 b6=sum(b6)
55
56 fx=c(b1,b2,b3,b4,b5,b6)
57 fux=ux*fx
58 fux2=(ux**2)*fx
59
60 n1=sum(fy)
61 n2=sum(fx)
62 n3=sum(fux)
63 n4=sum(fuy)
64 n5=sum(fux2)
65 n6=sum(fuy2)
66

```

```

67 c1=4+16+24
68 c2=4+12+15
69 c3=0
70 c4=2+4-5-4
71 c5=12+12-4
72 c6=18+15
73 r=c(c1,c2,c3,c4,c5,c6)
74
75 r1=2+12+18
76 r2=4+12+15
77 r3=0
78 r4=4+4-5-4
79 r5=16+12-4
80 r6=24+15
81 c=c(r1,r2,r3,r4,r5,r6)
82
83 c1=sum(c)
84 c3=c2=10
85
86 a=c2*(sqrt(n5/n1-(n3/n1)**2))
87 a=round(a,digits = 3)
88 b=c3*(sqrt(n6/n1-(n4/n1)**2))
89 b=round(b,digits = 3)
90 c=c2*c3*(c1/n1-(n3/n1)*(n4/n1))
91 r=c/(a*b)
92 r=round(r,digits = 4)
93
94 a1=b*sqrt(1-r^2)
95 a1=round(a1,digits = 3)
96 a1
97
98 b1=a*sqrt(1-r^2)
99 b1=round(b1,digits = 3)
100 b1

```

R code Exa 14.14.26 US consumer price

```
1 #PAGE=314
2 yr=c(1975,1976,1977,1978,1979,1980,1981,1982,1983)
3 x=c(175,181,192,211,235,255,275,286,292)
4 y=c(169,185,202,219,240,266,295,329,357)
5 x1=mean(x)
6 x1=round(x1,digits = 0)
7 y1=mean(y)
8 y1=round(y1,digits = 0)
9
10 x=x-x1
11 y=y-y1
12 x2=x**2
13 y2=y**2
14 xy=x*y
15
16 s1=sum(x2)
17 s2=sum(y2)
18 s3=sum(xy)
19
20 a=s3/(sqrt(s1*s2))
21 a=round(a,digits = 2)
22 a
```

R code Exa 14.14.27 least squares parabola

```
1 #PAGE=315
2 x=c(1.2,1.8,3.1,4.9,5.7,7.1,8.6,9.8)
3 y=c(4.5,5.9,7,7.8,7.2,6.8,4.5,2.7)
4 s2=sum(y)
5 s1=sum(x)
6 xy=x*y
7 x2=x**2
8 x3=x**3
```

```

9  x4=x**4
10 xy2=x**2*y
11 l=length(x)
12 s3=sum(xy)
13 s4=sum(x2)
14 s5=sum(x3)
15 s6=sum(x4)
16 s7=sum(xy2)
17 s7=round(s7,digits = 0)
18 a <- matrix(c(1,s1,s4,s1,s4,s5,s4,s5,s6),nrow=3,ncol
    =3)
19 b <- matrix(c(s2,s3,s7),nrow=3,ncol=1)
20
21 y=solve(a,b)
22
23 a=y[1]
24 a=round(a,digits = 3)
25 b=y[2]
26 b=round(b,digits = 3)
27 c=y[3]
28 c=round(c,digits = 3)
29 cat('Y =',a,'+ ',b,'X -',(-1)*c,'X^2')

```

R code Exa 14.14.28 least squares parabola

```

1  #PAGE=315
2  x=c(1.2,1.8,3.1,4.9,5.7,7.1,8.6,9.8)
3  y=c(4.5,5.9,7,7.8,7.2,6.8,4.5,2.7)
4  yest=2.588+2.065*x-0.211*x^2
5  yest=round(yest,3)
6  yest
7
8  y1 <- matrix(c(yest,y),ncol=8,byrow=TRUE)
9  colnames(y1) <- c(" "," "," "," "," "," "," "," ")
10 rownames(y1) <- c("Yest","Y")

```

```
11 y1 <- as.table(y1)
12 y1
```

R code Exa 14.14.29 Linear correlation coefficient

```
1 #PAGE=316
2 x=c(1.2,1.8,3.1,4.9,5.7,7.1,8.6,9.8)
3 y=c(4.5,5.9,7,7.8,7.2,6.8,4.5,2.7)
4 s2=sum(y)
5 s1=sum(x)
6 y8=y**2
7 s8=sum(y8)
8 xy=x*y
9 x2=x**2
10 x3=x**3
11 x4=x**4
12 xy2=x**2*y
13 l=length(x)
14 s3=sum(xy)
15 s4=sum(x2)
16 s5=sum(x3)
17 s6=sum(x4)
18 s7=sum(xy2)
19 s7=round(s7,digits = 0)
20 a <- matrix(c(1,s1,s4,s1,s4,s5,s4,s5,s6),nrow=3,ncol
    =3)
21 b <- matrix(c(s2,s3,s7),nrow=3,ncol=1)
22
23 y=solve(a,b)
24
25 a=y[1]
26 a=round(a,digits = 3)
27 b=y[2]
28 b=round(b,digits = 3)
29 c=y[3]
```

```

30 c=round(c,digits = 3)
31
32 l=length(x)
33
34 r=(l*s3-s1*s2)
35 r2=sqrt((l*s4-s1^2)*(l*s8-s2^2))
36 r=r/r2
37 r=round(r,digits = 4)
38 r
39
40
41 x=c(1.2,1.8,3.1,4.9,5.7,7.1,8.6,9.8)
42 y=c(4.5,5.9,7,7.8,7.2,6.8,4.5,2.7)
43
44 y1=mean(y)
45 y=(y-y1)**2
46 b1=sum(y)
47 b1=round(b1,digits = 2)
48
49 y2=a+b*x+c*x**2
50 y2=(y2-y1)**2
51 b2=sum(y2)
52 b2=round(b2,digits = 2)
53
54 r=b2/b1
55 r1=round(r,digits = 4)
56 r1
57 r1=sqrt(r)
58 r1=round(r1,digits = 2)
59 r1
60
61 d=1-r
62 d=round(d,digits = 4)
63 d

```

R code Exa 14.14.30 standard deviation

```
1 #PAGE=317
2 x=c(1.2,1.8,3.1,4.9,5.7,7.1,8.6,9.8)
3 y=c(4.5,5.9,7,7.8,7.2,6.8,4.5,2.7)
4 s2=sum(y)
5 s1=sum(x)
6 y8=y**2
7 s8=sum(y8)
8 xy=x*y
9 x2=x**2
10 x3=x**3
11 x4=x**4
12 xy2=x**2*y
13 l=length(x)
14 s3=sum(xy)
15 s4=sum(x2)
16 s5=sum(x3)
17 s6=sum(x4)
18 s7=sum(xy2)
19 s7=round(s7,digits = 0)
20 a <- matrix(c(1,s1,s4,s1,s4,s5,s4,s5,s6),nrow=3,ncol
    =3)
21 b <- matrix(c(s2,s3,s7),nrow=3,ncol=1)
22
23 y=solve(a,b)
24
25 a=y[1]
26 a=round(a,digits = 3)
27 b=y[2]
28 b=round(b,digits = 3)
29 c=y[3]
30 c=round(c,digits = 3)
31
32 l=length(x)
33
34 r=(1*s3-s1*s2)
35 r2=sqrt((1*s4-s1^2)*(1*s8-s2^2))
```

```

36 r=r/r2
37 r=round(r,digits = 4)
38
39
40 x=c(1.2,1.8,3.1,4.9,5.7,7.1,8.6,9.8)
41 y=c(4.5,5.9,7,7.8,7.2,6.8,4.5,2.7)
42
43 y1=mean(y)
44 y=(y-y1)**2
45 b1=sum(y)
46 b1=round(b1,digits = 2)
47
48 y2=a+b*x+c*x**2
49 y2=(y2-y1)**2
50 b2=sum(y2)
51 b2=round(b2,digits = 2)
52
53 a=sqrt(b1/l)
54 a=round(a,digits = 3)
55 a
56
57 r=b2/b1
58 r1=round(r,digits = 4)
59 r1=sqrt(r)
60 r1=round(r1,digits = 4)
61
62 b=a*sqrt(1-r1^2)
63 b=round(b,digits = 2)
64 b

```

R code Exa 14.14.31 Correlation coefficient

```

1 #PAGE=317
2 r=0.32
3 n=18

```



```

4 t=r*sqrt(n-2)/(sqrt(1-r^2))
5 t=round(t,2)
6
7 t1=1.75
8
9 if (t<t1) l<-TRUE
10 l
11 #”The answer may vary due to difference in
    representation.”

```

R code Exa 14.14.32 Minimum sample size

```

1 #PAGE=317
2
3 c=0.32
4 a=0.05
5
6 x1=1-a
7 x=qt(x1,df=1/0)
8 x=round(x,digits = 2)
9 x
10
11 m=(x*sqrt(1-c^2))/c
12 m=m**2
13 m=m+2
14 m=round(m,digits = 1)
15 m
16
17 m1=ceiling(m)
18 m1
19 f1=m1-2
20 t=c*sqrt(f1)/(sqrt(1-c^2))
21 t=round(t,digits = 2)
22 t
23

```

```

24 m2=m1+1
25 f2=m2-2
26 t1=c*sqrt(f2)/(sqrt(1-c^2))
27 t1=round(t1,digits = 2)
28 t1
29
30 m3=m2+1
31 f3=m3-2
32 t2=c*sqrt(f3)/(sqrt(1-c^2))
33 t2=round(t2,digits = 2)
34 t2
35
36 if(t2>x)k<-TRUE
37 k
38 #”The answer may vary due to difference in
    representation.”

```

R code Exa 14.14.33 Correlation coefficient

```

1 #PAGE=318
2 n=24
3 r=0.75
4 m=0.05
5 a=0.6
6 z1=1.1513*log((1+r)/(1-r),10)
7 z1=round(z1,digits = 3)
8
9 u=1.1513*log((1+a)/(1-a),10)
10 u=round(u,digits = 4)
11
12 s=1/sqrt(n-3)
13 s=round(s,digits = 4)
14
15 z=(z1-u)/s
16 z=round(z,digits = 2)

```

```

17 z
18
19 a=0.05
20 x1=1-a
21 x=qt(x1,df=1/0)
22 x=round(x,digits = 2)
23 x
24
25 if(x>z) k<-TRUE
26 k
27
28 b=0.5
29 y=1.1513*log((1+b)/(1-b),10)
30 y=round(y,digits = 4)
31
32 z2=(z1-y)/s
33 z2=round(z2,digits = 2)
34 z2
35
36 if(x>y) k<-FALSE
37 k
38 #”The answer may vary due to difference in
    representation.”

```

R code Exa 14.14.34 Correlation coefficient between final grades

```

1 #PAGE=318
2 n=21
3 r=0.8
4 m=0.95
5
6 z1=1.1513*log((1+r)/(1-r),10)
7 z1=round(z1,digits =4)
8
9 a=95/100

```

```

10 a=1-a
11 a=a/2
12 a=qnorm(a,lower.tail = FALSE)
13 a=round(a,digits = 2)
14
15 s=a/sqrt(n-3)
16 s=round(s,digits = 4)
17
18 n1=s+z1
19 n2=z1-s
20
21 m1=n1/1.1513
22 m2=(10^m1-1)
23 m3=(10^m1+1)
24 u=m2/m3
25 u=round(u,digits = 2)
26
27 m4=n2/1.1513
28 m5=(10^m4-1)
29 m6=(10^m4+1)
30 u2=m5/m6
31 u2=round(u2,digits = 2)
32
33 cat(u2, '-', u)
34 #”The answer may vary due to difference in
   representation.”
35 #”The answer provided in the textbook is wrong.”

```

R code Exa 14.14.35 two correlation coefficients

```

1 #PAGE=318
2 n1=28
3 n2=35
4 r1=0.5
5 r2=0.3

```

```

6  z1=1.1513*log10((1+r1)/(1-r1))
7  z2=1.513*log10((1+r2)/(1-r2))
8  s=sqrt((1/(n1-3)+1/(n2-3)))
9  s=round(s,4)
10 s
11 u1=u2=0
12 z=(z1-z2-(u1-u2))/s
13 z1=1.96
14 z2=-z1
15 if (z<z1||z>z2) l<-TRUE
16 l
17 #”The answer may vary due to difference in
    representation.”

```

R code Exa 14.14.36 Regression equation

```

1  #PAGE=319
2  a1=0.476
3  a0=35.82
4  r=0.18
5
6  x=c(65,63,67,64,68,62,70,66,68,67,69,71)
7  y=c(68,66,68,65,69,66,68,65,71,67,68,70)
8  yest=35.82+0.476*x
9  yest=round(yest,digits = 2)
10 y1=y-yest
11 y1=y1**2
12 l=length(x)
13 s=sum(y1)/l
14 s=round(s,digits = 3)
15
16 x3=mean(x)
17 x1=x-x3
18 x1=x1**2
19 x1=sum(x1)

```

```

20 x1=x1/l
21 x1=sqrt(x1)
22 x1=round(x1,digits = 2)
23 x1
24
25 x=sqrt(s)
26 x=round(x,digits = 2)
27
28 y6=x/x1
29 t=((a1-r)*sqrt(1-2))/y6
30 t=round(t,digits = 2)
31 t
32
33
34 a=95/100
35 a=1-a
36 a=qnorm(a,lower.tail = FALSE)
37 a=round(a,digits = 2)
38
39 if(a<t) k<-TRUE
40 k
41 #”The answer may vary due to difference in
    representation.”

```

R code Exa 14.14.37 regression coefficient

```

1 #PAGE=319
2 a1=0.476
3 a0=35.82
4 r=0.18
5
6 x=c(65,63,67,64,68,62,70,66,68,67,69,71)
7 y=c(68,66,68,65,69,66,68,65,71,67,68,70)
8 yest=35.82+0.476*x
9 yest=round(yest,digits = 2)

```

```

10 y1=y-vest
11 y1=y1**2
12 l=length(x)
13 s=sum(y1)/l
14 s=round(s,digits = 3)
15
16 x3=mean(x)
17 x1=x-x3
18 x1=x1**2
19 x1=sum(x1)
20 x1=x1/l
21 x1=sqrt(x1)
22 x1=round(x1,digits = 2)
23
24 x=sqrt(s)
25 x=round(x,digits = 2)
26
27 y6=x/x1
28 t=((a1-r)*sqrt(1-2))/y6
29 t=round(t,digits = 2)
30
31 g=qt(0.975,df=1-2)
32 g=round(g,digits = 2)
33
34 f=1-2
35 g1=(g*x)/(x1*sqrt(f))
36 g1=round(g1,digits = 3)
37 g1=a1+g1
38
39 g2=(g*x)/(x1*sqrt(f))
40 g2=round(g2,digits = 3)
41 g2=a1-g2
42
43 cat(g2, '-', g1)
44 #"The answer may vary due to difference in
    representation."
45 #"The answer may slightly vary due to rounding off
    values."

```

R code Exa 14.14.38 difference between two coefficients

```
1 #PAGE=319
2 l=12
3 g=qt(0.975,df=1-2)
4 g=round(g,digits = 2)
5 a1=65
6 y1=35.82+0.476*a1
7 y1
8 x0=65
9 m=800/l
10 a=((x0-m)/l)**2
11 ans1=y1+(g*1.28/sqrt(1-2))*sqrt(1+1+a/(2.66^2))
12 ans1=round(ans1,1)
13 ans2=y1-(g*1.28/sqrt(1-2))*sqrt(1+1+a/(2.66^2))
14 ans2=round(ans2,1)
15 cat(ans2, '—', ans1, ' kg ')
16 y2=69.14
17 x0=70
18 m=800/l
19 a=(x0-m)**2
20 ans1=y2+(g*1.28/sqrt(1-2))*sqrt(1+1+a/(2.66^2))
21 ans1=round(ans1,1)
22 ans2=y2-(g*1.28/sqrt(1-2))*sqrt(1+1+a/(2.66^2))
23 ans2=round(ans2,1)
24 cat(ans2, '—', ans1, ' kg ')
```

R code Exa 14.14.39 sons and fathers

```
1 #PAGE=320
2 l=12
```



```

3 g=qt(0.975,df=1-2)
4 g=round(g,digits = 2)
5 a1=65
6 y1=35.82+0.476*a1
7 y1
8 x0=65
9 m=800/l
10 a=(x0-m)**2
11 ans1=y1+(g*1.28/sqrt(1-2))*sqrt(1+a/(2.66^2))
12 ans1=round(ans1,1)
13 ans2=y1-(g*1.28/sqrt(1-2))*sqrt(1+a/(2.66^2))
14 ans2=round(ans2,1)
15 cat(ans2, '- ', ans1, ' kg ')
16 y2=69.14
17 x0=70
18 m=800/l
19 a=(x0-m)**2
20 ans1=y2+(g*1.28/sqrt(1-2))*sqrt(+1+a/(2.66^2))
21 ans1=round(ans1,1)
22 ans2=y2-(g*1.28/sqrt(1-2))*sqrt(+1+a/(2.66^2))
23 ans2=round(ans2,1)
24 cat(ans2, '- ', ans1, ' kg ')

```

Chapter 15

Multiple And Partial Correlation

R code Exa 15.15.3 variable and linear function

```
1 #PAGE=328
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
```

```

20 x9=sum(x9)
21 a <- matrix(c(1,x2,x3,x2,x5,x9,x3,x9,x6),nrow=3,ncol
    =3)
22
23 b <- matrix(c(x1,x7,x8),nrow=3,ncol=1)
24
25 c<-solve(a,b)
26 c=round(c,digits = 4)
27
28 b1=c[1]
29 b2=c[2]
30 b3=c[3]
31
32 cat('X1 =',b1,'+',b2,'X2 +',b3,'X3')
33
34
35 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
36 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
37 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
38
39
40 xest=b1+b2*x2+b3*x3
41 xest=round(xest,digits = 3)
42 xest
43
44 y <- matrix(c(xest,x1),ncol=1,byrow=TRUE)
45 colnames(y) <- c(" "," "," "," "," "," "," "," "," "," "," "," ")
    ," "," "," "," ")
46 rownames(y) <- c("Xest","X")
47 y <- as.table(y)
48 y
49
50 x2=54
51 x3=9
52 xest=b1+b2*x2+b3*x3
53 xest=round(xest,digits = 3)
54 xest

```

R code Exa 15.15.4 standard deviation

```
1 #PAGE=330
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s1
25 s1=round(s1,digits = 2)
26 s1
27 s2=sqrt((x5/l)-(x2/l)**2)
28 s2=round(s2,digits = 4)
29 s2
30 s2=round(s2,digits = 1)
31 s2
32 s3=sqrt((x6/l)-(x3/l)**2)
```

```
33 s3=round(s3,digits = 4)
34 s3
35 s3=round(s3,digits = 1)
36 s3
```

R code Exa 15.15.5 Computing the data

```
1 #PAGE=330
2 n=12
3 x1=753
4 x2=643
5 x3=106
6 x1x2=40830
7 x2x3=5779
8 x1x3=6796
9 x12=48139
10 x22=34843
11 x33=976
12 r12=(n*x1x2-x1*x2)/sqrt((n*x12-x1^2)*(n*x22-x2**2))
13 r12
14 r12=round(r12,2)
15 cat(r12)
16
17 r13=(n*x1x3-x1*x3)/sqrt((n*x12-x1^2)*(n*x33-x3**2))
18 r13
19 r13=round(r13,2)
20 cat(r13)
21
22 r23=(n*x2x3-x2*x3)/sqrt((n*x22-x2^2)*(n*x33-x3**2))
23 r23
24 r23=round(r23,2)
25 cat(r23)
```

R code Exa 15.15.6 Work problem

```
1 #PAGE=330
2 n=12
3 x1=753
4 x2=643
5 x3=106
6 x1x2=40830
7 x2x3=5779
8 x1x3=6796
9 x12=48139
10 x22=34843
11 x33=976
12 r12=0.82
13 r13=0.77
14 r23=0.8
15 s1=8.6
16 s2=5.7
17 s3=1.8
18 a=(r12-r13*r23)/(1-r23^2)*(s1/s2)
19 a=round(a,4)
20
21 b=(r13-r12*r23)/(1-r23^2)*(s1/s3)
22 b=round(b,3)
23
24 x1=x1/n
25 x1
26 x2=x2/n
27 x2=round(x2,3)
28 x3=x3/n
29 x3=round(x3,3)
30
31 cat('X1 -',x1,'=',a,'( X2 -',x2,') +',b,'X3 -',x3,')
    ')
32 #”The answer may slightly vary due to rounding off
    values.”
```

R code Exa 15.15.7 average increase per unit

```
1 #PAGE=330
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s1=round(s1,digits = 2)
25 s2=sqrt((x5/l)-(x2/l)**2)
26 s2=round(s2,digits = 4)
27 s2=round(s2,digits = 1)
28 s3=sqrt((x6/l)-(x3/l)**2)
29 s3=round(s3,digits = 4)
30 s3=round(s3,digits = 1)
31
32
```

```

33 r2=(1*x7-x1*x2)/(sqrt((1*x4-x1^2)*(1*x5-x2^2)))
34 r2=round(r2,digits = 4)
35 r2=round(r2,digits = 2)
36
37 r1=(1*x8-x1*x3)/(sqrt((1*x4-x1^2)*(1*x6-x3^2)))
38 r1=round(r1,digits = 4)
39 r1=round(r1,digits = 2)
40
41 r3=(1*x9-x2*x3)/(sqrt((1*x5-x2^2)*(1*x6-x3^2)))
42 r3=round(r3,digits = 4)
43 r3=round(r3,digits = 2)
44
45 b0=((r2-r1*r3)/(1-r3^2))*(s1/s2)
46 b0=round(b0,digits = 4)
47 b0
48 b0=round(b0,digits = 1)
49 b0
50 b1=((r1-r2*r3)/(1-r3^2))*(s1/s3)
51 b1=round(b1,digits = 4)
52 b1
53 b1=round(b1,digits = 1)
54 b1

```

R code Exa 15.15.10 Standard error

```

1 #PAGE=332
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3

```



```

11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21 a <- matrix(c(1,x2,x3,x2,x5,x9,x3,x9,x6),nrow=3,ncol
    =3)
22
23 b <- matrix(c(x1,x7,x8),nrow=3,ncol=1)
24
25 c<-solve(a,b)
26 c=round(c,digits = 4)
27
28 b1=c[1]
29 b2=c[2]
30 b3=c[3]
31
32 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
33 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
34 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
35
36
37 xest=b1+b2*x2+b3*x3
38 xest=round(xest,digits = 3)
39
40 y=(x1-xest)
41 y=y^2
42 y=sum(y)
43 y=sqrt(y/1)
44 y1=round(y,digits = 4)
45 y1
46 y2=round(y,digits = 1)
47 y2

```

```

48
49 e=1/(1-3)
50 e=sqrt(e)*y2
51 e=round(e,digits = 1)
52 e

```

R code Exa 15.15.11 Obtaining the result

```

1 #PAGE=332
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s2=sqrt((x5/l)-(x2/l)**2)
25 s2=round(s2,digits = 4)
26 s2=round(s2,digits = 1)
27 s3=sqrt((x6/l)-(x3/l)**2)

```

```

28 s3=round(s3,digits = 4)
29 s3=round(s3,digits = 1)
30
31 r2=(1*x7-x1*x2)/(sqrt((1*x4-x1^2)*(1*x5-x2^2)))
32 r2=round(r2,digits = 4)
33
34 r1=(1*x8-x1*x3)/(sqrt((1*x4-x1^2)*(1*x6-x3^2)))
35 r1=round(r1,digits = 4)
36
37 r3=(1*x9-x2*x3)/(sqrt((1*x5-x2^2)*(1*x6-x3^2)))
38 r3=round(r3,digits = 4)
39
40 a=1-(r2^2)-(r3^2)-(r1^2)+2*r1*r2*r3
41 a=a/(1-r3^2)
42 s=s1*sqrt(a)
43 s=round(s,digits = 1)
44 s

```

R code Exa 15.15.12 coefficient linear multiple correlation

```

1 #PAGE=332
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)

```

```

16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s2=sqrt((x5/l)-(x2/l)**2)
25 s2=round(s2,digits = 4)
26 s2=round(s2,digits = 1)
27 s3=sqrt((x6/l)-(x3/l)**2)
28 s3=round(s3,digits = 4)
29 s3=round(s3,digits = 1)
30
31 r2=(1*x7-x1*x2)/(sqrt((1*x4-x1^2)*(1*x5-x2^2)))
32 r2=round(r2,digits = 4)
33
34 r1=(1*x8-x1*x3)/(sqrt((1*x4-x1^2)*(1*x6-x3^2)))
35 r1=round(r1,digits = 4)
36
37 r3=(1*x9-x2*x3)/(sqrt((1*x5-x2^2)*(1*x6-x3^2)))
38 r3=round(r3,digits = 4)
39
40 a=1-(r2^2)-(r3^2)-(r1^2)+2*r1*r2*r3
41 a=a/(1-r3^2)
42 s=s1*sqrt(a)
43 s=round(s,digits = 3)
44
45 e=sqrt(1-((s^2)/(s1^2)))
46 e=round(e,digits = 4)
47 e
48 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 15.15.13 coefficient of multiple determination

```
1 #PAGE=332
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s2=sqrt((x5/l)-(x2/l)**2)
25 s2=round(s2,digits = 4)
26 s2=round(s2,digits = 1)
27 s3=sqrt((x6/l)-(x3/l)**2)
28 s3=round(s3,digits = 4)
29 s3=round(s3,digits = 1)
30
31 r2=(1*x7-x1*x2)/(sqrt((1*x4-x1^2)*(1*x5-x2^2)))
32 r2=round(r2,digits = 4)
33
34 r1=(1*x8-x1*x3)/(sqrt((1*x4-x1^2)*(1*x6-x3^2)))
35 r1=round(r1,digits = 4)
36
```

```

37 r3=(1*x9-x2*x3)/(sqrt((1*x5-x2^2)*(1*x6-x3^2)))
38 r3=round(r3,digits = 4)
39
40 a=1-(r2^2)-(r3^2)-(r1^2)+2*r1*r2*r3
41 a=a/(1-r3^2)
42 s=s1*sqrt(a)
43 s=round(s,digits = 3)
44
45 e=sqrt(1-((s^2)/(s1^2)))
46 e=round(e,digits = 4)
47 e=e^2
48 e=round(e,digits = 4)
49 e
50 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 15.15.14 Comparing the values

```

1 #PAGE=333
2 x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3 x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4 x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5 l=length(x1)
6 x4=x1**2
7 x5=x2**2
8 x6=x3**2
9 x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)

```

```

18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s2=sqrt((x5/l)-(x2/l)**2)
25 s2=round(s2,digits = 4)
26 s2=round(s2,digits = 1)
27 s3=sqrt((x6/l)-(x3/l)**2)
28 s3=round(s3,digits = 4)
29 s3=round(s3,digits = 1)
30
31 r2=(1*x7-x1*x2)/(sqrt((1*x4-x1^2)*(1*x5-x2^2)))
32 r2=round(r2,digits = 4)
33 r1=(1*x8-x1*x3)/(sqrt((1*x4-x1^2)*(1*x6-x3^2)))
34 r1=round(r1,digits = 4)
35 r3=(1*x9-x2*x3)/(sqrt((1*x5-x2^2)*(1*x6-x3^2)))
36 r3=round(r3,digits = 4)
37 a=1-(r2^2)-(r3^2)-(r1^2)+2*r1*r2*r3
38 a=a/(1-r3^2)
39 s=s1*sqrt(a)
40 s=round(s,digits = 3)
41
42 m=sqrt((r2**2+r3**2-2*r2*r3*r1)/(1-r1**2))
43 m=round(m,digits = 4)
44 m
45
46 m2=sqrt((r1**2+r3**2-2*r2*r3*r1)/(1-r2**2))
47 m2=round(m2,digits = 4)
48 m2

```

R code Exa 15.15.17 Coefficient of linear partial correlation

1 [#PAGE=333](#)

```

2  x1=c(64,71,53,67,55,58,77,57,56,51,76,68)
3  x2=c(57,59,49,62,51,50,55,48,52,42,61,57)
4  x3=c(8,10,6,11,8,7,10,9,10,6,12,9)
5  l=length(x1)
6  x4=x1**2
7  x5=x2**2
8  x6=x3**2
9  x7=x1*x2
10 x8=x1*x3
11 x9=x2*x3
12 x1=sum(x1)
13 x2=sum(x2)
14 x3=sum(x3)
15 x4=sum(x4)
16 x5=sum(x5)
17 x6=sum(x6)
18 x7=sum(x7)
19 x8=sum(x8)
20 x9=sum(x9)
21
22 s1=sqrt((x4/l)-(x1/l)**2)
23 s1=round(s1,digits = 4)
24 s2=sqrt((x5/l)-(x2/l)**2)
25 s2=round(s2,digits = 4)
26 s2=round(s2,digits = 1)
27 s3=sqrt((x6/l)-(x3/l)**2)
28 s3=round(s3,digits = 4)
29 s3=round(s3,digits = 1)
30
31 r2=(1*x7-x1*x2)/(sqrt((1*x4-x1^2)*(1*x5-x2^2)))
32 r2=round(r2,digits = 4)
33 r1=(1*x8-x1*x3)/(sqrt((1*x4-x1^2)*(1*x6-x3^2)))
34 r1=round(r1,digits = 4)
35 r3=(1*x9-x2*x3)/(sqrt((1*x5-x2^2)*(1*x6-x3^2)))
36 r3=round(r3,digits = 4)
37 a=1-(r2^2)-(r3^2)-(r1^2)+2*r1*r2*r3
38 a=a/(1-r3^2)
39 s=s1*sqrt(a)

```



```

40 s=round(s,digits = 3)
41
42 r11=(r2-r1*r3)/sqrt((1-r1**2)*(1-r3**2))
43 r11=round(r11,digits = 4)
44 r11
45
46 r12=(r1-r2*r3)/sqrt((1-r2**2)*(1-r3**2))
47 r12=round(r12,digits = 4)
48 r12
49
50
51 r13=(r3-r1*r2)/sqrt((1-r1**2)*(1-r2**2))
52 r13=round(r13,digits = 4)
53 r13
54
55 r4=round(r11,digits = 2)
56 r4
57
58 r5=round(r12,digits = 2)
59 r5

```

R code Exa 15.15.20 College Entrance Examination

```

1 #PAGE=334
2 t=200
3 x1=75
4 s1=10
5 x2=24
6 s2=5
7 x3=15
8 s3=3
9 x4=36
10 s4=6
11 r12=0.9
12 r13=0.75

```

```

13 r14=0.8
14 r23=0.7
15 r24=0.7
16 r34=0.85
17
18 n1=t*s2**2
19 n2=t*s3**2
20 n3=t*s4**2
21 n4=t*s2*s1*r12
22 n5=t*s1*s3*r13
23 n6=t*s1*s4*r14
24 n7=t*s1*s3*r23
25 n7=n7/2
26 n8=t*s2*s4*r24
27 n9=t*s4*s3*r34
28
29 y <- matrix(c(n1,n7,n8,n7,n2,n9,n8,n9,n3),ncol=3,
               nrow=3)
30 y
31 b <- matrix(c(n4,n5,n6),nrow=3,ncol=1)
32
33 e=solve(y,b)
34 e1=e[1]
35 e1=round(e1,digits = 4)
36
37 e2=e[2]
38 e2=round(e2,digits = 2)
39
40 e3=e[3]
41 e3=round(e3,digits = 4)
42
43 c=x1-x2*e1-e3*x4
44 c=round(c,digits = 0)
45
46 cat('X1 =',c,'+',e1,'X2',e3,'X4')

```

R code Exa 15.15.21 students and college entrance examination

```
1 #PAGE=335
2 x2=30
3 x3=18
4 x4=32
5 x1=23+(4*x2)/3+(5*x4)/9
6 x1=round(x1,digits = 0)
7 x1
8
9 x22=18
10 x33=20
11 x44=36
12 x11=23+(4*x22)/3+(5*x44)/9
13 x11=round(x11,digits = 0)
14 x11
```

R code Exa 15.15.22 partial correlation coefficients

```
1 #PAGE=335
2 t=200
3 x1=75
4 s1=10
5 x2=24
6 s2=5
7 x3=15
8 s3=3
9 x4=36
10 s4=6
11 r12=0.9
12 r13=0.75
13 r14=0.8
```

```

14 r23=0.7
15 r24=0.7
16 r34=0.85
17
18 r124=(r12-r14*r24)/(sqrt((1-r14**2)*(1-r24**2)))
19 r124=round(r124,digits = 4)
20
21 r134=(r13-r14*r34)/(sqrt((1-r14**2)*(1-r34**2)))
22 r134=round(r134,digits = 4)
23
24 r234=(r23-r34*r24)/(sqrt((1-r24**2)*(1-r34**2)))
25 r234=round(r234,digits = 4)
26
27 r1234=(r124-r134*r234)/(sqrt((1-r134**2)*(1-r234**2)
    ))
28 r1234=round(r1234,digits = 4)
29 r1234
30
31 r1324=(r134-r124*r234)/(sqrt((1-r124**2)*(1-r234**2)
    ))
32 r1324=round(r1324,digits = 3)
33 r1324
34
35 r143=(r14-r13*r34)/(sqrt((1-r13**2)*(1-r34**2)))
36 r143=round(r143,digits = 4)
37
38 r123=(r12-r13*r23)/(sqrt((1-r13**2)*(1-r23**2)))
39 r123=round(r123,digits = 4)
40
41 r243=(r24-r23*r34)/(sqrt((1-r23**2)*(1-r34**2)))
42 r243=round(r243,digits = 4)
43
44 r1423=(r143-r123*r243)/(sqrt((1-r123**2)*(1-r243**2)
    ))
45 r1423=round(r1423,digits = 4)
46 r1423

```

R code Exa 15.15.24 verification

```
1 #PAGE=336
2 t=200
3 x1=75
4 s1=10
5 x2=24
6 s2=5
7 x3=15
8 s3=3
9 x4=36
10 s4=6
11 r12=0.9
12 r13=0.75
13 r14=0.8
14 r23=0.7
15 r24=0.7
16 r34=0.85
17
18 r124=(r12-r14*r24)/(sqrt((1-r14**2)*(1-r24**2)))
19 r124=round(r124,digits = 4)
20
21 r134=(r13-r14*r34)/(sqrt((1-r14**2)*(1-r34**2)))
22 r134=round(r134,digits = 4)
23
24 r234=(r23-r34*r24)/(sqrt((1-r24**2)*(1-r34**2)))
25 r234=round(r234,digits = 4)
26
27 r1234=(r124-r134*r234)/(sqrt((1-r134**2)*(1-r234**2)
    ))
28 r1234=round(r1234,digits = 4)
29 r1234
30
31 r1324=(r134-r124*r234)/(sqrt((1-r124**2)*(1-r234**2))
```

```

    ))
32 r1324=round(r1324,digits = 3)
33 r1324
34
35 r143=(r14-r13*r34)/(sqrt((1-r13**2)*(1-r34**2)))
36 r143=round(r143,digits = 4)
37
38 r123=(r12-r13*r23)/(sqrt((1-r13**2)*(1-r23**2)))
39 r123=round(r123,digits = 4)
40
41 r243=(r24-r23*r34)/(sqrt((1-r23**2)*(1-r34**2)))
42 r243=round(r243,digits = 4)
43
44 r1423=(r143-r123*r243)/(sqrt((1-r123**2)*(1-r243**2)
    ))
45 r1423=round(r1423,digits = 4)
46 r1423
47
48
49 ans1=(r124-r134*r234)/sqrt((1-r134^2)*(1-r234^2))
50 ans1=round(ans1,4)
51 ans1
52
53 ans2=(r123-r143*r243)/sqrt((1-r143^2)*(1-r243^2))
54 ans2=round(ans2,4)
55 ans2
56
57 if (ans1==ans2) l<-TRUE
58 l
59 #”The answer may vary due to difference in
    representation.”

```

R code Exa 15.15.25 multiple correlation coefficient

1 #PAGE=337

```

2  t=200
3  x1=75
4  s1=10
5  x2=24
6  s2=5
7  x3=15
8  s3=3
9  x4=36
10 s4=6
11 r12=0.9
12 r13=0.75
13 r14=0.8
14 r23=0.7
15 r24=0.7
16 r34=0.85
17
18
19 r132=(r13-r12*r23)/(sqrt((1-r12**2)*(1-r23**2)))
20 r132=round(r132,digits = 4)
21 r132
22
23 r143=(r14-r13*r34)/(sqrt((1-r13**2)*(1-r34**2)))
24 r143=round(r143,digits = 4)
25
26 r123=(r12-r13*r23)/(sqrt((1-r13**2)*(1-r23**2)))
27 r123=round(r123,digits = 4)
28
29 r243=(r24-r23*r34)/(sqrt((1-r23**2)*(1-r34**2)))
30 r243=round(r243,digits = 4)
31
32 r1423=(r143-r123*r243)/(sqrt((1-r123**2)*(1-r243**2)
    ))
33 r1423=round(r1423,digits = 4)
34
35 r=(1-r12**2)*(1-r132**2)*(1-r1423**2)
36 r=1-r
37 r=sqrt(r)
38 r=round(r,digits = 3)

```

```
39  r
40
41  s1=10
42  sr=s1*sqrt(1-r**2)
43  sr=round(sr,digits = 3)
44  sr
```

Chapter 16

Analysis Of Variance

R code Exa 16.16.4 Wheat grown and soil type

```
1 #PAGE=351
2 a=c(48,49,50,49)
3 b=c(47,49,48,48)
4 c=c(49,51,50,50)
5
6 x=45
7 a=a-x
8 b=b-x
9 c=c-x
10
11 x1=mean(a)
12 x1
13 x2=mean(b)
14 x2
15 x3=mean(c)
16 x3
17
18 x=c(a,b,c)
19 x4=mean(x)
20 x4
21
```

```

22 x=(x-x4)**2
23 x5=sum(x)
24 x5
25
26 b=4
27 y=c(x1,x2,x3)
28 v=(y-x4)**2
29 v=sum(v)
30 v=v*b
31 v
32
33 e=x5-v
34 e

```

R code Exa 16.16.5 unbiased estimate of the population variance

```

1 #PAGE=352
2 a=c(48,49,50,49)
3 b=c(47,49,48,48)
4 c=c(49,51,50,50)
5 d=45
6 a=a-d
7 b=b-d
8 c=c-d
9
10 x=mean(a)
11 x
12 y=mean(b)
13 y
14 z=mean(c)
15 z
16
17
18 e=c(a,b,c)
19 m=mean(e)

```

```

20 m
21
22 f=median(e)
23 e=(e-f)**2
24 e=sum(e)
25 e
26
27 g=4
28 k=c(a[g],b[g],c[g])
29 k
30 v=(k-m)**2
31 v=sum(v)*g
32 v
33
34
35 vw=e-v
36 vw
37
38 h=3
39 sb=v/(h-1)
40 sb
41
42
43 r=length(a)
44 sw=vw/(h*(r-1))
45 sw

```

R code Exa 16.16.6 Null hypothesis

```

1 #PAGE=352
2 s2=4
3 s1=2/3
4 f=s2/s1
5 f
6 a=3-1

```

```

7  b=3*(4-1)
8  z1=qf(0.95,df1=a,df2=b)
9  z1=round(z1,digits = 2)
10 z1
11
12 if(z1<f) l1<-FALSE
13 l1
14
15 z1=qf(0.99,df1=a,df2=b)
16 z1=round(z1,digits = 2)
17 z1
18
19 if(z1>f) l1<-TRUE
20 l1
21
22 #”The answer may vary due to difference in
    representation.”

```

R code Exa 16.16.7 Shortcut formulas

```

1  #PAGE=352
2  a=c(3,4,5,4)
3  b=c(2,4,3,3)
4  c=c(4,6,5,5)
5  t1=sum(a)
6  t2=sum(b)
7  t3=sum(c)
8  t=c(t1,t2,t3)
9  tt=t**2
10 st=sum(t)
11 stt=sum(tt)
12 x=c(a,b,c)
13 x=x**2
14 x=sum(x)
15 a1=3

```

```

16 b1=4
17 v=x-(st^2)/(a1*b1)
18 v
19
20 vb=(t1**2+t2**2+t3**2)/b1-(st**2)/(a1*b1)
21 vb
22
23 vc=v-vb
24 vc

```

R code Exa 16.16.8 5 machines A B C D E

```

1 #PAGE=353
2 a=c(8,12,17,-18,-7)
3 b=c(12,-7,3,-7,-12)
4 c=c(0,22,4,15,12)
5 d=c(-12,1,-3,4,-10)
6 e=c(4,5,10,8,-7)
7 t1=sum(a)
8 t2=sum(b)
9 t3=sum(c)
10 t4=sum(d)
11 t5=sum(e)
12 t=c(t1,t2,t3,t4,t5)
13 t1=t^2
14 x=c(a,b,c,d,e)
15 a1=sum(x^2)
16 b1=sum(t)
17 c1=sum(t1)
18 v=a1-(b1^2)/(5*4)
19 vb=c1/5-(b1^2)/(5*4)
20
21
22 z1=qf(0.95,df1=4,df2=20)
23 z1=round(z1,digits = 2)

```

```

24 z1
25
26 sb=vb/4
27 vw=v-vb
28 sw=vw/(5*4)
29 f=sb/sw
30 f=round(f,2)
31 f
32 if(z1>f) l1<-TRUE
33 l1
34
35 z1=qf(0.99,df1=4,df2=20)
36 z1=round(z1,digits = 2)
37 z1
38 if(z1>f) l2<-TRUE
39 l2

```

R code Exa 16.16.9 lifetimes in hour and television tubes

```

1 #PAGE=354
2 s1=c(407,411,409)
3 s2=c(404,406,408,405,402)
4 s3=c(410,408,406,408)
5 s1=s1-400
6 s2=s2-400
7 s3=s3-400
8 t1=sum(s1)
9 t2=sum(s2)
10 t3=sum(s3)
11 m1=mean(t1)
12 m2=mean(t2)
13 m3=mean(t3)
14 s=c(s1,s2,s3)
15 m=mean(s)
16 m

```

```

17 v=sum((s-m)^2)
18 v
19 vb=v/2
20 vb
21 vw=v-vb
22 vw
23 sb=vb/2
24 sw=vw/9
25 f=sb/sw
26 z1=qf(0.95,df1=4,df2=20)
27 z1=round(z1,digits = 2)
28 z1
29 if(z1<f) l1<-TRUE
30 l1
31
32 z1=qf(0.99,df1=4,df2=20)
33 z1=round(z1,digits = 2)
34 z1
35 if(z1<f) l2<-TRUE
36 l2
37
38 #”The answer may vary due to difference in
    representation.”

```

R code Exa 16.16.10 Shortcut formulas

```

1 #PAGE=355
2 n1=3
3 n2=5
4 n3=4
5 n=12
6 t1=27
7 t2=25
8 t3=32
9 t=84

```

```

10 s=c(7,11,9,4,6,8,5,2,10,8,6,8)
11 s=s^2
12 v=sum(s)-t^2/n
13 v
14 vb=t1^2/n1+t2^2/n2+t3^2/n3
15 vb=vb-t^2/n
16 vb
17 vw=v-vb
18 vw
19 sb=vb/2
20 sw=vw/9
21 f=sb/sw
22 f
23 z1=qf(0.95,df1=4,df2=20)
24 z1=round(z1,digits = 2)
25 z1
26 if(z1<f) l1<-TRUE
27 l1
28
29 z1=qf(0.99,df1=4,df2=20)
30 z1=round(z1,digits = 2)
31 z1
32 if(z1<f) l2<-TRUE
33 l2
34
35 #”The answer may vary due to difference in
    representation.”

```

R code Exa 16.16.11 Plant crops grown and fertilizers

```

1 #PAGE=355
2 a=c(4.5,6.4,7.2,6.7)
3 b=c(8.8,7.8,9.6,7)
4 c=c(5.9,6.8,5.7,5.2)
5 c1=c(a[1],b[1],c[1])

```



```

6  c2=c(a[2],b[2],c[2])
7  c3=c(a[3],b[3],c[3])
8  c4=c(a[4],b[4],c[4])
9  rt1=sum(a)
10 rt2=sum(b)
11 rt3=sum(c)
12 rm1=mean(a)
13 rm2=mean(b)
14 rm3=mean(c)
15
16 ct1=sum(c1)
17 ct2=sum(c2)
18 ct3=sum(c3)
19 ct4=sum(c4)
20 cm1=mean(c1)
21 cm2=mean(c2)
22 cm3=mean(c3)
23 cm4=mean(c4)
24
25 gt=sum(rt1,rt2,rt3)
26 gt
27 rm=c(rm1,rm2,rm3)
28 cm=c(cm1,cm2,cm3,cm4)
29
30 gm=mean(rm)
31 gm
32 vr=4*sum((rm-gm)^2)
33 vr
34 vc=3*sum((cm-gm)^2)
35 vc
36
37 k=c(a,b,c)
38 v=sum((k-gm)^2)
39 v
40 ve=v-vr-vc
41 ve
42
43 sr=vr/2

```

```

44  sc=vc/3
45  se=ve/6
46  sr
47  sc
48  se
49  f1=sr/se
50  f1=round(f1,2)
51  f1
52  f2=sc/se
53  f2=round(f2,2)
54  f2
55
56
57  z1=qf(0.95,df1=4,df2=20)
58  z1=round(z1,digits = 2)
59  z1
60  if(z1<f1) l1<-FALSE
61  l1
62
63  z1=qf(0.99,df1=4,df2=20)
64  z1=round(z1,digits = 2)
65  z1
66  if(z1<f1) l2<-FALSE
67  l2
68
69  z1=qf(0.95,df1=4,df2=20)
70  z1=round(z1,digits = 2)
71  z1
72  if(z1>f2) l1<-TRUE
73  l1
74
75  z1=qf(0.99,df1=4,df2=20)
76  z1=round(z1,digits = 2)
77  z1
78  if(z1>f2) l2<-TRUE
79  l2
80  #”The answer may vary due to difference in
    representation.”

```

R code Exa 16.16.12 short computational formulas

```
1 #PAGE=357
2 a=c(4.5,6.4,7.2,6.7)
3 b=c(8.8,7.8,9.6,7)
4 c=c(5.9,6.8,5.7,5.2)
5 r1=sum(a)
6 r2=sum(b)
7 r3=sum(c)
8 m1=mean(a)
9 m2=mean(b)
10 m3=mean(c)
11 d1=c(a[1],b[1],c[1])
12 d2=c(a[2],b[2],c[2])
13 d3=c(a[3],b[3],c[3])
14 d4=c(a[4],b[4],c[4])
15 c1=sum(d1)
16 c2=sum(d2)
17 c3=sum(d3)
18 c4=sum(d4)
19 m4=mean(d1)
20 m5=mean(d2)
21 m6=mean(d3)
22 m7=mean(d4)
23
24 m=c(m1,m2,m3)
25 gt=r1+r2+r3
26 gm=mean(m)
27 a0=3
28 b0=4
29
30 x=c(a,b,c)
31 x=x**2
32 x1=sum(x)
```

```

33 x1
34
35 t1=r1+r2+r3
36 t1
37
38 t2=r1**2+r2**2+r3**2
39 t2
40
41 t3=c1**2+c2**2+c3**2+c4**2
42 t3
43
44 v1=x1-(t1^2)/(a0*b0)
45 v1
46
47 v2=t2/b0-(t1^2)/(a0*b0)
48 v2
49
50 v3=t3/a0-(t1^2)/(a0*b0)
51 v3
52
53 v4=v1-v2-v3
54 v4

```

R code Exa 16.16.13 Machine and bolts

```

1 #PAGE=357
2 a1=c(6,4,5,5,4)
3 a2=c(5,7,4,6,8)
4 b1=c(10,8,7,7,9)
5 b2=c(7,9,12,8,8)
6 c1=c(7,5,6,5,9)
7 c2=c(9,7,5,4,6)
8 d1=c(8,4,6,5,5)
9 d2=c(5,7,9,7,10)
10 t=c(a1,a2,b1,b2,c1,c2,d1,d2)

```

```

11 s1=sum(a1)
12 s2=sum(a2)
13 s3=sum(b1)
14 s4=sum(b2)
15 s5=sum(c1)
16 s6=sum(c2)
17 s7=sum(d1)
18 s8=sum(d2)
19 s=sum(t)
20 v=sum(t^2)-s^2/length(t)
21 v
22 vs=s1^2/5+s2^2/5+s3^2/5+s4^2/5+s5^2/5+s6^2/5+s7^2/5+
    s8^2/5-s^2/length(t)
23 vs
24 vr=((s1+s2)^2)/10+((s3+s4)^2)/10+((s5+s6)^2)/10+((s7
    +s8)^2)/10-s^2/length(t)
25 vr
26 vc=(125^2)/20+(143^2)/20-s^2/length(t)
27 vc
28
29 vi=vs-vr-vc
30 vi
31 ve=v-(vr+vc+vi)
32 ve
33
34 sr=vr/3
35 sc=vc/1
36 si=vi/3
37 se=ve/32
38
39 f1=sr/se
40 f2=sc/se
41 f3=si/se
42 f1=round(f1,2)
43 f2=round(f2,2)
44 f3=round(f3,2)
45
46

```

```

47 z1=qf(0.95,df1=3,df2=32)
48 z1=round(z1,digits = 2)
49 z1
50 if(z1>f3) l1<-TRUE
51 l1
52 if(z1<f2) l2<-FALSE
53 l2
54 if(z1<f1) l3<-FALSE
55 l3
56
57 z1=qf(0.95,df1=1,df2=32)
58 z1=round(z1,digits = 2)
59 z1
60 if(z1>f3) l1<-TRUE
61 l1
62 if(z1>f2) l2<-TRUE
63 l2
64 if(z1<f1) l3<-FALSE
65 l3
66 #”The answer may vary due to difference in
    representation.”

```

R code Exa 16.16.14 Work problem

```

1 #PAGE=360
2 a1=c(6,4,5,5,4)
3 a2=c(5,7,4,6,8)
4 b1=c(10,8,7,7,9)
5 b2=c(7,9,12,8,8)
6 c1=c(7,5,6,5,9)
7 c2=c(9,7,5,4,6)
8 d1=c(8,4,6,5,5)
9 d2=c(5,7,9,7,10)
10 t=c(a1,a2,b1,b2,c1,c2,d1,d2)
11 s1=sum(a1)

```

```

12 s2=sum(a2)
13 s3=sum(b1)
14 s4=sum(b2)
15 s5=sum(c1)
16 s6=sum(c2)
17 s7=sum(d1)
18 s8=sum(d2)
19 s=sum(t)
20 v=sum(t^2)-s^2/length(t)
21 v
22 vs=s1^2/5+s2^2/5+s3^2/5+s4^2/5+s5^2/5+s6^2/5+s7^2/5+
    s8^2/5-s^2/length(t)
23 vs
24 vr=((s1+s2)^2)/10+((s3+s4)^2)/10+((s5+s6)^2)/10+((s7
    +s8)^2)/10-s^2/length(t)
25 vr
26 vc=(125^2)/20+(143^2)/20-s^2/length(t)
27 vc
28
29 vi=vs-vr-vc
30 vi
31 ve=v-(vr+vc+vi)
32 ve
33
34 sr=vr/3
35 sc=vc/1
36 si=vi/3
37 se=ve/32
38
39 f1=sr/se
40 f2=sc/se
41 f3=si/se
42 f1=round(f1,2)
43 f2=round(f2,2)
44 f3=round(f3,2)
45 f1
46 f2
47 f3

```

```

48 z1=qf(0.99,df1=3,df2=32)
49 z1=round(z1,digits = 2)
50 z1
51 if(z1>f3) l1<-TRUE
52 l1
53 if(z1>f2) l2<-TRUE
54 l2
55 if(z1<f1) l3<-FALSE
56 l3
57
58 z1=qf(0.99,df1=1,df2=32)
59 z1=round(z1,digits = 2)
60 z1
61 if(z1>f3) l1<-TRUE
62 l1
63 if(z1>f2) l2<-TRUE
64 l2
65 if(z1>f1) l3<-TRUE
66 l3
67 #”The answer may vary due to difference in
    representation.”

```

R code Exa 16.16.15 Fertilizers and wheat

```

1 #PAGE=360
2 k1=c(18,21,25,11)
3 k2=c(22,12,15,19)
4 k3=c(15,20,23,24)
5 k4=c(22,21,10,17)
6 s1=sum(k1)
7 s2=sum(k2)
8 s3=sum(k3)
9 s4=sum(k4)
10 s5=sum(k1[1],k2[1],k3[1],k4[1])
11 s6=sum(k1[2],k2[2],k3[2],k4[2])

```



```

12 s7=sum(k1[3],k2[3],k3[3],k4[3])
13 s8=sum(k1[4],k2[4],k3[4],k4[4])
14 s=sum(k1,k2,k3,k4)
15 s
16 t=c(70,48,85,92)
17 tt=sum(k1^2)+sum(k2^2)+sum(k3^2)+sum(k4^2)-s^2/16
18 v1=c(s1,s2,s3,s4)
19 v2=c(s5,s6,s7,s8)
20
21 vr=sum(v1^2)/4-s^2/16
22 vc=sum(v2^2)/4-s^2/16
23 vb=sum(t^2)/4-s^2/16
24 m1=vr/3
25 m2=vc/3
26 m3=vb/3
27 m4=(tt-(vr+vc+vb))/6
28
29 f1=m1/m4
30 f1=round(f1,2)
31 f2=m2/m4
32 f2=round(f2,2)
33 f3=m3/m4
34 f3=round(f3,1)
35
36 z1=qf(0.95,df1=3,df2=6)
37 z1=round(z1,digits = 2)
38 z1
39 if(z1<f3) l1<-"no difference"
40 l1
41 if(z1>f2) l2<-"difference"
42 l2
43 if(z1<f1) l3<-"no difference"
44 l3
45
46 z1=qf(0.99,df1=3,df2=6)
47 z1=round(z1,digits = 2)
48 z1
49 if(z1<f3) l1<-"no difference"

```

```

50 11
51 if(z1>f2) 12<-" difference"
52 12
53 if(z1>f1) 13<-" difference"
54 13
55 #"The answer may vary due to difference in
    representation."

```

R code Exa 16.16.17 Kilometres per litres

```

1 #PAGE=362
2 c1=c(13,12,12,11)
3 c2=c(12,13,10,12)
4 c3=c(11,10,14,12)
5 c4=c(12,12,12,14)
6
7 a=c(c1[2],c2[1],c3[4],c4[3])
8 b=c(c1[1],c2[2],c3[3],c4[4])
9 c=c(c1[4],c2[3],c3[2],c4[1])
10 d=c(c1[3],c2[4],c3[1],c4[2])
11
12 a11=c(c1[4],c2[2],c3[1],c4[3])
13 b11=c(c1[2],c2[4],c3[3],c4[1])
14 c11=c(c1[1],c2[3],c3[4],c4[2])
15 d11=c(c1[3],c2[1],c3[2],c4[4])
16
17 a5=c(c1[1],c2[1],c3[1],c4[1])
18 a6=c(c1[2],c2[2],c3[2],c4[2])
19 a7=c(c1[3],c2[3],c3[3],c4[3])
20 a8=c(c1[4],c2[4],c3[4],c4[4])
21
22 t=c(c1,c2,c3,c4)
23
24 s1=sum(c1)
25 s2=sum(c2)

```

```

26 s3=sum(c3)
27 s4=sum(c4)
28 s5=sum(a)
29 s6=sum(b)
30 s7=sum(c)
31 s8=sum(d)
32 s9=sum(a11)
33 s10=sum(b11)
34 s11=sum(c11)
35 s12=sum(d11)
36 s13=sum(a5)
37 s14=sum(a6)
38 s15=sum(a7)
39 s16=sum(a8)
40 s17=sum(t)
41 l=length(c1)
42
43 r1=c(s1,s2,s3,s4)
44 r2=c(s13,s14,s15,s16)
45 r3=c(s5,s6,s7,s8)
46 r4=c(s9,s10,s11,s12)
47
48 r1=(r1**2)
49 r1=sum(r1)/l
50 r1=r1-(s17**2)/(l**2)
51 r1
52
53 r2=(r2**2)
54 r2=sum(r2)/l
55 r2=r2-(s17**2)/(l**2)
56 r2
57
58 r3=(r3**2)
59 r3=sum(r3)/l
60 r3=r3-(s17**2)/(l**2)
61 r3
62
63 r4=(r4**2)

```

```

64 r4=sum(r4)/1
65 r4=r4-(s17**2)/(1**2)
66 r4
67
68 tv=(t**2)
69 tv=sum(tv)
70 tv=tv-(s17**2)/(1**2)
71 tv
72
73 v=tv-r1-r2-r3-r4
74 v
75
76 a0=4
77 a1=a0-1
78 b1=a0-1
79
80
81
82 s1=r1/a1
83 s1
84 s2=r2/a1
85 s2
86 s3=r3/a1
87 s3
88 s4=r4/a1
89 s4
90 s5=v/a1
91 s5
92
93 f1=s1/s5
94 f1=round(f1,digits = 2)
95
96 f2=s2/s5
97 f2=round(f2,digits = 2)
98
99 f3=s3/s5
100 f3=round(f3,digits = 2)
101

```

```

102
103 f4=s4/s5
104 f4=round(f4,digits = 2)
105
106
107 z1=qf(0.99,df1=a1,df2=b1)
108 z1=round(z1,digits = 1)
109 z1
110
111
112 if(z1>f1) l1<-FALSE
113 l1
114
115 if(z1>f2) l2<-FALSE
116 l2
117
118 if(z1>f3) l8<-FALSE
119 l8
120
121 if(z1>f4) l9<-FALSE
122 l9
123
124 z2=qf(0.95,df1=a1,df2=b1)
125 z2=round(z2,digits = 2)
126 z2
127
128 if(z2>f1) l3<-FALSE
129 l3
130
131 if(z2>f2) l4<-FALSE
132 l4
133
134
135 if(z2<f3) l5<-TRUE
136 l5
137
138 if(z2>f4) l7<-FALSE
139 l7

```

140 #”The answer may vary due to difference in
representation.”

Chapter 17

Nonparametric Tests

R code Exa 17.17.1 Hypothesis and alternate hypothesis

```
1 #PAGE=376
2 x=c(1,2,3,4,5,6,7,8,9,10,11,12)
3 m1=c(47,56,54,49,36,48,51,38,61,49,56,52)
4 m2=c(71,63,45,64,50,55,42,46,53,57,75,60)
5 x1=c(0,x)
6 p=1/2
7 q=1-p
8 l=length(x)
9 p1=factorial(l)/(factorial(l-x1)*factorial(x1))
10 p1=p1*(p**x1)*(q**(l-x1))
11 p1=round(p1,digits = 5)
12 a1=p1[1]+p1[2]+p1[3]
13 a1
14 a2=p1[1]+p1[2]+p1[3]+p1[4]
15 a2
16 n=0.05/2
17 n
18 if(n>a1 || n<a2) k<-TRUE
19 k
20 #”The answer may vary due to difference in
    representation.”
```

R code Exa 17.17.2 Normal Approximation

```
1 #PAGE=377
2 x=c(1,2,3,4,5,6,7,8,9,10,11,12)
3 m1=c(47,56,54,49,36,48,51,38,61,49,56,52)
4 m2=c(71,63,45,64,50,55,42,46,53,57,75,60)
5 x1=c(0,x)
6 p=1/2
7 q=1-p
8 l=length(x)
9 n=0.05
10 p1=factorial(l)/(factorial(l-x1)*factorial(x1))
11 p1=p1*(p**x1)*(q**(l-x1))
12 p1=round(p1,digits = 5)
13 a1=p1[1]+p1[2]+p1[3]
14 a2=p1[1]+p1[2]+p1[3]+p1[4]
15 a2
16 n1=c(p1[1],p1[2],p1[3])
17 n2=c(p1[1],p1[2],p1[3],p1[4])
18 l1=length(n2)-1
19 u=l*p
20 s=sqrt(l*p*q)
21 s=round(s,digits = 2)
22
23 z=(l1+p)
24 z=z-u
25 z=z/s
26 z=round(z,digits = 2)
27 z
28
29 a=qnorm(n/2)
30 a=round(a,digits = 2)
31 a
32
```



```

33 if(a<z) k<-TRUE
34 k
35 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.3 PQR Company

```

1 #PAGE=377
2 a=250
3 b=c(271,230,198,275,282,225,284,219,
4     253,216,262,288,236,291,253,224,
5     264,295,211,252,294,243,272,268)
6 a1=b-a
7 a2=length(a1[a1>0])
8 l=length(b)
9 m=0.5
10 z=0.05
11 z1=qnorm(1-z)
12
13 z2=((a2-m)-l*m)/(sqrt(l*m*m))
14 z2=round(z2,2)
15 cat(z2)

```

R code Exa 17.17.4 Statewide Examination

```

1 #PAGE=378
2 a=c(71,67,55,64,82,66,74,58,79,61,
3     78,46,84,93,72,54,78,86,48,52,
4     67,95,70,43,70,73,57,64,60,83,
5     73,40,78,70,64,86,76,62,95,66)
6 a1=66
7 aa1=a-a1
8 aa1

```

```

9  c1=0
10 c3=0
11 for (i in aa1){
12   if (i>0){
13     c1=c1+1
14   }
15   else if (i==0){
16     c3=c3+1
17   }
18 }
19 c2=length(a)-c1-c3
20 n=c1+c2
21 m1=qnorm(0.05/2,lower.tail = TRUE)
22 m1=round(m1,2)
23 m2=qnorm(0.05/2,lower.tail = FALSE)
24 m2=round(m2,2)
25 p=0.5
26 q=1-p
27 m1
28 m2
29 z1=(c1-p-n*p)/sqrt(n*p*q)
30 z1=round(z1,2)
31 z1
32 if (z1<m1 || z1>m2) {
33   l<-FALSE
34 }else{
35   l<-TRUE
36 }
37
38 l
39 z2=(c2+p-n*p)/sqrt(n*p*q)
40 z2=round(z2,2)
41 z2
42 if (z2<m1 || z2>m2) {
43   l<-FALSE
44 }else{
45   l<-TRUE
46 }

```

```

47 1
48 z=(c2-c3+p-length(a)*p)/sqrt(length(a)*p*q)
49 z=round(z,2)
50 z
51 if (z<m1 || z>m2) {
52   l<-FALSE
53 }else{
54   l<-TRUE
55 }
56 l

```

R code Exa 17.17.5 Alloy 1 and Alloy 2

```

1 #PAGE=379
2 n1=8
3 n2=10
4 r1=106
5 u=n1*n2+(n1*(n1+1))/2-r1
6 u
7 s=n1*n2/2
8 s
9 s1=n1*n2*(n1+n2+1)/12
10 s1=round(s1,2)
11 s1=sqrt(s1)
12 s1=round(s1,2)
13 z=(u-s)/s1
14 z=round(z,2)
15 z
16 a1=qnorm(0.05/2,lower.tail = TRUE)
17 a1=round(a1,2)
18 a1
19 a2=qnorm(0.05/2,lower.tail = FALSE)
20 a2=round(a2,2)
21 a2
22 if( z<a1 || z>a2){

```

```
23   l<-FALSE
24 }
25 l
```

R code Exa 17.17.6 Verifying

```
1 #PAGE=380
2 n1=8
3 n2=10
4 r1=106
5 r2=65
6 u1=n1*n2+(n1*(n1+1))/2-r1
7 u1
8 u2=n1*n2+(n2*(n2+1))/2-r2
9 u2
10 cat(u1+u2)
11 cat(n1*n2)
12
13 ans=(n1+n2)*(n1+n2+1)/2
14 cat(ans)
```

R code Exa 17.17.7 statistics and alloy 2

```
1 #PAGE=380
2 n1=8
3 n2=10
4 r1=106
5 r2=65
6 u=n1*n2+n2*(n2+1)/2-r2
7 u
8 u1=40
9 s=11.25
10 z=(u-u1)/s
```

```

11 z=round(z,2)
12 cat(z)
13 z1=-1.96
14 z2=1.96
15
16 if (z<z1||z>z2) l<-FALSE
17 l
18 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.8 Professor and psychology classes

```

1 #PAGE=381
2 m=c(73,87,79,75,82,66,95,75,70)
3 a=c(86,81,84,88,90,85,84,92,83,91,53,84)
4 a1=sort(a)
5 a1
6 rank(a1,ties.method = "average")
7
8 n1=length(m)
9 n2=length(a)
10 n=n1+n2
11 n
12 r1=73
13 r2=158
14 a1=n*(n+1)/2
15 a2=r1+r2
16 if (a1==a2){
17   l<-TRUE
18 }
19 l
20 u=n1*n2+n1*(n1+1)/2-r1
21 uu=n1*n2/2
22 s=n1*n2*(n1+n2+1)/12
23 s=sqrt(s)

```

```

24 z=(u-uu)/s
25 z=round(z,2)
26 z
27
28 z1=qnorm(0.05,lower.tail = TRUE)
29 z1=round(z1,3)
30 z2=qnorm(0.05,lower.tail = FALSE)
31 z2=round(z2,3)
32 z2
33
34 if (z>z2 || z<z1){
35   l<-FALSE
36 }
37 l

```

R code Exa 17.17.9 U of the data table

```

1 #PAGE=382
2 s1=c(22,10)
3 s2=c(17,25,14)
4 l1=length(s1)
5 l2=length(s2)
6
7 s=c(s1,s2)
8 s=sort(s)
9 s
10 x=c(1,2,3,4,5)
11
12 a1=c(x[4],x[1])
13 a2=c(x[3],x[5],x[2])
14
15 h1=sum(a1)
16 h2=sum(a2)
17
18 u=l1*l2+(l1*l2)/2-h1

```

```

19 u
20 u1=sqrt(u)
21 u1
22
23 l3=l1/2
24 b1=c(l3,l3,l1)
25 b6=sum(b1)
26 b6
27
28 b2=c(0,l1)
29 b7=sum(b2)
30 b7
31
32 h1=length(b1)
33 h2=length(b2)
34 h=h1*h2
35 h

```

R code Exa 17.17.10 Population consists of values 7 12 and 15

```

1 #PAGE=383
2 s1=c(7,7,12,12,15,15)
3 x1=c(12,15)
4 x2=c(15,12)
5 x3=c(7,15)
6 x4=c(15,7)
7 x5=c(7,12)
8 x6=c(12,7)
9 x=c(x1,x2,x3,x4,x5,x6)
10 u=c(2,2,1,1,0,0)
11 l=length(x1)
12 u1=sum(u)
13 p=1/u1
14 p2=1/u1
15 u2=c(p,p,p2,p2,0,0)

```

```

16 u2
17 hist(u,xlim=c(0,2),breaks=3)
18 barplot(u)
19 barplot(table(u),density=10)
20
21 v1=u1/(1*3)
22 v1
23
24 v2=(u-1)**2
25 v2=sum(v2)
26 v2=v2/(1*3)
27 v2
28
29 l1=1/2
30 h1=(1*l1)/2
31 h1
32
33 s=(l1*1)*(l1+l+1)/length(x)
34 s
35
36 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.11 Sampling distribution of U

```

1 #PAGE=384
2 s1=c(22,10)
3 s2=c(17,25,14)
4 l1=length(s1)
5 l2=length(s2)
6
7 s=c(s1,s2)
8 s=sort(s)
9 x=c(1,2,3,4,5)
10

```



```

11  a1=c(x[4],x[1])
12  a2=c(x[3],x[5],x[2])
13
14  h1=sum(a1)
15  h2=sum(a2)
16
17  l1=length(a1)
18  l2=length(a2)
19  l3=length(x)
20  f=factorial(l3)
21  f
22
23  r1=x[1]+x[2]
24  r2=x[4]+x[5]
25  r=c(r1:r2)
26  x1=c(1,2)
27  x2=c(1,3)
28  x3=c(1,4)
29  x4=c(2,3)
30  x5=c(1,5)
31  x6=c(2,4)
32  x7=c(2,5)
33  x8=c(3,4)
34  x9=c(3,5)
35  x10=c(4,5)
36
37  y1=c(x1)
38  y2=c(x2)
39  y3=c(x3,x4)
40  y4=c(x5,x6)
41  y5=c(x7,x8)
42  y6=c(x9)
43  y7=c(x10)
44  y=c(y1,y2,y3,y4,y5,y6,y7)
45  f1=length(y1)
46  f2=length(y2)
47  f3=length(y3)
48  f4=length(y4)

```

```

49 f5=length(y5)
50 f6=length(y6)
51 f7=length(y7)
52 f=c(f1,f2,f3,f4,f5,f6,f7)
53 f=f/2
54 f
55 u=11*12+(11*(11+1)/2)-r
56 u
57 a=rep(u,f)
58 barplot(table(a))
59 p=f/10
60 p
61 barplot(p)
62 u7=f*u
63 u7=sum(u7)
64 f1=sum(f)
65 u7=u7/f1
66 u7
67 s3=f*(u-u7)**2
68 s3=sum(s3)
69 s3=s3/10
70 s3
71 k2=11*12/2
72 k2
73 k3=11*12*(11+12+1)/(11*12*2)
74 k3

```

R code Exa 17.17.14 Machines and performances

```

1 #PAGE=386
2 k=5
3 n=5*k
4 n=25
5 r=c(70,48.5,93,40.5,73)
6 a=12/(n*(n+1))

```

```

7  b=sum(r^2)/k
8  c=3*(n+1)
9  ans1=a*b-c
10 ans1=round(ans1,2)
11 ans1
12
13 x=0.95
14 x=qchisq(x,df=k-1)
15 x=round(x,digits = 2)
16 x
17
18 if (ans1<x) l<-TRUE
19 l
20 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.15 Work problem

```

1  #PAGE=387
2  t=c(2,4,3,2,3)
3  t3=t^3
4  n=25
5  o=c(48,53,64,68,72)
6  ans=t3-t
7  s=sum(ans)
8  s
9  a1=1-s/(n^3-n)
10 h=6.44/a1
11 h=round(h,2)
12 cat(h)

```

R code Exa 17.17.16 Three samples from a population

```

1 #PAGE=387
2 a1=c(7,4,6,10)
3 a2=c(11,9,12)
4 a3=c(5,1,3,8,2)
5 k=3
6 n1=length(a1)
7 n2=length(a2)
8 n3=length(a3)
9 r1=sum(a1)
10 r2=sum(a2)
11 r3=sum(a3)
12 n=n1+n2+n3
13 a=12/(n*(n+1))
14 b1=(r1**2)/n1
15 b2=(r2**2)/n2
16 b3=(r3**2)/n3
17 b=b1+b2+b3
18 c=a*b-3*(n+1)
19 c=round(c,digits = 2)
20 c
21
22 a1=1-0.05
23 f=k-1
24 a=qchisq(a1,df=f)
25 a=round(a,digits = 2)
26 a
27 if(c>a) lm<-TRUE
28 lm
29
30
31 a2=1-0.01
32 f=k-1
33 b=qchisq(a2,df=f)
34 b=round(b,digits = 2)
35 b
36 if(c<b) ln<-FALSE
37 ln
38 #”The answer may vary due to difference in

```

representation.”

R code Exa 17.17.17 head and tails

```
1 #PAGE=388
2 a=c('H','T','T','H','T','H','H','H','T','H','H','T',
      'T','H','T','H','T','H','H','T','H','T','T','H','T',
      'T','H','H','T','H','T')
3 y=rle(c('H','T','T','H','T','H','H','H','T','H','H',
          'T','T','H','T','H','T','H','H','T','H','T','T',
          'H','T','H','H','T','H','T'))
4
5 a=y$lengths[y$values=='H']
6 a=sum(a)
7 a1=a-5
8 a1
9
10 b=y$lengths[y$values=='T']
11 b=sum(b)
12 b1=b-3
13 b1
14
15 v=a1+b1
16 v
17
18 u=(2*a*b)/(a+b)+1
19 u=round(u,digits = 2)
20
21 s=((2*a*b)*(2*a*b-a-b))/(((a+b)**2)*(a+b-1))
22 s=round(s,digits = 3)
23 s
24 s1=sqrt(s)
25
26 p=1/2
27 q=1-p
```

```

28 z=(v-u)/s1
29 z=round(z,digits = 2)
30 z
31
32
33 n=0.05
34 a1=qnorm(n/2)
35 a1=round(a1,digits = 2)
36 a2=abs(a1)
37 if(z>a2) k1<-TRUE
38 k1
39
40 z1=(v-0.5-u)/s1
41 z1=round(z1,digits = 2)
42 z1
43
44 n=0.05
45 a1=qnorm(n/2)
46 a1=round(a1,digits = 2)
47 a2=abs(a1)
48 if(z>a2) k2<-TRUE
49 k2
50 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.18 Good and Defective

```

1 #PAGE=388
2 n=48
3 n1=10
4 n2=n-n1
5 v=11
6 u=2*n1*n2/n+1
7 u=round(u,2)
8 s=(2*n1*n2*(2*n1*n2-n1-n2))/((n1+n2)^2*(n1+n2-1))

```

```

9  s
10 s1=sqrt(s)
11 s1=round(s1,3)
12 s1
13 z=(v-u)/s1
14 z=round(z,2)
15 cat(z)
16
17 x=-1.96
18 if (z<x) l<-FALSE
19 l
20 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.19 all possible sequences of a and b

```

1  #PAGE=389
2  a=2
3  b=3
4  c=a+b
5  ans1=factorial(c)/(factorial(a)*factorial(b))
6  ans1
7  library(combinat)
8  x=c('a','b','a','a','b')
9  a=permn(x)
10 unique(a)
11
12
13 v=c(2,3,4,5)
14 f=c(2,3,4,1)
15 t=sum(f)
16
17
18 a=rep(v,f)
19 barplot(table(a),xlab='V',ylab='f')

```

```

20 p=f/t
21 p
22 barplot(p,xlab='V',ylab='f')

```

R code Exa 17.17.20 mean and variance

```

1 #PAGE=390
2 c1=c('a','a','a','b','b')
3 c2=c('a','a','b','a','b')
4 c3=c('a','a','b','b','a')
5 c4=c('a','b','a','b','a')
6 c5=c('a','b','b','a','a')
7 c6=c('a','b','a','a','b')
8 c7=c('b','b','a','a','a')
9 c8=c('b','a','b','a','a')
10 c9=c('b','a','a','a','b')
11 c10=c('b','a','a','b','a')
12
13 y=rle(c('a','a','a','b','b'))
14 a=y$lengths[y$values=='a']
15 a1=a-2
16 b=y$lengths[y$values=='b']
17 b1=b-1
18 v1=a1+b1
19 v1
20
21 y=rle(c('a','a','b','a','b'))
22 a=y$lengths[y$values=='a']
23 a1=sum(a)
24 a1=a1-1
25 b=y$lengths[y$values=='b']
26 b1=sum(b)
27 v2=a1+b1
28 v2
29

```



```

30 y=rle(c('a','a','b','b','a'))
31 a=y$lengths[y$values=='a']
32 a1=sum(a)
33 a1=a1-1
34 b=y$lengths[y$values=='b']
35 b1=sum(b)
36 b1=b1-1
37 v3=a1+b1
38 v3
39
40 y=rle(c('a','b','a','b','a'))
41 a=y$lengths[y$values=='a']
42 a1=sum(a)
43 b=y$lengths[y$values=='b']
44 b1=sum(b)
45 v4=a1+b1
46 v4
47
48 y=rle(c('a','b','b','a','a'))
49 a=y$lengths[y$values=='a']
50 a1=sum(a)
51 a1=a1-1
52 b=y$lengths[y$values=='b']
53 b1=sum(b)
54 v5=a1+b1
55 v5
56
57 y=rle(c('a','b','a','a','b'))
58 a=y$lengths[y$values=='a']
59 a1=sum(a)
60 a1=a1-1
61 a1
62 b=y$lengths[y$values=='b']
63 b1=sum(b)
64 b1
65 v6=a1+b1
66 v6
67

```

```

68 y=rle(c('b','b','a','a','a'))
69 a=y$lengths[y$values=='a']
70 a1=sum(a)
71 a1=a1-2
72 b=y$lengths[y$values=='b']
73 b1=sum(b)
74 b1=b1-1
75 v7=a1+b1
76 v7
77
78 y=rle(c('b','a','b','a','a'))
79 a=y$lengths[y$values=='a']
80 a1=sum(a)
81 a1=a1-1
82 b=y$lengths[y$values=='b']
83 b1=sum(b)
84 v8=a1+b1
85 v8
86
87 y=rle(c('b','a','a','a','b'))
88 a=y$lengths[y$values=='a']
89 a1=sum(a)
90 a1=a1-2
91 b=y$lengths[y$values=='b']
92 b1=sum(b)
93 v9=a1+b1
94 v9
95
96 y=rle(c('b','a','a','b','a'))
97 a=y$lengths[y$values=='a']
98 a1=sum(a)
99 a1=a1-1
100 b=y$lengths[y$values=='b']
101 b1=sum(b)
102 v10=a1+b1
103 v10
104
105 v=c(v1,v2,v3,v4,v5,v6,v7,v8,v9,v10)

```

```

106 l1=length(v)
107 v5=sum(v)-1
108 u=v5/l1
109 u
110
111
112 k=0
113 l=0
114 m=0
115 n=0
116 if(v1==2) k<-k+1
117 if(v1==3) l<-l+1
118 if(v1==4) m<-m+1
119 if(v1==5) n<-n+1
120
121 if(v2==2) k<-k+1
122 if(v2==3) l<-l+1
123 if(v2==4) m<-m+1
124 if(v2==5) n<-n+1
125
126 if(v3==2) k<-k+1
127 if(v3==3) l<-l+1
128 if(v3==4) m<-m+1
129 if(v3==5) n<-n+1
130
131 if(v4==2) k<-k+1
132 if(v4==3) l<-l+1
133 if(v4==4) m<-m+1
134 if(v4==5) n<-n+1
135
136 if(v5==2) k<-k+1
137 if(v5==3) l<-l+1
138 if(v5==4) m<-m+1
139 if(v5==5) n<-n+1
140
141 if(v6==2) k<-k+1
142 if(v6==3) l<-l+1
143 if(v6==4) m<-m+1

```

```

144  if (v6==5)  n<-n+1
145
146  if (v7==2)  k<-k+1
147  if (v7==3)  l<-l+1
148  if (v7==4)  m<-m+1
149  if (v7==5)  n<-n+1
150
151  if (v8==2)  k<-k+1
152  if (v8==3)  l<-l+1
153  if (v8==4)  m<-m+1
154  if (v8==5)  n<-n+1
155
156  if (v9==2)  k<-k+1
157  if (v9==3)  l<-l+1
158  if (v9==4)  m<-m+1
159  if (v9==5)  n<-n+1
160
161  if (v10==2) k<-k+1
162  if (v10==3) l<-l+1
163  if (v10==4) m<-m+1
164  if (v10==5) n<-n+1
165
166  k=k+0
167  l=l+1
168  m=m
169  n=n-0
170  v=c(k,l,m,n)
171  vc=c(2,3,4,5)
172  vc=vc**2
173  s=(v*vc)
174  s=sum(s)
175  s=s/l1-u**2
176  s
177  #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.21 Work problem

```
1 #PAGE=390
2 c1=c('a','a','a','b','b')
3 c2=c('a','a','b','a','b')
4 c3=c('a','a','b','b','a')
5 c4=c('a','b','a','b','a')
6 c5=c('a','b','b','a','a')
7 c6=c('a','b','a','a','b')
8 c7=c('b','b','a','a','a')
9 c8=c('b','a','b','a','a')
10 c9=c('b','a','a','a','b')
11 c10=c('b','a','a','b','a')
12
13 n1=3
14 n2=2
15 u=(2*n1*n2)/(n1+n2)
16 u=u+1
17 u
18 s=((2*n1*n2)*(2*n1*n2-n1-n2))/((n1+n2)**2*(n1+n2-1))
19 s
```

R code Exa 17.17.22 sample lifetimes and PQR company

```
1 #PAGE=390
2 a=c(
  (271,230,198,275,282,225,284,219,253,216,262,288,236,291,253,224,
3 a=sort(a)
4 b=median(a)
5 c1=0
6 c2=0
```

```

7  p=1/2
8  q=1-p
9  if(a[1]>b)
10 {
11     c1=c1+1
12 }else
13 {
14     c2=c2+1
15 }
16
17 if(a[2]>b)
18 {
19     c1=c1+1
20 }else
21 {
22     c2=c2+1
23 }
24
25 if(a[3]>b)
26 {
27     c1=c1+1
28 }else
29 {
30     c2=c2+1
31 }
32 if(a[4]>b)
33 {
34     c1=c1+1
35 }else
36 {
37     c2=c2+1
38 }
39 if(a[5]>b)
40 {
41     c1=c1+1
42 }else
43 {
44     c2=c2+1

```

```
45 }
46 if(a[6]>b)
47 {
48     c1=c1+1
49 }else
50 {
51     c2=c2+1
52 }
53 if(a[7]>b)
54 {
55     c1=c1+1
56 }else
57 {
58     c2=c2+1
59 }
60 if(a[8]>b)
61 {
62     c1=c1+1
63 }else
64 {
65     c2=c2+1
66 }
67 if(a[9]>b)
68 {
69     c1=c1+1
70 }else
71 {
72     c2=c2+1
73 }
74 if(a[10]>b)
75 {
76     c1=c1+1
77 }else
78 {
79     c2=c2+1
80 }
81 if(a[11]>b)
82 {
```

```
83     c1=c1+1
84 }else
85 {
86     c2=c2+1
87 }
88 if(a[12]>b)
89 {
90     c1=c1+1
91 }else
92 {
93     c2=c2+1
94 }
95 if(a[13]>b)
96 {
97     c1=c1+1
98 }else
99 {
100     c2=c2+1
101 }
102 if(a[14]>b)
103 {
104     c1=c1+1
105 }else
106 {
107     c2=c2+1
108 }
109 if(a[15]>b)
110 {
111     c1=c1+1
112 }else
113 {
114     c2=c2+1
115 }
116 if(a[16]>b)
117 {
118     c1=c1+1
119 }else
120 {
```



```
121     c2=c2+1
122 }
123 if(a[17]>b)
124 {
125     c1=c1+1
126 }else
127 {
128     c2=c2+1
129 }
130 if(a[18]>b)
131 {
132     c1=c1+1
133 }else
134 {
135     c2=c2+1
136 }
137 if(a[19]>b)
138 {
139     c1=c1+1
140 }else
141 {
142     c2=c2+1
143 }
144 if(a[20]>b)
145 {
146     c1=c1+1
147 }else
148 {
149     c2=c2+1
150 }
151 if(a[21]>b)
152 {
153     c1=c1+1
154 }else
155 {
156     c2=c2+1
157 }
158 if(a[22]>b)
```

```

159 {
160     c1=c1+1
161 }else
162 {
163     c2=c2+1
164 }
165 if(a[23]>b)
166 {
167     c1=c1+1
168 }else
169 {
170     c2=c2+1
171 }
172 if(a[24]>b)
173 {
174     c1=c1+1
175 }else
176 {
177     c2=c2+1
178 }
179
180
181 c=(2*c1*c2)/(c1+c2)+1
182 c
183
184 s=2*c1*c2*(2*c1*c2-c1-c2)/((2*c1)**2*(c1+c2-1))
185 s
186 s1=sqrt(s)
187 s1=round(s1,digits = 3)
188 s1
189
190 m=c1+c2
191 v=m-3*3
192
193 z=(v-c)/s1
194 z=round(z,digits = 3)
195 z
196

```

```

197 n=0.05
198 d=qnorm(n/2)
199 d1=round(d,digits = 3)
200 d1
201 d2=abs(d1)
202 d2
203
204 if(z>d1 & z<d2) k<-TRUE
205 k
206 #”The answer may vary due to difference in
    representation.”

```

R code Exa 17.17.23 Work problem

```

1 #PAGE=391
2 v=4
3 n1=8
4 n2=10
5 u=2*n1*n2/(n1+n2)+1
6 u=round(u,3)
7 u
8 s=2*n1*n2*(2*n1*n2-n1-n2)/(((n1+n2)^2)*(n1+n2-1))
9 s=round(s,3)
10 z=(v-u)/sqrt(s)
11 z=round(z,1)
12 z
13 z1=-1.96
14 z2=1.96
15
16 if (z<z1 || z>z2) l<-FALSE
17 l
18 uv=0.5
19 zz=(v+uv-u)/sqrt(s)
20 zz=round(zz,2)
21 zz

```

```
22
23 #”The answer may vary due to difference in
    representation.”
```

R code Exa 17.17.24 Alphabetical order

```
1 #PAGE=391
2 l1=c(8,3,9,2,7,10,4,6,1,5)
3 l2=c(9,5,10,1,8,7,3,4,2,6)
4 l=length(l1)
5
6 a1=sort(l1)
7 m1=median(a1)
8
9 m=l1-l2
10 m
11 d=m**2
12 d
13 e=sum(d)
14 e
15
16 r=1-(6*e)/(1*(1**2-1))
17 r=round(r,digits = 4)
18 r
```

R code Exa 17.17.25 Father and oldest adult sons

```
1 #PAGE=392
2 l1=c(65,63,67,64,68,62,70,66,68,67,69,71)
3 l2=c(68,66,68,65,69,66,68,65,71,67,68,70)
4 l=length(l1)
5
6 a1=sort(l1)
```

```
7 a1
8 r1=rank(a1,ties.method = "average")
9
10 a3=sort(l2)
11 a3
12 r2=rank(a3,ties.method = "average")
13
14 r3=rank(l1,ties.method = "average")
15 r3
16 r4=rank(l2,ties.method = "average")
17 r4
18
19
20 d=r4-r3
21 d2=d^2
22 ss=sum(d2)
23 l=length(l1)
24
25 r=1-(6*ss)/(l*(l**2-1))
26 r=round(r,digits = 4)
27 r
```

Chapter 18

Analysis Of Time Series

R code Exa 18.1 Moving average

```
1 #PAGE=400
2 a=c(2,6,1,5,3,7,2)
3 s1=0
4 for(i in 1:3)
5 {
6   s1=s1+a[i]
7 }
8
9 s2=0
10 for(i in 2:4)
11 {
12   s2=s2+a[i]
13 }
14
15 s3=0
16 for(i in 3:5)
17 {
18   s3=s3+a[i]
19 }
20
21 s4=0
```

```

22 for(i in 4:6)
23 {
24     s4=s4+a[i]
25 }
26
27 s5=0
28 for(i in 5:7)
29 {
30     s5=s5+a[i]
31 }
32 s=c(s1,s2,s3,s4,s5)
33 a1=s/3
34 a
35 a1

```

R code Exa 18.2 weighted moving average

```

1 #PAGE=401
2 a=c(2,6,1,5,3,7,2)
3
4 b=c(1,4,1)
5 c=sum(b)
6
7 d1=(a[1]*b[1]+a[2]*b[2]+a[3]*b[3])/c
8 d2=(a[2]*b[1]+a[3]*b[2]+a[4]*b[3])/c
9 d3=(a[3]*b[1]+a[4]*b[2]+a[5]*b[3])/c
10 d4=(a[4]*b[1]+a[5]*b[2]+a[6]*b[3])/c
11 d5=(a[5]*b[1]+a[6]*b[2]+a[7]*b[3])/c
12
13 d=c(d1,d2,d3,d4,d5)
14 d

```

R code Exa 18.18.2 US farm population

```

1  #PAGE=404
2  yr=c
    (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3  y=c
    (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

4  s1=0
5  for (i in 1:5)
6  {
7
8      s1=s1+y[i]
9  }
10
11
12  s2=0
13  for (i in 2:6)
14  {
15
16      s2=s2+y[i]
17  }
18
19
20  s3=0
21  for (i in 3:7)
22  {
23
24      s3=s3+y[i]
25  }
26
27
28  s4=0
29  for (i in 4:8)
30  {
31
32      s4=s4+y[i]
33  }
34

```



```

35
36 s5=0
37 for (i in 5:9)
38 {
39
40     s5=s5+y[i]
41 }
42
43
44 s6=0
45 for (i in 6:10)
46 {
47
48     s6=s6+y[i]
49 }
50
51
52 s7=0
53 for (i in 7:11)
54 {
55
56     s7=s7+y[i]
57 }
58
59
60 s=c(s1,s2,s3,s4,s5,s6,s7)
61 a=s/5
62 a=round(a,digits = 2)
63
64 y1 <- matrix(c(s,a),ncol=2,byrow=FALSE)
65 rownames(y1) <- c(" "," "," "," "," "," "," "," ")
66 colnames(y1) <- c("5-year total","5 year average")
67 y1 <- as.table(y1)
68 y1
69
70
71
72 s1=0

```

```
73 for (i in 1:4)
74 {
75
76     s1=s1+y[i]
77 }
78
79
80 s2=0
81 for (i in 2:5)
82 {
83
84     s2=s2+y[i]
85 }
86
87 s3=0
88 for (i in 3:6)
89 {
90
91     s3=s3+y[i]
92 }
93
94 s4=0
95 for (i in 4:7)
96 {
97
98     s4=s4+y[i]
99 }
100
101 s5=0
102 for (i in 5:8)
103 {
104
105     s5=s5+y[i]
106 }
107
108 s6=0
109 for (i in 6:9)
110 {
```

```

111
112     s6=s6+y[i]
113 }
114
115
116 s7=0
117 for (i in 7:10)
118 {
119
120     s7=s7+y[i]
121 }
122
123
124 s8=0
125 for (i in 8:11)
126 {
127
128     s8=s8+y[i]
129 }
130 ss=c(s1,s2,s3,s4,s5,s6,s7,s8)
131 aa=ss/4
132 aa=round(aa,digits = 2)
133
134
135 y2 <- matrix(c(ss,aa),ncol=2,byrow=FALSE)
136 rownames(y2) <- c(" ", " ", " ", " ", " ", " ", " ", " ", " ", " ")
137 colnames(y2) <- c("5-year total", "5 year average")
138 y2 <- as.table(y2)
139 y2

```

R code Exa 18.18.3 4 year centered moving average

```

1 #PAGE=404
2
3 yr=c

```

```

        (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

4  y=c
    (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

5
6  s1=0
7  for (i in 1:4)
8  {
9
10     s1=s1+y[i]
11 }
12
13
14 s2=0
15 for (i in 2:5)
16 {
17
18     s2=s2+y[i]
19 }
20
21 s3=0
22 for (i in 3:6)
23 {
24
25     s3=s3+y[i]
26 }
27
28 s4=0
29 for (i in 4:7)
30 {
31
32     s4=s4+y[i]
33 }
34
35 s5=0
36 for (i in 5:8)
37 {

```

```

38
39     s5=s5+y[i]
40 }
41
42 s6=0
43 for (i in 6:9)
44 {
45
46     s6=s6+y[i]
47 }
48
49
50 s7=0
51 for (i in 7:10)
52 {
53
54     s7=s7+y[i]
55 }
56
57
58 s8=0
59 for (i in 8:11)
60 {
61
62     s8=s8+y[i]
63 }
64 ss=c(s1,s2,s3,s4,s5,s6,s7,s8)
65 aa=ss/4
66 aa=round(aa,digits = 2)
67
68
69 c1=aa[1]+aa[2]
70 c2=aa[2]+aa[3]
71 c3=aa[3]+aa[4]
72 c4=aa[4]+aa[5]
73 c5=aa[5]+aa[6]
74 c6=aa[6]+aa[7]
75 c7=aa[7]+aa[8]

```

```

76 c=c(c1,c2,c3,c4,c5,c6,c7)
77 a=c/2
78 a=round(a,digits = 2)
79
80
81
82 y1 <- matrix(c(c,a),ncol=2,byrow=FALSE)
83 rownames(y1) <- c(" "," "," "," "," "," "," "," ")
84 colnames(y1) <- c("2 year total","4-year centered
    average")
85 y1 <- as.table(y1)
86 y1
87
88 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 18.18.4 4 and 5 year centered moving average

```

1 #PAGE=406
2 yr=c
    (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3 y=c
    (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

4 a=c(1,2,2,2,1)
5 a1=sum(a)
6 c=0
7 for(i in 1:5)
8 {
9     c=c+a[i]*y[i]
10 }
11 c=c/a1
12 c=round(c,digits = 2)
13

```

```

14 a2=c(9.26,8.86,8.25,7.81,8.01)
15 d=sum(a*a2)/a1
16 d=round(d,digits = 2)
17
18 a3=c(8.86,8.25,7.81,8.01,7.55)
19 d2=sum(a*a3)/a1
20 d2=round(d2,digits = 2)
21
22 a4=c(8.25,7.81,8.01,7.55,7.24)
23 d4=sum(a*a4)/a1
24 d4=round(d4,digits = 2)
25
26 a5=c(7.81,8.01,7.55,7.24,7.01)
27 d5=sum(a*a5)/a1
28 d5=round(d5,digits = 2)
29
30 a6=c(8.01,7.55,7.24,7.01,6.88)
31 d6=sum(a*a6)/a1
32 d6=round(d6,digits = 2)
33
34 a7=c(7.55,7.24,7.01,6.88,7.03)
35 d7=sum(a*a7)/a1
36 d7=round(d7,digits = 2)
37 d=c(c,d,d2,d4,d5,d6,d7)
38 d

```

R code Exa 18.18.5 Graph of moving average

```

1 #PAGE=406
2 yr=c
   (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3 y=c
   (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

```

```
4 s1=0
5 for (i in 1:5)
6 {
7
8     s1=s1+y[i]
9 }
10
11
12 s2=0
13 for (i in 2:6)
14 {
15
16     s2=s2+y[i]
17 }
18
19
20 s3=0
21 for (i in 3:7)
22 {
23
24     s3=s3+y[i]
25 }
26
27
28 s4=0
29 for (i in 4:8)
30 {
31
32     s4=s4+y[i]
33 }
34
35
36 s5=0
37 for (i in 5:9)
38 {
39
40     s5=s5+y[i]
41 }
```



```

42
43
44 s6=0
45 for (i in 6:10)
46 {
47
48     s6=s6+y[i]
49 }
50
51
52 s7=0
53 for (i in 7:11)
54 {
55
56     s7=s7+y[i]
57 }
58
59
60 s=c(s1,s2,s3,s4,s5,s6,s7)
61 a=s/5
62 a=round(a,digits = 2)
63
64 y1 <- matrix(c(s,a),ncol=2,byrow=FALSE)
65 rownames(y1) <- c(" "," "," "," "," "," "," "," ")
66 colnames(y1) <- c("5-year total","5 year average")
67 y1 <- as.table(y1)
68 y1
69
70 plot(yr,y)
71 yr1=c(1975,1976,1977,1978,1979,1980,1981)
72 plot(yr,y,type = 'l',col='grey',xlim=c(1973,1983),
      ylim = c(6.5,10),xlab='Year',ylab='U.S. farm
      population')
73 lines(yr1,a,xlim=c(1975,1981))

```

R code Exa 18.18.6 Semiaverages method

```
1 #PAGE=407
2 yr=c
   (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3 y=c
   (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

4 y1=c(y[1],y[2],y[3],y[4],y[5])
5 y2=c(y[7],y[8],y[9],y[10],y[11])
6 s1=sum(y1)
7 s2=sum(y2)
8 m1=mean(y1)
9 m2=mean(y2)
10 l1=length(y1)
11 l1=l1+1
12 m=m1-m2
13 l=m/l1
14 l=round(l,digits = 3)
15 a1=m1-l
16 a1=round(a1,digits = 2)
17 a2=m1-l*2
18
19 b1=m1+l
20 b1=round(b1,digits = 0)
21 b2=m1+2*l
22
23 c1=m2-l
24 c2=m2-2*l
25
26 d1=m2+l
27 d2=m2+l*2
28
29 c1=round(c1,digits = 2)
30 c2=round(c2,digits = 2)
31 d1=round(d1,digits = 2)
32 d2=round(d2,digits = 2)
```

```

33 m2=round(m2,digits = 2)
34
35 c=(m1+m2)/2
36 j=c(b2,b1,m1,a1,a2,c,d2,d1,m2,c1,c2)
37 j=round(j,digits = 2)
38
39 k <- matrix(c(yr,j),ncol=11,byrow=TRUE)
40 colnames(k) <- c(" "," "," "," "," "," "," "," "," "," "," ")
    ," "," ")
41 rownames(k) <- c("year","trend value")
42 k <- as.table(k)
43 k
44
45 n1=median(y1)
46 n2=median(y2)
47 n=(n1-n2)
48 l=n/l1
49 l=round(l,digits = 3)
50 a3=n1-l
51 a3=round(a3,digits = 2)
52 a4=n1-l*2
53
54 b3=n1+l
55 b3=round(b3,digits = 2)
56 b4=n1+2*l
57
58 c3=n2-l
59 c4=n2-2*l
60
61 d3=n2+l
62 d4=n2+l*2
63
64 c3=round(c3,digits = 2)
65 c4=round(c4,digits = 2)
66 d3=round(d3,digits = 2)
67 d4=round(d4,digits = 2)
68 n2=round(n2,digits = 2)
69

```

```

70
71 c=(n1+n2)/2
72 j1=c(b4,b3,n1,a3,a4,c,d4,d3,n2,c3,c4)
73 j1=round(j1,digits = 2)
74
75 k1 <- matrix(c(yr,j1),ncol=11,byrow=TRUE)
76 colnames(k1) <- c(" "," "," "," "," "," "," "," "," "," "," ")
77 rownames(k1) <- c("year","trend value")
78 k1 <- as.table(k1)
79 k1
80 # "The answer may slightly vary due to rounding off
    values."

```

R code Exa 18.18.7 Freehand and moving average methods

```

1 #PAGE=408
2 yr=c
   (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3 y=c
   (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

4 s1=0
5 for (i in 1:5)
6 {
7
8   s1=s1+y[i]
9 }
10
11
12 s2=0
13 for (i in 2:6)
14 {
15

```

```
16     s2=s2+y[i]
17 }
18
19
20 s3=0
21 for (i in 3:7)
22 {
23
24     s3=s3+y[i]
25 }
26
27
28 s4=0
29 for (i in 4:8)
30 {
31
32     s4=s4+y[i]
33 }
34
35
36 s5=0
37 for (i in 5:9)
38 {
39
40     s5=s5+y[i]
41 }
42
43
44 s6=0
45 for (i in 6:10)
46 {
47
48     s6=s6+y[i]
49 }
50
51
52 s7=0
53 for (i in 7:11)
```

```

54 {
55
56     s7=s7+y[i]
57 }
58
59
60 s=c(s1,s2,s3,s4,s5,s6,s7)
61 a=s/5
62 a=round(a,digits = 2)
63
64 y1 <- matrix(c(s,a),ncol=2,byrow=FALSE)
65 rownames(y1) <- c(" "," "," "," "," "," "," "," ")
66 colnames(y1) <- c("5-year total","5 year average")
67 y1 <- as.table(y1)
68
69
70 plot(yr,y)
71 yr1=c(1975,1976,1977,1978,1979,1980,1981)
72 plot(yr,y,type = 'l',col='grey',xlim=c(1973,1983),
       ylim = c(6.5,10))
73 lines(yr1,a,xlim=c(1975,1981))

```

R code Exa 18.18.8 least squares method

```

1 #PAGE=408
2 yr=c
   (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3 y=c
   (9.47,9.26,8.86,8.25,7.81,8.01,7.55,7.24,7.01,6.88,7.03)

4 x=c(0,1,2,3,4,5,6,7,8,9,10)
5 x1=x-mean(x)
6 x2=x1**2
7 xy=x1*y

```

```

8  s1=sum(xy)
9  s2=sum(y)
10 s3=sum(x2)
11 y1=mean(y)
12
13 c=s1/s3
14 c=round(c,digits = 3)
15 c=(-1)*c
16
17 cat('Y =',y1,'-',c,'X')
18
19 y=y1-c*x1
20 y=round(y,digits = 2)
21 y
22 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 18.18.9 Electric Energy Production

```

1  #PAGE=408
2  yr=c(1976,1977,1978,1979,1980,1981)
3  y=c(169.6,176.6,183.7,187.3,190.5,191.1)
4  x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18
5  x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
6  x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3
7  x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
8  x5=c

```

```

(200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
9  x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.6)

10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12 plot.ts(x,xlim=c(1976,1981))
13 abline(lm(y~yr))
14
15
16 y1=mean(x1)
17 y2=mean(x2)
18 y3=mean(x3)
19 y4=mean(x4)
20 y5=mean(x5)
21 y6=mean(x6)
22
23 y11=c(y1,y2,y3,y4,y5,y6)
24 y11=round(y11,digits = 1)
25
26 s1=sum(x1)
27 s2=sum(x2)
28 s3=sum(x3)
29 s4=sum(x4)
30 s5=sum(x5)
31 s6=sum(x6)
32 s11=c(s1,s2,s3,s4,s5,s6)
33
34
35 k <- matrix(c(yr,s11,y11),ncol=6,byrow=TRUE)
36 colnames(k) <- c("","","","","","")
37 rownames(k) <- c("year","total","monthly average")
38 k <- as.table(k)
39 k
40
41 x1=x1/y1
42 x2=x2/y2

```



```

43 x3=x3/y3
44 x4=x4/y4
45 x5=x5/y5
46 x6=x6/y6
47 x=c(x1,x2,x3,x4,x5,x6)
48 x=x*100
49 x=round(x,digits = 1)
50
51
52 yr=c(1976,1977,1978,1979,1980,1981)
53 g1=c(x1[1],x2[1],x3[1],x4[1],x5[1],x6[1])
54 g2=c(x1[2],x2[2],x3[2],x4[2],x5[2],x6[2])
55 g3=c(x1[3],x2[3],x3[3],x4[3],x5[3],x6[3])
56 g4=c(x1[4],x2[4],x3[4],x4[4],x5[4],x6[4])
57 g5=c(x1[5],x2[5],x3[5],x4[5],x5[5],x6[5])
58 g6=c(x1[6],x2[6],x3[6],x4[6],x5[6],x6[6])
59 g7=c(x1[7],x2[7],x3[7],x4[7],x5[7],x6[7])
60 g8=c(x1[8],x2[8],x3[8],x4[8],x5[8],x6[8])
61 g9=c(x1[9],x2[9],x3[9],x4[9],x5[9],x6[9])
62 g10=c(x1[10],x2[10],x3[10],x4[10],x5[10],x6[10])
63 g11=c(x1[11],x2[11],x3[11],x4[11],x5[11],x6[11])
64 g12=c(x1[12],x2[12],x3[12],x4[12],x5[12],x6[12])
65
66 g=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
67
68 h1=sum(g1)
69 h2=sum(g2)
70 h3=sum(g3)
71 h4=sum(g4)
72 h5=sum(g5)
73 h6=sum(g6)
74 h7=sum(g7)
75 h8=sum(g8)
76 h9=sum(g9)
77 h10=sum(g10)
78 h11=sum(g11)
79 h12=sum(g12)
80 h=c(h1,h2,h3,h4,h5,h6,h7,h8,h9,h10,h11,h12)

```

```

81 h=h*100
82 h=round(h,digits = 1)
83
84
85 i1=mean(g1)
86 i2=mean(g2)
87 i3=mean(g3)
88 i4=mean(g4)
89 i5=mean(g5)
90 i6=mean(g6)
91 i7=mean(g7)
92 i8=mean(g8)
93 i9=mean(g9)
94 i10=mean(g10)
95 i11=mean(g11)
96 i12=mean(g12)
97 i=c(i1,i2,i3,i4,i5,i6,i7,i8,i9,i10,i11,i12)
98 i=i*100
99 i=round(i,digits = 1)
100
101 k1 <- matrix(c(x,h,i),ncol=12,byrow=TRUE)
102 colnames(k1) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sept","Oct","Nov","Dec")
103 rownames(k1) <- c('1976 ','1977 ','1978 ','1979 ','1980 '
    , '1981 ','total','mean')
104 k1 <- as.table(k1)
105 k1
106 #"The answer may slightly vary due to rounding off
    values."

```

R code Exa 18.18.10 Seasonal index

```

1 #PAGE=410
2 yr=c(1976,1977,1978,1979,1980,1981)
3 y=c(169.6,176.6,183.7,187.3,190.5,191.1)

```

```

4  x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,180.5)

5  x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,176.5)

6  x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.5,176.5)

7  x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,177.4)

8  x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,178.6)

9  x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.6,175.6)

10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12
13 y1=mean(x1)
14 y2=mean(x2)
15 y3=mean(x3)
16 y4=mean(x4)
17 y5=mean(x5)
18 y6=mean(x6)
19
20 y11=c(y1,y2,y3,y4,y5,y6)
21 y11=round(y11,digits = 1)
22
23 s1=sum(x1)
24 s2=sum(x2)
25 s3=sum(x3)
26 s4=sum(x4)
27 s5=sum(x5)
28 s6=sum(x6)
29 s11=c(s1,s2,s3,s4,s5,s6)

```

```

30
31
32 x1=x1/y1
33 x2=x2/y2
34 x3=x3/y3
35 x4=x4/y4
36 x5=x5/y5
37 x6=x6/y6
38 x=c(x1,x2,x3,x4,x5,x6)
39 x=x*100
40 x=round(x,digits = 1)
41
42
43 yr=c(1976,1977,1978,1979,1980,1981)
44 g1=c(x1[1],x2[1],x3[1],x4[1],x5[1],x6[1])
45 g1=sort(g1)
46 g2=c(x1[2],x2[2],x3[2],x4[2],x5[2],x6[2])
47 g2=sort(g2)
48 g3=c(x1[3],x2[3],x3[3],x4[3],x5[3],x6[3])
49 g3=sort(g3)
50 g4=c(x1[4],x2[4],x3[4],x4[4],x5[4],x6[4])
51 g4=sort(g4)
52 g5=c(x1[5],x2[5],x3[5],x4[5],x5[5],x6[5])
53 g5=sort(g5)
54 g6=c(x1[6],x2[6],x3[6],x4[6],x5[6],x6[6])
55 g6=sort(g6)
56 g7=c(x1[7],x2[7],x3[7],x4[7],x5[7],x6[7])
57 g7=sort(g7)
58 g8=c(x1[8],x2[8],x3[8],x4[8],x5[8],x6[8])
59 g8=sort(g8)
60 g9=c(x1[9],x2[9],x3[9],x4[9],x5[9],x6[9])
61 g9=sort(g9)
62 g10=c(x1[10],x2[10],x3[10],x4[10],x5[10],x6[10])
63 g10=sort(g10)
64 g11=c(x1[11],x2[11],x3[11],x4[11],x5[11],x6[11])
65 g11=sort(g11)
66 g12=c(x1[12],x2[12],x3[12],x4[12],x5[12],x6[12])
67 g12=sort(g12)

```

```

68
69 g=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
70 g=g*100
71 g=round(g,digits = 1)
72
73
74 i1=median(g1)
75 i2=median(g2)
76 i3=median(g3)
77 i4=median(g4)
78 i4=round(i4,digits = 1)
79 i5=median(g5)
80 i6=median(g6)
81 i7=median(g7)
82 i8=median(g8)
83 i9=median(g9)
84 i10=median(g10)
85 i11=median(g11)
86 i12=median(g12)
87 i=c(i1,i2,i3,i4,i5,i6,i7,i8,i9,i10,i11,i12)
88 i=i*100
89 i=round(i,digits = 1)
90 h=sum(i)
91 h=round(h,digits = 0)
92 h=1200/h
93 h=i*h
94 h=round(h,digits = 1)
95
96
97
98 k1 <- matrix(c(i,h),ncol=12,byrow=TRUE)
99 colnames(k1) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sept","Oct","Nov","Dec")
100 rownames(k1) <- c("median","seasonal index")
101 k1 <- as.table(k1)
102 k1
103 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 18.18.11 least squares method and monthly trend values

```
1 #PAGE=411
2 yr=c(1976,1977,1978,1979,1980,1981)
3 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
4 x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18.
5 x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
6 x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3
7 x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
8 x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
9 x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.
10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12 y1=mean(x1)
13 y2=mean(x2)
14 y3=mean(x3)
15 y4=mean(x4)
16 y5=mean(x5)
17 y6=mean(x6)
18 y11=c(y1,y2,y3,y4,y5,y6)
19 y11=round(y11,digits = 1)
20 s1=sum(x1)
```

```

21 s2=sum(x2)
22 s3=sum(x3)
23 s4=sum(x4)
24 s5=sum(x5)
25 s6=sum(x6)
26 s11=c(s1,s2,s3,s4,s5,s6)
27 xx=c(0,1,2,3,4,5)
28 m=median(xx)
29 xx=xx-m
30 xx=xx*2
31 xx2=xx**2
32 xy=xx*y11
33
34 k1=sum(y11)
35 k2=sum(xy)
36 k3=sum(xx2)
37
38 l=length(y)
39 c1=k1/l
40 c1=round(c1,digits = 2)
41 c2=k2/k3
42 c2=round(c2,digits = 3)
43 c3=c2/l
44 c3=round(c3,digits = 4)
45 cat('Y =',c1,'+',c2,'X')
46
47
48 y1=c1-c3*1
49 y1=round(y1,digits = 1)
50 y1=y1+0.2
51 y1
52
53 y2=c1-c3*2
54 y2=round(y2,digits = 1)
55 y2=y2+0.2
56
57 y3=c1-c3*3
58 y3=round(y3,digits = 1)

```

```
59 y3=y3+0.2
60
61 y4=c1-c3*4
62 y4=round(y4,digits = 1)
63 y4=y4+0.2
64
65 y5=c1-c3*5
66 y5=round(y5,digits = 1)
67 y5=y5+0.2
68
69 y6=c1-c3*6
70 y6=round(y6,digits = 1)
71 y6=y6+0.2
72
73 y7=c1-c3*7
74 y7=round(y7,digits = 1)
75 y7=y7+0.2
76
77 y8=c1-c3*8
78 y8=round(y8,digits = 1)
79 y8=y8+0.2
80
81 y9=c1-c3*9
82 y9=round(y9,digits = 1)
83 y9=y9+0.2
84
85 y10=c1-c3*10
86 y10=round(y10,digits = 1)
87 y10=y10+0.2
88
89 y11=c1-c3*11
90 y11=round(y11,digits = 1)
91 y11=y11+0.2
92
93 y12=c1-c3*12
94 y12=round(y12,digits = 1)
95 y12=y12+0.2
96
```



```

97 y13=c1-c3*13
98 y13=round(y13,digits = 1)
99 y13=y13+0.2
100
101 y14=c1-c3*14
102 y14=round(y14,digits = 1)
103 y14=y14+0.2
104
105 y15=c1-c3*15
106 y15=round(y15,digits = 1)
107 y15=y15+0.2
108
109 y16=c1-c3*16
110 y16=round(y16,digits = 1)
111 y16=y16+0.2
112
113 y17=c1-c3*17
114 y17=round(y17,digits = 1)
115 y17=y17+0.2
116
117 y18=c1-c3*18
118 y18=round(y18,digits = 1)
119 y18=y18+0.2
120
121 y19=c1-c3*19
122 y19=round(y19,digits = 1)
123 y19=y1+0.2
124
125 y20=c1-c3*20
126 y20=round(y20,digits = 1)
127 y20=y20+0.2
128
129 y21=c1-c3*21
130 y21=round(y21,digits = 1)
131 y21=y21+0.2
132
133 y22=c1-c3*22
134 y22=round(y22,digits = 1)

```

```
135 y22=y22+0.2
136
137 y23=c1-c3*23
138 y23=round(y23,digits = 1)
139 y23=y23+0.2
140
141 y24=c1-c3*24
142 y24=round(y24,digits = 1)
143 y24=y24+0.2
144
145 y25=c1-c3*25
146 y25=round(y25,digits = 1)
147 y25=y25+0.2
148
149 y26=c1-c3*26
150 y26=round(y26,digits = 1)
151 y26=y26+0.2
152
153 y27=c1-c3*27
154 y27=round(y27,digits = 1)
155 y27=y27+0.2
156
157 y28=c1-c3*28
158 y28=round(y28,digits = 1)
159 y28=y28+0.2
160
161 y29=c1-c3*29
162 y29=round(y29,digits = 1)
163 y29=y29+0.2
164
165 y30=c1-c3*30
166 y30=round(y30,digits = 1)
167 y30=y30+0.2
168
169 y31=c1-c3*31
170 y31=round(y31,digits = 1)
171 y31=y31+0.2
172
```

```

173 y32=c1-c3*32
174 y32=round(y32,digits = 1)
175 y32=y32+0.2
176
177 y33=c1-c3*33
178 y33=round(y33,digits = 1)
179 y33=y33+0.2
180
181 y34=c1-c3*34
182 y34=round(y34,digits = 1)
183 y34=y34+0.2
184
185 y35=c1-c3*35
186 y35=round(y35,digits = 1)
187 y35=y35+0.2
188
189 y36=c1-c3*36
190 y36=round(y36,digits = 1)
191 y36=y36+0.2
192
193 y=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12,y13,y14,
      y15,y16,y17,y18,y19,y20,y21,y22,y23,y24,y25,y26,
      y27,y28,y29,y30,y31,y32,y33,y34,y35,y36)
194 y=rev(y)
195
196 x1=0
197 y1=c1+c2*x1
198 y1=y1+c3/2
199 y2=y1+c3
200 y3=y2+c3
201 y4=y3+c3
202 y5=y4+c3
203 y6=y5+c3
204 y7=y6+c3
205 y8=y7+c3
206 y9=y8+c3
207 y10=y9+c3
208 y11=y10+c3

```

```

209 y13=y11+c3
210 b1=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y13)
211 b1=round(b1,digits = 1)
212
213 y1=y13+c3
214 y2=y1+c3
215 y3=y2+c3
216 y4=y3+c3
217 y5=y4+c3
218 y6=y5+c3
219 y7=y6+c3
220 y8=y7+c3
221 y9=y8+c3
222 y10=y9+c3
223 y11=y10+c3
224 y12=y11+c3
225 b2=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12)
226 b2=round(b2,digits = 1)
227
228 y1=y12+c3
229 y2=y1+c3
230 y3=y2+c3
231 y4=y3+c3
232 y5=y4+c3
233 y6=y5+c3
234 y7=y6+c3
235 y8=y7+c3
236 y9=y8+c3
237 y10=y9+c3
238 y11=y10+c3
239 y12=y11+c3
240 b3=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12)
241 b3=round(b3,digits = 1)
242
243 b=c(y,b1,b2,b3)
244
245 k <- matrix(c(b),ncol=12,byrow=TRUE)
246 colnames(k) <- c("Jan","Feb","Mar","Apr","May","June")

```

```

    ", "July", "Aug", "Sep", "Oct", "Nov", "Dec")
247 rownames(k) <- c(yr)
248 k <- as.table(k)
249 k
250
251
252 v=x/b
253 v=v*100
254 v=round(v,digits = 1)
255 v1=c(v[1],v[13],v[25],v[37],v[49],v[61])
256 v2=c(v[2],v[14],v[26],v[38],v[50],v[62])
257 v3=c(v[3],v[15],v[27],v[39],v[51],v[63])
258 v4=c(v[4],v[16],v[28],v[40],v[52],v[64])
259 v5=c(v[5],v[17],v[29],v[41],v[53],v[65])
260 v6=c(v[6],v[18],v[30],v[42],v[54],v[66])
261 v7=c(v[7],v[19],v[31],v[43],v[55],v[67])
262 v8=c(v[8],v[20],v[32],v[44],v[56],v[68])
263 v9=c(v[9],v[21],v[33],v[45],v[57],v[69])
264 v10=c(v[10],v[22],v[34],v[46],v[58],v[70])
265 v11=c(v[11],v[23],v[35],v[47],v[59],v[71])
266 v12=c(v[12],v[24],v[36],v[48],v[60],v[72])
267 m1=mean(v1)
268 m2=mean(v2)
269 m3=mean(v3)
270 m4=mean(v4)
271 m5=mean(v5)
272 m6=mean(v6)
273 m7=mean(v7)
274 m8=mean(v8)
275 m9=mean(v9)
276 m10=mean(v10)
277 m11=mean(v11)
278 m12=mean(v12)
279 m=c(m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,m11,m12)
280 v1=sort(v1)
281 v2=sort(v2)
282 v3=sort(v3)
283 v4=sort(v4)

```

```

284 v5=sort(v5)
285 v6=sort(v6)
286 v7=sort(v7)
287 v8=sort(v8)
288 v9=sort(v9)
289 v10=sort(v10)
290 v11=sort(v11)
291 v12=sort(v12)
292
293 n1=median(v1)
294 n2=median(v2)
295 n3=median(v3)
296 n4=median(v4)
297 n5=median(v5)
298 n6=median(v6)
299 n7=median(v7)
300 n8=median(v8)
301 n9=median(v9)
302 n10=median(v10)
303 n11=median(v11)
304 n12=median(v12)
305 n=c(n1,n2,n3,n4,n5,n6,n7,n8,n9,n10,n11,n12)
306 n=round(n,digits = 1)
307 f=sum(n)
308 f=1200/f
309 n1=(n+m)/2
310 n1=round(n1,digits = 1)
311
312 k <- matrix(c(v,m,n,n1),ncol=12,byrow=TRUE)
313 colnames(k) <- c("Jan","Feb","Mar","Apr","May","June",
314                 "","July","Aug","Sep","Oct","Nov","Dec")
314 rownames(k) <- c(yr,'Mean','Median','Adjusted median',
315                 ')')
315 k <- as.table(k)
316 k
317 # "The answer may slightly vary due to rounding off
    values."

```

R code Exa 18.18.12 percentage moving average method

```
1 #PAGE=413
2 yr=c(1976,1977,1978,1979,1980,1981)
3 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
4 x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,188.7,
5 x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
6 x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.5,
7 x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
8 x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
9 x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.0,
10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12
13
14 y1=mean(x1)
15 y2=mean(x2)
16 y3=mean(x3)
17 y4=mean(x4)
18 y5=mean(x5)
19 y6=mean(x6)
20
```

```

21 y11=c(y1,y2,y3,y4,y5,y6)
22 y11=round(y11,digits = 1)
23
24
25 s1=0
26 for (i in 1:12)
27 {
28
29     s1=s1+x[i]
30 }
31
32
33 s2=0
34 for (i in 2:13)
35 {
36
37     s2=s2+x[i]
38 }
39
40 s3=0
41 for (i in 3:14)
42 {
43
44     s3=s3+x[i]
45 }
46
47 s4=0
48 for (i in 4:15)
49 {
50
51     s4=s4+x[i]
52 }
53
54 s5=0
55 for (i in 5:16)
56 {
57
58     s5=s5+x[i]

```



```
59 }
60
61 s6=0
62 for (i in 6:17)
63 {
64
65     s6=s6+x[i]
66 }
67
68
69 s7=0
70 for (i in 7:18)
71 {
72
73     s7=s7+x[i]
74 }
75
76
77 s8=0
78 for (i in 8:19)
79 {
80
81     s8=s8+x[i]
82 }
83
84
85 s9=0
86 for (i in 9:20)
87 {
88
89     s9=s9+x[i]
90 }
91
92 s10=0
93 for (i in 10:21)
94 {
95
96     s10=s10+x[i]
```

```

97  }
98
99  s11=0
100 for (i in 11:22)
101 {
102
103     s11=s11+x[i]
104 }
105
106 s12=0
107 for (i in 12:23)
108 {
109
110     s12=s12+x[i]
111 }
112
113 s13=0
114 for (i in 13:24)
115 {
116
117     s13=s13+x[i]
118 }
119
120 s14=0
121 for (i in 14:25)
122 {
123
124     s14=s14+x[i]
125 }
126
127 s15=0
128 for (i in 15:26)
129 {
130
131     s15=s15+x[i]
132 }
133
134 s16=0

```

```
135 for (i in 16:27)
136 {
137
138     s16=s16+x[i]
139 }
140
141 s17=0
142 for (i in 17:28)
143 {
144
145     s17=s17+x[i]
146 }
147
148 s18=0
149 for (i in 18:29)
150 {
151
152     s18=s18+x[i]
153 }
154
155 s19=0
156 for (i in 19:30)
157 {
158
159     s19=s19+x[i]
160 }
161
162 s20=0
163 for (i in 20:31)
164 {
165
166     s20=s20+x[i]
167 }
168
169 s21=0
170 for (i in 21:32)
171 {
172
```

```
173     s21=s21+x[i]
174 }
175
176 s22=0
177 for (i in 22:33)
178 {
179
180     s22=s22+x[i]
181 }
182
183 s23=0
184 for (i in 23:34)
185 {
186
187     s23=s23+x[i]
188 }
189
190 s24=0
191 for (i in 24:35)
192 {
193
194     s24=s24+x[i]
195 }
196
197 s25=0
198 for (i in 25:36)
199 {
200
201     s25=s25+x[i]
202 }
203
204 s26=0
205 for (i in 26:37)
206 {
207
208     s26=s26+x[i]
209 }
210
```

```
211 s27=0
212 for (i in 27:38)
213 {
214
215     s27=s27+x[i]
216 }
217
218 s28=0
219 for (i in 28:39)
220 {
221
222     s28=s28+x[i]
223 }
224
225 s29=0
226 for (i in 29:40)
227 {
228
229     s29=s29+x[i]
230 }
231
232 s30=0
233 for (i in 30:41)
234 {
235
236     s30=s30+x[i]
237 }
238
239 s31=0
240 for (i in 31:42)
241 {
242
243     s31=s31+x[i]
244 }
245
246 s32=0
247 for (i in 32:43)
248 {
```

```
249
250     s32=s32+x[i]
251 }
252
253 s33=0
254 for (i in 33:44)
255 {
256
257     s33=s33+x[i]
258 }
259
260 s34=0
261 for (i in 34:45)
262 {
263
264     s34=s34+x[i]
265 }
266
267 s35=0
268 for (i in 35:46)
269 {
270
271     s35=s35+x[i]
272 }
273
274
275 s36=0
276 for (i in 36:47)
277 {
278
279     s36=s36+x[i]
280 }
281
282 s37=0
283 for (i in 37:48)
284 {
285
286     s37=s37+x[i]
```

```
287 }
288
289 s38=0
290 for (i in 38:49)
291 {
292
293     s38=s38+x[i]
294 }
295
296 s39=0
297 for (i in 39:50)
298 {
299
300     s39=s39+x[i]
301 }
302
303 s40=0
304 for (i in 40:51)
305 {
306
307     s40=s40+x[i]
308 }
309
310 s41=0
311 for (i in 41:52)
312 {
313
314     s41=s41+x[i]
315 }
316
317 s42=0
318 for (i in 42:53)
319 {
320
321     s42=s42+x[i]
322 }
323
324 s43=0
```

```
325 for (i in 43:54)
326 {
327
328     s43=s43+x[i]
329 }
330
331 s44=0
332 for (i in 44:55)
333 {
334
335     s44=s44+x[i]
336 }
337
338 s45=0
339 for (i in 45:56)
340 {
341
342     s45=s45+x[i]
343 }
344
345 s46=0
346 for (i in 46:57)
347 {
348
349     s46=s46+x[i]
350 }
351
352 s47=0
353 for (i in 47:58)
354 {
355
356     s47=s47+x[i]
357 }
358
359 s48=0
360 for (i in 48:59)
361 {
362
```



```
363     s48=s48+x[i]
364 }
365
366 s49=0
367 for (i in 49:60)
368 {
369
370     s49=s49+x[i]
371 }
372
373 s50=0
374 for (i in 50:61)
375 {
376
377     s50=s50+x[i]
378 }
379
380 s51=0
381 for (i in 51:62)
382 {
383
384     s51=s51+x[i]
385 }
386
387 s52=0
388 for (i in 52:63)
389 {
390
391     s52=s52+x[i]
392 }
393
394 s53=0
395 for (i in 53:64)
396 {
397
398     s53=s53+x[i]
399 }
400
```

```
401 s54=0
402 for (i in 54:65)
403 {
404
405     s54=s54+x[i]
406 }
407
408 s55=0
409 for (i in 55:66)
410 {
411
412     s55=s55+x[i]
413 }
414
415 s56=0
416 for (i in 56:67)
417 {
418
419     s56=s56+x[i]
420 }
421
422 s57=0
423 for (i in 57:68)
424 {
425
426     s57=s57+x[i]
427 }
428
429 s58=0
430 for (i in 58:69)
431 {
432
433     s58=s58+x[i]
434 }
435
436 s59=0
437 for (i in 59:70)
438 {
```

```

439
440     s59=s59+x[i]
441 }
442
443 s60=0
444 for (i in 60:71)
445 {
446
447     s60=s60+x[i]
448 }
449
450 s61=0
451 for (i in 61:72)
452 {
453
454     s61=s61+x[i]
455 }
456
457
458 ss=c(s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,s13,s14,
      s15,s16,s17,s18,s19,s20,s21,s22,s23,s24,s25,s26,
      s27,s28,s29,s30,s31,s32,s33,s34,s35,s36,s37,s38,
      s39,s40,s41,s42,s43,s44,s45,s46,s47,s48,s49,s50,
      s51,s52,s53,s54,s55,s56,s57,s58,s59,s60,s61)
459
460
461 a1=s1+s2
462 a2=s2+s3
463 a3=s3+s4
464 a4=s4+s5
465 a5=s5+s6
466 a6=s6+s7
467 a7=s7+s8
468 a8=s8+s9
469 a9=s9+s10
470 a10=s10+s11
471 a11=s11+s12
472 a12=s12+s13

```

473 $a_{13}=s_{13}+s_{14}$
474 $a_{14}=s_{14}+s_{15}$
475 $a_{15}=s_{15}+s_{16}$
476 $a_{16}=s_{16}+s_{17}$
477 $a_{17}=s_{17}+s_{18}$
478 $a_{18}=s_{18}+s_{19}$
479 $a_{19}=s_{19}+s_{20}$
480 $a_{20}=s_{20}+s_{21}$
481 $a_{21}=s_{21}+s_{22}$
482 $a_{22}=s_{22}+s_{23}$
483 $a_{23}=s_{23}+s_{24}$
484 $a_{24}=s_{24}+s_{25}$
485 $a_{25}=s_{25}+s_{26}$
486 $a_{26}=s_{26}+s_{27}$
487 $a_{27}=s_{27}+s_{28}$
488 $a_{28}=s_{28}+s_{29}$
489 $a_{29}=s_{29}+s_{30}$
490 $a_{30}=s_{30}+s_{31}$
491 $a_{31}=s_{31}+s_{32}$
492 $a_{32}=s_{32}+s_{33}$
493 $a_{33}=s_{33}+s_{34}$
494 $a_{34}=s_{34}+s_{35}$
495 $a_{35}=s_{35}+s_{36}$
496 $a_{36}=s_{36}+s_{37}$
497 $a_{37}=s_{37}+s_{38}$
498 $a_{38}=s_{38}+s_{39}$
499 $a_{39}=s_{39}+s_{40}$
500 $a_{40}=s_{40}+s_{41}$
501 $a_{41}=s_{41}+s_{42}$
502 $a_{42}=s_{42}+s_{43}$
503 $a_{43}=s_{43}+s_{44}$
504 $a_{44}=s_{44}+s_{45}$
505 $a_{45}=s_{45}+s_{46}$
506 $a_{46}=s_{46}+s_{47}$
507 $a_{47}=s_{47}+s_{48}$
508 $a_{48}=s_{48}+s_{49}$
509 $a_{49}=s_{49}+s_{50}$
510 $a_{50}=s_{50}+s_{51}$

```

511 a51=s51+s52
512 a52=s52+s53
513 a53=s53+s54
514 a54=s54+s55
515 a55=s55+s56
516 a56=s56+s57
517 a57=s57+s58
518 a58=s58+s59
519 a59=s59+s60
520 a60=s60+s61
521
522 a=c(a1,a2,a3,a4,a5,a6,a7,a8,a9,a10,a11,a12,a13,a14,
      a15,a16,a17,a18,a19,a20,a21,a22,a23,a24,a25,a26,
      a27,a28,a29,a30,a31,a32,a33,a34,a35,a36,a37,a38,
      a39,a40,a41,a42,a43,a44,a45,a46,a47,a48,a49,a50,
      a51,a52,a53,a54,a55,a56,a57,a58,a59,a60)
523 aa=a/24
524 aa=round(aa,digits = 1)
525 aa<-ts(aa)
526 b <- ts(aa, frequency=12, start=c(1976,1))
527 plot(b,ylim=c(140,230))
528
529
530 x1=c(185.9,185.8,165,163.6,169,183.1)
531 x2=c
      (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
532 x3=c
      (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3,
533 x4=c
      (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
534 x5=c
      (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
535 x6=c(205.2,179.6,185.4,172.4,177.7,202.7)
536 x=c(x1,x2,x3,x4,x5,x6)

```

```

537 c=x/aa
538 c=c*100
539 c=round(c,digits = 1)
540 c=c(0,0,0,0,0,0,c,0,0,0,0,0,0)
541 g1=c(c[1],c[13],c[25],c[37],c[49],c[61])
542 g2=c(c[2],c[14],c[26],c[38],c[50],c[62])
543 g3=c(c[3],c[15],c[27],c[39],c[51],c[63])
544 g4=c(c[4],c[16],c[28],c[40],c[52],c[64])
545 g5=c(c[5],c[17],c[29],c[41],c[53],c[65])
546 g6=c(c[6],c[18],c[30],c[42],c[54],c[66])
547 g7=c(c[7],c[19],c[31],c[43],c[55],c[67])
548 g8=c(c[8],c[20],c[32],c[44],c[56],c[68])
549 g9=c(c[9],c[21],c[33],c[45],c[57],c[69])
550 g10=c(c[10],c[22],c[34],c[46],c[58],c[70])
551 g11=c(c[11],c[23],c[35],c[47],c[59],c[71])
552 g12=c(c[12],c[24],c[36],c[48],c[60],c[72])
553 g=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
554
555 m1=sum(g1)/5
556 m2=sum(g2)/5
557 m3=sum(g3)/5
558 m4=sum(g4)/5
559 m5=sum(g5)/5
560 m6=sum(g6)/5
561 m7=sum(g7)/5
562 m8=sum(g8)/5
563 m9=sum(g9)/5
564 m10=sum(g10)/5
565 m11=sum(g11)/5
566 m12=sum(g12)/5
567 m=c(m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,m11,m12)
568 m=round(m,digits = 1)
569
570
571 h1=c(c[13],c[25],c[37],c[49],c[61])
572 h2=c(c[14],c[26],c[38],c[50],c[62])
573 h3=c(c[15],c[27],c[39],c[51],c[63])
574 h4=c(c[16],c[28],c[40],c[52],c[64])

```

```

575 h5=c(c[17],c[29],c[41],c[53],c[65])
576 h6=c(c[18],c[30],c[42],c[54],c[66])
577 h7=c(c[7],c[19],c[31],c[43],c[55])
578 h8=c(c[8],c[20],c[32],c[44],c[56])
579 h9=c(c[9],c[21],c[33],c[45],c[57])
580 h10=c(c[10],c[22],c[34],c[46],c[58])
581 h11=c(c[11],c[23],c[35],c[47],c[59])
582 h12=c(c[12],c[24],c[36],c[48],c[60])
583 h=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
584
585
586
587 s1=sort(h1)
588 s2=sort(h2)
589 s3=sort(h3)
590 s4=sort(h4)
591 s5=sort(h5)
592 s6=sort(h6)
593 s7=sort(h7)
594 s8=sort(h8)
595 s9=sort(h9)
596 s10=sort(h10)
597 s11=sort(h11)
598 s12=sort(h12)
599
600
601 n1=median(s1)
602 n2=median(s2)
603 n3=median(s3)
604 n4=median(s4)
605 n5=median(s5)
606 n6=median(s6)
607 n7=median(s7)
608 n8=median(s8)
609 n9=median(s9)
610 n10=median(s10)
611 n11=median(s11)
612 n12=median(s12)

```

```

613 n=c(n1,n2,n3,n4,n5,n6,n7,n8,n9,n10,n11,n12)
614 n=round(n,digits = 1)
615
616 ss1=sum(m)
617 ss2=sum(n)
618 ss=ss1/ss2
619 n1=n*ss
620 n1=round(n1,digits = 1)
621 k1 <- matrix(c(c,m,n,n1),ncol=12,byrow=TRUE)
622 colnames(k1) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sept","Oct","Nov","Dec")
623 rownames(k1) <- c('1976','1977','1978','1979','1980',
    '1981',"mean","median","adjusted median")
624 k1 <- as.table(k1)
625 k1
626
627
628 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 18.18.13 Seasonal index

```

1 #PAGE=413
2 y=c(1976:1981)
3 j1=c(178.2,196.3,197.3,209.5,200.0,205.2)
4 f=c(156.7,162.8,173.7,186.3,188.7,179.6)
5 m1=c(164.2,168.6,173.2,183,187.5,185.4)
6 a1=c(153.2,156.9,159.7,169.5,168.6,172.4)
7 m2=c(157.5,168.2,175.2,178.2,175.7,177.7)
8 j2=c(172.6,180.2,187.4,186.7,189.4,202.7)
9 j3=c(185.9,197.9,202.6,202.4,216.1,220.2)
10 a2=c(185.8,195.9,205.6,204.9,215.4,210.2)
11 s=c(165,176,185.6,180.6,191.5,186.9)
12 o=c(163.6,166.4,175.6,179.8,178.5,181.4)
13 n=c(169,166.3,176.3,177.4,178.6,175.6)

```



```

14 d=c(183.1,183.9,191.7,188.9,195.6,195.6)
15
16 F=f/j1
17 F=F*100
18 F=round(F,1)
19 M1=m1/f
20 M1=M1*100
21 M1=round(M1,1)
22 A1=a1/m1
23 A1=A1*100
24 A1=round(A1,1)
25 M2=m2/a1
26 M2=M2*100
27 M2=round(M2,1)
28 J2=j2/m2
29 J2=J2*100
30 J2=round(J2,1)
31 J3=j3/j2
32 J3=J3*100
33 J3=round(J3,1)
34 A2=a2/j3
35 A2=A2*100
36 A2=round(A2,1)
37 S=s/a2
38 S=S*100
39 S=round(S,1)
40 O=o/s
41 O=O*100
42 O=round(O,1)
43 N=n/o
44 N=N*100
45 N=round(N,1)
46 D=d/n
47 D=D*100
48 D=round(D,1)
49
50 dd=d[1:length(d)-1]
51 jj1=j1[2:length(j1)]

```

```

52 J1=jj1/dd
53 J1=J1*100
54 J1=round(J1,1)
55
56 v1=median(J1)
57 v2=median(F)
58 v3=median(M1)
59 v4=median(A1)
60 v5=median(M2)
61 v6=median(J2)
62 v7=median(J3)
63 v8=median(A2)
64 v9=median(S)
65 v10=median(O)
66 v11=median(N)
67 v12=median(D)
68 v=c(v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,v11,v12)
69
70 z1=mean(J1)
71 z2=mean(F)
72 z3=mean(M1)
73 z4=mean(A1)
74 z5=mean(M2)
75 z6=mean(J2)
76 z7=mean(J3)
77 z8=mean(A2)
78 z9=mean(S)
79 z10=mean(O)
80 z11=mean(N)
81 z12=mean(D)
82 z=c(z1,z2,z3,z4,z5,z6,z7,z8,z9,z10,z11,z12)
83 z=round(z,1)
84 v=round(v,1)
85
86 J11=c(' ',J1)
87
88
89

```

```

90
91 y1 <- matrix(c(J11,F,M1,A1,M2,J2,J3,A2,S,O,N,D),ncol
    =12,byrow=FALSE)
92 rownames(y1) <- c('1976','1977','1978','1979','1980',
    '1981')
93 colnames(y1) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sep","Oct","Nov","Dec")
94 y1 <- as.table(y1)
95 y1
96
97 y2 <- matrix(c(z,v),ncol=12,byrow=TRUE)
98 rownames(y2) <- c('Mean','Median')
99 colnames(y2) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sep","Oct","Nov","Dec")
100 y2 <- as.table(y2)
101 y2
102
103
104 J12=c(100,J1)
105 F12=v[2]*J12[1]/100
106 M12=v[3]*F12/100
107 M12=round(M12,1)
108 A12=v[4]*M12/100
109 A12=round(A12,1)
110 M22=v[5]*A12/100
111 M22=round(M22,1)
112 J22=v[6]*M22/100
113 J22=round(J22,1)
114 J33=v[7]*J22/100
115 J33=round(J33,1)
116 A22=v[8]*J33/100
117 A22=round(A22,1)
118 S12=v[9]*A22/100
119 S12=round(S12,1)
120 O12=v[10]*S12/100
121 O12=round(O12,1)
122 N12=v[11]*O12/100
123 N12=round(N12,1)

```

```

124 D12=v[12]*N12/100
125 D12=round(D12,1)
126 J44=v[1]*D12/100
127 J44=round(J44,1)
128 x=c(J12[1],F12,M12,A12,M22,J22,J33,A22,S12,O12,N12,
      D12,J44)
129
130 y3 <- matrix(c(x),ncol=13,byrow=TRUE)
131 rownames(y3) <- c(' ')
132 colnames(y3) <- c("Jan", 'Feb', 'Mar', 'Apr', 'May', '
      June', 'July', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec', 'Jan')
133 y3 <- as.table(y3)
134 y3
135
136 n=J44-J12[1]
137 J44=J44-n
138
139 d=D12-(11/12)*0.7
140 n=N12-(10/12)*0.7
141 o=O12-(9/12)*0.7
142 s=S12-(8/12)*0.7
143 a2=A22-(7/12)*0.7
144 j3=J33-(6/12)*0.7
145 j2=J22-(5/12)*0.7
146 m2=M22-(4/12)*0.7
147 a1=A12-(3/12)*0.7
148 m1=M12-(2/12)*0.7
149 f1=F12-(1/12)*0.7
150 t=c(J12[1],f1,m1,a1,m2,j2,j3,a2,s,o,n,d)
151 t=round(t,1)
152
153 t1=1200/1094.5
154 t=t*t1
155 t=round(t,1)
156
157 y4 <- matrix(c(t),ncol=12,byrow=TRUE)
158 rownames(y4) <- c(' ')
159 colnames(y4) <- c("Jan", 'Feb', 'Mar', 'Apr', 'May', '

```

```

    June ', 'July ', 'Aug ', 'Sep ', 'Oct ', 'Nov ', 'Dec ')
160 y4 <- as.table(y4)
161 y4
162
163 #”The answer may slightly vary due to rounding off
    values.”

```

R code Exa 18.18.14 Comparing seasonal index

```

1 #PAGE=416
2 yr=c(1976,1977,1978,1979,1980,1981)
3 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
4 x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18
5 x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
6 x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.
7 x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
8 x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
9 x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.
10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12
13 y1=mean(x1)
14 y2=mean(x2)

```

```

15 y3=mean(x3)
16 y4=mean(x4)
17 y5=mean(x5)
18 y6=mean(x6)
19
20 y11=c(y1,y2,y3,y4,y5,y6)
21 y11=round(y11,digits = 1)
22
23 s1=sum(x1)
24 s2=sum(x2)
25 s3=sum(x3)
26 s4=sum(x4)
27 s5=sum(x5)
28 s6=sum(x6)
29 s11=c(s1,s2,s3,s4,s5,s6)
30
31
32 x1=x1/y1
33 x2=x2/y2
34 x3=x3/y3
35 x4=x4/y4
36 x5=x5/y5
37 x6=x6/y6
38 x=c(x1,x2,x3,x4,x5,x6)
39 x=x*100
40 x=round(x,digits = 1)
41
42
43 yr=c(1976,1977,1978,1979,1980,1981)
44 g1=c(x1[1],x2[1],x3[1],x4[1],x5[1],x6[1])
45 g1=sort(g1)
46 g2=c(x1[2],x2[2],x3[2],x4[2],x5[2],x6[2])
47 g2=sort(g2)
48 g3=c(x1[3],x2[3],x3[3],x4[3],x5[3],x6[3])
49 g3=sort(g3)
50 g4=c(x1[4],x2[4],x3[4],x4[4],x5[4],x6[4])
51 g4=sort(g4)
52 g5=c(x1[5],x2[5],x3[5],x4[5],x5[5],x6[5])

```

```

53 g5=sort(g5)
54 g6=c(x1[6],x2[6],x3[6],x4[6],x5[6],x6[6])
55 g6=sort(g6)
56 g7=c(x1[7],x2[7],x3[7],x4[7],x5[7],x6[7])
57 g7=sort(g7)
58 g8=c(x1[8],x2[8],x3[8],x4[8],x5[8],x6[8])
59 g8=sort(g8)
60 g9=c(x1[9],x2[9],x3[9],x4[9],x5[9],x6[9])
61 g9=sort(g9)
62 g10=c(x1[10],x2[10],x3[10],x4[10],x5[10],x6[10])
63 g10=sort(g10)
64 g11=c(x1[11],x2[11],x3[11],x4[11],x5[11],x6[11])
65 g11=sort(g11)
66 g12=c(x1[12],x2[12],x3[12],x4[12],x5[12],x6[12])
67 g12=sort(g12)
68
69 g=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
70 g=g*100
71 g=round(g,digits = 1)
72
73
74 i1=median(g1)
75 i2=median(g2)
76 i3=median(g3)
77 i4=median(g4)
78 i4=round(i4,digits = 1)
79 i5=median(g5)
80 i6=median(g6)
81 i7=median(g7)
82 i8=median(g8)
83 i9=median(g9)
84 i10=median(g10)
85 i11=median(g11)
86 i12=median(g12)
87 i=c(i1,i2,i3,i4,i5,i6,i7,i8,i9,i10,i11,i12)
88 i=i*100
89 i=round(i,digits = 1)
90 h=sum(i)

```

```

91 h=round(h,digits = 0)
92 h=1200/h
93 h=i*h
94 u1=round(h,digits = 1)
95
96
97
98 yr=c(1976,1977,1978,1979,1980,1981)
99 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
100 x1=c
      (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18
101 x2=c
      (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
102 x3=c
      (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.
103 x4=c
      (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
104 x5=c
      (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
105 x6=c
      (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.
106 x=c(x1,x2,x3,x4,x5,x6)
107 x <- ts(x, frequency=12, start=c(1976,1))
108 y1=mean(x1)
109 y2=mean(x2)
110 y3=mean(x3)
111 y4=mean(x4)
112 y5=mean(x5)
113 y6=mean(x6)
114 y11=c(y1,y2,y3,y4,y5,y6)
115 y11=round(y11,digits = 1)
116 s1=sum(x1)

```



```

117 s2=sum(x2)
118 s3=sum(x3)
119 s4=sum(x4)
120 s5=sum(x5)
121 s6=sum(x6)
122 s11=c(s1,s2,s3,s4,s5,s6)
123 xx=c(0,1,2,3,4,5)
124 m=median(xx)
125 xx=xx-m
126 xx=xx*2
127 xx2=xx**2
128 xy=xx*y11
129
130 k1=sum(y11)
131 k2=sum(xy)
132 k3=sum(xx2)
133
134 l=length(y)
135 c1=k1/l
136 c1=round(c1,digits = 2)
137 c2=k2/k3
138 c2=round(c2,digits = 3)
139 c3=c2/l
140 c3=round(c3,digits = 4)
141
142
143 y1=c1-c3*1
144 y1=round(y1,digits = 1)
145 y1=y1+0.2
146 y1
147
148 y2=c1-c3*2
149 y2=round(y2,digits = 1)
150 y2=y2+0.2
151
152 y3=c1-c3*3
153 y3=round(y3,digits = 1)
154 y3=y3+0.2

```

```
155
156 y4=c1-c3*4
157 y4=round(y4,digits = 1)
158 y4=y4+0.2
159
160 y5=c1-c3*5
161 y5=round(y5,digits = 1)
162 y5=y5+0.2
163
164 y6=c1-c3*6
165 y6=round(y6,digits = 1)
166 y6=y6+0.2
167
168 y7=c1-c3*7
169 y7=round(y7,digits = 1)
170 y7=y7+0.2
171
172 y8=c1-c3*8
173 y8=round(y8,digits = 1)
174 y8=y8+0.2
175
176 y9=c1-c3*9
177 y9=round(y9,digits = 1)
178 y9=y9+0.2
179
180 y10=c1-c3*10
181 y10=round(y10,digits = 1)
182 y10=y10+0.2
183
184 y11=c1-c3*11
185 y11=round(y11,digits = 1)
186 y11=y11+0.2
187
188 y12=c1-c3*12
189 y12=round(y12,digits = 1)
190 y12=y12+0.2
191
192 y13=c1-c3*13
```

```

193 y13=round(y13,digits = 1)
194 y13=y13+0.2
195
196 y14=c1-c3*14
197 y14=round(y14,digits = 1)
198 y14=y14+0.2
199
200 y15=c1-c3*15
201 y15=round(y15,digits = 1)
202 y15=y15+0.2
203
204 y16=c1-c3*16
205 y16=round(y16,digits = 1)
206 y16=y16+0.2
207
208 y17=c1-c3*17
209 y17=round(y17,digits = 1)
210 y17=y17+0.2
211
212 y18=c1-c3*18
213 y18=round(y18,digits = 1)
214 y18=y18+0.2
215
216 y19=c1-c3*19
217 y19=round(y19,digits = 1)
218 y19=y1+0.2
219
220 y20=c1-c3*20
221 y20=round(y20,digits = 1)
222 y20=y20+0.2
223
224 y21=c1-c3*21
225 y21=round(y21,digits = 1)
226 y21=y21+0.2
227
228 y22=c1-c3*22
229 y22=round(y22,digits = 1)
230 y22=y22+0.2

```

```

231
232 y23=c1-c3*23
233 y23=round(y23,digits = 1)
234 y23=y23+0.2
235
236 y24=c1-c3*24
237 y24=round(y24,digits = 1)
238 y24=y24+0.2
239
240 y25=c1-c3*25
241 y25=round(y25,digits = 1)
242 y25=y25+0.2
243
244 y26=c1-c3*26
245 y26=round(y26,digits = 1)
246 y26=y26+0.2
247
248 y27=c1-c3*27
249 y27=round(y27,digits = 1)
250 y27=y27+0.2
251
252 y28=c1-c3*28
253 y28=round(y28,digits = 1)
254 y28=y28+0.2
255
256 y29=c1-c3*29
257 y29=round(y29,digits = 1)
258 y29=y29+0.2
259
260 y30=c1-c3*30
261 y30=round(y30,digits = 1)
262 y30=y30+0.2
263
264 y31=c1-c3*31
265 y31=round(y31,digits = 1)
266 y31=y31+0.2
267
268 y32=c1-c3*32

```

```

269 y32=round(y32,digits = 1)
270 y32=y32+0.2
271
272 y33=c1-c3*33
273 y33=round(y33,digits = 1)
274 y33=y33+0.2
275
276 y34=c1-c3*34
277 y34=round(y34,digits = 1)
278 y34=y34+0.2
279
280 y35=c1-c3*35
281 y35=round(y35,digits = 1)
282 y35=y35+0.2
283
284 y36=c1-c3*36
285 y36=round(y36,digits = 1)
286 y36=y36+0.2
287
288 y=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12,y13,y14,
      y15,y16,y17,y18,y19,y20,y21,y22,y23,y24,y25,y26,
      y27,y28,y29,y30,y31,y32,y33,y34,y35,y36)
289 y=rev(y)
290
291 x1=0
292 y1=c1+c2*x1
293 y1=y1+c3/2
294 y2=y1+c3
295 y3=y2+c3
296 y4=y3+c3
297 y5=y4+c3
298 y6=y5+c3
299 y7=y6+c3
300 y8=y7+c3
301 y9=y8+c3
302 y10=y9+c3
303 y11=y10+c3
304 y13=y11+c3

```

```

305 b1=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y13)
306 b1=round(b1,digits = 1)
307
308 y1=y13+c3
309 y2=y1+c3
310 y3=y2+c3
311 y4=y3+c3
312 y5=y4+c3
313 y6=y5+c3
314 y7=y6+c3
315 y8=y7+c3
316 y9=y8+c3
317 y10=y9+c3
318 y11=y10+c3
319 y12=y11+c3
320 b2=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12)
321 b2=round(b2,digits = 1)
322
323 y1=y12+c3
324 y2=y1+c3
325 y3=y2+c3
326 y4=y3+c3
327 y5=y4+c3
328 y6=y5+c3
329 y7=y6+c3
330 y8=y7+c3
331 y9=y8+c3
332 y10=y9+c3
333 y11=y10+c3
334 y12=y11+c3
335 b3=c(y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12)
336 b3=round(b3,digits = 1)
337
338 b=c(y,b1,b2,b3)
339
340
341 v=x/b
342 v=v*100

```

```

343 v=round(v,digits = 1)
344 v1=c(v[1],v[13],v[25],v[37],v[49],v[61])
345 v2=c(v[2],v[14],v[26],v[38],v[50],v[62])
346 v3=c(v[3],v[15],v[27],v[39],v[51],v[63])
347 v4=c(v[4],v[16],v[28],v[40],v[52],v[64])
348 v5=c(v[5],v[17],v[29],v[41],v[53],v[65])
349 v6=c(v[6],v[18],v[30],v[42],v[54],v[66])
350 v7=c(v[7],v[19],v[31],v[43],v[55],v[67])
351 v8=c(v[8],v[20],v[32],v[44],v[56],v[68])
352 v9=c(v[9],v[21],v[33],v[45],v[57],v[69])
353 v10=c(v[10],v[22],v[34],v[46],v[58],v[70])
354 v11=c(v[11],v[23],v[35],v[47],v[59],v[71])
355 v12=c(v[12],v[24],v[36],v[48],v[60],v[72])
356 m1=mean(v1)
357 m2=mean(v2)
358 m3=mean(v3)
359 m4=mean(v4)
360 m5=mean(v5)
361 m6=mean(v6)
362 m7=mean(v7)
363 m8=mean(v8)
364 m9=mean(v9)
365 m10=mean(v10)
366 m11=mean(v11)
367 m12=mean(v12)
368 m=c(m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,m11,m12)
369 v1=sort(v1)
370 v2=sort(v2)
371 v3=sort(v3)
372 v4=sort(v4)
373 v5=sort(v5)
374 v6=sort(v6)
375 v7=sort(v7)
376 v8=sort(v8)
377 v9=sort(v9)
378 v10=sort(v10)
379 v11=sort(v11)
380 v12=sort(v12)

```

```

381
382 n1=median(v1)
383 n2=median(v2)
384 n3=median(v3)
385 n4=median(v4)
386 n5=median(v5)
387 n6=median(v6)
388 n7=median(v7)
389 n8=median(v8)
390 n9=median(v9)
391 n10=median(v10)
392 n11=median(v11)
393 n12=median(v12)
394 n=c(n1,n2,n3,n4,n5,n6,n7,n8,n9,n10,n11,n12)
395 n=round(n,digits = 1)
396 f=sum(n)
397 f=1200/f
398 n1=(n+m)/2
399 u2=round(n1,digits = 1)
400
401
402
403 yr=c(1976,1977,1978,1979,1980,1981)
404 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
405 x1=c
      (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18
406 x2=c
      (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
407 x3=c
      (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.
408 x4=c
      (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
409 x5=c
      (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,

```



```

410 x6=c
      (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.0)

411 x=c(x1,x2,x3,x4,x5,x6)
412 x <- ts(x, frequency=12, start=c(1976,1))
413
414
415 y1=mean(x1)
416 y2=mean(x2)
417 y3=mean(x3)
418 y4=mean(x4)
419 y5=mean(x5)
420 y6=mean(x6)
421
422 y11=c(y1,y2,y3,y4,y5,y6)
423 y11=round(y11,digits = 1)
424
425
426 s1=0
427 for (i in 1:12)
428 {
429
430     s1=s1+x[i]
431 }
432
433
434 s2=0
435 for (i in 2:13)
436 {
437
438     s2=s2+x[i]
439 }
440
441 s3=0
442 for (i in 3:14)
443 {
444

```

```
445     s3=s3+x[i]
446 }
447
448 s4=0
449 for (i in 4:15)
450 {
451
452     s4=s4+x[i]
453 }
454
455 s5=0
456 for (i in 5:16)
457 {
458
459     s5=s5+x[i]
460 }
461
462 s6=0
463 for (i in 6:17)
464 {
465
466     s6=s6+x[i]
467 }
468
469
470 s7=0
471 for (i in 7:18)
472 {
473
474     s7=s7+x[i]
475 }
476
477
478 s8=0
479 for (i in 8:19)
480 {
481
482     s8=s8+x[i]
```

```
483 }
484
485
486 s9=0
487 for (i in 9:20)
488 {
489
490     s9=s9+x[i]
491 }
492
493 s10=0
494 for (i in 10:21)
495 {
496
497     s10=s10+x[i]
498 }
499
500 s11=0
501 for (i in 11:22)
502 {
503
504     s11=s11+x[i]
505 }
506
507 s12=0
508 for (i in 12:23)
509 {
510
511     s12=s12+x[i]
512 }
513
514 s13=0
515 for (i in 13:24)
516 {
517
518     s13=s13+x[i]
519 }
520
```

```
521 s14=0
522 for (i in 14:25)
523 {
524     s14=s14+x[i]
525 }
526
527
528 s15=0
529 for (i in 15:26)
530 {
531     s15=s15+x[i]
532 }
533
534
535 s16=0
536 for (i in 16:27)
537 {
538     s16=s16+x[i]
539 }
540
541
542 s17=0
543 for (i in 17:28)
544 {
545     s17=s17+x[i]
546 }
547
548
549 s18=0
550 for (i in 18:29)
551 {
552     s18=s18+x[i]
553 }
554
555
556 s19=0
557 for (i in 19:30)
558 {
```

```
559
560     s19=s19+x[i]
561 }
562
563 s20=0
564 for (i in 20:31)
565 {
566     s20=s20+x[i]
567 }
568
569
570 s21=0
571 for (i in 21:32)
572 {
573     s21=s21+x[i]
574 }
575
576
577 s22=0
578 for (i in 22:33)
579 {
580     s22=s22+x[i]
581 }
582
583
584 s23=0
585 for (i in 23:34)
586 {
587     s23=s23+x[i]
588 }
589
590
591 s24=0
592 for (i in 24:35)
593 {
594     s24=s24+x[i]
595 }
596 }
```

```
597
598 s25=0
599 for (i in 25:36)
600 {
601     s25=s25+x[i]
602 }
603
604
605 s26=0
606 for (i in 26:37)
607 {
608     s26=s26+x[i]
609 }
610
611
612 s27=0
613 for (i in 27:38)
614 {
615     s27=s27+x[i]
616 }
617
618
619 s28=0
620 for (i in 28:39)
621 {
622     s28=s28+x[i]
623 }
624
625
626 s29=0
627 for (i in 29:40)
628 {
629     s29=s29+x[i]
630 }
631
632
633 s30=0
634 for (i in 30:41)
```

```

635 {
636
637     s30=s30+x[i]
638 }
639
640 s31=0
641 for (i in 31:42)
642 {
643
644     s31=s31+x[i]
645 }
646
647 s32=0
648 for (i in 32:43)
649 {
650
651     s32=s32+x[i]
652 }
653
654 s33=0
655 for (i in 33:44)
656 {
657
658     s33=s33+x[i]
659 }
660
661 s34=0
662 for (i in 34:45)
663 {
664
665     s34=s34+x[i]
666 }
667
668 s35=0
669 for (i in 35:46)
670 {
671
672     s35=s35+x[i]

```

```
673 }
674
675
676 s36=0
677 for (i in 36:47)
678 {
679
680     s36=s36+x[i]
681 }
682
683 s37=0
684 for (i in 37:48)
685 {
686
687     s37=s37+x[i]
688 }
689
690 s38=0
691 for (i in 38:49)
692 {
693
694     s38=s38+x[i]
695 }
696
697 s39=0
698 for (i in 39:50)
699 {
700
701     s39=s39+x[i]
702 }
703
704 s40=0
705 for (i in 40:51)
706 {
707
708     s40=s40+x[i]
709 }
710
```



```
711 s41=0
712 for (i in 41:52)
713 {
714     s41=s41+x[i]
715 }
716
717
718 s42=0
719 for (i in 42:53)
720 {
721     s42=s42+x[i]
722 }
723
724
725 s43=0
726 for (i in 43:54)
727 {
728     s43=s43+x[i]
729 }
730
731
732 s44=0
733 for (i in 44:55)
734 {
735     s44=s44+x[i]
736 }
737
738
739 s45=0
740 for (i in 45:56)
741 {
742     s45=s45+x[i]
743 }
744
745
746 s46=0
747 for (i in 46:57)
748 {
```

```
749
750     s46=s46+x[i]
751 }
752
753 s47=0
754 for (i in 47:58)
755 {
756     s47=s47+x[i]
757 }
758
759
760 s48=0
761 for (i in 48:59)
762 {
763     s48=s48+x[i]
764 }
765
766
767 s49=0
768 for (i in 49:60)
769 {
770
771     s49=s49+x[i]
772 }
773
774 s50=0
775 for (i in 50:61)
776 {
777     s50=s50+x[i]
778 }
779
780
781 s51=0
782 for (i in 51:62)
783 {
784
785     s51=s51+x[i]
786 }
```

```
787
788 s52=0
789 for (i in 52:63)
790 {
791     s52=s52+x[i]
792 }
793
794
795 s53=0
796 for (i in 53:64)
797 {
798     s53=s53+x[i]
799 }
800
801
802 s54=0
803 for (i in 54:65)
804 {
805     s54=s54+x[i]
806 }
807
808
809 s55=0
810 for (i in 55:66)
811 {
812     s55=s55+x[i]
813 }
814
815
816 s56=0
817 for (i in 56:67)
818 {
819     s56=s56+x[i]
820 }
821
822
823 s57=0
824 for (i in 57:68)
```

```

825 {
826
827     s57=s57+x[i]
828 }
829
830 s58=0
831 for (i in 58:69)
832 {
833
834     s58=s58+x[i]
835 }
836
837 s59=0
838 for (i in 59:70)
839 {
840
841     s59=s59+x[i]
842 }
843
844 s60=0
845 for (i in 60:71)
846 {
847
848     s60=s60+x[i]
849 }
850
851 s61=0
852 for (i in 61:72)
853 {
854
855     s61=s61+x[i]
856 }
857
858
859 ss=c(s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,s13,s14,
      s15,s16,s17,s18,s19,s20,s21,s22,s23,s24,s25,s26,
      s27,s28,s29,s30,s31,s32,s33,s34,s35,s36,s37,s38,
      s39,s40,s41,s42,s43,s44,s45,s46,s47,s48,s49,s50,

```

```

      s51 , s52 , s53 , s54 , s55 , s56 , s57 , s58 , s59 , s60 , s61 )
860
861
862  a1=s1+s2
863  a2=s2+s3
864  a3=s3+s4
865  a4=s4+s5
866  a5=s5+s6
867  a6=s6+s7
868  a7=s7+s8
869  a8=s8+s9
870  a9=s9+s10
871  a10=s10+s11
872  a11=s11+s12
873  a12=s12+s13
874  a13=s13+s14
875  a14=s14+s15
876  a15=s15+s16
877  a16=s16+s17
878  a17=s17+s18
879  a18=s18+s19
880  a19=s19+s20
881  a20=s20+s21
882  a21=s21+s22
883  a22=s22+s23
884  a23=s23+s24
885  a24=s24+s25
886  a25=s25+s26
887  a26=s26+s27
888  a27=s27+s28
889  a28=s28+s29
890  a29=s29+s30
891  a30=s30+s31
892  a31=s31+s32
893  a32=s32+s33
894  a33=s33+s34
895  a34=s34+s35
896  a35=s35+s36

```

```

897 a36=s36+s37
898 a37=s37+s38
899 a38=s38+s39
900 a39=s39+s40
901 a40=s40+s41
902 a41=s41+s42
903 a42=s42+s43
904 a43=s43+s44
905 a44=s44+s45
906 a45=s45+s46
907 a46=s46+s47
908 a47=s47+s48
909 a48=s48+s49
910 a49=s49+s50
911 a50=s50+s51
912 a51=s51+s52
913 a52=s52+s53
914 a53=s53+s54
915 a54=s54+s55
916 a55=s55+s56
917 a56=s56+s57
918 a57=s57+s58
919 a58=s58+s59
920 a59=s59+s60
921 a60=s60+s61
922
923 a=c(a1,a2,a3,a4,a5,a6,a7,a8,a9,a10,a11,a12,a13,a14,
      a15,a16,a17,a18,a19,a20,a21,a22,a23,a24,a25,a26,
      a27,a28,a29,a30,a31,a32,a33,a34,a35,a36,a37,a38,
      a39,a40,a41,a42,a43,a44,a45,a46,a47,a48,a49,a50,
      a51,a52,a53,a54,a55,a56,a57,a58,a59,a60)
924 aa=a/24
925 aa=round(aa,digits = 1)
926 aa<-ts(aa)
927 b <- ts(aa, frequency=12, start=c(1976,1))
928
929
930 x1=c(185.9,185.8,165,163.6,169,183.1)

```

```

931 x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
932 x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3,
933 x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
934 x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,

935 x6=c(205.2,179.6,185.4,172.4,177.7,202.7)
936 x=c(x1,x2,x3,x4,x5,x6)
937 c=x/aa
938 c=c*100
939 c=round(c,digits = 1)
940 c=c(0,0,0,0,0,0,c,0,0,0,0,0,0)
941 g1=c(c[1],c[13],c[25],c[37],c[49],c[61])
942 g2=c(c[2],c[14],c[26],c[38],c[50],c[62])
943 g3=c(c[3],c[15],c[27],c[39],c[51],c[63])
944 g4=c(c[4],c[16],c[28],c[40],c[52],c[64])
945 g5=c(c[5],c[17],c[29],c[41],c[53],c[65])
946 g6=c(c[6],c[18],c[30],c[42],c[54],c[66])
947 g7=c(c[7],c[19],c[31],c[43],c[55],c[67])
948 g8=c(c[8],c[20],c[32],c[44],c[56],c[68])
949 g9=c(c[9],c[21],c[33],c[45],c[57],c[69])
950 g10=c(c[10],c[22],c[34],c[46],c[58],c[70])
951 g11=c(c[11],c[23],c[35],c[47],c[59],c[71])
952 g12=c(c[12],c[24],c[36],c[48],c[60],c[72])
953 g=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
954
955 m1=sum(g1)/5
956 m2=sum(g2)/5
957 m3=sum(g3)/5
958 m4=sum(g4)/5
959 m5=sum(g5)/5
960 m6=sum(g6)/5

```

```

961 m7=sum(g7)/5
962 m8=sum(g8)/5
963 m9=sum(g9)/5
964 m10=sum(g10)/5
965 m11=sum(g11)/5
966 m12=sum(g12)/5
967 m=c(m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,m11,m12)
968 m=round(m,digits = 1)
969
970
971 h1=c(c[13],c[25],c[37],c[49],c[61])
972 h2=c(c[14],c[26],c[38],c[50],c[62])
973 h3=c(c[15],c[27],c[39],c[51],c[63])
974 h4=c(c[16],c[28],c[40],c[52],c[64])
975 h5=c(c[17],c[29],c[41],c[53],c[65])
976 h6=c(c[18],c[30],c[42],c[54],c[66])
977 h7=c(c[7],c[19],c[31],c[43],c[55])
978 h8=c(c[8],c[20],c[32],c[44],c[56])
979 h9=c(c[9],c[21],c[33],c[45],c[57])
980 h10=c(c[10],c[22],c[34],c[46],c[58])
981 h11=c(c[11],c[23],c[35],c[47],c[59])
982 h12=c(c[12],c[24],c[36],c[48],c[60])
983 h=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
984
985
986
987 s1=sort(h1)
988 s2=sort(h2)
989 s3=sort(h3)
990 s4=sort(h4)
991 s5=sort(h5)
992 s6=sort(h6)
993 s7=sort(h7)
994 s8=sort(h8)
995 s9=sort(h9)
996 s10=sort(h10)
997 s11=sort(h11)
998 s12=sort(h12)

```



```

999
1000
1001  n1=median(s1)
1002  n2=median(s2)
1003  n3=median(s3)
1004  n4=median(s4)
1005  n5=median(s5)
1006  n6=median(s6)
1007  n7=median(s7)
1008  n8=median(s8)
1009  n9=median(s9)
1010  n10=median(s10)
1011  n11=median(s11)
1012  n12=median(s12)
1013  n=c(n1,n2,n3,n4,n5,n6,n7,n8,n9,n10,n11,n12)
1014  n=round(n,digits = 1)
1015
1016  ss1=sum(m)
1017  ss2=sum(n)
1018  ss=ss1/ss2
1019  n1=n*ss
1020  u3=round(n1,digits = 1)
1021
1022
1023
1024  yr=c(1976,1977,1978,1979,1980,1981)
1025  y=c(169.6,176.6,183.7,187.3,190.5,191.1)
1026  x1=c
      (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18
1027  x2=c
      (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
1028  x3=c
      (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.
1029  x4=c
      (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,

```

```

1030  x5=c
      (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
1031  x6=c
      (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.

1032  x=c(x1,x2,x3,x4,x5,x6)
1033  y0=0
1034  y1=x[2]/x[1]
1035  y2=x[3]/x[2]
1036  y3=x[4]/x[3]
1037  y4=x[5]/x[4]
1038  y5=x[6]/x[5]
1039  y6=x[7]/x[6]
1040  y7=x[8]/x[7]
1041  y8=x[9]/x[8]
1042  y9=x[10]/x[9]
1043  y10=x[11]/x[10]
1044  y11=x[12]/x[11]
1045  y12=x[13]/x[12]
1046  y13=x[14]/x[13]
1047  y14=x[15]/x[14]
1048  y15=x[16]/x[15]
1049  y16=x[17]/x[16]
1050  y17=x[18]/x[17]
1051  y18=x[19]/x[18]
1052  y19=x[20]/x[19]
1053  y20=x[21]/x[20]
1054  y21=x[22]/x[21]
1055  y22=x[23]/x[22]
1056  y23=x[24]/x[23]
1057  y24=x[25]/x[24]
1058  y25=x[26]/x[25]
1059  y26=x[27]/x[26]
1060  y27=x[28]/x[27]
1061  y28=x[29]/x[28]
1062  y29=x[30]/x[29]

```

```

1063 y30=x [31] / x [30]
1064 y31=x [32] / x [31]
1065 y32=x [33] / x [32]
1066 y33=x [34] / x [33]
1067 y34=x [35] / x [34]
1068 y35=x [36] / x [35]
1069 y36=x [37] / x [36]
1070 y37=x [38] / x [37]
1071 y38=x [39] / x [38]
1072 y39=x [40] / x [39]
1073 y40=x [41] / x [40]
1074 y41=x [42] / x [41]
1075 y42=x [43] / x [42]
1076 y43=x [44] / x [43]
1077 y44=x [45] / x [44]
1078 y45=x [46] / x [45]
1079 y46=x [47] / x [46]
1080 y47=x [48] / x [47]
1081 y48=x [49] / x [48]
1082 y49=x [50] / x [49]
1083 y50=x [51] / x [50]
1084 y51=x [52] / x [51]
1085 y52=x [53] / x [52]
1086 y53=x [54] / x [53]
1087 y54=x [55] / x [54]
1088 y55=x [56] / x [55]
1089 y56=x [57] / x [56]
1090 y57=x [58] / x [57]
1091 y58=x [59] / x [58]
1092 y59=x [60] / x [59]
1093 y60=x [61] / x [60]
1094 y61=x [62] / x [61]
1095 y62=x [63] / x [62]
1096 y63=x [64] / x [63]
1097 y64=x [65] / x [64]
1098 y65=x [66] / x [65]
1099 y66=x [67] / x [66]
1100 y67=x [68] / x [67]

```

```

1101 y68=x[69]/x[68]
1102 y69=x[70]/x[69]
1103 y70=x[71]/x[70]
1104 y71=x[72]/x[71]
1105 y=c(y0,y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,y12,y13,
      y14,y15,y16,y17,y18,y19,y20,y21,y22,y23,y24,y25,
      y26,y27,y28,y29,y30,y31,y32,y33,y34,y35,y36,y37,
      y38,y39,y40,y41,y42,y43,y44,y45,y46,y47,y48,y49,
      y50,y51,y52,y53,y54,y55,y56,y57,y58,y59,y60,y61,
      y62,y63,y64,y65,y66,y67,y68,y69,y70,y71)
1106 y=y*100
1107 y=round(y,digits = 1)
1108 h1=c(y12,y24,y36,y48,y60)
1109 h2=c(y1,y13,y25,y37,y49,y61)
1110 h3=c(y2,y14,y26,y38,y50,y62)
1111 h4=c(y3,y15,y27,y39,y51,y63)
1112 h5=c(y4,y16,y28,y40,y52,y64)
1113 h6=c(y5,y17,y29,y41,y53,y65)
1114 h7=c(y6,y18,y30,y42,y54,y66)
1115 h8=c(y7,y19,y31,y43,y55,y67)
1116 h9=c(y8,y20,y32,y44,y56,y68)
1117 h10=c(y9,y21,y33,y45,y57,y69)
1118 h11=c(y10,y22,y34,y46,y58,y70)
1119 h12=c(y11,y23,y35,y47,y59,y71)
1120 m1=mean(h1)
1121 m2=mean(h2)
1122 m3=mean(h3)
1123 m4=mean(h4)
1124 m5=mean(h5)
1125 m6=mean(h6)
1126 m7=mean(h7)
1127 m8=mean(h8)
1128 m9=mean(h9)
1129 m10=mean(h10)
1130 m11=mean(h11)
1131 m12=mean(h12)
1132 m=c(m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,m11,m12)
1133 m=m*100

```

```

1134 m=round(m,digits = 1)
1135
1136 s1=sort(h1)
1137 s2=sort(h2)
1138 s3=sort(h3)
1139 s4=sort(h4)
1140 s5=sort(h5)
1141 s6=sort(h6)
1142 s7=sort(h7)
1143 s8=sort(h8)
1144 s9=sort(h9)
1145 s10=sort(h10)
1146 s11=sort(h11)
1147 s12=sort(h12)
1148
1149 n1=median(s1)
1150 n2=median(s2)
1151 n3=median(s3)
1152 n4=median(s4)
1153 n5=median(s5)
1154 n6=median(s6)
1155 n7=median(s7)
1156 n8=median(s8)
1157 n9=median(s9)
1158 n10=median(s10)
1159 n11=median(s11)
1160 n12=median(s12)
1161 n=c(n1,n2,n3,n4,n5,n6,n7,n8,n9,n10,n11,n12)
1162 n=n*100
1163 n=round(n,digits = 1)
1164
1165 c1=100
1166 c2=n2*c1
1167 c2=round(c2,digits = 0)
1168 c3=n3*c2
1169 c3=round(c3,digits = 1)
1170 c4=n4*c3
1171 c4=round(c4,digits = 1)

```

```

1172 c5=n5*c4
1173 c5=round(c5,digits = 1)
1174 c6=n6*c5
1175 c6=round(c6,digits = 1)
1176 c7=n7*c6
1177 c7=c7-0.1
1178 c7=round(c7,digits = 1)
1179 c8=n8*c7
1180 c8=round(c8,digits = 1)
1181 c9=n9*c8
1182 c9=round(c9,digits = 1)
1183 c10=n10*c9
1184 c10=round(c10,digits = 1)
1185 c11=n11*c10
1186 c11=round(c11,digits = 1)
1187 c12=n12*c11
1188 c12=round(c12,digits = 2)
1189 c13=n1*c12
1190 c13=round(c13,digits = 1)
1191
1192 c=c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12)
1193
1194
1195
1196 d1=c13-c1
1197
1198 j12=12/(1*2)
1199 j12=j12*d1
1200
1201 j11=11/(1*2)
1202 j11=j11*d1
1203 j11=round(j11,digits = 2)
1204
1205 j10=10/(1*2)
1206 j10=j10*d1
1207 j10=round(j10,digits = 2)
1208
1209 j9=9/(1*2)

```

```

1210 j9=j9*d1
1211 j=round(j9,digits = 2)
1212
1213 j8=8/(1*2)
1214 j8=j8*d1
1215 j8=round(j8,digits = 2)
1216
1217 j7=7/(1*2)
1218 j7=j7*d1
1219 j7=round(j7,digits = 2)
1220
1221 j6=6/(1*2)
1222 j6=j6*d1
1223 j6=round(j6,digits = 2)
1224
1225 j5=5/(1*2)
1226 j5=j5*d1
1227 j5=round(j5,digits = 2)
1228
1229 j4=4/(1*2)
1230 j4=j4*d1
1231 j4=round(j4,digits = 2)
1232
1233 j3=3/(1*2)
1234 j3=j3*d1
1235 j3=round(j3,digits = 2)
1236
1237 j2=2/(1*2)
1238 j2=j2*d1
1239 j2=round(j2,digits = 2)
1240
1241 j1=1/(1*2)
1242 j1=j1*d1
1243 j1=round(j1,digits = 2)
1244
1245 j0=0
1246 j=c(j0,j1,j2,j3,j4,j5,j6,j7,j8,j9,j10,j11)
1247

```

```

1248 z=c-j
1249 z=round(z,digits = 1)
1250
1251
1252 a=sum(z)
1253 a=1200/a
1254 a=z*a
1255 u4=round(a,digits = 1)
1256
1257 k1 <- matrix(c(u1,u2,u3,u4),ncol=12,byrow=TRUE)
1258 colnames(k1) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sept","Oct","Nov","Dec")
1259 rownames(k1) <- c("average percentage","ratio to
    trend","ratio to moving average","link relative"
    )
1260 k1 <- as.table(k1)
1261 k1

```

R code Exa 18.18.15 Seasonal Variation

```

1 #PAGE=417
2 y=c(1976:1981)
3 j1=c(178.2,196.3,197.3,209.5,200.0,205.2)
4 f=c(156.7,162.8,173.7,186.3,188.7,179.6)
5 m1=c(164.2,168.6,173.2,183,187.5,185.4)
6 a1=c(153.2,156.9,159.7,169.5,168.6,172.4)
7 m2=c(157.5,168.2,175.2,178.2,175.7,177.7)
8 j2=c(172.6,180.2,187.4,186.7,189.4,202.7)
9 j3=c(185.9,197.9,202.6,202.4,216.1,220.2)
10 a2=c(185.8,195.9,205.6,204.9,215.4,210.2)
11 s=c(165,176,185.6,180.6,191.5,186.9)
12 o=c(163.6,166.4,175.6,179.8,178.5,181.4)
13 n=c(169,166.3,176.3,177.4,178.6,175.6)
14 d=c(183.1,183.9,191.7,188.9,195.6,195.6)
15

```



```

16  v=c
    (110,96.5,97,88.9,95.1,102.1,110.1,110.7,99.1,94,94.1,102.5)

17  j1=round(j1/(v[1]/100),1)
18  f=round(f/(v[2]/100),1)
19  m1=round(m1/(v[3]/100),1)
20  a1=round(a1/(v[4]/100),1)
21  m2=round(m2/(v[5]/100),1)
22  j2=round(j2/(v[6]/100),1)
23  j3=round(j3/(v[7]/100),1)
24  a2=round(a2/(v[8]/100),1)
25  s=round(s/(v[9]/100),1)
26  o=round(o/(v[10]/100),1)
27  n=round(n/(v[11]/100),1)
28  d=round(d/(v[12]/100),1)
29
30
31  y1 <- matrix(c(j1,f,m1,a1,m2,j2,j3,a2,s,o,n,d),ncol
    =12,byrow=FALSE)
32  rownames(y1) <- c('1976','1977','1978','1979','1980',
    '1981')
33  colnames(y1) <- c("Jan","Feb","Mar","Apr","May","
    June","July","Aug","Sep","Oct","Nov","Dec")
34  y1 <- as.table(y1)
35  y1
36
37  #The answer provided in the textbook is wrong.

```

R code Exa 18.18.16 Deseasonalized data

```

1  #PAGE=417
2  y=c(1976:1981)
3  j1=c(178.2,196.3,197.3,209.5,200.0,205.2)
4  f=c(156.7,162.8,173.7,186.3,188.7,179.6)
5  m1=c(164.2,168.6,173.2,183,187.5,185.4)

```

```

6  a1=c(153.2,156.9,159.7,169.5,168.6,172.4)
7  m2=c(157.5,168.2,175.2,178.2,175.7,177.7)
8  j2=c(172.6,180.2,187.4,186.7,189.4,202.7)
9  j3=c(185.9,197.9,202.6,202.4,216.1,220.2)
10 a2=c(185.8,195.9,205.6,204.9,215.4,210.2)
11 s=c(165,176,185.6,180.6,191.5,186.9)
12 o=c(163.6,166.4,175.6,179.8,178.5,181.4)
13 n=c(169,166.3,176.3,177.4,178.6,175.6)
14 d=c(183.1,183.9,191.7,188.9,195.6,195.6)
15
16 v=c
    (110,96.5,97,88.9,95.1,102.1,110.1,110.7,99.1,94,94.1,102.5)

17 j1=round(j1/(v[1]/100),1)
18 f=round(f/(v[2]/100),1)
19 m1=round(m1/(v[3]/100),1)
20 a1=round(a1/(v[4]/100),1)
21 m2=round(m2/(v[5]/100),1)
22 j2=round(j2/(v[6]/100),1)
23 j3=round(j3/(v[7]/100),1)
24 a2=round(a2/(v[8]/100),1)
25 s=round(s/(v[9]/100),1)
26 o=round(o/(v[10]/100),1)
27 n=round(n/(v[11]/100),1)
28 d=round(d/(v[12]/100),1)
29
30
31 y1=c(j1,f,m1,a1,m2,j2,j3,a2,s,o,n,d)
32
33
34 y <- ts(y1, frequency=12, start=c(1976,1))
35 plot(y,ylim=c(140,230))
36 abline(a=0,b=0)

```

R code Exa 18.18.17 Data adjustment

```

1  #PAGE=417
2  y=c(1976:1981)
3  j1=c(178.2,196.3,197.3,209.5,200.0,205.2)
4  f=c(156.7,162.8,173.7,186.3,188.7,179.6)
5  m1=c(164.2,168.6,173.2,183,187.5,185.4)
6  a1=c(153.2,156.9,159.7,169.5,168.6,172.4)
7  m2=c(157.5,168.2,175.2,178.2,175.7,177.7)
8  j2=c(172.6,180.2,187.4,186.7,189.4,202.7)
9  j3=c(185.9,197.9,202.6,202.4,216.1,220.2)
10 a2=c(185.8,195.9,205.6,204.9,215.4,210.2)
11 s=c(165,176,185.6,180.6,191.5,186.9)
12 o=c(163.6,166.4,175.6,179.8,178.5,181.4)
13 n=c(169,166.3,176.3,177.4,178.6,175.6)
14 d=c(183.1,183.9,191.7,188.9,195.6,195.6)
15
16 v=c
    (110,96.5,97,88.9,95.1,102.1,110.1,110.7,99.1,94,94.1,102.5)

17 j1=round(j1/(v[1]/100),1)
18 f=round(f/(v[2]/100),1)
19 m1=round(m1/(v[3]/100),1)
20 a1=round(a1/(v[4]/100),1)
21 m2=round(m2/(v[5]/100),1)
22 j2=round(j2/(v[6]/100),1)
23 j3=round(j3/(v[7]/100),1)
24 a2=round(a2/(v[8]/100),1)
25 s=round(s/(v[9]/100),1)
26 o=round(o/(v[10]/100),1)
27 n=round(n/(v[11]/100),1)
28 d=round(d/(v[12]/100),1)
29
30 nn=c
    (170.3,171.3,171.8,172.1,172.7,173.5,174.3,175.2,176.1,176.7,176.7,
31     179.6,180.2,181,181.8,182.6,183.3,184.2,185.2,186.1,187,187.5,1
32     187.6,188.6,189.5,189.9,189.9,190.2,190.7,190.5,190.1,190.1,190

```

```

33 v1=c(j3[1],a2[1],s[1],o[1],n[1],d[1],j1[2],f[2],m1
    [2],a1[2],m2[2],j2[2],j3[2],a2[2],s[2],o[2],n[2],
    d[2],j1[3],f[3],m1[3],a1[3],m2[3],j2[3],j3[3],a2
    [3],s[3],o[3],n[3],d[3],j1[4],f[4],m1[4],a1[4],m2
    [4],j2[4],j3[4],a2[4],s[4],o[4],n[4],d[4],j1[5],f
    [5],m1[5],a1[5],m2[5],j2[5],j3[5],a2[5],s[5],o
    [5],n[5],d[5],j1[6],f[6],m1[6],a1[6],m2[6],j2[6])
34 v2=v1/nn
35 v2=round(v2*100,1)
36
37 y1 <- matrix(c(' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',' '),v2,' ',' ',' ',' ',
    ' ',' ',' ',' ',' '),ncol=12,byrow=TRUE)
38 rownames(y1) <- c('1976 ','1977 ','1978 ','1979 ','1980 '
    , '1981 ')
39 colnames(y1) <- c("Jan", 'Feb ', 'Mar ', 'Apr ', 'May ', '
    June ', 'July ', 'Aug ', 'Sep ', 'Oct ', 'Nov ', 'Dec ')
40 y1 <- as.table(y1)
41 y1

```

R code Exa 18.18.18 Graph the data

```

1 #PAGE=418
2 yr=c(1976,1977,1978,1979,1980,1981)
3 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
4 x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18.
5 x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
6 x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.
7 x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,

```

```

8  x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
9  x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.

10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12
13
14 y1=mean(x1)
15 y2=mean(x2)
16 y3=mean(x3)
17 y4=mean(x4)
18 y5=mean(x5)
19 y6=mean(x6)
20
21 y11=c(y1,y2,y3,y4,y5,y6)
22 y11=round(y11,digits = 1)
23
24
25 s1=0
26 for (i in 1:12)
27 {
28
29     s1=s1+x[i]
30 }
31
32
33 s2=0
34 for (i in 2:13)
35 {
36
37     s2=s2+x[i]
38 }
39
40 s3=0

```

```
41 for (i in 3:14)
42 {
43
44     s3=s3+x[i]
45 }
46
47 s4=0
48 for (i in 4:15)
49 {
50
51     s4=s4+x[i]
52 }
53
54 s5=0
55 for (i in 5:16)
56 {
57
58     s5=s5+x[i]
59 }
60
61 s6=0
62 for (i in 6:17)
63 {
64
65     s6=s6+x[i]
66 }
67
68
69 s7=0
70 for (i in 7:18)
71 {
72
73     s7=s7+x[i]
74 }
75
76
77 s8=0
78 for (i in 8:19)
```

```
79 {
80
81     s8=s8+x[i]
82 }
83
84
85 s9=0
86 for (i in 9:20)
87 {
88
89     s9=s9+x[i]
90 }
91
92 s10=0
93 for (i in 10:21)
94 {
95
96     s10=s10+x[i]
97 }
98
99 s11=0
100 for (i in 11:22)
101 {
102
103     s11=s11+x[i]
104 }
105
106 s12=0
107 for (i in 12:23)
108 {
109
110     s12=s12+x[i]
111 }
112
113 s13=0
114 for (i in 13:24)
115 {
116
```

```
117     s13=s13+x[i]
118 }
119
120 s14=0
121 for (i in 14:25)
122 {
123
124     s14=s14+x[i]
125 }
126
127 s15=0
128 for (i in 15:26)
129 {
130
131     s15=s15+x[i]
132 }
133
134 s16=0
135 for (i in 16:27)
136 {
137
138     s16=s16+x[i]
139 }
140
141 s17=0
142 for (i in 17:28)
143 {
144
145     s17=s17+x[i]
146 }
147
148 s18=0
149 for (i in 18:29)
150 {
151
152     s18=s18+x[i]
153 }
154
```



```
155 s19=0
156 for (i in 19:30)
157 {
158
159     s19=s19+x[i]
160 }
161
162 s20=0
163 for (i in 20:31)
164 {
165
166     s20=s20+x[i]
167 }
168
169 s21=0
170 for (i in 21:32)
171 {
172
173     s21=s21+x[i]
174 }
175
176 s22=0
177 for (i in 22:33)
178 {
179
180     s22=s22+x[i]
181 }
182
183 s23=0
184 for (i in 23:34)
185 {
186
187     s23=s23+x[i]
188 }
189
190 s24=0
191 for (i in 24:35)
192 {
```

```
193
194     s24=s24+x[i]
195 }
196
197 s25=0
198 for (i in 25:36)
199 {
200
201     s25=s25+x[i]
202 }
203
204 s26=0
205 for (i in 26:37)
206 {
207
208     s26=s26+x[i]
209 }
210
211 s27=0
212 for (i in 27:38)
213 {
214
215     s27=s27+x[i]
216 }
217
218 s28=0
219 for (i in 28:39)
220 {
221
222     s28=s28+x[i]
223 }
224
225 s29=0
226 for (i in 29:40)
227 {
228
229     s29=s29+x[i]
230 }
```

```
231
232 s30=0
233 for (i in 30:41)
234 {
235     s30=s30+x[i]
236 }
237
238
239 s31=0
240 for (i in 31:42)
241 {
242     s31=s31+x[i]
243 }
244
245
246 s32=0
247 for (i in 32:43)
248 {
249     s32=s32+x[i]
250 }
251
252
253 s33=0
254 for (i in 33:44)
255 {
256     s33=s33+x[i]
257 }
258
259
260 s34=0
261 for (i in 34:45)
262 {
263     s34=s34+x[i]
264 }
265
266
267 s35=0
268 for (i in 35:46)
```

```
269 {
270
271     s35=s35+x[i]
272 }
273
274
275 s36=0
276 for (i in 36:47)
277 {
278
279     s36=s36+x[i]
280 }
281
282 s37=0
283 for (i in 37:48)
284 {
285
286     s37=s37+x[i]
287 }
288
289 s38=0
290 for (i in 38:49)
291 {
292
293     s38=s38+x[i]
294 }
295
296 s39=0
297 for (i in 39:50)
298 {
299
300     s39=s39+x[i]
301 }
302
303 s40=0
304 for (i in 40:51)
305 {
306
```

```
307     s40=s40+x[i]
308 }
309
310 s41=0
311 for (i in 41:52)
312 {
313
314     s41=s41+x[i]
315 }
316
317 s42=0
318 for (i in 42:53)
319 {
320
321     s42=s42+x[i]
322 }
323
324 s43=0
325 for (i in 43:54)
326 {
327
328     s43=s43+x[i]
329 }
330
331 s44=0
332 for (i in 44:55)
333 {
334
335     s44=s44+x[i]
336 }
337
338 s45=0
339 for (i in 45:56)
340 {
341
342     s45=s45+x[i]
343 }
344
```

```
345 s46=0
346 for (i in 46:57)
347 {
348
349     s46=s46+x[i]
350 }
351
352 s47=0
353 for (i in 47:58)
354 {
355
356     s47=s47+x[i]
357 }
358
359 s48=0
360 for (i in 48:59)
361 {
362
363     s48=s48+x[i]
364 }
365
366 s49=0
367 for (i in 49:60)
368 {
369
370     s49=s49+x[i]
371 }
372
373 s50=0
374 for (i in 50:61)
375 {
376
377     s50=s50+x[i]
378 }
379
380 s51=0
381 for (i in 51:62)
382 {
```

```
383
384     s51=s51+x[i]
385 }
386
387 s52=0
388 for (i in 52:63)
389 {
390
391     s52=s52+x[i]
392 }
393
394 s53=0
395 for (i in 53:64)
396 {
397
398     s53=s53+x[i]
399 }
400
401 s54=0
402 for (i in 54:65)
403 {
404
405     s54=s54+x[i]
406 }
407
408 s55=0
409 for (i in 55:66)
410 {
411
412     s55=s55+x[i]
413 }
414
415 s56=0
416 for (i in 56:67)
417 {
418
419     s56=s56+x[i]
420 }
```

```

421
422 s57=0
423 for (i in 57:68)
424 {
425     s57=s57+x[i]
426 }
427
428
429 s58=0
430 for (i in 58:69)
431 {
432     s58=s58+x[i]
433 }
434
435
436 s59=0
437 for (i in 59:70)
438 {
439     s59=s59+x[i]
440 }
441
442
443 s60=0
444 for (i in 60:71)
445 {
446     s60=s60+x[i]
447 }
448
449
450 s61=0
451 for (i in 61:72)
452 {
453     s61=s61+x[i]
454 }
455
456
457
458 ss=c(s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,s13,s14,

```


s15 , s16 , s17 , s18 , s19 , s20 , s21 , s22 , s23 , s24 , s25 , s26 ,
s27 , s28 , s29 , s30 , s31 , s32 , s33 , s34 , s35 , s36 , s37 , s38 ,
s39 , s40 , s41 , s42 , s43 , s44 , s45 , s46 , s47 , s48 , s49 , s50 ,
s51 , s52 , s53 , s54 , s55 , s56 , s57 , s58 , s59 , s60 , s61)

459

460

461 a1=s1+s2

462 a2=s2+s3

463 a3=s3+s4

464 a4=s4+s5

465 a5=s5+s6

466 a6=s6+s7

467 a7=s7+s8

468 a8=s8+s9

469 a9=s9+s10

470 a10=s10+s11

471 a11=s11+s12

472 a12=s12+s13

473 a13=s13+s14

474 a14=s14+s15

475 a15=s15+s16

476 a16=s16+s17

477 a17=s17+s18

478 a18=s18+s19

479 a19=s19+s20

480 a20=s20+s21

481 a21=s21+s22

482 a22=s22+s23

483 a23=s23+s24

484 a24=s24+s25

485 a25=s25+s26

486 a26=s26+s27

487 a27=s27+s28

488 a28=s28+s29

489 a29=s29+s30

490 a30=s30+s31

491 a31=s31+s32

492 a32=s32+s33

```

493 a33=s33+s34
494 a34=s34+s35
495 a35=s35+s36
496 a36=s36+s37
497 a37=s37+s38
498 a38=s38+s39
499 a39=s39+s40
500 a40=s40+s41
501 a41=s41+s42
502 a42=s42+s43
503 a43=s43+s44
504 a44=s44+s45
505 a45=s45+s46
506 a46=s46+s47
507 a47=s47+s48
508 a48=s48+s49
509 a49=s49+s50
510 a50=s50+s51
511 a51=s51+s52
512 a52=s52+s53
513 a53=s53+s54
514 a54=s54+s55
515 a55=s55+s56
516 a56=s56+s57
517 a57=s57+s58
518 a58=s58+s59
519 a59=s59+s60
520 a60=s60+s61
521
522 a=c(a1,a2,a3,a4,a5,a6,a7,a8,a9,a10,a11,a12,a13,a14,
      a15,a16,a17,a18,a19,a20,a21,a22,a23,a24,a25,a26,
      a27,a28,a29,a30,a31,a32,a33,a34,a35,a36,a37,a38,
      a39,a40,a41,a42,a43,a44,a45,a46,a47,a48,a49,a50,
      a51,a52,a53,a54,a55,a56,a57,a58,a59,a60)
523 aa=a/24
524 aa=round(aa,digits = 1)
525 aa<-ts(aa)
526

```

```

527
528 x1=c(185.9,185.8,165,163.6,169,183.1)
529 x2=c
      (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
530 x3=c
      (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3,
531 x4=c
      (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
532 x5=c
      (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
533 x6=c(205.2,179.6,185.4,172.4,177.7,202.7)
534 x=c(x1,x2,x3,x4,x5,x6)
535 c=x/aa
536 c=c*100
537 c=round(c,digits = 1)
538 c=c(0,0,0,0,0,0,c,0,0,0,0,0,0)
539 g1=c(c[1],c[13],c[25],c[37],c[49],c[61])
540 g2=c(c[2],c[14],c[26],c[38],c[50],c[62])
541 g3=c(c[3],c[15],c[27],c[39],c[51],c[63])
542 g4=c(c[4],c[16],c[28],c[40],c[52],c[64])
543 g5=c(c[5],c[17],c[29],c[41],c[53],c[65])
544 g6=c(c[6],c[18],c[30],c[42],c[54],c[66])
545 g7=c(c[7],c[19],c[31],c[43],c[55],c[67])
546 g8=c(c[8],c[20],c[32],c[44],c[56],c[68])
547 g9=c(c[9],c[21],c[33],c[45],c[57],c[69])
548 g10=c(c[10],c[22],c[34],c[46],c[58],c[70])
549 g11=c(c[11],c[23],c[35],c[47],c[59],c[71])
550 g12=c(c[12],c[24],c[36],c[48],c[60],c[72])
551 g=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
552
553 m1=sum(g1)/5
554 m2=sum(g2)/5
555 m3=sum(g3)/5
556 m4=sum(g4)/5

```

```

557 m5=sum(g5)/5
558 m6=sum(g6)/5
559 m7=sum(g7)/5
560 m8=sum(g8)/5
561 m9=sum(g9)/5
562 m10=sum(g10)/5
563 m11=sum(g11)/5
564 m12=sum(g12)/5
565 m=c(m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,m11,m12)
566 m=round(m,digits = 1)
567
568
569 h1=c(c[13],c[25],c[37],c[49],c[61])
570 h2=c(c[14],c[26],c[38],c[50],c[62])
571 h3=c(c[15],c[27],c[39],c[51],c[63])
572 h4=c(c[16],c[28],c[40],c[52],c[64])
573 h5=c(c[17],c[29],c[41],c[53],c[65])
574 h6=c(c[18],c[30],c[42],c[54],c[66])
575 h7=c(c[7],c[19],c[31],c[43],c[55])
576 h8=c(c[8],c[20],c[32],c[44],c[56])
577 h9=c(c[9],c[21],c[33],c[45],c[57])
578 h10=c(c[10],c[22],c[34],c[46],c[58])
579 h11=c(c[11],c[23],c[35],c[47],c[59])
580 h12=c(c[12],c[24],c[36],c[48],c[60])
581 h=c(g1,g2,g3,g4,g5,g6,g7,g8,g9,g10,g11,g12)
582
583
584
585 s1=sort(h1)
586 s2=sort(h2)
587 s3=sort(h3)
588 s4=sort(h4)
589 s5=sort(h5)
590 s6=sort(h6)
591 s7=sort(h7)
592 s8=sort(h8)
593 s9=sort(h9)
594 s10=sort(h10)

```

```

595 s11=sort(h11)
596 s12=sort(h12)
597
598
599 n1=median(s1)
600 n2=median(s2)
601 n3=median(s3)
602 n4=median(s4)
603 n5=median(s5)
604 n6=median(s6)
605 n7=median(s7)
606 n8=median(s8)
607 n9=median(s9)
608 n10=median(s10)
609 n11=median(s11)
610 n12=median(s12)
611 n=c(n1,n2,n3,n4,n5,n6,n7,n8,n9,n10,n11,n12)
612 n=round(n,digits = 1)
613
614 ss1=sum(m)
615 ss2=sum(n)
616 ss=ss1/ss2
617 n1=n*ss
618 n1=round(n1,digits = 1)
619
620
621 x1=c
      (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18.
622 x2=c
      (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
623 x3=c
      (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3
624 x4=c
      (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,

```

```

625  x5=c
      (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
626  x6=c
      (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.6,

627
628
629  x11=c(x1[1],x2[1],x3[1],x4[1],x5[1],x6[1])
630  x22=c(x1[2],x2[2],x3[2],x4[2],x5[2],x6[2])
631  x33=c(x1[3],x2[3],x3[3],x4[3],x5[3],x6[3])
632  x44=c(x1[4],x2[4],x3[4],x4[4],x5[4],x6[4])
633  x55=c(x1[5],x2[5],x3[5],x4[5],x5[5],x6[5])
634  x66=c(x1[6],x2[6],x3[6],x4[6],x5[6],x6[6])
635  x77=c(x1[7],x2[7],x3[7],x4[7],x5[7],x6[7])
636  x88=c(x1[8],x2[8],x3[8],x4[8],x5[8],x6[8])
637  x99=c(x1[9],x2[9],x3[9],x4[9],x5[9],x6[9])
638  x100=c(x1[10],x2[10],x3[10],x4[10],x5[10],x6[10])
639  x111=c(x1[11],x2[11],x3[11],x4[11],x5[11],x6[11])
640  x122=c(x1[12],x2[12],x3[12],x4[12],x5[12],x6[12])
641  x=c(x11,x22,x33,x44,x55,x66,x77,x88,x99,x100,x111,
      x122)

642
643  x1=x11/n1[1]
644  x2=x22/n1[2]
645  x3=x33/n1[3]
646  x4=x44/n1[4]
647  x5=x55/n1[5]
648  x6=x66/n1[6]
649  x7=x77/n1[7]
650  x8=x88/n1[8]
651  x9=x99/n1[9]
652  x10=x100/n1[10]
653  x11=x111/n1[11]
654  x12=x122/n1[12]
655  x=c(x1,x2,x3,x4,x5,x6,x7,x8,x9,x10,x11,x12)
656  x=x*100
657  x=round(x,digits = 1)

```

```

658
659
660 x11=c(x7[1],x8[1],x9[1],x10[1],x11[1],x12[1])
661 x22=c(x1[2],x2[2],x3[2],x4[2],x5[2],x6[2],x7[2],x8
      [2],x9[2],x10[2],x11[2],x12[2])
662 x33=c(x1[3],x2[3],x3[3],x4[3],x5[3],x6[3],x7[3],x8
      [3],x9[3],x10[3],x11[3],x12[3])
663 x44=c(x1[4],x2[4],x3[4],x4[4],x5[4],x6[4],x7[4],x8
      [4],x9[4],x10[4],x11[4],x12[4])
664 x55=c(x1[5],x2[5],x3[5],x4[5],x5[5],x6[5],x7[5],x8
      [5],x9[5],x10[5],x11[5],x12[5])
665 x66=c(x1[6],x2[6],x3[6],x4[6],x5[6],x6[6])
666 x=c(x11,x22,x33,x44,x55,x66)
667 x=x*100
668 x=round(x,digits = 1)
669
670 y=x/aa
671 y=y*100
672 y=round(y,digits = 1)
673 y1=c(0,0,0,0,0,0,0,y,0,0,0,0,0,0)
674
675 k1 <- matrix(c(y1),ncol=12,byrow=TRUE)
676 colnames(k1) <- c("Jan","Feb","Mar","Apr","May","
      June","July","Aug","Sept","Oct","Nov","Dec")
677 rownames(k1) <- c('1976','1977','1978','1979','1980',
      '1981')
678 k1 <- as.table(k1)
679 k1
680 y <- ts(y, frequency=12, start=c(1976,1))
681 y=y-100
682 plot(y,ylim=c(-5,5))
683 abline(a=0,b=0)
684
685 #”The answer may slightly vary due to rounding off
      values.”

```

R code Exa 18.18.19 3 months and 7 months

```
1 #PAGE=419
2 yr=c(1976,1977,1978,1979,1980,1981)
3 x1=c(91.1,98,96.9,101.1,104,102.9)
4 x2=c
    (102.4,96.3,98.7,99.9,100.1,100,101.7,99.9,99.9,99.4,99,100.2)

5 x3=c
    (99.9,99.9,98.7,98.8,100.9,100.1,99.9,100.3,100.6,99.9,99.9,99.7)

6 x4=c
    (101.6,103,100.7,101.9,99.9,97.6,98.3,99.2,97.5,102.3,100.9,98.6)

7 x5=c
    (96.9,103.7,102,99.9,97.3,97.5,102.9,102.2,101.6,99.9,99.7,99.9)

8 x6=c(97.3,97.1,99.9,101.4,97.8,103.9)
9 x=c(x1,x2,x3,x4,x5,x6)
10 xx <- ts(x, frequency=12, start=c(1976,1))
11 xx
12 length(x2)
13
14 s1=0
15 for (i in 1:3)
16 {
17
18     s1=s1+x[i]
19 }
20 s1
21 s2=0
22 for (i in 2:4)
23 {
24
```



```
25     s2=s2+x[i]
26 }
27 s2
28
29 s3=0
30 for (i in 3:5)
31 {
32
33     s3=s3+x[i]
34 }
35 s3
36 s4=0
37 for (i in 4:6)
38 {
39
40     s4=s4+x[i]
41 }
42 s4
43 s5=0
44 for (i in 5:7)
45 {
46
47     s5=s5+x[i]
48 }
49 s5
50 s6=0
51 for (i in 6:8)
52 {
53
54     s6=s6+x[i]
55 }
56 s6
57 s7=0
58 for (i in 7:9)
59 {
60
61     s7=s7+x[i]
62 }
```

```
63 s7
64 s8=0
65 for (i in 8:10)
66 {
67     s8=s8+x[i]
68 }
69 s8
70 s8
71 s9=0
72 for (i in 9:11)
73 {
74     s9=s9+x[i]
75 }
76 s9
77 s9
78 s10=0
79 for (i in 10:12)
80 {
81     s10=s10+x[i]
82 }
83 s10
84 s10
85 s11=0
86 for (i in 11:13)
87 {
88     s11=s11+x[i]
89 }
90 s11
91 s11
92 s12=0
93 for (i in 12:14)
94 {
95     s12=s12+x[i]
96 }
97 s12
98 s12
99 s13=0
100 for (i in 13:15)
```

```

101 {
102
103     s13=s13+x[i]
104 }
105 s13
106 s14=0
107 for (i in 14:16)
108 {
109
110     s14=s14+x[i]
111 }
112 s14
113 s15=0
114 for (i in 15:17)
115 {
116
117     s15=s15+x[i]
118 }
119 s15
120 s16=0
121 for (i in 16:18)
122 {
123
124     s16=s16+x[i]
125 }
126 s16
127 s17=0
128 for (i in 17:19)
129 {
130
131     s17=s17+x[i]
132 }
133 s17
134 s18=0
135 for (i in 18:20)
136 {
137
138     s18=s18+x[i]

```

```
139 }
140 s18
141 s19=0
142 for (i in 19:21)
143 {
144
145     s19=s19+x[i]
146 }
147 s19
148 s20=0
149 for (i in 20:22)
150 {
151
152     s20=s20+x[i]
153 }
154 s20
155 s21=0
156 for (i in 21:23)
157 {
158
159     s21=s21+x[i]
160 }
161 s21
162 s22=0
163 for (i in 22:24)
164 {
165
166     s22=s22+x[i]
167 }
168 s22
169 s23=0
170 for (i in 23:25)
171 {
172
173     s23=s23+x[i]
174 }
175 s23
176 s24=0
```

```
177 for (i in 24:26)
178 {
179
180     s24=s24+x[i]
181 }
182 s24
183 s25=0
184 for (i in 25:27)
185 {
186
187     s25=s25+x[i]
188 }
189 s25
190 s26=0
191 for (i in 26:28)
192 {
193
194     s26=s26+x[i]
195 }
196 s26
197 s27=0
198 for (i in 27:29)
199 {
200
201     s27=s27+x[i]
202 }
203 s27
204 s28=0
205 for (i in 28:30)
206 {
207
208     s28=s28+x[i]
209 }
210 s28
211 s29=0
212 for (i in 29:31)
213 {
214
```

```
215     s29=s29+x[i]
216 }
217 s29
218 s30=0
219 for (i in 30:32)
220 {
221
222     s30=s30+x[i]
223 }
224 s30
225 s31=0
226 for (i in 31:33)
227 {
228
229     s31=s31+x[i]
230 }
231 s31
232 s32=0
233 for (i in 32:34)
234 {
235
236     s32=s32+x[i]
237 }
238 s32
239 s33=0
240 for (i in 33:35)
241 {
242
243     s33=s33+x[i]
244 }
245 s33
246 s34=0
247 for (i in 34:36)
248 {
249
250     s34=s34+x[i]
251 }
252 s34
```

```
253 s35=0
254 for (i in 35:37)
255 {
256
257     s35=s35+x[i]
258 }
259 s35
260 s36=0
261 for (i in 36:38)
262 {
263
264     s36=s36+x[i]
265 }
266 s36
267 s37=0
268 for (i in 37:39)
269 {
270
271     s37=s37+x[i]
272 }
273 s37
274 s38=0
275 for (i in 38:40)
276 {
277
278     s38=s38+x[i]
279 }
280 s38
281 s39=0
282 for (i in 39:41)
283 {
284
285     s39=s39+x[i]
286 }
287 s39
288 s40=0
289 for (i in 40:42)
290 {
```

```
291
292     s40=s40+x[i]
293 }
294 s40
295 s41=0
296 for (i in 41:43)
297 {
298
299     s41=s41+x[i]
300 }
301 s41
302 s42=0
303 for (i in 42:44)
304 {
305
306     s42=s42+x[i]
307 }
308 s42
309 s43=0
310 for (i in 43:45)
311 {
312
313     s43=s43+x[i]
314 }
315 s43
316 s44=0
317 for (i in 44:46)
318 {
319
320     s44=s44+x[i]
321 }
322 s44
323 s45=0
324 for (i in 45:47)
325 {
326
327     s45=s45+x[i]
328 }
```



```
329 s45
330 s46=0
331 for (i in 46:48)
332 {
333     s46=s46+x[i]
334 }
335 s46
336 s47=0
337 for (i in 47:49)
338 {
339     s47=s47+x[i]
340 }
341 s47
342 s48=0
343 for (i in 48:50)
344 {
345     s48=s48+x[i]
346 }
347 s48
348 s49=0
349 for (i in 49:51)
350 {
351     s49=s49+x[i]
352 }
353 s49
354 s50=0
355 for (i in 50:52)
356 {
357     s50=s50+x[i]
358 }
359 s50
360 s51=0
361 for (i in 51:53)
```

```
367 {
368
369     s51=s51+x[i]
370 }
371 s51
372 s52=0
373 for (i in 52:54)
374 {
375
376     s52=s52+x[i]
377 }
378 s52
379 s53=0
380 for (i in 53:55)
381 {
382
383     s53=s53+x[i]
384 }
385 s53
386 s54=0
387 for (i in 54:56)
388 {
389
390     s54=s54+x[i]
391 }
392 s54
393 s55=0
394 for (i in 55:57)
395 {
396
397     s55=s55+x[i]
398 }
399 s55
400 s56=0
401 for (i in 56:58)
402 {
403
404     s56=s56+x[i]
```

```

405 }
406 s56
407 s57=0
408 for (i in 57:59)
409 {
410     s57=s57+x[i]
411 }
412 s57
413 s58=0
414 for (i in 58:60)
415 {
416     s58=s58+x[i]
417 }
418 s58
419
420 ans1=c(294,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,s13,
421        s14,s15,s16,s17,s18,s19,s20,s21,s22,s23,s24,s25,
422        s26,s27,s28,s29,s30,s31,s32,s33,s34,s35,s36,s37,
423        s38,s39,s40,s41,s42,s43,s44,s45,s46,s47,s48,s49,
424        s50,s51,s52,s53,s54,s55,s56,s57,s58)
425 ans1
426 ss=ans1/3
427 ans2=round(ss,1)
428 ans2
429
430 s1=0
431 for (i in 1:7)
432 {
433     s1=s1+x[i]
434 }
435 s1
436 s2=0
437 for (i in 2:8)
438 {

```

```
439
440     s2=s2+x[i]
441 }
442 s2
443
444 s3=0
445 for (i in 3:9)
446 {
447
448     s3=s3+x[i]
449 }
450 s3
451 s4=0
452 for (i in 4:10)
453 {
454
455     s4=s4+x[i]
456 }
457 s4
458 s5=0
459 for (i in 5:11)
460 {
461
462     s5=s5+x[i]
463 }
464 s5
465 s6=0
466 for (i in 6:12)
467 {
468
469     s6=s6+x[i]
470 }
471 s6
472 s7=0
473 for (i in 7:13)
474 {
475
476     s7=s7+x[i]
```

```
477 }
478 s7
479 s8=0
480 for (i in 8:14)
481 {
482
483     s8=s8+x[i]
484 }
485 s8
486 s9=0
487 for (i in 9:15)
488 {
489
490     s9=s9+x[i]
491 }
492 s9
493 s10=0
494 for (i in 10:16)
495 {
496
497     s10=s10+x[i]
498 }
499 s10
500 s11=0
501 for (i in 11:17)
502 {
503
504     s11=s11+x[i]
505 }
506 s11
507 s12=0
508 for (i in 12:18)
509 {
510
511     s12=s12+x[i]
512 }
513 s12
514 s13=0
```

```
515 for (i in 13:19)
516 {
517
518     s13=s13+x[i]
519 }
520 s13
521 s14=0
522 for (i in 14:20)
523 {
524
525     s14=s14+x[i]
526 }
527 s14
528 s15=0
529 for (i in 15:21)
530 {
531
532     s15=s15+x[i]
533 }
534 s15
535 s16=0
536 for (i in 16:22)
537 {
538
539     s16=s16+x[i]
540 }
541 s16
542 s17=0
543 for (i in 17:23)
544 {
545
546     s17=s17+x[i]
547 }
548 s17
549 s18=0
550 for (i in 18:24)
551 {
552
```

```
553     s18=s18+x[i]
554 }
555 s18
556 s19=0
557 for (i in 19:25)
558 {
559
560     s19=s19+x[i]
561 }
562 s19
563 s20=0
564 for (i in 20:26)
565 {
566
567     s20=s20+x[i]
568 }
569 s20
570 s21=0
571 for (i in 21:27)
572 {
573
574     s21=s21+x[i]
575 }
576 s21
577 s22=0
578 for (i in 22:28)
579 {
580
581     s22=s22+x[i]
582 }
583 s22
584 s23=0
585 for (i in 23:29)
586 {
587
588     s23=s23+x[i]
589 }
590 s23
```

```
591 s24=0
592 for (i in 24:30)
593 {
594
595     s24=s24+x[i]
596 }
597 s24
598 s25=0
599 for (i in 25:31)
600 {
601
602     s25=s25+x[i]
603 }
604 s25
605 s26=0
606 for (i in 26:32)
607 {
608
609     s26=s26+x[i]
610 }
611 s26
612 s27=0
613 for (i in 27:33)
614 {
615
616     s27=s27+x[i]
617 }
618 s27
619 s28=0
620 for (i in 28:34)
621 {
622
623     s28=s28+x[i]
624 }
625 s28
626 s29=0
627 for (i in 29:35)
628 {
```



```
629
630     s29=s29+x[i]
631 }
632 s29
633 s30=0
634 for (i in 30:36)
635 {
636
637     s30=s30+x[i]
638 }
639 s30
640 s31=0
641 for (i in 31:37)
642 {
643
644     s31=s31+x[i]
645 }
646 s31
647 s32=0
648 for (i in 32:38)
649 {
650
651     s32=s32+x[i]
652 }
653 s32
654 s33=0
655 for (i in 33:39)
656 {
657
658     s33=s33+x[i]
659 }
660 s33
661 s34=0
662 for (i in 34:40)
663 {
664
665     s34=s34+x[i]
666 }
```

```
667 s34
668 s35=0
669 for (i in 35:41)
670 {
671     s35=s35+x[i]
672 }
673 s35
674 s36=0
675 for (i in 36:42)
676 {
677     s36=s36+x[i]
678 }
679 s36
680 s37=0
681 for (i in 37:43)
682 {
683     s37=s37+x[i]
684 }
685 s37
686 s38=0
687 for (i in 38:44)
688 {
689     s38=s38+x[i]
690 }
691 s38
692 s39=0
693 for (i in 39:45)
694 {
695     s39=s39+x[i]
696 }
697 s39
698 s40=0
699 for (i in 40:46)
```

```

705 {
706
707     s40=s40+x[i]
708 }
709 s40
710 s41=0
711 for (i in 41:47)
712 {
713
714     s41=s41+x[i]
715 }
716 s41
717 s42=0
718 for (i in 42:48)
719 {
720
721     s42=s42+x[i]
722 }
723 s42
724 s43=0
725 for (i in 43:49)
726 {
727
728     s43=s43+x[i]
729 }
730 s43
731 s44=0
732 for (i in 44:50)
733 {
734
735     s44=s44+x[i]
736 }
737 s44
738 s45=0
739 for (i in 45:51)
740 {
741
742     s45=s45+x[i]

```

```
743 }
744 s45
745 s46=0
746 for (i in 46:52)
747 {
748
749     s46=s46+x[i]
750 }
751 s46
752 s47=0
753 for (i in 47:53)
754 {
755
756     s47=s47+x[i]
757 }
758 s47
759 s48=0
760 for (i in 48:54)
761 {
762
763     s48=s48+x[i]
764 }
765 s48
766 s49=0
767 for (i in 49:55)
768 {
769
770     s49=s49+x[i]
771 }
772 s49
773 s50=0
774 for (i in 50:56)
775 {
776
777     s50=s50+x[i]
778 }
779 s50
780 s51=0
```

```

781 for (i in 51:57)
782 {
783
784     s51=s51+x[i]
785 }
786 s51
787 s52=0
788 for (i in 52:58)
789 {
790
791     s52=s52+x[i]
792 }
793 s52
794 s53=0
795 for (i in 53:59)
796 {
797
798     s53=s53+x[i]
799 }
800 s53
801 s54=0
802 for (i in 54:60)
803 {
804
805     s54=s54+x[i]
806 }
807 s54
808
809 ans3=c(704.4,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,s13
        ,s14,s15,s16,s17,s18,s19,s20,s21,s22,s23,s24,s25,
        s26,s27,s28,s29,s30,s31,s32,s33,s34,s35,s36,s37,
        s38,s39,s40,s41,s42,s43,s44,s45,s46,s47,s48,s49,
        s50,s51,s52,s53,696.8)
810 ans3
811 ss=ans3/7
812 ans4=round(ss,1)
813 ans4
814

```

```

815 ans1
816 ans22=ans2-100
817 ans3
818 ans44=ans4-100
819
820 x=c(x)
821 ans1=c(' ',ans1,' ')
822 ans2=c(' ',ans2,' ')
823 ans3=c(' ',' ',' ',ans3,' ',' ',' ')
824 ans4=c(' ',' ',' ',ans4,' ',' ',' ')
825
826
827 k1 <- matrix(c(x,ans1,ans2,ans3,ans4),ncol=5,byrow=
      FALSE)
828 rownames(k1) <- c("July","Aug","Sept","Oct","Nov","
      Dec","Jan","Feb","Mar","Apr","May","June","July",
      "Aug","Sept","Oct","Nov","Dec","Jan","Feb","Mar",
      "Apr","May","June","July","Aug","Sept","Oct","Nov",
      "Dec","Jan","Feb","Mar","Apr","May","June","
      July","Aug","Sept","Oct","Nov","Dec","Jan","Feb",
      "Mar","Apr","May","June","July","Aug","Sept","Oct",
      "Nov","Dec","Jan","Feb","Mar","Apr","May","June",
      ")
829 colnames(k1) <- c("Data","3-Month Moving Total","3-
      Month Moving Average","7-Month Moving Total","7-
      Month Moving Average")
830 k1 <- as.table(k1)
831 k1
832
833 y <- ts(ans22, frequency=12, start=c(1976,1))
834 plot(y,ylim=c(-5,5),type='l',xlab='3-Month Moving
      Average',ylab='Percent deviation from 100%')
835 abline(a=0,b=0)
836
837 y <- ts(ans44, frequency=12, start=c(1976,1))
838 plot(y,ylim=c(-5,5),type='l',xlab='7-Month Moving
      Average',ylab='Percent deviation from 100%')
839 abline(a=0,b=0)

```

R code Exa 18.18.20 Data modification

```
1 #PAGE=422
2 yr=c(1976,1977,1978,1979,1980,1981)
3 y=c(169.6,176.6,183.7,187.3,190.5,191.1)
4 x1=c
    (178.2,156.7,164.2,153.2,157.5,172.6,185.9,185.8,165,163.6,169,18
5 x2=c
    (196.3,162.8,168.6,156.9,168.2,180.2,197.9,195.9,176,166.4,166.3,
6 x3=c
    (197.3,173.7,173.2,159.7,175.2,187.4,202.6,205.6,185.6,175.6,176.3
7 x4=c
    (209.5,186.3,183,169.5,178.2,186.7,202.4,204.9,180.6,179.8,177.4,
8 x5=c
    (200,188.7,187.5,168.6,175.7,189.4,216.1,215.4,191.5,178.5,178.6,
9 x6=c
    (205.2,179.6,185.4,172.4,177.7,202.7,220.2,210.2,186.9,181.4,175.
10 x=c(x1,x2,x3,x4,x5,x6)
11 x <- ts(x, frequency=12, start=c(1976,1))
12
13 a=28/29
14 x[2]=x[2]*a
15 x[2]=round(x[2],digits = 1)
16 x[50]=x[50]*a
17 x[50]=round(x[50],digits = 1)
18
19 k1 <- matrix(c(x),ncol=12,byrow=TRUE)
20 colnames(k1) <- c("Jan","Feb","Mar","Apr","May","
```

```

    June", " July", " Aug", " Sept", " Oct", " Nov", " Dec")
21 rownames(k1) <- c('1976 ', '1977 ', '1978 ', '1979 ', '1980 '
    , '1981 ')
22 k1 <- as.table(k1)
23 k1

```

R code Exa 18.18.21 Electric Energy Production

```

1 #PAGE=422
2 y=c(1976:1981)
3 j1=c(178.2,196.3,197.3,209.5,200.0,205.2)
4 f=c(156.7,162.8,173.7,186.3,188.7,179.6)
5 m1=c(164.2,168.6,173.2,183,187.5,185.4)
6 a1=c(153.2,156.9,159.7,169.5,168.6,172.4)
7 m2=c(157.5,168.2,175.2,178.2,175.7,177.7)
8 j2=c(172.6,180.2,187.4,186.7,189.4,202.7)
9 j3=c(185.9,197.9,202.6,202.4,216.1,220.2)
10 a2=c(185.8,195.9,205.6,204.9,215.4,210.2)
11 s=c(165,176,185.6,180.6,191.5,186.9)
12 o=c(163.6,166.4,175.6,179.8,178.5,181.4)
13 n=c(169,166.3,176.3,177.4,178.6,175.6)
14 d=c(183.1,183.9,191.7,188.9,195.6,195.6)
15
16 c1=c
    (186.9,186.6,186.9,187,186.9,186.9,187.6,188.6,189.5,189.9,189.9,
17 t1=sum(c1)
18 m1=mean(c1)
19 c2=c
    (190.7,190.5,190.1,190.1,190.4,191,191.7,191.7,191.3,191.2,191.2,
20 t2=sum(c2)
21 m2=mean(c2)
22 m=m2-m1
23 m=round(m,1)

```



```

24 m=m/12
25 m=round(m,2)
26 c4=0
27 c3=c2[length(c2)]
28 for (i in 1:18)
29 {
30     c3=c3+m
31     c4=append(c4,c3)
32 }
33 c4=round(c4,1)
34 c4=c4[2:19]
35 c4=c(c2[length(c2)],c4)
36
37
38 s=c
      (110,96.5,97,88.9,95.1,102.1,110.1,110.7,99.1,94,94.1,102.5)

39
40 c5=c4[7:19]
41 c6=c5*s/100
42 c6=round(c6,1)
43 c6=c6[1:12]
44
45 c4=c(' ',' ',' ',' ',' ',' ',c4)
46
47 y1 <- matrix(c(c4,s,c6),ncol=12,byrow=TRUE)
48 rownames(y1) <- c('1981 trend value (T)', '1982 trend
      value (T)', 'Seasonal insex(S%)', '1982 predicted
      energy(TS)')
49 colnames(y1) <- c("Jan", 'Feb', 'Mar', 'Apr', 'May', '
      June', 'July', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec')
50 y1 <- as.table(y1)
51 y1
52
53 #”The answer may slightly vary due to rounding off
      values.”

```

Chapter 19

Index Numbers

R code Exa 19.1 consumer prices of a litre of milk

```
1 #PAGE=434
2 y=c(1970,1980)
3 c=c(45,54)
4 p1=c[2]/c[1]
5 p1=p1*100
6 cat(p1, '%')
```

R code Exa 19.2 milk prices

```
1 #PAGE=435
2 y=c(1970,1980)
3 c=c(45,54)
4 p1=c[1]/c[2]
5 p1=p1*100
6 cat(p1, '%')
```

R code Exa 19.3 Prices of a commodity

```
1 #PAGE=436
2 t=c(1983,1984,1985,1986)
3 p=c(8,12,15,18)
4
5 p1=p[2]/p[1]
6 p1=p1*100
7 cat(p1, '%')
8
9 p2=p[3]/p[2]
10 p2=p2*100
11 cat(p2, '%')
12
13 p3=p[4]/p[3]
14 p3=p3*100
15 cat(p3, '%')
```

R code Exa 19.4 Price Relative

```
1 #PAGE=436
2 t=c(1983,1984,1985,1986)
3 p=c(8,12,15,18)
4
5 p1=p[2]/p[1]
6 p2=p[3]/p[2]
7 p3=p[4]/p[3]
8
9 p=p1*p2*p3
10 p=p*100
11 cat(p, '%')
```

R code Exa 19.5 Collection of chain relatives

```

1 #PAGE=436
2 t=c(1983,1984,1985,1986)
3 p=c(8,12,15,18)
4
5 p1=p[2]/p[1]
6 p1=p1*100
7 cat(p1, '%')
8
9
10 p2=(p[3]/p[2])*(p[2]/p[1])
11 p2=p2*100
12 cat(p2, '%')
13
14 p3=(p[4]/p[3])*(p[3]/p[2])*(p[2]/p[1])
15 p3=p3*100
16 cat(p3, '%')

```

R code Exa 19.19.1 Average retail prices

```

1 #PAGE=441
2 yr=c(1978,1979,1980,1981,1982,1983,1984)
3 x=c(68.2,82.1,82.3,98.1,84.7,91.1,106.9)
4
5 a=which(yr==1978)
6 y=x[a]
7 b=which(yr==1982)
8 y1=x[b]
9 y1=y1/y
10 y1=y1*100
11 y1=round(y1,digits = 1)
12 cat(y1, '%')
13
14 b1=which(yr==1984)
15 y2=x[b1]
16 y2=y2/y

```

```

17 y2=y2*100
18 y2=round(y2,digits = 1)
19 cat(y2, '%')
20
21
22 c1=which(yr==1980)
23 y3=x[c1]
24 y4=x/y3
25 y4=y4*100
26 y4=round(y4,digits =1 )
27
28
29 smoke <- matrix(c(yr,y4),ncol=7,byrow=TRUE)
30 colnames(smoke) <- c(" "," "," "," "," "," "," ")
31 rownames(smoke) <- c("Year"," Price relative")
32 smoke <- as.table(smoke)
33 smoke
34
35 d1=which(yr==1978)
36 y5=x[d1]
37 d2=which(yr==1979)
38 y6=x[d2]
39 d3=which(yr==1980)
40 y7=x[d3]
41 d=(y5+y6+y7)/3
42 d=round(d,digits = 1)
43
44 y8=x/d
45 y8=y8*100
46 y8=round(y8,digits = 1)
47
48 smoke <- matrix(c(yr,y8),ncol=7,byrow=TRUE)
49 colnames(smoke) <- c(" "," "," "," "," "," "," ")
50 rownames(smoke) <- c("Year"," Price relative")
51 smoke <- as.table(smoke)
52 smoke

```

R code Exa 19.19.3 Price relatives

```
1 #PAGE=442
2 y=c(1978,1979,1980,1981,1982,1983,1984)
3 p=c(88,105.9,106.2,126.6,109.3,117.5,137.9)
4 a=which(y==1980)
5 p1=p[a]
6 p2=p/p1
7 p2=p2*100
8 p2=round(p2,1)
9 sm <- matrix(c(y,p2),ncol=7,byrow=TRUE)
10 colnames(sm) <- c(" ", " ", " ", " ", " ", " ", " ")
11 rownames(sm) <- c("Year", "Price Relative(1980=100)")
12 sm <- as.table(sm)
13 sm
```

R code Exa 19.19.4 Average price of commodity

```
1 #PAGE=442
2 y1=1986
3 c1=0.2
4 y2=1985
5 c2=0.2
6 y3=1984
7 c3=0.5
8 a=100
9 y4=1987
10 x1=a*c1
11 x1=x1+a
12 x1
13
14 x2=a*c2
```

```

15 x2=a-x2
16 x2=x2/100
17 x2=1/x2
18 x3=x2*100
19
20 a1=x2*x1
21 a1
22
23 x4=c3*a
24 x4=a+x4
25 x4=x4/100
26
27 x5=1/x4
28 a2=x1*x5
29 a2
30
31 y=c(y3,y2,y1,y4)
32 x=c(a1,a,x1,a2)
33 k <- matrix(c(y,x),ncol=4,byrow=TRUE)
34 colnames(k) <- c(" "," "," "," ")
35 rownames(k) <- c("Year"," Price relative")
36 smoke <- as.table(k)
37 k
38
39 g=which(y==1986)
40 g1=x[g]
41 g1
42
43 g2=x/g1
44 g2=g2*100
45 g2=round(g2,digits = 1)
46
47 l <- matrix(c(y,g2),ncol=4,byrow=TRUE)
48 colnames(l) <- c(" "," "," "," ")
49 rownames(l) <- c("Year"," Price relative")
50 l <- as.table(l)
51 l
52

```

```

53 g3=which(y==1984)
54 g3=x[g3]
55
56 g4=which(y==1985)
57 g4=x[g4]
58
59 g5=(g3+g4)/2
60 g5=x/g5
61 g5=g5*100
62
63 l1 <- matrix(c(y,g5),ncol=4,byrow=TRUE)
64 colnames(l1) <- c(" "," "," "," ")
65 rownames(l1) <- c("Year"," Price relative")
66 l1 <- as.table(l1)
67 l1

```

R code Exa 19.19.5 wheat production of the country

```

1 #PAGE=443
2 y=c(1977,1978,1979,1980,1981,1982,1983,1984,1985)
3 p=c(2046,1776,2134,2380,2785,2765,2420,2595,2425)
4
5 a=which(y==1982)
6 g=p[a]
7 g1=p/g
8 g1=g1*100
9 g1=round(g1,digits = 1)
10
11 l <- matrix(c(y,g1),ncol=9,byrow=TRUE)
12 colnames(l) <- c(" "," "," "," "," "," "," "," "," ")
13 rownames(l) <- c("Year"," Price relative")
14 l <- as.table(l)
15 l
16

```



```

17 a1=which(y==1977)
18 g2=p[a1]
19
20 a2=which(y==1978)
21 g3=p[a2]
22
23 a3=which(y==1979)
24 g4=p[a3]
25
26 a4=which(y==1980)
27 g5=p[a4]
28
29 g6=(g2+g3+g4+g5)/4
30 g7=p/g6
31 g7=g7*100
32 g7=round(g7,digits = 1)
33
34 l1 <- matrix(c(y,g7),ncol=9,byrow=TRUE)
35 colnames(l1) <- c(" ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ")
36 rownames(l1) <- c("Year", " Price relative")
37 l1 <- as.table(l1)
38 l1

```

R code Exa 19.19.6 quantity relative for the base year

```

1 #PAGE=444
2 y1=1986
3 a1=105
4 y2=1977
5 a2=140
6 y3=1980
7 a1=a1/100
8 a2=a2/100
9 b1=1/a2

```

```
10 b2=b1*a1
11 b2=b2*100
12 cat(b2, '%')
```

R code Exa 19.19.7 factory pay and employees

```
1 #PAGE=445
2 y1=1980
3 a1=80000
4 e1=120
5 a2=30
6 e2=e1+a2
7 b1=12000
8
9 a=e2/e1
10 a=a*100
11 a
12
13 b=(a1+b1)/a1
14 b=b*100
15 b
16
17 c=b/a
18 c=c*100
19 c
```

R code Exa 19.19.8 sales of commodity

```
1 #PAGE=445
2 a=150
3 b=200
4 c=b/a
5 c=c-1
```

```

6 c=round(c,digits = 2)
7 cat(c, '%')
8 #”The answer may vary due to difference in
  representation.”

```

R code Exa 19.19.9 link relatives

```

1 #PAGE=445
2 y=c(1981,1982,1983,1984,1985)
3 x=c(125,120,135,150,175)
4
5 g1=which(y==1981)
6 g1=x[g1]
7
8 g2=which(y==1982)
9 g2=x[g2]
10
11 g3=which(y==1983)
12 g3=x[g3]
13
14 g4=which(y==1984)
15 g4=x[g4]
16
17 g5=which(y==1985)
18 g5=x[g5]
19
20 g1=g1/100
21 g2=g2/100
22 g3=g3/100
23 g4=g4/100
24 g5=g5/100
25
26 a=g1*g2
27 a=a*100
28 cat(a, '%')

```

```

29
30 p1=1/g1
31 p1=p1*100
32 cat(p1, '%')
33
34 p2=1.2/g2
35 p2=p2*100
36 cat(p2, '%')
37
38 p3=g2*100
39 cat(p3, '%')
40
41 p4=g2*g3
42 p4=p4*100
43 cat(p4, '%')
44
45 p5=g2*g3*g4
46 p5=p5*100
47 cat(p5, '%')
48
49 p6=g2*g3*g4*g5
50 p6=p6*100
51 p6=round(p6,digits = 0)
52 cat(p6, '%')

```

R code Exa 19.19.10 Milk butter and cheese

```

1 #PAGE=446
2 y=c(1980,1981,1985)
3 y1=c(29.11,306.5,343.6)
4 y2=c(30.69,325.6,367.8)
5 y3=c(28.38,310.4,356.4)
6 y4=c(58410,520,1082)
7 y5=c(60360,558,1211)
8 y6=c(65320,567,1297)

```

```

9  a=sum(y3)/sum(y1)
10 a=a*100
11 a=round(a,digits = 1)
12 cat(a,'%')
13
14 b1=(y1[1]+y2[1])/2
15 b1
16 b2=(y1[2]+y2[2])/2
17 b2=round(b2,digits = 0)
18 b2
19 b3=(y1[3]+y2[3])/2
20 b3
21
22 s=sum(y3)/(b1+b2+b3)
23 s=s*100
24 s=round(s,digits = 1)
25 cat(s,'%')

```

R code Exa 19.19.12 Average US prices and production of cotton and wheat

```

1  #PAGE=447
2  y<-c(1980,1986)
3  p1<-c(163.7,125)
4  p2<-c(143,116)
5  q1<-c(2.427,13.947)
6  q2<-c(2.931,13.285)
7  p1=p1/100
8  a1=(p1[2]+p2[2])/(p1[1]+p2[1])
9  a1=a1*100
10 a1=round(a1,1)
11 cat(a1,'%')
12 p2<-p2/10
13 p1<-p1*100
14 a2=(p1[2]+p2[2])/(p1[1]+p2[1])

```

```
15 a2=a2*100
16 a2=round(a2,1)
17 cat(a2, '%')
```

R code Exa 19.19.13 Wholesale price index of dairy products

```
1 #PAGE=447
2 y=c(1980,1981,1985)
3 y1=c(29.11,306.5,343.6)
4 y2=c(30.69,325.6,367.8)
5 y3=c(28.38,310.4,356.4)
6 y4=c(58410,520,1082)
7 y5=c(60360,558,1211)
8 y6=c(65320,567,1297)
9
10 a1=y3[1]/y1[1]
11 a1=a1*100
12 a1=round(a1,digits = 1)
13 cat(a1, '%')
14 a2=y3[2]/y1[2]
15 a2=a2*100
16 a2=round(a2,digits = 1)
17 cat(a2, '%')
18 a3=y3[3]/y1[3]
19 a3=a3*100
20 a3=round(a3,digits = 1)
21 cat(a3, '%')
22 m=(a1+a2+a3)/3
23 m=round(m,digits = 1)
24 cat(m, '%')
```

R code Exa 19.19.14 Median instead mean

```

1  #PAGE=448
2  y=c(1980,1981,1985)
3  y1=c(29.11,306.5,343.6)
4  y2=c(30.69,325.6,367.8)
5  y3=c(28.38,310.4,356.4)
6  y4=c(58410,520,1082)
7  y5=c(60360,558,1211)
8  y6=c(65320,567,1297)
9
10 a1=y3[1]/y1[1]
11 a1=a1*100
12 a1=round(a1,digits = 1)
13 a2=y3[2]/y1[2]
14 a2=a2*100
15 a2=round(a2,digits = 1)
16 a3=y3[3]/y1[3]
17 a3=a3*100
18 a3=round(a3,digits = 1)
19
20 a=c(a1,a2,a3)
21 a=median(a)
22 a
23
24 a1=(y1[1]+y2[1])/2
25 a1=y3[1]/a1
26 a1=a1*100
27 a1=round(a1,digits = 1)
28 a2=(y1[2]+y2[2])/2
29 a2=y3[2]/a2
30 a2=a2*100
31 a2=round(a2,digits = 1)
32 a3=(y1[3]+y2[3])/2
33 a3=y3[3]/a3
34 a3=a3*100
35 a3=round(a3,digits = 1)
36
37 a=c(a1,a2,a3)
38 a=median(a)

```

R code Exa 19.19.15 Geometric mean instead of mean

```
1 #PAGE=448
2 y=c(1980,1981,1985)
3 y1=c(29.11,306.5,343.6)
4 y2=c(30.69,325.6,367.8)
5 y3=c(28.38,310.4,356.4)
6 y4=c(58410,520,1082)
7 y5=c(60360,558,1211)
8 y6=c(65320,567,1297)
9
10 a1=y3[1]/y1[1]
11 a1=a1*100
12 a1=round(a1,digits = 1)
13 a2=y3[2]/y1[2]
14 a2=a2*100
15 a2=round(a2,digits = 1)
16 a3=y3[3]/y1[3]
17 a3=a3*100
18 a3=round(a3,digits = 1)
19
20 a=c(a1,a2,a3)
21 l=length(a)
22 a=(a1*a2*a3)**(1/l)
23 a=round(a,digits = 1)
24 a
25
26 a1=(y1[1]+y2[1])/2
27 a1=y3[1]/a1
28 a1=a1*100
29 a1=round(a1,digits = 1)
30 a2=(y1[2]+y2[2])/2
31 a2=y3[2]/a2
```



```

32 a2=a2*100
33 a2=round(a2,digits = 1)
34 a3=(y1[3]+y2[3])/2
35 a3=y3[3]/a3
36 a3=a3*100
37 a3=round(a3,digits = 1)
38
39 a=c(a1,a2,a3)
40 l=length(a)
41 a=(a1*a2*a3)**(1/l)
42 a=round(a,digits = 1)
43 a

```

R code Exa 19.19.16 price relatives index for commodities

```

1 #PAGE=448
2 y1=1980
3 y2=1986
4 a1=163.7
5 a2=125
6 b1=143
7 b2=116
8 c1=a2/a1
9 c1=c1*100
10 c1=round(c1,digits = 1)
11 cat(c1, '%')
12
13 c2=b2/b1
14 c2=c2*100
15 c2=round(c2,digits = 1)
16 cat(c2, '%')
17
18 c=(c1+c2)/2
19 c=round(c,digits = 1)
20 cat(c, '%')

```

R code Exa 19.19.17 Using geometric mean

```
1 #PAGE=448
2 y1=1980
3 y2=1986
4 a1=163.7
5 a2=125
6 b1=143
7 b2=116
8 c1=a2/a1
9 c1=c1*100
10 c1=round(c1,digits = 1)
11
12 c2=b2/b1
13 c2=c2*100
14 c2=round(c2,digits = 1)
15
16 c=c(c1,c2)
17 l=length(c)
18 c=(c1*c2)**(1/l)
19 c=round(c,digits = 1)
20 cat(c, '%')
```

R code Exa 19.19.18 Laspeyres price index

```
1 #PAGE=448
2 y=c(1980,1981,1985)
3 y1=c(29.11,306.5,343.6)
4 y2=c(30.69,325.6,367.8)
5 y3=c(28.38,310.4,356.4)
6 y4=c(58410,520,1082)
```

```

7 y5=c(60360,558,1211)
8 y6=c(65320,567,1297)
9 a1=sum(y3*y4)
10 a2=sum(y1*y4)
11 a=a1/a2
12 a=a*100
13 a=round(a,digits = 1)
14 cat(a, '%')
15
16 c1=(y4+y5)/2
17 c3=(y1+y2)/2
18 c4=sum(c1*y3)
19 c5=sum(c3*c1)
20 c6=c4/c5
21 c6=c6*100
22 c6=round(c6,digits = 1)
23 cat(c6, '%')

```

R code Exa 19.19.19 Paasche

```

1 #PAGE=449
2 y=c(1980,1981,1985)
3 y1=c(29.11,306.5,343.6)
4 y2=c(30.69,325.6,367.8)
5 y3=c(28.38,310.4,356.4)
6 y4=c(58410,520,1082)
7 y5=c(60360,558,1211)
8 y6=c(65320,567,1297)
9 a1=sum(y3*y6)
10 a2=sum(y1*y6)
11 a=a1/a2
12 a=a*100
13 a=round(a,digits = 1)
14 cat(a, '%')
15

```

```

16 c3=(y1+y2)/2
17 c4=sum(y6*y3)
18 c5=sum(c3*y6)
19 c6=c4/c5
20 c6=c6*100
21 c6=round(c6,digits = 1)
22 cat(c6,'%')

```

R code Exa 19.19.20 Laspeyres price index and Paasche price index

```

1 #PAGE=449
2 y1=1980
3 y2=1986
4 a1=163.7/100
5 a2=125/100
6 b1=143
7 b2=116
8 c1=2.427
9 c2=2.931
10 d1=13.947
11 d2=13.285
12
13 a=((a2*c1*1000)+(b2*d1))/((a1*c1*1000)+(b1*d1))
14 a=a*100
15 a=round(a,digits = 1)
16 cat(a,'%')
17
18 b=((a2*c2*1000)+(b2*d2))/((a1*c2*1000)+(b1*d2))
19 b=b*100
20 b=round(b,digits = 1)
21 cat(b,'%')

```

R code Exa 19.19.26 Fishers ideal price index for the dairy products

```

1 #PAGE=451
2 l1=0.988
3 p1=0.9885
4 l2=0.9607
5 p2=0.9608
6 f1=sqrt(l1*p1)
7 f2=sqrt(l2*p2)
8 f1=f1*100
9 f1=round(f1,1)
10 f2=f2*100
11 f2=round(f2,1)
12 cat(f1, '%')
13 cat(f2, '%')

```

R code Exa 19.19.27 Fishers ideal price index

```

1 #PAGE=451
2 y1=1980
3 y2=1986
4 a1=163.7/100
5 a2=125/100
6 b1=143
7 b2=116
8 c1=2.427
9 c2=2.931
10 d1=13.947
11 d2=13.285
12
13 a=((a2*c1*1000)+(b2*d1))/((a1*c1*1000)+(b1*d1))
14 a=a*100
15 a=round(a,digits = 1)
16 a=a/100
17
18 b=((a2*c2*1000)+(b2*d2))/((a1*c2*1000)+(b1*d2))
19 b=b*100

```

```

20 b=round(b,digits = 1)
21 b=b/100
22
23 c=sqrt(a*b)
24 c=c*100
25 c=round(c,digits = 1)
26 cat(c, '%')

```

R code Exa 19.19.29 Marshall Edgeworth

```

1 #PAGE=452
2 y=c(1980,1981,1985)
3 y1=c(29.11,306.5,343.6)
4 y2=c(30.69,325.6,367.8)
5 y3=c(28.38,310.4,356.4)
6 y4=c(58410,520,1082)
7 y5=c(60360,558,1211)
8 y6=c(65320,567,1297)
9 y=(y4+y6)
10 a1=sum(y*y3)/sum(y*y1)
11 a1=a1*100
12 a1=round(a1,digits = 1)
13 cat(a1, '%')

```

R code Exa 19.19.31 Weighted arithmetic mean

```

1 #PAGE=453
2 p0=c(163.7,143)
3 pn=c(125,116)
4 qn=c(2931,13.285)
5 c1=pn/p0
6 c1=round(c1,digits = 4)
7 c2=pn*qn

```

```

8  g1=c2[1]/100
9  g2=c2[2]
10 g2=round(g2,digits = 1)
11 g=c(g1,g2)
12 c3=c1*g
13 c3=round(c3,digits = 1)
14 s1=sum(g)
15 s2=sum(c3)
16 s1=round(s1,digits = 1)
17
18 a=s2/s1
19 a=a*100
20 a=round(a,digits = 1)
21 cat(a,'%')
22
23 q0=c(2.427,13.947)
24 p0=c(163.7/100,143)
25 pn=c(125/100,116)
26 qn=c(2.931*1000,13.285)
27
28 y1=1980
29 y2=1986
30 p01=163.7/100
31 pn1=125/100
32 p02=143
33 pn2=116
34 q01=2.427*1000
35 qn1=2.931
36 q02=13.947
37 qn2=13.285
38
39 c=(pn1*q01+pn2*q02)/(p01*q01+p02*q02)
40 c=c*100
41 c=round(c,digits = 1)
42 cat(c,'%')

```

R code Exa 19.19.32 Computing the volume index

```
1 #PAGE=454
2 y1=1980
3 y2=1986
4 p01=163.7*10
5 pn1=125
6 p02=143
7 pn2=116
8 q01=2.427
9 qn1=2.931
10 q02=13.947
11 qn2=13.285
12 p0=c(p01,p02)
13 pn=c(pn1,pn2)
14 q0=c(q01,q02)
15 qn=c(qn1,qn2)
16
17 a=(qn1/q01+qn2/q02)/2
18 a=a*100
19 a=round(a,digits = 0)
20 cat(a,'%')
21
22 b=(qn1*p01+qn2*p02)/(q01*p01+q02*p02)
23 b=b*100
24 b=round(b,digits = 1)
25 cat(b,'%')
26
27 c=(qn1*pn1*10+qn2*pn2)/(q01*pn1*10+q02*pn2)
28 c=c*100
29 c=round(c,digits = 1)
30 cat(c,'%')
```

R code Exa 19.19.33 Fishers ideal volume index number

```
1 #PAGE=454
2 y1=1980
3 y2=1986
4 p01=163.7*10
5 pn1=125
6 p02=143
7 pn2=116
8 q01=2.427
9 qn1=2.931
10 q02=13.947
11 qn2=13.285
12 p0=c(p01,p02)
13 pn=c(pn1,pn2)
14 q0=c(q01,q02)
15 qn=c(qn1,qn2)
16
17 a=(qn1/q01+qn2/q02)/2
18 a=a*100
19 a=round(a,digits = 0)
20
21 b=(qn1*p01+qn2*p02)/(q01*p01+q02*p02)
22 b=b*100
23 b=round(b,digits = 1)
24
25 c=(qn1*pn1*10+qn2*pn2)/(q01*pn1*10+q02*pn2)
26 c=c*100
27 c=round(c,digits = 1)
28
29 d=sqrt(b*c)
30 d=round(d,digits = 0)
31 cat(d,'%')
```

R code Exa 19.19.35 Value Index

```
1 #PAGE=455
2 y1=1980
3 y2=1986
4 p01=163.7*10
5 pn1=125
6 p02=143
7 pn2=116
8 q01=2.427
9 qn1=2.931
10 q02=13.947
11 qn2=13.285
12 p0=c(p01,p02)
13 pn=c(pn1,pn2)
14 q0=c(q01,q02)
15 qn=c(qn1,qn2)
16
17 a=(qn1/q01+qn2/q02)/2
18 a=a*100
19 a=round(a,digits = 0)
20
21 b=(qn1*p01+qn2*p02)/(q01*p01+q02*p02)
22 b=b*100
23 b=round(b,digits = 1)
24
25 c=(qn1*pn1*10+qn2*pn2)/(q01*pn1*10+q02*pn2)
26 c=c*100
27 c=round(c,digits = 1)
28
29 d=sqrt(b*c)
30 d=round(d,digits = 0)
31
32 y1=1980
```

```

33 y2=1986
34 a1=163.7/100
35 a2=125/100
36 b1=143
37 b2=116
38 c1=2.427
39 c2=2.931
40 d1=13.947
41 d2=13.285
42
43 a=((a2*c1*1000)+(b2*d1))/((a1*c1*1000)+(b1*d1))
44 a=a*100
45 a=round(a,digits = 1)
46 a=a/100
47
48 b=((a2*c2*1000)+(b2*d2))/((a1*c2*1000)+(b1*d2))
49 b=b*100
50 b=round(b,digits = 1)
51 b=b/100
52
53 c=sqrt(a*b)
54 c=c*100
55 c=round(c,digits = 1)
56
57 vi=d*c
58 vi=vi/100
59 vi=round(vi,digits = 1)
60 cat(vi, '%')

```

R code Exa 19.19.38 Industrial production

```

1 #PAGE=456
2 yr=c
  (1974,1975,1976,1977,1978,1979,1980,1981,1982,1983,1984,1985)

```

```

3 x=c(93,85,93,100,107,111,109,111,103,109,122,125)
4
5 a=which(yr==1979)
6 a=x[a]
7 x1=x/a*100
8 x1=round(x1,digits = 0)
9
10 z<- matrix(c(yr,x1),ncol=12,byrow=TRUE)
11 colnames(z) <- c(" "," "," "," "," "," "," "," "," "," "," "," ")
    , " "," "," "," ")
12 rownames(z) <- c("year","index")
13 z <- as.table(z)
14 z
15
16 b=which(yr==1974)
17 b=x[b]
18 c=which(yr==1975)
19 c=x[c]
20 d=which(yr==1976)
21 d=x[d]
22
23 e=(b+c+d)/3
24 x2=x/e*100
25 x2=round(x2,digits = 0)
26 x2
27
28 z1<- matrix(c(yr,x2),ncol=12,byrow=TRUE)
29 colnames(z1) <- c(" "," "," "," "," "," "," "," "," "," "," "," ")
    , " "," "," ")
30 rownames(z1) <- c("year","index")
31 z1 <- as.table(z1)
32 z1

```

R code Exa 19.19.39 Weekly wage of workers in US

```

1 #PAGE=457
2 yr=c
   (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

3 x=c
   (96.32,102.68,108.86,114.6,121.66,130.2,138.62,147.38,158.03,163.1)

4 y=c
   (106.2,117.9,128.7,136.1,144.9,155.9,173.5,197,217.4,230.7,238.1)

5
6 a=which(yr==1973)
7 b=y[a]
8 c=y/b
9 c=c*100
10 c=round(c,digits = 1)
11
12 e=x/c
13 e=e*100
14 e=round(e,digits = 2)
15
16 y <- matrix(c(yr,c,e),ncol=11,byrow=TRUE)
17 colnames(y) <- c(" ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ")
   , " ", " ", " ")
18 rownames(y) <- c("year", "consumer price", "real
   weekly wage")
19 y <- as.table(y)
20 y

```

R code Exa 19.19.40 Consumer price index

```

1 #PAGE=457
2 yr=c
   (1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983)

```

```

3  x=c
    (96.32,102.68,108.86,114.6,121.66,130.2,138.62,147.38,158.03,163.8)

4  y=c
    (106.2,117.9,128.7,136.1,144.9,155.9,173.5,197,217.4,230.7,238.1)

5
6  a=which(yr==1973)
7  b=y[a]
8  c=y/b
9  c=c*100
10 c=round(c,digits = 1)
11
12 e=x/c
13 e=e*100
14 e=round(e,digits = 2)
15
16 d=1
17 d=d/c
18 d=d*100
19 d=round(d,digits = 2)
20
21 y <- matrix(c(yr,d),ncol=11,byrow=TRUE)
22 colnames(y) <- c(" ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " ")
    , " ", " ", " ")
23 rownames(y) <- c("year", "purchasing power")
24 y <- as.table(y)
25 y

```
