R Textbook Companion for Introductory Statistics by Sheldon M. Ross[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

Contents

List of R Codes

Chapter 2

Describing Data Sets

R code Exa 2.1 Sick Leave

```
# Page No. 18
sick_days<-c(0,1,2,3,4,5,6,7,8,9)
frequency<-c(12,8,5,4,5,8,0,5,2,1)
leave<-data.frame(sick_days,frequency)
View(leave)
total_workers=sum(leave$frequency)
print(total_workers -leave[1,2])
print(sum(leave$frequency[4:6]))
print(sum(leave$frequency[7:10]))
```

R code Exa 2.2 Golf Tournament

```
# Page No. 23
winning_score<-c
   (270,271,272,274,275,276,277,278,279,280,281,282,283,284,285,286)

frequency<-c(1,1,1,1,2,4,5,3,6,4,3,1,2,1,1,1)
relative_frequency<-c(frequency/37)
```

```
golf<-data.frame(winning_score,frequency,relative_
   frequency)
View(golf)
barplot(relative_frequency, main="Relative Frequency
    Bar Graph", xlab="Winning Score",ylab = "
   Relative Frequency",names.arg = golf$winning_
   score,  col="darkred")
```

R code Exa 2.3 Birth Rate

```
# Page No. 35
class_intervals<-c
   (14.2,21.9,19,14.5,19.2,15.9,14.7,17.1,15.2,17.1,17.6,15.2,16,14.

breaks=seq(12.0,22.5,by=1.5)
class_intervals.cut=cut(class_intervals,breaks,right
   =FALSE)
class_intervals.freq=table(class_intervals.cut)
View(class_intervals.freq)
barplot(class_intervals.freq, main="Histogram", xlab
   ="Birth Rate",ylab="Frequency",col="purple",space
    = 0)
```

R code Exa 2.4 Blood Pressure

```
# Page No. 37
bloodpressure<-c("Less than 90","90-100","100-110","
   110-120","120-130","130-140","140-150","150-160",
   "160-170","170-180","180-190","190-200","2000-210
   ","210-220","220-230","230-240")
rf_30_40<-c
   (3,17,118,460,768,675,312,120,45,18,3,1,0,0,0,0)/
   2450
```

```
rf_50_60<-c
   (1,2,23,57,122,149,167,73,62,35,20,9,3,5,2,1)/731
BP<-c
   (90,100,110,120,130,140,150,160,170,180,190,200,210,220,230,240)

bp<-data.frame(bloodpressure,rf_30_40,rf_50_60)
View(bp)
plot(BP,rf_30_40, type="l", col="red", main="Aged
   30-40->Red. Aged 50-60->Green.")
par(new=TRUE)
plot(BP,rf_50_60, type="l", col="green" )
```

R code Exa 2.5 Income

```
# Page No.44
income<-c(30941,25128,32151,26183,23512,32996,
          33276,42706,32779,42120,29596,28821,30001,25057,

          33404,28240,28280,29141,25579,25446,27744,36298,

          39244,30296,34071,22372,28936,25020,29771,30180,

          34334,39543,23941,36043,27711,26962,29406,25575,

          28731,31727,31319,25400,26894,27671,28551,24306,

          29567,32922,32677,23688,29923,30578)
d = sort(income)
n = 3
d2 = sapply(split(d, trunc(d/10^n)), function(x){
  before = trunc(x[1]/10^n)
  fmt = paste0("%0", n, "d")
  after = toString(sprintf(fmt, sort(x %% 10^n)))
  paste(before, after, sep = " | ")
})
```

```
for(x in d2){
  cat(x)
  cat("\n")
}
```

R code Exa 2.6 Minority

```
# Page No. 45
student_minority<-c(55.2, 47.8, 44.6, 64.2, 61.4,
    36.6, 28.2, 57.4, 41.3,44.6, 55.2, 39.6, 40.9,
    52.2, 63.3, 34.5, 30.8, 45.3)
stem(student_minority,scale=8, width=250)
```

R code Exa 2.7 Sporting Convention

```
# Page No. 46
weights_attendees<-c
    (102,103,103,104,107,110,111,112,112,113,116,119,121,122,124,124,

                              ,127,129,131,132,132,135,135,136,136,138,139,1

                              151,151,155,156,156,156,157,160,161,161,161,16

                              175,176,176,176,181,182,182,185,185,186,186,18

stem(weights_attendees,scale=2)
```

Chapter 3

Using Statistics to Summarize Data Sets

R code Exa 3.1 Fuel Efficiency

```
#  Page No. 73
fuel_efficiencies<-c(28.2, 28.3, 28.4, 28.5, 29.0)
print(mean(fuel_efficiencies))
```

R code Exa 3.2 Masters Golf Tournament

```
# Page No. 74
WinningScores<-c(280, 284, 280, 277, 282, 279, 285,
    281, 283, 278)
trans_data<-c(WinningScores-280)
View(trans_data)
print(mean(trans_data)+280)
```

R code Exa 3.3 Suits

```
# Page No. 75
value<-c(3,4,5)
frequency<-c(2,1,3)
suits<-data.frame(value,frequency)
View(suits)
print(mean((value*frequency))/2)
# The  answer provided in the textbook is wrong
```

R code Exa 3.4 Motorcycle Accidents

```
# Page No. 76
classification<-c(0,1,2,3,4,5,6)
f1<-sum(freq_with_helmet<-c(248,58,11,3,2,8,1))
v1<-sum(val_with_helmet<-c(classification*freq_with_
    helmet))
f2<-sum(freq_without_helmet<-c(227,135,33,14,3,21,6)
    )
v2<-sum(val_without_helmet<-c(classification*freq_
    without_helmet))
cat("Wearing  Helmet=",round(v1/f1, digits = 4))
cat("\nNot  Wearing  Helmet=",round((v2/f2),digits =
    3))
```

R code Exa 3.5 Deviations

```
# Page No. 79
fuel_efficiency<-c(28.2, 28.3, 28.4, 28.5, 29.0)
mean=28.48
deviation<-c(fuel_efficiency-mean)
View(deviation)
print(all.equal(sum(deviation),0))
```

R code Exa 3.6 Drivers License

```
# Page No. 83
weeks<-c(2, 110, 5, 7, 6, 7, 3)
print(median(weeks))
```

R code Exa 3.7 Smoking

```
# Page No. 84
no_of_days<-c(1, 2, 3, 5, 8, 100)
print(median(no_of_days))
```

R code Exa 3.8 NBA

```
# Page No. 84
scoring_avg<-c
    (32.6,29.8,29.3,30.4,29.6,28.7,26.8,29.7,31.1,31.4,32.1,28.0,30.7

print(median(scoring_avg))
print(mean(scoring_avg))
```

R code Exa 3.9 Percentile

```
# Page No. 91
sample1=8
sample2=16
sample3=100
```

```
print(0.9*sample1)
print(0.9*sample2)
print(0.9*sample3)
```

R code Exa 3.10 Assets

```
# Page No. 91
funds<-c
   (25473721,15224900,12205000,11610997,11206500,6712436,5221916,519
View(funds)
p_90=(funds[2]+funds[3])/2
print(p_90)
p_20=(funds[16]+funds[17])/2
print(p_20)
```

R code Exa 3.11 Bowling Tournament

```
# Page No. 93
sample_q<-c(122, 126, 133, 140, 145, 145, 149, 150,
   157, 162, 166, 175, 177, 177, 183,188, 199, 212)
View(sample_q)
p=0.253*18
percentile_25=sample_q[ceiling(p)]
print(percentile_25)
q=0.50*18
second_quartile=(sample_q[q]+sample_q[q+1])/2
print(second_quartile)
q3=0.75*18
third_quartile=sample_q[ceiling(q3)]
print(third_quartile)
```

R code Exa 3.12 Dresses

```
# Page No. 97
mode <- function(value){
unique_value <- unique(value)
unique_value[which.max(tabulate(match(value, unique_
    value)))]
}
dresses<-c(8, 10, 6, 4, 10, 12, 14, 10)
print(mode(dresses))
```

R code Exa 3.13 Day Care

```
# Page No. 97
library(modeest)
ages<-c(2, 5, 3, 5, 2, 4)
print(mfv(ages))
```

R code Exa 3.14 Dice

```
# Page No. 97
library(modeest)
Value<-c(1,2,3,4,5,6)
Freq<-c(6,4,5,8,3,4)
ValxFreq<-c(Value*Freq)
Dice<-data.frame(Value,Freq,ValxFreq)
View(Dice)
cat("\nMode=",mfv(Freq))
cat("\nMedian=",median(ValxFreq)," value.Median=",(
    Value[3]+Value[4])/2)
```

```
cat("\nMean=",(sum(ValxFreq)/30))
```

R code Exa 3.15 Variance of Data

```
# Page No. 100
xi<-c(1,2,5,6,6)
m=mean(xi)
xm<-c(m,m,m,m,m)
xi_xm<-c(xi-xm)
xi_xm_sq<-c(xi_xm^2)
variance<-data.frame(xi,xm,xi_xm,xi_xm_sq)
View(variance)
var=sum(xi_xm_sq)/4
print(var)
```

R code Exa 3.16 Variance

```
# Page No. 100
xi<-c(-40, 0, 5, 20, 35)
m=mean(xi)
xm<-c(m,m,m,m,m)
xi_xm<-c(xi-xm)
xi_xm_sq<-c(xi_xm^2)
variance<-data.frame(xi,xm,xi_xm,xi_xm_sq)
View(variance)
var=sum(xi_xm_sq)/4
print(var)
```

R code Exa 3.17 Identity

```r
# Page No. 101
xi<-c(1,2,5,6,6)
xi2<-c(sum(xi^2))
n=5
x_mean=4
summation=xi2-n*(x_mean^2)
print(summation)
xi_xm<-c(xi-x_mean)
xi_xm_sq<-c(sum(xi_xm^2))
print(all.equal(summation,xi_xm_sq))
```

R code Exa 3.18 Law Enforcement Officers

```r
# Page No. 102
officers_killed<-c(164, 165, 157, 164, 152, 147,
   148, 131, 147, 155)
n=10
officers_killed_new<-c(officers_killed-150)
sample_mean=mean(officers_killed_new)
officers_killed_new_sq<-c(sum(officers_killed_new^2)
   )
summation=officers_killed_new_sq-n*(sample_mean^2)
print(round(var(officers_killed),digits = 2))
```

R code Exa 3.19 Miller Analogies Test

```r
# Page No. 103
salary<-c(47,48,49,50,51,52,53,54,56,57,60)
frequency<-c(4,1,3,5,8,10,0,5,2,3,1)
Miller_Analogy<-data.frame(salary,frequency)
View(Miller_Analogy)
boxplot(Miller_Analogy$salary,xlab = "Frequency",
   ylab = "Salary",main = "Miller Analogy")
```

R code Exa 3.20 History Exam

```
# Page No. 111
scores<-c(90,90,94,83,84,84,86,86,89,70,70,73,75,75,78,79,62,62,64,65,67,5
print(mean(scores))
print(signif(sd(scores),digits=4))
```

R code Exa 3.21 Stem and Leaf

```
# Page No.112
stem_women<-"16| 0, 5
15| 0, 1, 1, 1, 5
14| 0, 0, 1, 2, 3, 4, 6, 7, 9
13| 0, 0, 1, 1, 2, 2, 2, 2, 3, 4, 5, 5, 6, 6, 6, 6, 7, 8, 8, 8, 9, 9, 9
12| 1, 1, 1, 2, 2, 2, 3, 4, 4, 5, 5, 6, 6, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 8, 8, 9, 9
11| 0, 0, 1, 1, 2, 2, 2, 2, 3, 3, 4, 4, 5, 5, 6, 9, 9
10| 2, 3, 3, 3, 4, 4, 5, 7, 7, 8
9| 0, 0, 9
8| 6"
rows<-strsplit(stem_women,"\n")[[1]]
rows.lst <- strsplit(rows,"\\|")
tens<-as.numeric(sapply(rows.lst, "[", 1)) * 10
ones<-sapply(strsplit(sapply(rows.lst, "[", 2), ","), as.numeric)
vals<-unlist(mapply("+", tens, ones))
vals<-vals[!is.na(vals)]
```

```
cat("Mean Women=",signif(mean(vals),digits=4))
cat("\nSD Women=",signif(sd(vals),digits=4))
stem_men <- "24| 9
23|
22| 1
21| 7
20| 2, 2, 5, 5, 6, 9, 9, 9
19| 0, 0, 0, 0, 0, 1, 1, 2, 4, 4, 5, 8
18| 0, 1, 1, 2, 2, 2, 3, 4, 4, 4, 5, 5, 5, 6, 6, 6,
    6, 7, 9, 9, 9
17| 1, 1, 1, 2, 3, 3, 4, 4, 4, 5, 5, 6, 6, 6, 6, 7,
    7, 7, 7, 9
16| 0, 1, 1, 1, 1, 2, 4, 5, 6, 6, 8, 8, 8, 8
15| 1, 1, 1, 5, 5, 5, 6, 6, 6, 7, 7, 8, 9
14| 0, 5, 7, 7, 8, 9
13| 0, 1, 2, 3, 7
12| 9"
rows1 <- strsplit(stem_men,"\n")[[1]]
rows1.lst <- strsplit(rows1,"\\|")
tens1<-as.numeric(sapply(rows1.lst, "[", 1)) * 10
ones1<-sapply(strsplit(sapply(rows1.lst, "[", 2), ",
    "), as.numeric)
vals1<-unlist(mapply("+", tens1, ones1))
vals1<-vals1[!is.na(vals1)]
cat("\nMean Men=",signif(mean(vals1),digits=4))
cat("\nSD Men=",signif(sd(vals1),digits=4))
```

R code Exa 3.22 Milk

```
# Page No. 124
x<-c(17.1, 14.7, 12.8)
y<-c(10.6, 11.5, 13.2)
xi<-c(x-12.8)
yi<-c(y-10.6)
cat("r=",signif(cor(xi, yi,  method = "pearson", use
```

```
= "complete.obs"),digits=2))
```

R code Exa 3.23 Correlation Coefficient

```
# Page No. 125
xi<-c(18,32,25,60,12,25,50,15,22,30 )
yi<-c(202,644,411,755,144,302,512,223,183,375)
cat("r=",cor(xi, yi,  method = "pearson", use = "
   complete.obs"))
```

R code Exa 3.24 Sample Correlation Coefficient

```
# Page No. 126
xi<-c(12,16,13,18,19,12,18,19,12,14 )
yi<-c(73,67,74,63,73,84,60,62,76,71)
cat("r=",cor(xi, yi,  method = "pearson", use = "
   complete.obs"))
```

Chapter 4

Probability

R code Exa 4.1 Probability

```
# Page No. 146
library(prob)
library(permutations)
s<-c('g,b')
print(s)
print(tosscoin(2))
print(permn(7))
print(rolldie(2))
```

R code Exa 4.2 Boy Girl

```
# Page No. 147
library(venneuler)
library(permutations)
library(prob)
library(dplyr)
library(permute)
s<-c('g,b')
```

```
print(s)
df<-data.frame(tosscoin(2))
print(df %>% slice(1,3))
setA<-df %>% slice(1)
setB<-df %>% slice(3)
s1=as.numeric(count(setA))
s2=as.numeric(count(setB))
per <- data.frame(matrix(unlist(permn(7)), nrow=
   length(permn(7)), byrow=TRUE))
print(filter(per, X1==2))
perA<-filter(per, X1==4)
perB<-filter(per,X2==2)
perC<-filter(per,X1==3)
c1=as.numeric(count(perB))
c2=as.numeric(count(perC))
AunionB<-rbind(perA, perB)
print(AunionB)
res<-subset(rolldie(2),X1+X2==7)
print(res)
vd1 <- venneuler(c(A=c1, B=c2,"A&B"=100 ))
vd1$colors<-c(0.8,0.8)
plot(vd1)
vd2 <- venneuler(c(A=s1, B=s2,"A&B"=1))
plot(vd2)
vd3 <- venneuler(c(A=c1, B=c2,"A&B"=0))
plot(vd3)
```

R code Exa 4.3 AE VISA

```
# Page No. 155
p_A=22/100
p_B=58/100
pAintB=14/100
pAunionB=p_A+p_B-pAintB
print(pAunionB)
```

R code Exa 4.4 Retirement Centre

```
# Page No. 161
library(MASS)
p_smoker=144/420
print(fractions(p_smoker))
```

R code Exa 4.5 Two Dice

```
# Page No. 162
library(MASS)
A<-c(1,5,2,4,3,3,4,2,5,1)
B<-c(1,6,2,5,3,4,4,3,5,2,6,1)
p_A=5/36
p_B=6/36
print(fractions(p_A))
print(fractions(p_B))
```

R code Exa 4.6 Married Couples

```
# Page No. 162
library(MASS)
p_couple=1/10
print(fractions(p_couple))
```

R code Exa 4.7 Spanish or French

```
# Page No. 162
library(MASS)
pA=32/120
pB=36/120
pAintB=8/120
pAunionB=pA+pB-pAintB
print(fractions(pAunionB))
```

R code Exa 4.8 Earnings

```
# Page No. 163
totalworkers=(31340000 + 49678000)
prob_woman=31340000/totalworkers
print(signif(prob_woman,digits=4))
prob_man=1-prob_woman
print(round(prob_man,digits=4))
man_under30K=548+358+889+1454+5081
p=man_under30K/(totalworkers/1000)
print(signif(p,digits=4))
woman_over50K=(8255 + 947)/(totalworkers/1000)
print(round(woman_over50K,digits=4))
```

R code Exa 4.9 Conditional Probability

```
# Page No. 169
library(MASS)
pBA=(1/36)/(6/36)
print(fractions(pBA))
```

R code Exa 4.10 Parent Daughter Dinner

```
# Page No. 169
library(MASS)
pB_A=(1/4)/(3/4)
print(fractions(pB_A))
```

R code Exa 4.11 California State College

```
# Page No. 170
p_woman=6663/12544
print(round(p_woman,digits=4))
p_man_over35=684/5881
print(signif(p_man_over35,digits=4))
p_woman_over35=1339/6663
print(round(p_woman_over35,digits=4))
p_w_35=1339/(684+1339)
print(round(p_w_35,digits=4))
p_man_20_21=1089/(1089+1135)
print(round(p_man_20_21,digits=4))
```

R code Exa 4.12 Man or Woman

```
# Page No. 172
library(MASS)
p_women=4/10
p_remaining=3/9
p_womenintremaining=p_women*p_remaining
print(fractions(p_womenintremaining))
p_men=6/10
p_men_remaining=4/9
p_man_then_woman=p_men*p_men_remaining
print(fractions(p_man_then_woman))
p_woman_then_man=p_women*6/9
print(fractions(p_woman_then_man))
```

```
p_1man_1woman=4/15+4/15
print(fractions(p_1man_1woman))
```

R code Exa 4.13 Dice

```
# Page No. 174
prob_a_int_b=1/36
prob_a=6/36
prob_b=5/36
print(all.equal(prob_a_int_b,(prob_a*prob_b)))
cat("Not independent.\n")
prob_a_int_c=1/36
prob_a_1=1/6
prob_c=6/36
print(all.equal(prob_a_int_c,(prob_a_1*prob_c)))
cat("Independent.")
```

R code Exa 4.14 Female Student

```
# Page No. 175
p_m_22_24=1080/5881
print(signif(p_m_22_24,digits=4))
p_w_22_24=968/6663
print(signif(p_w_22_24,digits=4))
p_both=p_m_22_24*p_w_22_24
print(round(p_both,digits=3)*100)
```

R code Exa 4.15 Children

```
# Page No. 176
```

```r
library(MASS)
p_girls=(1/2)*(1/2)*(1/2)
print(fractions(p_girls))
p_allboys=1/8
p_atleastone=1-p_allboys
print(fractions(p_atleastone))
```

R code Exa 4.16 Insurance Company

```r
# Page No.186
library(MASS)
p_ah=0.1
p_h=0.2
p_ahc=0.05
p_hc=0.8
pa=(p_ah*p_h)+(p_ahc*p_hc)
print(pa)
p_ha=p_ah*p_h/pa
print(fractions(p_ha))
```

R code Exa 4.17 Blood Test

```r
# Page No. 187
p_ed=0.99
p_d=0.005
p_edc=0.02
p_dc=0.995
p_de=(p_ed*p_d)/((p_ed*p_d)+(p_edc*p_dc))
print(signif(p_de,digits=3))
```

R code Exa 4.18 Different Choices

```
# Page No. 190
possible_outcomes=12*8
print(possible_outcomes)
```

R code Exa 4.19 Group of Married Couples

```
# Page No. 190
library(MASS)
outcomes=20*19
outcomes_couples=2*10
prob_married=outcomes_couples/outcomes
print(fractions(prob_married))
```

R code Exa 4.20 Four People in a Room

```
# Page No. 191
n=4
diff_out=1
possible_outcomes=365^n
for (i in seq(from=0, to=3, by=1)){
  diff_out<-diff_out*(365-i)
}
prob_notsamebday=diff_out/possible_outcomes
print(prob_notsamebday,round(6))
```

R code Exa 4.21 Probability

```
# Page No. 193
```

```r
out=1
out1=1
gp=1
gp1=1
g=1
g1=1
for (i in seq(from=0, to=1, by=1)){
  out<-out*(3-i)
  out1<-out1*(2-i)
  gp<-gp*(6-i)
  gp1<-gp1*(2-i)
}
for (i in seq(from=0, to=2, by=1)){
  g1<-g1*(3-i)
  g<-g*(6-i)
}
groups_selected=out/out1
print(groups_selected)
groups_size2=gp/gp1
print(groups_size2)
groups_size3=g/g1
print(groups_size3)
```

R code Exa 4.22 Random Sample

```r
# Page No. 193
library(MASS)
grp_c=1
grp_c1=1
grp_ch=1
grp_ch1=1
for (i in seq(from=0, to=1, by=1)){
  grp_c<-grp_c*(9-i)
  grp_c1<-grp_c1*(2-i)
}
```

```
for (i in seq(from=0, to=2, by=1)){
  grp_ch<-grp_ch*(10-i)
  grp_ch1<-grp_ch1*(3-i)
}
grp_chosen=grp_ch/grp_ch1
grp_contain=grp_c/grp_c1
prob=grp_contain/grp_chosen
print(fractions(prob))
```

R code Exa 4.23 Committee

```
# Page No. 194
library(MASS)
pwomen=1
pwomen1=1
pom=1
pom1=1
po=1
po1=1
for (i in seq(from=0, to=1, by=1)){
  pwomen<-pwomen*(5-i)
  pwomen1<-pwomen1*(2-i)
  pom<-pom*(7-i)
  pom1<-pom1*(2-i)
}

for (i in seq(from=0, to=3, by=1)){
  po<-po*(12-i)
  po1<-po1*(4-i)
}
possible_outcomes=po/po1
possible_2men=pom/pom1
possible_2women=pwomen/pwomen1
desired_probability=(possible_2men*possible_2women)/
   possible_outcomes
```

```
print(fractions(desired_probability))
```

R code Exa 4.24 Compare

```
# Page No. 194
n=1
n1=1
r=1
r1=1
for (i in seq(from=0, to=2, by=1)){
  n<-n*(8-i)
  n1<-n1*(3-i)
}
for (i in seq(from=0, to=1, by=1)){
  r<-r*(12-i)
  r1<-r1*(2-i)
}
n1r1=n/n1
print(n1r1)
n2r2=r/r1
print(n2r2)
```

R code Exa 4.25 Possible Arrangements

```
#Page No. 195
n=2
m=1
print(factorial(n+m)/factorial(n))
```

Chapter 5

Discrete Random Variables

R code Exa 5.1 NBA

```
# Page No. 211
library(MASS)
total_balls=66
p<-c(11,10,9,8,7,6,5,4,3,2,1)
p1=fractions(p[1]/total_balls)
print(p1)
p2=fractions(p[2]/total_balls)
print(p2)
p3=fractions(p[3]/total_balls)
print(p3)
p4=fractions(p[4]/total_balls)
print(p4)
p5=fractions(p[5]/total_balls)
print(p5)
p6=fractions(p[6]/total_balls)
print(p6)
p7=fractions(p[7]/total_balls)
print(p7)
p8=fractions(p[8]/total_balls)
print(p8)
p9=fractions(p[9]/total_balls)
```

```
print(p9)
p10=fractions(p[10]/total_balls)
print(p10)
p11=fractions(p[11]/total_balls)
print(p11)
# The answer may vary due to difference in
    representation
```

R code Exa 5.2 Sexes of 3 Children

```
# Page No. 212
library(MASS)
p<-c(1,3,3,1)
outcomes=8
p0=fractions(p[1]/outcomes)
print(p0)
p1=fractions(p[2]/outcomes)
print(p1)
p2=fractions(p[3]/outcomes)
print(p2)
p3=fractions(p[4]/outcomes)
print(p3)
```

R code Exa 5.3 Random Variable

```
# Page No. 213
p1=0.4
p2=0.1
p3=1-(p1+p2)
cat("P(X=3)=",p3)
p<-c(p1,p2,p3)
plot(p,xlab=" i ",ylab = "P(X=i)")
```

R code Exa 5.4 Saleswoman

```
# Page No. 214
px0=(1-0.3)*(1-0.6)
cat("P(X=0)=",px0)
px1=0.3*(1-0.6) +(1-0.3)*0.6
cat("\nP(X=1)=",px1)
px2=0.3*0.6
cat("\nP(X=2)=",px2)
cat("\n",all.equal((px0+px1+px2),1))
```

R code Exa 5.5 Die

```
# Page No. 219
library(prob)
ex=0
sample_space<-(rolldie(1))
print(sample_space)
len<-(sum(table(sample_space)))
p =1/6
for (i in 1:len){
  ex=(i*p)+ex
}
print(ex)
```

R code Exa 5.6 Variable

```
# Page No. 220
library(rSymPy)
```

```
p <- Var("p")
p1=p
p2=1-p
ex= 1*p1 + 0*p2
print(ex)
```

R code Exa 5.7 Insurance Company

```
# Page No. 220
library(rSymPy)
A <- Var("A")
ex= A*(1-0.02)+(A-200)*(0.02)
print(ex)
```

R code Exa 5.8 Christmas Bonus

```
# Page No. 221
ewife=1500
ehusband=0.8*ewife
cat("E[X]=",ehusband)
ehusband_bonus=ewife+1000
cat("\nE[with bonus]=",ehusband_bonus)
```

R code Exa 5.9 Annual Incomes

```
# Page No. 222
men<-c(33.5,25.0,28.6,41.0,30.5,29.6, 32.8)
women<-c(24.2, 19.5,27.4,28.6,32.2,22.4,21.6)
emen=(1/7)*sum(men)
cat("E[Men]=",signif(emen,digits=5))
```

```
ewomen=(1/7)*sum(women)
cat("\nE[Women]=",round(ewomen,digits=3))
cat("\nE[Men+Women]=",(emen+ewomen))
```

R code Exa 5.10 Law Enforcement Employees

```
# Page No. 223
library(MASS)
law_emp<-c(105,155,149,195,290,357,246,178)
ex=fractions((1/8)*sum(law_emp))
cat("E[X]=",ex)
exy=sum(law_emp)/4
cat("\nE[X+Y]=",exy)
```

R code Exa 5.11 Bids

```
# Page No. 224
px20=0.3
pxneg2=1-px20
ex1=20*px20-2*pxneg2
ex2=25*(0.6)-2*(0.4)
ex3=40*(0.2)-2*(0.8)
ex=ex1+ex2+ex3
cat("E[total profit]=",ex)
```

R code Exa 5.12 VarX

```
# Page No.232
library(rSymPy)
p <- Var("p")
```

```
varx= p-p*p
print(varx)
```

R code Exa 5.13 Investment

```
# Page No. 232
pxneg1=0.7
px4=0.2
px8=0.1
ex=(-1*pxneg1)+(4*px4)+(8*px8)
exsq=1*pxneg1+16*px4+64*px8
varx=exsq-(ex^2)
print(varx)
```

R code Exa 5.14 Dice

```
# Page No. 234
library(MASS)
ex=7/2
a<-c(1,2,3,4,5,6)
a_sq<-sum(a^2)
exsq=(1/6)*a_sq
print(fractions(exsq))
varx=exsq-(7/2)^2
print(fractions(varx))
varxplusy=varx+varx
print(fractions(varxplusy))
```

R code Exa 5.15 Gross Earnings

```
# Page No. 235
x=400000
ex=15/100*x
print(ex)
sd=80000
varx=15/100*sd
print(varx)
```

R code Exa 5.16 Coins

```
# Page No. 240
library(MASS)
n=3
p=0.5
px0=(factorial(n)/(factorial(0)*factorial(n-0)))*(p
   ^0)*(1-p)^(n-0)
px1=(factorial(n)/(factorial(1)*factorial(n-1)))*(p
   ^1)*(1-p)^(n-1)
px2=(factorial(n)/(factorial(2)*factorial(n-2)))*(p
   ^2)*(1-p)^(n-2)
px3=(factorial(n)/(factorial(3)*factorial(n-3)))*(p
   ^3)*(1-p)^(n-3)
print(fractions(px0))
print(fractions(px1))
print(fractions(px2))
print(fractions(px3))
```

R code Exa 5.17 Genes

```
# Page No. 240
library(MASS)
p_gene=(1/2)*(1/2)
print(fractions(p_gene))
```

```
n=4
px1=(factorial(n)/(factorial(1)*factorial(n-1)))*(p_
   gene^1)*(1-p_gene)^(n-1)
print(fractions(px1))
```

R code Exa 5.18 Binomial Random Variable

```
# Page No. 242
print(round(pbinom(12,20,0.4),digits=3))
print(signif((1-(pbinom(9,16,0.5))),digits=4))
```

R code Exa 5.19 Screws

```
# Page No. 244
total_no_of_screws=1000
prob_of_defectiveness=0.01
no_of_defectives=(total_no_of_screws*prob_of_
   defectiveness)
variance_of_screws=(total_no_of_screws*prob_of_
   defectiveness*0.99)
print(no_of_defectives)
print(variance_of_screws)
```

R code Exa 5.20 Hypergeometric Random Variable

```
# Page No. 248
n=6
N=20
p=8/20
ex=n*p
```

```r
print(ex)
varx=(N-n)/(N-1)*n*p*(1-p)
print(signif(varx,digits=4))
```

R code Exa 5.21 Poisson Random Variable

```r
# Page No. 250
mean_val=2
p=exp(-mean_val)
print(signif(p,digits=4))
```

R code Exa 5.22 Items

```r
# Page No. 251
n=10
p=0.1
px0=exp(-1)
px1=exp(-1)
print(round(px0+px1,digits=4))
```

R code Exa 5.23 Accidents

```r
# Page No. 252
mean_val=1.2
p=1-exp(-mean_val)
print(round(p*100))
```

Chapter 6

Normal Random Variables

R code Exa 6.1 SAT

```
# Page No. 268
x <- seq(252, 756, by = .1)
y <- dnorm(x, mean=mean(x), sd=sd(x))
plot(x, y, type="l", lwd=1)
prob=0.68/2
print(prob)
```

R code Exa 6.2 P

```
# Page No. 273
pza=pnorm(1.5)
pzb=(1-pnorm(0.8))
print(signif(pza),digits=4)
print(signif(pzb),digits=4)
```

R code Exa 6.3 P Value

```
# Page No. 274
pza=pnorm(2)-pnorm(1)
pzb=pnorm(2.5)-(1-pnorm(1.5))
print(signif(pza),digits=4)
print(signif(pzb),digits=4)
```

R code Exa 6.4 PZ

```
# Page No. 275
pz=2*(1-pnorm(1.8))
print(signif(pz),digits=4)
```

R code Exa 6.5 Determine P

```
# Page No. 276
pz=pnorm(0.84)
print(signif(1-pz),digits=3)
```

R code Exa 6.6 IQ

```
# Page No. 278
za=pnorm(130,100,14.2,lower.tail = FALSE)
print(signif(za),digits=2)
zb=pnorm(1.056)-pnorm(-0.7042)
print(signif(zb), digits=3)
# The answer may slightly vary due to rounding off
  values.
```

R code Exa 6.7 Standard Deviation

```
# Page No. 279
pa=2*(1-pnorm(1))
cat("P{|Z| > 1}=",signif(pa,digits=4))
pb=2*(1-pnorm(2))
cat("\nP{|Z| > 2}=",signif(pb, digits=4))
pc=2*(1-pnorm(3))
cat("\nP{|Z| > 3}=",signif(pc,digits=4))
cat("\nApproximation rule verified")
# The answer may slightly vary due to rounding off
    values.
```

R code Exa 6.8 Light Bulb

```
# Page No. 280
z=pnorm(750,800,sqrt(3200),lower.tail = FALSE)
print(signif(z, digits=2))
```

R code Exa 6.9 US Department of Agriculture

```
# Page No. 281
Z=pnorm(0.17,0.8,4.669,lower.tail = FALSE)
cat("Probabilty=",1-Z)
# The answer may slightly vary due to rounding off
    values.
```

R code Exa 6.10 Normal Random Variables

```
# Page No. 286
```

```
print(signif(1-pnorm(0.67),digits=2))
print(signif(pnorm(0.67),digits=2))
mean=40
sd=5
x=(1.645*sd)+mean
print(x)
zx=pnorm(x,40,5,lower.tail = FALSE)
cat("Value at percentile",round(zx,3))
```

R code Exa 6.11 IQ Test

```
# Page No. 288
x=(14.2*2.33)+100
zx=pnorm(x,100,14.2,lower.tail = FALSE)
cat("Range=",x)
cat("\nProbabilty=",round(zx, digits=3))
```

Chapter 7

Distributions of Sampling Statistics

R code Exa 7.1 Population

```
# Page No. 301
library(MASS)
px1=1/2
px2=1/2
mu=1*(1/2)+2*(1/2)
print(mu)
varx=(1-mu)^2*(px1)+(2-mu)^2*px2
print(fractions(varx))
p1=1/4
p_half=1/2
p2=1/4
ex=(1*p1)+(1.5*p_half)+(2*p2)
print(ex)
vx=((1-mu)^2*p1)+((1.5-mu)^2*p_half)+((2-mu)^2*p2)
print(fractions(vx))
```

R code Exa 7.2 Insurance Company

```
# Page No. 304
pz=pnorm(2.8*10^6,2.6*10^6,8*10^4,lower.tail = FALSE)
print(signif(pz),digits=2)
```

R code Exa 7.3 Blood Cholesterol Levels

```
# Page No. 308
Zworkers1=pnorm(206,202,(7/3))-pnorm(198,202,(7/3))
Zworkers2=pnorm(206,202,(7/4))-pnorm(198,202,(7/4))
print(signif(Zworkers1),digits=3)
print(signif(Zworkers2),digits=3)
```

R code Exa 7.4 Astronomer

```
# Page No. 309
Zworkers=2*pnorm(0.527)-1
print(signif(Zworkers),digits=3)
```

R code Exa 7.5 Students

```
#Page No.313
n=900
left_handed=60
p=left_handed/n
print(p)
px2=400/1000
print(px2)
```

```
px2x1=399/1000
print(px2x1)
px2px1_0=400/999
print(px2px1_0)
```

R code Exa 7.6 Election

```
# Page No. 316
ex=0.50
standard_deviation=sqrt((ex*(1-ex))/100)
print(standard_deviation)
```

R code Exa 7.7 Candidates

```
# Page No. 317
Z_candidate=pnorm(99.5,92,7.0484,lower.tail = FALSE)
print(signif(Z_candidate),digits=3)
```

Chapter 8

Estimation

R code Exa 8.1 Amount of Damages

```
# Page No. 333
amounts<-c(121, 55, 63, 12, 8, 141, 42, 51, 66, 103)
print(mean(amounts)*1000)
```

R code Exa 8.2 Level of Potassium

```
# Page No. 334
potassium_readings<-c(3.6, 3.9, 3.4, 3.5)
n=4
sd=0.3
print(mean(potassium_readings))
print(sd/sqrt(n))
```

R code Exa 8.3 Dress Code

```
# Page No. 337
```

```
students=50
in_favour=20
p=in_favour/students
print(p)
print(round(sqrt(p*(1-p)/50),digits=4))
```

R code Exa 8.4 Nine Electronic Components

```
# Page No. 343
elec_components<-c(1211, 1224, 1197, 1208, 1220,
   1216, 1213, 1198, 1197)
print(var(elec_components))
print(round(sd(elec_components),digits=3))
```

R code Exa 8.5 Signal

```
# Page No.349
n=10
signal<-c(17, 21, 20, 18, 19, 22, 20, 21, 16, 19)
mean_signal=mean(signal)
cat("Mean=",mean_signal)
sd=3
cat("\nActual Intensity=",19.3-1.9*sd/sqrt(n),",",19.3+1.9*sd/sqrt(n))
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 8.6 Confidence Interval Estimate

```
# Page No. 350
```

```
n = 10
X = 19.3
sig= 3
z90=1.645
z99=2.576
cie90=X+z90*(sig/sqrt(n))
cie90m=X-z90*(sig/sqrt(n))
print(cie90)
print(cie90m)
cie99=X+z99*(sig/sqrt(n))
cie99m=X-z99*(sig/sqrt(n))
print(cie99)
print(cie99m)
# The answer may slightly vary due to rounding off
    values.
```

R code Exa 8.7 Population Standard Deviation

```
# Page No. 352
sigma=2
b=0.1
n=(3.92*sigma/b)^2
print(round(n))
```

R code Exa 8.8 Weights of Salmon

```
# Page No. 353
b=0.2
n=(2*1.645*0.3/b)^2
print(signif(n,digits=4))
n1=(2*2.576*0.3/b)^2
print(signif(n1,digits=4))
```

R code Exa 8.9 Average Nicotine Content

```
# Page No. 354
n=44
X=1.74
sig=0.7
z95=1.96
cie95=X+z95*(sig/sqrt(n))
cie95m=X-z95*(sig/sqrt(n))
print(cie95)
print(cie95m)
n=(2*z95*sig/0.3)^2
print(round(n,digits=1))
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 8.10 Salmon

```
# Page No. 356
z=1.645
sig=0.3
n=50
x=5.6
lcb=x-z*(sig/sqrt(n))
print(signif(lcb,digits=3))
```

R code Exa 8.11 Upper Confidence Bound

```
# Page No. 357
```

```
z=1.645
sig=0.7
n=44
x=1.74
lcb=x+z*(sig/sqrt(n))
print(round(lcb,digits=3))
```

R code Exa 8.13 EPA

```
# Page No. 362
pcb<-c(16, 0, 0, 2, 3, 6, 8, 2, 5, 0, 12, 10, 5, 7,
   2, 3, 8, 17, 9, 1)
x_mean=mean(pcb)
sd=sd(pcb)
n=20
t1=2.093
t2=2.861
cle95=x_mean+t1*(sd/sqrt(n))
print(cle95)
cle99=x_mean+t2*(sd/sqrt(n))
print(cle99)
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 8.14 PCB

```
# Page No. 365
n=20
X=5.8
sig=5.085
z1=1.729
z2=2.539
ucb95=X+z1*(sig/sqrt(n))
```

```
print(round(ucb95,digits=2))
ucb99=X-z2*(sig/sqrt(n))
print(round(ucb99,digits=2))
```

R code Exa 8.15 Nonsmokers

```
# Page No. 371
p=0.82
n=100
z=2.576
print(p+z*sqrt((p*(1-p))/100))
print(p-z*sqrt((p*(1-p))/100))
```

R code Exa 8.16 The New York Times

```
# Page No. 372
p=0.46
z=1.96
n=((z)^2*p*(1-p))/(0.03)^2
print(round(n,digits=1))
```

R code Exa 8.17 Confidence Interval Estimate

```
# Page No. 374
p=0.01
z=1.645
n=(z/p)^2
print(n)
```

R code Exa 8.18 Working Conditions

```
# Page No. 376
p=42/125
n=125
z=1.645
lb=p-z*sqrt(p*(1-p)/n)
print(signif(lb,digits=4))
```

Chapter 9

Testing Statistical Hypotheses

R code Exa 9.1 Star

```
# Page No. 396
test_statistic= (sqrt(20)/4)*(11.6-10)
cat("Test Statistic=",round(test_statistic,digits=2)
   ,"\nNull hypothesis rejected.")
```

R code Exa 9.2 Absolute Value

```
# Page No. 398
test_statistic=sqrt(20)/4*(10.8-10)
print(test_statistic)
print((dnorm(test_statistic)))
# The answer provided in the textbook is wrong.
```

R code Exa 9.3 Null Hypothesis

```
# Page No. 399
```

```
m=9.2
sd=0.894
p1=pnorm(11.753,m,sd,lower.tail = FALSE)
p2=1-pnorm(8.247,m,sd,lower.tail = FALSE)
P=signif(p1,4)+round(p2,4)
print(round(P,digits=4))
```

R code Exa 9.4 Cigarettes

```
# Page No. 405
t=sqrt(20)*((1.42-1.5)/0.7)
print(signif(t,digits=3))
P=pnorm(t)
print(signif(P,digits=3))
```

R code Exa 9.5 Clinic Patients

```
# Page No. 412
n=40
m=6.8
sd=12.1
t=sqrt(n)*(m/sd)
print(signif(t,digits=4))
P=2*pt(t,39, lower.tail = FALSE)
print(round(P,3))
print("Null Hypothesis Rejected")
#The answer provided in the textbook is wrong.
```

R code Exa 9.6 pH

```r
# Page No. 413
acidity<-c(6.1, 5.4, 4.8, 5.8, 6.6, 5.3, 6.1, 4.4,
   3.9, 6.8, 6.5, 6.3)
mean_acidity=mean(acidity)
sd_acidity=sd(acidity)
mu=5.2
n=12
t=sqrt(n)*((mean_acidity-mu)/sd_acidity)
print(round(t,digits=2))
cat("Null hypothesis not rejected.")
```

R code Exa 9.7 Fiberglass Tire

```r
# Page No. 415
t=sqrt(8)*((47.2-50)/3.1)
print(round(t,digits=2))
```

R code Exa 9.8 US Population

```r
# Page No. 422
P=pnorm(477.5,460,sqrt(203),lower.tail = FALSE)
print(P)
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 9.9 Computer Chip Manufacturer

```r
# Page No. 423
P=pnorm(12.5,8,sqrt(8*0.98),lower.tail = FALSE)
print(signif(P,digits = 2))
```

R code Exa 9.10 Manufacturing Facility

```
# Page No. 426
P=2*pnorm(16,20,4.38)
print(P)
# The answer provided in the textbook is wrong.
```

R code Exa 9.11 DNA

```
# Page No. 427
p=2*pnorm(-2.630)
print(signif(p,digits=2))
# The answer may slightly vary due to rounding off
  values.
```

Chapter 10

Hypothesis Tests Concerning Two Populations

R code Exa 10.1 Tire

```
# Page No. 447
x_mean=62.2444
y_mean=58.2714
n= 9
m = 7
sigmax = 3
sigmay = 4
ts=(x_mean-y_mean)/sqrt((sigmax^2)/n+(sigmay^2)/m)
print(round(ts,digits=3))
print(round(2*(1-pnorm(ts)),digits=4))
```

R code Exa 10.2 Set of Tires

```
# Page No. 449
x_mean=62.2444
y_mean=59.2714
```

```
n= 9
m = 7
sigmax = 3
sigmay = 4
ts=(x_mean-y_mean)/sqrt((sigmax^2)/n+(sigmay^2)/m)
print(signif(ts,digits=3))
print(round((1-pnorm(ts)),digits=4))
```

R code Exa 10.3 New Cholesterol Lowering Medication

```
# Page No. 455
x_mean=8.8
y_mean=8.2
n=50
m=50
sigmax = 4.5
sigmay = 5.4
ts=(x_mean-y_mean)/sqrt((sigmax)/n+(sigmay)/m)
print(ts)
print(round((1-pnorm(ts)),digits=3))
```

R code Exa 10.4 Placebo Effect

```
# Page No. 456
x_mean=242
y_mean=234
n=30
m=20
sigmax = 62.2
sigmay = 58.4
ts=(x_mean-y_mean)/sqrt((sigmax)/n+(sigmay)/m)
print(signif(ts,digits=3))
print(signif((1-pnorm(ts)),digits=3))
```

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

R code Exa 10.5 H0

```
# Page No. 458
x<-c(22, 21, 25, 29, 31, 18, 28, 33, 28, 26, 32,35, 27, 29, 26)
y<-c(14, 17, 22, 18, 19, 21, 24, 33, 28, 22, 27, 18, 21, 19, 33, 31)
x_mean=mean(x)
y_mean=mean(y)
n=15
m=16
sigmax = 21.238
sigmay = 34.329
ts=(x_mean-y_mean)/sqrt((sigmax)/n+(sigmay)/m)
print(round(ts,digits=2))
print(round((1-pnorm(ts)),digits=3))
```

R code Exa 10.6 Cold Research Institute

```
# Page No. 466
x<-c(6.5, 6, 8.5, 7, 6.5, 8, 7.5, 6.5, 7.5, 6, 8.5,7)
y<-c(5.5, 6, 7, 6, 7.5, 6, 7.5, 5.5, 7,6.5)
print(t.test(x,y))
# The answer provided in the textbook is wrong.
```

R code Exa 10.8 Gasoline

```r
# Page No. 473
data_diff<-c(0.7, 0.8, 0.4, 2.2,-0.3,-0.5, 1.6)
d=mean(data_diff)
sd=sd(data_diff)
n=7
ts=(sqrt(n)*d)/sd
print(ts)
print(t.test(data_diff))
```

R code Exa 10.9 Management

```r
# Page No. 475
first_week<-c(46,54,74,60,63,45)
second_week<-c(54,60,96,75,80,50)
d<-c(second_week-first_week)
print(t.test(d))
# The answer provided in the textbook is wrong.
```

R code Exa 10.10 Criminal Proceedings

```r
# Page No. 483
n1=142
n2=72
p1=74/142
p2=61/72
p=(74 + 61)/(n1+n2)
ts=(p1-p2)/sqrt((1/n1+1/n2)*(p*(1-p)))
print(signif(ts,digits=3))
print(round(2*(1-pnorm(abs(ts)))))
```

R code Exa 10.11 Gender of Future Children

```
# Page No. 485
n1=36694
n2=42212
p1=0.496
p2=0.523
p=((n1*p1)+(n2*p2))/(n1+n2)
ts=(p1-p2)/sqrt(((1/n1)+(1/n2))*(p*(1-p)))
print(signif(ts,digits=4))
pval=pnorm(ts)
print(round(pval))
```

R code Exa 10.13 Computer Chips

```
# Page No. 487
n1=360
n2=320
p1=94/360
p2=76/320
p=(94 + 76)/(n1+n2)
ts=(p1-p2)/sqrt((1/n1+1/n2)*(p*(1-p)))
print(signif(ts,digits=4))
print(round((1-pnorm(ts)),digits=3))
# The answer may slightly vary due to rounding off
    values.
```

Chapter 11

Analysis of Variance

R code Exa 11.1 Consumer Cooperative

```
# Page No. 508
m=3
n=5
x1<-c(220,251,226,246,260)
x2<-c(244,235,232,242,225)
x3<-c(252,272,250,238,256)
x1_mean=mean(x1)
x2_mean=mean(x2)
x3_mean=mean(x3)
sample_mean=(x1_mean+x2_mean+x3_mean)/3
sample_variance=((x1_mean-sample_mean)^2+(x2_mean-sample_mean)^2+(x3_mean-sample_mean)^2)/2
numerator_estimate=5*sample_variance
denominator_estimate=(var(x1)+var(x2)+var(x3))/3
ts=numerator_estimate/denominator_estimate
print(signif(ts),digits=3)
cat("H0 Accepted")
```

R code Exa 11.4 Reading Tests

```
# Page No.517
xi<-c(72.8,75,73.2,75)
xj<-c(76.5,70,62.25, 73, 88.25)
mu=74
a1=xi[1]-mu
b1=xj[2]-mu
est=mu+a1+b1
print(est)
```

R code Exa 11.5 Defective Items

```
# Page No. 525
machine<-c(1,2,3)
worker1<-c(41,35,42)
worker2<-c(42,42,39)
worker3<-c(40,43,44)
worker4<-c(35,36,47)
defective_items<-data.frame(machine,worker1,worker2,
   worker3,worker4)
View(defective_items)
m=3
n=4
xr1=(41 + 42 + 40 + 35)/4
xc1=(41 + 35 + 42)/3
xr2=(35 + 42 + 43 + 36)/4
xc2=(42 + 42 + 39)/3
xr3=(42 + 39 + 44 + 47)/4
xc3=(40 + 43 + 44)/3
xc4=(35 + 36 + 47)/3
xrsumcsum=(xr1+xr2+xr3)/3
cat("\nX=",xrsumcsum)
ssr=4*((xr1-xrsumcsum)^2+(xr2-xrsumcsum)^2+(xr3-
   xrsumcsum)^2)
cat("\nSSr=",ssr)
ssc=3*((xc1-xrsumcsum)^2+(xc2-xrsumcsum)^2+(xc3-
```

```
xrsumcsum)^2
        +(xc4-xrsumcsum)^2)
cat("\nSSc=",ssc)
sse=94.05
cat("\nSSe=",sse)
tsrow=(ssr/2)/(sse/6)
cat("\nTSrow=",signif(tsrow,digits=3))
tscol=(ssc/3)/(sse/6)
cat("\nTScol=",signif(tscol,digits=2))
```

Chapter 12

Linear Regression

R code Exa 12.1 Washing Machine

```
# Page no. 541
x<-c(280 ,290,300,310,320,330,340,350,360,370,380)
y<-c(44,41,34,38,33,30,32,26,28,23,20)
plot(x,y)
```

R code Exa 12.2 Midwestern Bank

```
# Page No. 546
training<-c(22,18,30,16,25,20,10,14)
completion<-c
    (18.4,19.2,14.5,19.0,16.6,17.7,24.4,21.0)
worker<-data.frame(training,completion)
sxx<-sum(training^2)-sum(training)^2/8
syy<-sum(completion^2)-sum(completion)^2/8
sxy<-sum(training*completion)-(sum(training)*sum(
    completion))/8
ssr<-((sxx*syy)-(sxy)^2)/sxx
b1<-sxy/sxx
```

```
b0<-mean(completion)-b1*mean(training)
print(b0)
print(b1)
cat(b0,"+x*",b1)
plot(training,completion,main="Regression Line",xlab
   ="Training Time",ylab="Completetion Time")
abline(lm(completion~training,data=worker))
```

R code Exa 12.3 Additional Statistics

```
# Page No. 555
ssr=5.336772
sigma_sq=ssr/6
print(round(sigma_sq,digits=4))
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 12.4 Fuel Consumption

```
# Page No. 558
speed<-c(45,50,55,60,65,70,75)
miles<-c(24.2,25.0,23.3,22.0,21.5,20.6,19.8)
sxx<-sum(speed^2)-sum(speed)^2/7
print(sxx)
syy<-sum(miles^2)-sum(miles)^2/7
print(signif(syy,digits=5))
sxy<-sum(speed*miles)-(sum(speed)*sum(miles))/7
print(sxy)
ssr<-((sxx*syy)-(sxy)^2)/sxx
print(signif(ssr,digits=4))
b=sxy/sxx
print(b)
ts=sqrt(5*sxx/ssr)*b
```

```
print(round(ts,digits=3))
```

R code Exa 12.5 Galtons Thesis

```
# Page No. 565
father_hght<-c(60,62,64,65,66,67,68,70,72,74)
son_hght<-c
   (63.6,65.2,66,65.5,66.9,67.1,67.4,68.3,70.1,70)
plot(father_hght,son_hght)
sxx<-sum(father_hght^2)-sum(father_hght)^2/10
syy<-sum(son_hght^2)-sum(son_hght)^2/10
sxy<-sum(father_hght*son_hght)-(sum(father_hght)*sum
   (son_hght))/10
ssr<-((sxx*syy)-(sxy)^2)/sxx
b1<-sxy/sxx
b0<-mean(son_hght)-b1*mean(father_hght)
print(b0)
print(b1)
cat(b0,"+x*",b1)
ts=sqrt(((8*sxx)/ssr))*(b1-1)
cat("\n",ts)
p=pnorm(ts)
cat("\n",round(p,digits=1))
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 12.6 Motor Vehicle Deaths

```
# Page No. 567
deaths_1988<-c
   (121,96,85,113,102,118,90,84,107,112,95,101)
deaths_1989<-c
   (104,91,101,110,117,108,96,102,114,96,88,106)
```

```
plot(deaths_1988,deaths_1989)
multi<-data.frame(deaths_1988,deaths_1989)
model <- lm(deaths_1989 ~ deaths_1988, data = multi)
print(summary(model)$coefficient)
b1=74.5893904
b0=0.2760844
cat(b0,"+x*",b1)
```

R code Exa 12.7 Adult Height

```
# Page No. 574
t8=2.306
w=0.4659
pi95=68.497+(t8*w)
pi95m=68.497-(t8*w)
print(pi95)
print(pi95m)
```

R code Exa 12.8 Hamburger Concession

```
# Page No. 574
ticket_sales<-c(29.4,21.4,18.0,25.2,32.5,23.9)
hamburgers<-c(19.5,16.2,15.3,18.0,20.4,16.8)
sxx<-sum(ticket_sales^2)-sum(ticket_sales)^2/10
syy<-sum(hamburgers^2)-sum(hamburgers)^2/10
sxy<-sum(ticket_sales*hamburgers)-(sum(ticket_sales)*sum(hamburgers))/10
b1<-sxy/sxx
b0<-mean(hamburgers)-b1*mean(ticket_sales)
val=b0+(26*b1)
print(val)
t4=2.776
W=0.3381453
```

```
pi95=val+(t4*W)
pi95m=val-(t4*W)
print(pi95)
print(pi95m)
# The answer may slightly vary due to rounding off
    values.
```

R code Exa 12.9 Height

```
# Page No.579
syy=38.521
ssr=1.497
r=1-(ssr/syy)
print(round(r*100))
```

R code Exa 12.10 Football Game

```
# Page No. 579
syy=19.440
ssr=0.390
r=1-(ssr/syy)
print(round(r*100))
```

R code Exa 12.13 Suicide Rate

```
# Page No. 588
divorce<-c(30.4,34.1,17.2,26.8,29.1,18.7,32.6,32.5)
suicide<-c(11.6,16.1,9.3,9.1,8.4,7.7,11.3,8.4)
population<-c(679,1420, 1349,296,3975,323,2200,633)
multi<-data.frame(population,divorce,suicide)
```

```
model <- lm(suicide ~ divorce + population, data =
   multi)
print(summary(model)$coefficient)
b0=3.6866154396
b1=-0.0002411115
b2=0.2485508748
cat(b0,"+x1*",b1,"+x2*",b2,"\n")
x1=400
x2=28.4
predicted=b0+x1*b1+x2*b2
print(round(predicted,digits=3))
# The answer may slightly vary due to rounding off
   values.
```

Chapter 13

Chi Squared Goodness of Fit Tests

R code Exa 13.2 Stomach Cancer Patients

```
# Page No. 611
N1=92
N2=20
N3=4
N4=84
np1=200*0.41
np2=200*0.09
np3=200*0.04
np4 =200*0.46
ts=(N1-np1)^2/np1+(N2-np2)^2/np2+(N3-np3)^2/np3+(N4-
   np4)^2/np4
print(signif(ts,digits=4))
```

R code Exa 13.3 Accidents

```
# Page No. 612
```

```
n=250
N1=62
N2=47
N3=44
N4=45
N5=52
p1=(1/5)
p2=(1/5)
p3=(1/5)
p4=(1/5)
p5=(1/5)
e1=n*p1
e2=n*p2
e3=n*p3
e4=n*p4
e5=n*p5
ts=((N1-e1)^2/e1)+((N2-e2)^2/e2)+((N3-e3)^2/e3)+((N4
   -e4)^2/e4)+((N5-e5)^2/e5)
print(ts)
print(signif(2*pt(-abs(ts),df=0.4125),digits=3))
print("Null Hypothesis Accepted")
```

R code Exa 13.4 Gregor Mendel

```
# Page No. 613
N1=6022
N2=2001
n=8023
p1=3/4
p2=1/4
e1=n*p1
e2=n*p2
ts=((N1-e1)^2/e1)+((N2-e2)^2/e2)
print(signif(ts,digits=3))
print(round(pchisq(2.747609, df=1, lower.tail=FALSE)
```

```
,4))
```

R code Exa 13.8 Level of Significance

```
# Page No. 624
e11=156*120/300
e12=156*128/300
e13=156*52/300
e21=144*120/300
e22=144*128/300
e23=144*52/300
ts=((68-e11)^2/e11)+((56-e12)^2/e12)+((32-e13)^2/e13
  )+((52-e21)^2/e21)+((72-e22)^2/e22)+((20-e23)^2/
  e23)
print(signif(ts,digits=4))
print("Null Hypothesis Rejected")
```

R code Exa 13.9 Public Health Scientist

```
# Page No. 625
e11=57*69/159
e12=57*54/159
e13=57*36/159
e21=76*69/159
e22=76*54/159
e23=76*36/159
e31=26*69/159
e32=26*54/159
e33=26*36/159
ts=(22-e11)^2/e11+(16-e12)^2/e12+(19-e13)^2/e13+(33-
  e21)^2/e21+(29-e22)^2/e22+(14-e23)^2/e23+(14-e31)
  ^2/e31+(9-e32)^2/e32+(3-e33)^2/e33
print(signif(ts,digits=3))
```

```
print(signif(2*pt(-abs(ts),df=0.75),digits=3))
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 13.10 Lung Cancer

```
#Page No. 632
affect<-c("Lung Cancer","No lung Cancer","Total")
smokers<-c(62,9938,10000)
non_smokers<-c(14,19968,20000)
total<-c(76,29924,30000)
Smoking_Cancer<-data.frame(affect,smokers,non_
   smokers,total)
View(Smoking_Cancer)
e11=(total[1]*smokers[3])/total[3]
e12=(total[1]*non_smokers[3])/total[3]
e21=(total[2]*smokers[3])/total[3]
e22=(total[2]*non_smokers[3])/total[3]
cat("\ne11=",e11)
cat("\ne12=",e12)
cat("\ne21=",e21)
cat("\ne22=",e22)
ts=((smokers[1]-e11)^2/e11)+((non_smokers[1]-e12)^2/
   e12)+((smokers[2]-e21)^2/e21)+((non_smokers[2]-
   e22)^2/e22)
cat("\nTS=",ts)
cat("\nWe reject the hypothesis.")
# The  answer may slightly vary due to rounding off
   values
```

R code Exa 13.11 Female Office Workers

```
# Page No. 633
```

```
e11=171*500/2000
e12=171*500/2000
e13=171*500/2000
e14=171*500/2000
e21=1829*500/2000
e22=1829*500/2000
e23=1829*500/2000
e24=1829*500/2000
ts=(28-e11)^2/e11+(30-e12)^2/e12+(58-e13)^2/e13+(55-
   e14)^2/e14+(472-e21)^2/e21+(470-e22)^2/e22+(442-
   e23)^2/e23+(445-e24)^2/e24
print(signif(ts,digits=3))
print(2*pt(-abs(ts),df=3))
# The answer may slightly vary due to rounding off
   values.
```

Chapter 14

Nonparametric Hypotheses Tests

R code Exa 14.1 Shoe Store

```
# Page No. 651
p=2*pnorm(35.5,25,sqrt(12.5),lower.tail = FALSE)
print(round(p,digits=4))
```

R code Exa 14.2 Sunscreen Lotions

```
# Page No. 652
p=(factorial(12)/(factorial(10)*factorial(2)))*(1/2)
   ^12+(factorial(12)/(factorial(11)*factorial(1)))*
   (1/2)^12+(factorial(12)/(factorial(12)*factorial
   (0)))*(1/2)^12
print(round((2*p),digits=4))
```

R code Exa 14.3 Bank

```
# Page No. 654
p=pbinom(28,80,1/2)
print(round(p,digits=4))
```

R code Exa 14.4 Four Paired Sample Values

```
# Page No. 658
xi<-c(4.6,3.8,6.0,6.6)
yi<-c(6.2,1.5,2.1,11.7)
difference<-c(xi-yi)
View(difference)
View(sort(abs(difference)))
df<-match(c(-1.6,-5.1),difference,nomatch = 1)
ts=sum(df)
print(ts)
```

R code Exa 14.5 Psychology

```
# Page No. 660
a<-c(763, 419, 586, 920, 881, 758, 262, 332, 717,
    909, 940, 835)
b<-c(797, 404, 576, 855, 762, 707, 195, 341, 728,
    817, 947, 849)
difference<-c(a-b)
View(difference)
difference_sort<-sort(abs(difference))
View(difference_sort)
df<-match(c(7,9,11,14,34),difference_sort,nomatch =
    1)
ts=sum(df)
print(ts)
```

R code Exa 14.6 Normal Approximation

```
# Page No. 661
p=2*pnorm(-1.530)
print(signif(p,digits=3))
```

R code Exa 14.7 Symmetric

```
# Page No. 662
p=pnorm(237.5,162.5,37.165,lower.tail = FALSE)
print(round((2*p),digits=4))
```

R code Exa 14.8 Reflex Reaction Time

```
# Page No. 667
twenty_years_fifty_years<-c(4.22, 5.13, 1.80, 3.34,
    2.72, 2.80, 4.33, 3.60,5.42, 3.39, 2.55, 4.45,
    5.55, 4.96, 5.88, 6.30, 5.10)
View(twenty_years_fifty_years)
diff_20<-sort(twenty_years_fifty_years)
View(diff_20)
df<-match(c(1.80,2.72,2.80,3.34,3.60,4.22,4.33,5.13)
    ,diff_20,nomatch = 1)
ts=sum(df)
print(ts)
```

R code Exa 14.9 Sum of the Ranks

```
# Page No. 669
ets=(8*18)/2
varts=(8*9*18)/12
p=2*(1-pnorm(50.5,ets,sqrt(varts),lower.tail = FALSE
    ))
print(signif(p,digits=3))
# The answer may slightly vary due to rounding off
    values.
```

R code Exa 14.10 Vocabulary

```
# Page No. 670
ts=(47*49)+(107*11)+(127*5)+(139*4)+147+151
n=71
m=84
mu=((n+m+1)*n)/2
sd=(n+m+1)*(n*m)/12
p=2*(1-pnorm(ts,mu,sqrt(sd),lower.tail = FALSE))
print(signif(p,digits=3))
```

R code Exa 14.11 Like ex 9

```
# Page no.672
ets=(8*18)/2
varts=(8*9*18)/12
p=2*(1-pnorm(50.5,ets,sqrt(varts),lower.tail = FALSE
    ))
print(signif(p,digits=3))
# The answer may slightly vary due to rounding off
    values.
```

R code Exa 14.12 Softball

```
# Page No. 677
n=8
m=16
mu=((2*n*m)/(n+m))+1
sd=sqrt(((2*n*m)*(2*n*m-n-m))/((n+m)^2*(n+m-1)))
p=2*pnorm(15.77,mu,sd,lower.tail = FALSE)
print(signif(p,digits=3))
print("Hypothesis of Randomness accepted")
# The answer may slightly vary due to rounding off values.
```

R code Exa 14.13 Approximate p value

```
# Page No. 678
mu=2*8*16/24+1
sd=sqrt((256*(256-24))/(24*24*23))
p=2*pnorm(15.5,mu,sd,lower.tail = FALSE)
print(signif(p,digits=2))
```

R code Exa 14.14 Normal Approximation

```
# Page No. 679
mu=(2*20*20)/40+1
sd=sqrt((2*20*20*760)/(40*40*39))
p=2*pnorm(26.5,mu,sd,lower.tail = FALSE)
print(signif(p,digits=2))
```

R code Exa 14.15 Fahrenheit

```
# Page No. 680
mu=200/20+1
sd=sqrt((200*180)/(400*19))
p=2*pnorm(mu,10.5,sd,lower.tail = FALSE)
print(signif(p,digits=3))
```

R code Exa 14.16 Basketball Team

```
# Page No. 661
p=2*pnorm(-1.530)
print(signif(p,digits=3))
```

R code Exa 14.17 Wines

```
# Page No. 684
ra=176
rb=175
rc=114
ts=(12/(30*31))*((ra)^2+(rb)^2+(rc)^2)/10-93
print(signif(ts,digits=4))
print(signif(pchisq(3.254, df=2, lower.tail=FALSE),
   digits=4))
```

R code Exa 14.18 Null Hypothesis

```
# Page No. 687
a<-c(1,1,3,2,1,1,3,2,1,3)
ra=sum(a)
b<-c(3,2,1,1,3,2,1,1,3,1)
rb=sum(b)
```

```
c<-c(2,3,2,3,2,3,2,3,2,2)
rc=sum(c)
ts=(ra-20)^2+(rb-20)^2+(rc-20)^2
print(ts)
print(signif(pchisq(2.4, df=2, lower.tail=FALSE),
   digits=4))
```

R code Exa 14.19 DVD Players

```
# Page No. 690
p1=pnorm(-2.757)
print(signif(p1,digits=2))
p2=pnorm(-1.514)
print(signif(p2,digits=3))
p3=pnorm(-0.565)
print(signif(p3,digits=3))
```

Chapter 15

Quality Control

R code Exa 15.1 Computer Servicing Firm

```
# Page No. 702
subgroup_data<-c( 23.6,
   24.6,29.4,32.8,20.8,22.6,27.8,23.3,
          25.5,24.4,26.8,30.5,26.2,24.7,27.2,25.3,23.3,26.0,24.0,34.1
subgroup_mean=25
subgroup_sd=6
n=4
lcl=subgroup_mean-(3*subgroup_sd/sqrt(n))
ucl=subgroup_mean+(3*subgroup_sd/sqrt(n))
print(lcl)
print(ucl)
plot(subgroup_data)
```

R code Exa 15.2 Video Rental Store

```
# Page No. 704
video_rental_mean=52
```

```
video_rental_sd=10
n=4
l=video_rental_mean-(3*video_rental_sd/sqrt(n))
u=video_rental_mean+(3*video_rental_sd/sqrt(n))
print(l)
print(u)
video_rental<-c( 32, 38, 28, 30)
cat("Recent subgroup average=",mean(video_rental))
```

R code Exa 15.3 Automobile Air Conditioners

```
# Page No. 708
subgroup_data<-c
   (30.1,29.7,31.2,29.9,30.3,30.2,31.0,31.4,30.9,32.0)

View(subgroup_data)
subgroup_mean=mean(subgroup_data)
subgroup_sd=sd(subgroup_data)
n=5
lcl=subgroup_mean-(3*subgroup_sd/sqrt(n))
ucl=subgroup_mean+(3*subgroup_sd/sqrt(n))
print(lcl)
print(ucl)
z=pnorm(33.40,30.670,1.304,lower.tail = FALSE)
print(z)
# The answer may slightly vary due to rounding off
   values.
```

R code Exa 15.4 Steel Shafts

```
# Page No. 711
```

```
subgroup_data<-c(35.1,33.2,31.7,35.4,34.5,36.4,35.9,38.4,35.7,27.2,38.1,37.6,38.8
subgroup_mean=35.94
subgroup_sd=4.35
n=5
cn=0.94
lcl=subgroup_mean-(3*subgroup_sd/(cn*sqrt(n)))
ucl=subgroup_mean+(3*subgroup_sd/(cn*sqrt(n)))
print(signif(lcl),digits=5)
print(signif(ucl),digits=5)
lcls=subgroup_sd*(1-3*sqrt((1/(cn^2))-1))
ucls=subgroup_sd*(1+3*sqrt((1/(cn^2))-1))
print(signif(lcls),digits=4)
print(signif(ucls),digits=4)
```

R code Exa 15.5 Automatic Screw Machine

```
# Page No. 716
n = 200
p = 0.07
np=n*p
lcl=np-3*sqrt(np*(1-p))
print(signif(lcl), digits=4)
ucl=np+3*sqrt(np*(1-p))
print(signif(ucl), digits=5)
```

R code Exa 15.6 Repair Shop

```
# Page No. 719
w<-c(62.50, 61.61, 65.48, 69.60, 71.70, 73.78,
   73.83, 75.87, 73.90, 76.43)
plot(w)
```

```
x=3*sqrt(0.25/1.75)*(24/sqrt(4))
print(x)
ucl=62+13.61
lcl=62-13.61
print(lcl)
print(ucl)
```

R code Exa 15.7 Subgroup Average

```
#Page No. 723
mean=30
sd=8
b=5
control_limit=b*sd
print(control_limit)
```