STAT 40001/STAT 50001 Statistical Computing Fall 2024

Lab-10

1. An experiment was conducted to measure the pulse rate of students in a class. The students took their own pulse rate. They were then asked to flip a coin. If the coin came up heads, they were to run in place for one minute Otherwise they sat for one minute. Then everyone took their pulse again. The pulse rates and other physiological and lifestyle data are given in the data.
   http://www.statsci.org/data/oz/ms212.txt

Variable	Description
Height	Height (cm)
Weight	Weight (kg)
Age	Age (years)
Gender	Sex (1 = male, 2 = female)
Smokes	Regular smoker? (1 = yes, 2 = no)
Alcohol	Regular drinker? (1 = yes, 2 = no)
Exercise	Frequency of exercise (1 = high, 2 = moderate, 3 = low)
Ran	Whether the student ran or sat between the first and second pulse measurements (1 = ran, 2 = sat)
Pulse1	First pulse measurement (rate per minute)
Pulse2	Second pulse measurement (rate per minute)
Year	Year of class (93 - 98)

   a) Test the hypothesis whether there is a difference in pulse rate if the students were sitting.
   b) Test the hypothesis whether the average pulse rate for running students is increased by 10 units after they ran.

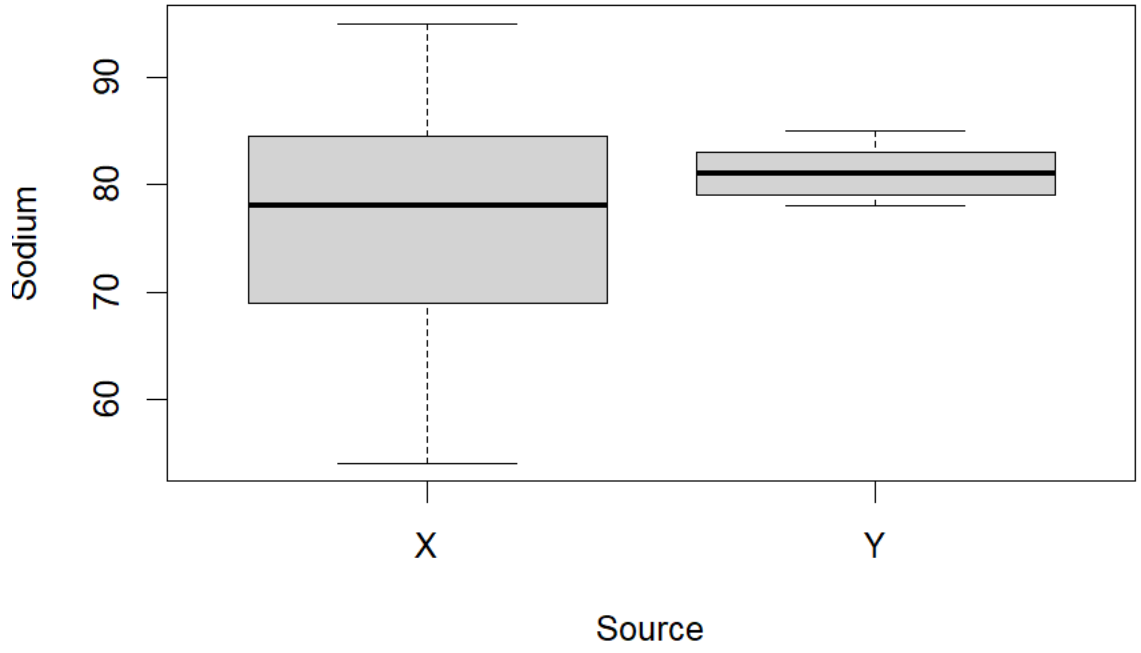
```
> Q1 <- read.table("http://www.statsci.org/data/oz/ms212.txt", header = T)
> head(Q1)
  Height Weight Age Gender Smokes Alcohol Exercise Ran Pulse1 Pulse2 Year
1    173     57  18      2      2       1        2   2     86     88   93
2    179     58  19      2      2       1        2   1     82    150   93
3    167     62  18      2      2       1        1   1     96    176   93
4    195     84  18      1      2       1        1   2     71     73   93
5    173     64  18      2      2       1        3   2     90     88   93
6    184     74  22      1      2       1        3   1     78    141   93
> dim(Q1)
[1] 110  11
> attach(Q1)
> table(Ran)
Ran
 1  2
46 64
> S <- subset(Q1, Ran == 2)
> head(S)
  Height Weight Age Gender Smokes Alcohol Exercise Ran Pulse1 Pulse2 Year
1    173     57  18      2      2       1        2   2     86     88   93
4    195     84  18      1      2       1        1   2     71     73   93
5    173     64  18      2      2       1        3   2     90     88   93
```

```
7    162     57  20      2      2       1        2   2     68     72   93
8    169     55  18      2      2       1        2   2     71     77   93
9    164     56  19      2      2       1        1   2     68     68   93
> t.test(S$Pulse1, S$Pulse2, paired = T) # since the same set of students we are using, paired  =
TRUE

         Paired t-test

data:  S$Pulse1 and S$Pulse2
t = 2.0234, df = 62, p-value = 0.04734
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 0.01209616 1.98790384
sample estimates:
mean difference
              1

> cat("Since p-value < 0.05, we reject the null hypothesis. There is sufficient evidence to concl
ude that there is a significant difference in pulse rates before and after sitting.")
Since p-value < 0.05, we reject the null hypothesis. There is sufficient evidence to conclude tha
t there is a significant difference in pulse rates before and after sitting.
> R <- subset(Q1, Ran == 1)
> head(R)
   Height Weight Age Gender Smokes Alcohol Exercise Ran Pulse1 Pulse2 Year
2     179     58  19      2      2       1        2   1     82    150   93
3     167     62  18      2      2       1        1   1     96    176   93
6     184     74  22      1      2       1        3   1     78    141   93
10    168     60  23      1      2       1        2   1     88    150   93
11    170     75  20      1      2       1        1   1     76     88   93
18    180     70  18      1      2       1        2   1     80    146   93
> dim(R)
[1] 46 11
> t.test(R$Pulse2, R$Pulse1, mu = 10, alt = "greater", paired = T)

         Paired t-test

data:  R$Pulse2 and R$Pulse1
t = 13.311, df = 45, p-value < 2.2e-16
alternative hypothesis: true mean difference is greater than 10
95 percent confidence interval:
 46.16911      Inf
sample estimates:
mean difference
        51.3913

> cat("Since p-value < 0.05, we reject the null hypothesis. There is sufficient evidence to concl
ude that the average pulse rate increase after running is greater than 10 bpm.")
Since p-value < 0.05, we reject the null hypothesis. There is sufficient evidence to conclude tha
t the average pulse rate increase after running is greater than 10 bpm.
```

2. A bottled water company acquires its water from two independent sources, X and Y. Data set *Water* in *PASWR* contains the sodium content in each brand of water. Is there statistical evidence to suggest that the variance of sodium content in the water from source X is different than the variance of sodium content in water from source Y?

```
> install.packages("PASWR")
> library(PASWR)
> data("Water")
> head(water)
   X  Y Sodium Source
1 84 78     84      X
2 73 79     73      X
3 92 84     92      X
4 84 82     84      X
5 95 80     95      X
6 74 85     74      X
> attach(water)
> str(water)
'data.frame':       30 obs. of  4 variables:
 $ X     : int  84 73 92 84 95 74 80 86 80 77 ...
 $ Y     : int  78 79 84 82 80 85 81 83 79 81 ...
 $ Sodium: int  84 73 92 84 95 74 80 86 80 77 ...
 $ Source: Factor w/ 2 levels "X","Y": 1 1 1 1 1 1 1 1 1 1 ...
```

```
> boxplot(Sodium~Source)
> var.test(Sodium~Source)

        F test to compare two variances

data:  Sodium by Source
F = 23.215, num df = 19, denom df = 9, p-value = 3.921e-05
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
  6.302573 66.858988
sample estimates:
ratio of variances
          23.21451

> cat("Since the p-value is less than 0.05, we reject the null hypothesis. This means that there
is strong evidence to suggest that the variances of sodium content from Source X and Source Y are
different.")
Since the p-value is less than 0.05, we reject the null hypothesis. This means that there is stro
ng evidence to suggest that the variances of sodium content from Source X and Source Y are differ
ent.
```



3. The Pew Research Group conducted a poll in which they asked, "Are you in favor of, or opposed to, executing persons as a general policy when the crime was committed while under the age of 18?" Of the 580 Catholics surveyed, 180 indicated they favored capital punishment; of the 600 seculars (those who do not associate with a religion) surveyed, 238 favored capital punishment. Is there a significant difference in the proportion of individuals in these groups in favor of capital punishment for persons under the age of 18?

```
> prop.test(x = c(180,238), n = c(580,600))

        2-sample test for equality of proportions with continuity correction

data:  c(180, 238) out of c(580, 600)
X-squared = 9.233, df = 1, p-value = 0.002377
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.14232944 -0.03031424
sample estimates:
   prop 1    prop 2
```

```
0.3103448 0.3966667

> cat("Since the p-value is less than 0.05, we reject the null hypothesis. This means that there
is significant statistical evidence that the proportions of Catholics and secular individuals in
favor of capital punishment for persons.")
Since the p-value is less than 0.05, we reject the null hypothesis. This means that there is sign
ificant statistical evidence that the proportions of Catholics and secular individuals in favor o
f capital punishment for persons.
```

4. Furness and Bryant (1996) compared the metabolic rates of male and female breeding northern fulmars (data described in Logan (2010) and Quinn (2002)).

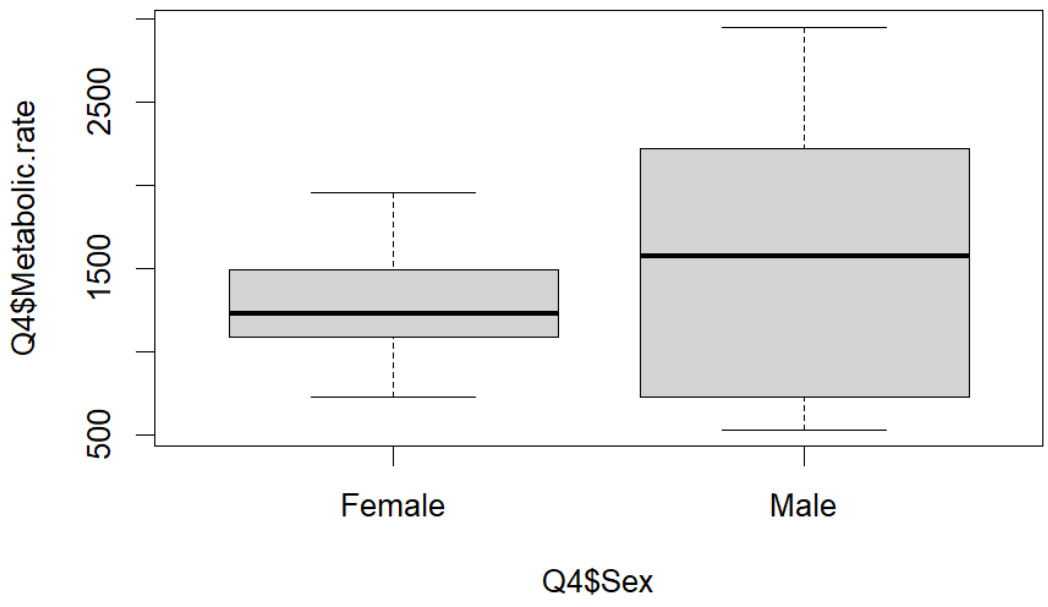
Sex	Metabolic rate
Female	728
Female	1087
Female	1091
Female	1361
Female	1491
Female	1956
Male	526
Male	606
Male	843
Male	1196
Male	1946
Male	2136
Male	2309
Male	2950

a) Display the metabolic rate of Female and Male group using side-by-side boxplot

b) Test the hypothesis whether there is a difference in Metabolic rate based on gender.

```
> Q4 <- read.csv("C:\\Users\\PNW_checkout\\Downloads\\vaishak\\PNW_COURSE-WORK\\FALL24\\STATISTIC
AL COMPUTING\\Assignment\\Assignment 10\\q4.csv", header = T)
> head(Q4)
     Sex Metabolic.rate
1 Female            728
2 Female           1087
3 Female           1091
4 Female           1361
5 Female           1491
6 Female           1956
> dim(Q4)
[1] 14  2
> boxplot(Q4$Metabolic.rate~Q4$Sex)
> t.test(Q4$Metabolic.rate~Q4$Sex)

         Welch Two Sample t-test

data:  Q4$Metabolic.rate by Q4$Sex
t = -0.77341, df = 10.466, p-value = 0.4564
alternative hypothesis: true difference in means between group Female and group Male is not equal
to 0
95 percent confidence interval:
 -1075.375   518.708
sample estimates:
```

```
mean in group Female   mean in group Male
            1285.667             1564.000

> cat("Fail to reject the null hypothesis: There is no significant difference in the metabolic ra
tes between genders (p-value = 0.4564).")
Fail to reject the null hypothesis: There is no significant difference in the metabolic rates bet
ween genders (p-value = 0.4564).
> # also
> # if variance_equal, more appropriate is as below
> var.test(Q4$Metabolic.rate~Q4$Sex)

         F test to compare two variances

data:  Q4$Metabolic.rate by Q4$Sex
F = 0.2214, num df = 5, denom df = 7, p-value = 0.1161
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
 0.04189038 1.51727484
sample estimates:
ratio of variances
         0.2214006

> cat("Fail to reject the null hypothesis: There is no significant difference in variances betwee
n the groups (p-value = 0.1161).")
Fail to reject the null hypothesis: There is no significant difference in variances between the g
roups (p-value = 0.1161).
> # if var.test p value > 0.05, then
> t.test(Q4$Metabolic.rate~Q4$Sex, var.equal = T)

         Two Sample t-test

data:  Q4$Metabolic.rate by Q4$Sex
t = -0.70106, df = 12, p-value = 0.4966
alternative hypothesis: true difference in means between group Female and group Male is not equal
to 0
95 percent confidence interval:
 -1143.3658   586.6992
sample estimates:
mean in group Female   mean in group Male
            1285.667             1564.000

> cat("Fail to reject the null hypothesis: There is no significant difference in the mean metabol
ic rates between genders (p-value = 0.4966).")
Fail to reject the null hypothesis: There is no significant difference in the mean metabolic rate
s between genders (p-value = 0.4966).
```



5. The website below provides the dataset related to the study of the maternal smoking and infant health.
   http://www.stat.berkeley.edu/~statlabs/data/babiesI.data
   There are two variables
   bwt=Birth weight in ounces
   smoke=Smoking status of mother 0=not now, 1=yes now, 9=unknown

   a) Import the data set in R
   b) How many observations have smoking status unknown?
   c) CLEAN data set by removing subjects whose smoking status is unknown.
   d) Do we have evidence to prove that the newborn baby will have significantly low weight for a smoker mom than for a non-smoker mom?

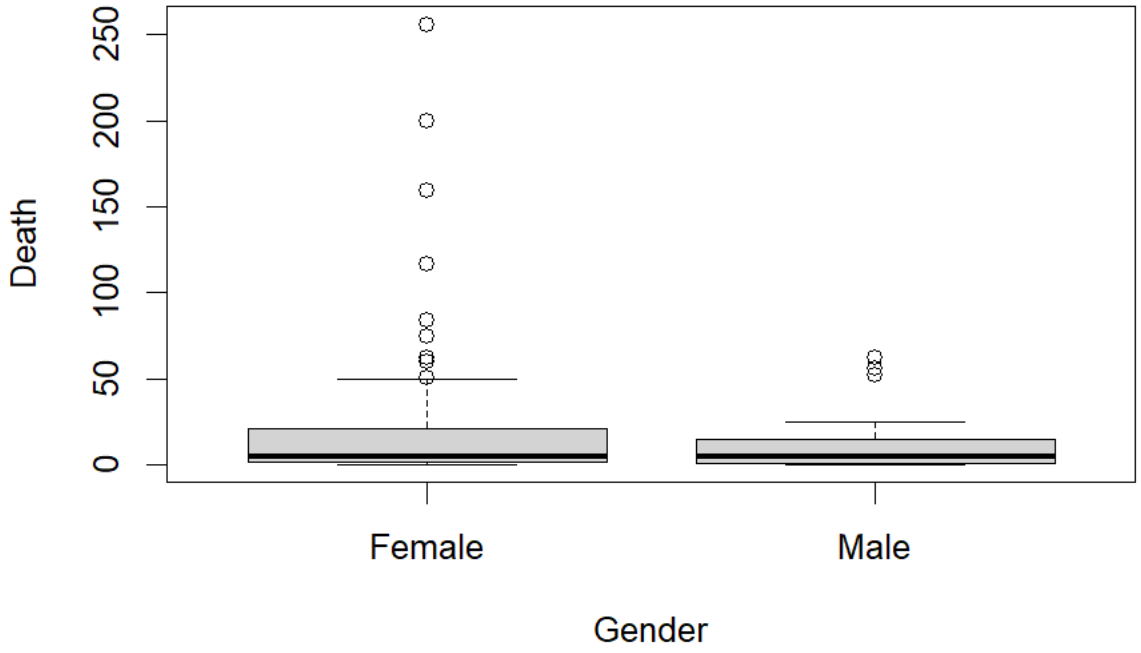
```
> Q5 <- read.table("C:\\Users\\PNW_checkout\\Downloads\\vaishak\\PNW_COURSE-WORK\\FALL24\\STATIST
ICAL COMPUTING\\Assignment\\Assignment 10\\babiesI.data", header = T)
> attach(Q5)
> dim(Q5)
[1] 1236    2
> head(Q5)
  bwt smoke
1 120     0
2 113     0
3 128     1
4 123     0
5 108     1
6 136     0
> sum(Q5$smoke == "9")
[1] 10
> head(Q5,20)
   bwt smoke
1  120     0
2  113     0
3  128     1
4  123     0
5  108     1
6  136     0
7  138     0
8  132     0
9  120     0
10 143     1
11 140     0
12 144     1
13 141     1
14 110     1
15 114     0
16 115     0
17  92     1
18 115     1
19 144     0
20 119     1
> clean_data <- subset(Q5,smoke!=9)
> dim(clean_data)
[1] 1226    2
> t.test(bwt~smoke, data = clean_data, alt = "greater")

         Welch Two Sample t-test

data:  bwt by smoke
t = 8.5813, df = 1003.2, p-value < 2.2e-16
alternative hypothesis: true difference in means between group 0 and group 1 is greater than 0
95 percent confidence interval:
 7.222928      Inf
sample estimates:
mean in group 0 mean in group 1
       123.0472        114.1095

> cat("Reject the null hypothesis: There is significant evidence (p-value < 2.2e-16) that newborn
babies of smoker moms have significantly lower birth weights than those of non-smoker moms.")
```

```
Reject the null hypothesis: There is significant evidence (p-value < 2.2e-16) that newborn babies
of smoker moms have significantly lower birth weights than those of non-smoker moms.
```

6. Are Female Hurricanes Deadlier than Male Hurricanes? The data set contains archival data on actual fatalities caused by hurricanes in the United States between 1950 and 2012 is provided with this Lab. Please note that two deadliest hurricanes (hurricane Katrina in 2005 (1833 deaths) and Audrey in 1957 (416 deaths) were removed from the data set). Perform the appropriate test.

```
> # install.packages("xlsx") -> range = "A1:D47" not working
> # readxl package -> read_excel
> install.packages(readxl)
Error in install.packages : object 'readxl' not found
> library(readxl)
> data1 <- read_excel("C:\\Users\\PNW_checkout\\Downloads\\vaishak\\PNW_COURSE-WORK\\FALL24\\STAT
ISTICAL COMPUTING\\Assignment\\Assignment 10\\Hurricane.xlsx", range = "A1:D47")
> data2 <- read_excel("C:\\Users\\PNW_checkout\\Downloads\\vaishak\\PNW_COURSE-WORK\\FALL24\\STAT
ISTICAL COMPUTING\\Assignment\\Assignment 10\\Hurricane.xlsx", range = "E1:H47")
> head(data1)
# A tibble: 6 × 4
  Hurricane  Year Gender Death
  <chr>     <dbl> <chr>  <dbl>
1 Easy       1950 Female     2
2 King       1950 Male       4
3 Able       1952 Male       3
4 Barbara    1953 Female     1
5 Florence   1953 Female     0
6 Carol      1954 Female    60
> dim(data1)
[1] 46  4
> head(data2)
# A tibble: 6 × 4
  Hurricane  Year Gender Death
  <chr>     <dbl> <chr>  <dbl>
1 Elena      1985 Female     4
2 Gloria     1985 Female     8
3 Juan       1985 Male      12
4 Kate       1985 Female     5
5 Bonnie     1986 Female     3
6 Charley    1986 Male       5
> dim(data2)
[1] 46  4
> data <- rbind(data1, data2)
> head(data)
# A tibble: 6 × 4
  Hurricane  Year Gender Death
  <chr>     <dbl> <chr>  <dbl>
1 Easy       1950 Female     2
2 King       1950 Male       4
3 Able       1952 Male       3
4 Barbara    1953 Female     1
5 Florence   1953 Female     0
6 Carol      1954 Female    60
> dim(data)
[1] 92  4
> attach(data)
> boxplot(Death~Gender)
> t.test(Death~Gender, alt = "greater")

        Welch Two Sample t-test

data:  Death by Gender
t = 1.9022, df = 86.161, p-value = 0.03024
alternative hypothesis: true difference in means between group Female and group Male is greater t
han 0
95 percent confidence interval:
 1.622587      Inf
sample estimates:
mean in group Female   mean in group Male
            24.71429             11.82759

> cat("Reject the null hypothesis. This suggests that female-named hurricanes, on average, cause
more deaths than male-named hurricanes.")
```

```
Reject the null hypothesis. This suggests that female-named hurricanes, on average, cause more de
aths than male-named hurricanes.
```



7. The *birthwt* data in MASS package were collected at Baystate Medical Center, Springfield, Massachusetts. Perform a two-sample proportion test to determine whether smoking gives a higher fraction of low-weight births.
Variables provided in the data

`Low`: indicator of birth weight less than 2.5 kg.
`Age`: mother's age in years.
`Lwt`: mother's weight in pounds at last menstrual period.
`Race`: mother's race (`1` = white, `2` = black, `3` = other).
`Smoke`: smoking status during pregnancy.
`Pt1`: number of previous premature labours.
`Ht`: history of hypertension.
`Ui`: presence of uterine irritability.
`Ftv`: number of physician visits during the first trimester.
`Bwt`: birth weight in grams.

```
> install.packages("MASS")
> library(MASS)
> data("birthwt")
> tab <- table(birthwt$smoke, birthwt$low)
>
> prop.test(tab)

        2-sample test for equality of proportions with continuity correction

data:  tab
X-squared = 4.2359, df = 1, p-value = 0.03958
alternative hypothesis: two.sided
95 percent confidence interval:
 0.004967192 0.301495793
sample estimates:
```

```
   prop 1    prop 2
0.7478261 0.5945946

> cat("p value is 0.03958 < 0,05, There is a significant higher fraction of low-weight births amo
ng smokers.")
p value is 0.03958 < 0,05, There is a significant higher fraction of low-weight births among smok
ers.
```