# Homework 1

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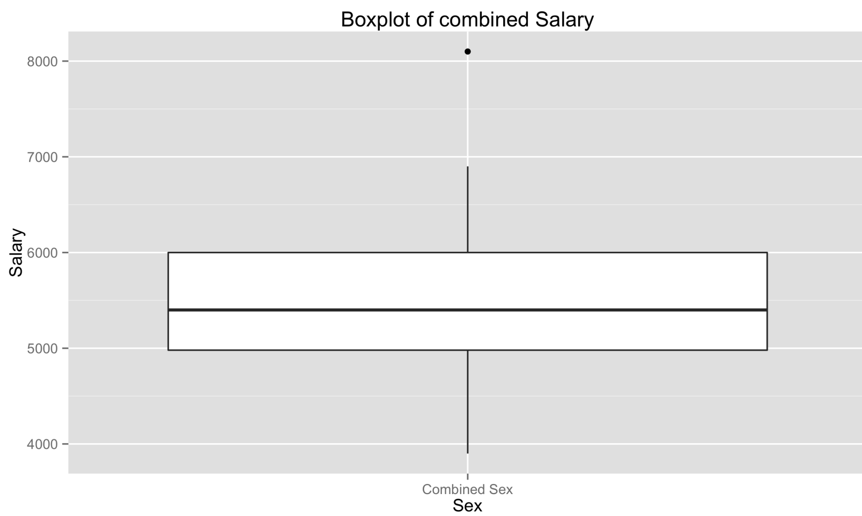
**Consider the Salary Data (Display 1.3) in Ramsey & Schafer. Chapter 1, and partially appended below.**

I). Determine whether there are outliers in the combined data, using boxplots or other suitable methods.

From the box-plot below, we can find that within the combined data for salary. There is one outlier here with salary 8100 and sex MALE.




We can also see from the stem-leaf plot that there is an outlier in the combined data.

stem-leaf plot for combined data

```
The decimal point is 3 digit(s) to the right of the |

3 | 9
4 | 03444444
4 | 55668888888888
5 | 0011111111222233344444444444444444
5 | 5566777777
6 | 0000000000000001333
6 | 666899
7 |
7 |
8 | 1
```

II). Performs seperate EDA, and compute the sample SD and IQR for Salary in each group.

First, check if there is missing value in data. We can find there is no missing values here because R function returns TRUE here.
Second, check if there is outlier here, from the grouped scatter-plot and box-plot we can find that there is

Table 1: Statistic of FEMALE groups

| Min | $1^{st}$qu | Median | Mean | $3^{rd}$qu | Max |
|---|---|---|---|---|---|
| 3900 | 4800 | 5220 | 5139 | 5400 | 6300 |

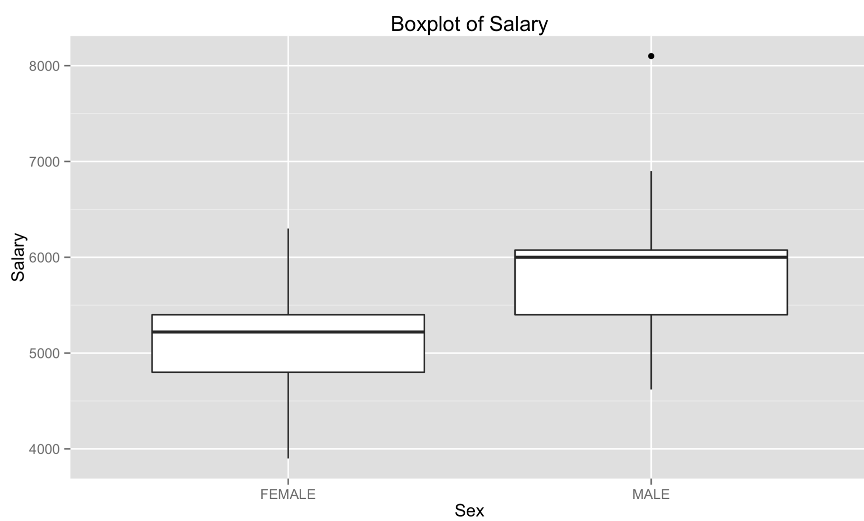
Table 2: Statistic of MALE groups

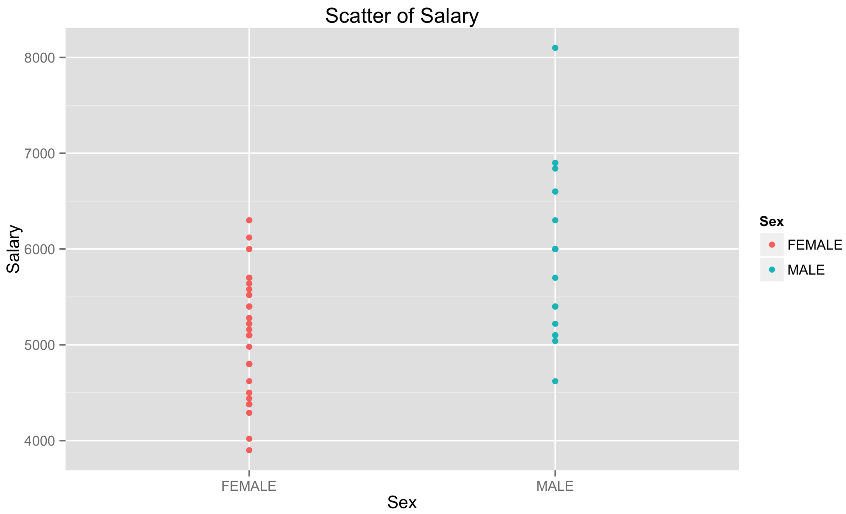
| Min | $1^{st}$qu | Median | Mean | $3^{rd}$qu | Max |
|---|---|---|---|---|---|
| 4620 | 5400 | 6000 | 5957 | 6075 | 8100 |

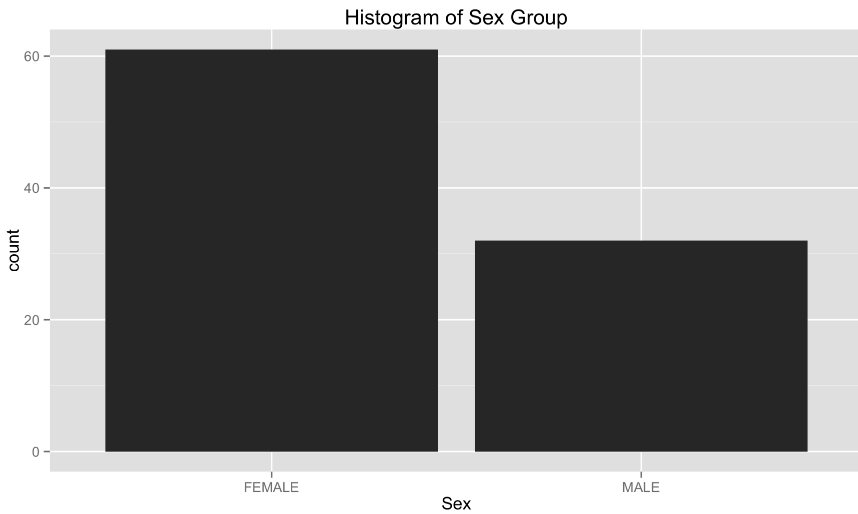
Table 3: SD & IQR

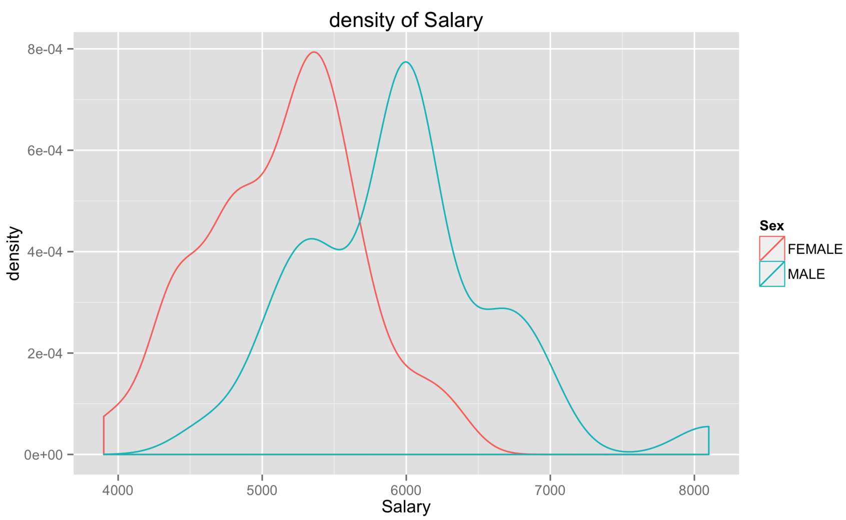
| | Sample SD | IQR |
|---|---|---|
| MALE | 690.7333 | 675 |
| FEMALE | 539.8707 | 600 |

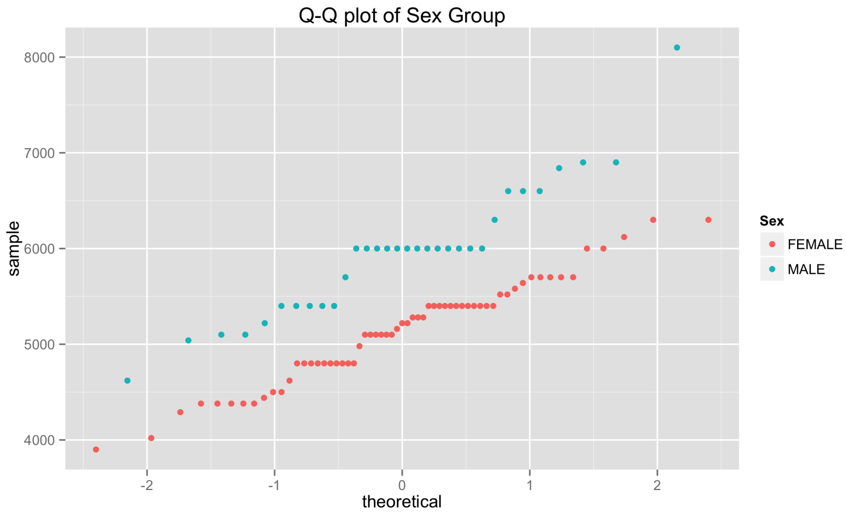
one outlier within MALE group, which is of salary 8100, whereas there is no outlier within FEMALE group. And from the first question we know that it is also the combined outlier.
And we can also see from the stem-leaf plot that there is an outlier in the MALE data, but no outlier in FEMALE data.
Third, draw histogram to see the number of observations in each group. MALE group has 32 observations and FEMALE group has 61 observations, with total 93 observations. And also some other statistics, see the following table.
Fourth, draw estimate density plot to see the distribution. We can see that both of the two groups are not gaussian distribution but a little bit close gaussian.
Then, draw Q-Q plot to see the gaussian assumption. We can see that both of the two groups are not gaussian distribution.
And then, calculate the sample standard deviation. Sample SD in MALE group is 690.7333 and Sample SD in Female group is 640.




Scatter of Salary
8000
7000
6000
5000
4000
Salary
FEMALE
MALE
Sex
Sex
FEMALE
MALE


Histogram of Sex Group
60
40
20
0
count
FEMALE
MALE
Sex


density of Salary
8e-04
6e-04
4e-04
2e-04
0e+00
density
4000
5000
6000
7000
8000
Salary
Sex
FEMALE
MALE




stem-leaf plot for Male Group

```
The decimal point is 3 digit(s) to the right of the |

4 | 6
5 | 011244444
5 | 7
6 | 00000000000003
6 | 666899
7 |
7 |
8 | 1
```

stem-leaf plot for Female Group

```
The decimal point is 2 digit(s) to the right of the |

38 | 0
40 | 2
42 | 988888
44 | 400
46 | 2
48 | 00000000008
50 | 0000006
52 | 22888
54 | 000000000000228
56 | 400000
58 |
60 | 002
62 | 00
```

III). For each of the estimates computed in II above, determine the bias and variance using each of the following methods (Jackknife, Bootstrap).

- Jackknife

Using Jackknife method, we calculate the bias and variance of the statistics, including sample mean, median, variance, sd, and IQR. The results are as follows:

Table 4: Jackknife result of bias and variance for MALE

| | Mean | Median | Variance | SD | IQR |
|---|---|---|---|---|---|
| bias | 0 | 0 | 0 | -11.28011 | 1162.5 |
| variance | 14909.78 | 0 | 26077372928 | 15578.98 | 130781.2 |

Table 5: Jackknife result of bias and variance for FEMALE

| | Mean | Median | Variance | SD | IQR |
|---|---|---|---|---|---|
| bias | 0 | -914.7541 | 0 | -1.946738 | 0 |
| variance | 4778.038 | 13496.38 | 2401113681 | 2101.91 | 0 |

- Bootstrap

Using Bootstrap method, we calculate the bias and variance of the statistics, including sample mean, median, variance, sd, and IQR. The results are as follows:

Table 6: Bootstrap result of bias and variance for MALE

| | Mean | Median | Variance | SD | IQR |
|---|---|---|---|---|---|
| bias | -7.25625 | -9 | -16276.43 | -37.64311 | 44.55 |
| variance | 17465.74 | 3100 | 26402928665 | 12611.84 | 89892.98 |

Table 7: Bootstrap result of bias and variance for FEMALE

| | Mean | Median | Variance | SD | IQR |
|---|---|---|---|---|---|
| bias | -5.965574 | -14.4 | -2040.152 | -6.274852 | 64.2 |
| variance | 5188.242 | 12008.73 | 2424468372 | 2346.072 | 16673.09 |

### R Code:

```r
rm(list=ls())

#input raw data file
file <-file("/Users/raymond/Desktop/STAT W4201/HW1/data.txt","r")
data<-readLines(file)
index<-which((1:length(data))%%2==1)
salary<-as.numeric(data[index])
sex<-data[-index]
close( file )
data<-data.frame(Salary=salary,Sex=sex)

#boxplot for the combined data
library (ggplot2)
combined<-ggplot(data,aes("Combined Sex",Salary))
combined+geom_boxplot()+labs(x="Sex",title="Boxplot of combined Salary")
ggsave( file ="/Users/raymond/Desktop/STAT W4201/HW1/boxcombined.png")

stem(data$Salary)
sink("/Users/raymond/Desktop/STAT W4201/HW1/stemCombined.txt")
stem(data$Salary)
sink()

#explore if missing values
any(is.na(data$Salary))

#boxplot for Grouped data
Group<-ggplot(data,aes(Sex,Salary))
Group+geom_boxplot()+ggtitle("Boxplot of Salary")
ggsave( file ="/Users/raymond/Desktop/STAT W4201/HW1/boxgroup.png")

#stem-leaf plot for Grouped data
stem(data$Salary[data$Sex=="FEMALE"])
stem(data$Salary[data$Sex=="MALE"])
sink("/Users/raymond/Desktop/STAT W4201/HW1/stemFemale.txt")
stem(data$Salary[data$Sex=="FEMALE"])
sink()
sink("/Users/raymond/Desktop/STAT W4201/HW1/stemMale.txt")
stem(data$Salary[data$Sex=="MALE"])
sink()


#scatter plot for Grouped data
Group+geom_point(aes(color=factor(Sex)))+scale_color_discrete(name="Sex")+ggtitle("Scatter of Salary")
ggsave( file ="/Users/raymond/Desktop/STAT W4201/HW1/scatter.png")

#histogram for two groups
hist <-ggplot(data,aes(Sex))
hist +geom_histogram()+ggtitle("Histogram of Sex Group")
ggsave( file ="/Users/raymond/Desktop/STAT W4201/HW1/histogram.png")
Female<-data$Salary[data$Sex=="FEMALE"]
Male<-data$Salary[data$Sex=="MALE"]
summary(data$Salary[data$Sex=="FEMALE"])
summary(data$Salary[data$Sex=="MALE"])

#estimate density for two groups
epdf<-ggplot(data,aes(Salary))
epdf+geom_density(aes(color=Sex))+ggtitle("density of Salary")
ggsave( file ="/Users/raymond/Desktop/STAT W4201/HW1/epdf.png")

#qqplot for two groups
qqplot<-ggplot(data,aes(sample=Salary))
qqplot+stat_qq(aes(color=factor(Sex)))+ggtitle("Q-Q plot of Sex Group")+scale_color_discrete(name="Sex")
ggsave( file ="/Users/raymond/Desktop/STAT W4201/HW1/qqplot.png")

#calculate sd for two groups
SD1<-sd(Female)
```

```
SD2<-sd(Male)

#jackknife calculate two groups
#MALE group
library(bootstrap)
jmean_Male<-jackknife(Male,mean)
jsd_Male<-jackknife(Male,sd)
jmed_Male<-jackknife(Male,median)
jIQR_Male<-jackknife(Male,IQR)
jvar_Male<-jackknife(Male,var)

#FEMALE group
jmean_Female<-jackknife(Female,mean)
jsd_Female<-jackknife(Female,sd)
jmed_Female<-jackknife(Female,median)
jIQR_Female<-jackknife(Female,IQR)
jvar_Female<-jackknife(Female,var)

#Bootstrap calculate two groups
#MALE group
set.seed(123)
bMeanMale<-bootstrap(Male,100,mean)
bMeanMale_bias<-mean(bMeanMale$thetastar)-mean(Male)
bMeanMale_var<-var(bMeanMale$thetastar)
bMedMale<-bootstrap(Male,100,median)
bMedMale_bias<-mean(bMedMale$thetastar)-median(Male)
bMedMale_var<-var(bMedMale$thetastar)
bsdMale<-bootstrap(Male,100,sd)
bsdMale_bias<-mean(bsdMale$thetastar)-sd(Male)
bsdMale_var<-var(bsdMale$thetastar)
bvarMale<-bootstrap(Male,100,var)
bvarMale_bias<-mean(bvarMale$thetastar)-var(Male)
bvarMale_var<-var(bvarMale$thetastar)
bIQRMale<-bootstrap(Male,100,IQR)
bIQRMale_bias<-mean(bIQRMale$thetastar)-IQR(Male)
bIQRMale_var<-var(bIQRMale$thetastar)

#FEMALE Group
bMeanFemale<-bootstrap(Female,100,mean)
bMeanFemale_bias<-mean(bMeanFemale$thetastar)-mean(Female)
bMeanFemale_var<-var(bMeanFemale$thetastar)
bMedFemale<-bootstrap(Female,100,median)
bMedFemale_bias<-mean(bMedFemale$thetastar)-median(Female)
bMedFemale_var<-var(bMedFemale$thetastar)
bsdFemale<-bootstrap(Female,100,sd)
bsdFemale_bias<-mean(bsdFemale$thetastar)-sd(Female)
bsdFemale_var<-var(bsdFemale$thetastar)
bvarFemale<-bootstrap(Female,100,var)
bvarFemale_bias<-mean(bvarFemale$thetastar)-var(Female)
bvarFemale_var<-var(bvarFemale$thetastar)
bIQRFemale<-bootstrap(Female,100,IQR)
bIQRFemale_bias<-mean(bIQRFemale$thetastar)-IQR(Female)
bIQRFemale_var<-var(bIQRFemale$thetastar)
```