Homework Week 02

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```
getwd()
```

```
## [1] "/Users/abir/Desktop/FA"
```

```
Machine <- c("Machine 1","Machine 1","Machine 1","Machine 1","Machine 1","Machine 1","Machine 1","Machi
dat <- c(16.03,16.04,16.05,16.05,16.02,16.01,15.96,15.98,16.02,15.99,16.02,15.97,15.96,16.01,15.99,16.0
length(Machine)
```

```
## [1] 20
```

```
length(dat)
```

```
## [1] 20
```

```
str(Machine)
```

```
##  chr [1:20] "Machine 1" "Machine 1" "Machine 1" "Machine 1" "Machine 1" ...
```

```
Machine <- as.factor(Machine)
str(Machine)
```

```
##  Factor w/ 2 levels "Machine 1","Machine 2": 1 1 1 1 1 1 1 1 1 1 ...
```

```
str(dat)
```

```
##  num [1:20] 16 16 16.1 16.1 16 ...
```

```
dat1 <- data.frame(Machine,dat)
dat1
```

```
##      Machine   dat
## 1  Machine 1 16.03
## 2  Machine 1 16.04
## 3  Machine 1 16.05
## 4  Machine 1 16.05
## 5  Machine 1 16.02
## 6  Machine 1 16.01
## 7  Machine 1 15.96
## 8  Machine 1 15.98
## 9  Machine 1 16.02
## 10 Machine 1 15.99
## 11 Machine 2 16.02
## 12 Machine 2 15.97
## 13 Machine 2 15.96
## 14 Machine 2 16.01
## 15 Machine 2 15.99
## 16 Machine 2 16.03
```

```
## 17 Machine 2 16.04
## 18 Machine 2 16.02
## 19 Machine 2 16.01
## 20 Machine 2 16.00
```

```
# Answer to the problem No: 2.24.(a)
# Hypotheses Statement:
# H0: u1 = u2 or u1-u2 = 0
# Ha: u1 != u2 or u1 -u2 != 0

# Answer to the problem No: 2.24.(b)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
dat2 <- dat1 %>% filter(Machine=="Machine 1") %>% select(dat)
dat3 <- dat1 %>% filter(Machine=="Machine 2") %>% select(dat)
t.test(dat2,dat3,var.equal = TRUE)
```

```
##
##  Two Sample t-test
##
## data:  dat2 and dat3
## t = 0.79894, df = 18, p-value = 0.4347
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.01629652  0.03629652
## sample estimates:
## mean of x mean of y
##    16.015    16.005
```

```
# p value > 0.05 so we fail to reject H0. Hence, the mean is equal so the both
# machines fill to the same net volume regardless of the volume is 16.0 ounce at the
# alpha = 0.05 level of significance and the quality engineering department's suspect is true.

# Answer to the problem No: 2.24.(c)
# P-value for this test is 0.4347

# Answer to the problem No: 2.24.(d)
# 95 percent confidence interval on the difference in the mean fill volume for
# the two machines are
#  -0.01629652<= u1-u2 <=0.03629652

# Answer to the problem No: 2.26
Type <- c("Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type2","Type1
dat4 <- c(65,81,57,66,82,82,67,59,75,70,64,71,83,59,65,56,69,74,82,79)
str(Type)
```

```
##  chr [1:20] "Type1" "Type1" "Type1" "Type1" "Type1" "Type1" "Type1" "Type1" ...
```

```
Type <- as.factor(Type)
str(Type)
```

```
##  Factor w/ 2 levels "Type1","Type2": 1 1 1 1 1 1 1 1 1 1 ...
```

```
str(dat4)
```

```
##  num [1:20] 65 81 57 66 82 82 67 59 75 70 ...
```

```
dat5 <- data.frame(Type,dat4)
dat5
```

```
##     Type dat4
## 1  Type1   65
## 2  Type1   81
## 3  Type1   57
## 4  Type1   66
## 5  Type1   82
## 6  Type1   82
## 7  Type1   67
## 8  Type1   59
## 9  Type1   75
## 10 Type1   70
## 11 Type2   64
## 12 Type2   71
## 13 Type2   83
## 14 Type2   59
## 15 Type2   65
## 16 Type2   56
## 17 Type2   69
## 18 Type2   74
## 19 Type2   82
## 20 Type2   79
```

```
# Answer to the problem No: 2.26.(a)
library(lawstat)
levene.test(dat5$dat4,dat5$Type,location="mean")
```

```
##
##  Classical Levene's test based on the absolute deviations from the mean
##  ( none not applied because the location is not set to median )
##
## data:  dat5$dat4
## Test Statistic = 0.0014598, p-value = 0.9699
```

```
# Hence, P value > 0.05, so we fail to reject H0 and therefore the variance's are equal
# at alpha = 0.05 level of significance.

# Answer to the problem No: 2.26.(b)
# From the results of (a), we see that variance's are equal. Hence we can use
# Two Sample t test with pooled variance to test the hypotheses.
# Hypotheses Statement:
# H0: u1 = u2 or u1-u2 = 0
# Ha: u1 != u2 or u1 -u2 != 0
library(dplyr)
dat6 <- dat5 %>% filter(Type=="Type1") %>% select(dat4)
```

```r
dat7 <- dat5 %>% filter(Type=="Type2") %>% select(dat4)
t.test(dat6,dat7,var.equal = TRUE)
```

```
##
##  Two Sample t-test
##
## data:  dat6 and dat7
## t = 0.048008, df = 18, p-value = 0.9622
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -8.552441  8.952441
## sample estimates:
## mean of x mean of y
##      70.4      70.2
```

```r
# Hence, P value > 0.05, so we fail to reject H0 and therefore the mean burning times
# are equal at alpha = 0.05 level of significance.
# P-value for this test is 0.9622.

# Answer to the problem No: 2.29
Temp95 <- c(11.176,7.089,8.097,11.739,11.291,10.759,6.467,8.315)
Temp100 <- c(5.263,6.748,7.461,7.015,8.133,7.418,3.772,8.963)
dat8 <- data.frame(Temp100,Temp95)
dat8
```

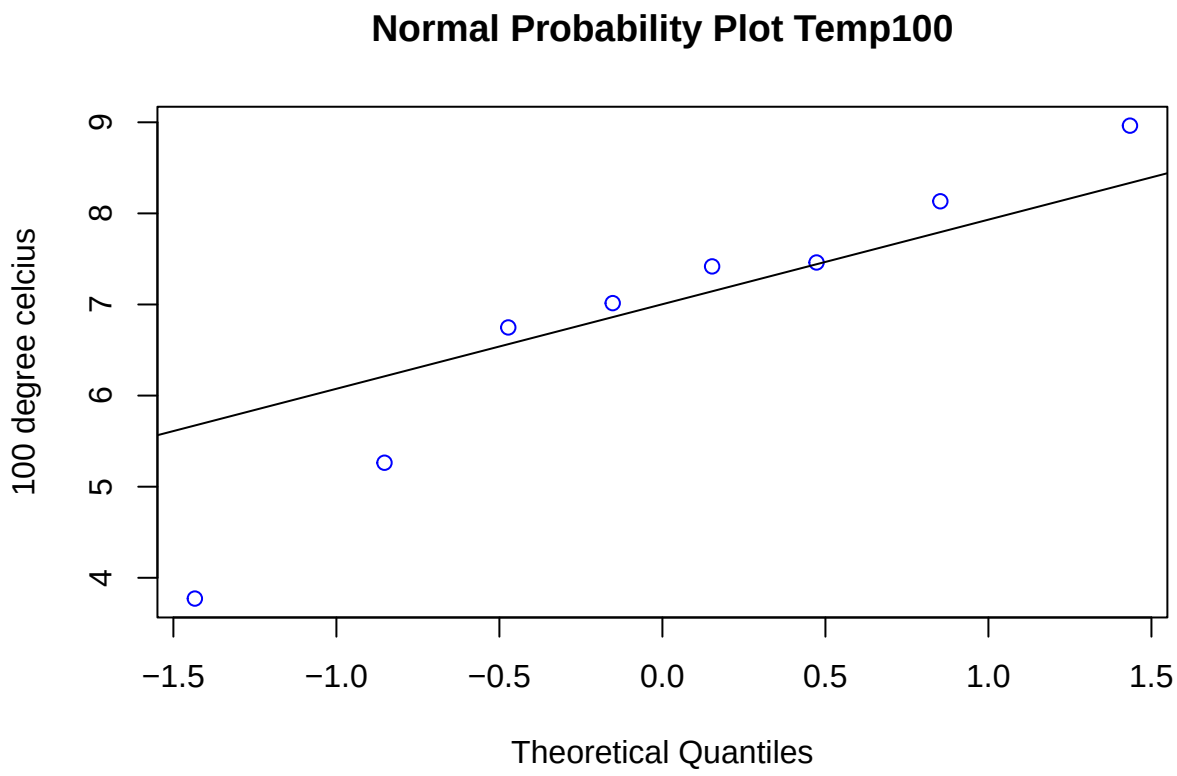
```
##   Temp100 Temp95
## 1   5.263 11.176
## 2   6.748  7.089
## 3   7.461  8.097
## 4   7.015 11.739
## 5   8.133 11.291
## 6   7.418 10.759
## 7   3.772  6.467
## 8   8.963  8.315
```

```r
# Answer to the problem No: 2.29.(a)
# Hypotheses Statement:
# H0: u1 (mean of Temp 100) = u2 (mean of Temp 95) or u1-u2 = 0
# Ha: u1 (mean of Temp 100) < u2 (mean of Temp 95)
# Two sample t test is as follows:
t.test(Temp100,Temp95,var.equal = TRUE,alternative = "less")
```

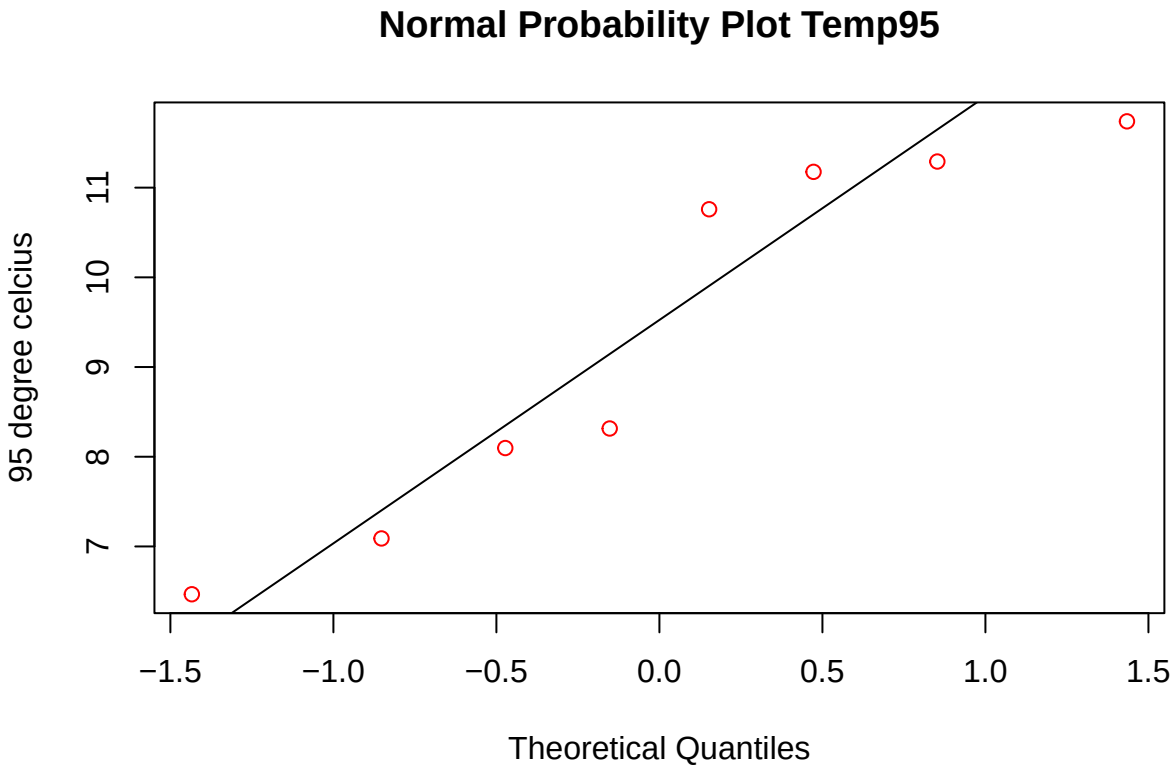
```
##
##  Two Sample t-test
##
## data:  Temp100 and Temp95
## t = -2.6751, df = 14, p-value = 0.009059
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##        -Inf -0.8608158
## sample estimates:
## mean of x mean of y
##  6.846625  9.366625
```

```r
# Since P-value < 0.05 at a alpha = 0.05 level of significance so we reject H0
# Thus, there is evidence to support the claim that higher the baking temperature
```

```
# results with a lower mean photo resist thickness.

# Answer to the problem No: 2.29.(b)
# P-value for the test conducted in part (a) is 0.009059.

# Answer to the problem No: 2.29.(c)
# 95% confidence interval on the difference in mean is
# -infinity <= u1-u2 <= -0.8608158
# This confidence interval does not include 0 in it. So, there is a difference
# in the two temperatures on the thickness of the photo resist.

# Answer to the problem No: 2.29.(e)
# Normality assumptions check
qqnorm(dat8$Temp100,main="Normal Probability Plot Temp100",col="blue",ylab="100 degree celcius")
qqline(dat8$Temp100)
```




```
qqnorm(dat8$Temp95,main="Normal Probability Plot Temp95",col="red",ylab="95 degree celcius")
qqline(dat8$Temp95)
```




```
# No significant deviations been observed from both (Temp 100 and Temp 95) of the
# the normality assumptions.
```

Source Code

```
getwd()
Machine <- c("Machine 1","Machine 1","Machine 1","Machine 1","Machine 1","Machine 1","Machine 1","Machi
dat <- c(16.03,16.04,16.05,16.05,16.02,16.01,15.96,15.98,16.02,15.99,16.02,15.97,15.96,16.01,15.99,16.0
length(Machine)
length(dat)
str(Machine)
Machine <- as.factor(Machine)
str(Machine)
str(dat)
dat1 <- data.frame(Machine,dat)
dat1
library(dplyr)
dat2 <- dat1 %>% filter(Machine=="Machine 1") %>% select(dat)
dat3 <- dat1 %>% filter(Machine=="Machine 2") %>% select(dat)
t.test(dat2,dat3,var.equal = TRUE)
Type <- c("Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type1","Type2","Type1
dat4 <- c(65,81,57,66,82,82,67,59,75,70,64,71,83,59,65,56,69,74,82,79)
str(Type)
Type <- as.factor(Type)
str(Type)
str(dat4)
dat5 <- data.frame(Type,dat4)
dat5
library(lawstat)
levene.test(dat5$dat4,dat5$Type,location="mean")
```

```
library(dplyr)
dat6 <- dat5 %>% filter(Type=="Type1") %>% select(dat4)
dat7 <- dat5 %>% filter(Type=="Type2") %>% select(dat4)
t.test(dat6,dat7,var.equal = TRUE)
Temp95 <- c(11.176,7.089,8.097,11.739,11.291,10.759,6.467,8.315)
Temp100 <- c(5.263,6.748,7.461,7.015,8.133,7.418,3.772,8.963)
dat8 <- data.frame(Temp100,Temp95)
dat8
t.test(Temp100,Temp95,var.equal = TRUE,alternative = "less")
qqnorm(dat8$Temp100,main="Normal Probability Plot Temp100",col="blue",ylab="100 degree celcius")
qqline(dat8$Temp100)
qqnorm(dat8$Temp95,main="Normal Probability Plot Temp95",col="red",ylab="95 degree celcius")
qqline(dat8$Temp95)
```