**STAT 40001/STAT 50001 Statistical Computing Fall 2024**

**Lab -20**

**1.**  The effective life of insulating fluids at an accelerated load of 35 KV is being studied. Test data have been obtained for four types of fluids. The result from a completely randomized experiment is as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Type I | Type II | Type III | Type IV |
| 17.6 | 16.9 | 21.4 | 19.3 |
| 18.9 | 15.3 | 23.6 | 21.1 |
| 16.3 | 18.6 | 19.4 | 16.9 |
| 17.4 | 17.1 | 18.5 | 17.5 |
| 20.1 | 19.5 | 20.5 | 18.3 |
| 21.6 | 20.3 | 22.3 | 19.8 |

1. Is there any indication that the fluids differ at α = 0.1. What about at α = 0.05?
2. Use the Tukey’s HSD test to identify the fluid types that are different (if any).

> y = c(17.6 ,16.9 ,21.4 ,19.3,

+ 18.9 ,15.3 ,23.6 ,21.1,

+ 16.3 ,18.6 ,19.4 ,16.9,

+ 17.4 ,17.1 ,18.5 ,17.5,

+ 20.1 ,19.5 ,20.5 ,18.3,

+ 21.6 ,20.3 ,22.3 ,19.8)

> y

[1] 17.6 16.9 21.4 19.3 18.9 15.3 23.6 21.1 16.3 18.6 19.4 16.9 17.4 17.1 18.5 17.5 20.1

[18] 19.5 20.5 18.3 21.6 20.3 22.3 19.8

> x = rep(c("I","II","III","IV"), 6)

> x

[1] "I" "II" "III" "IV" "I" "II" "III" "IV" "I" "II" "III" "IV" "I" "II"

[15] "III" "IV" "I" "II" "III" "IV" "I" "II" "III" "IV"

> data <- data.frame(y,x)

> data

y x

1 17.6 I

2 16.9 II

3 21.4 III

4 19.3 IV

5 18.9 I

6 15.3 II

7 23.6 III

8 21.1 IV

9 16.3 I

10 18.6 II

11 19.4 III

12 16.9 IV

13 17.4 I

14 17.1 II

15 18.5 III

16 17.5 IV

17 20.1 I

18 19.5 II

19 20.5 III

20 18.3 IV

21 21.6 I

22 20.3 II

23 22.3 III

24 19.8 IV

> dim(data)

[1] 24 2

> names(data)

[1] "y" "x"

> attach(data)

> # install.packages("PASWR")

> library(PASWR)

> # oneway.plots(y,x)

> boxplot(y~x)

> fit = aov(y~x)

> summary(fit)

Df Sum Sq Mean Sq F value Pr(>F)

x 3 30.17 10.05 3.047 0.0525 .

Residuals 20 65.99 3.30

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> cat("for 0.05 alpha value level, no evidence to tell that mean of each category is different")

for 0.05 alpha value level, no evidence to tell that mean of each category is different

> plot(fit,which =1)

> bartlett.test(y~x)

Bartlett test of homogeneity of variances

data: y by x

Bartlett's K-squared = 0.26691, df = 3, p-value = 0.9661

> cat("Here p value = 0.9661 > 0.05, fail to reject again i.e., no evidence to tell that the mean value of each category are different")

Here p value = 0.9661 > 0.05, fail to reject again i.e., no evidence to tell that the mean value of each category are different

> TukeyHSD(aov(y~x), data = data, conf.level = 0.99)

Tukey multiple comparisons of means

99% family-wise confidence level

Fit: aov(formula = y ~ x)

$x

diff lwr upr p adj

II-I -0.7000000 -4.4212724 3.021272 0.9080815

III-I 2.3000000 -1.4212724 6.021272 0.1593262

IV-I 0.1666667 -3.5546057 3.887939 0.9985213

III-II 3.0000000 -0.7212724 6.721272 0.0440578

IV-II 0.8666667 -2.8546057 4.587939 0.8413288

IV-III -2.1333333 -5.8546057 1.587939 0.2090635

> plot(TukeyHSD(aov(y~x), data = data, conf.level = 0.9), las = 2)





