Statistics for Engineers

Digital Assignment – 6

1) **A firm wishes to compare four programs for training workers to perform a certain manual task twenty new employees are randomly assigned to the training programs, with 5 in each program at the end of the training period, a test is conducted to see how quickly trainees can perform the task the number of times the task is performed per minute is recorded for each trainee.**

Program 1	Program 2	Program 3	Program 4
9	10	12	9
12	6	14	8
14	9	11	11
11	9	13	7
13	10	11	8

Calculate and interpret the above one way ANOVA table.

```
> P1 = c(9,12,14,11,13)
> P2 = c(10,6,9,9,10)
> P3 = c(12,14,11,13,11)
> P4 = c(9,8,11,7,8)
> df1 = data.frame(P1,P2,P3,P4)
> df1
  P1 P2 P3 P4
1  9 10 12  9
2 12  6 14  8
3 14  9 11 11
4 11  9 13  7
5 13 10 11  8
> r = c(t(as.matrix(df1)))
> r
 [1]  9 10 12  9 12  6 14  8 14  9 11 11 11  9 13  7 13 10 11  8
> f = c("Program 1", "Program 2", "Program 3", "Program 4")
> f
[1] "Program 1" "Program 2" "Program 3" "Program 4"
> k = 4
> n = 5
> tm = gl(k, 1, n*k, factor(f))
> tm
 [1] Program 1 Program 2 Program 3 Program 4 Program 1 Program 2 Program 3 Program 4 Program 1 Program 2
[11] Program 3 Program 4 Program 1 Program 2 Program 3 Program 4 Program 1 Program 2 Program 3 Program 4
Levels: Program 1 Program 2 Program 3 Program 4
> crdfit = aov(r ~ tm)
> summary(crdfit)
            Df Sum Sq Mean Sq F value  Pr(>F)
tm           3  54.95   18.32   7.045 0.00311 **
Residuals   16  41.60    2.60
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

P-value = 0.00311

2) **In a factory producing edible oil and marketing its product in 15 kg tins, uses five filling machines. random samples of the packed tins were taken for each machine A, B, C, D and E were presented below.**

A	B	C	D	E
14.85	14.28	14.16	15.25	14.60
15.00	14.42	14.15	15.30	14.84
15.25		14.19	15.10	14.82
15.10		14.50	15.35	14.74
14.80			15.00	

Analyse the data to test the equality of efficiency of machines.

```
> data = c(14.85,15.00,15.25,15.10,14.80,14.28,14.42,14.16,14.15,14.19,14.50,15.25,15.30,15.10,15.35,15.00,14.60,14.84,14.82,14.74)
> Machines = c("A", "A", "A", "A", "A", "B", "B", "C", "C", "C", "C", "D", "D", "D", "D", "D", "E", "E", "E", "E")
> s = data.frame(data,Machines)
> s
    data Machines
1  14.85        A
2  15.00        A
3  15.25        A
4  15.10        A
5  14.80        A
6  14.28        B
7  14.42        B
8  14.16        C
9  14.15        C
10 14.19        C
11 14.50        C
12 15.25        D
13 15.30        D
14 15.10        D
15 15.35        D
16 15.00        D
17 14.60        E
18 14.84        E
19 14.82        E
20 14.74        E
> ANOVA = aov(data ~ Machines)
> summary(ANOVA)
            Df Sum Sq Mean Sq F value   Pr(>F)
Machines     4 2.6205  0.6551   28.11 8.18e-07 ***
Residuals   15 0.3496  0.0233
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

H_0 : $\mu 1 = \mu 2 = \mu 3 = \mu 4 = \mu 5$
H_1 : $\mu 1 \neq \mu 2 \neq \mu 3 \neq \mu 4 \neq \mu 5$
P-value = 0.0000
Since the P-value is less than 0.05 LOS, we'll reject H_0 and accept H_1.
Hence all the machines are not equally efficient.

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