HW3

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Problem 2

```
setwd("C:/Users/Prashan.Welipitiya/Downloads")
data = read.table("car.dat", header = TRUE)
#data
```

a.

```
data$ftype = as.factor(data$type)
# head(data)
# summary(data)
full.model<-aov(response~ftype,data=data)
anova(full.model)
```

```
## Analysis of Variance Table
##
## Response: response
##           Df Sum Sq Mean Sq F value    Pr(>F)
## ftype      5 7.9958 1.59916  29.193 4.887e-08 ***
## Residuals 18 0.9860 0.05478
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

$H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$
$H_A : \alpha_i \neq \alpha_j$ for at least for at least one pair (i,j).

We reject the null hypothesis that all 6 models consume oil at the same rate.

b.

1.

```
library(emmeans)
```

```
## Warning: package 'emmeans' was built under R version 3.6.2
```

```
## Welcome to emmeans.
## NOTE -- Important change from versions <= 1.41:
##     Indicator predictors are now treated as 2-level factors by default.
##     To revert to old behavior, use emm_options(cov.keep = character(0))
```

```
lsmType = lsmeans(full.model, ~ftype)
summary(contrast(lsmType, list(impvsdom = c(-1/4,-1/4,1/2,-1/4,-1/4,1/2))),
  infer=c(T,T))
```

```
##  contrast estimate    SE df lower.CL upper.CL t.ratio p.value
##  impvsdom    0.719 0.101 18    0.506    0.932 7.093   <.0001
##
## Confidence level used: 0.95
```

The 95% confidence interval for $(\mu_1 + \mu_2 + \mu_4 + \mu_5)/4 - (\mu_3 + \mu_6)/2$ is (0.506,0.932). Because 0 is not in the interval, we reject the null hypothesis. We can learn from observing the confidence interval that domestic cars on average consume more oil.

2.

```
lsmType = lsmeans(full.model, ~ftype)
summary(contrast(lsmType, list(impvsdom = c(1/3,1/3,1/3,-1/3,-1/3,-1/3))),
  infer=c(T,T))
```

```
##  contrast estimate     SE df lower.CL upper.CL t.ratio p.value
##  impvsdom   -0.766 0.0955 18   -0.967   -0.565 -8.017  <.0001
##
## Confidence level used: 0.95
```

The 95% confidence interval for $(\mu_1 + \mu_2 + \mu_3)/3 - (\mu_4 + \mu_5 + \mu_6)/3$ is (-0.967,-0.565). Because 0 is not in the interval, we reject the null hypothesis. We can learn from observing the confidence interval that less expensive cars on average consume less oil.