STAT 423/523 HW4

Q1

$$c = \frac{1}{2}(\mu_1 + \mu_2) - \mu_3$$
$$\hat{C} = 0.5 \cdot 1.63 + 0.5 \cdot 1.56 - 1.42 = 0.165$$
$$\sum c_i^2 = 0.25 + 0.25 + 1 = 1.5$$
$$\frac{\alpha}{2} = 0.025$$
$$t_{0.025,27} = 2.052$$
$$(Formula10G) 0.175 \pm 2.052 \cdot \sqrt{\frac{0.6603 \cdot 1.5}{10}} = 0.175 \pm 0.646 = (-0.471, 0.821)$$

Q2

a

Note: ANOVA tabel given by R do not have the last row: Total, df. and SStotal, you have to complete it by hand.

```
setwd("C:/Users/T460p/Desktop/STAT523")
library(readr)
iris = read_csv("iris color.csv")
```

```
## Parsed with column specification:
## cols(
##   Color = col_character(),
##   cff = col_double()
## )
```

```
out = aov(cff ~ Color, data = iris)
summary(out)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## Color        2  23.00  11.499   4.802 0.0232 *
## Residuals   16  38.31   2.394
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

b

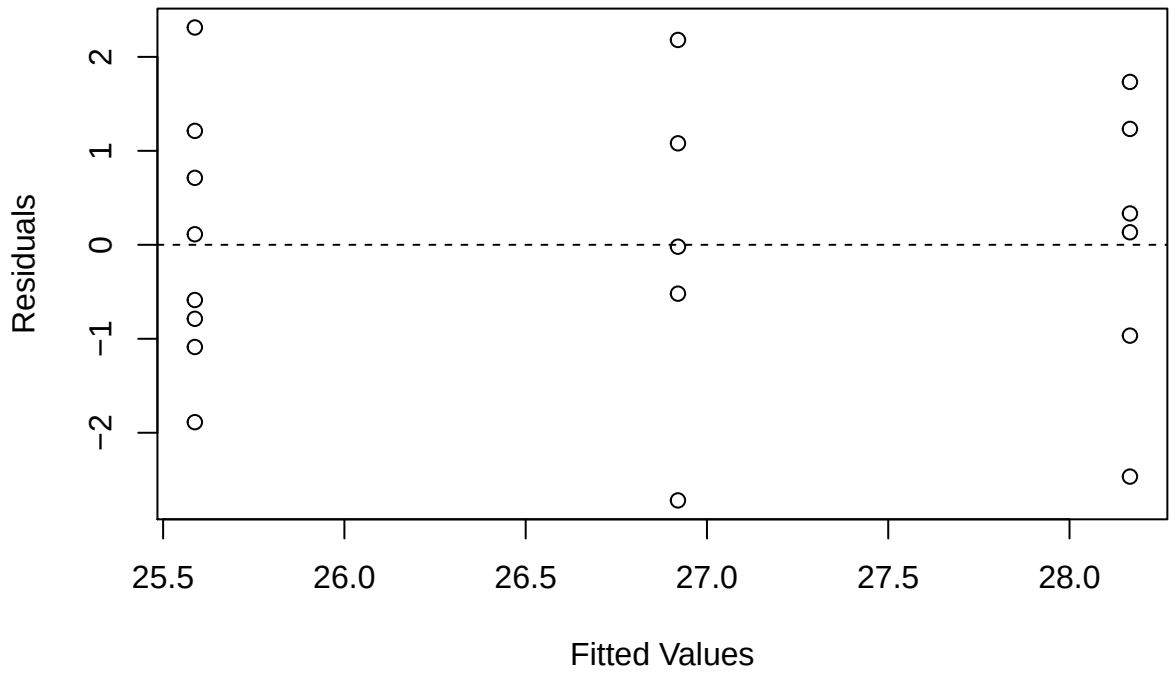
Ho: all μ_i are equal.
Ha: at least one μ_i is different.
p-value = 0.0232.
Reject Ho if p < 0.05.
Reject Ho, there is significant evidence to claim at least one μ_i is different.

c

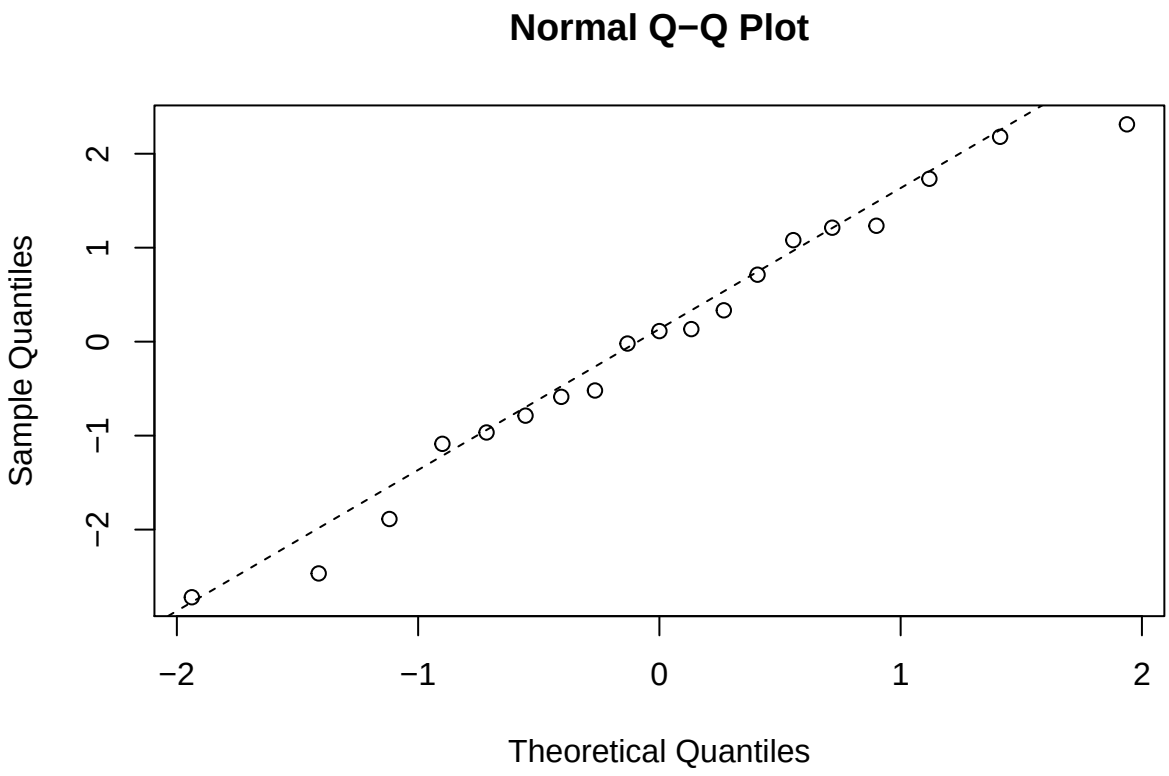
The plot of residuals versus fitted indicates similar variances across the treatments (i.e. no violation of the constant variance assumption).(check levene's test)

The normal probability plot is linear. There is no evidence contradicting the assumption of normality. (shapiro test)

```
plot(out$fitted.values, out$residuals, xlab="Fitted Values", ylab="Residuals")
abline(h=0, lty=2)
```




```
qqnorm(out$residuals)
qqline(out$residuals, lty=2)
```




```
# Do this following line every time you use ad.test.
#if you have some error, may be because you have not install the library.
#install.packages("nortest") # do it just for once
library(car)
```

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

```
## Loading required package: carData
```

```
# Levene's test check the variances
leveneTest(cff ~ Color, data = iris)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  2  0.0912 0.9133
##       16
```

```
library(nortest)
shapiro.test(out$residuals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  out$residuals
## W = 0.97113, p-value = 0.7988
```

d

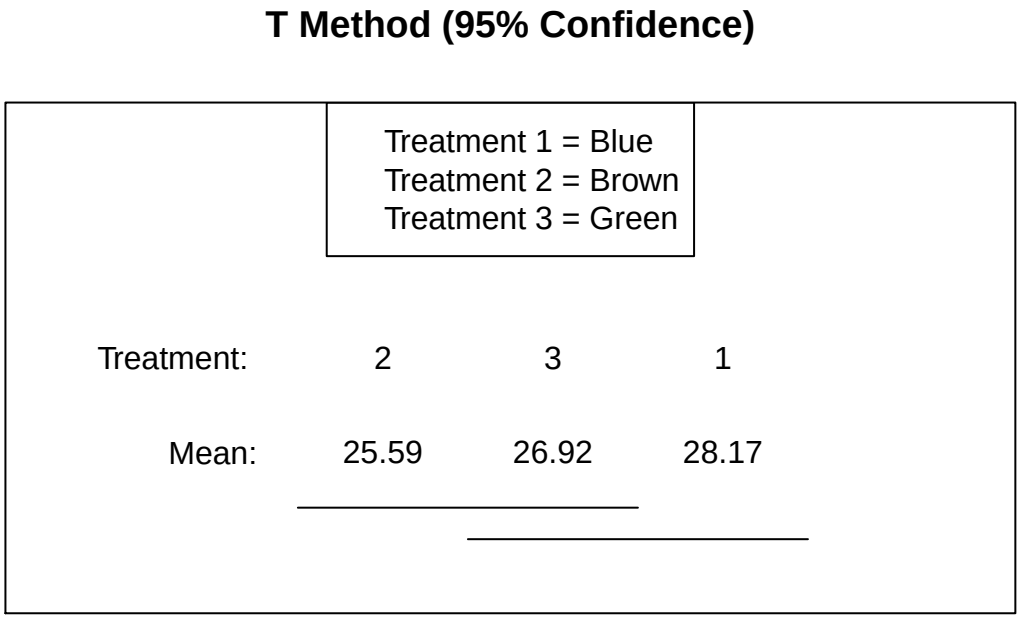
The average cff for brown and blue iris colors are significantly different, the cff for the green is neither significantly different from that of brown, nor from that of blue.

```
TukeyHSD(out) #similar to Tukey simultaneous intervals for
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = cff ~ Color, data = iris)
##
## $Color
##                   diff        lwr       upr     p adj
## Brown-Blue  -2.579167 -4.7354973 -0.422836 0.0183579
## Green-Blue  -1.246667 -3.6643959  1.171063 0.3994319
## Green-Brown  1.332500 -0.9437168  3.608717 0.3124225
```

```
source(url("http://math.wsu.edu/math/faculty/jpascual/stat423/R/one-way-T-method.R"))
oneway.t.method(out) # Tukey underscoring method
```

```
##          [,1]     [,2]     [,3]
## [1,]       NA 2.156331 2.417729
## [2,] 2.156331       NA 2.276217
## [3,] 2.417729 2.276217       NA
```




```
## [1] "Trt  2 mean +wij = 27.86"
## [1] "2 3 Not different."
## [1] "Trt  2 mean +wij = 27.74"
```

```
## [1] "2 1 Different."
## [1] "Trt  3 mean +wij = 29.34"
## [1] "3 1 Not different."
```