Excercise Soils

1st Part

Use the data “Soils” included in the package “car” in R, it contains Soil characteristics measured on samples from three types of contours (Top, Slope, and Depression) and at four depths (0-10cm, 10-30cm, 30-60cm, and 60-90cm). The area was divided into 4 blocks, in a randomized block design. Use ?Soil to have more information about the data.

For the variable N:

1. calculate the *mean*, *SD* and *range*.
2. stablish the hypothesis and test normality with *Shapiro-Wilk*.
3. analyse the distribution to test normality using a density plot with a normal distribution curve.
    - If there are outliers (*mean+3sd*) remove them and do again the previous steps.
    - If the variable does not have a normal distribution use a logaritmic transformation and do again the previous steps.
4. stablish the hypothesis and test homoscedasticity with *Levene* for **Depth**.
5. calculate the means by **Depth**.
6. stablish the hypothesis test using **Depth** as factor.
7. fit an One-Way ANOVA using **Depth**, and interpret the results.
8. fit the ANOVA with SS III, and interpret the results.
9. use a multiple comparison test (*TukeyHSD*) for **Depth** and write your conclusions.

```r
# Reads data
library(car)
data("Soils")
head(Soils)
```

```
##   Group Contour Depth Gp Block   pH     N Dens   P    Ca   Mg    K   Na
## 1     1     Top  0-10 T0     1 5.40 0.188 0.92 215 16.35 7.65 0.72 1.14
## 2     1     Top  0-10 T0     2 5.65 0.165 1.04 208 12.25 5.15 0.71 0.94
## 3     1     Top  0-10 T0     3 5.14 0.260 0.95 300 13.02 5.68 0.68 0.60
## 4     1     Top  0-10 T0     4 5.14 0.169 1.10 248 11.92 7.88 1.09 1.01
## 5     2     Top 10-30 T1     1 5.14 0.164 1.12 174 14.17 8.12 0.70 2.17
## 6     2     Top 10-30 T1     2 5.10 0.094 1.22 129  8.55 6.92 0.81 2.67
##   Conduc
## 1   1.09
## 2   1.35
## 3   1.41
## 4   1.64
## 5   1.85
## 6   3.18
```

```r
# Analysis for N
mean(Soils$N)
```

```
## [1] 0.1019375
```

```r
sd(Soils$N)
```

```
## [1] 0.06715856
```

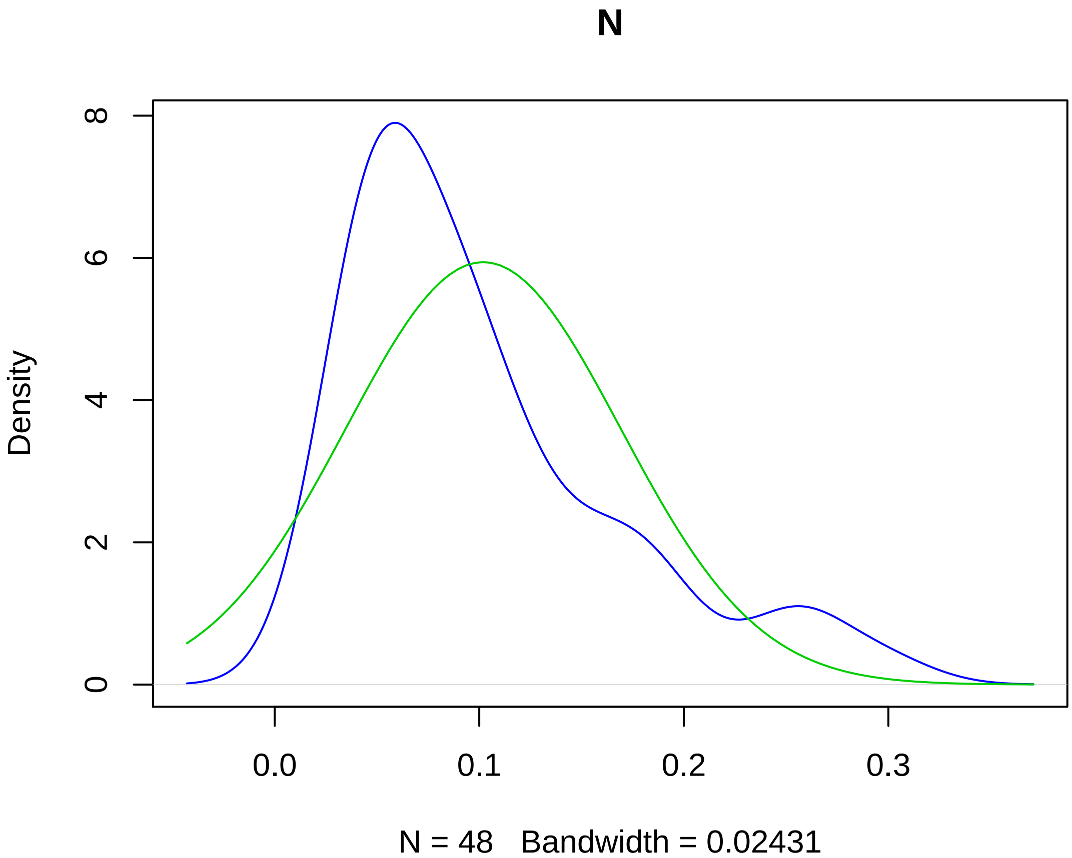
```r
range(Soils$N)
```

```
## [1] 0.030 0.298
```

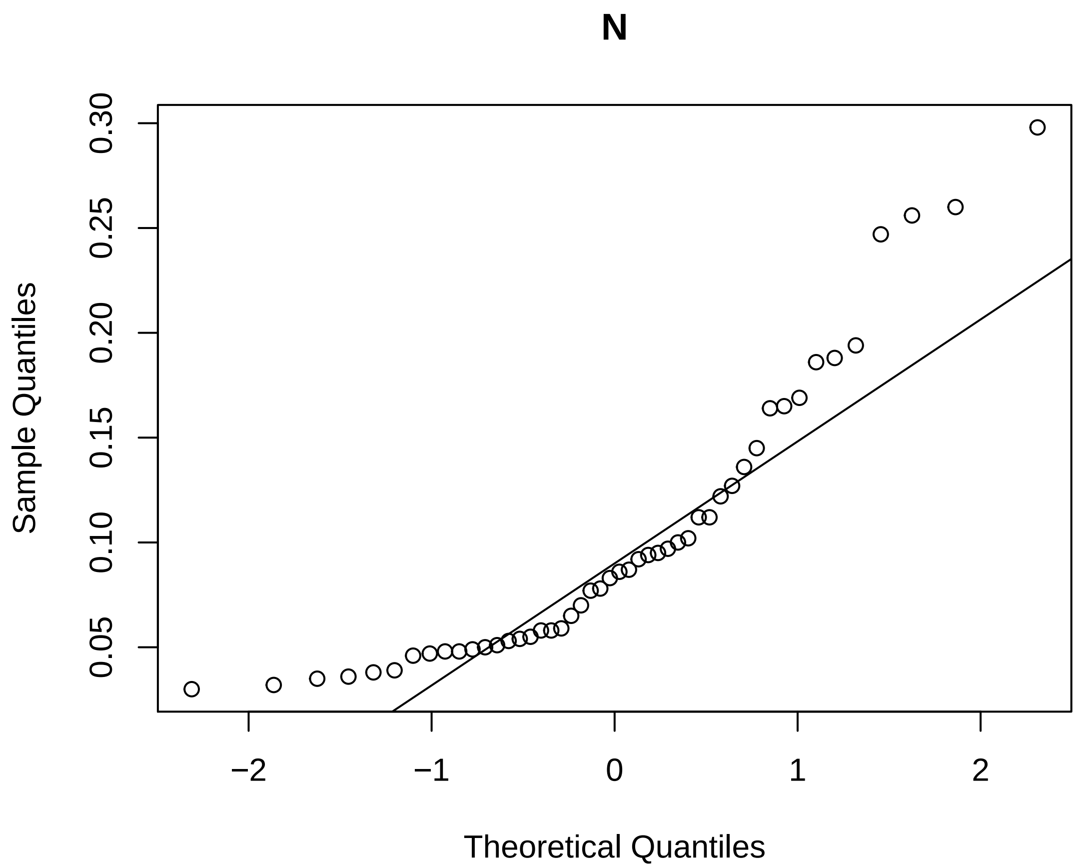
```r
shapiro.test(Soils$N)   # Shapiro - Wilk normality test
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Soils$N
## W = 0.85596, p-value = 3.141e-05
```

```r
# Density plot with normal distribution curve
plot(density(Soils$N), col=4, main="N")
curve(dnorm(x, mean = mean(Soils$N), sd = sd(Soils$N)), add = T, col=3)
```




```
# Q-Q Plot
qqnorm(Soils$N,main = "N")
qqline(Soils$N)
```




```r
# Outliers
which(Soils$N > (mean(Soils$N)+sd(Soils$N)*3))
```

```
## integer(0)
```

```r
# Logaritmic transformation
Log_N<- log(Soils$N)

# Analysis for Log_N
mean(Log_N)
```

```
## [1] -2.473009
```

```r
sd(Log_N)
```

```
## [1] 0.6139724
```

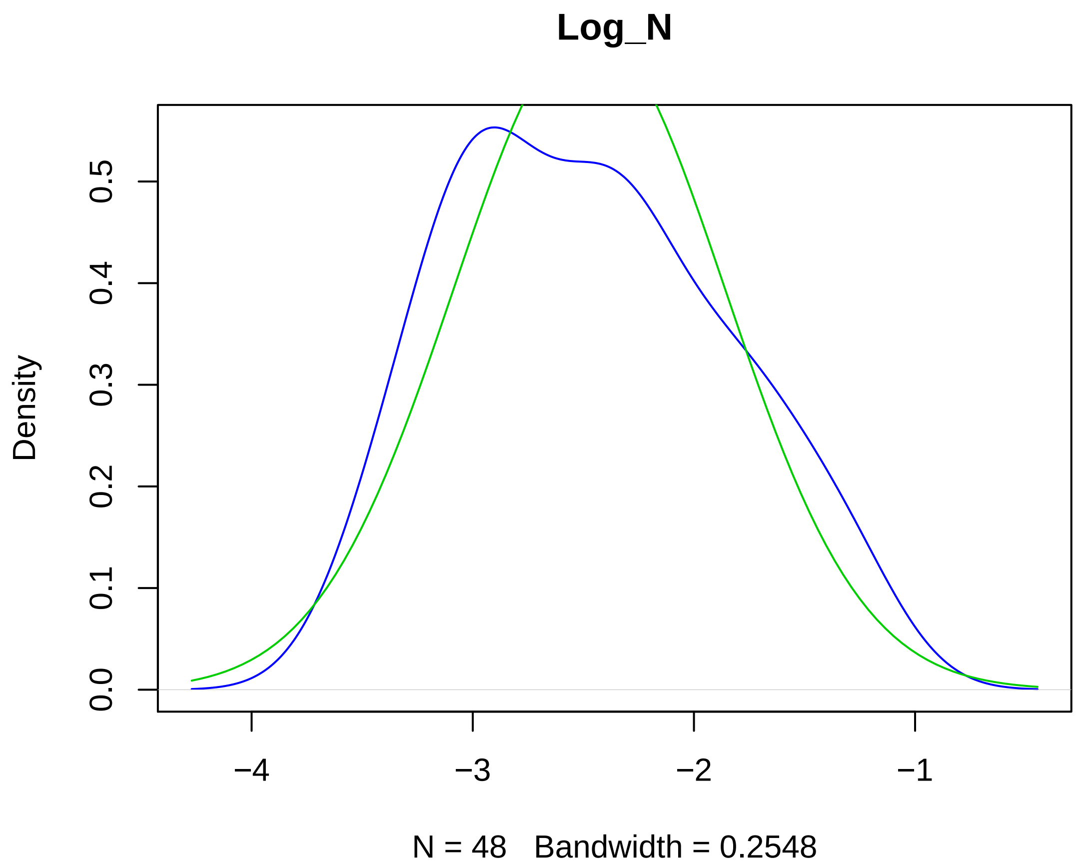
```r
range(Log_N)
```

```
## [1] -3.506558 -1.210662
```

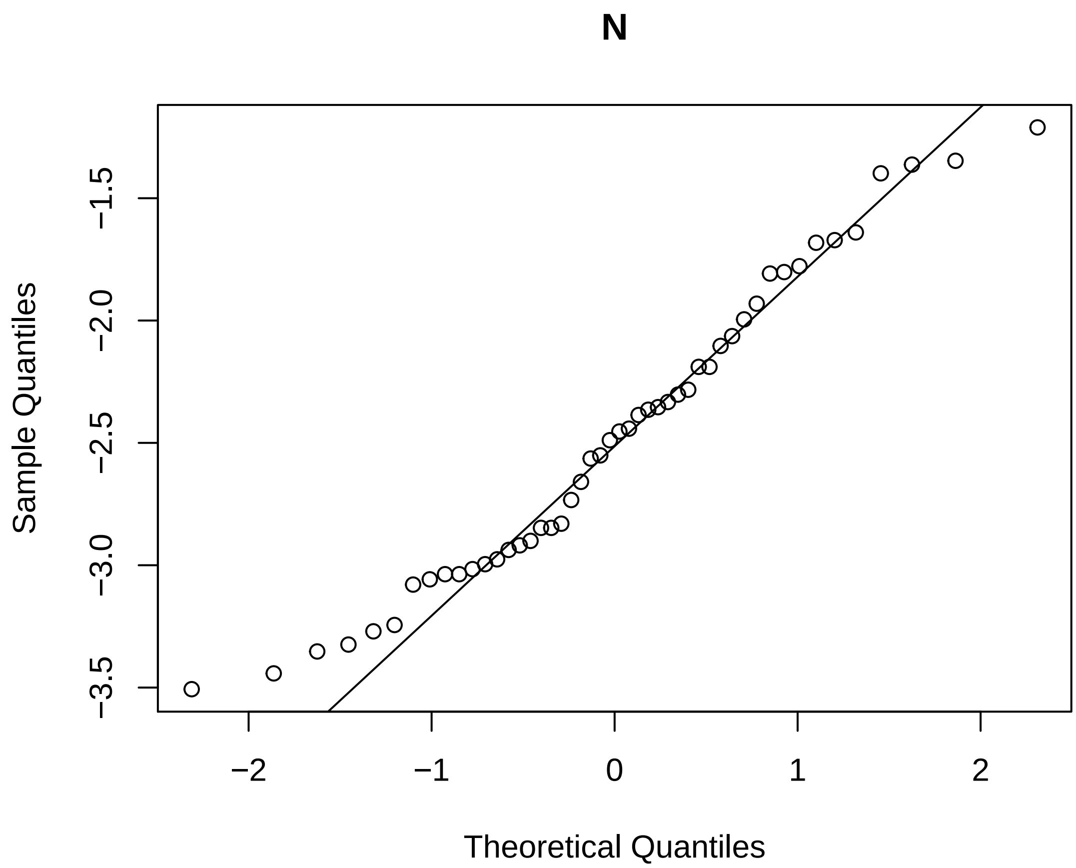
```r
shapiro.test(Log_N)   # Shapiro - Wilk normality test
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Log_N
## W = 0.965, p-value = 0.1606
```

```r
# Density plot with normal distribution curve
plot(density(Log_N), col=4, main="Log_N")
curve(dnorm(x, mean = mean(Log_N), sd = sd(Log_N)), add = T, col=3)
```




```
# Q-Q Plot
qqnorm(Log_N,main = "N")
qqline(Log_N)
```




```r
# Homocedasticity
# install.packages("car")
car::leveneTest(Log_N ~ as.factor(Soils$Depth))
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  3  0.2212 0.8811
##       44
```

```r
# Means by group
aggregate(Log_N, by=list(Soils$Depth), FUN = mean) # Means by group
```

```
##   Group.1         x
## 1    0-10 -1.656771
## 2   10-30 -2.342664
## 3   30-60 -2.802740
## 4   60-90 -3.089860
```

```r
# Fit the Linear Model
tm<-lm(Log_N ~  Soils$Depth) # Fit the linear model
summary(tm)                         # Linear Model Summary
```

```
##
## Call:
## lm(formula = Log_N ~ Soils$Depth)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.71494 -0.15905 -0.01288  0.16241  0.61348
##
## Coefficients:
```

```
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -1.65677    0.08312 -19.933  < 2e-16 ***
## Soils$Depth10-30 -0.68589    0.11755  -5.835 5.89e-07 ***
## Soils$Depth30-60 -1.14597    0.11755  -9.749 1.45e-12 ***
## Soils$Depth60-90 -1.43309    0.11755 -12.192 1.05e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2879 on 44 degrees of freedom
## Multiple R-squared:  0.7941, Adjusted R-squared:  0.7801
## F-statistic: 56.57 on 3 and 44 DF,  p-value: 3.828e-15
```

```
fm<-aov(Log_N ~  Soils$Depth) # Fit the ANOVA
summary(fm)                            # ANOVA Table SS I
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## Soils$Depth  3 14.070   4.690   56.57 3.83e-15 ***
## Residuals   44  3.648   0.083
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

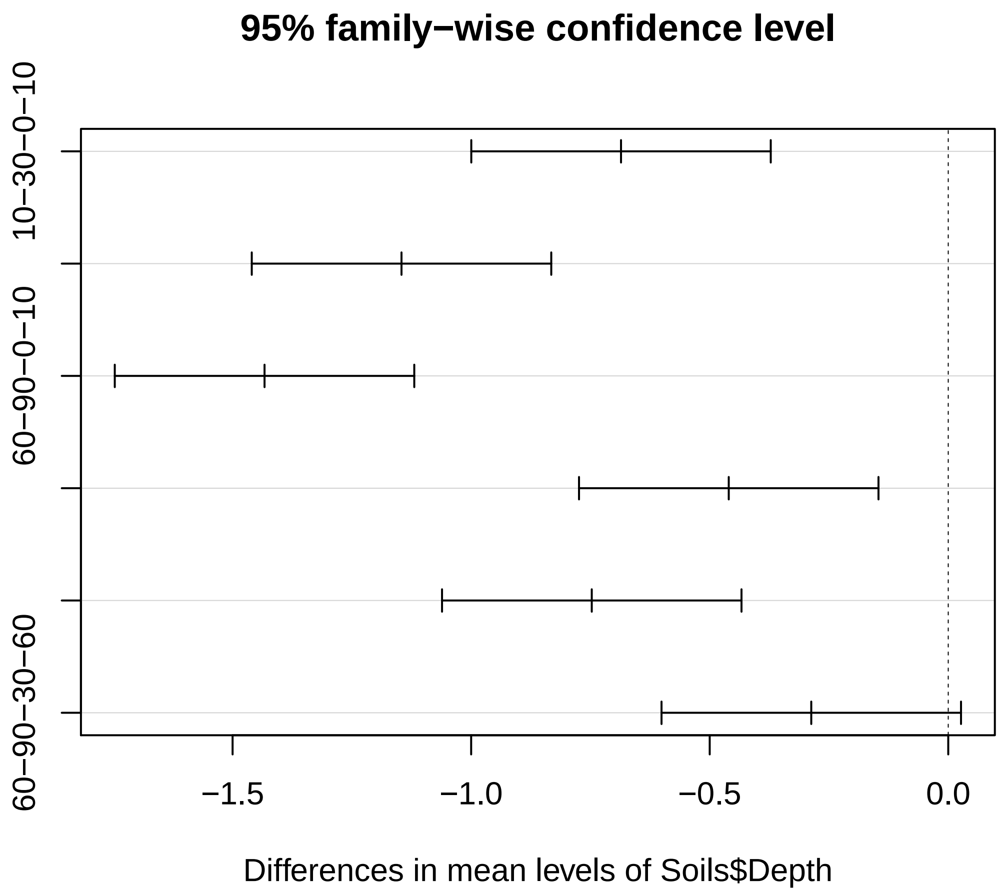
```
car::Anova(lm(Log_N ~  Soils$Depth), type=3) #Fit the ANOVA type SS III
```

```
## Anova Table (Type III tests)
##
## Response: Log_N
##             Sum Sq Df F value    Pr(>F)
## (Intercept) 32.939  1 397.320 < 2.2e-16 ***
## Soils$Depth 14.070  3  56.571 3.828e-15 ***
## Residuals    3.648 44
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

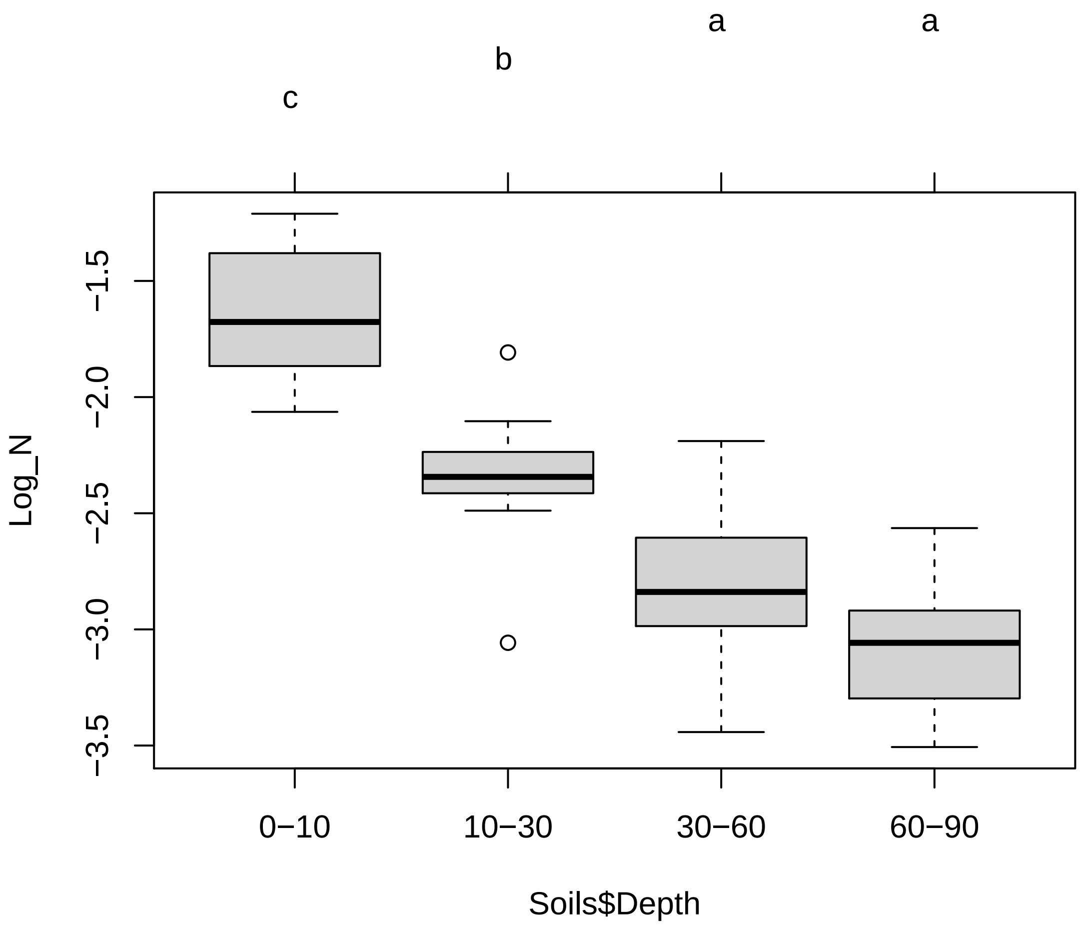
```
TukeyHSD(fm)          # Tukey test for multiple comparisons
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = Log_N ~ Soils$Depth)
##
## $`Soils$Depth`
##                     diff        lwr         upr     p adj
## 10-30-0-10  -0.6858926 -0.9997405 -0.37204460 0.0000035
## 30-60-0-10  -1.1459683 -1.4598163 -0.83212038 0.0000000
## 60-90-0-10  -1.4330883 -1.7469362 -1.11924031 0.0000000
## 30-60-10-30 -0.4600758 -0.7739237 -0.14622782 0.0017132
## 60-90-10-30 -0.7471957 -1.0610437 -0.43334775 0.0000006
## 60-90-30-60 -0.2871199 -0.6009679  0.02672803 0.0838070
```

```
plot(TukeyHSD(fm))    # Plot for tukey test
```




```
library(multcomp)
par(mar=c(4,4,6,2)) # Change parameters for the plot margins
tuk <- glht(fm, linfct=mcp('Soils$Depth'="Tukey")) # Fit the general Linear Hypotheses
plot(cld(tuk, level=0.05),col="lightgrey") # Plot the mean differences
```



c
b
a
a
−1.5
−2.0
−2.5
−3.0
−3.5
Log_N
0−10
10−30
30−60
60−90
Soils$Depth

2nd Part

For the variable Mg:

1. calculate the *mean*, *SD* and *range*.
2. stablish the hypothesis and test normality with *Shapiro-Wilk*.
3. analyse the distribution to test normality using a density plot with a normal distribution curve.
    - If there are outliers (*mean+3sd*) remove them and do again the previous steps.
    - If the variable does not have a normal distribution use a logaritmic transformation and do again the previous steps.
4. stablish the hypothesis and test homoscedasticity with *Levene* for **Depth**.
5. calculate the means of **Depth** by **Contour**.
6. stablish the hypothesis test using **Depth** and **Contour** as factors.
7. fit a Two-Way ANOVA using **Depth**, **Contour** (and interaction between them), and include **Block** as blocking factor, then interpret the results.
8. fit the ANOVA with SS III for the previous model, and interpret the results.
9. estimate the LSM for **Depth** and **Contour**
10. use a multiple comparison test (*TukeyHSD*) for **Depth** and **Contour** and plot the LSM, then write your conclusions.

```r
# Reads data
library(car)
data("Soils")

# Analysis for Mg
mean(Soils$Mg)
```

```
## [1] 8.464583
```

```r
sd(Soils$Mg)
```

```
## [1] 1.368203
```

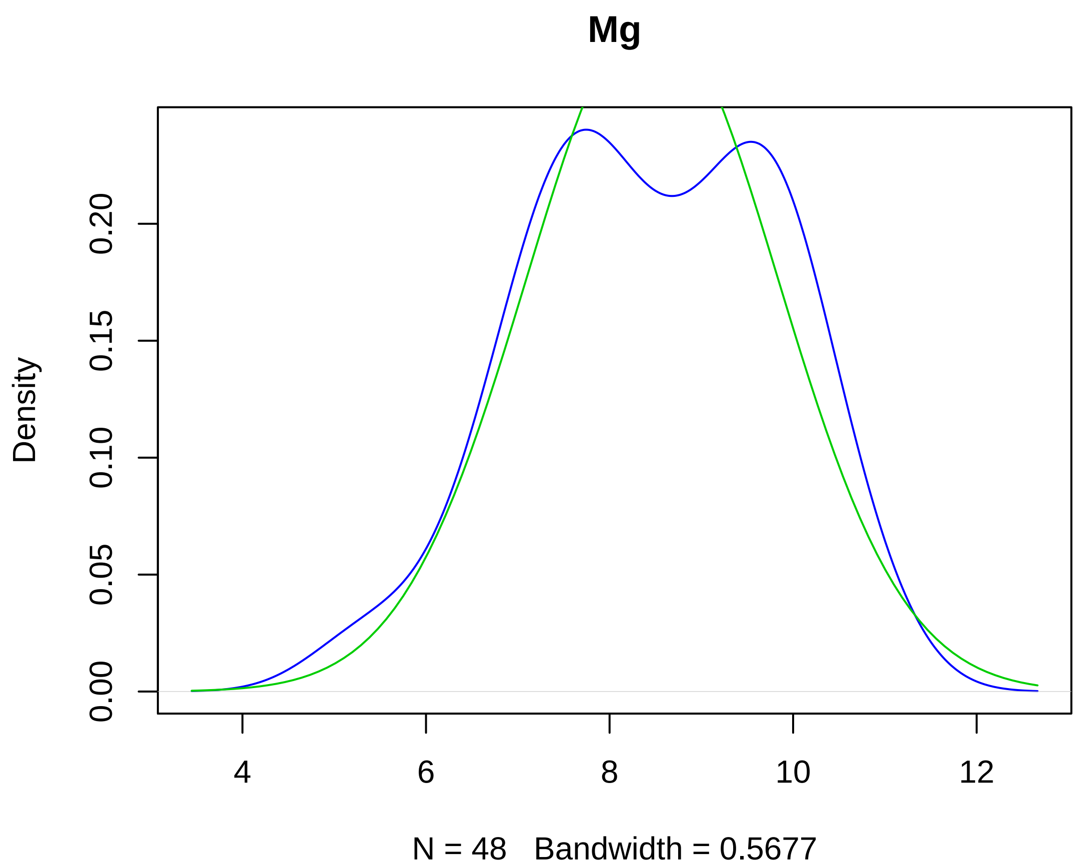
```r
range(Soils$Mg)
```

```
## [1]  5.15 10.96
```

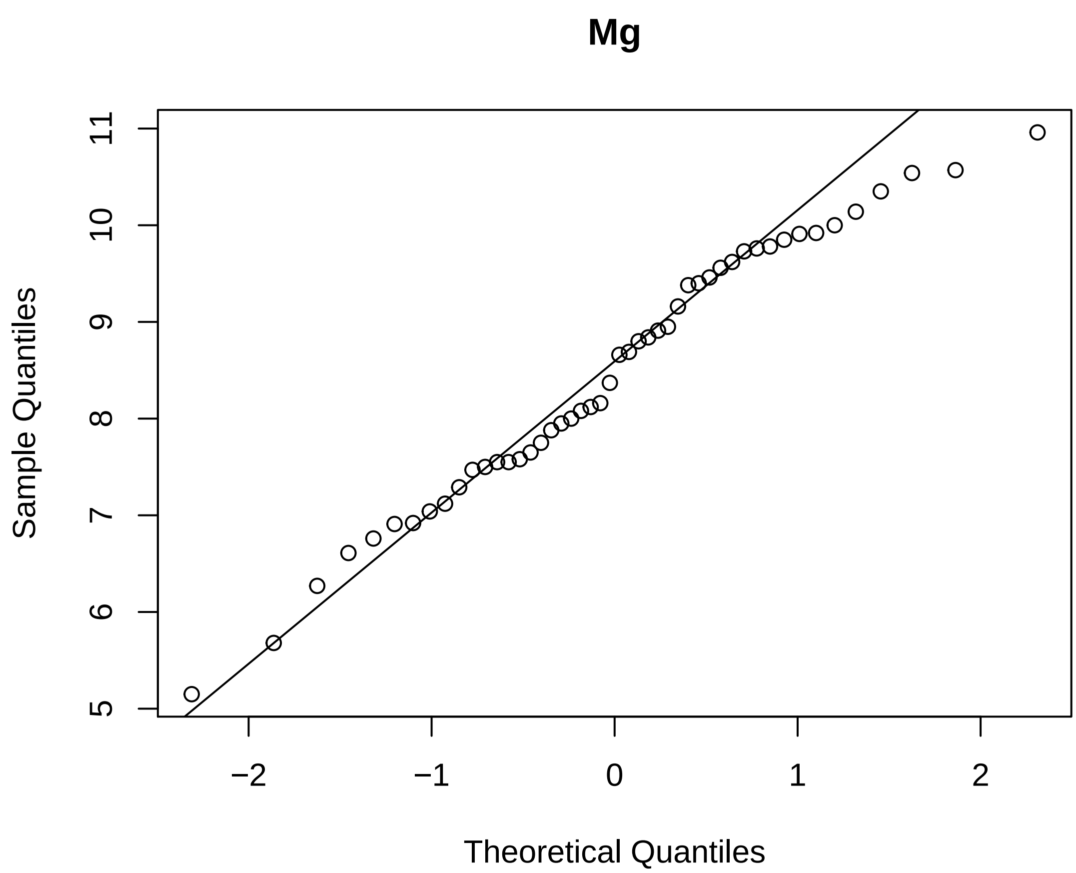
```r
shapiro.test(Soils$Mg)    # Shapiro - Wilk normality test
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Soils$Mg
## W = 0.97575, p-value = 0.4162
```

```r
# Density plot with normal distribution curve
plot(density(Soils$Mg), col=4, main="Mg")
curve(dnorm(x, mean = mean(Soils$Mg), sd = sd(Soils$Mg)), add = T, col=3)
```




```r
# Q-Q Plot
qqnorm(Soils$Mg,main = "Mg")
qqline(Soils$Mg)
```




```r
# Outliers
which(Soils$Mg > (mean(Soils$Mg)+sd(Soils$Mg)*3))
```

```
## integer(0)
```

```r
# Homocedasticity
# install.packages("car")
car::leveneTest(Soils$Mg ~ Soils$Depth)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  3  0.3218 0.8095
##       44
```

```r
car::leveneTest(Soils$Mg ~ Soils$Contour)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  2  0.6886 0.5075
##       45
```

```r
# Means by group
aggregate(Soils$Mg, by=list(Soils$Depth,Soils$Contour), FUN = mean) # Means by group
```

```
##    Group.1    Group.2      x
## 1     0-10 Depression 7.2350
## 2    10-30 Depression 9.6350
## 3    30-60 Depression 9.9175
## 4    60-90 Depression 9.1575
## 5     0-10      Slope 7.2325
## 6    10-30      Slope 8.9800
## 7    30-60      Slope 8.9675
```

```
## 8    60-90      Slope 8.1000
## 9     0-10        Top 6.5900
## 10   10-30        Top 8.0900
## 11   30-60        Top 8.7425
## 12   60-90        Top 8.9275
```

```r
# Fit the Linear Model
tm<-lm(Mg ~  Depth + Contour + Depth:Contour + Block, data=Soils)
summary(tm)                             # Linear Model Summary
```

```
##
## Call:
## lm(formula = Mg ~ Depth + Contour + Depth:Contour + Block, data = Soils)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.75542 -0.56167  0.09958  0.50854  1.49708
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)               7.81125    0.51265  15.237  < 2e-16 ***
## Depth10-30                2.40000    0.64845   3.701 0.000779 ***
## Depth30-60                2.68250    0.64845   4.137 0.000228 ***
## Depth60-90                1.92250    0.64845   2.965 0.005590 **
## ContourSlope             -0.00250    0.64845  -0.004 0.996947
## ContourTop               -0.64500    0.64845  -0.995 0.327130
## Block2                   -1.13833    0.37438  -3.041 0.004600 **
## Block3                   -1.08750    0.37438  -2.905 0.006512 **
## Block4                   -0.07917    0.37438  -0.211 0.833830
## Depth10-30:ContourSlope -0.65250    0.91705  -0.712 0.481760
## Depth30-60:ContourSlope -0.94750    0.91705  -1.033 0.309020
## Depth60-90:ContourSlope -1.05500    0.91705  -1.150 0.258235
## Depth10-30:ContourTop   -0.90000    0.91705  -0.981 0.333531
## Depth30-60:ContourTop   -0.53000    0.91705  -0.578 0.567227
## Depth60-90:ContourTop    0.41500    0.91705   0.453 0.653842
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.917 on 33 degrees of freedom
## Multiple R-squared:  0.6846, Adjusted R-squared:  0.5508
## F-statistic: 5.116 on 14 and 33 DF,  p-value: 5.694e-05
```

```r
fm<-aov(Mg ~  Depth + Contour + Depth:Contour + Block, data=Soils) # Fit the ANOVA
summary(fm)                             # ANOVA Table SS I
```

```
##               Df Sum Sq Mean Sq F value   Pr(>F)
## Depth          3  34.85  11.617  13.814 5.29e-06 ***
## Contour        2   6.96   3.482   4.140  0.02487 *
## Block          3  13.88   4.626   5.501  0.00354 **
## Depth:Contour  6   4.54   0.756   0.899  0.50698
## Residuals     33  27.75   0.841
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#Fit the ANOVA type SS III
car::Anova(lm(Mg ~  Depth + Contour + Depth:Contour + Block, data=Soils), type=3)
```

```
## Anova Table (Type III tests)
##
## Response: Mg
##                Sum Sq Df  F value    Pr(>F)
## (Intercept)   195.250  1 232.1707 < 2.2e-16 ***
```

```
## Depth          17.537  3   6.9511 0.0009415 ***
## Contour         1.105  2   0.6570 0.5250303
## Block          13.878  3   5.5006 0.0035447 **
## Depth:Contour   4.539  6   0.8995 0.5069810
## Residuals      27.752 33
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
library(lsmeans)
lsmeans(tm,"Contour")   #LSM for Contour
```

```
##  Contour     lsmean        SE df lower.CL upper.CL
##  Depression 8.98625 0.2292619 33 8.519813 9.452687
##  Slope      8.32000 0.2292619 33 7.853563 8.786437
##  Top        8.08750 0.2292619 33 7.621063 8.553937
##
## Results are averaged over the levels of: Depth, Block
## Confidence level used: 0.95
```

```
lsmeans(tm,"Depth")     #LSM for Depth
```

```
##  Depth   lsmean        SE df lower.CL upper.CL
##  0-10  7.019167 0.2647288 33 6.480572 7.557761
##  10-30 8.901667 0.2647288 33 8.363072 9.440261
##  30-60 9.209167 0.2647288 33 8.670572 9.747761
##  60-90 8.728333 0.2647288 33 8.189739 9.266928
##
## Results are averaged over the levels of: Contour, Block
## Confidence level used: 0.95
```

```
TukeyHSD(fm)         # Tukey test for multiple comparisons
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = Mg ~ Depth + Contour + Depth:Contour + Block, data = Soils)
##
## $Depth
##                   diff        lwr       upr     p adj
## 10-30-0-10   1.8825000  0.8698135 2.8951865 0.0000963
## 30-60-0-10   2.1900000  1.1773135 3.2026865 0.0000087
## 60-90-0-10   1.7091667  0.6964802 2.7218532 0.0003687
## 30-60-10-30  0.3075000 -0.7051865 1.3201865 0.8439510
## 60-90-10-30 -0.1733333 -1.1860198 0.8393532 0.9665757
## 60-90-30-60 -0.4808333 -1.4935198 0.5318532 0.5791112
##
## $Contour
##                      diff       lwr        upr     p adj
## Slope-Depression -0.66625 -1.461832  0.1293321 0.1151256
## Top-Depression   -0.89875 -1.694332 -0.1031679 0.0240310
## Top-Slope        -0.23250 -1.028082  0.5630821 0.7551908
##
## $Block
##            diff           lwr         upr     p adj
## 2-1 -1.13833333 -2.151019845 -0.12564682 0.0226879
## 3-1 -1.08750000 -2.100186511 -0.07481349 0.0314590
## 4-1 -0.07916667 -1.091853178  0.93351984 0.9965902
## 3-2  0.05083333 -0.961853178  1.06351984 0.9990876
## 4-2  1.05916667  0.046480155  2.07185318 0.0375904
## 4-3  1.00833333 -0.004353178  2.02101984 0.0513306
##
## $`Depth:Contour`
```

```
##                                      diff         lwr        upr     p adj
## 10-30:Depression-0-10:Depression   2.4000  0.12324314  4.6767569 0.0316018
## 30-60:Depression-0-10:Depression   2.6825  0.40574314  4.9592569 0.0103760
## 60-90:Depression-0-10:Depression   1.9225 -0.35425686  4.1992569 0.1649267
## 0-10:Slope-0-10:Depression        -0.0025 -2.27925686  2.2742569 1.0000000
## 10-30:Slope-0-10:Depression        1.7450 -0.53175686  4.0217569 0.2742437
## 30-60:Slope-0-10:Depression        1.7325 -0.54425686  4.0092569 0.2834757
## 60-90:Slope-0-10:Depression        0.8650 -1.41175686  3.1417569 0.9679782
## 0-10:Top-0-10:Depression          -0.6450 -2.92175686  1.6317569 0.9967895
## 10-30:Top-0-10:Depression          0.8550 -1.42175686  3.1317569 0.9705024
## 30-60:Top-0-10:Depression          1.5075 -0.76925686  3.7842569 0.4802603
## 60-90:Top-0-10:Depression          1.6925 -0.58425686  3.9692569 0.3143515
## 30-60:Depression-10-30:Depression  0.2825 -1.99425686  2.5592569 0.9999990
## 60-90:Depression-10-30:Depression -0.4775 -2.75425686  1.7992569 0.9997921
## 0-10:Slope-10-30:Depression       -2.4025 -4.67925686 -0.1257431 0.0313031
## 10-30:Slope-10-30:Depression      -0.6550 -2.93175686  1.6217569 0.9963399
## 30-60:Slope-10-30:Depression      -0.6675 -2.94425686  1.6092569 0.9957063
## 60-90:Slope-10-30:Depression      -1.5350 -3.81175686  0.7417569 0.4536263
## 0-10:Top-10-30:Depression         -3.0450 -5.32175686 -0.7682431 0.0022717
## 10-30:Top-10-30:Depression        -1.5450 -3.82175686  0.7317569 0.4440753
## 30-60:Top-10-30:Depression        -0.8925 -3.16925686  1.3842569 0.9602259
## 60-90:Top-10-30:Depression        -0.7075 -2.98425686  1.5692569 0.9930520
## 60-90:Depression-30-60:Depression -0.7600 -3.03675686  1.5167569 0.9877216
## 0-10:Slope-30-60:Depression       -2.6850 -4.96175686 -0.4082431 0.0102710
## 10-30:Slope-30-60:Depression      -0.9375 -3.21425686  1.3392569 0.9447866
## 30-60:Slope-30-60:Depression      -0.9500 -3.22675686  1.3267569 0.9398542
## 60-90:Slope-30-60:Depression      -1.8175 -4.09425686  0.4592569 0.2246935
## 0-10:Top-30-60:Depression         -3.3275 -5.60425686 -1.0507431 0.0006662
## 10-30:Top-30-60:Depression        -1.8275 -4.10425686  0.4492569 0.2183958
## 30-60:Top-30-60:Depression        -1.1750 -3.45175686  1.1017569 0.8002345
## 60-90:Top-30-60:Depression        -0.9900 -3.26675686  1.2867569 0.9220954
## 0-10:Slope-60-90:Depression       -1.9250 -4.20175686  0.3517569 0.1636710
## 10-30:Slope-60-90:Depression      -0.1775 -2.45425686  2.0992569 1.0000000
## 30-60:Slope-60-90:Depression      -0.1900 -2.46675686  2.0867569 1.0000000
## 60-90:Slope-60-90:Depression      -1.0575 -3.33425686  1.2192569 0.8850978
## 0-10:Top-60-90:Depression         -2.5675 -4.84425686 -0.2907431 0.0164779
## 10-30:Top-60-90:Depression        -1.0675 -3.34425686  1.2092569 0.8788622
## 30-60:Top-60-90:Depression        -0.4150 -2.69175686  1.8617569 0.9999470
## 60-90:Top-60-90:Depression        -0.2300 -2.50675686  2.0467569 0.9999999
## 10-30:Slope-0-10:Slope             1.7475 -0.52925686  4.0242569 0.2724214
## 30-60:Slope-0-10:Slope             1.7350 -0.54175686  4.0117569 0.2816133
## 60-90:Slope-0-10:Slope             0.8675 -1.40925686  3.1442569 0.9673232
## 0-10:Top-0-10:Slope               -0.6425 -2.91925686  1.6342569 0.9968945
## 10-30:Top-0-10:Slope               0.8575 -1.41925686  3.1342569 0.9698856
## 30-60:Top-0-10:Slope               1.5100 -0.76675686  3.7867569 0.4778184
## 60-90:Top-0-10:Slope               1.6950 -0.58175686  3.9717569 0.3123632
## 30-60:Slope-10-30:Slope           -0.0125 -2.28925686  2.2642569 1.0000000
## 60-90:Slope-10-30:Slope           -0.8800 -3.15675686  1.3967569 0.9639006
## 0-10:Top-10-30:Slope              -2.3900 -4.66675686 -0.1132431 0.0328231
## 10-30:Top-10-30:Slope             -0.8900 -3.16675686  1.3867569 0.9609814
## 30-60:Top-10-30:Slope             -0.2375 -2.51425686  2.0392569 0.9999998
## 60-90:Top-10-30:Slope             -0.0525 -2.32925686  2.2242569 1.0000000
## 60-90:Slope-30-60:Slope           -0.8675 -3.14425686  1.4092569 0.9673232
## 0-10:Top-30-60:Slope              -2.3775 -4.65425686 -0.1007431 0.0344107
## 10-30:Top-30-60:Slope             -0.8775 -3.15425686  1.3992569 0.9646051
## 30-60:Top-30-60:Slope             -0.2250 -2.50175686  2.0517569 0.9999999
## 60-90:Top-30-60:Slope             -0.0400 -2.31675686  2.2367569 1.0000000
## 0-10:Top-60-90:Slope              -1.5100 -3.78675686  0.7667569 0.4778184
## 10-30:Top-60-90:Slope             -0.0100 -2.28675686  2.2667569 1.0000000
## 30-60:Top-60-90:Slope              0.6425 -1.63425686  2.9192569 0.9968945
```

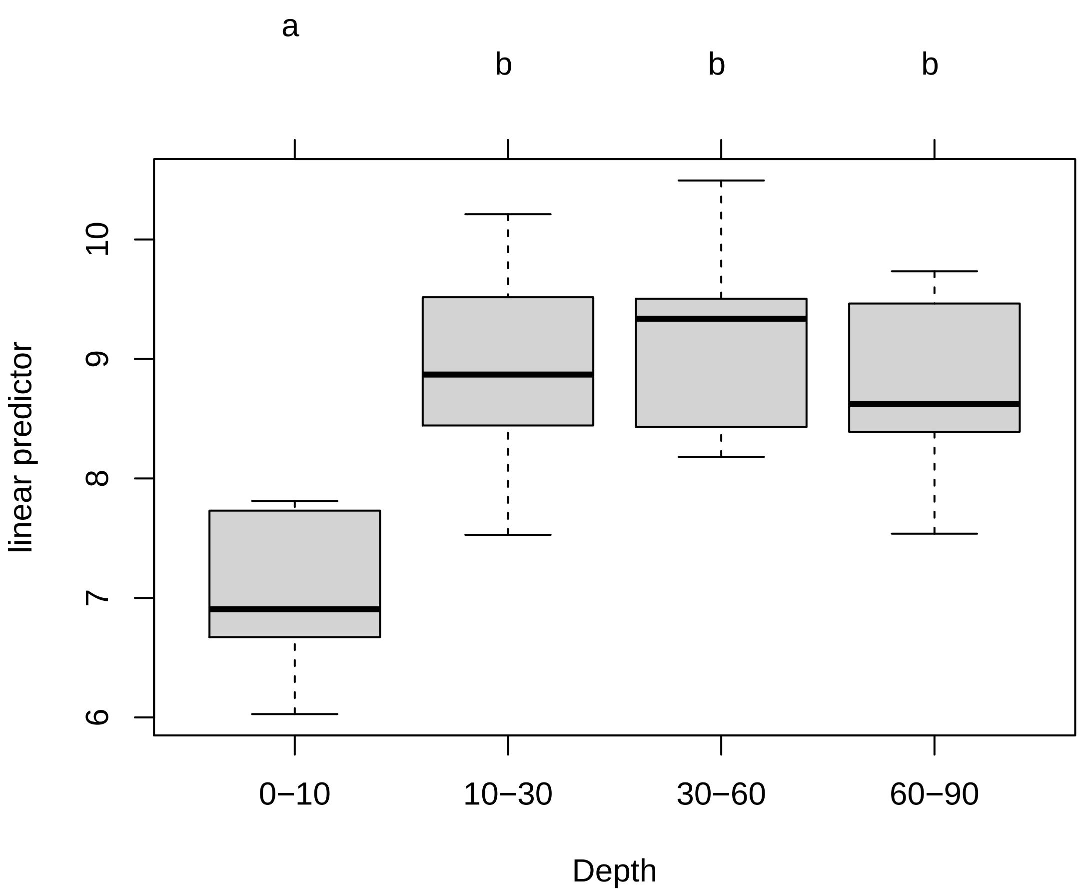
```
## 60-90:Top-60-90:Slope             0.8275 -1.44925686  3.1042569 0.9766857
## 10-30:Top-0-10:Top                1.5000 -0.77675686  3.7767569 0.4876082
## 30-60:Top-0-10:Top                2.1525 -0.12425686  4.4292569 0.0777806
## 60-90:Top-0-10:Top                2.3375  0.06074314  4.6142569 0.0399751
## 30-60:Top-10-30:Top               0.6525 -1.62425686  2.9292569 0.9964569
## 60-90:Top-10-30:Top               0.8375 -1.43925686  3.1142569 0.9745620
## 60-90:Top-30-60:Top               0.1850 -2.09175686  2.4617569 1.0000000
```

```r
#plot(TukeyHSD(fm))   # Plot for tukey test

library(multcomp)
par(mar=c(4,4,6,2)) # Change parameters for the plot margins
tuk <- glht(fm, linfct=mcp('Depth'="Tukey")) # Fit the general Linear Hypotheses
```

```
## Warning in mcp2matrix(model, linfct = linfct): covariate interactions found
## -- default contrast might be inappropriate
```

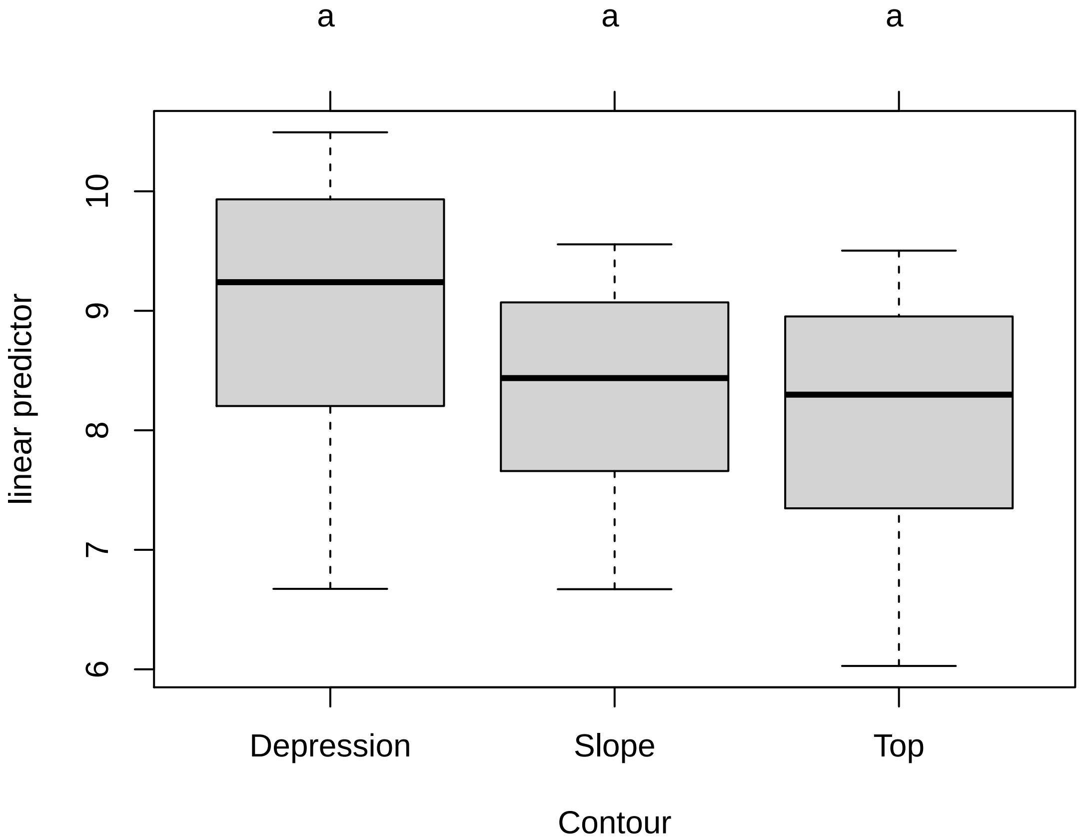
```r
plot(cld(tuk, level=0.05),col="lightgrey") # Plot the mean differences
```



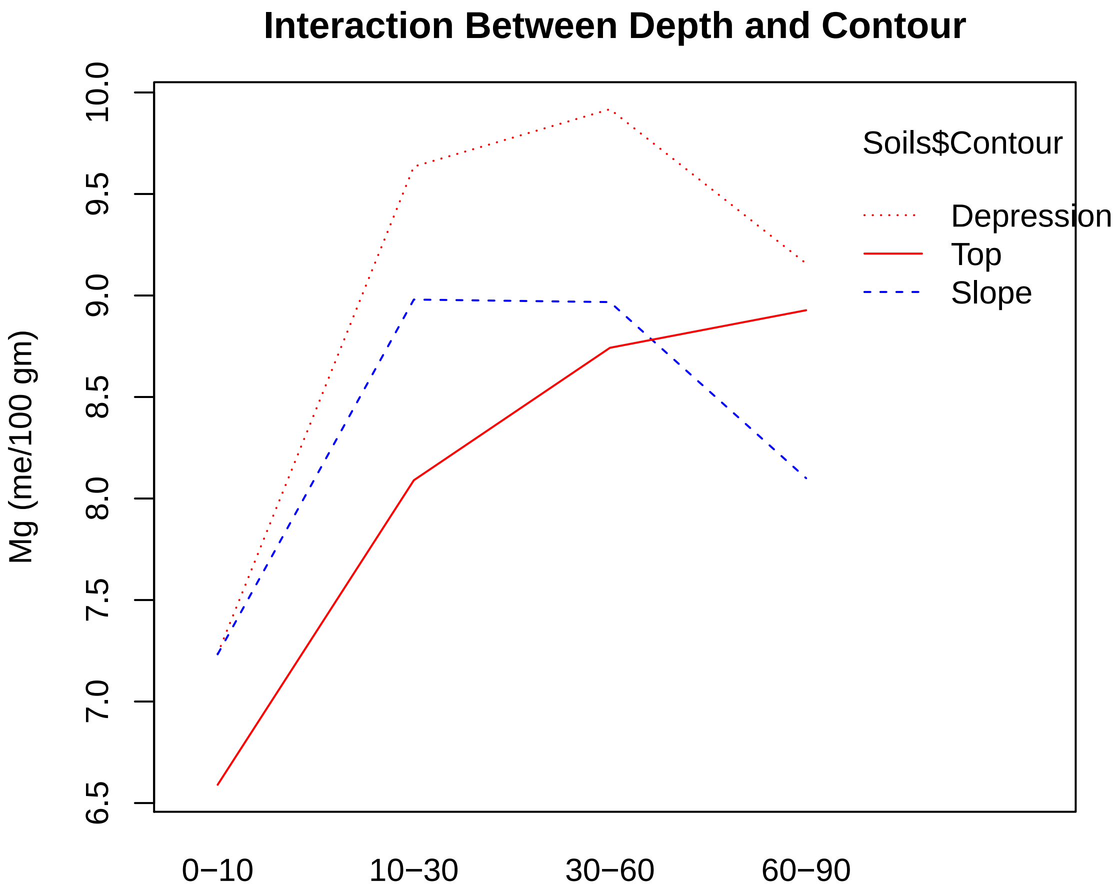

```r
tuk <- glht(fm, linfct=mcp('Contour'="Tukey")) # Fit the general Linear Hypotheses
```

```
## Warning in mcp2matrix(model, linfct = linfct): covariate interactions found
## -- default contrast might be inappropriate
```

```r
plot(cld(tuk, level=0.05),col="lightgrey") # Plot the mean differences
```




```
par(mar=c(3,4,3,2)) # Change parameters for the plot margins
interaction.plot(Soils$Depth,Soils$Contour,response = Soils$Mg,
               col=c("red","blue"),pch = c(16,18),
               main="Interaction Between Depth and Contour",
               ylab = "Mg (me/100 gm)")
```


Interaction Between Depth and Contour
Mg (me/100 gm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
0−10
10−30
30−60
60−90
Soils$Contour
Depression
Top
Slope