

Clerid_eggs_th.R

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```
# Clerid_eggs_th.R
# Two-way ANOVA for T. dubius egg mortality

# Load necessary libraries
library(car)

## Loading required package: carData
library(ggplot2)
library(emmeans)
library(multcomp)

## Loading required package: mvtnorm
## Loading required package: survival
## Loading required package: TH.data
## Loading required package: MASS

##
## Attaching package: 'TH.data'

## The following object is masked from 'package:MASS':
##
##      geyser

# Read in data set
mortdata <- read.table(header=T,colClasses=c("factor","factor","numeric"),text="
temp rh mortrate
15    55  0.137
15    75  0.102
15   100  0.333
20    55  0.181
20    75  0.337
20   100  0.188
25    55  0.123
25    75  0.259
25   100  0.205
30    55  0.202
30    75  0.321
30   100  0.226
35    55  0.680
35    75  0.447
35   100  0.431
37.5  55  1.000
37.5  75  1.000
37.5 100  1.000
")

# Apply transformations here
```

```
mortdata <- transform(mortdata,y=asin(sqrt(mortrate)))
```

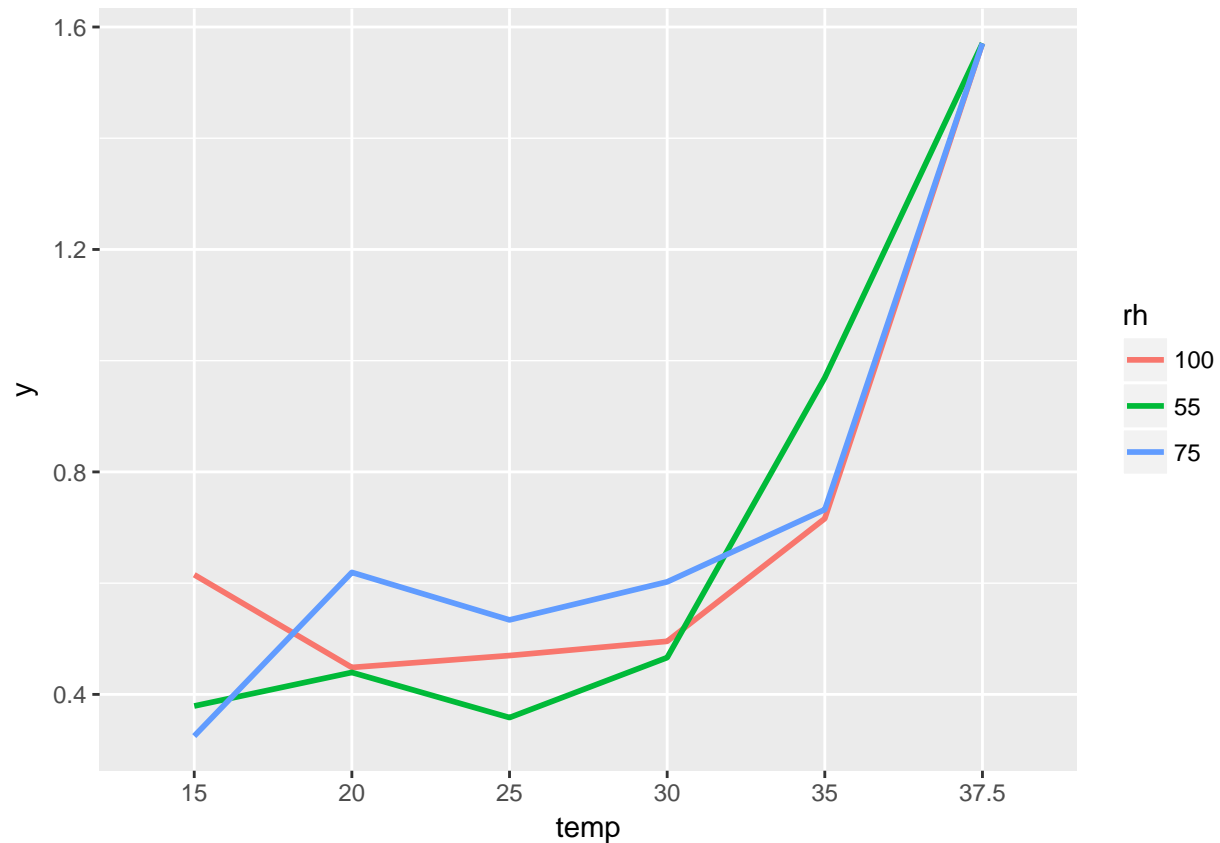
```
# Print data set
```

```
mortdata
```

```
##      temp  rh mortrate      y
## 1     15  55   0.137 0.3791545
## 2     15  75   0.102 0.3250692
## 3     15 100   0.333 0.6151261
## 4     20  55   0.181 0.4394491
## 5     20  75   0.337 0.6193635
## 6     20 100   0.188 0.4484726
## 7     25  55   0.123 0.3583330
## 8     25  75   0.259 0.5339302
## 9     25 100   0.205 0.4698687
## 10    30  55   0.202 0.4661429
## 11    30  75   0.321 0.6023356
## 12    30 100   0.226 0.4954125
## 13    35  55   0.680 0.9695321
## 14    35  75   0.447 0.7322984
## 15    35 100   0.431 0.7161773
## 16   37.5  55   1.000 1.5707963
## 17   37.5  75   1.000 1.5707963
## 18   37.5 100   1.000 1.5707963
```

```
# Graphics using ggplot2
```

```
print(ggplot(mortdata,aes(temp,y,group=rh,color=rh))+  
geom_line(size=1))
```



```
# Two-way ANOVA without replication
options(contrasts=c("contr.sum", "contr.poly"))
aovout <- aov(y~temp+rh, data=mortdata)
```

```
# Type II SS
print>Anova(aovout))
```

```
## Anova Table (Type II tests)
##
## Response: y
##          Sum Sq Df F value    Pr(>F)
## temp      2.90165  5 44.3051 1.669e-06 ***
## rh         0.00346  2  0.1321  0.8777
## Residuals 0.13098 10
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Calculate least squares means
emmeans(aovout, ~temp)
```

```
## temp    emmean      SE df lower.CL upper.CL
## 15      0.4397833 0.06607693 10 0.2925547 0.5870118
## 20      0.5024284 0.06607693 10 0.3551998 0.6496570
## 25      0.4540440 0.06607693 10 0.3068154 0.6012725
## 30      0.5212970 0.06607693 10 0.3740684 0.6685256
## 35      0.8060026 0.06607693 10 0.6587740 0.9532312
## 37.5    1.5707963 0.06607693 10 1.4235678 1.7180249
```

```
##
## Results are averaged over the levels of: rh
## Confidence level used: 0.95
emmeans(aovout,~rh)

##      rh      emmean      SE df lower.CL upper.CL
## 100 0.7193089 0.04672344 10 0.6152026 0.8234152
##  55 0.6972346 0.04672344 10 0.5931283 0.8013410
##  75 0.7306322 0.04672344 10 0.6265259 0.8347385
##
## Results are averaged over the levels of: temp
## Confidence level used: 0.95
# All pairwise comparisons - Tukey method
compout <- glht(aovout,linfct=mcp(temp="Tukey"))
summary(compout)

##
##      Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Tukey Contrasts
##
## Fit: aov(formula = y ~ temp + rh, data = mortdata)
##
## Linear Hypotheses:
##              Estimate Std. Error t value Pr(>|t|)
## 20 - 15 == 0    0.06265   0.09345   0.670  0.9815
## 25 - 15 == 0    0.01426   0.09345   0.153  1.0000
## 30 - 15 == 0    0.08151   0.09345   0.872  0.9450
## 35 - 15 == 0    0.36622   0.09345   3.919  0.0253 *
## 37.5 - 15 == 0  1.13101   0.09345  12.103 <0.001 ***
## 25 - 20 == 0   -0.04838   0.09345  -0.518  0.9941
## 30 - 20 == 0    0.01887   0.09345   0.202  0.9999
## 35 - 20 == 0    0.30357   0.09345   3.249  0.0702 .
## 37.5 - 20 == 0  1.06837   0.09345  11.433 <0.001 ***
## 30 - 25 == 0    0.06725   0.09345   0.720  0.9749
## 35 - 25 == 0    0.35196   0.09345   3.766  0.0319 *
## 37.5 - 25 == 0  1.11675   0.09345  11.951 <0.001 ***
## 35 - 30 == 0    0.28471   0.09345   3.047  0.0953 .
## 37.5 - 30 == 0  1.04950   0.09345  11.231 <0.001 ***
## 37.5 - 35 == 0  0.76479   0.09345   8.184 <0.001 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
confint(compout)

##
##      Simultaneous Confidence Intervals
##
## Multiple Comparisons of Means: Tukey Contrasts
##
## Fit: aov(formula = y ~ temp + rh, data = mortdata)
```

```
##
## Quantile = 3.4719
## 95% family-wise confidence level
##
##
## Linear Hypotheses:
##           Estimate lwr      upr
## 20 - 15 == 0    0.06265 -0.26179  0.38708
## 25 - 15 == 0    0.01426 -0.31018  0.33870
## 30 - 15 == 0    0.08151 -0.24293  0.40595
## 35 - 15 == 0    0.36622  0.04178  0.69066
## 37.5 - 15 == 0  1.13101  0.80657  1.45545
## 25 - 20 == 0   -0.04838 -0.37282  0.27605
## 30 - 20 == 0    0.01887 -0.30557  0.34331
## 35 - 20 == 0    0.30357 -0.02087  0.62801
## 37.5 - 20 == 0  1.06837  0.74393  1.39281
## 30 - 25 == 0    0.06725 -0.25719  0.39169
## 35 - 25 == 0    0.35196  0.02752  0.67640
## 37.5 - 25 == 0  1.11675  0.79231  1.44119
## 35 - 30 == 0    0.28471 -0.03973  0.60914
## 37.5 - 30 == 0  1.04950  0.72506  1.37394
## 37.5 - 35 == 0  0.76479  0.44035  1.08923

cld(compout)

##    15    20    25    30    35 37.5
##  "a" "ab"  "a" "ab"  "b"  "c"

# All pairwise comparisons - Tukey method
compout <- glht(aovout, linfct=mcp(rh="Tukey"))
summary(compout)

##
## Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Tukey Contrasts
##
##
## Fit: aov(formula = y ~ temp + rh, data = mortdata)
##
## Linear Hypotheses:
##           Estimate Std. Error t value Pr(>|t|)
## 55 - 100 == 0 -0.02207   0.06608  -0.334   0.941
## 75 - 100 == 0  0.01132   0.06608   0.171   0.984
## 75 - 55 == 0   0.03340   0.06608   0.505   0.870
## (Adjusted p values reported -- single-step method)

confint(compout)

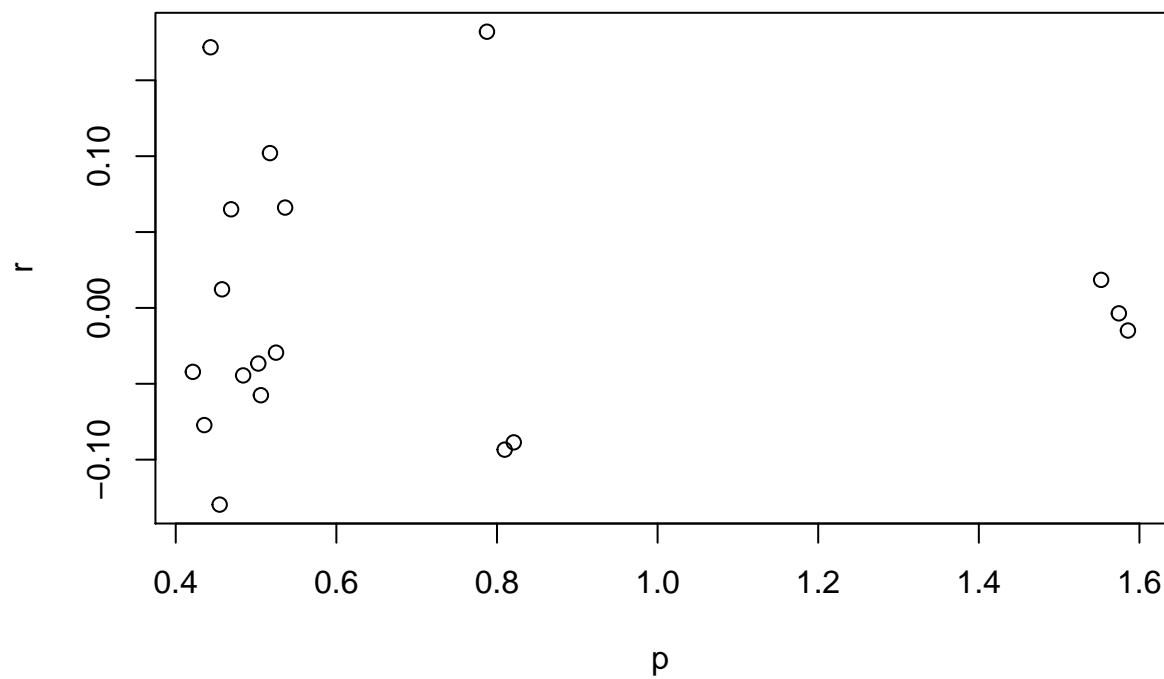
##
## Simultaneous Confidence Intervals
##
## Multiple Comparisons of Means: Tukey Contrasts
##
##
## Fit: aov(formula = y ~ temp + rh, data = mortdata)
```

```
##
## Quantile = 2.7414
## 95% family-wise confidence level
##
##
## Linear Hypotheses:
##           Estimate lwr      upr
## 55 - 100 == 0 -0.02207 -0.20322  0.15907
## 75 - 100 == 0  0.01132 -0.16982  0.19246
## 75 - 55 == 0   0.03340 -0.14774  0.21454

cld(compout)

## 100 55 75
## "a" "a" "a"

# Diagnostic plots to check ANOVA assumptions
p <- predict(aovout)
r <- resid(aovout)
plot(p,r)
```



```
qqnorm(r)
```

Normal Q-Q Plot

