DVM Reproducible Research

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CO2 Uptake in Grass Plants

This document provides a reproducible research of "Carbon Dioxide Uptake in Grass Plants" from a library dataset in "R" called "datasets".

The research was complied into a initial data frame called "CO2"

CO2 has 84 rows and 5 columns of data from an experiment on the cold tolerance of the grass species "Echinochloa crus-galli".

CO2 was uptaken within six (6) plants from Quebec and six (6) plants from Mississippi.

It was measured at several levels of ambient CO2 concentration. Half the plants of each type were chilled overnight before the experiment was conducted.

Summary of CO2

```
#install.packages("datasets")
suppressMessages(suppressWarnings(library(datasets)))
data(CO2)
summary(CO2)
```

```
##      Plant            Type         Treatment       conc
##  Qn1    : 7   Quebec     :42   nonchilled:42   Min.   :  95
##  Qn2    : 7   Mississippi:42   chilled   :42   1st Qu.: 175
##  Qn3    : 7                                   Median : 350
##  Qc1    : 7                                   Mean   : 435
##  Qc3    : 7                                   3rd Qu.: 675
##  Qc2    : 7                                   Max.   :1000
##  (Other):42
##       uptake
##  Min.   : 7.70
##  1st Qu.:17.90
##  Median :28.30
##  Mean   :27.21
##  3rd Qu.:37.12
##  Max.   :45.50
##
```

Summary Explained

- **Plant**: *an ordered factor with levels* ***Qn1 < Qn2 < Qn3 < ... < Mc1*** *giving a unique identifier for each plant.*
- **Type**: *a factor with levels Quebec and Mississippi giving the origin of the plant*

- **Treatment**: *a factor with levels nonchilled chilled*
- **Conc**: *a numeric vector of ambient carbon dioxide concentrations (mL/L).*
- **Uptake**: *a numeric vector of carbon dioxide uptake rates (umol/m^2 sec).*

Relationship between "Type" and "Treatment"

Table of CO2-Type

```
table(CO2$Type)
```

```
##
##      Quebec Mississippi
##          42          42
```

Table of CO2-Treatment

```
table(CO2$Treatment)
```

```
##
## nonchilled    chilled
##         42         42
```

Table of CO2-Type and Treatment

```
table(CO2$Type,CO2$Treatment)
```

```
##
##                nonchilled chilled
##   Quebec               21      21
##   Mississippi          21      21
```

Cross Table of CO2 - Type and Treatment

Relationship of Type and Treatment using the Cross Tabulations

```
#install.packages("gmodels")
suppressMessages(suppressWarnings(library("gmodels")))
#Contingency tables
joint.CO2<-CrossTable(CO2$Type,CO2$Treatment, prop.chisq = F)
```

```
##
##
##    Cell Contents
## |-------------------------|
## |                       N |
## |           N / Row Total |
```

```
## |           N / Col Total |
## |         N / Table Total |
## |-------------------------|
##
##
## Total Observations in Table:  84
##
##
##              | CO2$Treatment
##     CO2$Type | nonchilled |    chilled |  Row Total |
## -------------|------------|------------|------------|
##       Quebec |         21 |         21 |         42 |
##              |      0.500 |      0.500 |      0.500 |
##              |      0.500 |      0.500 |            |
##              |      0.250 |      0.250 |            |
## -------------|------------|------------|------------|
##  Mississippi |         21 |         21 |         42 |
##              |      0.500 |      0.500 |      0.500 |
##              |      0.500 |      0.500 |            |
##              |      0.250 |      0.250 |            |
## -------------|------------|------------|------------|
## Column Total |         42 |         42 |         84 |
##              |      0.500 |      0.500 |            |
## -------------|------------|------------|------------|
##
##
```

- **Note**: *Based on PROC Frequency "PROC FREQ" in SAS or "CROSSTABS" in SPSS"*

Nested Contingency Tables

```
joint.CO2
```

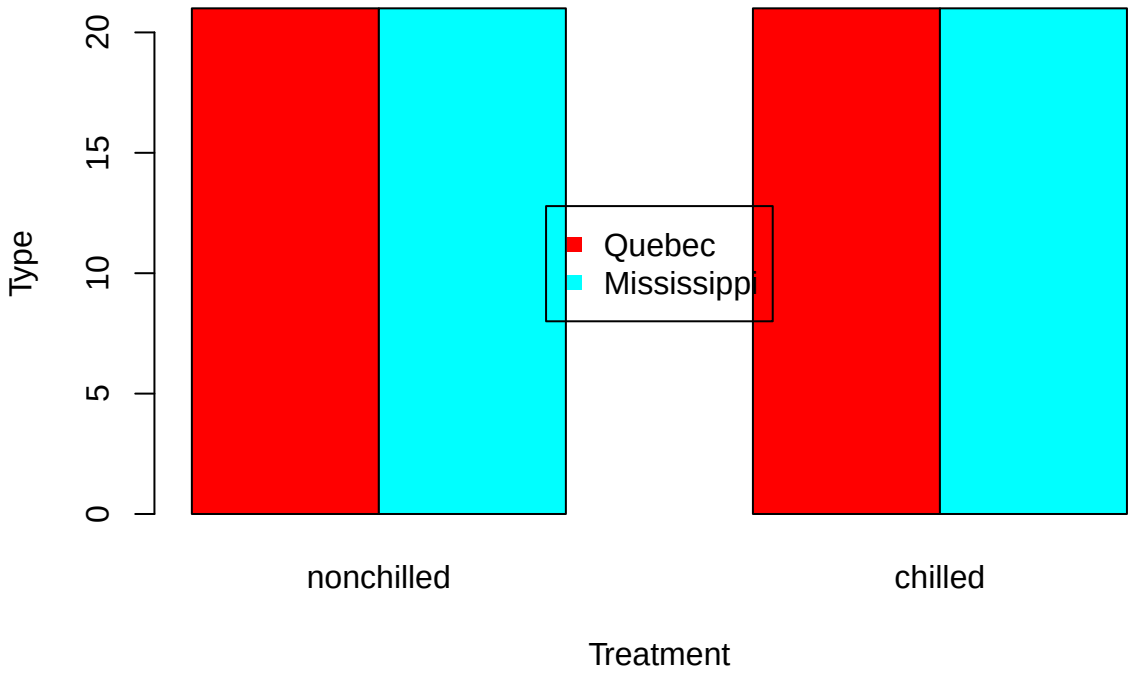
```
## $t
##              y
## x             nonchilled chilled
##   Quebec              21      21
##   Mississippi         21      21
##
## $prop.row
##              y
## x             nonchilled chilled
##   Quebec             0.5     0.5
##   Mississippi        0.5     0.5
##
## $prop.col
##              y
## x             nonchilled chilled
##   Quebec             0.5     0.5
##   Mississippi        0.5     0.5
##
## $prop.tbl
##              y
## x             nonchilled chilled
```

```
##    Quebec            0.25    0.25
##    Mississippi       0.25    0.25
```

- **Note**: *Based on PROC Frequency "PROC FREQ" in SAS or "CROSSTABS" in SPSS"*

Barplot Relationship of "Type" and "Treatment"

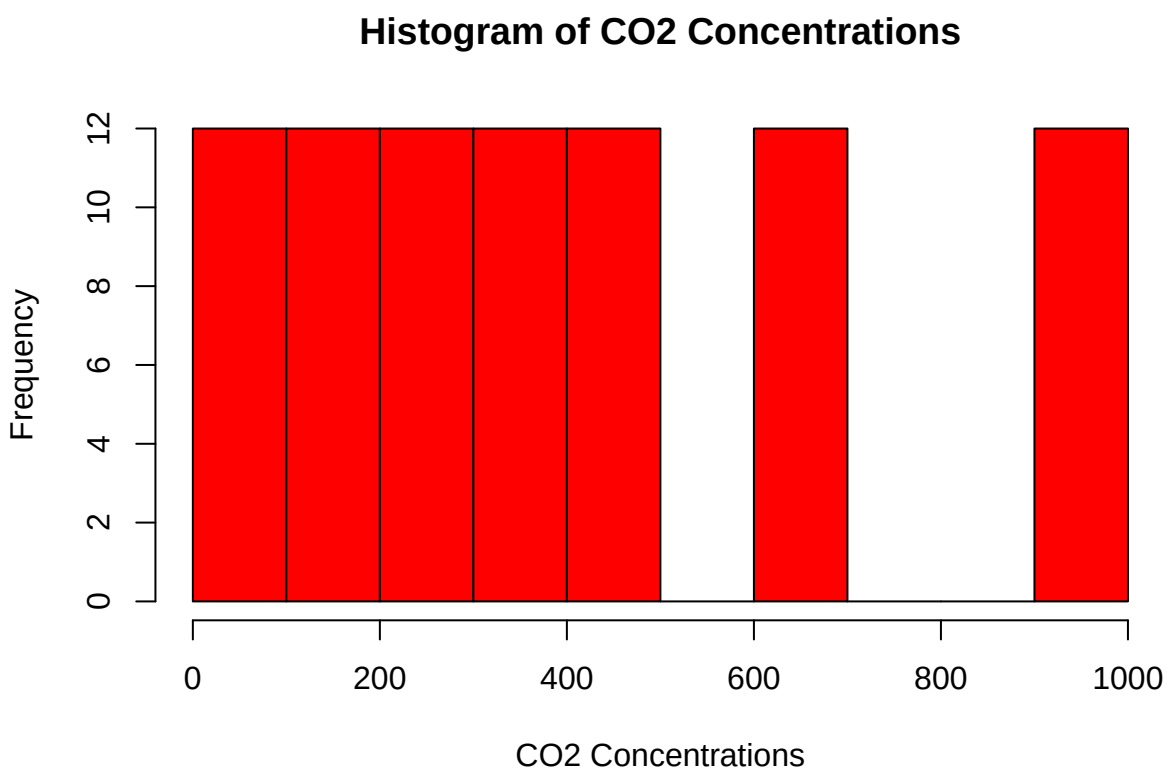
```
par(mfrow=c(1,1))
joint.CO2_count<-joint.CO2$t
barplot(joint.CO2_count, beside = TRUE, col = rainbow(2),
        ylab = "Type", xlab = "Treatment")
legend("center", c("Quebec", "Mississippi"),
       pch = 15, col = rainbow(2))
```



"Conc" and "UpTake" using Histograms

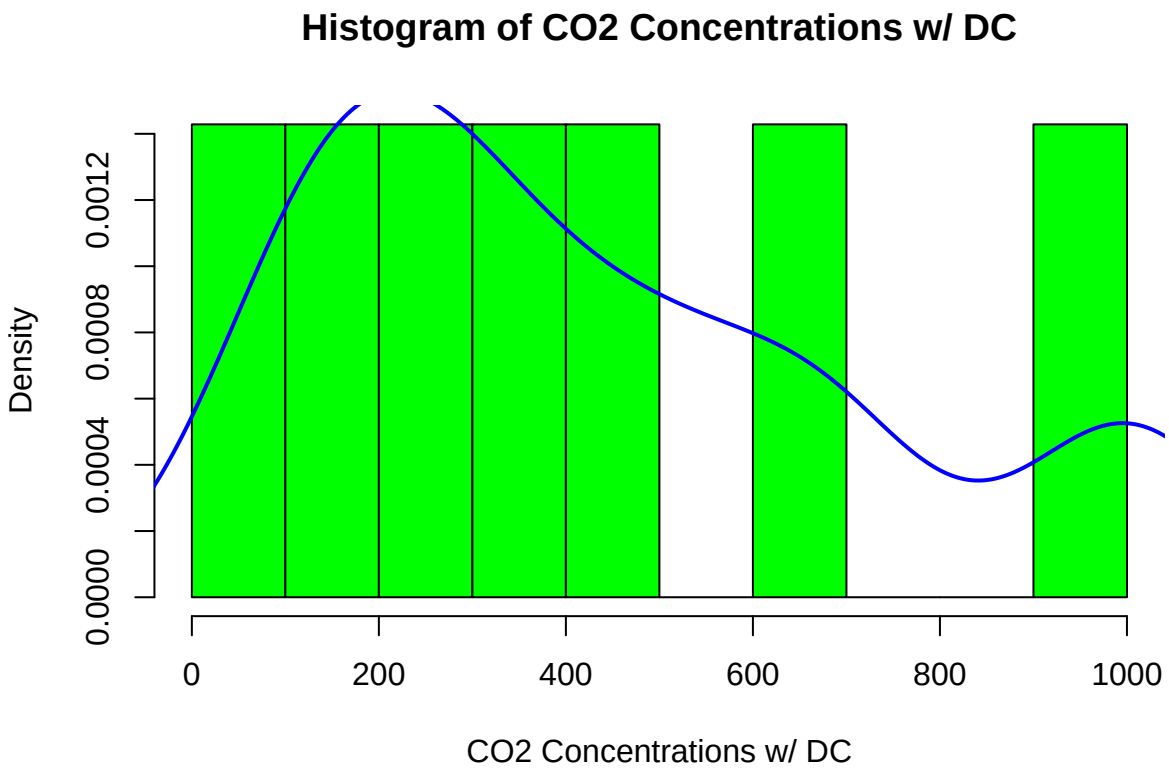
Histogram of CO2 Concentrations

```
par(mfrow=c(1,1))
hist(CO2$conc, xlab="CO2 Concentrations",
     main="Histogram of CO2 Concentrations", col="red")
```



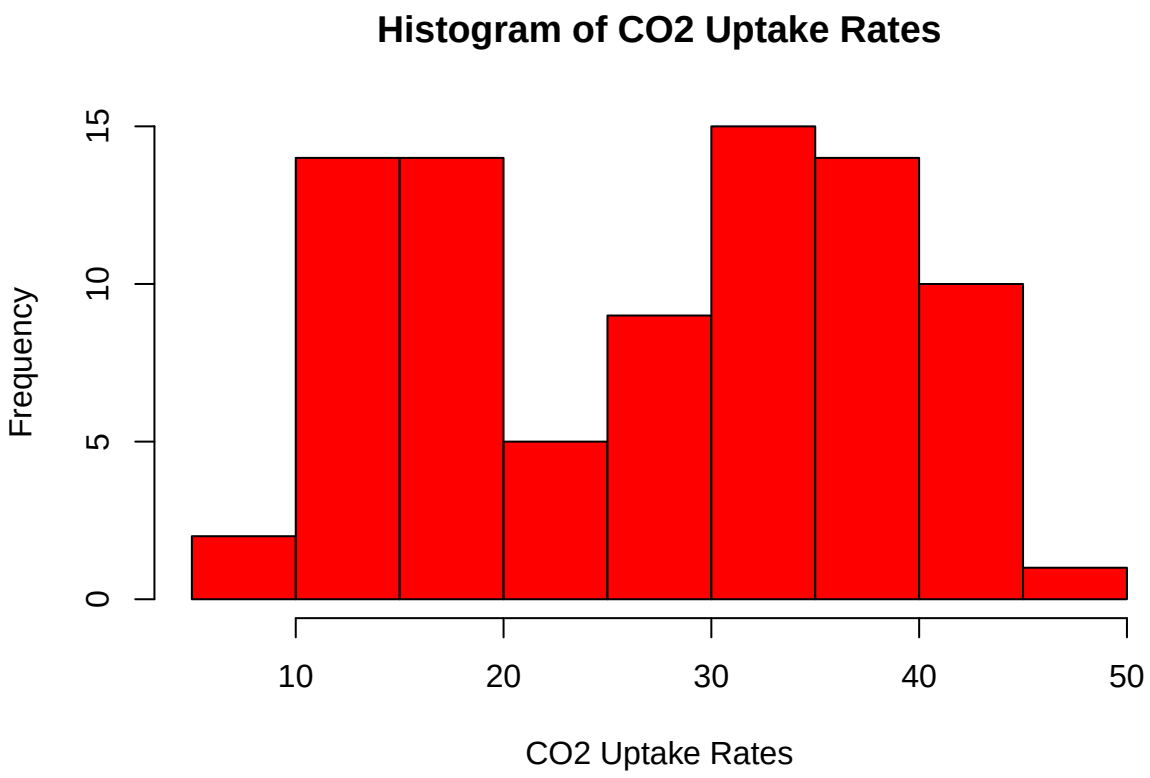
Histogram of CO2 Concentrations with it's Density Curve (DC)

```
par(mfrow=c(1,1))
x2 <- CO2$conc
hist(CO2$conc, xlab="CO2 Concentrations w/ DC",
     main="Histogram of CO2 Concentrations w/ DC",
     col="green", probability=TRUE)
lines(density(x2),col="blue", lwd=2)
```



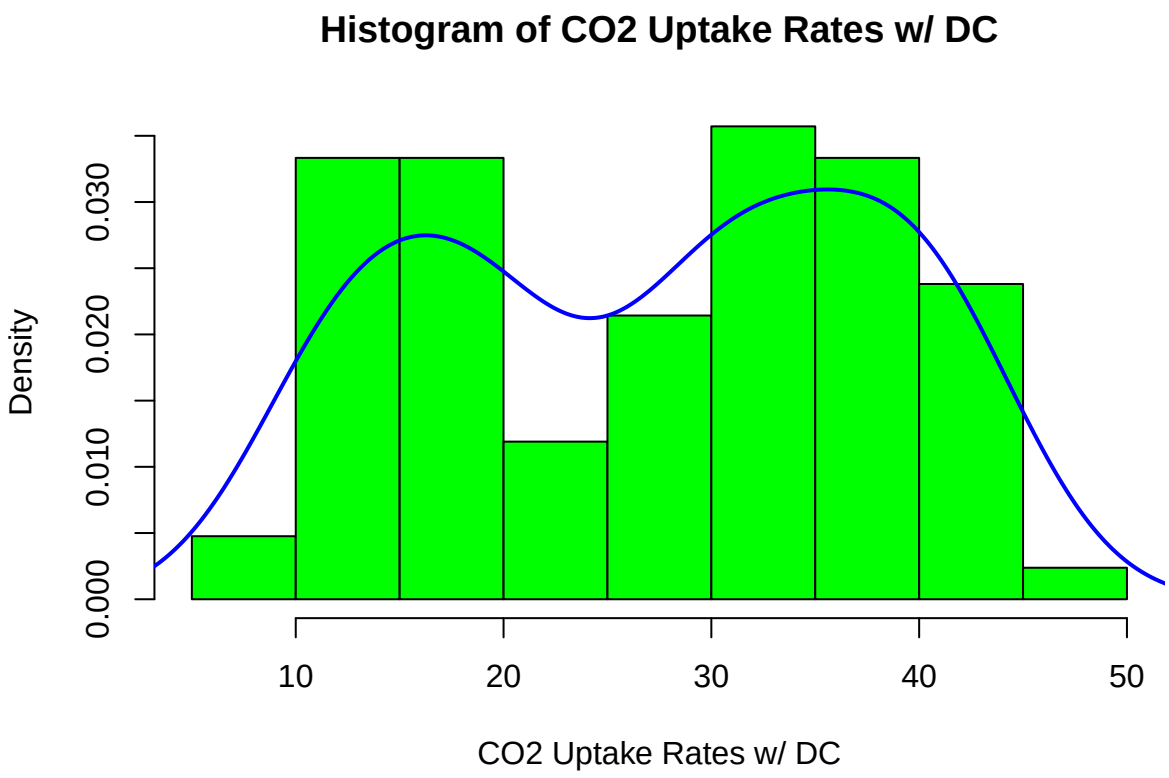
Histogram of CO2 Uptake Rates

```
par(mfrow=c(1,1))
hist(CO2$uptake, xlab="CO2 Uptake Rates",
     main="Histogram of CO2 Uptake Rates", col="red")
```



Histogram of CO2 Uptake Rates with it's Density Curve (DC)

```
par(mfrow=c(1,1))
x3 <- CO2$uptake
hist(CO2$uptake, xlab="CO2 Uptake Rates w/ DC",
     main="Histogram of CO2 Uptake Rates w/ DC",
     col="green", probability=TRUE)
lines(density(x3),col="blue", lwd=2)
```



Linear Regression of "Conc" and "Uptake"

Linear Regression Analysis of "Conc" and "Uptake"

```
fm <- lm(CO2$uptake ~ CO2$conc, data=CO2)
summary(fm)
```

```
##
## Call:
## lm(formula = CO2$uptake ~ CO2$conc, data = CO2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -22.831  -7.729   1.483   7.748  16.394
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 19.500290   1.853080  10.523  < 2e-16 ***
## CO2$conc     0.017731   0.003529   5.024 2.91e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.514 on 82 degrees of freedom
```

```
## Multiple R-squared:  0.2354, Adjusted R-squared:  0.2261
## F-statistic: 25.25 on 1 and 82 DF,  p-value: 2.906e-06
```

Linear Regression Model of "Conc" and "Uptake"

```
par(mfrow=c(1,1))
plot(CO2$conc, CO2$uptake,
     xlab="Ambient carbon dioxide concentrations (mL/L)",
     ylab="Carbon dioxide uptake rates (umol/m^2 sec)",
     main="Linear Regression Model of Conc and Uptake", col="red")
fm <- lm(CO2$uptake ~ CO2$conc, data=CO2)
abline(coef(fm), lty=4, col="blue")

#Extract coefficients of Conc and Uptake
fm_coef <- round(coef(fm), 3)

#Display the regression equation of the line
mtext(bquote(y == .(fm_coef[2])*x + .(fm_coef[1])),
      adj=1, padj=0)
```