UHURU data set visualization

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2023-02-23

A tip for working with Rmarkdown

The Working directory inside this Rmarkdown r chunk is the following:

```
getwd()
```

```
## [1] "/Users/lunasare/Desktop/spring2023/documents"
```

Note: remember that working directories in a project and an R chunk are not always the same!

1. Describing the working data set

UHURU data set

```
knitr::include_graphics("https://www.google.com/url?sa=i&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FVa
```

2. Reading the data set

We are reading a data set in TSV format. This is a "tab separated values" file. To read it into R we use the function `read.csv()` with the `sep =` argument set to `"\t"` which represents a tab in computer language.

```
read.csv(file = "../data-raw/ACACIA_DREPANOLOBIUM_SURVEY.txt", sep = "\t")
```

Assign the data to a variable so we can work with it

```
acacia <- read.csv(file = "../data-raw/ACACIA_DREPANOLOBIUM_SURVEY.txt", sep = "\t")
```

3. Acessing elements of a `data.frame`

It is similar to what we do for vectors, but we have two dimensions

```
numbers <- 1:10
numbers
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10
```

```
numbers[3:6]
```

```
## [1] 3 4 5 6
```

```
numbers[c(1,5,7,3)]
```

```
## [1] 1 5 7 3
```

```
acacia[,6]
```

```
##    [1] "S1TOTAL" "S1TOTAL" "S1TOTAL" "S1TOTAL" "S1TOTAL" "S1TOTAL" "S1TOTAL"
##    [8] "S1TOTAL" "S1MESO"  "S1MESO"  "S1MESO"  "S1MESO"  "S1MESO"  "S1MESO"
##   [15] "S1MESO"  "S1MESO"  "S1MESO"  "S1MESO"  "S1MESO"  "S1MESO"  "S2OPEN"
```

```
## [22] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [29] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [36] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [43] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [50] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [57] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [64] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [71] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [78] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [85] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [92] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [99] "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL" "S2TOTAL"
## [106] "S2TOTAL" "S2TOTAL" "S2MEGA"  "S2MEGA"  "S2MEGA"  "S2MEGA"  "S2MEGA"
## [113] "S2MEGA"  "S2MEGA"  "S2MEGA"  "S2MEGA"  "S2MEGA"  "S2MEGA"  "S2MEGA"
## [120] "S2MEGA"  "S2MESO"  "S2MESO"  "S2MESO"  "S3OPEN"  "S3OPEN"  "S3TOTAL"
## [127] "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL"
## [134] "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL"
## [141] "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL"
## [148] "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL" "S3TOTAL"
## [155] "S3TOTAL" "S3MESO"  "S3MESO"
```

```
str(acacia)
```

```
## 'data.frame':    157 obs. of  15 variables:
##  $ SURVEY   : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ YEAR     : int  2012 2012 2012 2012 2012 2012 2012 2012 2012 2012 ...
##  $ SITE     : chr  "SOUTH" "SOUTH" "SOUTH" "SOUTH" ...
##  $ BLOCK    : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ TREATMENT: chr  "TOTAL" "TOTAL" "TOTAL" "TOTAL" ...
##  $ PLOT     : chr  "S1TOTAL" "S1TOTAL" "S1TOTAL" "S1TOTAL" ...
##  $ ID       : int  581 582 3111 3112 3113 3114 3115 3199 941 942 ...
##  $ HEIGHT   : chr  "2.25" "2.65" "1.5" "2.01" ...
##  $ AXIS1    : num  2.75 4.1 1.7 1.8 1.84 1.62 1.95 2 2.15 5.55 ...
##  $ AXIS2    : num  2.15 3.9 0.85 1.6 1.42 0.85 0.9 1.75 1.82 4.82 ...
##  $ CIRC     : num  20 28 17 12 13 15 9 12.2 13 35 ...
##  $ FLOWERS  : int  0 0 2 0 0 0 0 0 0 0 ...
##  $ BUDS     : int  0 0 1 0 0 0 0 0 0 0 ...
##  $ FRUITS   : int  10 150 50 75 20 0 0 25 0 50 ...
##  $ ANT      : chr  "CS" "TP" "TP" "CS" ...
```

All the following are different ways of accessing a column or variable inside a data frame

```
acacia$SURVEY
```

```
##   [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##  [38] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##  [75] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [112] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [149] 1 1 1 1 1 1 1 1 1
```

```
acacia[, 1]
```

```
##   [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##  [38] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##  [75] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [112] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [149] 1 1 1 1 1 1 1 1 1
```

```
acacia[ , "SURVEY"]
```

```
##   [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##  [38] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
##  [75] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [112] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [149] 1 1 1 1 1 1 1 1 1 1
```

Replacing elements in a data.frame

First we locate the element that we want to replace

```
numbers[5] <- 100
numbers
```

```
## [1]   1   2   3   4 100   6   7   8   9  10
```

4. Quality Control check

Check that everything is the correct class and type

```
head(acacia)
```

```
##   SURVEY YEAR  SITE BLOCK TREATMENT    PLOT   ID HEIGHT AXIS1 AXIS2 CIRC
## 1      1 2012 SOUTH     1     TOTAL S1TOTAL  581   2.25  2.75  2.15   20
## 2      1 2012 SOUTH     1     TOTAL S1TOTAL  582   2.65  4.10  3.90   28
## 3      1 2012 SOUTH     1     TOTAL S1TOTAL 3111    1.5  1.70  0.85   17
## 4      1 2012 SOUTH     1     TOTAL S1TOTAL 3112   2.01  1.80  1.60   12
## 5      1 2012 SOUTH     1     TOTAL S1TOTAL 3113   1.75  1.84  1.42   13
## 6      1 2012 SOUTH     1     TOTAL S1TOTAL 3114   1.65  1.62  0.85   15
##   FLOWERS BUDS FRUITS ANT
## 1       0    0     10  CS
## 2       0    0    150  TP
## 3       2    1     50  TP
## 4       0    0     75  CS
## 5       0    0     20  CS
## 6       0    0      0   E
```

```
str(acacia)
```

```
## 'data.frame':    157 obs. of  15 variables:
##  $ SURVEY   : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ YEAR     : int  2012 2012 2012 2012 2012 2012 2012 2012 2012 2012 ...
##  $ SITE     : chr  "SOUTH" "SOUTH" "SOUTH" "SOUTH" ...
##  $ BLOCK    : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ TREATMENT: chr  "TOTAL" "TOTAL" "TOTAL" "TOTAL" ...
##  $ PLOT     : chr  "S1TOTAL" "S1TOTAL" "S1TOTAL" "S1TOTAL" ...
##  $ ID       : int  581 582 3111 3112 3113 3114 3115 3199 941 942 ...
##  $ HEIGHT   : chr  "2.25" "2.65" "1.5" "2.01" ...
##  $ AXIS1    : num  2.75 4.1 1.7 1.8 1.84 1.62 1.95 2 2.15 5.55 ...
##  $ AXIS2    : num  2.15 3.9 0.85 1.6 1.42 0.85 0.9 1.75 1.82 4.82 ...
##  $ CIRC     : num  20 28 17 12 13 15 9 12.2 13 35 ...
##  $ FLOWERS  : int  0 0 2 0 0 0 0 0 0 0 ...
##  $ BUDS     : int  0 0 1 0 0 0 0 0 0 0 ...
##  $ FRUITS   : int  10 150 50 75 20 0 0 25 0 50 ...
##  $ ANT      : chr  "CS" "TP" "TP" "CS" ...
```

```r
class(acacia$HEIGHT)
```

```
## [1] "character"
```

```r
is.numeric(acacia$HEIGHT)
```

```
## [1] FALSE
```

```r
acacia$HEIGHT
```

```
##   [1] "2.25" "2.65" "1.5"  "2.01" "1.75" "1.65" "1.2"  "1.45" "1.87" "2.38"
##  [11] "2.58" "2.65" "2.35" "1.88" "2.32" "2.39" "2.2"  "1.05" "2"     "1.28"
##  [21] "dead" "1.4"  "1.9"  "1.75" "1.8"  "2.7"  "2.02" "1.9"  "1.85" "1.65"
##  [31] "1.4"  "2.5"  "2.05" "2.26" "2.13" "1.8"  "1.85" "1.5"  "1.87" "1.58"
##  [41] "2.05" "1.75" "1.49" "1.28" "1.49" "1.07" "1.48" "1.25" "1.41" "1.6"
##  [51] "1.2"  "1.49" "1.5"  "1.65" "1.13" "1.25" "1.1"  "2.2"  "1.45" "1.6"
##  [61] "1.55" "1.5"  "1.03" "2.14" "1.2"  "1.05" "1.8"  "1.2"  "1.75" "1.45"
##  [71] "1.17" "2.15" "1.7"  "1.98" "1.26" "1.11" "1.14" "1.26" "1.3"  "1.29"
##  [81] "1.31" "1.15" "1.87" "1.47" "1.05" "2.1"  "1.99" "1.42" "1.5"  "1.06"
##  [91] "1.49" "1.8"  "1.93" "1.2"  "1.65" "1.52" "1.43" "1.25" "1.88" "1.03"
## [101] "1.1"  "1.4"  "1.05" "1.18" "1.4"  "1.37" "1.32" "1.55" "1.3"  "1.24"
## [111] "1.5"  "1.65" "2.17" "1.28" "1.07" "0.67" "0.68" "1.87" "1.35" "1.75"
## [121] "1.75" "1.64" "1.42" "dead" "0.9"  "dead" "1.8"  "2.47" "2.15" "1.7"
## [131] "1.9"  "1.95" "1.8"  "1.4"  "1"    "1.75" "1.28" "1"    "1.45" "1"
## [141] "1.03" "1.51" "1.17" "1.33" "1.3"  "1.13" "1.58" "1.06" "1.05" "1.45"
## [151] "1.15" "1.42" "1.02" "1.4"  "1.45" "1.95" "dead"
```

```r
as.numeric(acacia$HEIGHT)
```

```
## Warning: NAs introduced by coercion
```

```
##   [1] 2.25 2.65 1.50 2.01 1.75 1.65 1.20 1.45 1.87 2.38 2.58 2.65 2.35 1.88 2.32
##  [16] 2.39 2.20 1.05 2.00 1.28   NA 1.40 1.90 1.75 1.80 2.70 2.02 1.90 1.85 1.65
##  [31] 1.40 2.50 2.05 2.26 2.13 1.80 1.85 1.50 1.87 1.58 2.05 1.75 1.49 1.28 1.49
##  [46] 1.07 1.48 1.25 1.41 1.60 1.20 1.49 1.50 1.65 1.13 1.25 1.10 2.20 1.45 1.60
##  [61] 1.55 1.50 1.03 2.14 1.20 1.05 1.80 1.20 1.75 1.45 1.17 2.15 1.70 1.98 1.26
##  [76] 1.11 1.14 1.26 1.30 1.29 1.31 1.15 1.87 1.47 1.05 2.10 1.99 1.42 1.50 1.06
##  [91] 1.49 1.80 1.93 1.20 1.65 1.52 1.43 1.25 1.88 1.03 1.10 1.40 1.05 1.18 1.40
## [106] 1.37 1.32 1.55 1.30 1.24 1.50 1.65 2.17 1.28 1.07 0.67 0.68 1.87 1.35 1.75
## [121] 1.75 1.64 1.42   NA 0.90   NA 1.80 2.47 2.15 1.70 1.90 1.95 1.80 1.40 1.00
## [136] 1.75 1.28 1.00 1.45 1.00 1.03 1.51 1.17 1.33 1.30 1.13 1.58 1.06 1.05 1.45
## [151] 1.15 1.42 1.02 1.40 1.45 1.95   NA
```

We identified that HEIGHT should be numeric and is insetad character:

```r
acacia$HEIGHT <- as.numeric(acacia$HEIGHT)
```

```
## Warning: NAs introduced by coercion
```

```r
acacia$HEIGHT
```

```
##   [1] 2.25 2.65 1.50 2.01 1.75 1.65 1.20 1.45 1.87 2.38 2.58 2.65 2.35 1.88 2.32
##  [16] 2.39 2.20 1.05 2.00 1.28   NA 1.40 1.90 1.75 1.80 2.70 2.02 1.90 1.85 1.65
##  [31] 1.40 2.50 2.05 2.26 2.13 1.80 1.85 1.50 1.87 1.58 2.05 1.75 1.49 1.28 1.49
##  [46] 1.07 1.48 1.25 1.41 1.60 1.20 1.49 1.50 1.65 1.13 1.25 1.10 2.20 1.45 1.60
##  [61] 1.55 1.50 1.03 2.14 1.20 1.05 1.80 1.20 1.75 1.45 1.17 2.15 1.70 1.98 1.26
##  [76] 1.11 1.14 1.26 1.30 1.29 1.31 1.15 1.87 1.47 1.05 2.10 1.99 1.42 1.50 1.06
##  [91] 1.49 1.80 1.93 1.20 1.65 1.52 1.43 1.25 1.88 1.03 1.10 1.40 1.05 1.18 1.40
## [106] 1.37 1.32 1.55 1.30 1.24 1.50 1.65 2.17 1.28 1.07 0.67 0.68 1.87 1.35 1.75
```

```
## [121] 1.75 1.64 1.42   NA 0.90   NA 1.80 2.47 2.15 1.70 1.90 1.95 1.80 1.40 1.00
## [136] 1.75 1.28 1.00 1.45 1.00 1.03 1.51 1.17 1.33 1.30 1.13 1.58 1.06 1.05 1.45
## [151] 1.15 1.42 1.02 1.40 1.45 1.95   NA
```

Coercion in R computer language means that a value was forced to be a type, in this case, the word "Dead" cannot be trasnformed to a number, so it is assigned the NA value

```r
acacia <- read.csv(file = "../data-raw/ACACIA_DREPANOLOBIUM_SURVEY.txt",
        sep = "\t",
        na.strings = "dead")
is.numeric(acacia$HEIGHT)
```

```
## [1] TRUE
```

```r
head(acacia)
```

```
##   SURVEY YEAR  SITE BLOCK TREATMENT    PLOT   ID HEIGHT AXIS1 AXIS2 CIRC
## 1      1 2012 SOUTH     1     TOTAL S1TOTAL  581   2.25  2.75  2.15   20
## 2      1 2012 SOUTH     1     TOTAL S1TOTAL  582   2.65  4.10  3.90   28
## 3      1 2012 SOUTH     1     TOTAL S1TOTAL 3111   1.50  1.70  0.85   17
## 4      1 2012 SOUTH     1     TOTAL S1TOTAL 3112   2.01  1.80  1.60   12
## 5      1 2012 SOUTH     1     TOTAL S1TOTAL 3113   1.75  1.84  1.42   13
## 6      1 2012 SOUTH     1     TOTAL S1TOTAL 3114   1.65  1.62  0.85   15
##   FLOWERS BUDS FRUITS ANT
## 1       0    0     10  CS
## 2       0    0    150  TP
## 3       2    1     50  TP
## 4       0    0     75  CS
## 5       0    0     20  CS
## 6       0    0      0   E
```
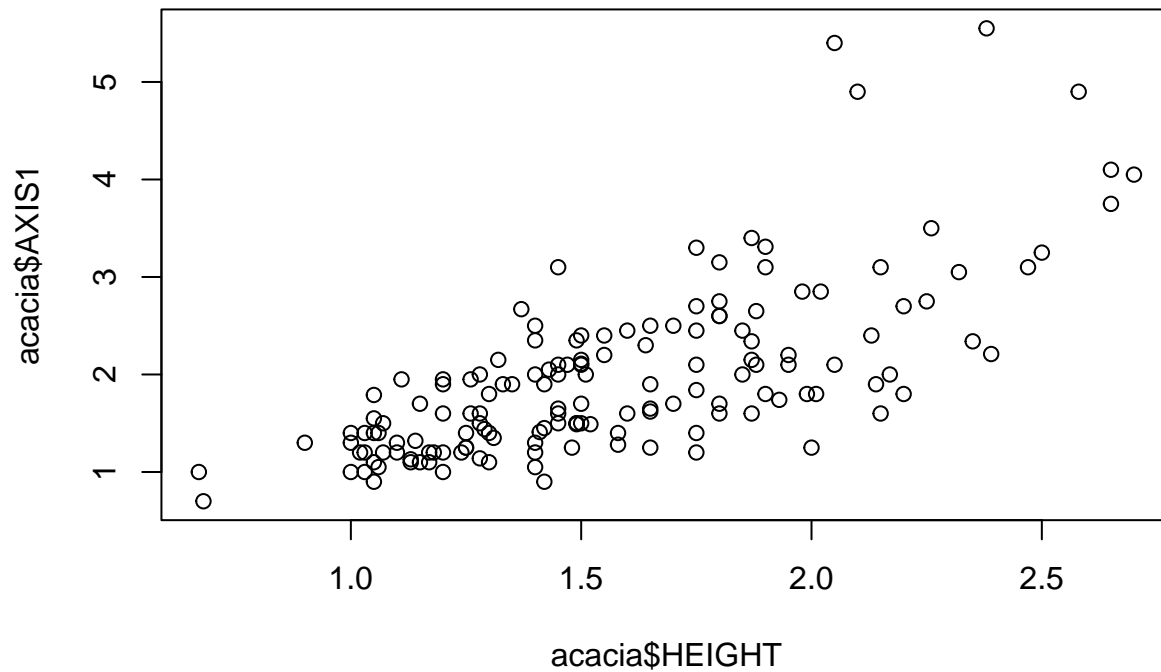
```r
# View(acacia)
```

5. Plotting data with `ggplot2`

Regular way to plot in R

```r
plot(x = acacia$HEIGHT, y = acacia$AXIS1, main = "Acacia height vs axis1")
```
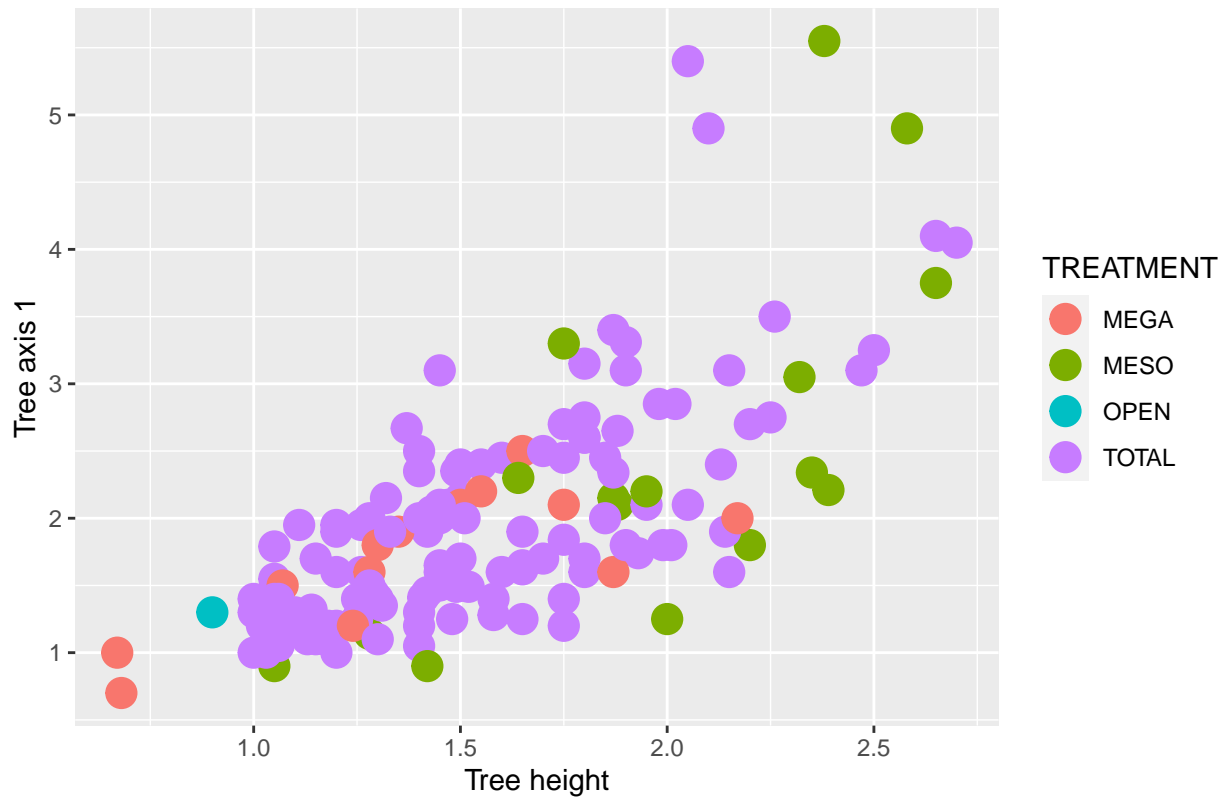
Acacia height vs axis1


```
?legend
```

With ggplot, we create layers

```
library(ggplot2)

ggplot(data = acacia, mapping = aes(x = HEIGHT, y = AXIS1, color = TREATMENT)) +
  geom_point(size = 5) +
  labs(x = "Tree height", y = "Tree axis 1", title = "Acacia tree size relationships")
```

```
## Warning: Removed 4 rows containing missing values (`geom_point()`).
```

Acacia tree size relationships


```
colors()
```

```
##    [1] "white"           "aliceblue"         "antiquewhite"
##    [4] "antiquewhite1"   "antiquewhite2"     "antiquewhite3"
##    [7] "antiquewhite4"   "aquamarine"        "aquamarine1"
##   [10] "aquamarine2"     "aquamarine3"       "aquamarine4"
##   [13] "azure"           "azure1"            "azure2"
##   [16] "azure3"          "azure4"            "beige"
##   [19] "bisque"          "bisque1"           "bisque2"
##   [22] "bisque3"         "bisque4"           "black"
##   [25] "blanchedalmond"  "blue"              "blue1"
##   [28] "blue2"           "blue3"             "blue4"
##   [31] "blueviolet"      "brown"             "brown1"
##   [34] "brown2"          "brown3"            "brown4"
##   [37] "burlywood"       "burlywood1"        "burlywood2"
##   [40] "burlywood3"      "burlywood4"        "cadetblue"
##   [43] "cadetblue1"      "cadetblue2"        "cadetblue3"
##   [46] "cadetblue4"      "chartreuse"        "chartreuse1"
##   [49] "chartreuse2"     "chartreuse3"       "chartreuse4"
##   [52] "chocolate"       "chocolate1"        "chocolate2"
##   [55] "chocolate3"      "chocolate4"        "coral"
##   [58] "coral1"          "coral2"            "coral3"
##   [61] "coral4"          "cornflowerblue"    "cornsilk"
##   [64] "cornsilk1"       "cornsilk2"         "cornsilk3"
##   [67] "cornsilk4"       "cyan"              "cyan1"
##   [70] "cyan2"           "cyan3"             "cyan4"
##   [73] "darkblue"        "darkcyan"          "darkgoldenrod"
```

```
##  [76] "darkgoldenrod1"    "darkgoldenrod2"    "darkgoldenrod3"
##  [79] "darkgoldenrod4"    "darkgray"          "darkgreen"
##  [82] "darkgrey"          "darkkhaki"         "darkmagenta"
##  [85] "darkolivegreen"    "darkolivegreen1"   "darkolivegreen2"
##  [88] "darkolivegreen3"   "darkolivegreen4"   "darkorange"
##  [91] "darkorange1"       "darkorange2"       "darkorange3"
##  [94] "darkorange4"       "darkorchid"        "darkorchid1"
##  [97] "darkorchid2"       "darkorchid3"       "darkorchid4"
## [100] "darkred"           "darksalmon"        "darkseagreen"
## [103] "darkseagreen1"     "darkseagreen2"     "darkseagreen3"
## [106] "darkseagreen4"     "darkslateblue"     "darkslategray"
## [109] "darkslategray1"    "darkslategray2"    "darkslategray3"
## [112] "darkslategray4"    "darkslategrey"     "darkturquoise"
## [115] "darkviolet"        "deeppink"          "deeppink1"
## [118] "deeppink2"         "deeppink3"         "deeppink4"
## [121] "deepskyblue"       "deepskyblue1"      "deepskyblue2"
## [124] "deepskyblue3"      "deepskyblue4"      "dimgray"
## [127] "dimgrey"           "dodgerblue"        "dodgerblue1"
## [130] "dodgerblue2"       "dodgerblue3"       "dodgerblue4"
## [133] "firebrick"         "firebrick1"        "firebrick2"
## [136] "firebrick3"        "firebrick4"        "floralwhite"
## [139] "forestgreen"       "gainsboro"         "ghostwhite"
## [142] "gold"              "gold1"             "gold2"
## [145] "gold3"             "gold4"             "goldenrod"
## [148] "goldenrod1"        "goldenrod2"        "goldenrod3"
## [151] "goldenrod4"        "gray"              "gray0"
## [154] "gray1"             "gray2"             "gray3"
## [157] "gray4"             "gray5"             "gray6"
## [160] "gray7"             "gray8"             "gray9"
## [163] "gray10"            "gray11"            "gray12"
## [166] "gray13"            "gray14"            "gray15"
## [169] "gray16"            "gray17"            "gray18"
## [172] "gray19"            "gray20"            "gray21"
## [175] "gray22"            "gray23"            "gray24"
## [178] "gray25"            "gray26"            "gray27"
## [181] "gray28"            "gray29"            "gray30"
## [184] "gray31"            "gray32"            "gray33"
## [187] "gray34"            "gray35"            "gray36"
## [190] "gray37"            "gray38"            "gray39"
## [193] "gray40"            "gray41"            "gray42"
## [196] "gray43"            "gray44"            "gray45"
## [199] "gray46"            "gray47"            "gray48"
## [202] "gray49"            "gray50"            "gray51"
## [205] "gray52"            "gray53"            "gray54"
## [208] "gray55"            "gray56"            "gray57"
## [211] "gray58"            "gray59"            "gray60"
## [214] "gray61"            "gray62"            "gray63"
## [217] "gray64"            "gray65"            "gray66"
## [220] "gray67"            "gray68"            "gray69"
## [223] "gray70"            "gray71"            "gray72"
## [226] "gray73"            "gray74"            "gray75"
## [229] "gray76"            "gray77"            "gray78"
## [232] "gray79"            "gray80"            "gray81"
## [235] "gray82"            "gray83"            "gray84"
```

```
## [238] "gray85"          "gray86"            "gray87"
## [241] "gray88"          "gray89"            "gray90"
## [244] "gray91"          "gray92"            "gray93"
## [247] "gray94"          "gray95"            "gray96"
## [250] "gray97"          "gray98"            "gray99"
## [253] "gray100"         "green"             "green1"
## [256] "green2"          "green3"            "green4"
## [259] "greenyellow"     "grey"              "grey0"
## [262] "grey1"           "grey2"             "grey3"
## [265] "grey4"           "grey5"             "grey6"
## [268] "grey7"           "grey8"             "grey9"
## [271] "grey10"          "grey11"            "grey12"
## [274] "grey13"          "grey14"            "grey15"
## [277] "grey16"          "grey17"            "grey18"
## [280] "grey19"          "grey20"            "grey21"
## [283] "grey22"          "grey23"            "grey24"
## [286] "grey25"          "grey26"            "grey27"
## [289] "grey28"          "grey29"            "grey30"
## [292] "grey31"          "grey32"            "grey33"
## [295] "grey34"          "grey35"            "grey36"
## [298] "grey37"          "grey38"            "grey39"
## [301] "grey40"          "grey41"            "grey42"
## [304] "grey43"          "grey44"            "grey45"
## [307] "grey46"          "grey47"            "grey48"
## [310] "grey49"          "grey50"            "grey51"
## [313] "grey52"          "grey53"            "grey54"
## [316] "grey55"          "grey56"            "grey57"
## [319] "grey58"          "grey59"            "grey60"
## [322] "grey61"          "grey62"            "grey63"
## [325] "grey64"          "grey65"            "grey66"
## [328] "grey67"          "grey68"            "grey69"
## [331] "grey70"          "grey71"            "grey72"
## [334] "grey73"          "grey74"            "grey75"
## [337] "grey76"          "grey77"            "grey78"
## [340] "grey79"          "grey80"            "grey81"
## [343] "grey82"          "grey83"            "grey84"
## [346] "grey85"          "grey86"            "grey87"
## [349] "grey88"          "grey89"            "grey90"
## [352] "grey91"          "grey92"            "grey93"
## [355] "grey94"          "grey95"            "grey96"
## [358] "grey97"          "grey98"            "grey99"
## [361] "grey100"         "honeydew"          "honeydew1"
## [364] "honeydew2"       "honeydew3"         "honeydew4"
## [367] "hotpink"         "hotpink1"          "hotpink2"
## [370] "hotpink3"        "hotpink4"          "indianred"
## [373] "indianred1"      "indianred2"        "indianred3"
## [376] "indianred4"      "ivory"             "ivory1"
## [379] "ivory2"          "ivory3"            "ivory4"
## [382] "khaki"           "khaki1"            "khaki2"
## [385] "khaki3"          "khaki4"            "lavender"
## [388] "lavenderblush"   "lavenderblush1"    "lavenderblush2"
## [391] "lavenderblush3"  "lavenderblush4"    "lawngreen"
## [394] "lemonchiffon"    "lemonchiffon1"     "lemonchiffon2"
## [397] "lemonchiffon3"   "lemonchiffon4"     "lightblue"
```

```
## [400] "lightblue1"          "lightblue2"          "lightblue3"
## [403] "lightblue4"          "lightcoral"          "lightcyan"
## [406] "lightcyan1"          "lightcyan2"          "lightcyan3"
## [409] "lightcyan4"          "lightgoldenrod"      "lightgoldenrod1"
## [412] "lightgoldenrod2"     "lightgoldenrod3"     "lightgoldenrod4"
## [415] "lightgoldenrodyellow" "lightgray"          "lightgreen"
## [418] "lightgrey"           "lightpink"           "lightpink1"
## [421] "lightpink2"          "lightpink3"          "lightpink4"
## [424] "lightsalmon"         "lightsalmon1"        "lightsalmon2"
## [427] "lightsalmon3"        "lightsalmon4"        "lightseagreen"
## [430] "lightskyblue"        "lightskyblue1"       "lightskyblue2"
## [433] "lightskyblue3"       "lightskyblue4"       "lightslateblue"
## [436] "lightslategray"      "lightslategrey"      "lightsteelblue"
## [439] "lightsteelblue1"     "lightsteelblue2"     "lightsteelblue3"
## [442] "lightsteelblue4"     "lightyellow"         "lightyellow1"
## [445] "lightyellow2"        "lightyellow3"        "lightyellow4"
## [448] "limegreen"           "linen"               "magenta"
## [451] "magenta1"            "magenta2"            "magenta3"
## [454] "magenta4"            "maroon"              "maroon1"
## [457] "maroon2"             "maroon3"             "maroon4"
## [460] "mediumaquamarine"    "mediumblue"          "mediumorchid"
## [463] "mediumorchid1"       "mediumorchid2"       "mediumorchid3"
## [466] "mediumorchid4"       "mediumpurple"        "mediumpurple1"
## [469] "mediumpurple2"       "mediumpurple3"       "mediumpurple4"
## [472] "mediumseagreen"      "mediumslateblue"     "mediumspringgreen"
## [475] "mediumturquoise"     "mediumvioletred"     "midnightblue"
## [478] "mintcream"           "mistyrose"           "mistyrose1"
## [481] "mistyrose2"          "mistyrose3"          "mistyrose4"
## [484] "moccasin"            "navajowhite"         "navajowhite1"
## [487] "navajowhite2"        "navajowhite3"        "navajowhite4"
## [490] "navy"                "navyblue"            "oldlace"
## [493] "olivedrab"           "olivedrab1"          "olivedrab2"
## [496] "olivedrab3"          "olivedrab4"          "orange"
## [499] "orange1"             "orange2"             "orange3"
## [502] "orange4"             "orangered"           "orangered1"
## [505] "orangered2"          "orangered3"          "orangered4"
## [508] "orchid"              "orchid1"             "orchid2"
## [511] "orchid3"             "orchid4"             "palegoldenrod"
## [514] "palegreen"           "palegreen1"          "palegreen2"
## [517] "palegreen3"          "palegreen4"          "paleturquoise"
## [520] "paleturquoise1"      "paleturquoise2"      "paleturquoise3"
## [523] "paleturquoise4"      "palevioletred"       "palevioletred1"
## [526] "palevioletred2"      "palevioletred3"      "palevioletred4"
## [529] "papayawhip"          "peachpuff"           "peachpuff1"
## [532] "peachpuff2"          "peachpuff3"          "peachpuff4"
## [535] "peru"                "pink"                "pink1"
## [538] "pink2"               "pink3"               "pink4"
## [541] "plum"                "plum1"               "plum2"
## [544] "plum3"               "plum4"               "powderblue"
## [547] "purple"              "purple1"             "purple2"
## [550] "purple3"             "purple4"             "red"
## [553] "red1"                "red2"                "red3"
## [556] "red4"                "rosybrown"           "rosybrown1"
## [559] "rosybrown2"          "rosybrown3"          "rosybrown4"
```

```
## [562] "royalblue"       "royalblue1"      "royalblue2"
## [565] "royalblue3"      "royalblue4"      "saddlebrown"
## [568] "salmon"          "salmon1"         "salmon2"
## [571] "salmon3"         "salmon4"         "sandybrown"
## [574] "seagreen"        "seagreen1"       "seagreen2"
## [577] "seagreen3"       "seagreen4"       "seashell"
## [580] "seashell1"       "seashell2"       "seashell3"
## [583] "seashell4"       "sienna"          "sienna1"
## [586] "sienna2"         "sienna3"         "sienna4"
## [589] "skyblue"         "skyblue1"        "skyblue2"
## [592] "skyblue3"        "skyblue4"        "slateblue"
## [595] "slateblue1"      "slateblue2"      "slateblue3"
## [598] "slateblue4"      "slategray"       "slategray1"
## [601] "slategray2"      "slategray3"      "slategray4"
## [604] "slategrey"       "snow"            "snow1"
## [607] "snow2"           "snow3"           "snow4"
## [610] "springgreen"     "springgreen1"    "springgreen2"
## [613] "springgreen3"    "springgreen4"    "steelblue"
## [616] "steelblue1"      "steelblue2"      "steelblue3"
## [619] "steelblue4"      "tan"             "tan1"
## [622] "tan2"            "tan3"            "tan4"
## [625] "thistle"         "thistle1"        "thistle2"
## [628] "thistle3"        "thistle4"        "tomato"
## [631] "tomato1"         "tomato2"         "tomato3"
## [634] "tomato4"         "turquoise"       "turquoise1"
## [637] "turquoise2"      "turquoise3"      "turquoise4"
## [640] "violet"          "violetred"       "violetred1"
## [643] "violetred2"      "violetred3"      "violetred4"
## [646] "wheat"           "wheat1"          "wheat2"
## [649] "wheat3"          "wheat4"          "whitesmoke"
## [652] "yellow"          "yellow1"         "yellow2"
## [655] "yellow3"         "yellow4"         "yellowgreen"
```