UHURU data set visualization

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A tip for working with Rmarkdown

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

```
getwd()
```

```
## [1] "/Users/avineetkaur/Desktop/Bio197/Bio197/Documents"
```

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

Describing the working data set

UHURU data set

Introduction: The experimental treatment is to characterizing the effects in the system by removing the greatest size classes of herbivores successfully and measure how variation in precipitation regimes measure direction and magnitude of the effects. There are three herbivore-exclusion treatments along with an unfenced control that was applicable to the contiguous 1-ha plots. Mega is the exclusion of giraffes and elephants only, Meso is the exclusion of megaherbivores and mesoherbivores and Total is the exclusion os the exclusion of all herbivores.

The different variables that were measured MEGA, MESO, and TOTAL. The influence of the experimental group is that it clearly organizes all of the data points for MESO, MEGA, OPEN, and TOTAL in a way that can be easily interpreted as we can observe that certain groups possess a higher tree height while some possess a lower height. The acacias in the open plots were removed since the largest class of herbivores were removed from the experiment so there is no data to fill those open plots that are present.

2. Reading the data set

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

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

```
##     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 20.0
## 2        1 2012 SOUTH     1     TOTAL S1TOTAL  582   2.65  4.10  3.90 28.0
## 3        1 2012 SOUTH     1     TOTAL S1TOTAL 3111    1.5  1.70  0.85 17.0
## 4        1 2012 SOUTH     1     TOTAL S1TOTAL 3112   2.01  1.80  1.60 12.0
## 5        1 2012 SOUTH     1     TOTAL S1TOTAL 3113   1.75  1.84  1.42 13.0
## 6        1 2012 SOUTH     1     TOTAL S1TOTAL 3114   1.65  1.62  0.85 15.0
```

```
## 7        1 2012 SOUTH     1     TOTAL S1TOTAL 3115    1.2  1.95  0.90  9.0
## 8        1 2012 SOUTH     1     TOTAL S1TOTAL 3199   1.45  2.00  1.75 12.2
## 9        1 2012 SOUTH     1      MESO  S1MESO  941   1.87  2.15  1.82 13.0
## 10       1 2012 SOUTH     1      MESO  S1MESO  942   2.38  5.55  4.82 35.0
## 11       1 2012 SOUTH     1      MESO  S1MESO  943   2.58  4.90  4.24 24.0
## 12       1 2012 SOUTH     1      MESO  S1MESO  944   2.65  3.75  3.10 27.0
## 13       1 2012 SOUTH     1      MESO  S1MESO  946   2.35  2.34  2.05 20.0
## 14       1 2012 SOUTH     1      MESO  S1MESO  947   1.88  2.10  1.85 28.0
## 15       1 2012 SOUTH     1      MESO  S1MESO 3116   2.32  3.05  2.63 30.0
## 16       1 2012 SOUTH     1      MESO  S1MESO 3117   2.39  2.21  2.10 13.0
## 17       1 2012 SOUTH     1      MESO  S1MESO 3118    2.2  1.80  1.50 10.0
## 18       1 2012 SOUTH     1      MESO  S1MESO 3119   1.05  0.90  0.55  8.0
## 19       1 2012 SOUTH     1      MESO  S1MESO 3120      2  1.25  1.20 10.0
## 20       1 2012 SOUTH     1      MESO  S1MESO 3131   1.28  1.14  1.00 10.0
## 21       1 2012 SOUTH     2      OPEN  S2OPEN  341   dead    NA    NA   NA
## 22       1 2012 SOUTH     2     TOTAL S2TOTAL 3178    1.4  2.50  2.15 18.0
## 23       1 2012 SOUTH     2     TOTAL S2TOTAL  101    1.9  3.31  2.65 15.0
## 24       1 2012 SOUTH     2     TOTAL S2TOTAL  102   1.75  2.70  2.55 16.0
## 25       1 2012 SOUTH     2     TOTAL S2TOTAL  103    1.8  2.75  2.30 16.0
## 26       1 2012 SOUTH     2     TOTAL S2TOTAL  104    2.7  4.05  4.00 35.2
## 27       1 2012 SOUTH     2     TOTAL S2TOTAL  105   2.02  2.85  1.49 17.0
## 28       1 2012 SOUTH     2     TOTAL S2TOTAL  108    1.9  3.10  2.85 19.0
## 29       1 2012 SOUTH     2     TOTAL S2TOTAL  109   1.85  2.45  1.90 19.0
## 30       1 2012 SOUTH     2     TOTAL S2TOTAL  110   1.65  1.90  1.54 17.0
## 31       1 2012 SOUTH     2     TOTAL S2TOTAL  111    1.4  2.35  1.45 14.0
## 32       1 2012 SOUTH     2     TOTAL S2TOTAL  113    2.5  3.25  2.30 22.0
## 33       1 2012 SOUTH     2     TOTAL S2TOTAL  115   2.05  5.40  4.50 33.0
## 34       1 2012 SOUTH     2     TOTAL S2TOTAL  116   2.26  3.50  3.10 33.0
## 35       1 2012 SOUTH     2     TOTAL S2TOTAL  117   2.13  2.40  2.30 20.0
## 36       1 2012 SOUTH     2     TOTAL S2TOTAL  118    1.8  3.15  2.55 22.0
## 37       1 2012 SOUTH     2     TOTAL S2TOTAL 1211   1.85  2.00  2.27 20.0
## 38       1 2012 SOUTH     2     TOTAL S2TOTAL 1212    1.5  2.15  1.80 15.0
## 39       1 2012 SOUTH     2     TOTAL S2TOTAL 1213   1.87  2.34  2.05 13.0
## 40       1 2012 SOUTH     2     TOTAL S2TOTAL 1214   1.58  1.28  0.75 11.0
## 41       1 2012 SOUTH     2     TOTAL S2TOTAL 1215   2.05  2.10  1.75 17.0
## 42       1 2012 SOUTH     2     TOTAL S2TOTAL 1216   1.75  2.45  3.28 16.0
## 43       1 2012 SOUTH     2     TOTAL S2TOTAL 1217   1.49  1.50  1.45 13.0
## 44       1 2012 SOUTH     2     TOTAL S2TOTAL 1218   1.28  2.00  0.90 10.0
## 45       1 2012 SOUTH     2     TOTAL S2TOTAL 1219   1.49  2.35  1.65 13.0
## 46       1 2012 SOUTH     2     TOTAL S2TOTAL 1220   1.07  1.20  0.95 11.0
## 47       1 2012 SOUTH     2     TOTAL S2TOTAL 1231   1.48  1.25  1.20  9.0
## 48       1 2012 SOUTH     2     TOTAL S2TOTAL 1232   1.25  1.25  0.90 10.0
## 49       1 2012 SOUTH     2     TOTAL S2TOTAL 1233   1.41  1.41  1.40 14.0
## 50       1 2012 SOUTH     2     TOTAL S2TOTAL 1234    1.6  1.60  1.30 13.0
## 51       1 2012 SOUTH     2     TOTAL S2TOTAL 1235    1.2  1.20  1.30 14.0
## 52       1 2012 SOUTH     2     TOTAL S2TOTAL 1236   1.49  1.49  1.20  8.0
## 53       1 2012 SOUTH     2     TOTAL S2TOTAL 1237    1.5  1.50  1.50 14.0
## 54       1 2012 SOUTH     2     TOTAL S2TOTAL 1238   1.65  1.65  2.00 20.0
## 55       1 2012 SOUTH     2     TOTAL S2TOTAL 1239   1.13  1.13  1.20 10.0
## 56       1 2012 SOUTH     2     TOTAL S2TOTAL 1240   1.25  1.25  0.90 10.0
## 57       1 2012 SOUTH     2     TOTAL S2TOTAL 1251    1.1  1.20  1.10 10.0
## 58       1 2012 SOUTH     2     TOTAL S2TOTAL 1252    2.2  2.70  2.40 25.0
## 59       1 2012 SOUTH     2     TOTAL S2TOTAL 1253   1.45  1.65  1.25 10.0
## 60       1 2012 SOUTH     2     TOTAL S2TOTAL 1254    1.6  2.45  2.10 13.0
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## 61       1 2012 SOUTH     2     TOTAL S2TOTAL 1255   1.55  2.40  1.80 13.0
## 62       1 2012 SOUTH     2     TOTAL S2TOTAL 1256    1.5  2.40  2.15 13.0
## 63       1 2012 SOUTH     2     TOTAL S2TOTAL 1257   1.03  1.20  1.00 10.0
## 64       1 2012 SOUTH     2     TOTAL S2TOTAL 1258   2.14  1.90  1.70 13.0
## 65       1 2012 SOUTH     2     TOTAL S2TOTAL 1259    1.2  1.90  1.65 12.0
## 66       1 2012 SOUTH     2     TOTAL S2TOTAL 1260   1.05  1.10  1.00  9.0
## 67       1 2012 SOUTH     2     TOTAL S2TOTAL 2131    1.8  2.60  2.40 15.0
## 68       1 2012 SOUTH     2     TOTAL S2TOTAL 2132    1.2  1.00  0.95  7.0
## 69       1 2012 SOUTH     2     TOTAL S2TOTAL 2133   1.75  1.40  1.10 10.0
## 70       1 2012 SOUTH     2     TOTAL S2TOTAL 2134   1.45  3.10  1.80 10.0
## 71       1 2012 SOUTH     2     TOTAL S2TOTAL 2135   1.17  1.20  1.10  5.0
## 72       1 2012 SOUTH     2     TOTAL S2TOTAL 2136   2.15  3.10  2.58 22.0
## 73       1 2012 SOUTH     2     TOTAL S2TOTAL 2137    1.7  1.70  1.40 12.0
## 74       1 2012 SOUTH     2     TOTAL S2TOTAL 3132   1.98  2.85  2.70 12.0
## 75       1 2012 SOUTH     2     TOTAL S2TOTAL 3133   1.26  1.95  1.75 17.0
## 76       1 2012 SOUTH     2     TOTAL S2TOTAL 3134   1.11  1.95  1.50 10.0
## 77       1 2012 SOUTH     2     TOTAL S2TOTAL 3135   1.14  1.32  1.05 10.0
## 78       1 2012 SOUTH     2     TOTAL S2TOTAL 3136   1.26  1.60  1.40 10.0
## 79       1 2012 SOUTH     2     TOTAL S2TOTAL 3137    1.3  1.40  0.80 10.0
## 80       1 2012 SOUTH     2     TOTAL S2TOTAL 3138   1.29  1.44  1.35 13.0
## 81       1 2012 SOUTH     2     TOTAL S2TOTAL 3139   1.31  1.35  1.15  7.0
## 82       1 2012 SOUTH     2     TOTAL S2TOTAL 3140   1.15  1.70  1.28 10.0
## 83       1 2012 SOUTH     2     TOTAL S2TOTAL 3151   1.87  3.40  1.85 15.0
## 84       1 2012 SOUTH     2     TOTAL S2TOTAL 3152   1.47  2.10  1.61  8.0
## 85       1 2012 SOUTH     2     TOTAL S2TOTAL 3153   1.05  1.79  1.50 10.0
## 86       1 2012 SOUTH     2     TOTAL S2TOTAL 3154    2.1  4.90  3.75 25.0
## 87       1 2012 SOUTH     2     TOTAL S2TOTAL 3155   1.99  1.80  1.35 13.0
## 88       1 2012 SOUTH     2     TOTAL S2TOTAL 3156   1.42  1.90  1.80 14.0
## 89       1 2012 SOUTH     2     TOTAL S2TOTAL 3157    1.5  2.11  1.75 12.0
## 90       1 2012 SOUTH     2     TOTAL S2TOTAL 3158   1.06  1.05  0.85  4.0
## 91       1 2012 SOUTH     2     TOTAL S2TOTAL 3159   1.49  1.50  1.15 13.0
## 92       1 2012 SOUTH     2     TOTAL S2TOTAL 3160    1.8  1.60  1.50 14.0
## 93       1 2012 SOUTH     2     TOTAL S2TOTAL 3171   1.93  1.74  1.20 14.0
## 94       1 2012 SOUTH     2     TOTAL S2TOTAL 3172    1.2  1.60  1.30 10.0
## 95       1 2012 SOUTH     2     TOTAL S2TOTAL 3173   1.65  1.25  1.10 11.0
## 96       1 2012 SOUTH     2     TOTAL S2TOTAL 3174   1.52  1.49  1.10 12.0
## 97       1 2012 SOUTH     2     TOTAL S2TOTAL 3175   1.43  2.05  1.54 13.0
## 98       1 2012 SOUTH     2     TOTAL S2TOTAL 3176   1.25  1.40  1.25 13.0
## 99       1 2012 SOUTH     2     TOTAL S2TOTAL 3177   1.88  2.65  2.64 20.0
## 100      1 2012 SOUTH     2     TOTAL S2TOTAL 3179   1.03  1.40  0.60 13.0
## 101      1 2012 SOUTH     2     TOTAL S2TOTAL 3180    1.1  1.30  1.20 10.0
## 102      1 2012 SOUTH     2     TOTAL S2TOTAL 3191    1.4  1.05  1.00 10.0
## 103      1 2012 SOUTH     2     TOTAL S2TOTAL 3192   1.05  1.55  0.90 10.0
## 104      1 2012 SOUTH     2     TOTAL S2TOTAL 3193   1.18  1.20  1.00  7.0
## 105      1 2012 SOUTH     2     TOTAL S2TOTAL 3194    1.4  1.30  1.85 13.0
## 106      1 2012 SOUTH     2     TOTAL S2TOTAL 3195   1.37  2.67  2.19 19.0
## 107      1 2012 SOUTH     2     TOTAL S2TOTAL 3196   1.32  2.15  1.55 11.0
## 108      1 2012 SOUTH     2      MEGA  S2MEGA  182   1.55  2.20  1.20 20.0
## 109      1 2012 SOUTH     2      MEGA  S2MEGA  183    1.3  1.80  0.90  8.0
## 110      1 2012 SOUTH     2      MEGA  S2MEGA  184   1.24  1.20  1.20 25.0
## 111      1 2012 SOUTH     2      MEGA  S2MEGA  185    1.5  2.10  1.75 16.0
## 112      1 2012 SOUTH     2      MEGA  S2MEGA  186   1.65  2.50  2.20 15.0
## 113      1 2012 SOUTH     2      MEGA  S2MEGA  187   2.17  2.00  1.20 15.0
## 114      1 2012 SOUTH     2      MEGA  S2MEGA  188   1.28  1.60  1.50 10.0
```

```
## 115      1 2012 SOUTH     2      MEGA  S2MEGA  189   1.07  1.50  1.50 10.0
## 116      1 2012 SOUTH     2      MEGA  S2MEGA  190   0.67  1.00  0.80  8.0
## 117      1 2012 SOUTH     2      MEGA  S2MEGA  191   0.68  0.70  0.60  4.0
## 118      1 2012 SOUTH     2      MEGA  S2MEGA  192   1.87  1.60  1.40  9.0
## 119      1 2012 SOUTH     2      MEGA  S2MEGA  193   1.35  1.90  1.50 14.0
## 120      1 2012 SOUTH     2      MEGA  S2MEGA  194   1.75  2.10  2.10 15.0
## 121      1 2012 SOUTH     2      MESO  S2MESO  462   1.75  3.30  2.50 23.0
## 122      1 2012 SOUTH     2      MESO  S2MESO  463   1.64  2.30  2.00 14.0
## 123      1 2012 SOUTH     2      MESO  S2MESO 2138   1.42  0.90  0.80 10.0
## 124      1 2012 SOUTH     3      OPEN  S3OPEN 1301   dead    NA    NA   NA
## 125      1 2012 SOUTH     3      OPEN  S3OPEN 1302    0.9  1.30  1.10 11.0
## 126      1 2012 SOUTH     3     TOTAL S3TOTAL 1061   dead    NA    NA   NA
## 127      1 2012 SOUTH     3     TOTAL S3TOTAL 1062    1.8  2.60  2.60 15.0
## 128      1 2012 SOUTH     3     TOTAL S3TOTAL 1063   2.47  3.10  2.20 18.0
## 129      1 2012 SOUTH     3     TOTAL S3TOTAL 1064   2.15  1.60  1.10 17.0
## 130      1 2012 SOUTH     3     TOTAL S3TOTAL 1066    1.7  2.50  2.15 15.0
## 131      1 2012 SOUTH     3     TOTAL S3TOTAL 1066    1.9  1.80  1.50 20.0
## 132      1 2012 SOUTH     3     TOTAL S3TOTAL 1067   1.95  2.10  1.90 13.0
## 133      1 2012 SOUTH     3     TOTAL S3TOTAL 1068    1.8  1.70  1.40 13.0
## 134      1 2012 SOUTH     3     TOTAL S3TOTAL 1069    1.4  2.00  1.60 14.0
## 135      1 2012 SOUTH     3     TOTAL S3TOTAL 1070      1  1.30  1.20  7.0
## 136      1 2012 SOUTH     3     TOTAL S3TOTAL 2139   1.75  1.20  1.10 13.0
## 137      1 2012 SOUTH     3     TOTAL S3TOTAL 2140   1.28  1.50  0.95  4.0
## 138      1 2012 SOUTH     3     TOTAL S3TOTAL 2151      1  1.40  1.20  4.0
## 139      1 2012 SOUTH     3     TOTAL S3TOTAL 2152   1.45  1.50  1.30 10.0
## 140      1 2012 SOUTH     3     TOTAL S3TOTAL 2153      1  1.00  0.75  8.0
## 141      1 2012 SOUTH     3     TOTAL S3TOTAL 2154   1.03  1.00  0.90  6.0
## 142      1 2012 SOUTH     3     TOTAL S3TOTAL 2155   1.51  2.00  1.80 12.0
## 143      1 2012 SOUTH     3     TOTAL S3TOTAL 2156   1.17  1.10  0.90 10.0
## 144      1 2012 SOUTH     3     TOTAL S3TOTAL 2157   1.33  1.90  1.85 14.0
## 145      1 2012 SOUTH     3     TOTAL S3TOTAL 2158    1.3  1.10  0.85  8.0
## 146      1 2012 SOUTH     3     TOTAL S3TOTAL 2159   1.13  1.10  0.90 10.0
## 147      1 2012 SOUTH     3     TOTAL S3TOTAL 2160   1.58  1.40  1.40 13.0
## 148      1 2012 SOUTH     3     TOTAL S3TOTAL 2171   1.06  1.40  1.00  5.0
## 149      1 2012 SOUTH     3     TOTAL S3TOTAL 2172   1.05  1.40  0.95  7.0
## 150      1 2012 SOUTH     3     TOTAL S3TOTAL 2173   1.45  1.60  1.10  6.0
## 151      1 2012 SOUTH     3     TOTAL S3TOTAL 2174   1.15  1.10  0.90  5.0
## 152      1 2012 SOUTH     3     TOTAL S3TOTAL 2175   1.42  1.45  1.30 13.0
## 153      1 2012 SOUTH     3     TOTAL S3TOTAL 2176   1.02  1.20  1.00  8.0
## 154      1 2012 SOUTH     3     TOTAL S3TOTAL 2177    1.4  1.20  1.00  9.0
## 155      1 2012 SOUTH     3     TOTAL S3TOTAL 2178   1.45  2.10  2.05 15.0
## 156      1 2012 SOUTH     3      MESO  S3MESO 1421   1.95  2.20  1.60 13.0
## 157      1 2012 SOUTH     3      MESO  S3MESO 1422   dead    NA    NA   NA
##     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
## 7         0    0      0    CS
## 8         0    0     25    CS
## 9         0    0      0    TP
## 10        0    0     50    TP
```

```
## 11      0    0      5    CS
## 12      0    0     60    TP
## 13      0    0     60    TP
## 14      2    0     60    CS
## 15      2    0      0    CS
## 16      0    0      0    TP
## 17      0    0      0    TP
## 18      0    0      0    CS
## 19      0    0      0    CM
## 20      0    0      0    TP
## 21     NA   NA     NA
## 22      0    0      5    CS
## 23      0    0     45    CS
## 24     40   50     35    CS
## 25      8    2     65    CS
## 26      0    0     20    TP
## 27      0    0     70    CS
## 28      0    0    125    CM
## 29      0    0    200    CM
## 30      0    0     10    CS
## 31      0    0      0    CS
## 32      0    0     35    TP
## 33      0    0    300    CM
## 34      2    2    100    CS
## 35      0    0     30    CM
## 36      0    0     50    TP
## 37      0    0     10    CM
## 38      0    0     25    CS
## 39      0    0     15    TP
## 40      0    0      0    TP
## 41      0    0     15    TP
## 42      0    0      0    TP
## 43      0    0     40    TP
## 44      0    0      0    TP
## 45      0    0     15    CM
## 46      0    0      0    CM
## 47      0    0      0    TP
## 48      0    0      0    TP
## 49      0    0      1    TP
## 50      0    0     20    TP
## 51      0    0      0    TP
## 52      0    0      0    TP
## 53      0    0     20    TP
## 54      0    0      0    TP
## 55      0    0      0    CN
## 56      0    0      0    CN
## 57      0    0      0    TP
## 58      0    0      5    TP
## 59      0    0      0    TP
## 60      0    0     25    TP
## 61      0    0     25    TP
## 62      0    0     20    TP
## 63      0    0      0    TP
## 64      0    0     10    CS
```

```
## 65        1     0     25    CS
## 66        0     0      0    TP
## 67        0     0     10    TP
## 68        0     0      0    TP
## 69        0     0      0    TP
## 70        0     0      0    TP
## 71        0     0      0    TP
## 72        0     0      0    CS
## 73        0     0      0    CS
## 74        0     0     25 AB_TP
## 75        0     0      0    TP
## 76        0     0      0    TP
## 77        0     0      0    TP
## 78        0     0      0    CS
## 79        0     0      0    CS
## 80        0     0      0    CS
## 81        0     0      0    CS
## 82        0     0      5    CS
## 83        6     0      0    CS
## 84        0     0      0    CS
## 85        0     0      1    CS
## 86        0     0     25    CS
## 87        0     0      0    CS
## 88        0     0      0    CS
## 89        0     0     10    CS
## 90        0     0      0    CS
## 91        0     0     35    CS
## 92        0     0      0    CS
## 93        0     0      0    CS
## 94        0     0      0    CS
## 95        0     0      0    CS
## 96        0     0     20    CS
## 97        0     0      0    CS
## 98        0     0      0    CM
## 99        0     0    100    CM
## 100       0     0      0    CS
## 101       0     0      0    CS
## 102       0     0      0    CS
## 103       0     0      0    CM
## 104       0     0      0    TP
## 105       0     0     30    CS
## 106       0     0     50    TP
## 107       0     0     10    CS
## 108       0     0      0    CS
## 109       0     0     15    CS
## 110       0     0     10    CS
## 111       5     0    200    CS
## 112       0     0     80    CS
## 113       0     0    150    TP
## 114       0     0     40    TP
## 115       0     0     60    TP
## 116       0     0      0    CS
## 117       0     0      0    TP
## 118       0     0     40    CS
```

```
## 119       0    0     20    CS
## 120       0    0     75    TP
## 121       0    0     20    CM
## 122       0    0      0    TP
## 123       0    0      0     E
## 124      NA   NA     NA
## 125       0    0      0    TP
## 126      NA   NA     NA
## 127       0    0     50    TP
## 128       0    0      0    TP
## 129       0    0      0    TP
## 130       0    0      2    TP
## 131       0    0     25    TP
## 132       0    0      0    TP
## 133       0    0      0    TP
## 134       0    0      0    TP
## 135       0    0      0    TP
## 136       0    0      0    TP
## 137       0    0      0    TP
## 138       0    0      0    TP
## 139       0    0      0    TP
## 140       0    0      0    TP
## 141       0    0      0    TP
## 142       0    0      0    TP
## 143       0    0      0    TP
## 144       0    0      0    TP
## 145       0    0      0    TP
## 146       0    0      0    TP
## 147       0    0      0    TP
## 148       0    0      8    TP
## 149       0    0      0    TP
## 150       0    0      0    TP
## 151       0    0      0    TP
## 152       0    0      0    TP
## 153       0    0      0    TP
## 154       0    0      0    TP
## 155       0    0     20    TP
## 156       0    0      2    CS
## 157      NA   NA     NA
```

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

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

###Accessing elements of a `data.frame`

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

```
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" ...
```

```
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
```

3 All the following are different ways to access a column

```
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
##  [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
##  [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
## [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
## [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
##  [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
##  [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
## [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
## [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
##  [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
##  [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
## [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
## [149] 1 1 1 1 1 1 1 1 1
```

#Replacing elements in a data. frame First we locate the elements

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

4. Quality Control check

Check that everything is the correct class

```
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" ...
```

```
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 20.0
## 2        1 2012 SOUTH     1     TOTAL S1TOTAL  582   2.65  4.10  3.90 28.0
## 3        1 2012 SOUTH     1     TOTAL S1TOTAL 3111    1.5  1.70  0.85 17.0
## 4        1 2012 SOUTH     1     TOTAL S1TOTAL 3112   2.01  1.80  1.60 12.0
## 5        1 2012 SOUTH     1     TOTAL S1TOTAL 3113   1.75  1.84  1.42 13.0
## 6        1 2012 SOUTH     1     TOTAL S1TOTAL 3114   1.65  1.62  0.85 15.0
## 7        1 2012 SOUTH     1     TOTAL S1TOTAL 3115    1.2  1.95  0.90  9.0
## 8        1 2012 SOUTH     1     TOTAL S1TOTAL 3199   1.45  2.00  1.75 12.2
## 9        1 2012 SOUTH     1      MESO  S1MESO  941   1.87  2.15  1.82 13.0
## 10       1 2012 SOUTH     1      MESO  S1MESO  942   2.38  5.55  4.82 35.0
## 11       1 2012 SOUTH     1      MESO  S1MESO  943   2.58  4.90  4.24 24.0
## 12       1 2012 SOUTH     1      MESO  S1MESO  944   2.65  3.75  3.10 27.0
## 13       1 2012 SOUTH     1      MESO  S1MESO  946   2.35  2.34  2.05 20.0
## 14       1 2012 SOUTH     1      MESO  S1MESO  947   1.88  2.10  1.85 28.0
## 15       1 2012 SOUTH     1      MESO  S1MESO 3116   2.32  3.05  2.63 30.0
## 16       1 2012 SOUTH     1      MESO  S1MESO 3117   2.39  2.21  2.10 13.0
## 17       1 2012 SOUTH     1      MESO  S1MESO 3118    2.2  1.80  1.50 10.0
## 18       1 2012 SOUTH     1      MESO  S1MESO 3119   1.05  0.90  0.55  8.0
## 19       1 2012 SOUTH     1      MESO  S1MESO 3120      2  1.25  1.20 10.0
## 20       1 2012 SOUTH     1      MESO  S1MESO 3131   1.28  1.14  1.00 10.0
## 21       1 2012 SOUTH     2      OPEN  S2OPEN  341   dead    NA    NA   NA
## 22       1 2012 SOUTH     2     TOTAL S2TOTAL 3178    1.4  2.50  2.15 18.0
## 23       1 2012 SOUTH     2     TOTAL S2TOTAL  101    1.9  3.31  2.65 15.0
## 24       1 2012 SOUTH     2     TOTAL S2TOTAL  102   1.75  2.70  2.55 16.0
## 25       1 2012 SOUTH     2     TOTAL S2TOTAL  103    1.8  2.75  2.30 16.0
## 26       1 2012 SOUTH     2     TOTAL S2TOTAL  104    2.7  4.05  4.00 35.2
## 27       1 2012 SOUTH     2     TOTAL S2TOTAL  105   2.02  2.85  1.49 17.0
## 28       1 2012 SOUTH     2     TOTAL S2TOTAL  108    1.9  3.10  2.85 19.0
## 29       1 2012 SOUTH     2     TOTAL S2TOTAL  109   1.85  2.45  1.90 19.0
## 30       1 2012 SOUTH     2     TOTAL S2TOTAL  110   1.65  1.90  1.54 17.0
## 31       1 2012 SOUTH     2     TOTAL S2TOTAL  111    1.4  2.35  1.45 14.0
```

```
## 32       1 2012 SOUTH     2     TOTAL S2TOTAL  113    2.5  3.25  2.30 22.0
## 33       1 2012 SOUTH     2     TOTAL S2TOTAL  115   2.05  5.40  4.50 33.0
## 34       1 2012 SOUTH     2     TOTAL S2TOTAL  116   2.26  3.50  3.10 33.0
## 35       1 2012 SOUTH     2     TOTAL S2TOTAL  117   2.13  2.40  2.30 20.0
## 36       1 2012 SOUTH     2     TOTAL S2TOTAL  118    1.8  3.15  2.55 22.0
## 37       1 2012 SOUTH     2     TOTAL S2TOTAL 1211   1.85  2.00  2.27 20.0
## 38       1 2012 SOUTH     2     TOTAL S2TOTAL 1212    1.5  2.15  1.80 15.0
## 39       1 2012 SOUTH     2     TOTAL S2TOTAL 1213   1.87  2.34  2.05 13.0
## 40       1 2012 SOUTH     2     TOTAL S2TOTAL 1214   1.58  1.28  0.75 11.0
## 41       1 2012 SOUTH     2     TOTAL S2TOTAL 1215   2.05  2.10  1.75 17.0
## 42       1 2012 SOUTH     2     TOTAL S2TOTAL 1216   1.75  2.45  3.28 16.0
## 43       1 2012 SOUTH     2     TOTAL S2TOTAL 1217   1.49  1.50  1.45 13.0
## 44       1 2012 SOUTH     2     TOTAL S2TOTAL 1218   1.28  2.00  0.90 10.0
## 45       1 2012 SOUTH     2     TOTAL S2TOTAL 1219   1.49  2.35  1.65 13.0
## 46       1 2012 SOUTH     2     TOTAL S2TOTAL 1220   1.07  1.20  0.95 11.0
## 47       1 2012 SOUTH     2     TOTAL S2TOTAL 1231   1.48  1.25  1.20  9.0
## 48       1 2012 SOUTH     2     TOTAL S2TOTAL 1232   1.25  1.25  0.90 10.0
## 49       1 2012 SOUTH     2     TOTAL S2TOTAL 1233   1.41  1.41  1.40 14.0
## 50       1 2012 SOUTH     2     TOTAL S2TOTAL 1234    1.6  1.60  1.30 13.0
## 51       1 2012 SOUTH     2     TOTAL S2TOTAL 1235    1.2  1.20  1.30 14.0
## 52       1 2012 SOUTH     2     TOTAL S2TOTAL 1236   1.49  1.49  1.20  8.0
## 53       1 2012 SOUTH     2     TOTAL S2TOTAL 1237    1.5  1.50  1.50 14.0
## 54       1 2012 SOUTH     2     TOTAL S2TOTAL 1238   1.65  1.65  2.00 20.0
## 55       1 2012 SOUTH     2     TOTAL S2TOTAL 1239   1.13  1.13  1.20 10.0
## 56       1 2012 SOUTH     2     TOTAL S2TOTAL 1240   1.25  1.25  0.90 10.0
## 57       1 2012 SOUTH     2     TOTAL S2TOTAL 1251    1.1  1.20  1.10 10.0
## 58       1 2012 SOUTH     2     TOTAL S2TOTAL 1252    2.2  2.70  2.40 25.0
## 59       1 2012 SOUTH     2     TOTAL S2TOTAL 1253   1.45  1.65  1.25 10.0
## 60       1 2012 SOUTH     2     TOTAL S2TOTAL 1254    1.6  2.45  2.10 13.0
## 61       1 2012 SOUTH     2     TOTAL S2TOTAL 1255   1.55  2.40  1.80 13.0
## 62       1 2012 SOUTH     2     TOTAL S2TOTAL 1256    1.5  2.40  2.15 13.0
## 63       1 2012 SOUTH     2     TOTAL S2TOTAL 1257   1.03  1.20  1.00 10.0
## 64       1 2012 SOUTH     2     TOTAL S2TOTAL 1258   2.14  1.90  1.70 13.0
## 65       1 2012 SOUTH     2     TOTAL S2TOTAL 1259    1.2  1.90  1.65 12.0
## 66       1 2012 SOUTH     2     TOTAL S2TOTAL 1260   1.05  1.10  1.00  9.0
## 67       1 2012 SOUTH     2     TOTAL S2TOTAL 2131    1.8  2.60  2.40 15.0
## 68       1 2012 SOUTH     2     TOTAL S2TOTAL 2132    1.2  1.00  0.95  7.0
## 69       1 2012 SOUTH     2     TOTAL S2TOTAL 2133   1.75  1.40  1.10 10.0
## 70       1 2012 SOUTH     2     TOTAL S2TOTAL 2134   1.45  3.10  1.80 10.0
## 71       1 2012 SOUTH     2     TOTAL S2TOTAL 2135   1.17  1.20  1.10  5.0
## 72       1 2012 SOUTH     2     TOTAL S2TOTAL 2136   2.15  3.10  2.58 22.0
## 73       1 2012 SOUTH     2     TOTAL S2TOTAL 2137    1.7  1.70  1.40 12.0
## 74       1 2012 SOUTH     2     TOTAL S2TOTAL 3132   1.98  2.85  2.70 12.0
## 75       1 2012 SOUTH     2     TOTAL S2TOTAL 3133   1.26  1.95  1.75 17.0
## 76       1 2012 SOUTH     2     TOTAL S2TOTAL 3134   1.11  1.95  1.50 10.0
## 77       1 2012 SOUTH     2     TOTAL S2TOTAL 3135   1.14  1.32  1.05 10.0
## 78       1 2012 SOUTH     2     TOTAL S2TOTAL 3136   1.26  1.60  1.40 10.0
## 79       1 2012 SOUTH     2     TOTAL S2TOTAL 3137    1.3  1.40  0.80 10.0
## 80       1 2012 SOUTH     2     TOTAL S2TOTAL 3138   1.29  1.44  1.35 13.0
## 81       1 2012 SOUTH     2     TOTAL S2TOTAL 3139   1.31  1.35  1.15  7.0
## 82       1 2012 SOUTH     2     TOTAL S2TOTAL 3140   1.15  1.70  1.28 10.0
## 83       1 2012 SOUTH     2     TOTAL S2TOTAL 3151   1.87  3.40  1.85 15.0
## 84       1 2012 SOUTH     2     TOTAL S2TOTAL 3152   1.47  2.10  1.61  8.0
## 85       1 2012 SOUTH     2     TOTAL S2TOTAL 3153   1.05  1.79  1.50 10.0
```

```
## 86       1 2012 SOUTH     2     TOTAL S2TOTAL 3154    2.1  4.90  3.75 25.0
## 87       1 2012 SOUTH     2     TOTAL S2TOTAL 3155   1.99  1.80  1.35 13.0
## 88       1 2012 SOUTH     2     TOTAL S2TOTAL 3156   1.42  1.90  1.80 14.0
## 89       1 2012 SOUTH     2     TOTAL S2TOTAL 3157    1.5  2.11  1.75 12.0
## 90       1 2012 SOUTH     2     TOTAL S2TOTAL 3158   1.06  1.05  0.85  4.0
## 91       1 2012 SOUTH     2     TOTAL S2TOTAL 3159   1.49  1.50  1.15 13.0
## 92       1 2012 SOUTH     2     TOTAL S2TOTAL 3160    1.8  1.60  1.50 14.0
## 93       1 2012 SOUTH     2     TOTAL S2TOTAL 3171   1.93  1.74  1.20 14.0
## 94       1 2012 SOUTH     2     TOTAL S2TOTAL 3172    1.2  1.60  1.30 10.0
## 95       1 2012 SOUTH     2     TOTAL S2TOTAL 3173   1.65  1.25  1.10 11.0
## 96       1 2012 SOUTH     2     TOTAL S2TOTAL 3174   1.52  1.49  1.10 12.0
## 97       1 2012 SOUTH     2     TOTAL S2TOTAL 3175   1.43  2.05  1.54 13.0
## 98       1 2012 SOUTH     2     TOTAL S2TOTAL 3176   1.25  1.40  1.25 13.0
## 99       1 2012 SOUTH     2     TOTAL S2TOTAL 3177   1.88  2.65  2.64 20.0
## 100      1 2012 SOUTH     2     TOTAL S2TOTAL 3179   1.03  1.40  0.60 13.0
## 101      1 2012 SOUTH     2     TOTAL S2TOTAL 3180    1.1  1.30  1.20 10.0
## 102      1 2012 SOUTH     2     TOTAL S2TOTAL 3191    1.4  1.05  1.00 10.0
## 103      1 2012 SOUTH     2     TOTAL S2TOTAL 3192   1.05  1.55  0.90 10.0
## 104      1 2012 SOUTH     2     TOTAL S2TOTAL 3193   1.18  1.20  1.00  7.0
## 105      1 2012 SOUTH     2     TOTAL S2TOTAL 3194    1.4  1.30  1.85 13.0
## 106      1 2012 SOUTH     2     TOTAL S2TOTAL 3195   1.37  2.67  2.19 19.0
## 107      1 2012 SOUTH     2     TOTAL S2TOTAL 3196   1.32  2.15  1.55 11.0
## 108      1 2012 SOUTH     2      MEGA  S2MEGA  182   1.55  2.20  1.20 20.0
## 109      1 2012 SOUTH     2      MEGA  S2MEGA  183    1.3  1.80  0.90  8.0
## 110      1 2012 SOUTH     2      MEGA  S2MEGA  184   1.24  1.20  1.20 25.0
## 111      1 2012 SOUTH     2      MEGA  S2MEGA  185    1.5  2.10  1.75 16.0
## 112      1 2012 SOUTH     2      MEGA  S2MEGA  186   1.65  2.50  2.20 15.0
## 113      1 2012 SOUTH     2      MEGA  S2MEGA  187   2.17  2.00  1.20 15.0
## 114      1 2012 SOUTH     2      MEGA  S2MEGA  188   1.28  1.60  1.50 10.0
## 115      1 2012 SOUTH     2      MEGA  S2MEGA  189   1.07  1.50  1.50 10.0
## 116      1 2012 SOUTH     2      MEGA  S2MEGA  190   0.67  1.00  0.80  8.0
## 117      1 2012 SOUTH     2      MEGA  S2MEGA  191   0.68  0.70  0.60  4.0
## 118      1 2012 SOUTH     2      MEGA  S2MEGA  192   1.87  1.60  1.40  9.0
## 119      1 2012 SOUTH     2      MEGA  S2MEGA  193   1.35  1.90  1.50 14.0
## 120      1 2012 SOUTH     2      MEGA  S2MEGA  194   1.75  2.10  2.10 15.0
## 121      1 2012 SOUTH     2      MESO  S2MESO  462   1.75  3.30  2.50 23.0
## 122      1 2012 SOUTH     2      MESO  S2MESO  463   1.64  2.30  2.00 14.0
## 123      1 2012 SOUTH     2      MESO  S2MESO 2138   1.42  0.90  0.80 10.0
## 124      1 2012 SOUTH     3      OPEN  S3OPEN 1301   dead    NA    NA   NA
## 125      1 2012 SOUTH     3      OPEN  S3OPEN 1302    0.9  1.30  1.10 11.0
## 126      1 2012 SOUTH     3     TOTAL S3TOTAL 1061   dead    NA    NA   NA
## 127      1 2012 SOUTH     3     TOTAL S3TOTAL 1062    1.8  2.60  2.60 15.0
## 128      1 2012 SOUTH     3     TOTAL S3TOTAL 1063   2.47  3.10  2.20 18.0
## 129      1 2012 SOUTH     3     TOTAL S3TOTAL 1064   2.15  1.60  1.10 17.0
## 130      1 2012 SOUTH     3     TOTAL S3TOTAL 1066    1.7  2.50  2.15 15.0
## 131      1 2012 SOUTH     3     TOTAL S3TOTAL 1066    1.9  1.80  1.50 20.0
## 132      1 2012 SOUTH     3     TOTAL S3TOTAL 1067   1.95  2.10  1.90 13.0
## 133      1 2012 SOUTH     3     TOTAL S3TOTAL 1068    1.8  1.70  1.40 13.0
## 134      1 2012 SOUTH     3     TOTAL S3TOTAL 1069    1.4  2.00  1.60 14.0
## 135      1 2012 SOUTH     3     TOTAL S3TOTAL 1070      1  1.30  1.20  7.0
## 136      1 2012 SOUTH     3     TOTAL S3TOTAL 2139   1.75  1.20  1.10 13.0
## 137      1 2012 SOUTH     3     TOTAL S3TOTAL 2140   1.28  1.50  0.95  4.0
## 138      1 2012 SOUTH     3     TOTAL S3TOTAL 2151      1  1.40  1.20  4.0
## 139      1 2012 SOUTH     3     TOTAL S3TOTAL 2152   1.45  1.50  1.30 10.0
```

```
## 140      1 2012 SOUTH     3     TOTAL S3TOTAL 2153      1  1.00  0.75  8.0
## 141      1 2012 SOUTH     3     TOTAL S3TOTAL 2154   1.03  1.00  0.90  6.0
## 142      1 2012 SOUTH     3     TOTAL S3TOTAL 2155   1.51  2.00  1.80 12.0
## 143      1 2012 SOUTH     3     TOTAL S3TOTAL 2156   1.17  1.10  0.90 10.0
## 144      1 2012 SOUTH     3     TOTAL S3TOTAL 2157   1.33  1.90  1.85 14.0
## 145      1 2012 SOUTH     3     TOTAL S3TOTAL 2158    1.3  1.10  0.85  8.0
## 146      1 2012 SOUTH     3     TOTAL S3TOTAL 2159   1.13  1.10  0.90 10.0
## 147      1 2012 SOUTH     3     TOTAL S3TOTAL 2160   1.58  1.40  1.40 13.0
## 148      1 2012 SOUTH     3     TOTAL S3TOTAL 2171   1.06  1.40  1.00  5.0
## 149      1 2012 SOUTH     3     TOTAL S3TOTAL 2172   1.05  1.40  0.95  7.0
## 150      1 2012 SOUTH     3     TOTAL S3TOTAL 2173   1.45  1.60  1.10  6.0
## 151      1 2012 SOUTH     3     TOTAL S3TOTAL 2174   1.15  1.10  0.90  5.0
## 152      1 2012 SOUTH     3     TOTAL S3TOTAL 2175   1.42  1.45  1.30 13.0
## 153      1 2012 SOUTH     3     TOTAL S3TOTAL 2176   1.02  1.20  1.00  8.0
## 154      1 2012 SOUTH     3     TOTAL S3TOTAL 2177    1.4  1.20  1.00  9.0
## 155      1 2012 SOUTH     3     TOTAL S3TOTAL 2178   1.45  2.10  2.05 15.0
## 156      1 2012 SOUTH     3      MESO  S3MESO 1421   1.95  2.20  1.60 13.0
## 157      1 2012 SOUTH     3      MESO  S3MESO 1422   dead    NA    NA   NA
##     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
## 7         0    0      0    CS
## 8         0    0     25    CS
## 9         0    0      0    TP
## 10        0    0     50    TP
## 11        0    0      5    CS
## 12        0    0     60    TP
## 13        0    0     60    TP
## 14        2    0     60    CS
## 15        2    0      0    CS
## 16        0    0      0    TP
## 17        0    0      0    TP
## 18        0    0      0    CS
## 19        0    0      0    CM
## 20        0    0      0    TP
## 21       NA   NA     NA
## 22        0    0      5    CS
## 23        0    0     45    CS
## 24       40   50     35    CS
## 25        8    2     65    CS
## 26        0    0     20    TP
## 27        0    0     70    CS
## 28        0    0    125    CM
## 29        0    0    200    CM
## 30        0    0     10    CS
## 31        0    0      0    CS
## 32        0    0     35    TP
## 33        0    0    300    CM
## 34        2    2    100    CS
## 35        0    0     30    CM
```

```
## 36        0    0     50    TP
## 37        0    0     10    CM
## 38        0    0     25    CS
## 39        0    0     15    TP
## 40        0    0      0    TP
## 41        0    0     15    TP
## 42        0    0      0    TP
## 43        0    0     40    TP
## 44        0    0      0    TP
## 45        0    0     15    CM
## 46        0    0      0    CM
## 47        0    0      0    TP
## 48        0    0      0    TP
## 49        0    0      1    TP
## 50        0    0     20    TP
## 51        0    0      0    TP
## 52        0    0      0    TP
## 53        0    0     20    TP
## 54        0    0      0    TP
## 55        0    0      0    CN
## 56        0    0      0    CN
## 57        0    0      0    TP
## 58        0    0      5    TP
## 59        0    0      0    TP
## 60        0    0     25    TP
## 61        0    0     25    TP
## 62        0    0     20    TP
## 63        0    0      0    TP
## 64        0    0     10    CS
## 65        1    0     25    CS
## 66        0    0      0    TP
## 67        0    0     10    TP
## 68        0    0      0    TP
## 69        0    0      0    TP
## 70        0    0      0    TP
## 71        0    0      0    TP
## 72        0    0      0    CS
## 73        0    0      0    CS
## 74        0    0     25 AB_TP
## 75        0    0      0    TP
## 76        0    0      0    TP
## 77        0    0      0    TP
## 78        0    0      0    CS
## 79        0    0      0    CS
## 80        0    0      0    CS
## 81        0    0      0    CS
## 82        0    0      5    CS
## 83        6    0      0    CS
## 84        0    0      0    CS
## 85        0    0      1    CS
## 86        0    0     25    CS
## 87        0    0      0    CS
## 88        0    0      0    CS
## 89        0    0     10    CS
```

```
## 90        0    0      0    CS
## 91        0    0     35    CS
## 92        0    0      0    CS
## 93        0    0      0    CS
## 94        0    0      0    CS
## 95        0    0      0    CS
## 96        0    0     20    CS
## 97        0    0      0    CS
## 98        0    0      0    CM
## 99        0    0    100    CM
## 100       0    0      0    CS
## 101       0    0      0    CS
## 102       0    0      0    CS
## 103       0    0      0    CM
## 104       0    0      0    TP
## 105       0    0     30    CS
## 106       0    0     50    TP
## 107       0    0     10    CS
## 108       0    0      0    CS
## 109       0    0     15    CS
## 110       0    0     10    CS
## 111       5    0    200    CS
## 112       0    0     80    CS
## 113       0    0    150    TP
## 114       0    0     40    TP
## 115       0    0     60    TP
## 116       0    0      0    CS
## 117       0    0      0    TP
## 118       0    0     40    CS
## 119       0    0     20    CS
## 120       0    0     75    TP
## 121       0    0     20    CM
## 122       0    0      0    TP
## 123       0    0      0     E
## 124      NA   NA     NA
## 125       0    0      0    TP
## 126      NA   NA     NA
## 127       0    0     50    TP
## 128       0    0      0    TP
## 129       0    0      0    TP
## 130       0    0      2    TP
## 131       0    0     25    TP
## 132       0    0      0    TP
## 133       0    0      0    TP
## 134       0    0      0    TP
## 135       0    0      0    TP
## 136       0    0      0    TP
## 137       0    0      0    TP
## 138       0    0      0    TP
## 139       0    0      0    TP
## 140       0    0      0    TP
## 141       0    0      0    TP
## 142       0    0      0    TP
## 143       0    0      0    TP
```

```
## 144       0    0      0    TP
## 145       0    0      0    TP
## 146       0    0      0    TP
## 147       0    0      0    TP
## 148       0    0      8    TP
## 149       0    0      0    TP
## 150       0    0      0    TP
## 151       0    0      0    TP
## 152       0    0      0    TP
## 153       0    0      0    TP
## 154       0    0      0    TP
## 155       0    0     20    TP
## 156       0    0      2    CS
## 157      NA   NA     NA
```

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

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

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

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

```
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"
```

```
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
```

Coercion in R computer language means that a value was forced to be a type.

We identified that height should be numeric and is instead character

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

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

```
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
```

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

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

```
head(acacia)
```

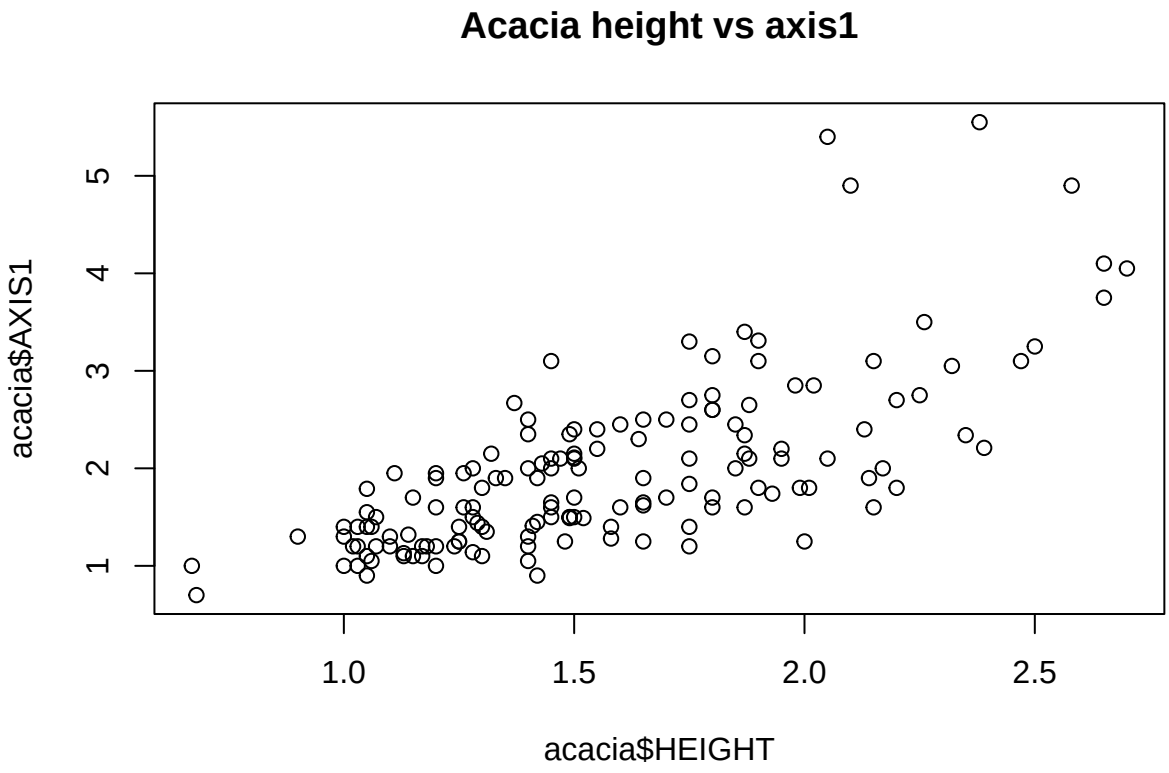
```
##   SURVEY YEAR  SITE BLOCK TREATMENT    PLOT   ID HEIGHT AXIS1 AXIS2 CIRC
## 1      1 2012 SOUTH     1     TOTAL S1TOTAL  581   2.25  2.75  2.15   20
## 2      1 2012 SOUTH     1     TOTAL S1TOTAL  582   2.65  4.10  3.90   28
## 3      1 2012 SOUTH     1     TOTAL S1TOTAL 3111   1.50  1.70  0.85   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
```

```
#View(acacia)
```

5 Plotting data with ggplot2

Regular way to plot in R

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

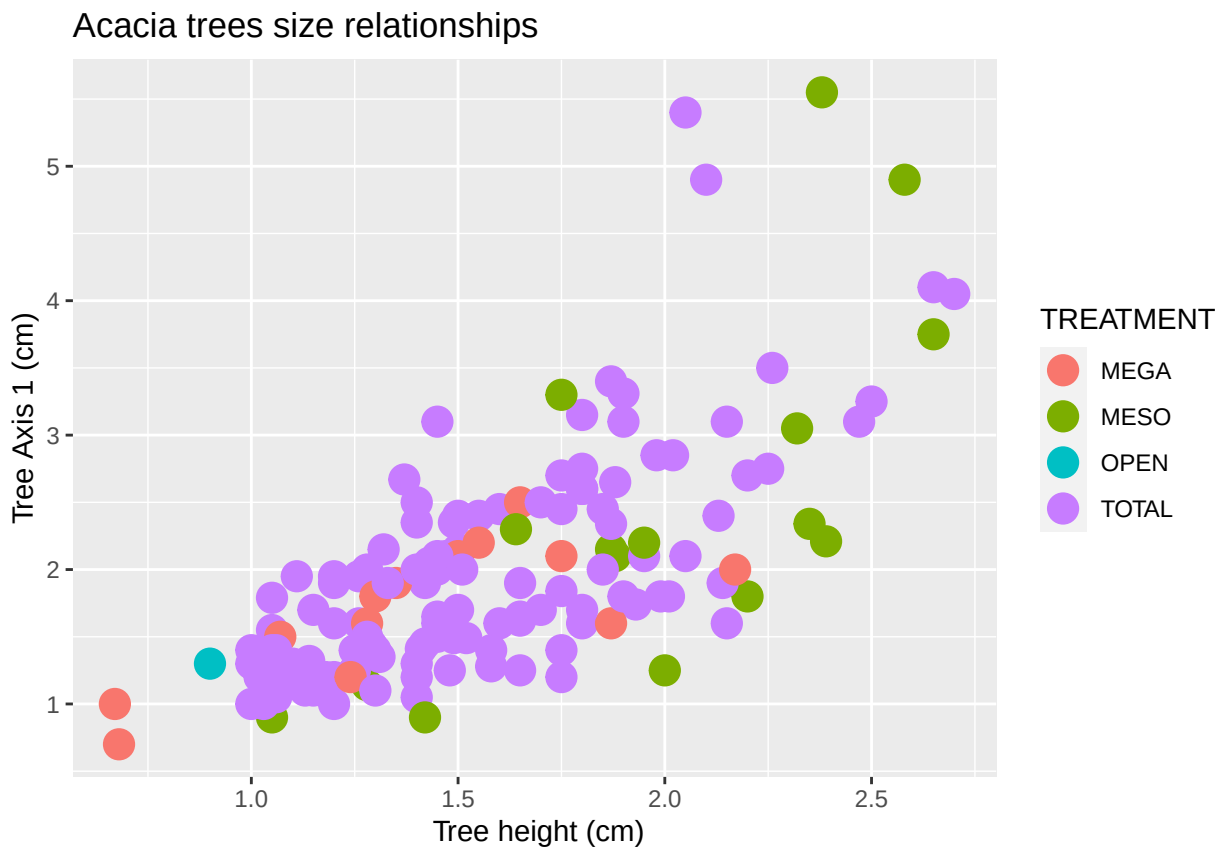



```
?legend
```

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 (cm)", y = "Tree Axis 1 (cm)", title = "Acacia trees size relationships")
```

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




```
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"
```