UHURU data set visualization

2023-02-23

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 t

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
## 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)
```

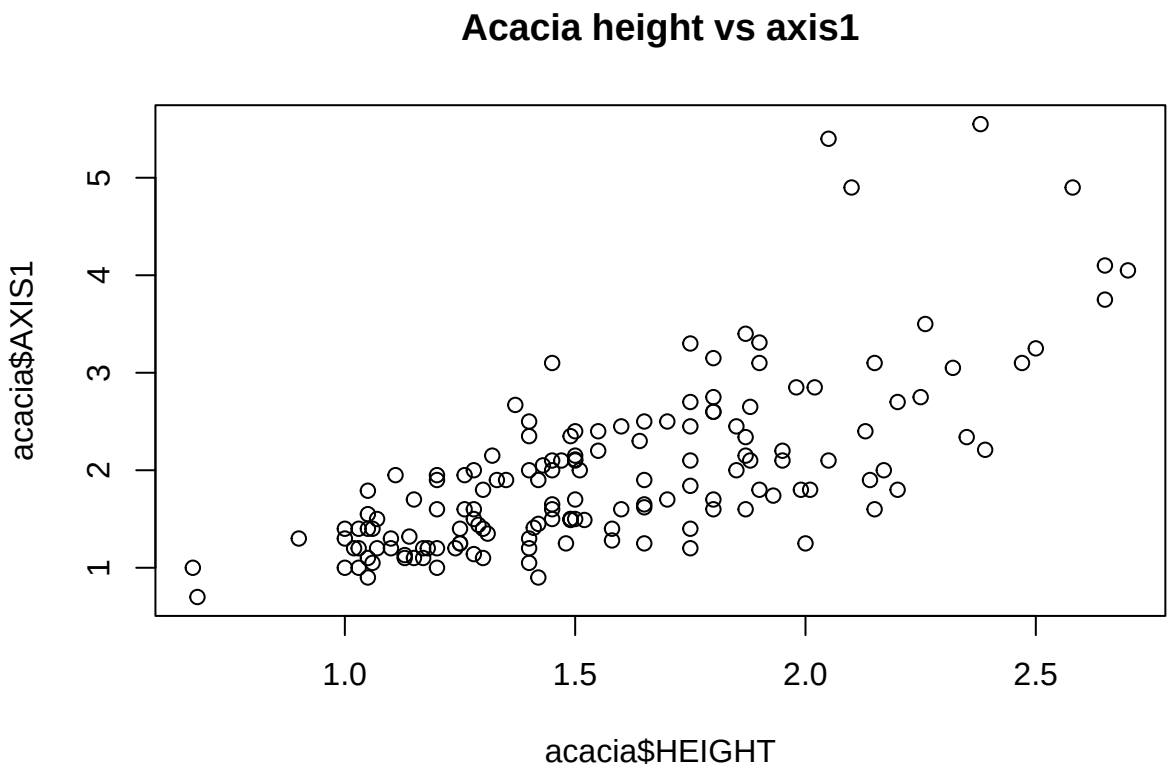
```
##   SURVEY YEAR  SITE BLOCK TREATMENT    PLOT   ID HEIGHT AXIS1 AXIS2 CIRC
## 1      1 2012 SOUTH     1     TOTAL S1TOTAL  581   2.25  2.75  2.15   20
## 2      1 2012 SOUTH     1     TOTAL S1TOTAL  582   2.65  4.10  3.90   28
## 3      1 2012 SOUTH     1     TOTAL S1TOTAL 3111   1.50  1.70  0.85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

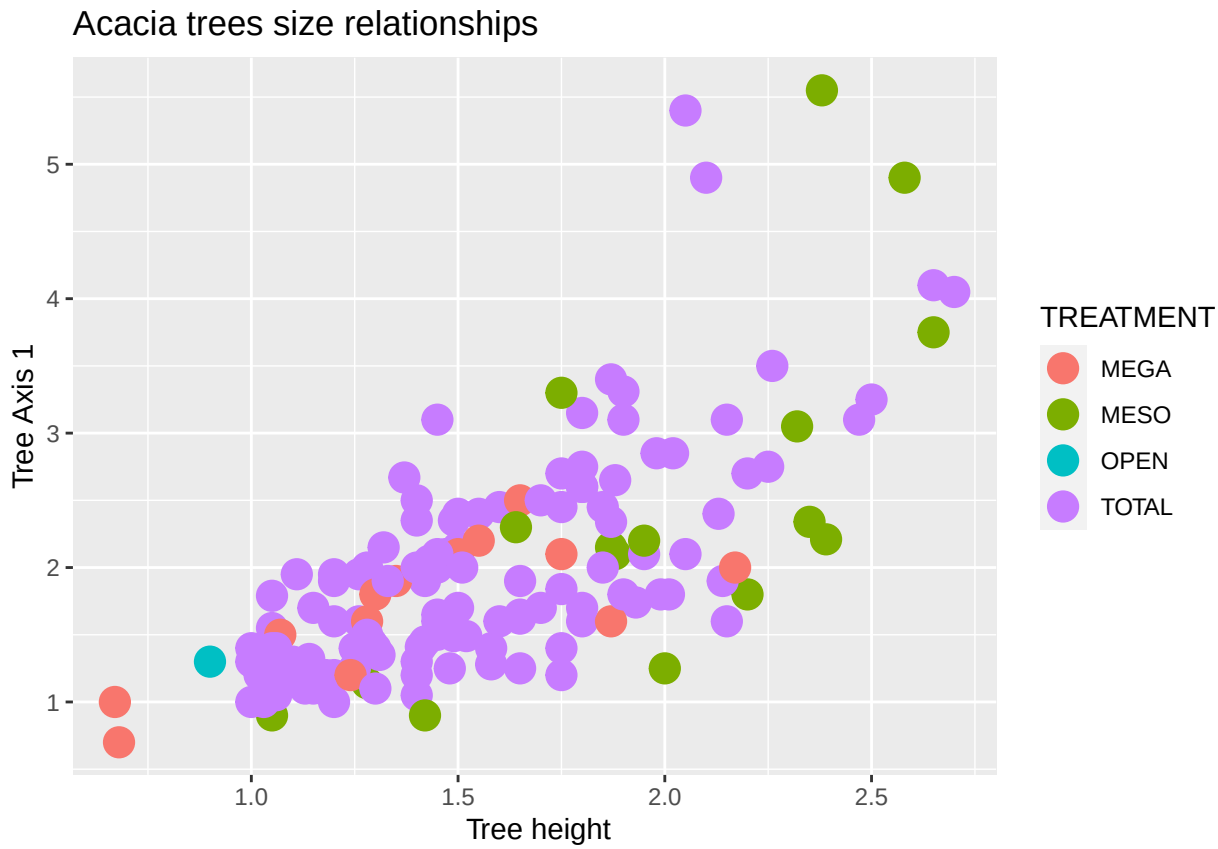



```
?legend
```

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", y = "Tree Axis 1", 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"
```