Aula 1

O que é R

R é um ambiente de programação de métodos estatísticos. Derivado do software S, pelo qual John Chambers venceu ACM Software Systems award. A desvantagem é que usando o R pode requerir mudanças na forma como analisar, visualizar e manipular dados. R é baseado em linhas de comandos.

O R base tem menos pacotes estatísticos inclusos em comparação com SPSS ou SAS, mas ele é muito mais fácil de extendê-lo.

Atulamente, existem disponiveis no website CRAN aproximadamente 10 000 pacotes (Revolutionanalytics, 2017)

R como calculadora

```
2 + 2
```

```
## [1] 4
```
```
5 - 10
```

```
## [1] -5
```
```
3 * 2
```

```
## [1] 6
```
```
80 / 100
```

```
## [1] 0.8
```
```
2^10
```

```
## [1] 1024
```
```
sqrt(49)
```

```
## [1] 7
```
```
1/ 0
```

```
## [1] Inf
```
```
sqrt(-1)
```

```
## Warning in sqrt(-1): NaNs produzidos
```
```
## [1] NaN
```
```
x = 3
```

```
y = 2
```

```
x + y
```

```
## [1] 5
```

```r
round(pi,6)
```

```
## [1] 3.141593
```

Lendo dados

Arquivos .txt

A função "read.table()" é u uma das principais funções do R; Importa dados para memoria RAM do computador. Cuidado ao armazenar grande quantidade de dados! Principais argumentos da função: file, header, sep, row.names, nrows.

Exemplo arquivo: "softdrin.txt"

```r
dados = read.table(file = "softdrin.txt", header = TRUE)
head(dados)
```

```
##    Time Cases Distance
## 1 16.68     7      560
## 2 11.50     3      220
## 3 12.03     3      340
## 4 14.88     4       80
## 5 13.75     6      150
## 6 18.11     7      330
```

Arquivos .csv

As funções : `read.csv()''` e`read.csv2()`'' funcionam de forma similar a função `read.table()''`; read.csv()''considera a virgula como separador das colunas e o ponto como separador dos numeros decimais, "read.csv2()" considera o ponto e virgula como separador das colunas e a virgula como separador dos numeros decimais.

Exemplos: Arquivos "forestfires.csv" and forestfires.csv2}

```r
dados_csv = read.csv(file = "forestfires.csv", header = TRUE)
head(dados_csv)
```

```
##   X Y month day FFMC  DMC    DC  ISI temp RH wind rain area
## 1 7 5   mar fri 86.2 26.2  94.3  5.1  8.2 51  6.7  0.0    0
## 2 7 4   oct tue 90.6 35.4 669.1  6.7 18.0 33  0.9  0.0    0
## 3 7 4   oct sat 90.6 43.7 686.9  6.7 14.6 33  1.3  0.0    0
## 4 8 6   mar fri 91.7 33.3  77.5  9.0  8.3 97  4.0  0.2    0
## 5 8 6   mar sun 89.3 51.3 102.2  9.6 11.4 99  1.8  0.0    0
## 6 8 6   aug sun 92.3 85.3 488.0 14.7 22.2 29  5.4  0.0    0
```

```r
dados_csv2 = read.csv2(file = "forestfires2.csv", header = TRUE)
head(dados_csv2)
```

```
##   X Y month day FFMC  DMC    DC  ISI temp RH wind rain area
## 1 7 5   mar fri 86.2 26.2  94.3  5.1  8.2 51  6.7  0.0    0
## 2 7 4   oct tue 90.6 35.4 669.1  6.7 18.0 33  0.9  0.0    0
## 3 7 4   oct sat 90.6 43.7 686.9  6.7 14.6 33  1.3  0.0    0
## 4 8 6   mar fri 91.7 33.3  77.5  9.0  8.3 97  4.0  0.2    0
## 5 8 6   mar sun 89.3 51.3 102.2  9.6 11.4 99  1.8  0.0    0
## 6 8 6   aug sun 92.3 85.3 488.0 14.7 22.2 29  5.4  0.0    0
```

**Obs:

"read.table()" pode ler arquivos diretamente da internet

```
fl2000<-read.table("http://faculty.washington.edu/tlumley/data/FLvote.dat", header=TRUE)
head(fl2000)
```

```
##              GORE    BUSH BUCHANAN NADER NELSON MCCOLLUM LOGAN
## ALACHUA     47365   34124      263  3226  49091    31060  1735
## BAKER        2392    5610       73    53   3104     4578    50
## BAY         18850   38637      248   828  22914    33901   358
## BRADFORD     3075    5414       65    84   4118     4699    92
## BREVARD     97318  115185      570  4470 112255    98813  2304
## BROWARD    386565  177323      788  7101 377081   174980  6166
```

Objetos

Vetores

Conjunto de elementos do mesmo tipo (logical, numeric, integer, double character)

    1. A forma mais simples de se criar um vetor é usar a função de concatenação "c()".

```
value.num  = c(3,4,2,6,20)

value.num
```

```
## [1]  3  4  2  6 20
```

```
value.char = c("koala", "kangaroo")

value.char
```

```
## [1] "koala"    "kangaroo"
```

```
value.logical = c(FALSE, FALSE, TRUE, TRUE)

value.logical
```

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

    2. Segunda maneira de criar vetor no R: usando a função "scan"

```
values = scan(text="
2
3
4
5"
)

values
```

```
## [1] 2 3 4 5
```

    3. Outra opção usando comando "rep"

```
rep(1,5)
```

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

```r
rep(c(1,2),3)
```

```
## [1] 1 2 1 2 1 2
```

```r
rep(c(1,6),each=3)
```

```
## [1] 1 1 1 6 6 6
```

```r
rep(c(1,6),c(3,5))
```

```
## [1] 1 1 1 6 6 6 6 6
```

4. Outra opção usando comando "seq"

```r
seq(from=1,to=5)
```

```
## [1] 1 2 3 4 5
```

```r
seq(from=1, to=5, by=0.1)
```

```
##  [1] 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6
## [18] 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3
## [35] 4.4 4.5 4.6 4.7 4.8 4.9 5.0
```

```r
seq(from=1, to=5, length=10)
```

```
##  [1] 1.000000 1.444444 1.888889 2.333333 2.777778 3.222222 3.666667
##  [8] 4.111111 4.555556 5.000000
```

```r
rep(seq(from=1, to=5, length=10),each=2)
```

```
##  [1] 1.000000 1.000000 1.444444 1.444444 1.888889 1.888889 2.333333
##  [8] 2.333333 2.777778 2.777778 3.222222 3.222222 3.666667 3.666667
## [15] 4.111111 4.111111 4.555556 4.555556 5.000000 5.000000
```

5. Outra opção usando comando ":"

```r
1:5
```

```
## [1] 1 2 3 4 5
```

```r
c(1:5,10)
```

```
## [1]  1  2  3  4  5 10
```

Operações com Vetores

```r
x = 1:4

y = 5:8

x + y
```

```
## [1]  6  8 10 12
```

```r
2*x +1
```

```
## [1] 3 5 7 9
```

```r
x * y
```

```
## [1]  5 12 21 32
```

4

```r
x / y
```

```
## [1] 0.2000000 0.3333333 0.4285714 0.5000000
```

```r
log(x)
```

```
## [1] 0.0000000 0.6931472 1.0986123 1.3862944
```

```r
log(x,10)
```

```
## [1] 0.0000000 0.3010300 0.4771213 0.6020600
```

```r
sum(x)
```

```
## [1] 10
```

```r
mean(x)
```

```
## [1] 2.5
```

```r
prod(x)
```

```
## [1] 24
```

```r
var(x)
```

```
## [1] 1.666667
```

Matriz

Conjunto de elementos dispostos em linhas e colunas, em que todos os elementos são do mesmo tipo

```r
mat.num  = matrix(c(1:16),4,4)

mat.num
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    5    9   13
## [2,]    2    6   10   14
## [3,]    3    7   11   15
## [4,]    4    8   12   16
```

```r
mat.char = matrix(LETTERS[1:4],2,2)

mat.char
```

```
##      [,1] [,2]
## [1,] "A"  "C"
## [2,] "B"  "D"
```

Manipulando Matrizes

```r
#Criando nomes para as linhas de uma matriz

rownames(mat.num) = c("Sao Paulo", "Americana", "Piracicaba", "Madson" )

colnames(mat.num) = 1:4
```

```
mat.num
```

```
##            1 2   3   4
## Sao Paulo  1 5   9  13
## Americana  2 6  10  14
## Piracicaba 3 7  11  15
## Madson     4 8  12  16
```

```
#Multiplicacao elemento a elemento

mat.num2 = diag(seq(10,40,by=10))

mat.num2
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   10    0    0    0
## [2,]    0   20    0    0
## [3,]    0    0   30    0
## [4,]    0    0    0   40
```

```
mat.num3 = mat.num * mat.num2

mat.num3
```

```
##             1   2   3   4
## Sao Paulo  10   0   0   0
## Americana   0 120   0   0
## Piracicaba  0   0 330   0
## Madson      0   0   0 640
```

```
#Multiplicacao de Matrizes

iden = diag(4)

iden
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    0    0    0
## [2,]    0    1    0    0
## [3,]    0    0    1    0
## [4,]    0    0    0    1
```

```
mat.num%*%iden
```

```
##            [,1] [,2] [,3] [,4]
## Sao Paulo     1    5    9   13
## Americana     2    6   10   14
## Piracicaba    3    7   11   15
## Madson        4    8   12   16
```

```
#Acessando elementos das matrizes

#Um elemento
mat.num[1,1]
```

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

```
#Linhas
mat.num[1,]
```

```
## 1  2  3  4
## 1  5  9 13
```

```
#Colunas
mat.num[,3]
```

```
##  Sao Paulo  Americana Piracicaba     Madson
##          9         10         11         12
```

```
#Sub Matrizes

mat.num[c(1,3,4), c(2,1,4)]
```

```
##           2 1  4
## Sao Paulo  5 1 13
## Piracicaba 7 3 15
## Madson     8 4 16
```

```
mat.num[c(T,F,T,T), c(T,T,F,T)]
```

```
##           1 2  4
## Sao Paulo  1 5 13
## Piracicaba 3 7 15
## Madson     4 8 16
```

```
mat.num[-c(1,3,4), -c(2,1,4)]
```

```
## [1] 10
```

Data.frames

São Similares as matrizes no entanto permite que as colunas tenham diferentes tipos

```
data(iris)
```

```
iris
```

```
##    Sepal.Length Sepal.Width Petal.Length Petal.Width   Species
## 1           5.1         3.5          1.4         0.2    setosa
## 2           4.9         3.0          1.4         0.2    setosa
## 3           4.7         3.2          1.3         0.2    setosa
## 4           4.6         3.1          1.5         0.2    setosa
## 5           5.0         3.6          1.4         0.2    setosa
## 6           5.4         3.9          1.7         0.4    setosa
## 7           4.6         3.4          1.4         0.3    setosa
## 8           5.0         3.4          1.5         0.2    setosa
## 9           4.4         2.9          1.4         0.2    setosa
## 10          4.9         3.1          1.5         0.1    setosa
## 11          5.4         3.7          1.5         0.2    setosa
## 12          4.8         3.4          1.6         0.2    setosa
## 13          4.8         3.0          1.4         0.1    setosa
## 14          4.3         3.0          1.1         0.1    setosa
## 15          5.8         4.0          1.2         0.2    setosa
## 16          5.7         4.4          1.5         0.4    setosa
## 17          5.4         3.9          1.3         0.4    setosa
```

```
## 18           5.1         3.5         1.4         0.3      setosa
## 19           5.7         3.8         1.7         0.3      setosa
## 20           5.1         3.8         1.5         0.3      setosa
## 21           5.4         3.4         1.7         0.2      setosa
## 22           5.1         3.7         1.5         0.4      setosa
## 23           4.6         3.6         1.0         0.2      setosa
## 24           5.1         3.3         1.7         0.5      setosa
## 25           4.8         3.4         1.9         0.2      setosa
## 26           5.0         3.0         1.6         0.2      setosa
## 27           5.0         3.4         1.6         0.4      setosa
## 28           5.2         3.5         1.5         0.2      setosa
## 29           5.2         3.4         1.4         0.2      setosa
## 30           4.7         3.2         1.6         0.2      setosa
## 31           4.8         3.1         1.6         0.2      setosa
## 32           5.4         3.4         1.5         0.4      setosa
## 33           5.2         4.1         1.5         0.1      setosa
## 34           5.5         4.2         1.4         0.2      setosa
## 35           4.9         3.1         1.5         0.2      setosa
## 36           5.0         3.2         1.2         0.2      setosa
## 37           5.5         3.5         1.3         0.2      setosa
## 38           4.9         3.6         1.4         0.1      setosa
## 39           4.4         3.0         1.3         0.2      setosa
## 40           5.1         3.4         1.5         0.2      setosa
## 41           5.0         3.5         1.3         0.3      setosa
## 42           4.5         2.3         1.3         0.3      setosa
## 43           4.4         3.2         1.3         0.2      setosa
## 44           5.0         3.5         1.6         0.6      setosa
## 45           5.1         3.8         1.9         0.4      setosa
## 46           4.8         3.0         1.4         0.3      setosa
## 47           5.1         3.8         1.6         0.2      setosa
## 48           4.6         3.2         1.4         0.2      setosa
## 49           5.3         3.7         1.5         0.2      setosa
## 50           5.0         3.3         1.4         0.2      setosa
## 51           7.0         3.2         4.7         1.4 versicolor
## 52           6.4         3.2         4.5         1.5 versicolor
## 53           6.9         3.1         4.9         1.5 versicolor
## 54           5.5         2.3         4.0         1.3 versicolor
## 55           6.5         2.8         4.6         1.5 versicolor
## 56           5.7         2.8         4.5         1.3 versicolor
## 57           6.3         3.3         4.7         1.6 versicolor
## 58           4.9         2.4         3.3         1.0 versicolor
## 59           6.6         2.9         4.6         1.3 versicolor
## 60           5.2         2.7         3.9         1.4 versicolor
## 61           5.0         2.0         3.5         1.0 versicolor
## 62           5.9         3.0         4.2         1.5 versicolor
## 63           6.0         2.2         4.0         1.0 versicolor
## 64           6.1         2.9         4.7         1.4 versicolor
## 65           5.6         2.9         3.6         1.3 versicolor
## 66           6.7         3.1         4.4         1.4 versicolor
## 67           5.6         3.0         4.5         1.5 versicolor
## 68           5.8         2.7         4.1         1.0 versicolor
## 69           6.2         2.2         4.5         1.5 versicolor
## 70           5.6         2.5         3.9         1.1 versicolor
## 71           5.9         3.2         4.8         1.8 versicolor
```

```
## 72             6.1         2.8         4.0         1.3 versicolor
## 73             6.3         2.5         4.9         1.5 versicolor
## 74             6.1         2.8         4.7         1.2 versicolor
## 75             6.4         2.9         4.3         1.3 versicolor
## 76             6.6         3.0         4.4         1.4 versicolor
## 77             6.8         2.8         4.8         1.4 versicolor
## 78             6.7         3.0         5.0         1.7 versicolor
## 79             6.0         2.9         4.5         1.5 versicolor
## 80             5.7         2.6         3.5         1.0 versicolor
## 81             5.5         2.4         3.8         1.1 versicolor
## 82             5.5         2.4         3.7         1.0 versicolor
## 83             5.8         2.7         3.9         1.2 versicolor
## 84             6.0         2.7         5.1         1.6 versicolor
## 85             5.4         3.0         4.5         1.5 versicolor
## 86             6.0         3.4         4.5         1.6 versicolor
## 87             6.7         3.1         4.7         1.5 versicolor
## 88             6.3         2.3         4.4         1.3 versicolor
## 89             5.6         3.0         4.1         1.3 versicolor
## 90             5.5         2.5         4.0         1.3 versicolor
## 91             5.5         2.6         4.4         1.2 versicolor
## 92             6.1         3.0         4.6         1.4 versicolor
## 93             5.8         2.6         4.0         1.2 versicolor
## 94             5.0         2.3         3.3         1.0 versicolor
## 95             5.6         2.7         4.2         1.3 versicolor
## 96             5.7         3.0         4.2         1.2 versicolor
## 97             5.7         2.9         4.2         1.3 versicolor
## 98             6.2         2.9         4.3         1.3 versicolor
## 99             5.1         2.5         3.0         1.1 versicolor
## 100            5.7         2.8         4.1         1.3 versicolor
## 101            6.3         3.3         6.0         2.5  virginica
## 102            5.8         2.7         5.1         1.9  virginica
## 103            7.1         3.0         5.9         2.1  virginica
## 104            6.3         2.9         5.6         1.8  virginica
## 105            6.5         3.0         5.8         2.2  virginica
## 106            7.6         3.0         6.6         2.1  virginica
## 107            4.9         2.5         4.5         1.7  virginica
## 108            7.3         2.9         6.3         1.8  virginica
## 109            6.7         2.5         5.8         1.8  virginica
## 110            7.2         3.6         6.1         2.5  virginica
## 111            6.5         3.2         5.1         2.0  virginica
## 112            6.4         2.7         5.3         1.9  virginica
## 113            6.8         3.0         5.5         2.1  virginica
## 114            5.7         2.5         5.0         2.0  virginica
## 115            5.8         2.8         5.1         2.4  virginica
## 116            6.4         3.2         5.3         2.3  virginica
## 117            6.5         3.0         5.5         1.8  virginica
## 118            7.7         3.8         6.7         2.2  virginica
## 119            7.7         2.6         6.9         2.3  virginica
## 120            6.0         2.2         5.0         1.5  virginica
## 121            6.9         3.2         5.7         2.3  virginica
## 122            5.6         2.8         4.9         2.0  virginica
## 123            7.7         2.8         6.7         2.0  virginica
## 124            6.3         2.7         4.9         1.8  virginica
## 125            6.7         3.3         5.7         2.1  virginica
```

```
## 126          7.2            3.2            6.0            1.8  virginica
## 127          6.2            2.8            4.8            1.8  virginica
## 128          6.1            3.0            4.9            1.8  virginica
## 129          6.4            2.8            5.6            2.1  virginica
## 130          7.2            3.0            5.8            1.6  virginica
## 131          7.4            2.8            6.1            1.9  virginica
## 132          7.9            3.8            6.4            2.0  virginica
## 133          6.4            2.8            5.6            2.2  virginica
## 134          6.3            2.8            5.1            1.5  virginica
## 135          6.1            2.6            5.6            1.4  virginica
## 136          7.7            3.0            6.1            2.3  virginica
## 137          6.3            3.4            5.6            2.4  virginica
## 138          6.4            3.1            5.5            1.8  virginica
## 139          6.0            3.0            4.8            1.8  virginica
## 140          6.9            3.1            5.4            2.1  virginica
## 141          6.7            3.1            5.6            2.4  virginica
## 142          6.9            3.1            5.1            2.3  virginica
## 143          5.8            2.7            5.1            1.9  virginica
## 144          6.8            3.2            5.9            2.3  virginica
## 145          6.7            3.3            5.7            2.5  virginica
## 146          6.7            3.0            5.2            2.3  virginica
## 147          6.3            2.5            5.0            1.9  virginica
## 148          6.5            3.0            5.2            2.0  virginica
## 149          6.2            3.4            5.4            2.3  virginica
## 150          5.9            3.0            5.1            1.8  virginica
```

```r
iris$Sepal.Length
```

```
##   [1] 5.1 4.9 4.7 4.6 5.0 5.4 4.6 5.0 4.4 4.9 5.4 4.8 4.8 4.3 5.8 5.7 5.4
##  [18] 5.1 5.7 5.1 5.4 5.1 4.6 5.1 4.8 5.0 5.0 5.2 5.2 4.7 4.8 5.4 5.2 5.5
##  [35] 4.9 5.0 5.5 4.9 4.4 5.1 5.0 4.5 4.4 5.0 5.1 4.8 5.1 4.6 5.3 5.0 7.0
##  [52] 6.4 6.9 5.5 6.5 5.7 6.3 4.9 6.6 5.2 5.0 5.9 6.0 6.1 5.6 6.7 5.6 5.8
##  [69] 6.2 5.6 5.9 6.1 6.3 6.1 6.4 6.6 6.8 6.7 6.0 5.7 5.5 5.5 5.8 6.0 5.4
##  [86] 6.0 6.7 6.3 5.6 5.5 5.5 6.1 5.8 5.0 5.6 5.7 5.7 6.2 5.1 5.7 6.3 5.8
## [103] 7.1 6.3 6.5 7.6 4.9 7.3 6.7 7.2 6.5 6.4 6.8 5.7 5.8 6.4 6.5 7.7 7.7
## [120] 6.0 6.9 5.6 7.7 6.3 6.7 7.2 6.2 6.1 6.4 7.2 7.4 7.9 6.4 6.3 6.1 7.7
## [137] 6.3 6.4 6.0 6.9 6.7 6.9 5.8 6.8 6.7 6.7 6.3 6.5 6.2 5.9
```

```r
iris$Renato = TRUE
```

```r
iris
```

```
##    Sepal.Length Sepal.Width Petal.Length Petal.Width   Species Renato
## 1           5.1         3.5          1.4         0.2    setosa   TRUE
## 2           4.9         3.0          1.4         0.2    setosa   TRUE
## 3           4.7         3.2          1.3         0.2    setosa   TRUE
## 4           4.6         3.1          1.5         0.2    setosa   TRUE
## 5           5.0         3.6          1.4         0.2    setosa   TRUE
## 6           5.4         3.9          1.7         0.4    setosa   TRUE
## 7           4.6         3.4          1.4         0.3    setosa   TRUE
## 8           5.0         3.4          1.5         0.2    setosa   TRUE
## 9           4.4         2.9          1.4         0.2    setosa   TRUE
## 10          4.9         3.1          1.5         0.1    setosa   TRUE
## 11          5.4         3.7          1.5         0.2    setosa   TRUE
## 12          4.8         3.4          1.6         0.2    setosa   TRUE
## 13          4.8         3.0          1.4         0.1    setosa   TRUE
```

```
## 14           4.3          3.0          1.1          0.1        setosa     TRUE
## 15           5.8          4.0          1.2          0.2        setosa     TRUE
## 16           5.7          4.4          1.5          0.4        setosa     TRUE
## 17           5.4          3.9          1.3          0.4        setosa     TRUE
## 18           5.1          3.5          1.4          0.3        setosa     TRUE
## 19           5.7          3.8          1.7          0.3        setosa     TRUE
## 20           5.1          3.8          1.5          0.3        setosa     TRUE
## 21           5.4          3.4          1.7          0.2        setosa     TRUE
## 22           5.1          3.7          1.5          0.4        setosa     TRUE
## 23           4.6          3.6          1.0          0.2        setosa     TRUE
## 24           5.1          3.3          1.7          0.5        setosa     TRUE
## 25           4.8          3.4          1.9          0.2        setosa     TRUE
## 26           5.0          3.0          1.6          0.2        setosa     TRUE
## 27           5.0          3.4          1.6          0.4        setosa     TRUE
## 28           5.2          3.5          1.5          0.2        setosa     TRUE
## 29           5.2          3.4          1.4          0.2        setosa     TRUE
## 30           4.7          3.2          1.6          0.2        setosa     TRUE
## 31           4.8          3.1          1.6          0.2        setosa     TRUE
## 32           5.4          3.4          1.5          0.4        setosa     TRUE
## 33           5.2          4.1          1.5          0.1        setosa     TRUE
## 34           5.5          4.2          1.4          0.2        setosa     TRUE
## 35           4.9          3.1          1.5          0.2        setosa     TRUE
## 36           5.0          3.2          1.2          0.2        setosa     TRUE
## 37           5.5          3.5          1.3          0.2        setosa     TRUE
## 38           4.9          3.6          1.4          0.1        setosa     TRUE
## 39           4.4          3.0          1.3          0.2        setosa     TRUE
## 40           5.1          3.4          1.5          0.2        setosa     TRUE
## 41           5.0          3.5          1.3          0.3        setosa     TRUE
## 42           4.5          2.3          1.3          0.3        setosa     TRUE
## 43           4.4          3.2          1.3          0.2        setosa     TRUE
## 44           5.0          3.5          1.6          0.6        setosa     TRUE
## 45           5.1          3.8          1.9          0.4        setosa     TRUE
## 46           4.8          3.0          1.4          0.3        setosa     TRUE
## 47           5.1          3.8          1.6          0.2        setosa     TRUE
## 48           4.6          3.2          1.4          0.2        setosa     TRUE
## 49           5.3          3.7          1.5          0.2        setosa     TRUE
## 50           5.0          3.3          1.4          0.2        setosa     TRUE
## 51           7.0          3.2          4.7          1.4 versicolor     TRUE
## 52           6.4          3.2          4.5          1.5 versicolor     TRUE
## 53           6.9          3.1          4.9          1.5 versicolor     TRUE
## 54           5.5          2.3          4.0          1.3 versicolor     TRUE
## 55           6.5          2.8          4.6          1.5 versicolor     TRUE
## 56           5.7          2.8          4.5          1.3 versicolor     TRUE
## 57           6.3          3.3          4.7          1.6 versicolor     TRUE
## 58           4.9          2.4          3.3          1.0 versicolor     TRUE
## 59           6.6          2.9          4.6          1.3 versicolor     TRUE
## 60           5.2          2.7          3.9          1.4 versicolor     TRUE
## 61           5.0          2.0          3.5          1.0 versicolor     TRUE
## 62           5.9          3.0          4.2          1.5 versicolor     TRUE
## 63           6.0          2.2          4.0          1.0 versicolor     TRUE
## 64           6.1          2.9          4.7          1.4 versicolor     TRUE
## 65           5.6          2.9          3.6          1.3 versicolor     TRUE
## 66           6.7          3.1          4.4          1.4 versicolor     TRUE
## 67           5.6          3.0          4.5          1.5 versicolor     TRUE
```

```
## 68           5.8           2.7           4.1           1.0 versicolor    TRUE
## 69           6.2           2.2           4.5           1.5 versicolor    TRUE
## 70           5.6           2.5           3.9           1.1 versicolor    TRUE
## 71           5.9           3.2           4.8           1.8 versicolor    TRUE
## 72           6.1           2.8           4.0           1.3 versicolor    TRUE
## 73           6.3           2.5           4.9           1.5 versicolor    TRUE
## 74           6.1           2.8           4.7           1.2 versicolor    TRUE
## 75           6.4           2.9           4.3           1.3 versicolor    TRUE
## 76           6.6           3.0           4.4           1.4 versicolor    TRUE
## 77           6.8           2.8           4.8           1.4 versicolor    TRUE
## 78           6.7           3.0           5.0           1.7 versicolor    TRUE
## 79           6.0           2.9           4.5           1.5 versicolor    TRUE
## 80           5.7           2.6           3.5           1.0 versicolor    TRUE
## 81           5.5           2.4           3.8           1.1 versicolor    TRUE
## 82           5.5           2.4           3.7           1.0 versicolor    TRUE
## 83           5.8           2.7           3.9           1.2 versicolor    TRUE
## 84           6.0           2.7           5.1           1.6 versicolor    TRUE
## 85           5.4           3.0           4.5           1.5 versicolor    TRUE
## 86           6.0           3.4           4.5           1.6 versicolor    TRUE
## 87           6.7           3.1           4.7           1.5 versicolor    TRUE
## 88           6.3           2.3           4.4           1.3 versicolor    TRUE
## 89           5.6           3.0           4.1           1.3 versicolor    TRUE
## 90           5.5           2.5           4.0           1.3 versicolor    TRUE
## 91           5.5           2.6           4.4           1.2 versicolor    TRUE
## 92           6.1           3.0           4.6           1.4 versicolor    TRUE
## 93           5.8           2.6           4.0           1.2 versicolor    TRUE
## 94           5.0           2.3           3.3           1.0 versicolor    TRUE
## 95           5.6           2.7           4.2           1.3 versicolor    TRUE
## 96           5.7           3.0           4.2           1.2 versicolor    TRUE
## 97           5.7           2.9           4.2           1.3 versicolor    TRUE
## 98           6.2           2.9           4.3           1.3 versicolor    TRUE
## 99           5.1           2.5           3.0           1.1 versicolor    TRUE
## 100          5.7           2.8           4.1           1.3 versicolor    TRUE
## 101          6.3           3.3           6.0           2.5  virginica    TRUE
## 102          5.8           2.7           5.1           1.9  virginica    TRUE
## 103          7.1           3.0           5.9           2.1  virginica    TRUE
## 104          6.3           2.9           5.6           1.8  virginica    TRUE
## 105          6.5           3.0           5.8           2.2  virginica    TRUE
## 106          7.6           3.0           6.6           2.1  virginica    TRUE
## 107          4.9           2.5           4.5           1.7  virginica    TRUE
## 108          7.3           2.9           6.3           1.8  virginica    TRUE
## 109          6.7           2.5           5.8           1.8  virginica    TRUE
## 110          7.2           3.6           6.1           2.5  virginica    TRUE
## 111          6.5           3.2           5.1           2.0  virginica    TRUE
## 112          6.4           2.7           5.3           1.9  virginica    TRUE
## 113          6.8           3.0           5.5           2.1  virginica    TRUE
## 114          5.7           2.5           5.0           2.0  virginica    TRUE
## 115          5.8           2.8           5.1           2.4  virginica    TRUE
## 116          6.4           3.2           5.3           2.3  virginica    TRUE
## 117          6.5           3.0           5.5           1.8  virginica    TRUE
## 118          7.7           3.8           6.7           2.2  virginica    TRUE
## 119          7.7           2.6           6.9           2.3  virginica    TRUE
## 120          6.0           2.2           5.0           1.5  virginica    TRUE
## 121          6.9           3.2           5.7           2.3  virginica    TRUE
```

```
## 122           5.6       2.8       4.9       2.0  virginica    TRUE
## 123           7.7       2.8       6.7       2.0  virginica    TRUE
## 124           6.3       2.7       4.9       1.8  virginica    TRUE
## 125           6.7       3.3       5.7       2.1  virginica    TRUE
## 126           7.2       3.2       6.0       1.8  virginica    TRUE
## 127           6.2       2.8       4.8       1.8  virginica    TRUE
## 128           6.1       3.0       4.9       1.8  virginica    TRUE
## 129           6.4       2.8       5.6       2.1  virginica    TRUE
## 130           7.2       3.0       5.8       1.6  virginica    TRUE
## 131           7.4       2.8       6.1       1.9  virginica    TRUE
## 132           7.9       3.8       6.4       2.0  virginica    TRUE
## 133           6.4       2.8       5.6       2.2  virginica    TRUE
## 134           6.3       2.8       5.1       1.5  virginica    TRUE
## 135           6.1       2.6       5.6       1.4  virginica    TRUE
## 136           7.7       3.0       6.1       2.3  virginica    TRUE
## 137           6.3       3.4       5.6       2.4  virginica    TRUE
## 138           6.4       3.1       5.5       1.8  virginica    TRUE
## 139           6.0       3.0       4.8       1.8  virginica    TRUE
## 140           6.9       3.1       5.4       2.1  virginica    TRUE
## 141           6.7       3.1       5.6       2.4  virginica    TRUE
## 142           6.9       3.1       5.1       2.3  virginica    TRUE
## 143           5.8       2.7       5.1       1.9  virginica    TRUE
## 144           6.8       3.2       5.9       2.3  virginica    TRUE
## 145           6.7       3.3       5.7       2.5  virginica    TRUE
## 146           6.7       3.0       5.2       2.3  virginica    TRUE
## 147           6.3       2.5       5.0       1.9  virginica    TRUE
## 148           6.5       3.0       5.2       2.0  virginica    TRUE
## 149           6.2       3.4       5.4       2.3  virginica    TRUE
## 150           5.9       3.0       5.1       1.8  virginica    TRUE
```

List

Generalização dos vetores no sentido que uma lista é uma coleção de objetos

```r
A = list(x = 1:4, y = matrix(1:4,2,2), w = dados, v = list(A=4,B=5))

A
```

```
## $x
## [1] 1 2 3 4
##
## $y
##      [,1] [,2]
## [1,]    1    3
## [2,]    2    4
##
## $w
##      Time Cases Distance
## 1  16.68     7      560
## 2  11.50     3      220
## 3  12.03     3      340
## 4  14.88     4       80
## 5  13.75     6      150
```

```
## 6  18.11     7      330
## 7   8.00     2      110
## 8  17.83     7      210
## 9  79.24    30     1460
## 10 21.50     5      605
## 11 40.33    16      688
## 12 21.00    10      215
## 13 13.50     4      255
## 14 19.75     6      462
## 15 24.00     9      448
## 16 29.00    10      776
## 17 15.35     6      200
## 18 19.00     7      132
## 19  9.50     3       36
## 20 35.10    17      770
## 21 17.90    10      140
## 22 52.32    26      810
## 23 18.75     9      450
## 24 19.83     8      635
## 25 10.75     4      150
##
## $v
## $v$A
## [1] 4
##
## $v$B
## [1] 5
```

```r
A[[1]]
```

```
## [1] 1 2 3 4
```

```r
A[[4]]
```

```
## $A
## [1] 4
##
## $B
## [1] 5
```

```r
A$x
```

```
## [1] 1 2 3 4
```

```r
A$y
```

```
##      [,1] [,2]
## [1,]    1    3
## [2,]    2    4
```

```r
B = list(s = 1:5, r = 2)

Q = c(A,B)

Q
```

```
## $x
## [1] 1 2 3 4
```

```
## 
## $y
##      [,1] [,2]
## [1,]    1    3
## [2,]    2    4
## 
## $w
##      Time Cases Distance
## 1   16.68     7      560
## 2   11.50     3      220
## 3   12.03     3      340
## 4   14.88     4       80
## 5   13.75     6      150
## 6   18.11     7      330
## 7    8.00     2      110
## 8   17.83     7      210
## 9   79.24    30     1460
## 10  21.50     5      605
## 11  40.33    16      688
## 12  21.00    10      215
## 13  13.50     4      255
## 14  19.75     6      462
## 15  24.00     9      448
## 16  29.00    10      776
## 17  15.35     6      200
## 18  19.00     7      132
## 19   9.50     3       36
## 20  35.10    17      770
## 21  17.90    10      140
## 22  52.32    26      810
## 23  18.75     9      450
## 24  19.83     8      635
## 25  10.75     4      150
## 
## $v
## $v$A
## [1] 4
## 
## $v$B
## [1] 5
## 
## 
## $s
## [1] 1 2 3 4 5
## 
## $r
## [1] 2
```