

Objects & Functions

The R Bootcamp
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3 Object types for data

R has 3 main data objects...

list - R's multi-purpose container

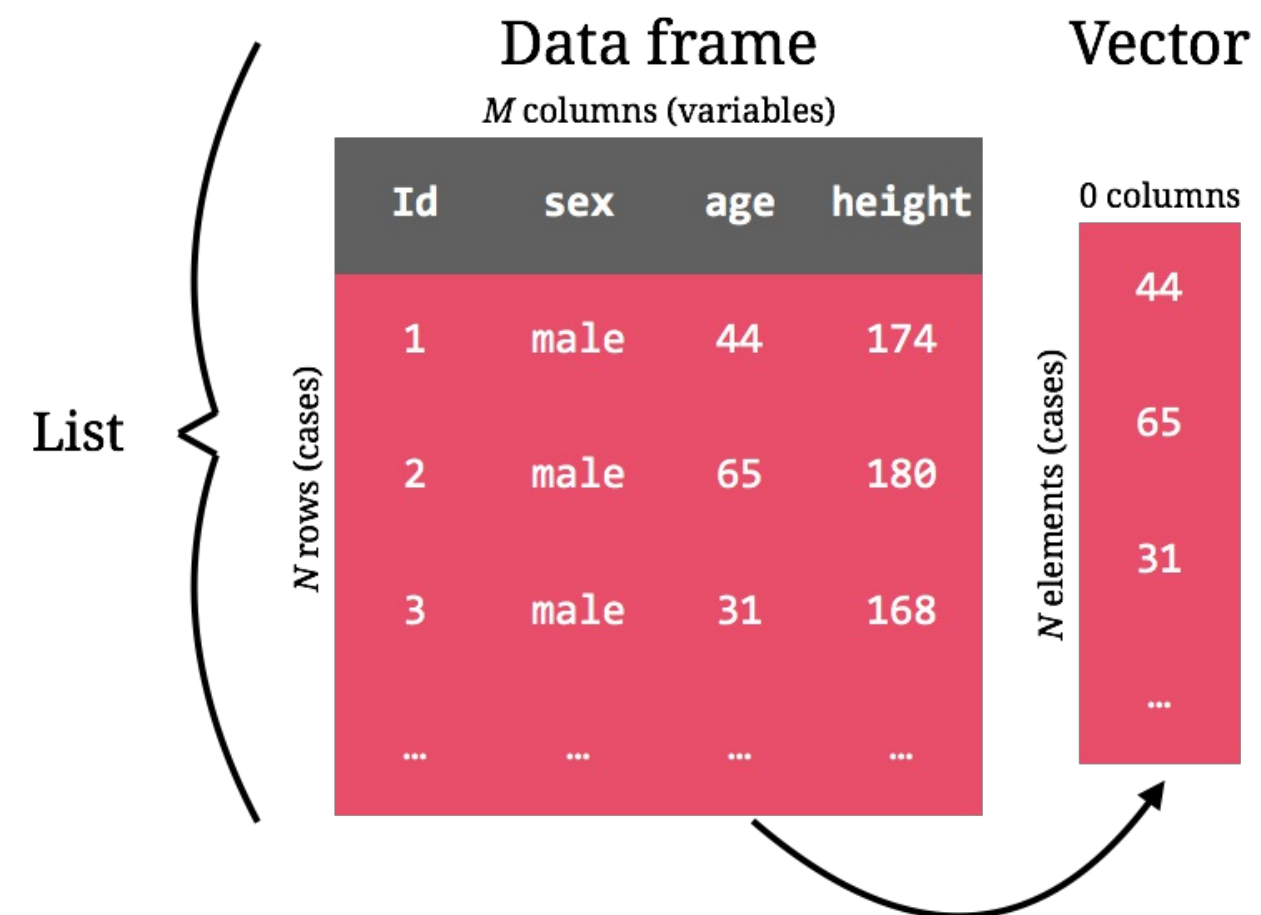
- Can carry any data, incl. lists
- Often used for function outputs

data_frame - R's spreadsheet

- Specific type of list
- Typical data format
- For multi-variable data sets

vectors - R's data container

- Actually carries the data
- Contain data of 1 of many types



list

- 1 - Can **carry any data**, incl. lists, data_frames, vectors, etc.
- 2 - Are often used for **function outputs**
- 3 - Have **named elements**.
- 4 - Elements can be **inspected** via names() or str().
- 5 - Elements are (typically) **selected** by \$.

List

N **named** Elements (objects)

coefficients			df	resid- uals	r square
var	est.	T	99	1.74	0.37
				1.42	
			99	8.21	
x1	1.17	1.86		4.24	
				0.45	
				43.1	
x2	3.32	2.65		2.1	
				...	

List: Select element using \$

```
# regression
reg_model <- lm(height ~ sex + age,
                 data = baselers)
reg_results <- summary(reg_model)

# get element names
names(reg_results)
```

```
## [1] "call"      "terms"
## [3] "residuals" "coefficients"
## [5] "aliased"    "sigma"
## [7] "df"         "r.squared"
```

```
# select element using $
reg_results$coefficients
```

```
##              Estimate t value
## (Intercept) 164.171266 499.5339
## sexmale      13.993699  66.4724
## age          -0.003753  -0.5819
```

List

N named Elements (objects)

coefficients			df	resid- uals	r square
var	est.	T	99	1.74	0.37
				1.42	
				8.21	
x1	1.17	1.86		4.24	
				0.45	
			99	43.1	
x2	3.32	2.65		2.1	
				...	

data_frame

- 1 - Are lists containing **vectors of equal length** representing the variables.
- 2 - Contain vectors of different types: numeric, character, etc.
- 3 - Have named elements.
- 4 - Elements can be **inspected** via `names()`, `str()`, `print()`, `View()`, or `skimr::skim()`.
- 5 - Elements are (typically) **selected** by `$`.
- 6 - Come in different flavors: `data.frame()`, `data.table()`, `tibble()`.

Data frame
4 columns (variables)

N rows (cases)	Id	sex	age	height
	1	male	44	174
	2	male	65	180
	3	male	31	168

Inspect content

```
# inspect baselers via print
baselers
```

```
## # A tibble: 10,000 x 20
##       id sex    age height weight
##   <int> <chr> <int> <dbl> <dbl>
## 1     1 male    44   174.  113.
## 2     2 male    65   180.   75.2
## 3     3 female  31   168.   55.5
## 4     4 male    27   209.   93.8
## 5     5 male    24   177.    NA
## 6     6 male    63   187.   67.4
## 7     7 male    71   152.   83.3
## 8     8 female  41   156.   67.8
## 9     9 male    43   176.   69.3
## 10    10 female  31   166.   66.3
## # ... with 9,990 more rows, and 15 more
## # variables
```

Data frame

4 columns (variables)

N rows (cases)	Id	sex	age	height
	1	male	44	174
	2	male	65	180
	3	male	31	168

Inspect content

```
# inspect baselers via print  
View(baselers)
```

	id	sex	age	height	weight	income
1	1	male	44	174.3	113.4	6300
2	2	male	65	180.3	75.2	10900
3	3	female	31	168.3	55.5	5100
4	4	male	27	209.0	93.8	4200
5	5	male	24	176.7	NA	4000
6	6	male	63	186.6	67.4	11400
7	7	male	71	151.6	83.3	12000
8	8	female	41	155.7	67.8	7600
9	9	male	43	176.1	69.3	8500
10	10	female	31	166.1	66.3	6100
11	11	female	42	157.8	51.9	8000

Data frame

4 columns (variables)

N rows (cases)	Id	sex	age	height
	1	male	44	174
	2	male	65	180
	3	male	31	168

Select via \$

```
# select age variable  
baselers$age
```

```
## [1] 44 65 31 27 24 63 71 41 43 31 42 31  
## [13] 38 49 39 54 78 62 88 74
```

```
# select age variable  
baselers$education
```

```
## [1] "SEK_III"  
## [2] "obligatory_school"  
## [3] "SEK_III"  
## [4] "SEK_III"  
## [5] "SEK_III"  
## [6] "SEK_III"  
## [7] "SEK_III"  
## [8] "SEK_III"  
## [9] "apprenticeship"  
## [10] "SEK_II"
```

Data frame

4 columns (variables)

N rows (cases)	Id	sex	age	height
	1	male	44	174
	2	male	65	180
	3	male	31	168

Change/Add via \$

```
# compute age in months
baselers$age <- baselers$age * 2

# inspect baselers
baselers
```

```
## # A tibble: 10,000 x 20
##       id sex    age height weight
##   <int> <chr> <dbl> <dbl> <dbl>
## 1     1 male    88   174.  113.
## 2     2 male   130   180.   75.2
## 3     3 female  62   168.   55.5
## 4     4 male    54   209.   93.8
## 5     5 male    48   177.    NA
## 6     6 male   126   187.   67.4
## 7     7 male   142   152.   83.3
## 8     8 female  82   156.   67.8
## 9     9 male    86   176.   69.3
## 10    10 female  62   166.   66.3
## # ... with 9,990 more rows, and 15 more
## # variables
```

Data frame

4 columns (variables)

N rows (cases)	Id	sex	age	height
	1	male	44	174
	2	male	65	180
	3	male	31	168

Tidy data

- 1 - Each variable you measure should be in one column.
- 2 - Each different observation of that variable should be in a different row.
- 3 - There should be one table for each "kind" of variable.
- 4 - If you have multiple tables, they should include a column in the table that allows them to be linked.

see [The Elements of Data Analytic Style](#) by Jeff Leek

Data frame

4 columns (variables)

N rows (cases)	Id	sex	age	height
	1	male	44	174
	2	male	65	180
	3	male	31	168

vector

1 - R's **basic and, in a way, only data container**.

2 - Can contain only a **single type of data** and missing values.

3 - Data types

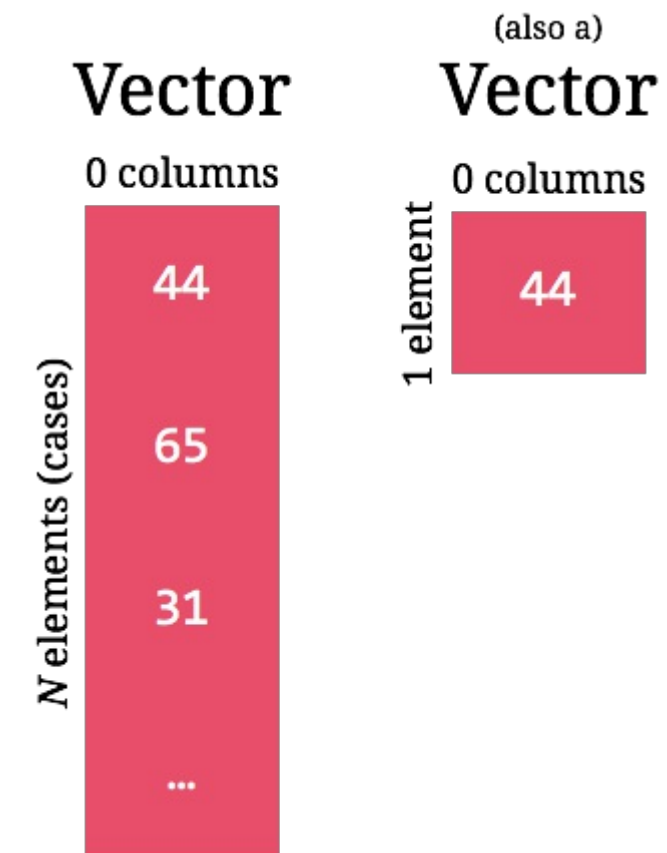
numeric - All numbers

character - All characters (e.g., names)

logical - TRUE or FALSE

...

NA - missing values



Select/Change/(Add) via []

```
# extract vector containing age
age <- baselers$age
age
```

```
## [1] 88 130 62 54 48 126 142 82 86
```

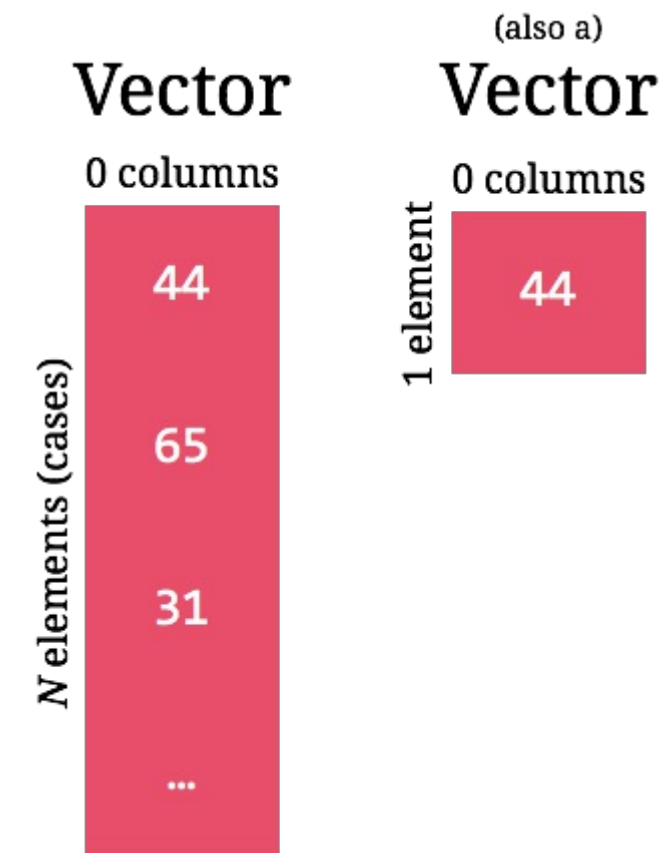
```
# select value
age[2]
```

```
## [1] 130
```

```
# change value
age[2] <- 2
age
```

```
## [1] 88 2 62 54 48 126 142 82 86
```

Find more info on indexing [here](#).



Data types: numeric

numeric vectors are used to store numbers and only numbers.

```
baselers$age

## [1] 88 130 62 54 48 126 142 82 86

# evaluate type
typeof(baselers$age)

## [1] "double"

is.numeric(baselers$age)

## [1] TRUE
```

numeric Vector	character Vector	logical Vector
.\$age	.\$sex	.\$sex=="male"
44	"male"	TRUE
65	"female"	FALSE
31	"male"	TRUE
...

Data types: character

character vector are used to store data represented by **letters and symbols, and all other data**.

```
baselers$sex
```

```
## [1] "male" "male" "female" "male"  
## [5] "male" "male" "male" "female"
```

```
# evaluate type  
as.character(baselers$age)
```

```
## [1] "88" "130" "62" "54" "48" "126"  
## [7] "142" "82" "86"
```

numeric Vector	character Vector	logical Vector
.\$age	.\$sex	.\$sex=="male"
44	"male"	TRUE
65	"female"	FALSE
31	"male"	TRUE
...

Data types: Logical

logical vector are used to **data** aka to select elements or rows. logical are typically created from other vectors via **logical comparisons**.

```
baselers$sex == "male"
```

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

```
# evaluate type  
baselers$age < 30
```

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

numeric Vector	character Vector	logical Vector
.\$age	.\$sex	.\$sex=="male"
44	"male"	TRUE
65	"female"	FALSE
31	"male"	TRUE
...

Data types: Logical

logical vector are used to **data** aka to select elements or rows. logical are typically created from other vectors via **logical comparisons**.

Logical operators

== - is equal to

<, > - smaller/greater than

≤, ≥ - smaller/greater than or equal

&, && - logical AND

|, || - logical OR

numeric Vector	character Vector	logical Vector
.\$age	.\$sex	.\$sex=="male"
44	"male"	TRUE
65	"female"	FALSE
31	"male"	TRUE
...

Object Classes

- 1 - R's objects have **content and attributes**.
- 2 - Attributes include always **names**, **dimensions**, and the **class** (or type) of the object.
- 3 - **Classes** are critical because they determine **when and how they can be used in functions!**

R (data) object

data	attributes
<i>numbers</i> -0.62, -0.08, 0.6 1, 0.52, -0.47, 0. 44, -0.57, -0.52	<i>names</i> names
<i>~ and/or ~</i>	<i>dimensions, length</i> dim, length
<i>character strings</i> ZRU, ZJB, PTK, QBD , CWK, HZM, LKB, RN Y, KFB, GOF	<i>class, type</i> class
<i>~ and/or ~</i> <i>many other types</i>	<i>other attributes</i> attributes

essential

Functions

Functions have 3 elements:

1 - **Name**: Used to refer to the function and call (execute) it.

2 - **Arguments**: Used to provide (data) inputs and to control what the function does.

Arguments with default values (e.g., `use = "everything"`) need not be specified.

Arguments without default values (e.g., `x`) need be specified. **Inputs must have the appropriate class!**

3 - **Body**: The code that uses the inputs (arguments) to produce the desired output. The code of the functions body is based **copies of the inputs**, which are named according to the arguments names.

A function

```
cor(x, y = NULL, use = "everything",  
    method = c("pearson", "kendall", "spearman"))
```

```
na.method <- pmatch(use, c("all.obs",  
  "complete.obs", "pairwise.complete.obs",  
  "everything", "na.or.complete"))  
...  
if (method == "pearson")  
  .Call(C_cor, x, y, na.method, FALSE)  
else if (na.method %in% c(2L, 5L)) {  
  if (is.null(y))  
    .Call(C_cor, Rank(na.omit(x)), NULL,  
          na.method, method == "kendall")  
  }  
...  
}
```

Documentation

R documentation (**help files** and **vignettes**) will become very to use once you are familiar with the basic R vocabulary.

Pay attention to...

Usage - shows how to use function, its arguments and their defaults.

Arguments - describes arguments, and their class.

Value - describes what the function returns.

Examples - provide working R code.

```
# To access help files
?name_of_function

# search help files
??name_of_function
```

?cor

cor {stats}

R Documentation

Correlation, Variance and Covariance (Matrices)

Description

var, cov and cor compute the variance of x and the covariance or correlation of x and y if these are vectors. If x and y are matrices then the covariances (or correlations) between the columns of x and the columns of y are computed.

cov2cor scales a covariance matrix into the corresponding correlation matrix *efficiently*.

Usage

var(x, y = NULL, na.rm = FALSE, use)

cov(x, y = NULL, use = "everything", method = c("pearson", "kendall", "spearman"))

cor(x, y = NULL, use = "everything", method = c("pearson", "kendall", "spearman"))

cov2cor(V)

Arguments

x a numeric vector, matrix or data frame.

y NULL (default) or a vector, matrix or data frame with compatible dimensions to x. The default is equivalent to y = x (but more efficient).

na.rm logical. Should missing values be removed?

use an optional character string giving a method for computing covariances in the presence of missing values. This must be (an abbreviation of) one of the strings "everything", "all.obs", "complete.obs", "na.or.complete", or "pairwise.complete.obs".

method a character string indicating which correlation coefficient (or covariance) is to be computed. One of "pearson" (default), "kendall", or "spearman": can be abbreviated.

V symmetric numeric matrix, usually positive definite such as a covariance matrix.

Practical

[Link to practical](#)