

Acting On Variables

Plan for today

- Actions we perform on our objects
 - **operators**
 - **functions**
- Getting help when we need it

Operators

An **operator** is a simple calculation

+

-

*

/

^

%%

addition

subtraction

multiplication

division

taking powers

modulus

Order of Operations

Important note: Order of operations matters!

```
(8-4)/2
```

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

```
8-(4/2)
```

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

Logical Operators

Test whether a statement is **TRUE** or **FALSE**

==

!=

>

>=

<

<=

equality

inequality

greater than

greater than or equal to

less than

less than or equal to

Logical Operators

- Return a value of `TRUE` or `FALSE`
 - `empire$gender == "female"`
- Which Starwars character is more than 150 cm tall?
 - `empire$height > 150`
- Are any Starwars characters exactly 150cm tall?
 - `empire$height == 150`
 - **WARNING:** `empire$height = 150` will change your data!

Functions

- **R** is not *just* a calculator. You often want to do something more complex.
- To perform more complicated actions, we use *functions*
 - **functions** are commands that describe, manipulate, or analyze objects
 - Logical operators & functions are the **verbs** of programming languages
 - This is why we use **R**! No one wants to calculate a regression by hand...

Functions have 3 parts

Function name

- Each function has one and only one name

```
# The function name is `log`  
log(10)
```

```
## [1] 2.302585
```


Functions have 3 parts

Arguments

- One argument is always specified -- the input; this is the object that the function acts on.
- Other arguments control *how* the function acts. For example, do you want the natural log? Or log base 10?
- Each function has defaults for its arguments. You should know where to find these and how to change them.

```
# The argument here is the input, or `10`  
log(10)
```

```
## [1] 2.302585
```

Functions have 3 parts

Output

- The output of a function can be *any* of the object types & and of any class or even a combination of these
- Outputs can be a single value, vector, data.frame, matrix, list, or a plot
- *You can store the output by assigning it to another object!*

```
# The output is `2.302`  
log(10)
```

```
## [1] 2.302585
```

```
# If we want to store `2.302` for later  
newObject <- log(10)
```

```
# Now print out what is contained in `newObject`  
newObject
```

```
## [1] 2.302585
```

Mathematical functions

Some obvious ones:

- `sqrt()` square root
- `round()` rounding a number
- `log()` logarithm
- `exp()` exponentiation
- `abs()` absolute value

Example:

```
sqrt(85)
```

```
## [1] 9.219544
```

Functions you'll use a lot!

`c()` - combine or concatenate

`length()` - find out how long a vector is (this is the same as getting the last position)

`factor()` - change a character vector into a factor vector (is there meaning? Ex: treatment vs. control, male vs. female, session 1 vs. session 2 etc.)

`table()` - really nice for getting quick counts (ex: how many males and females are there?)

`cbind()` and `rbind()` - add a vector to an existing data.frame. `cbind()` adds a new column. `rbind()` adds a new row

Multiple arguments

Most functions take more than 1 argument (more than just the input object).

Separate these arguments with commas ,

```
round(x = 5.86921, digits = 3)
```

```
## [1] 5.869
```

Arguments have names

Use the argument names!

```
# perfect  
round(x = 5.86921, digits = 3)
```

```
## [1] 5.869
```

```
# also perfect  
round(digits = 3, x = 5.86921)
```

```
## [1] 5.869
```

Arguments have names

Use the argument names!

```
# right answer bc right order  
round(5.86921, 3)
```

```
## [1] 5.869
```

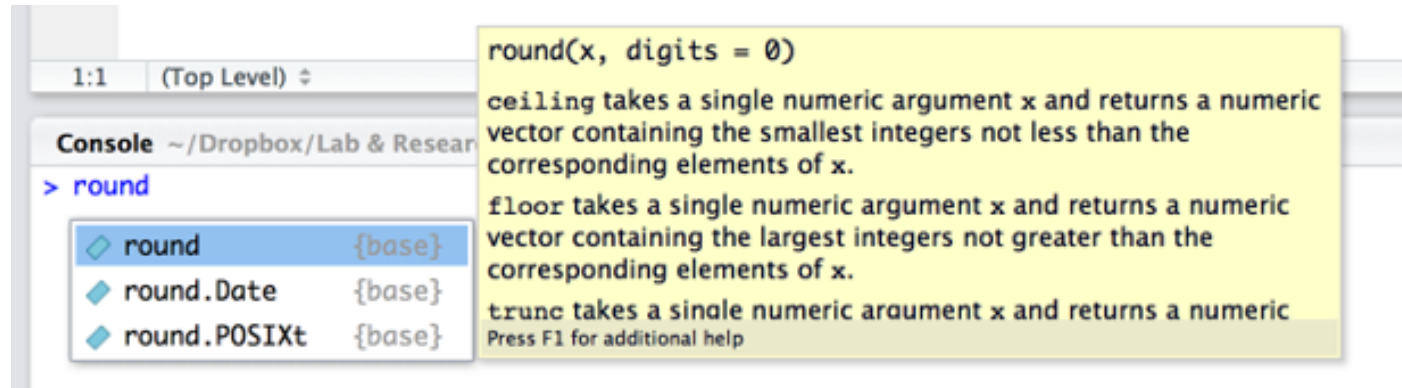
```
# wrong answer bc wrong order  
round(3, 5.86921)
```

```
## [1] 3
```

Great, but how do I know what the arguments are for a function?

Two ways:

1. In RStudio, press the **tab** key to see the names of arguments and descriptions.
(note, this might not work in the online practice assignments, but it should definitely work when running RStudio locally)



2. Look in the R Documentation

Looking at the documentation for help

Go to the `help` tab



Or type `?round` into the console



Breakdown of help documentation

Try `typing code` to look up the R documentation for the correlation function, which is called `cor`.

This will be the example we use.



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.

Details

`cor {stats}`

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.

Details

For `cov` and `cor` one must *either* give a matrix or data frame for `x` or give both `x` and `y`.

The inputs must be numeric (as determined by [is.numeric](#); logical values are also allowed for historical compatibility); the "kendall" and "spearman" methods make sense for ordered inputs but [xtfrm](#) can be used to find a suitable prior transformation to numbers.

Value

For `r <- cor(*, use = "all.obs")`, it is now guaranteed that `all(r <= 1)`.

Examples

```
var(1:10)  # 9.166667

var(1:5, 1:5) # 2.5

## Two simple vectors
cor(1:10, 2:11) # == 1

## Correlation Matrix of Multivariate sample:
(C1 <- cor(longley))
## Graphical Correlation Matrix:
symnum(C1) # highly correlated
```

All together

Logical operators evaluate TRUE or FALSE

- In `data$gender == "female"` the `==` is the **logical operator**
- However, `gender == "female"` doesn't work! R doesn't know where to look!

Indexing allows you to get a subset of your data

- For a 2-dimensional data.frame, `data[rows, columns]`
- If you want *all* the rows, `data[,columns]` (& vice versa)

COMBINING THESE is powerful!

- `data[data$gender == "female",]` is correct!
- `data[gender == "female"]` is *incorrect*! Can you find the 2 reasons why?

Note: we will go through other ways of doing this; but understanding the logic is really, really important!