

R Programming Cheat Sheet

JUST THE BASICS

CREATED BY: ARIANNE COLTON AND SEAN CHEN

GENERAL

- R version 3.0 and greater adds support for 64 bit integers
- R is case sensitive
- R index starts from 1

HELP

`help(functionName)` OR `?functionName`

Help Home Page	<code>help.start()</code>
Special Character Help	<code>help('[')</code>
Search Help	<code>help.search(..)</code> or <code>??..</code>
Search Function - with Partial Name	<code>apropos('mea')</code>
See Example(s)	<code>example(topic)</code>

OBJECTS in current environment

Display Object Name	<code>objects()</code> OR <code>ls()</code>
Remove Object	<code>rm(object1, object2,..)</code>

Notes:

- .name starting with a period are accessible but invisible, so they will not be found by 'ls'
- To guarantee memory removal, use 'gc', releasing unused memory to the OS. R performs automatic 'gc' periodically

SYMBOL NAME ENVIRONMENT

- If multiple packages use the same function name the function that the package loaded the last will get called.
- To avoid this precede the function with the name of the package. e.g. `packageName::functionName(..)`

LIBRARY

Only trust reliable R packages i.e., 'ggplot2' for plotting, 'sp' for dealing spatial data, 'reshape2', 'survival', etc.

Load Package	<code>library(packageName)</code> OR <code>require(packageName)</code>
Unload Package	<code>detach(packageName)</code>

Note: `require()` returns the status(True/False)

MANIPULATING STRINGS

Putting Together Strings	<code>paste('string1', 'string2', sep = '/')</code> # separator ('sep') is a space by default <code>paste(c('1', '2'), collapse = '/')</code> # returns '1/2'
Split String	<code>stringr::str_split(string = v1, pattern = '-')</code> # returns a list
Get Substring	<code>stringr::str_sub(string = v1, start = 1, end = 3)</code>
Match String	<code>isJohnFound <- stringr::str_detect(string = df1\$col1, pattern = ignore.case('John'))</code> # returns True/False if John was found <code>df1[isJohnFound, c('col1', ...)]</code>

DATA TYPES

Check data type: `class(variable)`

FOUR BASIC DATA TYPES

- Numeric** - includes float/double, int, etc.

`is.numeric(variable)`

- Character(string)**

`nchar(variable)` # length of a character or numeric

- Date/POSIXct**

- Date:** stores just a date. In numeric form, number of days since 1/1/1970 (see below).

`date1 <- as.Date('2012-06-28'), as.numeric(date1)`

- POSIXct:** stores a date and time. In numeric form, number of seconds since 1/1/1970.

`date2 <- as.POSIXct('2012-06-28 18:00')`

Note: Use 'lubridate' and 'chron' packages to work with Dates

- Logical**

- (TRUE = 1, FALSE = 0)
- Use `==/!=` to test equality and inequality

`as.numeric(TRUE) => 1`

DATA STRUCTURES

VECTOR

- Group of elements of the SAME type
- R is a vectorized language, operations are applied to each element of the vector automatically
- R has no concept of column vectors or row vectors
- Special vectors: letters and LETTERS, that contain lower-case and upper-case letters

Create Vector	<code>v1 <- c(1, 2, 3)</code>
Get Length	<code>length(v1)</code>
Check if All or Any is True	<code>all(v1); any(v1)</code>
Integer Indexing	<code>v1[1:3]; v1[c(1,6)]</code>
Boolean Indexing	<code>v1[is.na(v1)] <- 0</code>
Naming	<code>c(first = 'a', ..)</code> OR <code>names(v1) <- c('first', ..)</code>

FACTOR

- `as.factor(v1)` gets you the levels which is the number of unique values
- Factors can reduce the size of a variable because they only store unique values, but could be buggy if not used properly

LIST

Store any number of items of ANY type

Create List	<code>list1 <- list(first = 'a', ...)</code>
Create Empty List	<code>vector(mode = 'list', length = 3)</code>
Get Element	<code>list1[[1]]</code> OR <code>list1[['first']]</code>
Append Using Numeric Index	<code>list1[[6]] <- 2</code>
Append Using Name	<code>list1[['newElement']] <- 2</code>

Note: repeatedly appending to list, vector, data.frame etc. is expensive, it is best to create a list of a certain size, then fill it.

DATA.FRAME

- Each column is a variable, each row is an observation
- Internally, each column is a vector
- idata.frame is a data structure that creates a reference to a data.frame, therefore, no copying is performed

Create Data Frame	<code>df1 <- data.frame(col1 = v1, col2 = v2, v3)</code>
Dimension	<code>nrow(df1); ncol(df1); dim(df1)</code>
Get/Set Column Names	<code>names(df1)</code> <code>names(df1) <- c(...)</code>
Get/Set Row Names	<code>rownames(df1)</code> <code>rownames(df1) <- c(...)</code>
Preview	<code>head(df1, n = 10); tail(...)</code>
Get Data Type	<code>class(df1)</code> # is data.frame
Index by Column(s)	<code>df1['col1']</code> OR <code>df1[1]</code> ; <code>df1[c('col1', 'col3')]</code> OR <code>df1[c(1, 3)]</code>
Index by Rows and Columns	<code>df1[c(1, 3), 2:3]</code> # returns data from row 1 & 3, columns 2 to 3

† Index method: `df1$col1` OR `df1[, 'col1']` OR `df1[, 1]` returns as a vector. To return single column

data.frame while using single-square brackets, use 'drop': `df1[, 'col1', drop = FALSE]`

DATA.TABLE

What is a data.table

- Extends and enhances the functionality of data.frames

Differences: data.table vs. data.frame

- By default data.frame turns character data into factors, while data.table does not
- When you print data.frame data, all data prints to the console, with a data.table, it intelligently prints the first and last five rows
- Key Difference:** Data.tables are fast because they have an index like a database.
i.e., this search, `dt1$col1 > number`, does a sequential scan (vector scan). After you create a key for this, it will be much faster via binary search.

Create data.table from data.frame	<code>data.table(df1)</code>
Index by Column(s)*	<code>dt1[, 'col1', with = FALSE]</code> OR <code>dt1[, list(col1)]</code>
Show info for each data.table in memory (i.e. size, ...)	<code>tables()</code>
Show Keys in data.table	<code>key(dt1)</code>
Create index for col1 and reorder data according to col1	<code>setkey(dt1, col1)</code>
Use Key to Select Data	<code>dt1[c('col1Value1', 'col1Value2'),]</code>
Multiple Key Select	<code>dt1[J('1', c('2', '3')),]</code>
Aggregation**	<code>dt1[, list(col1 = mean(col1), by = col2)]</code> <code>dt1[, list(col1 = mean(col1), col2Sum = sum(col2)), by = list(col3, col4)]</code>

* Accessing columns must be done via list of actual names, not as characters. If column names are characters, then "with" argument should be set to FALSE.

** Aggregate and d'ply functions will work, but built-in aggregation functionality of data table is faster

MATRIX

- Similar to data.frame except every element must be the SAME type, most commonly all numerics
- Functions that work with data.frame should work with matrix as well

Create Matrix	<code>matrix1 <- matrix(1:10, nrow = 5), # fills rows 1 to 5, column 1 with 1:5, and column 2 with 6:10</code>
Matrix Multiplication	<code>matrix1 %*% t(matrix2)</code> # where t() is transpose

ARRAY

- Multidimensional vector of the SAME type
- `array1 <- array(1:12, dim = c(2, 3, 2))`
- Using arrays is not recommended
- Matrices are restricted to two dimensions while array can have any dimension

DATA MUNGING

APPLY (apply, tapply, lapply, mapply)

- Apply - most restrictive. Must be used on a matrix, all elements must be the same type
- If used on some other object, such as a data.frame, it will be converted to a matrix first

```
apply(matrix1, 1 - rows or 2 - columns,
function to apply)
# if rows, then pass each row as input to the function
```

- By default, computation on NA (missing data) always returns NA, so if a matrix contains NAs, you can ignore them (use `na.rm = TRUE` in the `apply(...)` which doesn't pass NAs to your function)

lapply

Applies a function to each element of a list and returns the results as a list

sapply

Same as lapply except return the results as a vector

Note: lapply & sapply can both take a vector as input, a vector is technically a form of list

AGGREGATE (SQL GROUPBY)

- `aggregate(formulas, data, function)`
- Formulas: $y \sim x$, y represents a variable that we want to make a calculation on, x represents one or more variables we want to group the calculation by
- Can only use one function in `aggregate()`. To apply more than one function, use the `plyr()` package

In the example below diamonds is a data.frame; price, cut, color etc. are columns of diamonds.

```
aggregate(price ~ cut, diamonds, mean)
# get the average price of different cuts for the diamonds
aggregate(price ~ cut + color, diamonds,
mean) # group by cut and color
aggregate(cbind(price, carat) ~ cut,
diamonds, mean) # get the average price and average
carat of different cuts
```

PLYR ('split-apply-combine')

- `ddply()`, `lply()`, `ldply()`, etc. (1st letter = the type of input, 2nd = the type of output)
- `plyr` can be slow, most of the functionality in `plyr` can be accomplished using base function or other packages, but `plyr` is easier to use

ddply

Takes a data.frame, splits it according to some variable(s), performs a desired action on it and returns a data.frame

lply

- Can use this instead of lapply
- For sapply, can use `lapply` ('a' is array/vector/matrix), however, lply result does not include the names.

DPLYR (for data.frame ONLY)

- Basic functions: `filter()`, `slice()`, `arrange()`, `select()`, `rename()`, `distinct()`, `mutate()`, `summarise()`,

`group_by()`, `sample_n()`

- Chain functions

```
df1 %>% group_by(year, month) %>%
select(col1, col2) %>% summarise(collmean =
mean(coll1))
```

- Much faster than `plyr`, with four types of easy-to-use joins (inner, left, semi, anti)
- Abstracts the way data is stored so you can work with data frames, data tables, and remote databases with the same set of functions

HELPER FUNCTIONS

`each()` - supply multiple functions to a function like `aggregate`

```
aggregate(price ~ cut, diamonds, each(mean,
median))
```

DATA

LOAD DATA FROM CSV

- Read csv

```
read.table(file = url or filepath, header =
TRUE, sep = ',')
```

- "stringAsFactors" argument defaults to TRUE, set it to FALSE to prevent converting columns to factors. This saves computation time and maintains character data
- Other useful arguments are "quote" and "colClasses", specifying the character used for enclosing cells and the data type for each column.
- If cell separator has been used inside a cell, then use `read.csv2()` or `read.delim2()` instead of `read.table()`

DATABASE

Connect to Database	<code>db1 <- RODB::odbcConnect('conStr')</code>
Query Database	<code>df1 <- RODB::sqlQuery(db1, 'SELECT ..', stringAsFactors = FALSE)</code>
Close Connection	<code>RODB::odbcClose(db1)</code>

- Only one connection may be open at a time. The connection automatically closes if R closes or another connection is opened.
- If table name has space, use `[]` to surround the table name in the SQL string.
- `which()` in R is similar to 'where' in SQL

INCLUDED DATA

R and some packages come with data included.

List Available Datasets	<code>data()</code>
List Available Datasets in a Specific Package	<code>data(package = 'ggplot2')</code>

MISSING DATA (NA and NULL)

NULL is not missing, it's nothingness. NULL is atomical and cannot exist within a vector. If used inside a vector, it simply disappears.

Check Missing Data	<code>is.na()</code>
Avoid Using	<code>is.null()</code>

FUNCTIONS AND CONTROLS

Create Function	<code>say_hello <- function(first, last = 'hola') { }</code>
Call Function	<code>say_hello(first = 'hello')</code>

- R automatically returns the value of the last line of code in a function. This is bad practice. Use `return()` explicitly instead.
- `do.call()` - specify the name of a function either as string (i.e. 'mean') or as object (i.e. mean) and provide arguments as a list.

```
do.call(mean, args = list(first = '1st'))
```

IF /ELSE /ELSE IF /SWITCH

	if { } else	ifelse
Works with Vectorized Argument	No	Yes
Most Efficient for Non-Vectorized Argument	Yes	No
Works with NA *	No	Yes
Use <code>&&, </code> **†	Yes	No
Use <code>&, </code> ***†	No	Yes

* NA == 1 result is NA, thus if won't work, it'll be an error. For `ifelse`, NA will return instead

** `&&, ||` is best used in `if`, since it only compares the first element of vector from each side

*** `&, |` is necessary for `ifelse`, as it compares every element of vector from each side

† `&&, ||` are similar to `if` in that they don't work with vectors, where `ifelse`, `&, |` work with vectors

- Similar to C++/Java, for `&, |`, both sides of operator are always checked. For `&&, ||`, if left side fails, no need to check the right side.
- `} else, else` must be on the same line as `}`

GRAPHICS

DEFAULT BASIC GRAPHIC

```
hist(df1$col1, main = 'title', xlab = 'x
axis label')
plot(col2 ~ col1, data = df1,
aka y ~ x or plot(x, y))
```

LATTICE AND GGLOT2 (more popular)

- Initialize the object and add layers (points, lines, histograms) using `+`, map variable in the data to an axis or aesthetic using 'aes'

```
ggplot(data = df1) + geom_histogram(aes(x =
col1))
```

- Normalized histogram (pdf, not relative frequency histogram)

```
ggplot(data = df1) + geom_density(aes(x =
col1), fill = 'grey50')
```

DATA RESHAPING

REARRANGE

Melt Data - from column to row	<code>reshape2.melt(df1, id.vars = c('col1', 'col2'), variable.name = 'newCol1', value.name = 'newCol2')</code>
Cast Data - from row to column	<code>reshape2.dcast(df1, col1 + col2 ~ newCol1, value.var = 'newCol2')</code>

If `df1` has 3 more columns, `col3` to `col5`, 'melting' creates a new df that has 3 rows for each combination of `col1` and `col2`, with the values coming from the respective `col3` to `col5`.

COMBINE (multiple sets into one)

- cbind** - bind by columns

data.frame from two vectors	<code>cbind(v1, v2)</code>
data.frame combining df1 and df2 columns	<code>cbind(df1, df2)</code>

- rbind** - similar to `cbind` but for rows, you can assign new column names to vectors in `cbind`

```
cbind(col1 = v1, ...)
```

- Joins** - (merge, join, data.table) using common keys

3.1 Merge

- `by.x` and `by.y` specify the key columns use in the `join()` operation
- Merge can be much slower than the alternatives

```
merge(x = df1, y = df2, by.x = c('col1',
'col3'), by.y = c('col3', 'col6'))
```

3.2 Join

- Join in `plyr()` package works similar to `merge` but much faster, drawback is key columns in each table must have the same name
- `join()` has an argument for specifying left, right, inner joins

```
join(x = df1, y = df2, by = c('col1',
'col3'))
```

3.3 data.table

```
dt1 <- data.table(df1, key = c('1',
'2')), dt2 <- ... ‡
```

- Left Join

```
dt1[dt2]
```

‡ Data table join requires specifying the keys for the data tables

Created by Arianne Colton and Sean Chen
data.scientist.info@gmail.com

Based on content from
 'R for Everyone' by Jared Lander

Updated: December 2, 2015