Anatomy of an R Help File

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1 Overview

1.1 Description

The R programming language has a vast and sprawling documentation library, and a lot of it is in a standardized format: the R help file. Unfortunately, R help files can be difficult to read at the best of times, and almost impossible to understand for those new to coding. This workshop will explain each section of the R help file, how to read them, and when they are the most useful. It will also introduce you a number of ways to search R documentation, both from R and on the internet.

Workshop site: https://d-rug.github.io/help_file_anatomy/

1.2 Learning Goals

- Know where to look for R documentation depending on what type of question you need answered
- Understand what information each section of a R help file contains
- Know which help file sections to look at depending on what type of problem you have

1.3 Setup

```
if (!require('sf')) install.packages('sf')
if (!require('forcats')) install.packages('forcats')
```

2 Getting Help in R

2.1 Looking for Help

When programming, it is not a matter of if you get stuck, or even when you get stuck, but how much time will you spend stuck. Some problems can be resolved in minutes where as others may last weeks or even months. Thankfully R has a wide variety of tools to help you get unstuck, from built-in documentation, to mailing lists, to help groups like the Davis R Users Group.

If you have ever asked for coding help, you may have gotten the response "Have you checked the documentation". This is the programming equivalent of asking if you have read the manual. And like many manuals, R documentation often seems like it was written for someone who already knows what they are doing. This is all well and good if you do know what you are doing. However, it doesn't help much if the documentation itself is a source of confusion.

The basic unit of documentation in R is the R help file. While help files may be difficult to decipher at first, they are all difficult in the same way. That means once you understand one of them, understanding the rest is much easier. Most R help files focus on a particular function, like `summary()`, which summarizes various types of data in R. However, many packages and built-in data sets like `mtcars` also have help pages.

2.2 Opening R Documentation

You can access R help files in several ways. If you know the name of the function or package you are looking for information about, you can use the `?` operator in the console with the name of the function to open the R help file. This will only open documentation for functions and packages you currently have **loaded** into R. This is also equivalent to using the `help()` function.

```
#these lines of code are equivalent
?summary

help('summary')
```

If you are using RStudio this will bring up documentation for that function in help window. If you use the GUI, it will open a separate help window. If you are running R in bash or zsh, R will open the help file in your default text editor.

Not all packages have help files the way functions do, but it is getting more common. To load the help file for a package, you need to add `-package` onto the name of the package. Since R does not view "sf-package" as a single word, you need to surround it in tick marks (‘).

```
#load documentation for the sf package
?`sf-package`
```

If you are unsure of the function name, you can use the `??` operator to search all of your local R documentation for a term or set of terms. For multiple search terms, enclose them in tick marks. The `??` operator is equivalent to the function `help.search()`, but for help.search you enclose your search term in quotes. The help.search function also gives you more control over what you are searching for.

```
??`linear model`

#look for linear model only in the title of the help file
help.search('linear model', fields='title')
```

This will search documentation for all packages you have **installed**. It will then provide a list links to documentation pages you can use to find the function that works best. Functions are labeled using the schema [PACKAGE NAME]::[FUNCTION NAME] so you can tell which package to load to access function you are interested in.

If you want to search documentation for packages that you haven't installed yet, you have a couple of options. If you are only looking for packages that are available through CRAN or bioconductor, you can use the `RSiteSearch()` function, or rdocumentation.org if you prefer a web interface. CRAN itself contains a lot of documentation for each package on the package's page (ex. dplyr), but the information isn't searchable from the website and you have to know what package you want information on. If you also want to be able to search packages hosted on R-forge and Github in addition to CRAN and bioconductor, you can use rdrr.io.

> **Documentation Duplication**
>
> Sometimes you will have functions from different packages that share the same name. For example, the stats package and the dplyr package both have functions called `filter`, but one is used for filtering time series and the other subsets data.frames by row. If you use the `?` operator to open the help file for one of these functions, a page will open with links to different documentation pages based on the package you are using. Be sure to click on the link that corresponds to the function you have questions about.

2.3 Definitions

R documentation uses a couple of terms that are sometimes glossed over at introductory levels. However, without them, many R help files are nigh impossible to read.

2.3.1 Functions

A function is a pre-programmed set of instructions that performs a certain task. For example, the `sqrt` function takes the square root of a given number or numbers. The `length` function tells you the number of elements in a vector or list. For more information on functions, see DataLab's Calling Functions and Functions sections of the R Basics reader.

2.3.2 Arguments

An argument is an input to a function, the information the function needs in order to work. Not all functions require arguments, but most do. Almost all arguments in R have names. Ideally argument name would tell you something about what the argument does, but that is not always the case. The name of the first three arguments to the lm function are `formula`, `data`, and `subset`, which are relatively informative. On the other hand, `sqrt()`'s singular argument `x` doesn't give us very much information, which is why the the Arguments section of help files are is important. There are a few functions with unnamed arguments, but we will discuss that later.

2.3.3 Objects

Everything you can interact with in R is an object. Whenever you create a variable, you create an object. All of the objects you create will appear in the Environment tab in RStudio. If you aren't using RStudio, you can also get a list of objects you created using `ls()`.

```
x = 5

ls()
```

```
[1] "x"
```

There are many more objects that R defines internally. R includes many built-in data sets (ex. `mtcars`), all of which are objects. Every function you use is also an object.

2.3.4 Classes

A class is the blueprint for the structure of an object. It defines how you can interact with the object and what types of information it can contain. To determine the class of an object, you can use the function `class()`. Common examples of classes include integers, characters, data.frames, lists, and functions. For more information on classes, see the Data Types and Classes section of DataLab's R Basics reader.

2.3.5 Methods

A method is a function that is defined for a particular class of object. For example, the function `st_area` calculates the area of a set of shapes. However, it only works for objects of the sf class, a type of object that stores geographical information. R assumes that the first argument you provide to `st_area` has the class sf, and if it doesn't you will get an error message.

Some functions may have methods defined for many different classes of objects. For example, you can use the summary function to summarize a vector of numbers or the columns of a data.frame. The internal code for the function automatically determines the class of the input data and applies the correct method for you.

```
summary(1:20)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   1.00    5.75   10.50   10.50   15.25   20.00
```

```
summary(iris)
```

```
  Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
 Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
 1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
 Median :5.800   Median :3.000   Median :4.350   Median :1.300
 Mean   :5.843   Mean   :3.057   Mean   :3.758   Mean   :1.199
 3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
 Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
       Species
 setosa    :50
 versicolor:50
 virginica :50
```

You can use the `methods` function to see what classes of objects have methods for a given function.

```
methods(summary)
```

```
 [1] summary,ANY-method                  summary,DBIObject-method
 [3] summary.aov                         summary.aovlist*
 [5] summary.aspell*                     summary.check_packages_in_dir*
 [7] summary.connection                  summary.data.frame
 [9] summary.Date                        summary.default
[11] summary.ecdf*                       summary.factor
[13] summary.glm                         summary.infl*
[15] summary.lca*                        summary.lm
[17] summary.loess*                      summary.manova
[19] summary.matrix                      summary.mlm*
[21] summary.nls*                        summary.packageStatus*
[23] summary.POSIXct                     summary.POSIXlt
[25] summary.ppr*                        summary.pr_DB*
[27] summary.prcomp*                     summary.princomp*
[29] summary.proc_time                   summary.proxy_registry*
[31] summary.rlang_error*                summary.rlang_message*
[33] summary.rlang_trace*                summary.rlang_warning*
[35] summary.rlang:::list_of_conditions* summary.sfc*
[37] summary.srcfile                     summary.srcref
[39] summary.stepfun                     summary.stl*
[41] summary.svm*                        summary.table
[43] summary.tukeysmooth*                summary.tune*
[45] summary.units*                      summary.vctrs_sclr*
[47] summary.vctrs_vctr*                 summary.warnings
see '?methods' for accessing help and source code
```

To look up documentation for a specific method, use the schema [FUNCTION NAME].[CLASS NAME]. For example, if we want to look up documentation for the `summary` method for the class `lm`, we would use the code `?summary.lm`.

> **i** Advanced Topic
>
> This system of objects, classes, and methods is called Object-Oriented Programming (OOP). Object oriented programming is not unique to R, but R does it a little differently. If you want a deeper understanding of methods in R, the S3 section of the Intermediate R reader describes the most widely used system of OOP in R. Additionally, Advanced R by Hadley Wickham provides a more complete description of the various OOP systems

available in R as well as their trade-offs.

3 Reading R Help Files

3.1 Sections of an R Help File

Each R help file has a standard set of sections. Not every help file will have every section, but all help files will have the starred sections in the list below. The sections of an R help file in order are:

- Title*
- Description*
- Usage*
- Arguments*
- Details
- Value
- Note
- References
- Author(s)
- See Also
- Examples

Let's take a look at each section you might find in a help file.

3.2 Title

This is the section at the top of the help file and tells you the name of the documentation page you are looking at as well as the package the documentation file is from (enclosed in {}). It also displays a very brief summary of what the function does in large lettering. Importantly, the title section is a good place to figure out what package a particular function lives in.

If the package that contains the function is the "base" package, that means it is a part of "base" R, or the the set of functions and classes available to you whenever you open an R session. The packages stats, graphics, utils, datasets, methods, and grDevices are also always loaded whenever you open an R session, so you don't need to call them with `require()` or `library()`.

3.3 Description

The Description section gives a more detailed description of what the function or package does. It is useful when trying to determine whether or not a function would suit your needs for a particular task.

3.4 Usage

The Usage section is particularly useful for troubleshooting. It is also probably the most difficult to interpret. In general, it gives you information about how to *use* the function.

Every Usage section will have at least one example function call with all of the named arguments listed out. Arguments with an `=` after them have a default value. This means you don't necessarily need to provide a value for that argument when calling the function. However it is important to check that the default value is what you want it to be. If there is no `=` after the argument, it is a required argument and you will need to provide it each time you call the function. The Usage section does not describe what each argument does. For that, you need to go to the Arguments section, which we will cover next. In general, the Usage and Arguments sections are closely links and I often find myself jumping back and forth between them when trying to understand what a function is doing.

Sometimes developers document multiple functions in a single help file. This is the case for `read.table` and `read.csv`, which share a documentation page. Even though two functions share a documentation page, that does not mean they share all the same arguments or default values. For example, the default value for the header argument is `FALSE` for `read.table` but `TRUE` for `read.csv`.

Sometimes there is more than one example function call for the same for functions with the same name. This is the case for functions with methods for multiple classes of objects. When this happens, the documentation will specify the class the method is for with a comment above the function call. You can see this in the `summary()` documentation. The help file for `summary()` lists methods for objects of class data.frame, factor, and matrix. It also lists a default method, for if none of the other methods apply.

> **Warning**
>
> Different methods may have different required arguments and default values. Make sure to use the documentation for the method that corresponds to the class of your first argument.

If we summarize survey data from the General Social Survey as a data.frame, R displays a maximum of 7 different values for categorical variables.

```
library(forcats)

summary(gss_cat)
```

```
      year                 marital           age                     race
 Min.   :2000   No answer    :   17   Min.   :18.00   Other         : 1959
 1st Qu.:2002   Never married: 5416   1st Qu.:33.00   Black         : 3129
 Median :2006   Separated    :  743   Median :46.00   White         :16395
 Mean   :2007   Divorced     : 3383   Mean   :47.18   Not applicable:    0
 3rd Qu.:2010   Widowed      : 1807   3rd Qu.:59.00
 Max.   :2014   Married      :10117   Max.   :89.00
                                      NA's   :76
          rincome                   partyid            relig
 $25000 or more:7363   Independent       :4119   Protestant:10846
 Not applicable:7043   Not str democrat  :3690   Catholic  : 5124
 $20000 - 24999:1283   Strong democrat   :3490   None      : 3523
 $10000 - 14999:1168   Not str republican:3032   Christian :  689
 $15000 - 19999:1048   Ind,near dem      :2499   Jewish    :  388
 Refused       : 975   Strong republican :2314   Other     :  224
 (Other)       :2603   (Other)           :2339   (Other)   :  689
              denom          tvhours
 Not applicable  :10072   Min.   : 0.000
 Other           : 2534   1st Qu.: 1.000
 No denomination : 1683   Median : 2.000
 Southern baptist: 1536   Mean   : 2.981
 Baptist-dk which: 1457   3rd Qu.: 4.000
 United methodist: 1067   Max.   :24.000
 (Other)         : 3134   NA's   :10146
```

However, if we summarize one column of the data set, the `summary()` function displays many more categories.

```
summary(gss_cat$relig)
```

```
            No answer            Don't know Inter-nondenominational
                   93                    15                     109
      Native american             Christian      Orthodox-christian
                   23                   689                      95
         Moslem/islam         Other eastern                Hinduism
                  104                    32                      71
             Buddhism                 Other                    None
```

```
                147                 224                3523
             Jewish            Catholic          Protestant
                388                5124               10846
     Not applicable
                  0
```

Going back to the documentation for `summary()`, we can see that for a data.frame the default value for `maxsum` is 7, while for a factor, the default value for `maxsum` is 100. Now, this is one difference between these two methods, but to determine if this is the reason the outputs are different, we will need to refer to the Arguments section.

3.5 Arguments

The Arguments section lists out the name each argument to the function, the required class for that argument, and a description of what the argument does. It is probably the section I use most commonly use when troubleshooting. If there are multiple functions listed in the Usage section, it is possible not every function will use every argument. You will need to refer to the Usage section to determine if a given argument applies to the function you are using.

To figure out what the `maxsum` argument actually does, we refer to the arguments section of the `summary()` help file. This tells us that `maxsum` determines the maximum number of values that should be displayed for factors. This matches the change in behavior we saw in `summary()` above.

3.5.1 The ... Argument

You may see `...` as one of the arguments in the Arguments and Usage sections. This is the exception to the rule that all arguments R functions are named. This "argument" allows you to pass arguments to the function that are not explicitly listed in the function's documentation. This is typically done for two reasons.

First, the function's author many not want to restrict the number of arguments you can provide to the function. This is the case for functions like `sum()` and `data.frame()`. It would be very inconvenient if the R developers restricted the number of columns you could create a data.frame with.

```
sum(1:10, 99, 21:91, -39:45)
```

```
[1] 4385
```

```r
data.frame(1:12, month.name, month.abb)
```

```
   X1.12 month.name month.abb
1      1    January       Jan
2      2   February       Feb
3      3      March       Mar
4      4      April       Apr
5      5        May       May
6      6       June       Jun
7      7       July       Jul
8      8     August       Aug
9      9  September       Sep
10    10    October       Oct
11    11   November       Nov
12    12   December       Dec
```

Second, the author of a given function may want to allow other packages to expand the use cases of that function. However, the original author won't necessarily know what arguments will be useful for future R developers. So instead, they can include `...` as an argument, and then other packages can define additional arguments that will be useful to them.

The `plot()` function is one example of this. If you look at the documentation for the generic `plot()` function, you can see that there are only a few arguments listed, and they seemed to be geared toward X-Y plotting. This is very useful, but it is definitely not the only type of plotting you may want to do.

Many different types of objects benefit from visualization, including ones that don't neatly fit into the X-Y paradigm. It is very common that packages will define a new class of object to accomplish a particular goal and want to visualize those object in some way. Instead of creating an entirely new function to visualize their new objects, the package's creator can create a new method for `plot()`. This is useful because it standardizes the way we visualize things, and it reduces the amount of work the developer needs to do.

The sf package uses this functionality. The sf package defines the `sf` class, which stores geographical information, like the counties of North Carolina. This is the type of data we use can to make maps.

```r
library(sf)

#read in North Carolina data
nc = st_read(system.file("shape/nc.shp", package="sf"), quiet = TRUE)
```

```
#class of data created using sf package
class(nc)
```

```
[1] "sf"         "data.frame"
```

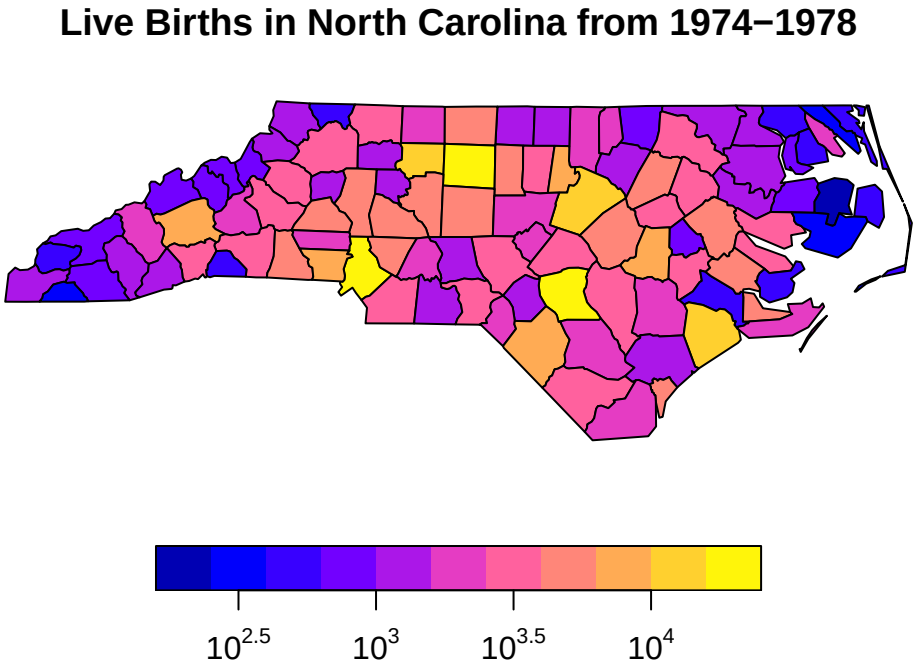
```
head(nc)
```

```
Simple feature collection with 6 features and 14 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: -81.74107 ymin: 36.07282 xmax: -75.77316 ymax: 36.58965
Geodetic CRS:  NAD27
   AREA PERIMETER CNTY_ CNTY_ID        NAME  FIPS FIPSNO CRESS_ID BIR74 SID74
1 0.114     1.442  1825    1825        Ashe 37009  37009        5  1091     1
2 0.061     1.231  1827    1827   Alleghany 37005  37005        3   487     0
3 0.143     1.630  1828    1828       Surry 37171  37171       86  3188     5
4 0.070     2.968  1831    1831   Currituck 37053  37053       27   508     1
5 0.153     2.206  1832    1832 Northampton 37131  37131       66  1421     9
6 0.097     1.670  1833    1833    Hertford 37091  37091       46  1452     7
  NWBIR74 BIR79 SID79 NWBIR79                       geometry
1      10  1364     0      19 MULTIPOLYGON (((-81.47276 3...
2      10   542     3      12 MULTIPOLYGON (((-81.23989 3...
3     208  3616     6     260 MULTIPOLYGON (((-80.45634 3...
4     123   830     2     145 MULTIPOLYGON (((-76.00897 3...
5    1066  1606     3    1197 MULTIPOLYGON (((-77.21767 3...
6     954  1838     5    1237 MULTIPOLYGON (((-76.74506 3...
```

If we open up the R help file for plot after loading sf using `?plot`, we have the option to select documentation for the plot function in the sf package by clicking on the link labeled "plot sf object". In the `sf::plot` help page there are many more arguments listed in the Usage and Arguments sections. In particular, we can specify the position of the key (legend), plot the data on a log scale, and add a title.

```
plot_title = 'Live Births in North Carolina from 1974-1978'

plot(nc['BIR74'], key.pos=1, logz=TRUE, main=plot_title)
```



3.6 Details

(optional)

The this section generally contains information that is important but may not clearly fit in any of the other sections. It is often where I go looking for help when I run into a problem that I can't easily solve. Details covers the "behavior" of a function, or how a function accomplishes its task. This is especially important for functions that "behave" differently when you change the value of certain arguments. The help file for the covariance and correlation functions (`cov` and `cor`) is one example of this. The Details section describes how the functions work for each of the five options for the `use` argument. This includes telling you that one of them ("pairwise.complete.obs") only works if you use `method="pearson"`. If the function in question implements a mathematical formula, the Details section may also include the formula, like in the case of `?dist`.

3.7 Value

(almost always present)

The Value section tells you what a function will return after it completes. If you save the output of the function to a variable, this is the information that will be stored in the variable. The Value section will generally specify the class of the object as well the information the

object contains. Some functions do not return a value. If this is the case, the Value section may specify that the function doesn't return anything or the Value section may be missing. Just because something displays in your console after running a function does not mean R returned anything. This is true for the function `str()`.

3.8 Note

(optional)

The Note section is a second Details section for less critical pieces of information. You may find information here useful for troubleshooting if the Details section does not solve your problem. In the help file for the `data.frame()` function, it tells us that if we need code to be compatible with versions of R earlier than R 2.4.0, the class of our row.names argument needs to be a character vector.

3.9 Author(s)

(optional)

The Authors(s) section lists the authors who wrote the function or package in question. It is more common to see for packages but there are some functions that mention specific authors as well, as is the case for `lm()`.

3.10 References

(optional)

If the function implements a formula, statistical method, algorithm, procedure, or data structure developed elsewhere, the References section will include the citation for the original source. For example, the References section for `data.frame()` cites a textbook on the S programming language, R's precursor.

3.11 See Also

(optional)

If the function whose documentation you are reviewing doesn't do exactly what you want, the See Also section is a good section to peruse. See Also contains links to the documentation files for functions that are similar to the function to the function you are investigating. This could

include functions that implement a modified formula (like weighted means), or methods that are implemented for a different class like the summary method for a linear regression model (`lm`) object. It also may include methods that can be used with a given class of object, like in the case of the `lm()` help file.

3.12 Examples

(almost always present)

The Examples section is by far the most useful section for beginners. It contains example code that can be run on any computer without loading any additional packages or data. You can copy and paste it into your console and it should just work. It is a great place to start if you have absolutely no experience with a function or package, or if you have tried everything and nothing seems to work. The examples can also help you understand how a function expects the input data to be structured.

Finally, the Examples section can also be a good place to get code to tinker with when trying to understand how a function works. For example, if you don't understand the description of the `digits` argument in the `summary()` documentation, you can use the code in the Examples section as a starting point.

```
#copied directly from the Examples section
summary(attenu, digits = 4)
```

```
     event            mag           station         dist
 Min.   : 1.00   Min.   :5.000   117     :  5   Min.   :  0.50
 1st Qu.: 9.00   1st Qu.:5.300   1028    :  4   1st Qu.: 11.32
 Median :18.00   Median :6.100   113     :  4   Median : 23.40
 Mean   :14.74   Mean   :6.084   112     :  3   Mean   : 45.60
 3rd Qu.:20.00   3rd Qu.:6.600   135     :  3   3rd Qu.: 47.55
 Max.   :23.00   Max.   :7.700   (Other):147   Max.   :370.00
                                 NA's    : 16
     accel
 Min.   :0.00300
 1st Qu.:0.04425
 Median :0.11300
 Mean   :0.15422
 3rd Qu.:0.21925
 Max.   :0.81000
```

You can then modify the digits argument to see what effect this has on the function's output.

```
summary(attenu, digits = 1)
```

```
     event          mag       station          dist           accel
 Min.   : 1   Min.   :5   117    :  5   Min.   :  0.5   Min.   :0.003
 1st Qu.: 9   1st Qu.:5   1028   :  4   1st Qu.: 11.3   1st Qu.:0.044
 Median :18   Median :6   113    :  4   Median : 23.4   Median :0.113
 Mean   :15   Mean   :6   112    :  3   Mean   : 45.6   Mean   :0.154
 3rd Qu.:20   3rd Qu.:7   135    :  3   3rd Qu.: 47.5   3rd Qu.:0.219
 Max.   :23   Max.   :8   (Other):147   Max.   :370.0   Max.   :0.810
                          NA's   : 16
```

It is rare that the code in the Examples section will do exactly what you want right off the bat. That does not mean the code is not useful. The key is to use this code as a starting point, code that you know runs, and then work from there.

3.13 Further Reading

- Getting Help with R