A recent topic of the Write The Docs’ great newsletter was [READMEs](https://www.writethedocs.org/blog/newsletter-july-2019/#readmes-on-readmes-and-other-readme-related-resources). It read *“As they’re often the first thing people see about a code project, READMEs are pretty important to get right.”*. In this post, we’ll share some insights around the READMEs of R packages: why they’re crucial; what they usually contain; how you can best write yours. Let’s dive in! 

**Why is a good README key**

As mentioned above, the WTD newsletter stated that READMEs are often the first entry point to a project. For a package you could think of other entry points such as the CRAN homepage, but the README remains quite important as seen in the poll below

When I try to become acquainted with a new (to me) [#rstats](https://twitter.com/hashtag/rstats?src=hash&ref_src=twsrc%5Etfw) package, I prefer to read \_\_\_\_\_\_\_\_\_\_\_

— Jonathan Carroll (@carroll\_jono) [March 2, 2018](https://twitter.com/carroll_jono/status/969442252610191361?ref_src=twsrc%5Etfw)

A good README is crucial to recruit users that’ll actually gain something from using your package. As written by [noffle](https://github.com/noffle/) in [the Art of README](https://github.com/noffle/art-of-readme),

“your job, when you’re doing it with optimal altruism in mind, isn’t to “sell” people on your work. It’s to let them evaluate what your creation does as objectively as possible, and decide whether it meets their needs or not – not to, say, maximize your downloads or userbase.”

Furthermore, you can recycle the content of your README in other venues (more on how to do that – without copy-pasting – later) like that vignette mentioned in the poll. If you summarize your package in a good one-liner for the top of the README,

> Connect to R-hub, from R

you can re-use it

* as Package Title in DESCRIPTION,

Title: Connect to 'R-hub'

* in the GitHub repo description,
* in your introduction at a social event (ok, maybe not).

Other parts of a pitch are good talk fodder, blog post introductions, vignette sections, etc. Therefore, the time you spend pitching your package in the best possible way is a gift that’ll keep on giving, to your users and you.

**What is a good README**

In the Art of README, noffle [includes a checklist](https://github.com/noffle/art-of-readme#bonus-the-readme-checklist); and the rOpenSci dev guide [features guidance about the README](https://devguide.ropensci.org/building.html#readme). Now, what about good READMEs in the wild? In this section, we’ll have a look at a small sample of READMEs.

**Sampling READMEs**

We shall start by merging the lists of top downloaded and trending CRAN packages one can obtain using [pkgsearch](https://r-hub.github.io/pkgsearch/).

library("magrittr")

trending <- pkgsearch::cran\_trending()

top <- pkgsearch::cran\_top\_downloaded()

pkglist <- unique(c(trending[["package"]], top[["package"]]))

This is a list of 184 package names, including effectsize, Copula.Markov, leaflet.providers, farver, renv and httptest. Then, again with pkgsearch, we’ll extract their metadata, before keeping only those that have a GitHub README. More arbitrary choices. 

meta <- pkgsearch::cran\_packages(pkglist)

meta <- meta %>%

dplyr::mutate(URL = strsplit(URL, "\\,")) %>%

tidyr::unnest(URL) %>%

dplyr::filter(stringr::str\_detect(URL, "github\\.com")) %>%

dplyr::mutate(URL = stringr::str\_remove\_all(URL, "\\(.\*")) %>%

dplyr::mutate(URL = stringr::str\_remove\_all(URL, "\\#.\*")) %>%

dplyr::mutate(URL = trimws(URL)) %>%

dplyr::select(Package, Title, Date, Version,

URL) %>%

dplyr::mutate(path = urltools::path(URL)) %>%

dplyr::mutate(path = stringr::str\_remove(path, "\\/$")) %>%

tidyr::separate(path, sep = "\\/", into = c("owner", "repo"))

str(meta)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 122 obs. of 7 variables:

## $ Package: chr "effectsize" "leaflet.providers" "farver" "httptest" ...

## $ Title : chr "Indices of Effect Size and Standardized Parameters" "Leaflet Providers" "High Performance Colour Space Manipulation" "A Test Environment for HTTP Requests" ...

## $ Date : chr NA NA NA NA ...

## $ Version: chr "0.0.1" "1.9.0" "2.0.1" "3.2.2" ...

## $ URL : chr "<https://github.com/easystats/effectsize>" "<https://github.com/rstudio/leaflet.providers>" "<https://github.com/thomasp85/farver>" "<https://github.com/nealrichardson/httptest>" ...

## $ owner : chr "easystats" "rstudio" "thomasp85" "nealrichardson" ...

## $ repo : chr "effectsize" "leaflet.providers" "farver" "httptest" ...

At this point we have 122 packages with 122 unique GitHub repo URLs, pfiew.

We’ll then extract their [preferred README from the GitHub V3 API](https://developer.github.com/v3/repos/contents/#get-the-readme). Some of them won’t even have one so we’ll lose them from the sample.

gh <- memoise::memoise(ratelimitr::limit\_rate(gh::gh,

ratelimitr::rate(1, 1)))

get\_readme <- function(owner, repo){

readme <- try(gh("GET /repos/:owner/:repo/readme",

owner = owner, repo = repo),

silent = TRUE)

if(inherits(readme, "try-error")){

return(NULL)

}

lines <- suppressWarnings(

readLines(

readme$download\_url

)

)

if (length(lines) == 1){

sub(readme$path, lines,

readme$download\_url) -> link

} else {

link <- readme$download\_url

}

tibble::tibble(owner = owner,

repo = repo,

readme = list(suppressWarnings(readLines(link))))

}

readmes <- purrr::map2\_df(.x = meta$owner, .y = meta$repo,

.f = get\_readme)

The readmes data.frame has 117 lines so we lost a few more packages.

**Assessing README size**

**Number of lines**

A first metric we’ll extract is the number of lines of the README.

count\_lines <- function(readme\_lines){

readme\_lines %>%

purrr::discard(. == "") %>% # emtpy lines

purrr::discard(stringr::str\_detect(., "\\<\\!\\-\\-")) %>% # html comments

length()

}

readmes <- dplyr::group\_by(readmes, owner, repo) %>%

dplyr::mutate(lines\_no = count\_lines(readme[[1]])) %>%

dplyr::ungroup()

How long are usual READMEs? Their number of lines range from 2 to 1426 with a median of 85.

library("ggplot2")

ggplot(readmes) +

geom\_histogram(aes(lines\_no), binwidth = 5) +

xlab("No. of lines") +

scale\_y\_continuous(NULL, breaks = NULL) +

hrbrthemes::theme\_ipsum(base\_size = 16,

axis\_title\_size = 16) +

ggtitle(glue::glue("Number of lines in a sample of {nrow(readmes)} READMEs"))

Figure 1: Dot plot of the number of lines in READMEs

READMEs in our sample most often don’t have more than 200 lines. Now, this metric might indicate how much a potential user needs to take in and how long they need to scroll down but we shall now look into other indicators of size: the number of lines of R code, the number of words outside of code and output.

**Other size indicators**

To access the numbers we’re after without using too many regular expressions, [we shall convert the Markdown content to XML via commonmark and use XPath to parse it](https://ropensci.org/technotes/2018/09/05/commonmark/).

get\_xml <- function(readme\_lines){

readme\_lines %>%

glue::glue\_collapse(sep = "\n") %>%

commonmark::markdown\_xml(normalize = TRUE,

hardbreaks = TRUE) %>%

xml2::read\_xml() %>%

xml2::xml\_ns\_strip() -> xml

xml2::xml\_replace(xml2::xml\_find\_all(xml, "//softbreak"),

xml2::read\_xml("\n"))

list(xml)

}

readmes <- dplyr::group\_by(readmes, owner, repo) %>%

dplyr::mutate(xml\_readme = get\_xml(readme[[1]])) %>%

dplyr::ungroup()

This is how a single README XML looks like:

readmes$xml\_readme[[1]]

## {xml\_document}

##

## [1] \n effectsize \n ...

## [2] \n Si ...

## [4] \n The goal of this package is to ...

## [5] \n Installation\n< ...

## [6] \n Run the following:\ninstall.packages("devtools")\n ...

## [8] library("effectsize")\n\n Documentation\n ...

## [10] \n Click on the buttons above to ...

## [12] \n \n \n \n Features\n\n This package is focused on ind ...

## [15] \n Effect Size Computatio ...

## [16] \n Basic Indices (Cohen’s ...

## [17] \n The package provides functions ...

## [18] cohens\_d(iris$Sepal.Length, ir ...

## [19] \n ANOVAs (Eta\n ...

## [20] model <- aov(Sepal.Length ~ ...

## ...

Let’s count lines of code.

get\_code\_lines <- function(xml) {

if(is.null(xml)) {

return(NULL)

}

xml2::xml\_find\_all(xml, "code\_block") %>%

purrr::keep(xml2::xml\_attr(., "info") == "r") %>%

xml2::xml\_text() %>%

length

}

loc <- readmes %>%

dplyr::group\_by(repo, owner) %>%

dplyr::summarise(loc = get\_code\_lines(xml\_readme[[1]]))

The number of lines of code of READMEs range from 0 (for 31 READMEs) to 41 with a median of 2.

What about words in text?

get\_wordcount <- function(xml, package) {

if(is.null(xml)) {

return(NULL)

}

xml %>%

xml2::xml\_find\_all("\*[not(self::code\_block) and not(self::html\_block)]") %>%

xml2::xml\_text() %>%

glue::glue\_collapse(sep = " ") %>%

tibble::tibble(text = .) %>%

tidytext::unnest\_tokens(word, text) %>%

nrow()

}

words <- readmes %>%

dplyr::group\_by(repo, owner) %>%

dplyr::summarise(wordcount = get\_wordcount(xml\_readme[[1]]))

The number of words in READMEs range from 13 to 2105 with a median of 278.

The README size might depend on the package interface size itself, i.e. a package with a single function/dataset probably doesn’t warrant many lines. Beyond a certain interface size or complexity, one might want to make it easier on potential users by breaking up documentation into smaller articles, instead of showing all there is in one page.

Now, a helpful way to still convey information efficiently when there are more than a few things is a good README *structure*. Besides, a good structure is important for READMEs of all sizes.

**Glimpsing at README structure**

To assess README structures a bit, we first need to extract headers.

get\_headings <- function(xml) {

if(is.null(xml)) {

return(NULL)

}

xml %>%

xml2::xml\_find\_all("heading") -> headings

list(tibble::tibble(text = xml2::xml\_text(headings),

position = seq\_along(headings),

level = xml2::xml\_attr(headings, "level")))

}

structure <- readmes %>%

dplyr::group\_by(repo, owner) %>%

dplyr::mutate(structure = get\_headings(xml\_readme[[1]])) %>%

dplyr::ungroup()

Here’s the structure of the 42th README.

structure$structure[42][[1]]

## # A tibble: 12 x 3

## text position level

##

## 1 Creating Pretty Documents From R Markdown 1 2

## 2 Themes for R Markdown 2 3

## 3 The prettydoc Engine 3 3

## 4 Options and Themes 4 3

## 5 Offline Math Expressions 5 3

## 6 Related Projects 6 3

## 7 Gallery 7 3

## 8 Cayman (demo page) 8 4

## 9 Tactile (demo page) 9 4

## 10 Architect (demo page) 10 4

## 11 Leonids (demo page) 11 4

## 12 HPSTR (demo page) 12 4

We wrote an ugly long and imperfect function to visualize the structure of any of the sampled READMEs, inspired by not ugly and better code in [fs](https://github.com/r-lib/fs/blob/master/R/tree.R).

Click to see the function.

pc <- function(...) {

paste0(..., collapse = "")

}

print\_readme\_structure <- function(structure){

structure$parent <- NA

for (i in seq\_len(nrow(structure))) {

possible\_parents <- structure$position[structure$level < structure$level[i]

& structure$position < structure$position[i]]

if (any(possible\_parents)) {

structure$parent[i] <- max(possible\_parents)

} else {

structure$parent[i] <- NA

}

}

structure$parent[structure$level == min(structure$level)] <- 0

for (i in seq\_len(nrow(structure))) {

if (structure$level[i] == 1) {

cat(structure$text[i])

} else {

if(structure$position[i] == max(structure$position[structure$parent==structure$parent[i]])) {

firstchar <- cli:::box\_chars()$l

} else {

firstchar <- cli:::box\_chars()$j

}

cat(

rep(" ", max(

0,

as.numeric(structure$level[i]) - 1

)),

pc(

firstchar,

pc(rep(

cli:::box\_chars()$h,

max(

0,

as.numeric(structure$level[i]) - 1

)

))

), structure$text[i]

)

}

cat("\n")

}

}

In practice,

print\_readme\_structure(structure$structure[42][[1]])

## └─ Creating Pretty Documents From R Markdown

## ├── Themes for R Markdown

## ├── The prettydoc Engine

## ├── Options and Themes

## ├── Offline Math Expressions

## ├── Related Projects

## └── Gallery

## ├─── Cayman (demo page)

## ├─── Tactile (demo page)

## ├─── Architect (demo page)

## ├─── Leonids (demo page)

## └─── HPSTR (demo page)

print\_readme\_structure(structure$structure[7][[1]])

## A Teradata Backend for dplyr

## ├─── Koji Makiyama (@hoxo-m)

## ├─ 1 Overview

## ├─ 2 Installation

## ├─ 3 Details

## ├── 3.1 Usage

## ├── 3.2 Translatable functions

## ├─── 3.2.1 lubridate friendly functions

## ├─── 3.2.2 Treat Boolean

## ├─── 3.2.3 to\_timestamp()

## └─── 3.2.4 cut()

## └── 3.3 Other useful functions

## └─── 3.3.1 blob\_to\_string()

## └─ 4 Related work

print\_readme\_structure(structure$structure[1][[1]])

## effectsize

## ├─ Installation

## └─ Documentation

## Features

## ├─ Effect Size Computation

## ├── Basic Indices (Cohen’s d, Hedges’ g, Glass’ delta)

## ├── ANOVAs (Eta2, Omega2, …)

## └── Regression Models

## ├─ Effect Size Interpretation

## ├─ Effect Size Conversion

## └─ Standardization

## └── Data standardization, normalization and rank-transformation

What are the most common headers?

structure %>%

tidyr::unnest(structure) %>%

dplyr::count(text, sort = TRUE) %>%

dplyr::filter(n > 4) %>%

knitr::kable()

| **text** | **n** |
| --- | --- |
| Installation | 85 |
| Usage | 45 |
| Overview | 23 |
| Code of Conduct | 17 |
| License | 15 |
| Example | 10 |
| Cheatsheet | 9 |
| Features | 9 |
| Getting help | 5 |
| Related work | 5 |

This seems to be quite in line with noffle’s checklist (e.g. having installation instructions). Headers related to the background and to examples might have a title specific to the package, in which case they don’t appear in the table above.

The headers are one thing, their *order* is another one which we won’t analyze in this post. In the Art of README, noffle [discusses “cognitive funneling”](https://github.com/noffle/art-of-readme#cognitive-funneling) which might help you choose an order.

**How to write a good README**

The previous sections aimed at giving an overview of reasons for writing a good README and content of READMEs in the wild, this one should give a few helpful tips.

**Tools for writing and re-using content**

**R Markdown**

In [noffle’s checklist for a README](https://github.com/noffle/art-of-readme#bonus-the-readme-checklist) one item is “Clear, runnable example of usage”. You probably want to go a step further and have “Clear, runnable, executed example of usage” for which using R Markdown is quite handy. Using R Markdown to produce your package README is our number one recommendation.

**usethis’ README templates**

To create the README, you can use either [usethis::use\_readme\_rmd() (for an R Markdown README) or usethis::use\_readme\_md() (for a Markdown README)](https://usethis.r-lib.org/reference/use_readme_rmd.html). The created README file will include a few sections for you to fill in.

**Re-use of Rmd portions in other Rmds**

Then, instead of writing everything in one .Rmd and then copying entire sections of it in a vignette, you can re-use Rmd chunks as explained in [this blog post by Garrick Aden-Buie presenting an idea by Brodie Gaslam](https://www.garrickadenbuie.com/blog/dry-vignette-and-readme/). Compared to that blog post, we recommend keeping re-usable Rmd pieces in man/rmdhunks/ so that they’re available to build vignettes. In the vignettes, use

```{r child='../man/rmdhunks/child.Rmd'}

```

In the README, use

```{r child='man/rmdhunks/child.Rmd'}

```

**Re-use of Rmd portions in manual pages**

Since roxygen2’s latest release, you can include md/Rmd in manual pages. What a handy thing for, say, your [package-level documentation](https://usethis.r-lib.org/reference/use_package_doc.html)! [Refer to roxygen2’s documentation](https://roxygen2.r-lib.org/articles/rd.html#including-external--rmd-md-files).

In the R files use

#' @includeRmd man/rmdhunks/child.Rmd

**Table of contents**

If your README is a bit long you might need to add a table of contents at the top, [as done for pkgsearch README](https://github.com/r-hub/pkgsearch/blob/846ccec71b4dfcc4d7a72257187320c94be8e454/README.Rmd#L5). In a pkgdown website, the README does not get a table of content in the sidebar, which might be an argument for keeping it small as opposed to articles that do get a table of contents in the sidebar.

**Hide clutter in details tags**

You can use the [details package](https://cran.r-project.org/web/packages/details/index.html) to hide some content that’d otherwise clutter the README, but that you still want to be available upon click. You can see it in action [in reactor README](https://github.com/yonicd/reactor/blob/master/README.Rmd).

**How to assess a README**

You should write the package README with potential users in mind, who might not understand the use case for your package, who might not know the tool you’re wrapping or porting, etc. It is not easy to change perspectives, though! Having actual external people review your README, or using the audience feedback after say a talk introducing the package, can help a lot here. Ask someone on your corridor or your usual discussion venues (forums, Twitter, etc.).

**Conclusion**

In this post we discussed the importance of a good package README, mentioned existing guidance, and gave some data-driven clues as to what is a usual README.