

Software Design, Development, and Distribution in R

Boston University BSA Seminar

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Dr. Dietz's Disclaimer

The views expressed in this presentation are strictly my own. They do not necessarily represent the position of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

About Us

- ▶ Friends since meeting in our Statistics PhD program in 2011
- ▶ Co-organizers of R Ladies-Twin Cities and the noRth conference
- ▶ Both cyclists & coffee lovers



Objectives of this talk

```
library(MyFirstPackage)

# Design your R package
design_package()

# Build your R package
build_package()

# Distribute your R package
distribute_package()

#Profit!
```

Our Assumptions

- ▶ You have some experience programming in R
- ▶ You have some experience on Git (i.e. we won't show you how to set it up)
- ▶ You have some custom R functions on your computer that get used repeatedly
- ▶ You have an audience (including yourself) for your code

Best practices for R package design



You nailed it.

What is a design document?



Why use a design document?

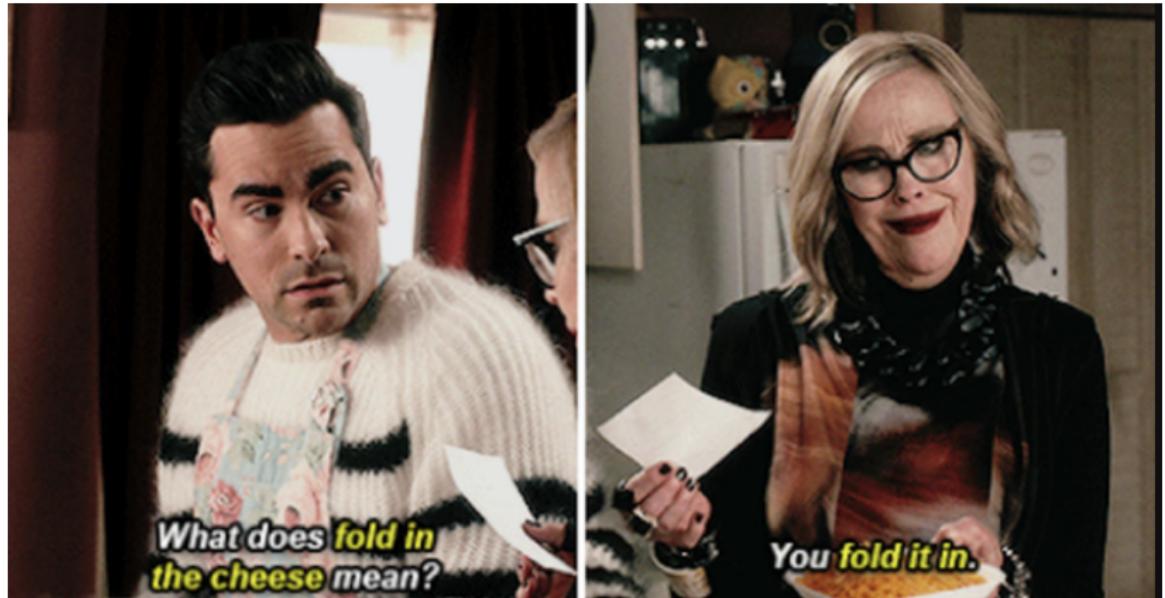


Separates thinking and coding



Imagine creating enchiladas without a recipe!

Forces you to explain everything in detail



Helps you divide the project into smaller tasks



No need to ladle and stir at the same time!

Helps you remember what you'll inevitably forget



Oh my God, is this not
your mother's recipe?

Helps you predict problems and tricky points



What to include in your design document

- ▶ Goal of each function
- ▶ Inputs and outputs of each
- ▶ Flow chart between functions
- ▶ Calculations/equations
- ▶ Any tricky points
- ▶ Numerical stability considerations
- ▶ How you will approach each function (and some pseudo code)
- ▶ Tests you will implement (again goals, details)
- ▶ Helpful sketches
- ▶ Major updates
- ▶ Things you want to add/change in the future

Examples of Design Docs

- ▶ glmm
- ▶ stableGR



Building An R Package

- ▶ You have the building blocks
 - ▶ Repeatable processes
 - ▶ Custom functions
 - ▶ Design document

How it started



How it's going



Create the Package

- ▶ Building R packages used to take expert knowledge. Not anymore!
- ▶ Several R packages and RStudio built-ins exist to help you
 - ▶ Option #1 - Use the RStudio interface: File -> New Project -> New Directory -> R Package
 - ▶ Option #2 - Use the aptly named `usethis` package

```
#install.packages('usethis')
library(usethis)

usethis::create_package("~/MyFirstPackage")
```

(Required) Add your functions

- ▶ Option #1 - Create .R files with your function and move them into the package's R folder
- ▶ Option #2 - usethis package - (**VIDEO LINK**)

```
usethis::use_r('target_psrf')
usethis::use_r('minESS')
```

If R functions are new to you, check out **this resource**

Create (or copy/paste) functions

```
target_psrf <- function(m, p, alpha = 0.05, epsilon = 0.05) {  
  
  # Calculate the minimum effective sample size for the given input parameters  
  Tee <- as.numeric(minESS(p = p, alpha = alpha, epsilon = epsilon))  
  
  # Calculate PSRF  
  psrf <- sqrt(1 + m / Tee)  
  
  return(list(psrf = psrf, epsilon = epsilon))  
}
```

(Required) Add help documentation for functions

- ▶ In an R package, help documentation is mandatory; good documentation is optional (but not really!)
- ▶ While you can create documents manually (in the man folder), the roxygen2 package makes it easy to create the documentation with your code

```
##' @title Target potential scale reduction factor (PSRF)
##' @description This function calculates the target PSRF for a set of MCMC chains.
##' This is adapted from the more complex version in stableGR
##' @param m Number of MCMC chains, e.g. 3 chains implies m = 3
##' @param p Number of parameters being sampled, e.g. (beta1, beta2, beta3) implies p = 3
##' @param alpha Significance level used to compute ESS; defaults to alpha = 0.05 i.e. 5%
##' @param epsilon Relative precision term; fixing all other elements,
##'                 as precision is set smaller, sample size increases; defaults to 0.05
##' @examples
##' target_psrf(m = 2, p = 2, alpha = 0.05, epsilon = 0.05)
##' target_psrf(m = 5, p = 2, alpha = 0.10, epsilon = 0.05)
##' @export target_psrf
##' @references D. Vats and C. Knudson. Revisiting the Gelman-Rubin Diagnostic.
##'             https://arxiv.org/abs/1812.09384
target_psrf <- function(m, p, alpha = 0.05, epsilon = 0.05) {
  # Calculate the minimum effective sample size for the given input parameters
  Tee <- as.numeric(minESS(p = p, alpha = alpha, epsilon = epsilon))
  # Calculate PSRF
```

Help documentation generated by roxygen2

The screenshot shows the RStudio interface with the following details:

- Toolbar:** Files, Plots, Packages, Help, Viewer.
- Search Bar:** target_psrf
- Text Area:** R Documentation for target_psrf {MyFirstPackage}
- Section Headers:** Target potential scale reduction factor (PSRF), Description, Usage, Arguments, References, Examples.
- Description:** This function calculates the target PSRF for a set of MCMC chains. This is adapted from the more complex version in stableGR.
- Usage:** target_psrf(m, p, alpha = 0.05, epsilon = 0.05)
- Arguments:**
 - m: Number of MCMC chains, e.g. 3 chains implies m = 3
 - p: Number of parameters being sampled, e.g. (beta1, beta2, beta3) implies p = 3
 - alpha: Significance level used to compute ESS; defaults to alpha = 0.05 i.e. 5%
 - epsilon: Relative precision term; fixing all other elements, as precision is set smaller, sample size increases; defaults to 0.05
- References:** D. Vats and C. Knudson. Revisiting the Gelman-Rubin Diagnostic. <https://arxiv.org/abs/1812.09384>
- Examples:** None shown.

(Best Practice) Add unit testing for your functions

- ▶ Why test? (**from Hadley Wickham**)
 - ▶ Decreased frustration
 - ▶ Better code structure
 - ▶ Less struggle to pick up development after a break
 - ▶ Increased confidence when making changes
- ▶ The `testthat` package makes it easy to integrate testing into your package especially if you are using the `usethis` package

```
#install.packages(c('usethis','testthat'))  
library(usethis)  
library(testthat)
```

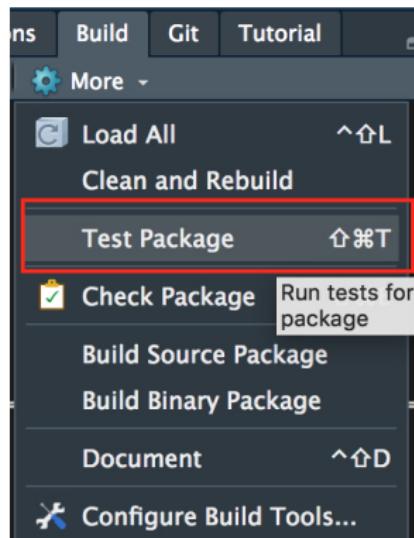
```
usethis::use_testthat()  
usethis::use_test('test-minESS.R')
```

Example of a test

```
test_that("ESS is integer", {  
  
  # Provide arguments  
  p <- 1  
  alpha <- 0.05  
  epsilon <- 0.05  
  
  #Run function  
  out <- MyFirstPackage::minESS(p = p, epsilon = epsilon, alpha = alpha)  
  
  #Check for integer type  
  expect_type(out, "integer")  
})
```

Running your tests

Option #1 Use the tools in RStudio ([VIDEO LINK](#))

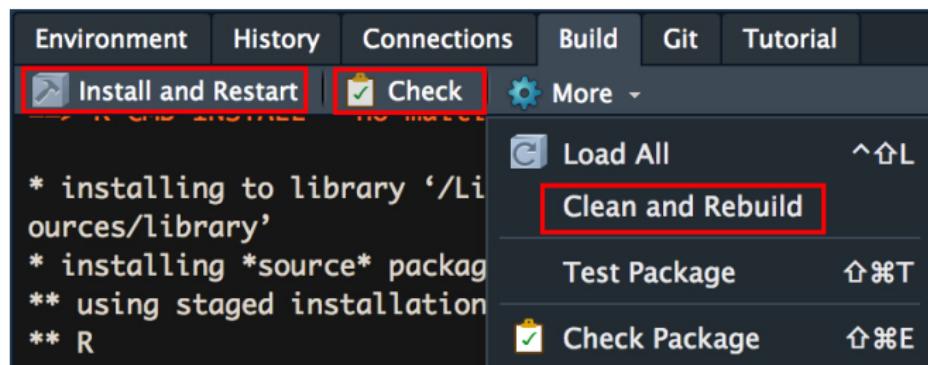


Option #2 Use the `devtools` package (does the same thing)

```
devtools::test()
```

Check, build, and install your package

Option #1 Use the tools in RStudio ([VIDEO LINK](#))



Option #2 Use the `devtools` package (can be useful when things get more complicated)

```
devtools::check()  
devtools::build()  
devtools::install()
```

Customize

- ▶ Add package dependencies, vignettes, etc.!
- ▶ Check out this **comprehensive R package building resource**

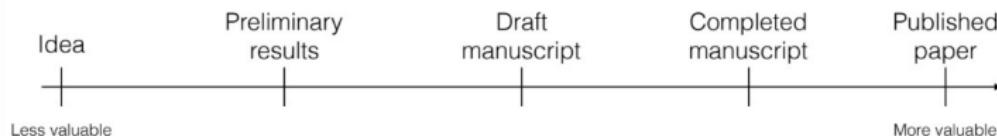


Distribution of Your R Package



Why Distribute Your R Package?

How I used to think of my goals:



How I should have been thinking of them:



From David Robinson's excellent talk at rstudio::conf(2019)

Why Distribute Your R Package?

- ▶ Gains in usership/citations for those in the public domain (academics, nonprofits)
- ▶ Gains in productivity for those in private industries
- ▶ Saving “future you” time with third parties such as audit
- ▶ You control the narrative of your code

Distribution in Git

- ▶ Git has become a dominant version control technique
- ▶ Git makes it easy to (1) track changes over time (2) plan future changes (3) work with teams
- ▶ Git is well integrated into RStudio



(Some) Startup in Github

- ▶ An amazing and free resource for R users is **Jenny Brian's book**
- ▶ Create an account
- ▶ **Create an SSH key**
- ▶ Create a new repository

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? [Import a repository.](#)

Owner * Repository name *

 lamaspacecoyote / MyFirstPackage 

Great repository names are short and memorable. Need inspiration? How about `fluffy-engine?`

Description (optional)

test repo for WiADS demo

Public
Anyone on the internet can see this repository. You choose who can commit.

Private
You choose who can see and commit to this repository.

Initialize this repository with:

Skip this step if you're importing an existing repository.

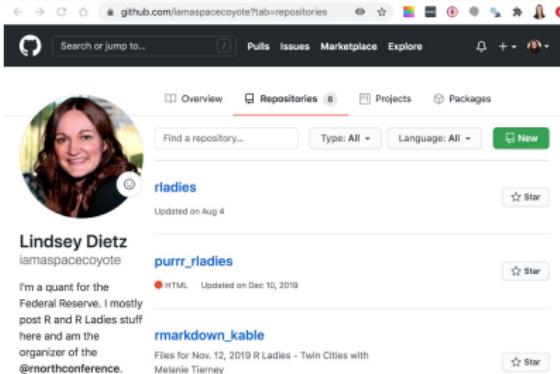
Add a README file
This is where you can write a long description for your project. [Learn more.](#)

.gitignore
Choose which files not to track from a list of templates. [Learn more.](#)

Choose a license
A license tells others what they can and can't do with your code. [Learn more.](#)

This will set `main` as the default branch. Change the default name in your [settings](#).

Create repository



Lindsey Dietz
lamaspacecoyote
I'm a quant for the Federal Reserve. I mostly post R and R Ladies stuff here and am the organizer of the @northconference.

rladies
Updated on Aug 4

purrr_rladies
HTML Updated on Dec 10, 2019

rmarkdown_kable
Files for Nov. 12, 2019 R Ladies - Twin Cities with Melanie Tierney

Git going

- ▶ Clone - ([VIDEO LINK](#))
- ▶ Commit & Push - ([VIDEO LINK](#))

in case of fire 

 git commit

 git push

 git out

Git Jargon

- ▶ **Git has A LOT of jargon.** Don't let it stop you!
- ▶ Some start-up words:
 - ▶ repository (repo) - a remote folder for your things on your Git site of choice (Github, GitLab, etc.)
 - ▶ clone - make a copy of your remote repository on your computer
 - ▶ pull - incorporate changes from a remote repository into your local clone
 - ▶ commit - record changes to your local clone
 - ▶ push - update remote repository with changes from your commits

The Beginning

- ▶ We hope we've planted the seeds for you to build R packages to showcase your work going forward
- ▶ Thanks for being here and for inviting us to join you today

