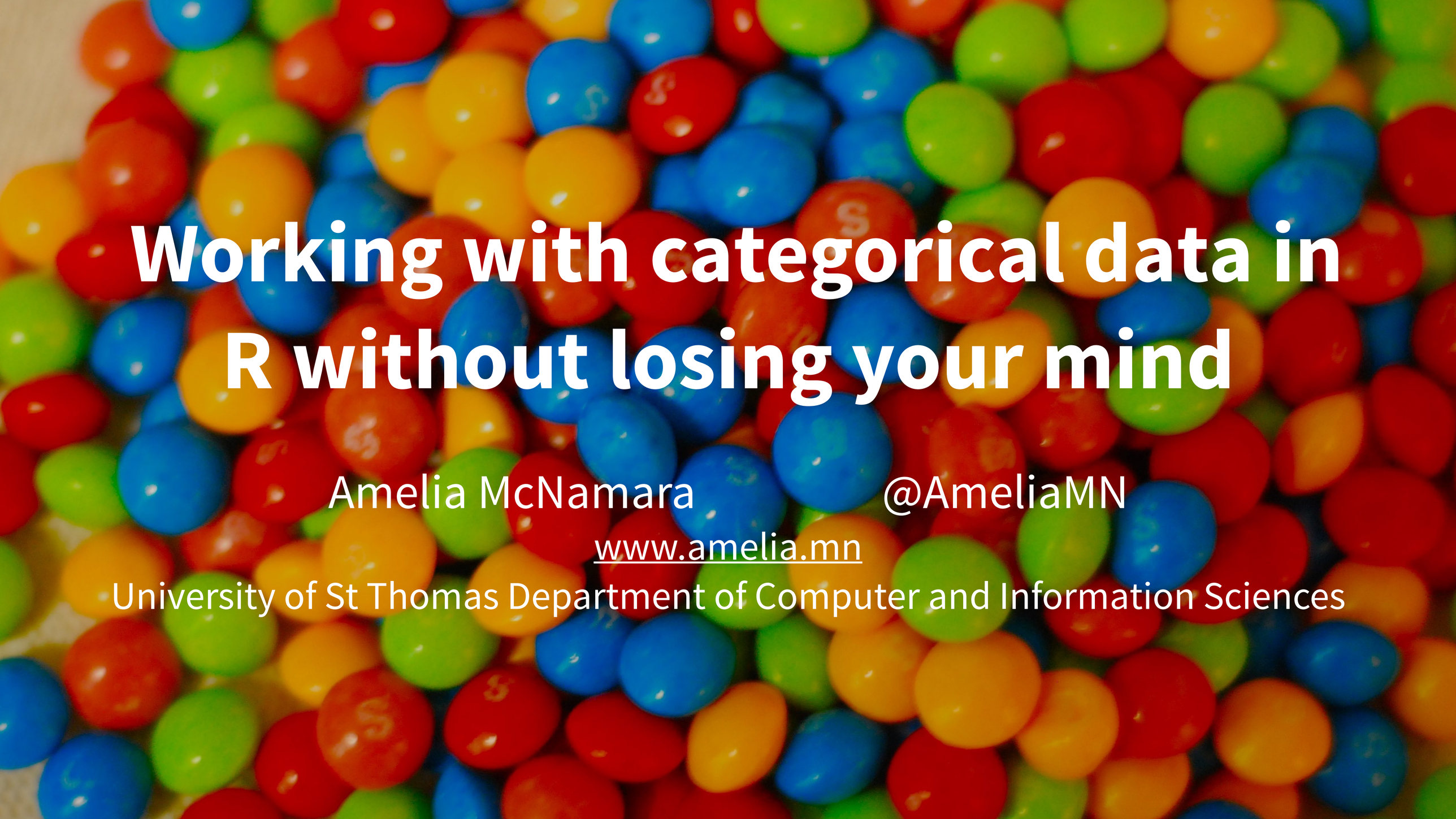

Working with categorical data in R without losing your mind

Amelia McNamara @AmeliaMN

www.amelia.mn

University of St Thomas Department of Computer and Information Sciences

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The "Practical Data Science for Stats" Collection contains preprints focusing on the practical side of data science workflows and statistical analysis. Curated by Jennifer Bryan and Hadley Wickham.

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- Modeling offensive player movement in professional basketball
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- How R helps Airbnb make the most of its data
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- Declutter your R workflow with tidy tools

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Places to Find Data

Finding the right data to answer your particular question is part of your responsibility for this assignment. Public data sets are available from hundreds of different websites, on virtually any topic. You might not be able to find the exact data that you want, but you should be able to find data that is relevant to your topic. You may also want to refine your research question so that it can be more clearly addressed by the data that you found. But be creative! Go find the data that you want!

Below is a list of places to get started, but this list should be considered grossly non-exhaustive:

- Data is Plural tinyletter and associated spreadsheet
- FiveThirtyEight data archive
- Data.gov 186,000+ datasets!
- Social Explorer is a great interface to Census and American Community Survey data (much more user-friendly than the official government sites). Smith has a site license, but you may need to create an account.
- Gallup Analytics (available through the library databases)
- Data and Story Library (DASL). (This, and more ideas from Robin Lock.)
- Jo Hardin at Pomona College has a nice list of data sources on her website.
- U.S. Bureau of Labor Statistics
- U.S. Census Bureau
- Gapminder, data about the world.
- IRE and NICAR are good resources for the types of data journalists care about. For example, Energy data sources and Chrys Wu's resource page.
- Nathan Yau's (old) guide to finding data on the internet

Keep the following in mind as you select your topic and dataset:

- You need to have enough data to make meaningful inferences. There is no magic number of individuals required for all

http://www.amelia.mn/sds220/project.html

THE GENERAL SOCIAL SURVEY

GSS

NORC at the UNIVERSITY of CHICAGO

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The GSS is now accepting proposals for new items and modules on the 2020 General Social Survey. Proposals are due by January 30th.

http://gss.norc.org/

factors

R's representation of categorical data. Consists of:

1. A set of **values**
2. An ordered set of **valid levels**

```
eyes <- factor(x = c("blue", "green", "green"),
               levels = c("blue", "brown", "green"))
eyes
## [1] blue  green green
## Levels: blue brown green
```

Open Wrangling categorical data in R -- Amelia McNamara and Nicholas... #26 Opened by jennybc

AmeliaMN commented on May 4, 2016

I'm just coming off of final student projects, so I'm thinking about things that might be useful to new data practitioners in R. Some ideas

1. A comparison of different ways to express the same action using different syntaxes. Probably I would focus on subsetting in different ways (rows/columns). For example, `mtcars %>% select(wt)` versus `mtcars[,6]` versus `mtcars[,"wt"]` or `mtcars %>% filter(mpg>30)` versus `mtcars[mtcars$mpg>30,]` Other than subsetting, I could also look at ways to create new variables, e.g. `mtcars %>% mutate(ratio = gear/carb)` versus `mtcars$ratio <- mtcars$gear/mtcars$carb` This one might be too simplistic and/or too related to #8.

2. Explanation of factors and how to recode them. I might need to talk to **@hadley** about best practices here, because my current solutions are a bit hacky and I often get warning messages. There are a few different factor issues I/my students often run into.

   a. Starting with the simplest: you want to change the formatting of the factor labels so they all start with a capital letter. When doing this, it is so easy to accidentally ruin your data, so you need a little EDA workflow: look at the `summary()` of the factor and note the numbers in each category, then try your level changes, then look at the `summary()` again.

   c. Another problem is reordering factor levels-- maybe because you want ggplot2 to show them in a particular order, or because there is some inherent order to your levels. Again, I often do `SummaryStats <- SummaryStats %>% mutate(Treatment = factor(Treatment, levels=c("Control", "E25", "E50", "E100")))` and ruin everything before I remember it's actually `SummaryStats <- SummaryStats %>% mutate(treatment = factor(treatment, levels=levels(treatment)[c(1,3,4,2)]))`

   b. Even easier to mess up is when you have a categorical variable with 10+ categories and want to condense down to 3-4. Again, this is where my hack often runs into errors.

None yet

Milestone

No milestone

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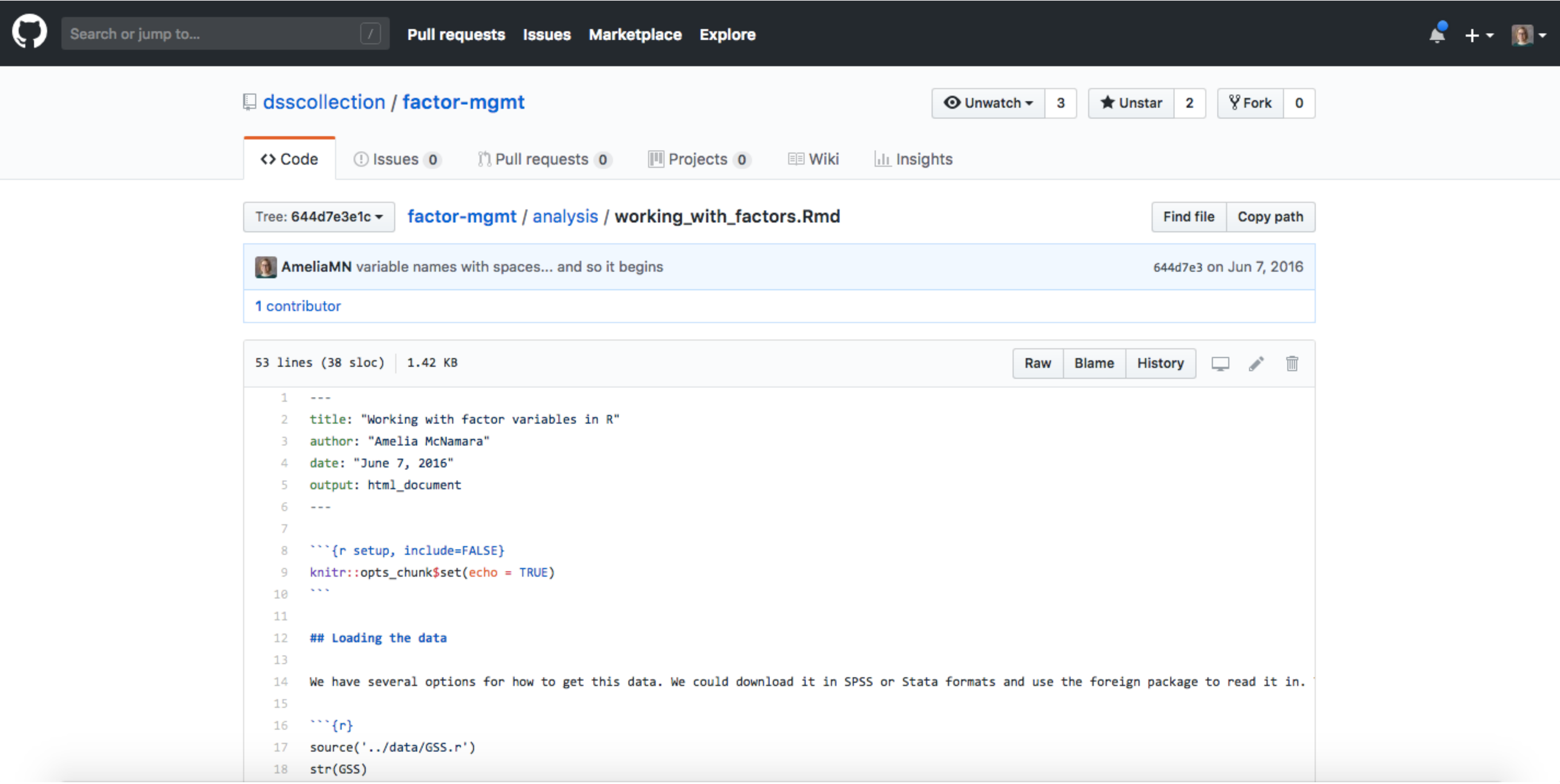

https://github.com/dsscollection/factor-mgmt

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Wrangling categorical data in R

Research article | Computer Education | Data Science | Scientific Computing and Simulation | Social Computing

Me

@askdrstats

Amelia McNamara[1], Nicholas J Horton[2]

August 30, 2017

http://bit.ly/WranglingCats

Highlighted in Practical Data Science for Stats

Author and article information

Abstract

Data wrangling is a critical foundation of data science, and wrangling of categorical data is an important component of this process. However,

Journal
The American Statistician ›
Volume 72, 2018 - Issue 1: Special Issue on Data Science

Article

Wrangling Categorical Data in R

Amelia McNamara & Nicholas J. Horton

Pages 97-104 | Received 01 May 2017, Accepted author version posted online: 27 Jul 2017, Published online: 27 Jul 2017

 https://doi.org/10.1080/00031305.2017.1356375

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[b] Department of Mathematics and Statistics, Amherst College, Amherst, MA

CONTACT Amelia McNamara *amcnamara@smith.edu* Program in Statistical and Data Sciences,

```
> x <- c(20, 20, 10, 40, 10)
> x
[1] 20 20 10 40 10
> xf <- factor(x)
> xf
[1] 20 20 10 40 10
Levels: 10 20 40
> as.numeric(xf)
[1] 2 2 1 3 1
>
```

```
> factor("a", levels=c("b"))
[1] <NA>
Levels: b
> 
```

Data Input

Description

Reads a file in table format and creates a data frame from it, with cases corresponding to lines and variables to fields in the file.

Usage

```
read.table(file, header = FALSE, sep = "", quote = "\"'",
           dec = ".", numerals = c("allow.loss", "warn.loss", "no.loss"),
           row.names, col.names, as.is = !stringsAsFactors,
           na.strings = "NA", colClasses = NA, nrows = -1,
           skip = 0, check.names = TRUE, fill = !blank.lines.skip,
           strip.white = FALSE, blank.lines.skip = TRUE,
           comment.char = "#",
           allowEscapes = FALSE, flush = FALSE,
           stringsAsFactors = default.stringsAsFactors(),
           fileEncoding = "", encoding = "unknown", text, skipNul = FALSE)

read.csv(file, header = TRUE, sep = ",", quote = "\"",
         dec = ".", fill = TRUE, comment.char = "", ...)

read.csv2(file, header = TRUE, sep = ";", quote = "\"",
          dec = ",", fill = TRUE, comment.char = "", ...)

read.delim(file, header = TRUE, sep = "\t", quote = "\"",
           dec = ".", fill = TRUE, comment.char = "", ...)
```

stringsAsFactors: An unauthorized biography

Roger Peng 2015/07/24

Recently, I was listening in on the conversation of some colleagues who were discussing a bug in their R code. The bug was ultimately traced back to the well-known phenomenon that functions like 'read.table()' and 'read.csv()' in R convert columns that are detected to be character/strings to be factor variables. This lead to the spontaneous outcry from one colleague of

> Why does stringsAsFactors not default to FALSE????

The argument 'stringsAsFactors' is an argument to the 'data.frame()' function in R. It is a logical that indicates whether strings in a data frame should be treated as factor variables or as just plain strings. The argument also appears in 'read.table()' and related functions because of the role these functions play in reading in table data and converting them to data frames. By default, 'stringsAsFactors' is set to TRUE.

This argument dates back to May 20, 2006 when it was originally introduced into R as the 'charToFactor' argument to 'data.frame()'. Soon afterwards, on May 24, 2006, it was changed to 'stringsAsFactors' to be compatible with S-PLUS by request from Bill Dunlap.

Most people I talk to today who use R are completely befuddled by the fact that 'stringsAsFactors' is set to TRUE by default. First of all, it should be noted that before the 'stringsAsFactors' argument even existed, the behavior of R was to coerce all character strings to be factors in a data frame. If you didn't want this behavior, you had to manually coerce each column to be character.

So here's the story:

In the old days, when R was primarily being used by statisticians and statistical types, this setting strings to be

https://simplystatistics.org/2015/07/24/stringsasfactors-an-unauthorized-biography/

Jenny Bryan
@JennyBryan

Following

Replying to @kwbroman

@kwbroman @hspter @_inundata @sgrifter @hadleywickham I'm ready for the mixer

10:25 AM - 8 Aug 2015

6 Retweets **50** Likes

5 6 50

Read a delimited file (including csv & tsv) into a tibble

Description

`read_csv()` and `read_tsv()` are special cases of the general `read_delim()`. They're useful for reading the most common types of flat file data, comma separated values and tab separated values, respectively. `read_csv2()` uses `;` for separators, instead of `,`. This is common in European countries which use `,` as the decimal separator.

Usage

```
read_delim(file, delim, quote = "\"", escape_backslash = FALSE,
  escape_double = TRUE, col_names = TRUE, col_types = NULL,
  locale = default_locale(), na = c("", "NA"), quoted_na = TRUE,
  comment = "", trim_ws = FALSE, skip = 0, n_max = Inf,
  guess_max = min(1000, n_max), progress = show_progress())

read_csv(file, col_names = TRUE, col_types = NULL,
  locale = default_locale(), na = c("", "NA"), quoted_na = TRUE,
  quote = "\"", comment = "", trim_ws = TRUE, skip = 0, n_max = Inf,
  guess_max = min(1000, n_max), progress = show_progress())

read_csv2(file, col_names = TRUE, col_types = NULL,
  locale = default_locale(), na = c("", "NA"), quoted_na = TRUE,
  quote = "\"", comment = "", trim_ws = TRUE, skip = 0, n_max = Inf,
  guess_max = min(1000, n_max), progress = show_progress())

read_tsv(file, col_names = TRUE, col_types = NULL,
  locale = default_locale(), na = c("", "NA"), quoted_na = TRUE,
  quote = "\"", comment = "", trim_ws = TRUE, skip = 0, n_max = Inf,
  guess_max = min(1000, n_max), progress = show_progress())
```

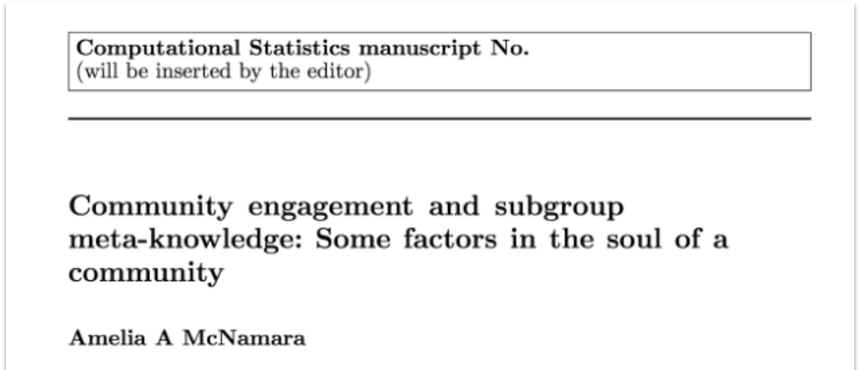
But sometimes, you still need factors…

In particular, for modeling (changing reference levels, etc) and plotting (reordering elements)

```
550  races08$race <- factor(races08$race)
551  levels(races08$race) <- c("Hispanic", "More than one", "Refused", "American Indian
     "Asian", "Black or African-American", "Native Hawaiian or other Pacific Islander",
     "White")
552
```

```
974  kidGroups$neg$Response <- factor(kidGroups$neg$Response,
975                                   levels=levels(kidGroups$neg$Response)[c(2,3,1)]
976
```

https://github.com/COSTDataExpo2013/AmeliaMN



Computational Statistics manuscript No.
(will be inserted by the editor)

Community engagement and subgroup meta-knowledge: Some factors in the soul of a community

Amelia A McNamara

```
> summary(GSS$BaseOpinionOfIncome)
    Above average           Average     Below average        Don't know Far above average
              483              1118               666                21                65
Far below average        No answer              NA's
              179                 6                 2
> GSS$BaseOpinionOfIncome <-
+   factor(GSS$BaseOpinionOfIncome,
+          levels = c("Far above average", "Above average", "Average ", "Below Average",
+                     "Far below average", "Don't know", "No answer"))
> summary(GSS$BaseOpinionOfIncome)
Far above average     Above average           Average     Below Average Far below average
               65               483                 0                 0               179
      Don't know        No answer              NA's
               21                 6              1786
>
```

```
> badApproach <- GSS$OpinionOfIncome
> summary(badApproach)
    Above average           Average     Below average        Don't know Far above average
              483              1118               666                21                65
Far below average        No answer                NA's
              179                 6                 2
> levels(badApproach) <- c("Far above average", "Above average",
+                          "Average", "Below Average", "Far below average",
+                          "Don't know", "No answer")
> summary(badApproach)
Far above average     Above average           Average     Below Average Far below average
              483              1118               666                21                65
       Don't know        No answer                NA's
              179                 6                 2
>
```

```
> badApproach <- GSS$OpinionOfIncome
> summary(badApproach)
    Above average           Average     Below average         Don't know Far above avera
              483              1118               666                21
Far below average        No answer              NA's
              179                 6                 2
> levels(badApproach) <- levels(badApproach)[c(5,1:3,6,4,7)]
> summary(badApproach)
Far above average     Above average           Average     Below average Far below avera
              483              1118               666                21
      Don't know        No answer              NA's
              179                 6                 2
>
```

dsscollection / factor-mgmt

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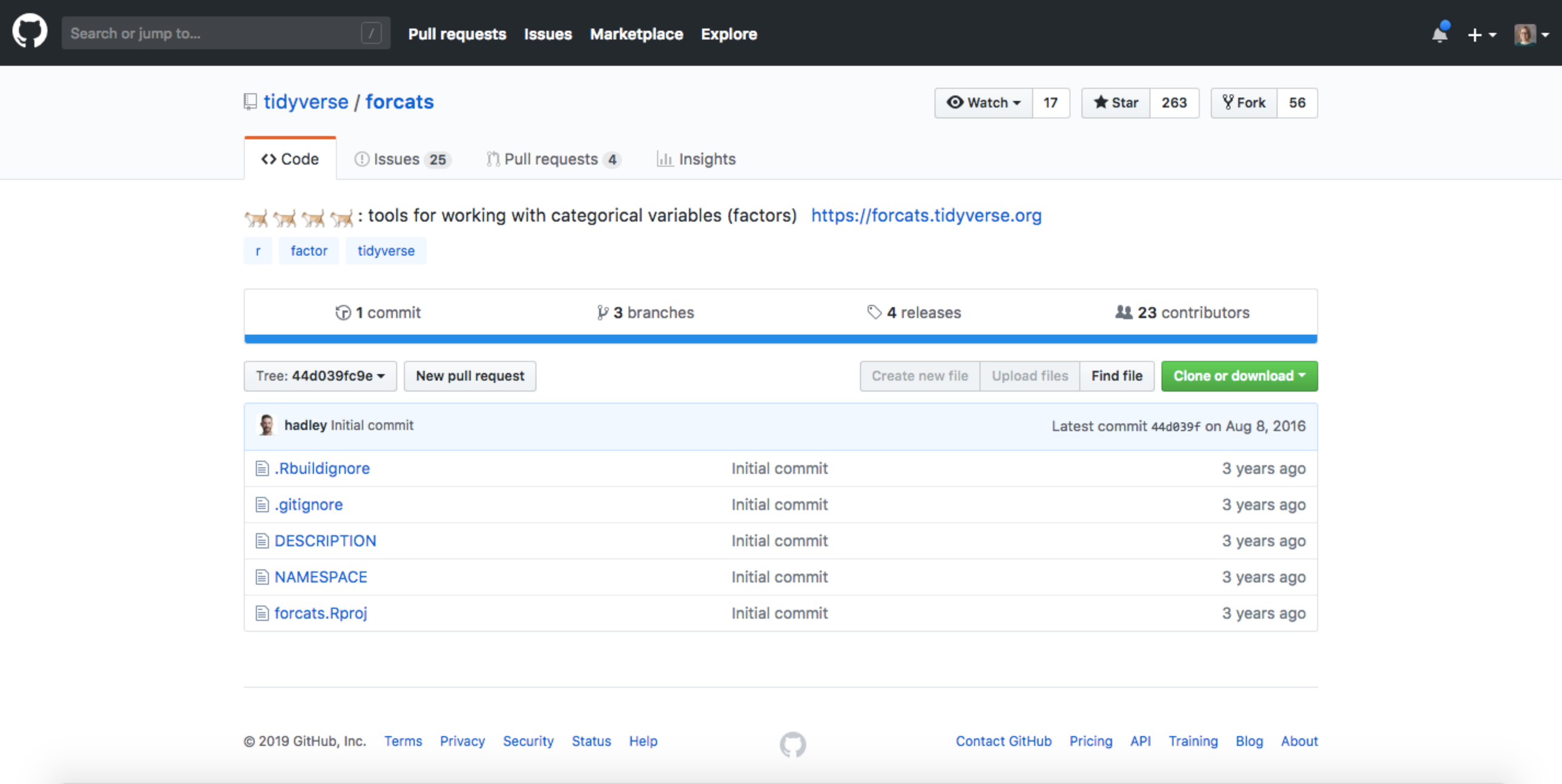


https://github.com/tidyverse/forcats

Level manipulation functions

Values change to match levels

`fct_recode()`	Relabel levels "by hand"
`fct_relevel()`	Reorder levels "by hand"
`fct_reorder()`	Reorder levels by another variable
`fct_collapse()`	Collapse levels "by hand"
`fct_lump()`	Lump levels with small counts together
`fct_other()`	Replace levels with "Other"

R Syntax Comparison : : **CHEAT SHEET**

Dollar sign syntax

```
goal(data$x, data$y)
```

SUMMARY STATISTICS:

one continuous variable:
```
mean(mtcars$mpg)
```

one categorical variable:
```
table(mtcars$cyl)
```

two categorical variables:
```
table(mtcars$cyl, mtcars$am)
```

one continuous, one categorical:
```
mean(mtcars$mpg[mtcars$cyl==4])
mean(mtcars$mpg[mtcars$cyl==6])
mean(mtcars$mpg[mtcars$cyl==8])
```

PLOTTING:

one continuous variable:
```
hist(mtcars$disp)

boxplot(mtcars$disp)
```

one categorical variable:
```
barplot(table(mtcars$cyl))
```

two continuous variables:
```
plot(mtcars$disp, mtcars$mpg)
```

two categorical variables:
```
mosaicplot(table(mtcars$am, mtcars$cyl))
```

one continuous, one categorical:
```
histogram(mtcars$disp[mtcars$cyl==4])
histogram(mtcars$disp[mtcars$cyl==6])
histogram(mtcars$disp[mtcars$cyl==8])

boxplot(mtcars$disp[mtcars$cyl==4])
boxplot(mtcars$disp[mtcars$cyl==6])
boxplot(mtcars$disp[mtcars$cyl==8])
```

WRANGLING:

subsetting:
```
mtcars[mtcars$mpg>30, ]
```

making a new variable:
```
mtcars$efficient[mtcars$mpg>30] <- TRUE
mtcars$efficient[mtcars$mpg<30] <- FALSE
```

Formula syntax

```
goal(y~x|z, data=data, group=w)
```

SUMMARY STATISTICS:

one continuous variable:
```
mosaic::mean(~mpg, data=mtcars)
```

one categorical variable:
```
mosaic::tally(~cyl, data=mtcars)
```

two categorical variables:
```
mosaic::tally(cyl~am, data=mtcars)
```

one continuous, one categorical:
```
mosaic::mean(mpg~cyl, data=mtcars)
```

tilde

PLOTTING:

one continuous variable:
```
lattice::histogram(~disp, data=mtcars)

lattice::bwplot(~disp, data=mtcars)
```

one categorical variable:
```
mosaic::bargraph(~cyl, data=mtcars)
```

two continuous variables:
```
lattice::xyplot(mpg~disp, data=mtcars)
```

two categorical variables:
```
mosaic::bargraph(~am, data=mtcars, group=cyl)
```

one continuous, one categorical:
```
lattice::histogram(~disp|cyl, data=mtcars)

lattice::bwplot(cyl~disp, data=mtcars)
```

The variety of R syntaxes give you many ways to "say" the same thing

read **across** the cheatsheet to see how different syntaxes approach the same problem

Tidyverse syntax

```
data %>% goal(x)
```

SUMMARY STATISTICS:

one continuous variable:
```
mtcars %>% dplyr::summarize(mean(mpg))
```

one categorical variable:
```
mtcars %>% dplyr::group_by(cyl) %>%
dplyr::summarize(n())
```

the pipe

two categorical variables:
```
mtcars %>% dplyr::group_by(cyl, am) %>%
dplyr::summarize(n())
```

one continuous, one categorical:
```
mtcars %>%  dplyr::group_by(cyl) %>%
  dplyr::summarize(mean(mpg))
```

PLOTTING:

one continuous variable:
```
ggplot2::qplot(x=mpg, data=mtcars, geom = "histogram")

ggplot2::qplot(y=disp, x=1, data=mtcars, geom="boxplot")
```

one categorical variable:
```
ggplot2::qplot(x=cyl, data=mtcars, geom="bar")
```

two continuous variables:
```
ggplot2::qplot(x=disp, y=mpg, data=mtcars, geom="point")
```

two categorical variables:
```
ggplot2::qplot(x=factor(cyl), data=mtcars, geom="bar") +
       facet_grid(.~am)
```

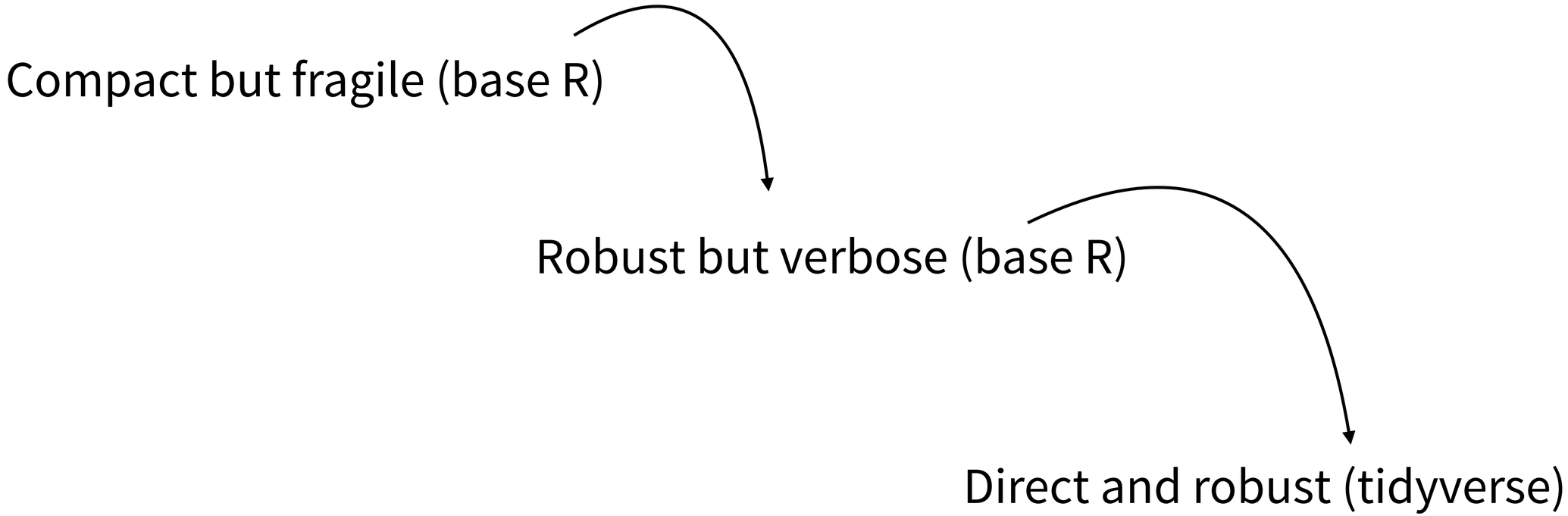
one continuous, one categorical:
```
ggplot2::qplot(x=disp, data=mtcars, geom = "histogram") +
       facet_grid(.~cyl)

ggplot2::qplot(y=disp, x=factor(cyl), data=mtcars,
              geom="boxplot")
```

WRANGLING:

subsetting:
```
mtcars %>% dplyr::filter(mpg>30)
```

making a new variable:
```
mtcars <- mtcars %>%
dplyr::mutate(efficient = if_else(mpg>30,  TRUE, FALSE))
```


https://www.rstudio.com/resources/cheatsheets/


Compact but fragile (base R)
Robust but verbose (base R)
Direct and robust (tidyverse)

```
> library(forcats)
> summary(GSS$OpinionOfIncome)
    Above average           Average     Below average        Don't know Far above average
              483              1118               666                21                65
Far below average        No answer              NA's
              179                 6                 2
> GSS <- GSS %>%
+   mutate(tidyOpinionOfIncome =
+            fct_relevel(OpinionOfIncome,
+                        "Far above average",
+                        "Above average",
+                        "Average",
+                        "Below average",
+                        "Far below average"))
> summary(GSS$tidyOpinionOfIncome)
Far above average     Above average           Average     Below average Far below average
               65               483              1118               666               179
       Don't know        No answer              NA's
               21                 6                 2
>
```

```
> GSS$BaseMarital <- GSS$MaritalStatus
> summary(GSS$BaseMarital)
     Divorced       Married Never married     No answer     Separated         Widowed
          411          1158           675             4            81           209
> levels(GSS$BaseMarital) <- c("Not married", "Married",
+                              "Not married", "No answer",
+                              "Not married", "Not married", NA)
> summary(GSS$BaseMarital)
Not married     Married   No answer        NA's
       1376        1158           4           2
>
```

```
> summary(GSS$MaritalStatus)
     Divorced       Married Never married     No answer     Separated       Widowed          NA's
          411          1158           675             4            81           209             2
> GSS <- GSS %>%
+   mutate(tidyMaritalStatus = recode(MaritalStatus,
+                                     Divorced = "Not married",
+                                     `Never married` = "Not married",
+                                     Widowed = "Not married",
+                                     Separated = "Not married"))
> summary(GSS$tidyMaritalStatus)
Not married     Married   No answer        NA's
       1376        1158           4           2
>
```

Defensive coding

```
> summary(GSS$tidyOpinionOfIncome)
Far above average     Above average           Average     Below average Far below average
               65               483              1118               666               179
      Don't know         No answer              NA's
               21                 6                 2
> summary(GSS$tidyOpinionOfIncome)
Far above average     Above average           Average     Below average Far below average
               65               483              1118               666               179
      Don't know         No answer              NA's
               21                 6                 2
> summary(GSS$tidyOpinionOfIncome)
Far above average     Above average           Average     Below average Far below average
               65               483              1118               666               179
      Don't know         No answer              NA's
               21                 6                 2
>
```

```
> library(assertthat)
> levels(drinkstat)
[1] "abstinent" "highrisk"  "moderate"
> assert_that(length(levels(drinkstat)) == 3)
[1] TRUE
> library(testthat)
> levels(GSS$Sex)
[1] "Female" "Male"
> expect_equivalent(levels(GSS$Sex), c("Female", "Male"))
> expect_equivalent(levels(GSS$Sex), c("Male", "Female"))
Error: levels(GSS$Sex) not equivalent to c("Male", "Female").
2/2 mismatches
x[1]: "Female"
y[1]: "Male"

x[2]: "Male"
y[2]: "Female"
>
```

Takeaways:

- Use `forcats`
- Practice defensive coding
- `summary()` is your friend
- `asserthat` and `testthat`
- Check out http://bit.ly/WranglingCats

Thank you

Amelia McNamara @AmeliaMN

www.amelia.mn

University of St Thomas Department of Computer and Information Sciences