Learning Tidy Evaluation by Reimplementing {dplyr}

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hi!

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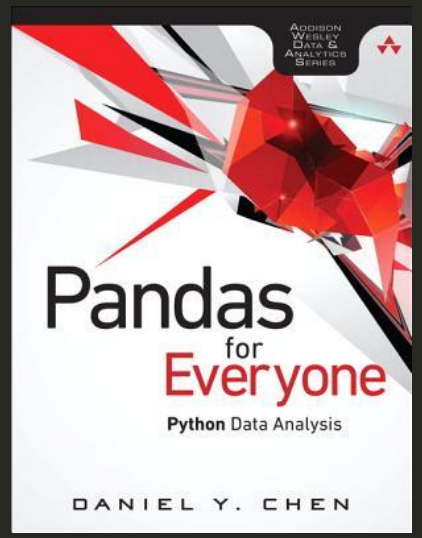


Parts of Tidy Evaluation

1. Quasiquotation
    - Quotation
2. Quosures
    - Quotation
    - Closures
    - Environments
3. Data mask
    - Environments

Learning Tidy Evaluation

- Using {`dplyr`} as an example
  - Something we are familiar with
- Really only using `dplyr::select()`

The Famous Penguin Dataset

```
library(palmerpenguins)
penguins
```

```
## # A tibble: 344 x 8
##    species island bill_length_mm bill_depth_mm flipper_length_~ body_mass_g
##    <fct>   <fct>           <dbl>         <dbl>             <int>       <int>
##  1 Adelie  Torge~           39.1          18.7               181        3750
##  2 Adelie  Torge~           39.5          17.4               186        3800
##  3 Adelie  Torge~           40.3          18                 195        3250
##  4 Adelie  Torge~           NA            NA                  NA          NA
##  5 Adelie  Torge~           36.7          19.3               193        3450
##  6 Adelie  Torge~           39.3          20.6               190        3650
##  7 Adelie  Torge~           38.9          17.8               181        3625
##  8 Adelie  Torge~           39.2          19.6               195        4675
##  9 Adelie  Torge~           34.1          18.1               193        3475
## 10 Adelie  Torge~           42            20.2               190        4250
## # ... with 334 more rows, and 2 more variables: sex <fct>, year <int>
```

Selecting Columns

Selecting columns: [row, col, drop]

```
head(penguins[, "species"]) # for tibble
```

```
## # A tibble: 6 x 1
##   species
##   <fct>
## 1 Adelie
## 2 Adelie
## 3 Adelie
## 4 Adelie
## 5 Adelie
## 6 Adelie
```

```
head(penguins[, c("species", "island")])
```

```
## # A tibble: 6 x 2
##   species island
##   <fct>   <fct>
## 1 Adelie  Torgersen
## 2 Adelie  Torgersen
## 3 Adelie  Torgersen
## 4 Adelie  Torgersen
## 5 Adelie  Torgersen
## 6 Adelie  Torgersen
```

```
head(penguins[, "species", drop = FALSE]) # for data.frame
```

```
## # A tibble: 6 x 1
##   species
##   <fct>
## 1 Adelie
## 2 Adelie
## 3 Adelie
## 4 Adelie
```

Selecting columns: $, drop=TRUE

```
penguins$species
```

```
penguins[, "species", drop = TRUE]
```

```
##   [1] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##   [8] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [15] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [22] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [29] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [36] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [43] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [50] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [57] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [64] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [71] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [78] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [85] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [92] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
##  [99] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
## [106] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
## [113] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
## [120] Adelie    Adelie    Adelie    Adelie    Adelie    Adelie    Adelie
```

Selecting columns: `base::select()`

```
base::subset(
  penguins,
  select = species)
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

```
base::subset(
  x = penguins,
  select = c(species, bill_length_mm))
```

```
## # A tibble: 344 x 2
##    species bill_length_mm
##    <fct>            <dbl>
##  1 Adelie            39.1
##  2 Adelie            39.5
##  3 Adelie            40.3
##  4 Adelie            NA
##  5 Adelie            36.7
##  6 Adelie            39.3
##  7 Adelie            38.9
##  8 Adelie            39.2
##  9 Adelie            34.1
## 10 Adelie            42
## # ... with 334 more rows
```

Selecting columns: `dplyr::select()`

```
dplyr::select(penguins, species)
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

```
penguins %>%
  dplyr::select(species, bill_length_mm)
```

```
## # A tibble: 344 x 2
##    species bill_length_mm
##    <fct>            <dbl>
##  1 Adelie            39.1
##  2 Adelie            39.5
##  3 Adelie            40.3
##  4 Adelie            NA
##  5 Adelie            36.7
##  6 Adelie            39.3
##  7 Adelie            38.9
##  8 Adelie            39.2
##  9 Adelie            34.1
## 10 Adelie            42
## # ... with 334 more rows
```

Selecting columns: index position

```
penguins[, 1, drop = FALSE]
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

```
penguins[, c(1, 3, 5)]
```

```
## # A tibble: 344 x 3
##    species bill_length_mm flipper_length_mm
##    <fct>            <dbl>              <int>
##  1 Adelie            39.1                181
##  2 Adelie            39.5                186
##  3 Adelie            40.3                195
##  4 Adelie            NA                   NA
##  5 Adelie            36.7                193
##  6 Adelie            39.3                190
##  7 Adelie            38.9                181
##  8 Adelie            39.2                195
##  9 Adelie            34.1                193
## 10 Adelie            42                  190
## # ... with 334 more rows
```

Quasiquotation

What is quoting?

What is an expression

The code you write that R interprets and evaluates

```
3 + 3
```

```
## [1] 6
```

Only code you write

```
quote(3 + 3)
```

```
## 3 + 3
```

Lazy evaluation: the `3+3` isn't evaluated right away

```
ex <- quote(3 + 3)
ex
```

```
## 3 + 3
```

```
eval(ex)
```

```
## [1] 6
```

Think of quoting as the strin representation of your code. It's not really a string, but it's a reasonable approximation.

Using {rlang}

```
rlang::expr(3 + 3)
```

```
## 3 + 3
```

```
ex <- rlang::expr(3 + 3)
ex
```

```
## 3 + 3
```

```
eval(ex)
```

```
## [1] 6
```

```
rlang::eval_tidy(ex)
```

```
## [1] 6
```

Expressions: call, symbol, constant, pairlist

```
ex <- quote(3 + 3)
str(ex)
```

```
##  language 3 + 3
```

```
ex <- quote(3)
str(ex)
```

```
##  num 3
```

```
ex <- quote(species)
str(ex)
```

```
##  symbol species
```

Selecting columns

Direct string column

```
penguins[, "species"]
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

Passing a variable

```
col <- "species"
penguins[, col]
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

Selecting columns: Variables need to exist

```
penguins[, species]
```

```
## Error in `[.tbl_df`(penguins, , species): object 'species' not found
```

Selecting: tibble specific (tibble)

```
as.name("species")
```

```
## species
```

```
penguins[, as.name("species")]
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

```
quote(species)
```

```
## species
```

```
penguins[, quote(species)]
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

Selecting: tibble specific (data.frame)

```
iris[, as.name("Species")]
```

```
## Error in .subset(x, j): invalid subscript type 'symbol'
```

```
iris[, quote(Species)]
```

```
## Error in .subset(x, j): invalid subscript type 'symbol'
```

my_select: try 1

```
my_select <- function(data, col) {
  return(
    data[, col, drop = FALSE]
  )
}
```

```
my_select(penguins, "species")
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
```

```
# remeber this is tibble input specific
my_select(penguins, quote(species))
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
## # ... with 334 more rows
```

`my_select`: try 1 needs to quote

```
my_select(penguins, species)
```

```
## Error in `[.tbl_df`(data, , col, drop = FALSE): object 'species' not found
```

`my_select`: try 2

Oh! I just learned how to quote inputs!

```
my_select <- function(data, col) {
  return(
    data[, quote(col), drop = FALSE]
  )
}
```

Nope!

We need a way to capture what the user passed, not the function parameter name.

```
my_select(penguins, species) # quote passed in col, not species
```

```
## Error: Can't subset columns that don't exist.
## x Column `col` doesn't exist.
```

{rlang} enriched expression

Use `rlang::expr()` to capture expressions outside of a function

Use `rlang::enexpr()` to capture expression **inside** a function

```
ex <- rlang::expr(x)
ex
```

```
## x
```

```
fexpr <- function(x) {
  rlang::expr(x)
}
fexpr(hello)
```

```
## x
```

```
fenexpr <- function(x) {
  rlang::enexpr(x)
}
fenexpr(hello)
```

```
## hello
```

my_select: try 3

```
my_select <- function(data, col) {
  return(
    data[, rlang::enexpr(col), drop = FALSE]
  )
}
```

```
my_select(penguins, species)
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
## 10 Adelie
```

```
my_select <- function(data, col) {
  col <- rlang::enexpr(col)
  return(
    data[, col, drop = FALSE]
  )
}
```

```
my_select(penguins, species)
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
##  7 Adelie
##  8 Adelie
##  9 Adelie
```

`my_select`: try 3 on `data.frame`

```
my_select(iris, Species)
```

```
## Error in .subset(x, j): invalid subscript type 'symbol'
```

Remember how we can select on index positions?

my_select: try 4

```
my_select <- function(data, col) {
  col <- rlang::enexpr(col)
  idx <- which(names(data) %in% as.character(col)) # create an index
  return(
    data[, idx, drop = FALSE]                      # subset on the index
  )
}
```

Works on a `tibble`

```
my_select(penguins, species)
```

```
## # A tibble: 344 x 1
##    species
##    <fct>
##  1 Adelie
##  2 Adelie
##  3 Adelie
##  4 Adelie
##  5 Adelie
##  6 Adelie
```

Works on a `data.frame`

```
my_select(iris, Species)
```

```
##        Species
## 1       setosa
## 2       setosa
## 3       setosa
## 4       setosa
## 5       setosa
## 6       setosa
## 7       setosa
## 8       setosa
```

`dplyr::select` source code

```
select <- function(.data, ...) {
  UseMethod("select")
}
```

```
select.data.frame <- function(.data, ...) {
  loc <- tidyselect::eval_select(expr(c(...)), .d
  loc <- ensure_group_vars(loc, .data, notify = T

  dplyr_col_select(.data, loc, names(loc))
}
```

```
dplyr_col_select <- function(.data, loc, names =
  loc <- vec_as_location(loc, n = ncol(.data), na
  ...
  ...
}
```

```
ensure_group_vars <- function(loc, data, notify =
  group_loc <- match(group_vars(data), names(data
  missing <- setdiff(group_loc, loc)

  if (length(missing) > 0) {
    vars <- names(data)[missing]
    if (notify) {
      inform(glue(
        "Adding missing grouping variables: ",
        paste0("`", names(data)[missing], "`", co
      ))
    }
    loc <- c(set_names(missing, vars), loc)
  }

  loc
}
```

`my_selct`: try 5: more variables . . .

`enexpr` for a single variable, `enxprs` for multiple variables

```
my_select <- function(data, ...) {
  cols <- rlang::enexprs(...)                    # the "s" for plural = multiple things
  cols_char <- as.vector(cols, mode = "character")
  idx <- which(names(data) %in% cols_char)
  return(
    data[, idx, drop = FALSE]
  )
}
```

```
my_select(penguins, species, year, island)
```

```
## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
```

```
my_select(iris, Species, Petal.Width)
```

```
##     Petal.Width    Species
## 1           0.2     setosa
## 2           0.2     setosa
## 3           0.2     setosa
## 4           0.2     setosa
## 5           0.2     setosa
## 6           0.4     setosa
## 7           0.3     setosa
```

my_select: try 6: match not which

```
my_select <- function(data, ...) {
  cols <- rlang::enexprs(...)
  cols_char <- as.vector(cols, mode = "character")
  idx <- match(cols_char, names(data))
  return(
    data[, idx, drop = FALSE]
  )
}
```

```
my_select(penguins, species, year, island)
```

```
## # A tibble: 344 x 3
##    species  year island
##    <fct>   <int> <fct>
##  1 Adelie   2007 Torgersen
##  2 Adelie   2007 Torgersen
##  3 Adelie   2007 Torgersen
##  4 Adelie   2007 Torgersen
##  5 Adelie   2007 Torgersen
##  6 Adelie   2007 Torgersen
##  7 Adelie   2007 Torgersen
```

```
my_select(iris, Species, Petal.Width)
```

```
##        Species Petal.Width
## 1       setosa         0.2
## 2       setosa         0.2
## 3       setosa         0.2
## 4       setosa         0.2
## 5       setosa         0.2
## 6       setosa         0.4
## 7       setosa         0.3
## 8       setosa         0.2
## 9       setosa         0.2
```

Quasiquotation: ...-quote-unquote-quote...

In the last try we had:

```
my_select <- function(data, ...) {
  cols <- rlang::enexprs(...)                    # handle the "weirdness"
  cols_char <- as.vector(cols, mode = "character") # unquote the arguments
  idx <- match(cols_char, names(data))           # do regular R things
  return(
    data[, idx, drop = FALSE]
  )
}
```

Variables, quoted, unquoted

```
col_name <- "species"
```

```
penguins[, c(col_name, "island", "year")]
```

```
## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
##  6 Adelie  Torgersen  2007
##  7 Adelie  Torgersen  2007
##  8 Adelie  Torgersen  2007
##  9 Adelie  Torgersen  2007
## 10 Adelie  Torgersen  2007
## # ... with 334 more rows
```

```
penguins %>%
  dplyr::select(col_name, island, year)
```

```
## Note: Using an external vector in selections is ambiguo
## i Use `all_of(col_name)` instead of `col_name` to silen
## i See <https://tidyselect.r-lib.org/reference/faq-exter
## This message is displayed once per session.

## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
##  6 Adelie  Torgersen  2007
##  7 Adelie  Torgersen  2007
##  8 Adelie  Torgersen  2007
```

Variables, quoted, unquoted: `my_select`

Subsets quoted variables

```
my_select(penguins, island, year)
```

```
## # A tibble: 344 x 2
##    island     year
##    <fct>     <int>
##  1 Torgersen  2007
##  2 Torgersen  2007
##  3 Torgersen  2007
##  4 Torgersen  2007
##  5 Torgersen  2007
##  6 Torgersen  2007
##  7 Torgersen  2007
##  8 Torgersen  2007
##  9 Torgersen  2007
## 10 Torgersen  2007
## # ... with 334 more rows
```

Does not work for unquoted variables.

We want `col_name` to be `species`

```
my_select(penguins, col_name, island, year)
```

```
## Error: Can't use NA as column index with `[` at position 1.
```

The problem

Need a way to treat the variable as the variable not as the quoted term

That is...

- Want to unquote `col_name` since the input is automatically quoted using `enexprs`
- Want to replace `col_name` with `species`

Solution

For a single variable we use `!!col_name` to unquote `col_name`

bang-bang ! !

```
col_name <- "species"
```

```
penguins %>%
  my_select("island", "year")
```

```
## # A tibble: 344 x 2
##    island     year
##    <fct>     <int>
##  1 Torgersen  2007
##  2 Torgersen  2007
##  3 Torgersen  2007
##  4 Torgersen  2007
##  5 Torgersen  2007
##  6 Torgersen  2007
##  7 Torgersen  2007
##  8 Torgersen  2007
##  9 Torgersen  2007
## 10 Torgersen  2007
## # ... with 334 more rows
```

```
penguins %>%
  my_select(!!col_name, island, "year")
```

```
## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
##  6 Adelie  Torgersen  2007
##  7 Adelie  Torgersen  2007
##  8 Adelie  Torgersen  2007
##  9 Adelie  Torgersen  2007
## 10 Adelie  Torgersen  2007
## # ... with 334 more rows
```

How to know if a function quotes inputs?

If you pass in the arguments into the function and it works

```
my_select(penguins, island) %>% head(3)
```

```
## # A tibble: 3 x 1
##   island
##   <fct>
## 1 Torgersen
## 2 Torgersen
## 3 Torgersen
```

but if you pass the argument outside the function and it fails

```
island
```

```
## Error in eval(expr, envir, enclos): object 'island' not found
```

```
library(rlang)
```

!! unquoting: selective evalutation on parts of a quoted expression

!!! is !! for ...

!!!

```
cols <- exprs(species, island, year)
cols
```

```
## [[1]]
## species
##
## [[2]]
## island
##
## [[3]]
## year
```

```
class(cols)
```

```
## [1] "list"
```

```
my_select(penguins, !!!cols)
```

```
## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
##  6 Adelie  Torgersen  2007
##  7 Adelie  Torgersen  2007
##  8 Adelie  Torgersen  2007
##  9 Adelie  Torgersen  2007
## 10 Adelie  Torgersen  2007
## # ... with 334 more rows
```

```
my_select(penguins, cols)
```

```
## Error: Can't use NA as column index with `[` at position 1.
```

{dplyr} has one more check

```
col_name <- "species"
```

Bare variable name

```
penguins %>%
  dplyr::select(col_name, island, year)
```

```
## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
##  6 Adelie  Torgersen  2007
##  7 Adelie  Torgersen  2007
##  8 Adelie  Torgersen  2007
##  9 Adelie  Torgersen  2007
## 10 Adelie  Torgersen  2007
## #     with 334 more rows
```

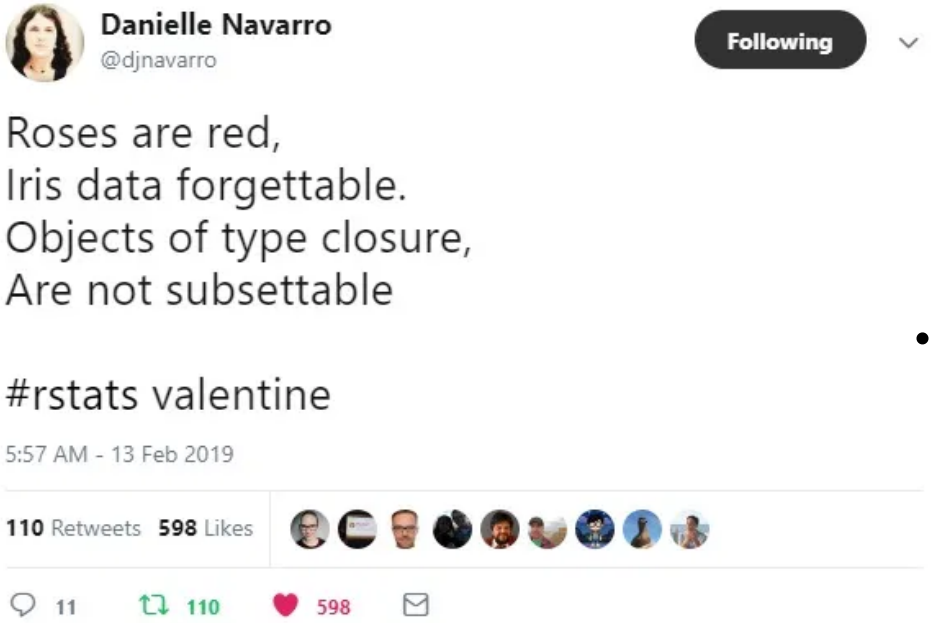
Using `!!` to unquote the variable name

```
penguins %>%
  dplyr::select(!!col_name, island, year)
```

```
## # A tibble: 344 x 3
##    species island     year
##    <fct>   <fct>     <int>
##  1 Adelie  Torgersen  2007
##  2 Adelie  Torgersen  2007
##  3 Adelie  Torgersen  2007
##  4 Adelie  Torgersen  2007
##  5 Adelie  Torgersen  2007
##  6 Adelie  Torgersen  2007
##  7 Adelie  Torgersen  2007
##  8 Adelie  Torgersen  2007
##  9 Adelie  Torgersen  2007
## 10 Adelie  Torgersen  2007
## #     with 334 more rows
```

Quosures = quote + closure

Closure?!




```
df[1]
```

```
## Error in df[1]: object of type 'closure' is not subsettable
```

`df()` is actually a function in `stats::df()`. You can't subset a function.

- Closure = "thing" (e.g., a function, expression) + environment

Environments

```
e <- new.env()
e$x <- 3
```

```
e$x
```

```
## [1] 3
```

```
x
```

```
## Error in eval(expr, envir, enclos): object 'x' not found
```

```
eval(quote(3 + x))
```

```
## Error in eval(quote(3 + x)): object 'x' not found
```

```
eval(quote(3 + x), envir = e)
```

```
## [1] 6
```

Formulas aren't just for models

```
~ 3 + 3
```

```
## ~3 + 3
```

```
form <- ~ 3 + 3
form
```

```
## ~3 + 3
```

```
attributes(form)
```

```
## $class
## [1] "formula"
##
## $.Environment
## <environment: R_GlobalEnv>
```

Extract parts of the formula

```
form[[1]]
```

```
## `~`
```

```
form[[2]]
```

```
## 3 + 3
```

Evaluate the expression of he formula

```
eval(form[[2]])
```

```
## [1] 6
```

Formulas = expression + environment

```
form <- ~ 3 + x
form[[1]]
```

```
## `~`
```

```
form[[2]]
```

```
## 3 + x
```

```
environment(form)
```

```
## <environment: R_GlobalEnv>
```

```
e <- new.env()
e$x <- 10
environment(form) <- e
```

```
eval(expr = form[[2]],
     envir = environment(form))
```

```
## [1] 13
```

```
eval(expr = form[[2]]) # no x in .GlobalEnv
```

```
## Error in eval(expr = form[[2]]): object 'x' not found
```

Quosure = expression + environment

- We can program with quosures easier than ~
  - Allows quasiquotation
  - User facing: ~
  - Developer facing: quosures

```
form <- ~ 3 + x
e <- rlang::env(x = 10)
environment(form) <- e
```

```
eval(expr = form[[2]],
     envir = environment(form))
```

```
## [1] 13
```

```
q <- rlang::new_quosure(
  expr = rlang::expr(3 + x),
  env = e)
```

```
rlang::eval_tidy(q) # uses the quosure env
```

```
## [1] 13
```

Quosures are subclass of formulas

```
class(q) # subclass of formula
```

```
## [1] "quosure" "formula"
```

Quosures in practice

- In practice we use `enquo()` and `enquos()` within a function definition
  - Remember the `en-` prefix for "**en**riched" which does the quoting from function arguments
- `quo()`, `quos()`, and `new_quosure()` exist for completeness

Data Masks

Data mask

- An object (e.g., usually a dataframe, but can also be a list) where the expression goes to look for values
- Data mask values **superceed** values in the environment

Quosure + Data Mask example

```
q1 <- rlang::new_quosure(rlang::expr(x * y),
                         rlang::env(x = 100))
q1
```

```
## <quosure>
## expr: ^x * y
## env:  000000001DC37C48
```

```
df <- data.frame(y = 1:5)
df
```

```
##   y
## 1 1
## 2 2
## 3 3
## 4 4
## 5 5
```

```
rlang::eval_tidy(expr = q1,
                 data = df)
```

```
## [1] 100 200 300 400 500
```

```
# uses the quosure's env
```

```
x * y
```

```
## Error in eval(expr, envir, enclos): object 'x' not foun
```

```
100 * y
```

```
## Error in eval(expr, envir, enclos): object 'y' not foun
```

```
100 * df$y
```

```
## [1] 100 200 300 400 500
```

`my_select`: previous try

```
col_name <- "species"
```

```
my_select <- function(data, ...) {
  cols <- rlang::enexprs(...)                       # handle the "weirdness"
  cols_char <- as.vector(cols, mode = "character") # unquote the arguments
  idx <- match(cols_char, names(data))              # find index positions
  return(
    data[, idx, drop = FALSE]                       # regular R things: subset on index
  )
}
```

```
my_select(penguins, col_name, year, "island")
```

```
## Error: Can't use NA as column index with `[` at position 1.
```

my_select:try 7 quosures + data mask

```
my_select <- function(data, ...) {
  cols <- rlang::enquos(...)                                  # handle the "weirdness"

  vars <- as.list(set_names(seq_along(data), names(data))) # list of columns and their index
  col_char_num <- purrr::map(cols, rlang::eval_tidy, vars) # tidy evaluate the user inputs
  idx <- purrr::map_int(col_char_num,                         # get index based on user input cols
                        function(x){ifelse(is.character(x),
                                           vars[[x]],
                                           x)})
  return(
    data[, idx, drop = FALSE]                                 # regular R things: subset on index
  )
}
```

```
my_select(penguins, col_name, year, "island")
```

```
## # A tibble: 344 x 3
##    species  year island
##    <fct>   <int> <fct>
##  1 Adelie   2007 Torgersen
##  2 Adelie   2007 Torgersen
##  3 Adelie   2007 Torgersen
```

In general...

`dplyr::select()`, `dplyr::arrange()`, { `tidyselect` }

- Getting the index position of the columns

```
idx <- c(1, 3, 2, 6, 1)
```

- Subsetting using base R on those index positions

```
penguins[, idx, drop = FALSE]
```

```
## # A tibble: 344 x 5
##    species bill_length_mm island    body_mass_g species
##    <fct>            <dbl> <fct>           <int> <fct>
##  1 Adelie            39.1 Torgersen        3750 Adelie
##  2 Adelie            39.5 Torgersen        3800 Adelie
##  3 Adelie            40.3 Torgersen        3250 Adelie
##  4 Adelie            NA   Torgersen          NA Adelie
##  5 Adelie            36.7 Torgersen        3450 Adelie
##  6 Adelie            39.3 Torgersen        3650 Adelie
##  7 Adelie            38.9 Torgersen        3625 Adelie
##  8 Adelie            39.2 Torgersen        4675 Adelie
##  9 Adelie            34.1 Torgersen        3475 Adelie
```

What I didn't cover

A lot...

For example...

- `:=` "colon equal", let's you quote the left hand side of an equal sign
- `.data` and `.env` pronouns in a data mask
  - https://adv-r.hadley.nz/evaluation.html#pronouns

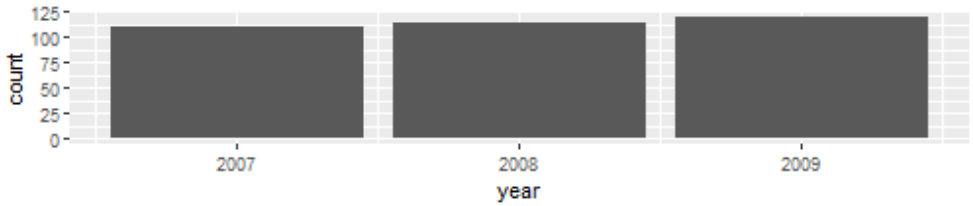
tl;dr

User: string; Function: string

- What we are used to
- Use the string version or string parameter

```
my_func <- function(data, col) {
  return(
    ggplot(data = data,
           aes_string(x = col)) +
      geom_bar()
  )
}
```

```
my_func(penguins, "year")
```

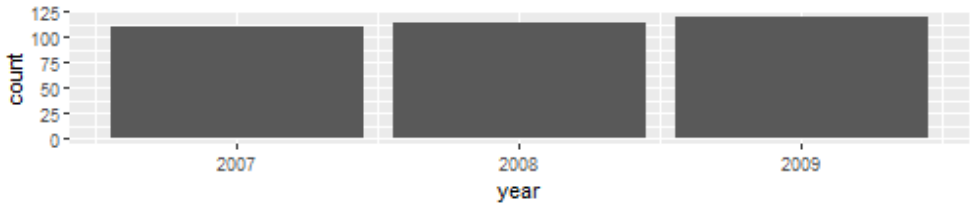


User: string; Function: quote

1. Convert to expression
    - `base::parse()`
    - `rlang::parse_expr()`, `rlang::parse_exprs()`, `rlang::parse_quo()`, `rlang::parse_quos()`
2. Unquote expression

```
my_func <- function(data, col) {
  ex <- rlang::parse_expr(col)
  return(
    ggplot(data = data,
           aes(x = !!ex)) +
      geom_bar()
  )
}
```

```
my_func(penguins, "year")
```



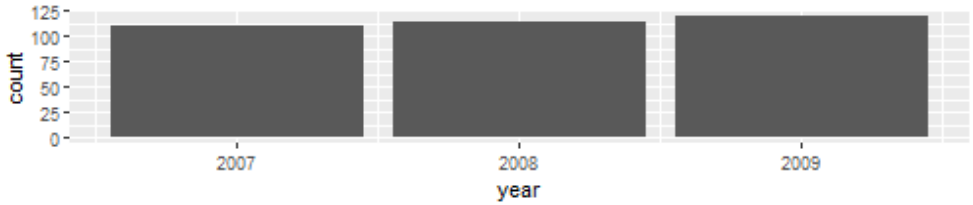

```
var <- "year"
my_func(penguins, var)
```

User: quote; Function: string

- Capture expression: `rlang::enexpr()`
- Convert to string: `rlang::as_string()`

```
my_func <- function(data, col) {
  q <- rlang::enexpr(col)
  s <- rlang::as_string(q)
  return(
    ggplot(data = data,
           aes_string(x = s)) +
      geom_bar()
  )
}
```

```
my_func(penguins, year)
```



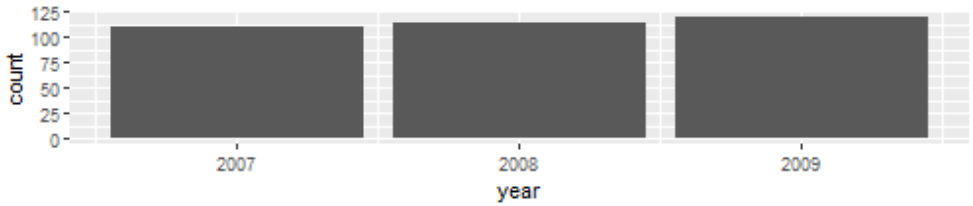
User: quote; Function: quote

- `rlang::enquo()` + `!!`
- `{{ }}`

```
my_func <- function(data, col) {
  col_quo <- rlang::enquo(col)
  return(
    ggplot(data = data,
           aes(x = !!col_quo )) +
      geom_bar()
  )
}
```

```
my_func <- function(data, col) {
  return(
    ggplot(data = data,
           aes(x = {{col}} )) +
      geom_bar()
  )
}
```

```
my_func(penguins, year)
```



Thanks!

@chendaniely

Read, read, and re-read:: https://adv-r.hadley.nz/metaprogramming.html

Slides: https://github.com/chendaniely/rstatsdc-2020-tidyeval