Manipulação e Visualização de Dados

a abordagem tidyverse

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Motivação

Manipulação e visualização de dados

- Manipular e visualizar dados são tarefas **obrigatórias** em Data Science (DS).
- O conhecimento sobre dados **determina o sucesso** das etapas seguintes.
- Fazer isso de forma eficiente requer:
  - Conhecer o processo e suas etapas.
  - Dominar a tecnologia para isso.
- Existem inúmeros softwares voltados para isso.
- R se destaca em DS por ser *free & open source*, ter muitos recursos e uma ampla comunidade.

O tempo gasto em DS

O que os cientistas de dados mais gastam tempo fazendo e como gostam disso?

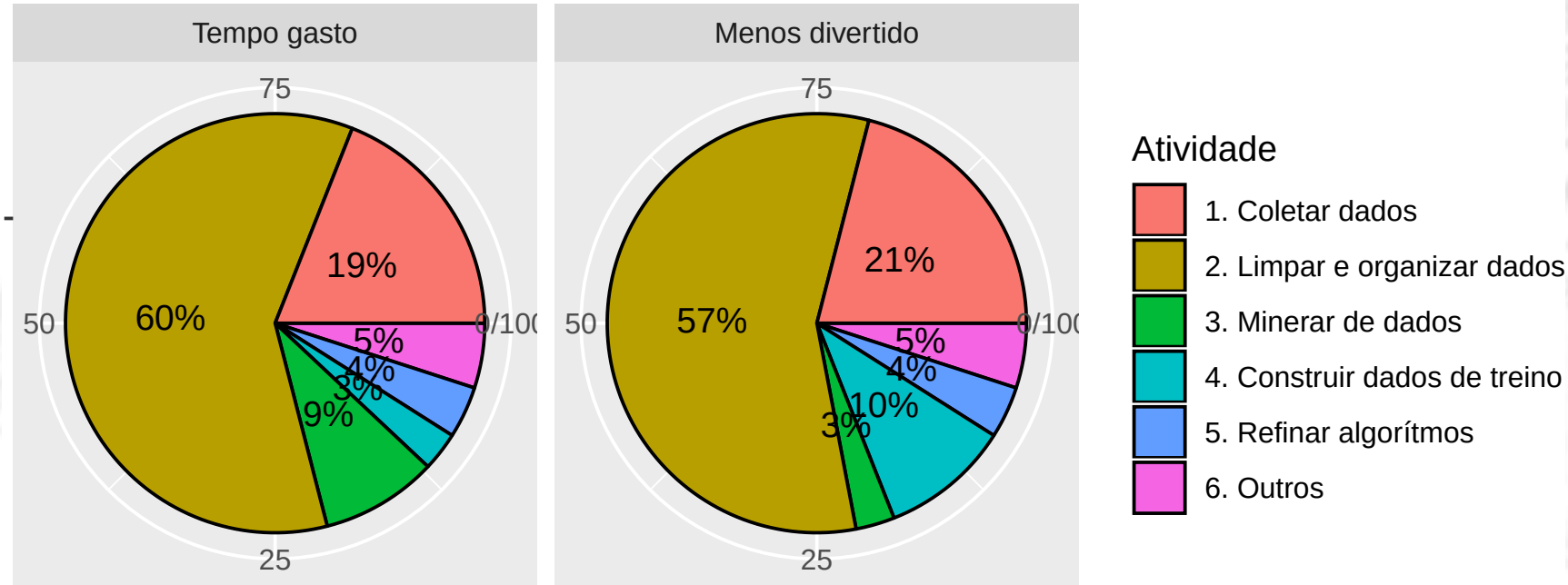
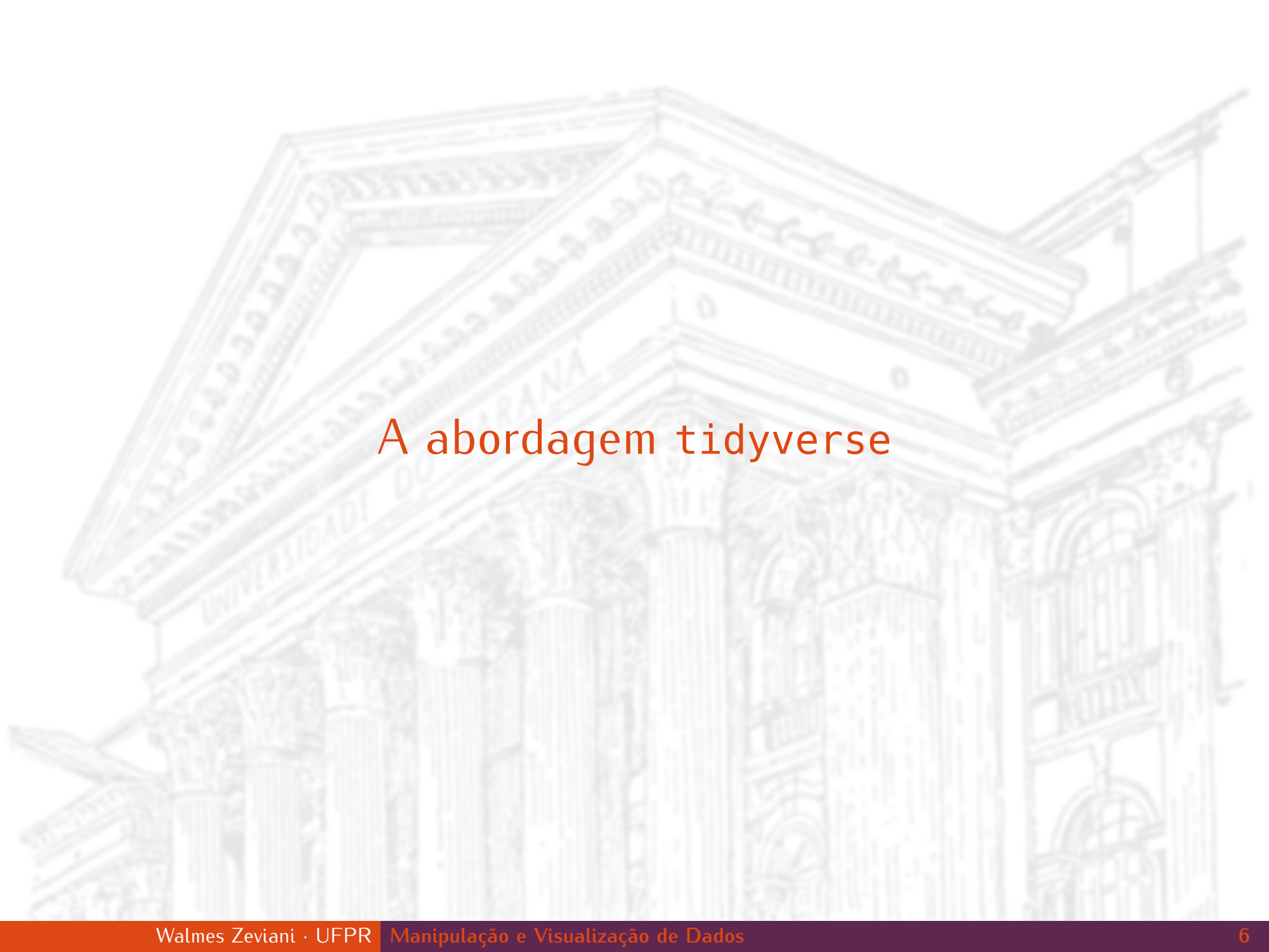


Figura 1. Tempo gasto e diversão em atividades. Fonte: Gil Press, 2016.

O ambiente R para manipulação de dados

- O R é a lingua franca da Estatística.
- Desde o princípio oferece recursos para manipulação de dados.
  - O `data.frame` é a estrutura base para dados tabulares.
  - `base`, `utils`, `stats`, `reshape`, etc com recursos para importar, transformar, modificar, filtrar, agregar, `data.frames`.
- Porém, existem "algumas imperfeições" ou espaço para melhorias:
  - Coerções indesejadas de `data.frame`/matriz para vetor.
  - Ordem/nome irregular/inconsistente dos argumentos nas funções.
  - Dependência de pacotes apenas em cascata.



A abordagem tidyverse

O `tidyverse`

- Oferece uma **reimplementação e extensão** das funcionalidades para manipulação e visualização.
- É uma coleção **8 de pacotes** R que operam em harmonia.
- Eles foram planejados e construídos para trabalhar em conjunto.
- Possuem gramática, organização, filosofia e estruturas de dados mais clara.
- Maior facilidade de desenvolvimento de código e portabilidade.
- Outros pacotes acoplam muito bem com o `tidyverse`.
- Pacotes: https://www.tidyverse.org/packages/.
- **R4DS**: https://r4ds.had.co.nz/.
- Cookbook: https://rstudio-education.github.io/tidyverse-cookbook/program.html.

O que o tidyverse contém

```
library(tidyverse)
ls("package:tidyverse")
```

```
## [1] "tidyverse_conflicts" "tidyverse_deps"      "tidyverse_logo"
## [4] "tidyverse_packages"  "tidyverse_update"
```

```
tidyverse_packages()
```

```
##  [1] "broom"       "cli"         "crayon"      "dplyr"
##  [5] "dbplyr"      "forcats"     "ggplot2"     "haven"
##  [9] "hms"         "httr"        "jsonlite"    "lubridate"
## [13] "magrittr"    "modelr"      "purrr"       "readr"
## [17] "readxl\n(>=" "reprex"      "rlang"       "rstudioapi"
## [21] "rvest"       "stringr"     "tibble"      "tidyr"
## [25] "xml2"        "tidyverse"
```

Os pacotes do tidyverse

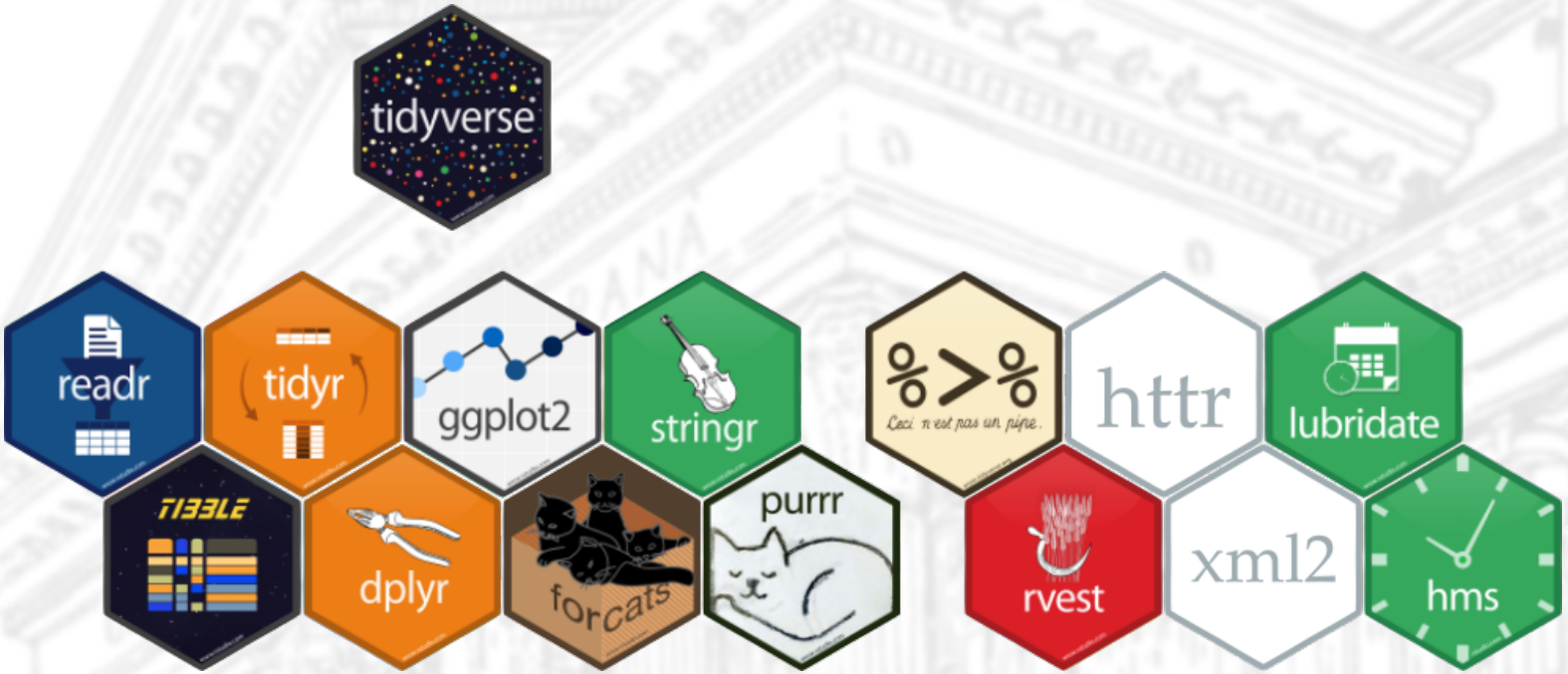


Figura 2. Pacotes que fazer parte do tidyverse.

Mas na realidade

Figura 3. Em um universo pararelo.

A anatomia do `tidyverse`

`tibble`

- Uma reimplementação do `data.frame` com muitas melhorias.
- Método `print()` enxuto.
- Documentação: https://tibble.tidyverse.org/.

`readr`

- Leitura de dados tabulares: csv, tsv, fwf.
- Recursos "inteligentes" que determinam tipo de variável.
- Ex: importar campos de datas como datas!
- Documentação: https://readr.tidyverse.org/.

A anatomia do `tidyverse`

`tidyr`

- Suporte para criação de dados no formato `tidy` (tabular).
  - Cada variável está em uma coluna.
  - Cada observação (unidade amostral) é uma linha.
  - Cada valor é uma cédula.
- Documentação: https://tidyr.tidyverse.org/.

`dplyr`

- Oferece uma gramática extensa pra manipulação de dados.
- Operações de *split-apply-combine*.
- Na maior parte da manipulação é usado o `dplyr`.
- Documentação: https://dplyr.tidyverse.org/.

A anatomia do `tidyverse`

`ggplot2`

- Criação de gráficos baseado no *The Grammar of Graphics* (WILKINSON et al., 2013).
- Claro mapeamento das variáveis do BD em variáveis visuais e construção baseada em camadas.
- Documentação: https://ggplot2.tidyverse.org/.
- WICKHAM (2016): `ggplot2` - Elegant Graphics for Data Analysis.
- TEUTONICO (2015): `ggplot2` Essentials.

`forcats`

- Para manipulação de variáveis categóricas/fatores.
  - Renomenar, reordenar, transformar, aglutinar.
- Documentação: https://forcats.tidyverse.org/.

A anatomia do `tidyverse`

`stringr`

- Recursos coesos construídos para manipulação de *strings*.
- Feito sobre o `stringi`.
- Documentação: https://stringr.tidyverse.org/.

`purrr`

- Recursos para **programação funcional**.
- Funções que aplicam funções em lote varrendo objetos: vetores, listas, etc.
- Documentação: https://purrr.tidyverse.org/.

Harmonizam bem com o `tidyverse`

- `magrittr`: operadores *pipe* → %>%.
- `rvest`: *web scraping*.
- `httr`: requisições HTTP e afins.
- `xml2`: manipulação de XML.
- `lubridate` e `hms`: manipulação de dados cronológicos.

Estruturas de dados do `tibble`

Anatomia do `tibble`

- Aperfeiçoamento do `data.frame`.
- A classe `tibble`.
- Formas ágeis de criar `tibbles`.
- Formas ágeis de modificar objetos das classes.
- Método print mais enxuto e informativo.

```r
# packageVersion("tibble")
ls("package:tibble")
```

```
##  [1] "add_case"              "add_column"
##  [3] "add_row"               "as_data_frame"
##  [5] "as_tibble"             "as.tibble"
##  [7] "column_to_rownames"    "data_frame"
##  [9] "data_frame_"           "deframe"
## [11] "enframe"               "frame_data"
## [13] "frame_matrix"          "glimpse"
## [15] "has_name"              "has_rownames"
## [17] "is_tibble"             "is.tibble"
## [19] "is_vector_s3"          "knit_print.trunc_mat"
## [21] "lst"                   "lst_"
## [23] "new_tibble"            "obj_sum"
## [25] "remove_rownames"       "repair_names"
## [27] "rowid_to_column"       "rownames_to_column"
## [29] "set_tidy_names"        "tbl_sum"
## [31] "tibble"                "tibble_"
## [33] "tidy_names"            "tribble"
## [35] "trunc_mat"             "type_sum"
```

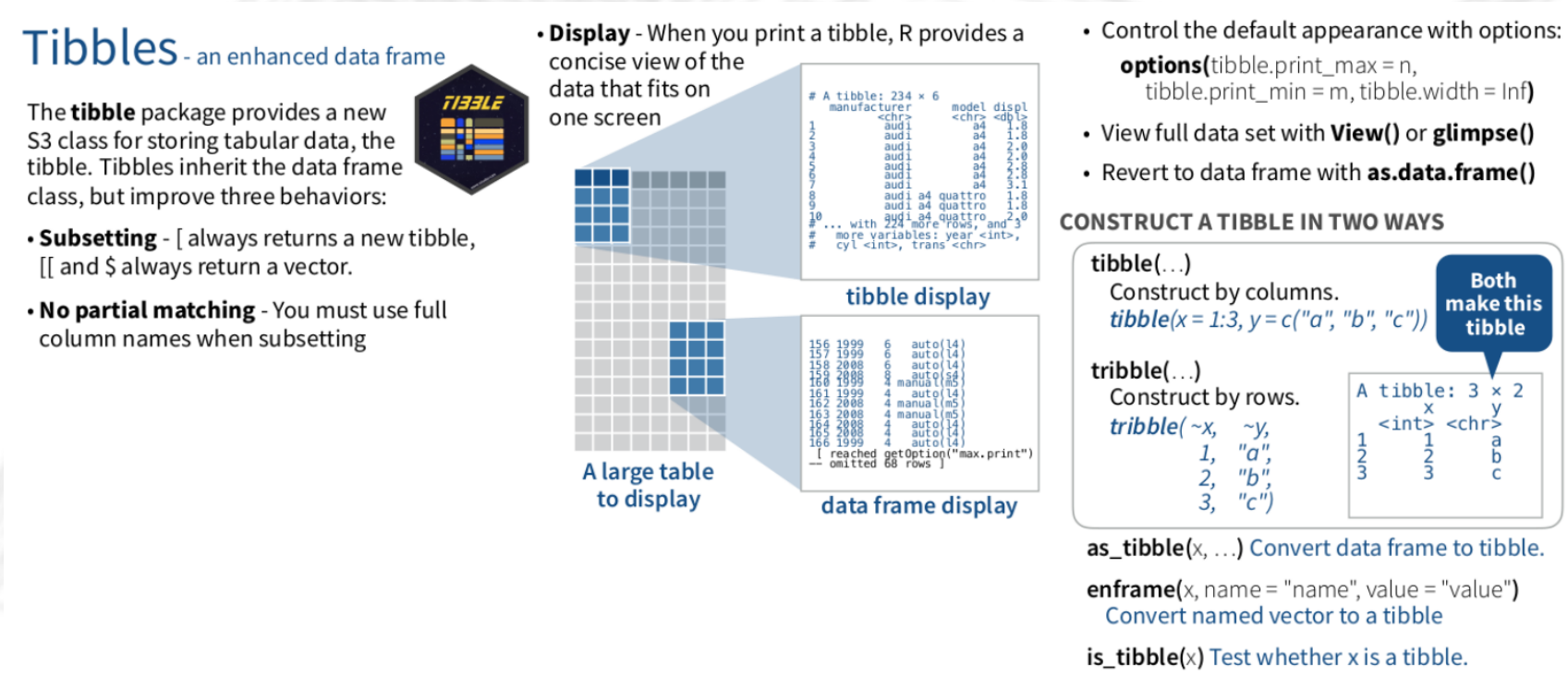


Figura 4. Uso do `tibble`.

Leitura de dados com readr

Anatomia do readr

- Importação de dados no formato texto.
  - Funções de importação: `read_*()`.
  - Funções de escrita: `write_*()`.
  - Funções de *parsing*: `parse_*`.
- Conseguem identificar campos de data.
- Muitas opções de controle de importação:
  - Encoding.
  - Separador de campo e decimal.
  - Aspas, comentários, etc.
- Cartão de leitura com o `readr` e arrumação com o `tidyr`: https://rawgit.com/rstudio/cheatsheets/master/data-import.pdf.
- Exemplos do curso de leitura de dados com o `readr`: http://leg.ufpr.br/~walmes/cursoR/data-vis/99-datasets.html.

```r
# packageVersion("readr")
ls("package:readr") %>%
    str_subset("(read|parse|write)_") %>%
    sort()
```

```
##  [1] "parse_character"    "parse_date"          "parse_datetime"
##  [4] "parse_double"       "parse_factor"        "parse_guess"
##  [7] "parse_integer"      "parse_logical"       "parse_number"
## [10] "parse_time"         "parse_vector"        "read_csv"
## [13] "read_csv2"          "read_csv2_chunked"   "read_csv_chunked"
## [16] "read_delim"         "read_delim_chunked"  "read_file"
## [19] "read_file_raw"      "read_fwf"            "read_lines"
## [22] "read_lines_chunked" "read_lines_raw"      "read_log"
## [25] "read_rds"           "read_table"          "read_table2"
## [28] "read_tsv"           "read_tsv_chunked"    "write_csv"
## [31] "write_delim"        "write_excel_csv"     "write_file"
## [34] "write_lines"        "write_rds"           "write_tsv"
```

Data Import : : CHEAT SHEET

R's **tidyverse** is built around **tidy data** stored in **tibbles**, which are enhanced data frames.

The front side of this sheet shows how to read text files into R with **readr**.

The reverse side shows how to create tibbles with **tibble** and to layout tidy data with **tidyr**.

OTHER TYPES OF DATA

Try one of the following packages to import other types of files

- **haven** - SPSS, Stata, and SAS files
- **readxl** - excel files (.xls and .xlsx)
- **DBI** - databases
- **jsonlite** - json
- **xml2** - XML
- **httr** - Web APIs
- **rvest** - HTML (Web Scraping)

Save Data

Save **x**, an R object, to **path**, a file path, as:

Comma delimited file
write_csv(x, path, na = "NA", append = FALSE, col_names = !append**)**

File with arbitrary delimiter
write_delim(x, path, delim = " ", na = "NA", append = FALSE, col_names = !append**)**

CSV for excel
write_excel_csv(x, path, na = "NA", append = FALSE, col_names = !append**)**

String to file
write_file(x, path, append = FALSE**)**

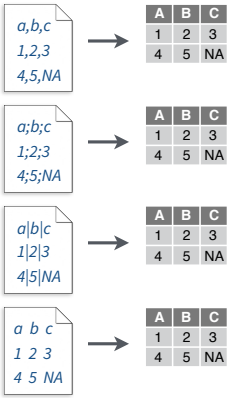
String vector to file, one element per line
write_lines(x,path, na = "NA", append = FALSE**)**

Object to RDS file
write_rds(x, path, compress = c("none", "gz", "bz2", "xz"), ...**)**

Tab delimited files
write_tsv(x, path, na = "NA", append = FALSE, col_names = !append**)**

Read Tabular Data - These functions share the common arguments:

read_*(file, col_names = TRUE, col_types = NULL, locale = default_locale(), na = c("", "NA"), quoted_na = TRUE, comment = "", trim_ws = TRUE, skip = 0, n_max = Inf, guess_max = min(1000, n_max), progress = interactive()**)**



Comma Delimited Files
read_csv("file.csv"**)**
To make file.csv run:
write_file(x = "a,b,c\n1,2,3\n4,5,NA", path = "file.csv")

Semi-colon Delimited Files
read_csv2("file2.csv"**)**
write_file(x = "a;b;c\n1;2;3\n4;5;NA", path = "file2.csv")

Files with Any Delimiter
read_delim("file.txt", delim = "|"**)**
write_file(x = "a|b|c\n1|2|3\n4|5|NA", path = "file.txt")

Fixed Width Files
read_fwf("file.fwf", col_positions = c(1, 3, 5)**)**
write_file(x = "a b c\n1 2 3\n4 5 NA", path = "file.fwf")

Tab Delimited Files
read_tsv("file.tsv"**)** Also **read_table().**
write_file(x = "a\tb\tc\n1\t2\t3\n4\t5\tNA", path = "file.tsv")

USEFUL ARGUMENTS

Example file
write_file("a,b,c\n1,2,3\n4,5,NA","file.csv")
f <- "file.csv"

A	B	C
1	2	3
4	5	NA

No header
read_csv(f, **col_names = FALSE**)

x	y	z
A	B	C
1	2	3
4	5	NA

Provide header
read_csv(f, **col_names = c("x", "y", "z")**)

1	2	3
4	5	NA

Skip lines
read_csv(f, **skip = 1**)

A	B	C
1	2	3

Read in a subset
read_csv(f, **n_max = 1**)

A	B	C
NA	2	3
4	5	NA

Missing Values
read_csv(f, **na = c("1", ".")**)

Read Non-Tabular Data

Read a file into a single string
read_file(file, locale = default_locale()**)**

Read each line into its own string
read_lines(file, skip = 0, n_max = -1L, na = character(), locale = default_locale(), progress = interactive()**)**

Read a file into a raw vector
read_file_raw(file**)**

Read each line into a raw vector
read_lines_raw(file, skip = 0, n_max = -1L, progress = interactive()**)**

Read Apache style log files
read_log(file, col_names = FALSE, col_types = NULL, skip = 0, n_max = -1, progress = interactive()**)**

Data types

readr functions guess the types of each column and convert types when appropriate (but will NOT convert strings to factors automatically).

A message shows the type of each column in the result.

```
## Parsed with column specification:
## cols(
##   age = col_integer(),
##   sex = col_character(),
##   earn = col_double()
## )
```

age is an integer
sex is a character
earn is a double (numeric)

1. Use **problems()** to diagnose problems.
x <- read_csv("file.csv"); problems(x)

2. Use a col_ function to guide parsing.
- **col_guess()** - the default
- **col_character()**
- **col_double()**, **col_euro_double()**
- **col_datetime(**format = ""**)** Also **col_date(**format = ""**)**, **col_time(**format = ""**)**
- **col_factor(**levels, ordered = FALSE**)**
- **col_integer()**
- **col_logical()**
- **col_number()**, **col_numeric()**
- **col_skip()**

x <- read_csv("file.csv", col_types = cols(
A = col_double(),
B = col_logical(),
C = col_factor()))

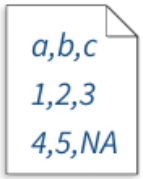
3. Else, read in as character vectors then parse with a parse_ function.
- **parse_guess()**
- **parse_character()**
- **parse_datetime()** Also **parse_date()** and **parse_time()**
- **parse_double()**
- **parse_factor()**
- **parse_integer()**
- **parse_logical()**
- **parse_number()**

x$A <- parse_number(x$A)

Figura 5. Cartão de referência importação de dados com o readr.

Read Tabular Data - These functions share the common arguments:

read_*(file, col_names = TRUE, col_types = NULL, locale = default_locale(), na = c("", "NA"), quoted_na = TRUE, comment = "", trim_ws = TRUE, skip = 0, n_max = Inf, guess_max = min(1000, n_max), progress = interactive()**)**



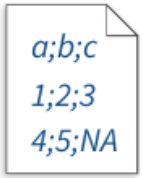
A	B	C
1	2	3
4	5	NA

Comma Delimited Files

read_csv("file.csv"**)**

To make file.csv run:

write_file(x = "a,b,c\n1,2,3\n4,5,NA", path = "file.csv")

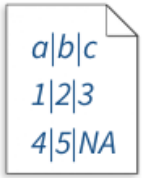


A	B	C
1	2	3
4	5	NA

Semi-colon Delimited Files

read_csv2("file2.csv"**)**

write_file(x = "a;b;c\n1;2;3\n4;5;NA", path = "file2.csv")

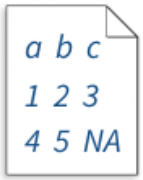


A	B	C
1	2	3
4	5	NA

Files with Any Delimiter

read_delim("file.txt", delim = "|"**)**

write_file(x = "a|b|c\n1|2|3\n4|5|NA", path = "file.txt")



A	B	C
1	2	3
4	5	NA

Fixed Width Files

read_fwf("file.fwf", col_positions = c(1, 3, 5)**)**

write_file(x = "a b c\n1 2 3\n4 5 NA", path = "file.fwf")

Tab Delimited Files

read_tsv("file.tsv"**)** Also **read_table().**

write_file(x = "a\tb\tc\n1\t2\t3\n4\t5\tNA", path = "file.tsv")

Figura 6. Leitura com o readr.

Data types

readr functions guess
the types of each column and
convert types when appropriate (but will NOT convert strings to factors automatically).

A message shows the type of each column in the result.

```
## Parsed with column specification:
## cols(
##   age = col_integer(),
##   sex = col_character(),
##   earn = col_double()
## )
```

age is an integer

sex is a character

earn is a double (numeric)

1. Use **problems()** to diagnose problems.

```
x <- read_csv("file.csv"); problems(x)
```

2. Use a col_ function to guide parsing.

- **col_guess()** - the default
- **col_character()**
- **col_double()**, **col_euro_double()**
- **col_datetime(**format = ""**)** Also **col_date(**format = ""**)**, **col_time(**format = ""**)**
- **col_factor(**levels, ordered = FALSE**)**
- **col_integer()**
- **col_logical()**
- **col_number()**, **col_numeric()**
- **col_skip()**

```
x <- read_csv("file.csv", col_types = cols(
  A = col_double(),
  B = col_logical(),
  C = col_factor()))
```

3. Else, read in as character vectors then parse with a parse_ function.

- **parse_guess()**
- **parse_character()**
- **parse_datetime()** Also **parse_date()** and **parse_time()**
- **parse_double()**
- **parse_factor()**
- **parse_integer()**
- **parse_logical()**
- **parse_number()**

```
x$A <- parse_number(x$A)
```

Figura 7. Parsing de valores com readr.

Dados no formato `tidy` com `tidyr`

Anatomia do `tidyr`

- Para fazer arrumação dos dados.
- Mudar a disposição dos dados: *long* $\rightleftharpoons$ *wide*.
- Partir uma variável em vários campos.
- Concatenar vários campos para criar uma variável.
- Remover ou imputar os valores ausentes: `NA`.
- Aninhar listas em tabelas: `tribble`.

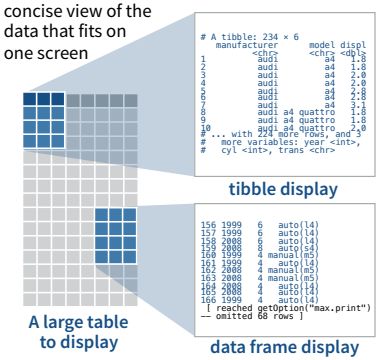
```r
# packageVersion("tidyr")
ls("package:tidyr")
```

```
##  [1] "%>%"           "complete"      "complete_"
##  [4] "crossing"      "crossing_"     "drop_na"
##  [7] "drop_na_"      "expand"        "expand_"
## [10] "extract"       "extract_"      "extract_numeric"
## [13] "fill"          "fill_"         "full_seq"
## [16] "gather"        "gather_"       "nest"
## [19] "nest_"         "nesting"       "nesting_"
## [22] "population"    "replace_na"    "separate"
## [25] "separate_"     "separate_rows" "separate_rows_"
## [28] "smiths"        "spread"        "spread_"
## [31] "table1"        "table2"        "table3"
## [34] "table4a"       "table4b"       "table5"
## [37] "uncount"       "unite"         "unite_"
## [40] "unnest"        "unnest_"       "who"
```

Tibbles - an enhanced data frame

The **tibble** package provides a new S3 class for storing tabular data, the tibble. Tibbles inherit the data frame class, but improve three behaviors:

- **Subsetting** - [always returns a new tibble, [[and $ always return a vector.
- **No partial matching** - You must use full column names when subsetting
- **Display** - When you print a tibble, R provides a concise view of the data that fits on one screen



- Control the default appearance with options:

  options(tibble.print_max = n, tibble.print_min = m, tibble.width = Inf**)**

- View full data set with **View()** or **glimpse()**
- Revert to data frame with **as.data.frame()**

CONSTRUCT A TIBBLE IN TWO WAYS

tibble(…)
Construct by columns.
tibble(x = 1:3, y = c("a", "b", "c"))

tribble(…)
Construct by rows.

```
tribble( ~x,  ~y,
         1,   "a",
         2,   "b",
         3,   "c")
```

Both make this tibble

```
A tibble: 3 × 2
      x     y
  <int> <chr>
1     1     a
2     2     b
3     3     c
```

as_tibble(x, …) Convert data frame to tibble.

enframe(x, name = "name", value = "value")
Convert named vector to a tibble

is_tibble(x) Test whether x is a tibble.

Tidy Data with tidyr

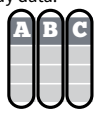
Tidy data is a way to organize tabular data. It provides a consistent data structure across packages.

A table is tidy if:

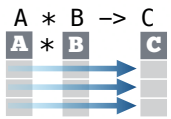
Each **variable** is in its own **column**

Each **observation**, or **case**, is in its own **row**

Tidy data:



Makes variables easy to access as vectors



Preserves cases during vectorized operations

Reshape Data - change the layout of values in a table

Use **gather()** and **spread()** to reorganize the values of a table into a new layout.

gather(data, key, value, ..., na.rm = FALSE, convert = FALSE, factor_key = FALSE**)**

gather() moves column names into a **key** column, gathering the column values into a single **value** column.

table4a

country	1999	2000
A	0.7K	2K
B	37K	80K
C	212K	213K

→

country	year	cases
A	1999	0.7K
B	1999	37K
C	1999	212K
A	2000	2K
B	2000	80K
C	2000	213K

key value

gather(table4a, `1999`, `2000`, key = "year", value = "cases")

spread(data, key, value, fill = NA, convert = FALSE, drop = TRUE, sep = NULL**)**

spread() moves the unique values of a **key** column into the column names, spreading the values of a **value** column across the new columns.

table2

country	year	type	count
A	1999	cases	0.7K
A	1999	pop	19M
A	2000	cases	2K
A	2000	pop	20M
B	1999	cases	37K
B	1999	pop	172M
B	2000	cases	80K
B	2000	pop	174M
C	1999	cases	212K
C	1999	pop	1T
C	2000	cases	213K
C	2000	pop	1T

→

country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172M
B	2000	80K	174M
C	1999	212K	1T
C	2000	213K	1T

key value

spread(table2, type, count)

Handle Missing Values

drop_na(data, ...)
Drop rows containing NA's in … columns.

x

x1	x2
A	1
B	NA
C	NA
D	3
E	NA

→

x1	x2
A	1
D	3

drop_na(x, x2)

fill(data, ..., .direction = c("down", "up")**)**
Fill in NA's in … columns with most recent non-NA values.

x

x1	x2
A	1
B	NA
C	NA
D	3
E	NA

→

x1	x2
A	1
B	1
C	1
D	3
E	3

fill(x, x2)

replace_na(data, replace = list(), ...**)**
Replace NA's by column.

x

x1	x2
A	1
B	NA
C	NA
D	3
E	NA

→

x1	x2
A	1
B	2
C	2
D	3
E	2

replace_na(x, list(x2 = 2))

Expand Tables - quickly create tables with combinations of values

complete(data, ..., fill = list())
Adds to the data missing combinations of the values of the variables listed in …
complete(mtcars, cyl, gear, carb)

expand(data, ...)
Create new tibble with all possible combinations of the values of the variables listed in …
expand(mtcars, cyl, gear, carb)

Split Cells

Use these functions to split or combine cells into individual, isolated values.

separate(data, col, into, sep = "[^[:alnum:]]+", remove = TRUE, convert = FALSE, extra = "warn", fill = "warn", ...**)**

Separate each cell in a column to make several columns.

table3

country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M
C	1999	212K/1T
C	2000	213K/1T

→

country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172
B	2000	80K	174
C	1999	212K	1T
C	2000	213K	1T

separate(table3, rate, into = c("cases", "pop"))

separate_rows(data, ..., sep = "[^[:alnum:].]+", convert = FALSE**)**

Separate each cell in a column to make several rows. Also **separate_rows_()**.

table3

country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M
C	1999	212K/1T
C	2000	213K/1T

→

country	year	rate
A	1999	0.7K
A	1999	19M
A	2000	2K
A	2000	20M
B	1999	37K
B	1999	172M
B	2000	80K
B	2000	174M
C	1999	212K
C	1999	1T
C	2000	213K
C	2000	1T

separate_rows(table3, rate)

unite(data, col, ..., sep = "_", remove = TRUE**)**

Collapse cells across several columns to make a single column.

table5

country	century	year
Afghan	19	99
Afghan	20	0
Brazil	19	99
Brazil	20	0
China	19	99
China	20	0

→

country	year
Afghan	1999
Afghan	2000
Brazil	1999
Brazil	2000
China	1999
China	2000

unite(table5, century, year, col = "year", sep = "")

Figura 8. Cartão de referência arrumação de dados com `tidyr`.

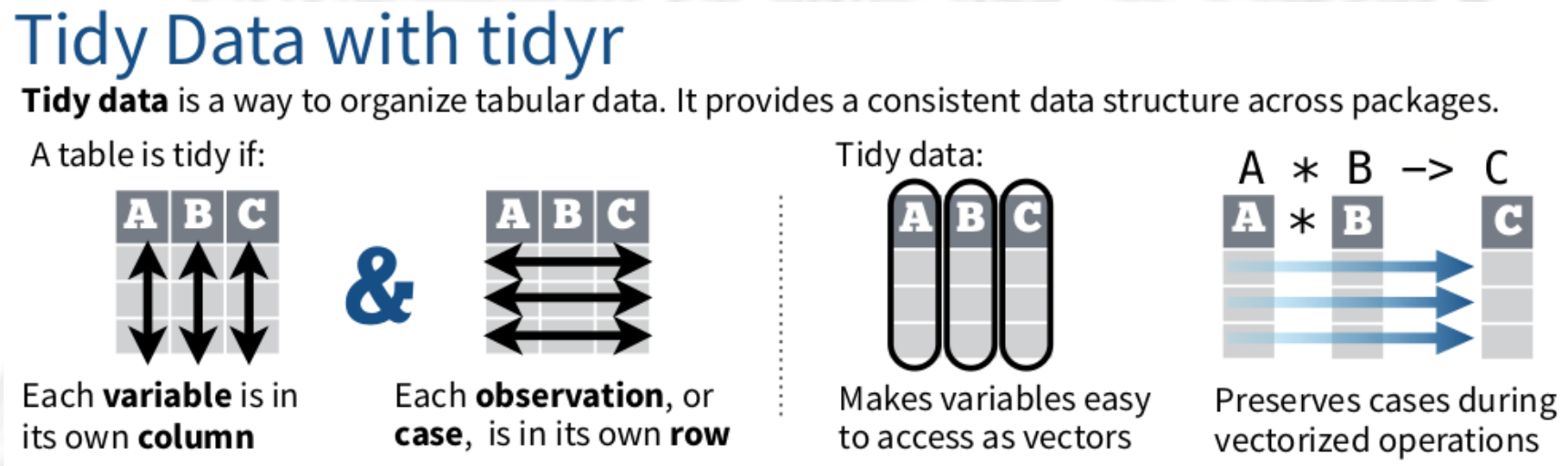


Figura 9. A definição de *tidy data* ou formato tabular.

Reshape Data - change the layout of values in a table

Use **gather()** and **spread()** to reorganize the values of a table into a new layout.

gather(data, key, value, ..., na.rm = FALSE, convert = FALSE, factor_key = FALSE**)**

gather() moves column names into a **key** column, gathering the column values into a single **value** column.

spread(data, key, value, fill = NA, convert = FALSE, drop = TRUE, sep = NULL**)**

spread() moves the unique values of a **key** column into the column names, spreading the values of a **value** column across the new columns.

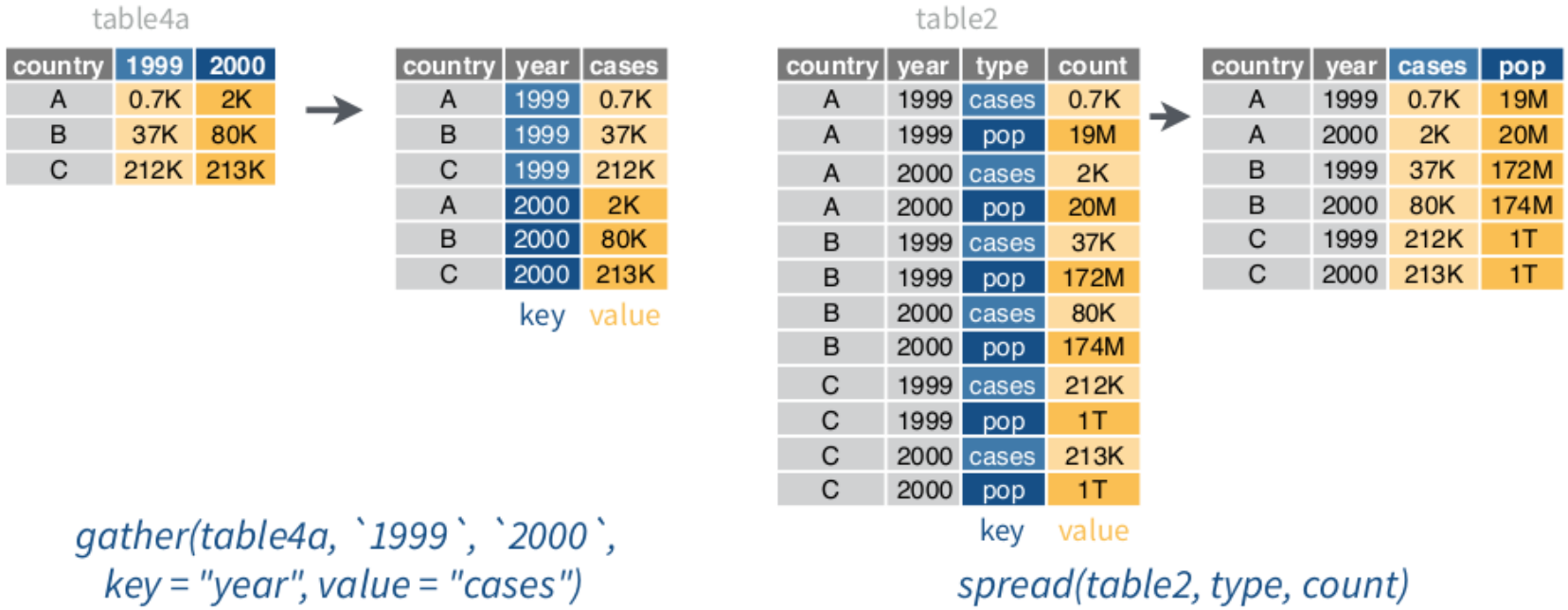


Figura 10. Modificação da disposição dos dados com o `tidyr`.

Handle Missing Values

drop_na(data, ...**)**

Drop rows containing NA's in … columns.

x

x1	x2
A	1
B	NA
C	NA
D	3
E	NA

→

x1	x2
A	1
D	3

drop_na(x, x2)

fill(data, ..., .direction = c("down", "up")**)**

Fill in NA's in … columns with most recent non-NA values.

x

x1	x2
A	1
B	NA
C	NA
D	3
E	NA

→

x1	x2
A	1
B	1
C	1
D	3
E	3

fill(x, x2)

replace_na(data, replace = list(), ...**)**

Replace NA's by column.

x

x1	x2
A	1
B	NA
C	NA
D	3
E	NA

→

x1	x2
A	1
B	2
C	2
D	3
E	2

replace_na(x, list(x2 = 2))

Expand Tables - quickly create tables with combinations of values

complete(data, ..., fill = list()**)**

Adds to the data missing combinations of the values of the variables listed in …

complete(mtcars, cyl, gear, carb)

expand(data, ...**)**

Create new tibble with all possible combinations of the values of the variables listed in …

expand(mtcars, cyl, gear, carb)

Figura 11. Recursos para lidar com dados ausentes do `tidyr`.

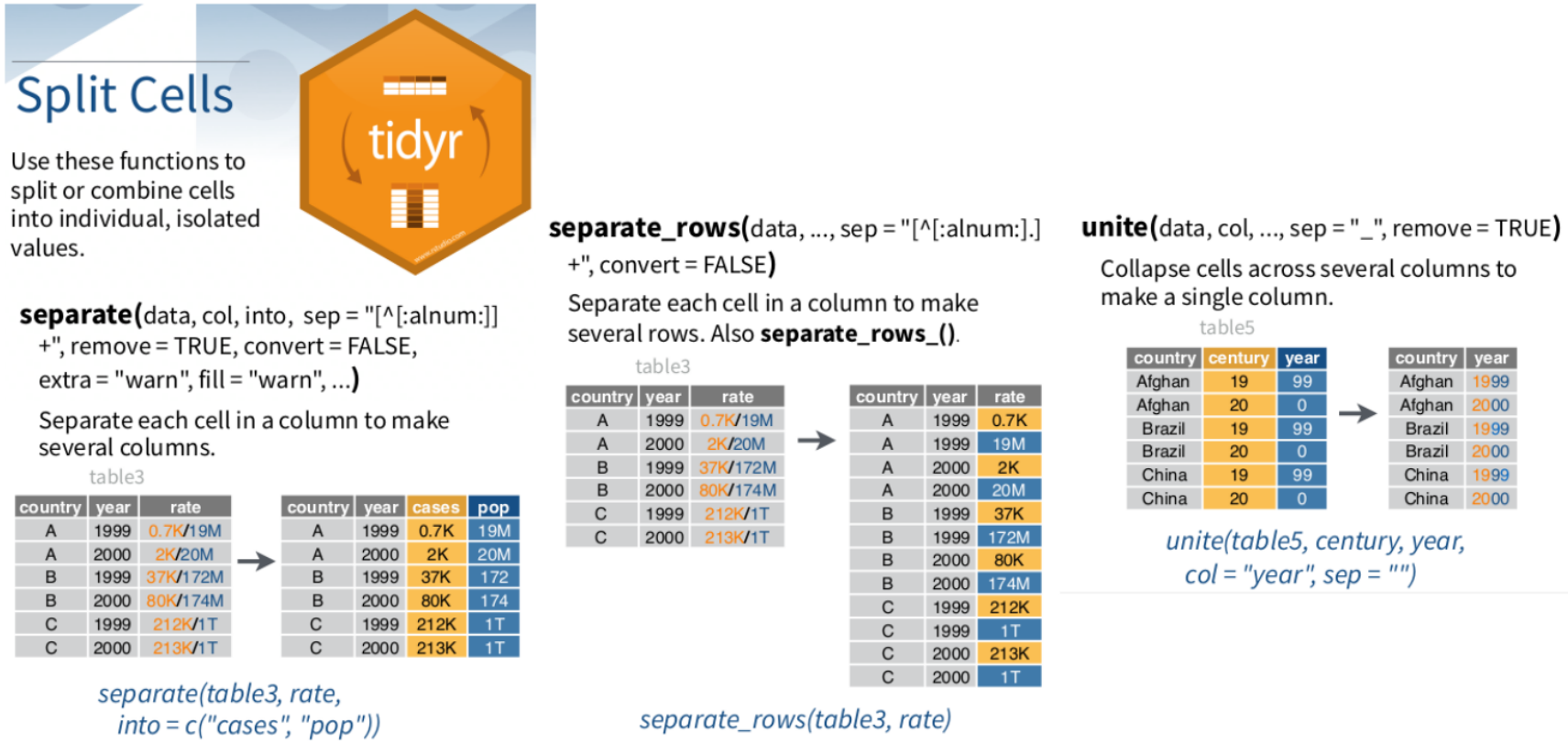


Figura 12. Partir e concatenar valores com `tidyr`.

Agregação com dplyr

Anatomia do `dplyr`

- O `dplyr` é a **gramática** para manipulação de dados.
- Tem um conjunto **consistente** de verbos para atuar sobre tabelas.
  - Verbos: `mutate()`, `select()`, `filter()`, `arrange()`, `summarise()`, `slice()`, `rename()`, etc.
  - Sufixos: `_at()`, `_if()`, `_all()`, etc.
  - Agrupamento: `group_by()` e `ungroup()`.
  - Junções: `inner_join()`, `full_join()`, `left_join()` e `right_join()`.
  - Funções resumo: `n()`, `n_distinct()`, `first()`, `last()`, `nth()`, etc.
  - E muito mais no cartão de referência.
- Cartão de referência: https://github.com/rstudio/cheatsheets/raw/master/data-transformation.pdf.
- É sem dúvida **o pacote mais importante** do `tidyverse`.

```r
# library(dplyr)
ls("package:dplyr") %>% str_c(collapse = ", ") %>% strwrap()
```

```
##  [1] "%>%, add_count, add_count_, add_row, add_rownames, add_tally,"
##  [2] "add_tally_, all_equal, all_vars, anti_join, any_vars, arrange,"
##  [3] "arrange_, arrange_all, arrange_at, arrange_if, as_data_frame,"
##  [4] "as.tbl, as.tbl_cube, as_tibble, auto_copy, band_instruments,"
##  [5] "band_instruments2, band_members, bench_tbls, between,"
##  [6] "bind_cols, bind_rows, case_when, changes, check_dbplyr,"
##  [7] "coalesce, collapse, collect, combine, common_by, compare_tbls,"
##  [8] "compare_tbls2, compute, contains, copy_to, count, count_,"
##  [9] "cumall, cumany, cume_dist, cummean, current_vars, data_frame,"
## [10] "data_frame_, db_analyze, db_begin, db_commit, db_create_index,"
## [11] "db_create_indexes, db_create_table, db_data_type, db_desc,"
## [12] "db_drop_table, db_explain, db_has_table, db_insert_into,"
## [13] "db_list_tables, db_query_fields, db_query_rows, db_rollback,"
## [14] "db_save_query, db_write_table, dense_rank, desc, dim_desc,"
## [15] "distinct, distinct_, do, do_, dr_dplyr, ends_with, enexpr,"
## [16] "enexprs, enquo, enquos, ensym, ensyms, eval_tbls, eval_tbls2,"
## [17] "everything, explain, expr, failwith, filter, filter_,"
## [18] "filter_all, filter_at, filter_if, first, frame_data, full_join,"
## [19] "funs, funs_, glimpse, group_by, group_by_, group_by_all,"
## [20] "group_by_at, group_by_if, group_by_prepare, grouped_df,"
## [21] "group_indices, group_indices_, groups, group_size, group_vars,"
## [22] "id, ident, if_else, inner_join, intersect, is_grouped_df,"
## [23] "is.grouped_df, is.src, is.tbl, lag, last, lead, left_join,"
## [24] "location, lst, lst_, make_tbl, matches, min_rank, mutate,"
## [25] "mutate_, mutate_all, mutate_at, mutate_each, mutate_each_,"
## [26] "mutate_if, n, na_if, nasa, n_distinct, near, n_groups, nth,"
## [27] "ntile, num_range, one_of, order_by, percent_rank,"
## [28] "progress_estimated, pull, quo, quo_name, quos, rbind_all,"
```

Data Transformation with dplyr : : **CHEAT SHEET**

dplyr functions work with pipes and expect **tidy data**. In tidy data:

Each **variable** is in its own **column** & Each **observation**, or **case**, is in its own **row**

pipes

x %>% f(y) becomes **f(x, y)**

Summarise Cases

These apply **summary functions** to columns to create a new table of summary statistics. Summary functions take vectors as input and return one value (see back).

summary function

summarise(.data, …)
Compute table of summaries.
summarise(mtcars, avg = mean(mpg))

count(x, ..., wt = NULL, sort = FALSE)
Count number of rows in each group defined by the variables in … Also **tally**().
count(iris, Species)

VARIATIONS

summarise_all() - Apply funs to every column.
summarise_at() - Apply funs to specific columns.
summarise_if() - Apply funs to all cols of one type.

Group Cases

Use **group_by()** to create a "grouped" copy of a table. dplyr functions will manipulate each "group" separately and then combine the results.

```
mtcars %>%
group_by(cyl) %>%
summarise(avg = mean(mpg))
```

group_by(.data, ..., add = FALSE)
Returns copy of table grouped by …
g_iris <- group_by(iris, Species)

ungroup(x, …)
Returns ungrouped copy of table.
ungroup(g_iris)

Manipulate Cases

EXTRACT CASES

Row functions return a subset of rows as a new table.

filter(.data, …) Extract rows that meet logical criteria. *filter(iris, Sepal.Length > 7)*

distinct(.data, ..., .keep_all = FALSE) Remove rows with duplicate values.
distinct(iris, Species)

sample_frac(tbl, size = 1, replace = FALSE, weight = NULL, .env = parent.frame()) Randomly select fraction of rows.
sample_frac(iris, 0.5, replace = TRUE)

sample_n(tbl, size, replace = FALSE, weight = NULL, .env = parent.frame()) Randomly select size rows. *sample_n(iris, 10, replace = TRUE)*

slice(.data, …) Select rows by position.
slice(iris, 10:15)

top_n(x, n, wt) Select and order top n entries (by group if grouped data). *top_n(iris, 5, Sepal.Width)*

Logical and boolean operators to use with filter()

<	<=	is.na()	%in%	|	xor()
>	>=	!is.na()	!	&	

See **?base::logic** and **?Comparison** for help.

ARRANGE CASES

arrange(.data, …) Order rows by values of a column or columns (low to high), use with **desc()** to order from high to low.
arrange(mtcars, mpg)
arrange(mtcars, desc(mpg))

ADD CASES

add_row(.data, ..., .before = NULL, .after = NULL)
Add one or more rows to a table.
add_row(faithful, eruptions = 1, waiting = 1)

Manipulate Variables

EXTRACT VARIABLES

Column functions return a set of columns as a new vector or table.

pull(.data, var = -1) Extract column values as a vector. Choose by name or index.
pull(iris, Sepal.Length)

select(.data, …)
Extract columns as a table. Also **select_if()**.
select(iris, Sepal.Length, Species)

Use these helpers with select (),
e.g. select(iris, starts_with("Sepal"))

contains(match)
ends_with(match)
matches(match)
num_range(prefix, range)
one_of(…)
starts_with(match)
:, e.g. mpg:cyl
-, e.g, -Species

MAKE NEW VARIABLES

These apply **vectorized functions** to columns. Vectorized funs take vectors as input and return vectors of the same length as output (see back).

vectorized function

mutate(.data, …)
Compute new column(s).
mutate(mtcars, gpm = 1/mpg)

transmute(.data, …)
Compute new column(s), drop others.
transmute(mtcars, gpm = 1/mpg)

mutate_all(.tbl, .funs, …) Apply funs to every column. Use with **funs()**. Also **mutate_if()**.
mutate_all(faithful, funs(log(.), log2(.)))
mutate_if(iris, is.numeric, funs(log(.)))

mutate_at(.tbl, .cols, .funs, …) Apply funs to specific columns. Use with **funs()**, **vars()** and the helper functions for select().
mutate_at(iris, vars(-Species), funs(log(.)))

add_column(.data, ..., .before = NULL, .after = NULL) Add new column(s). Also **add_count()**, **add_tally()**. *add_column(mtcars, new = 1:32)*

rename(.data, …) Rename columns.
rename(iris, Length = Sepal.Length)

Figura 13. Cartão de referência de operações em dados com tabulares com `dplyr`.

Vector Functions

TO USE WITH MUTATE ()

mutate() and **transmute()** apply vectorized functions to columns to create new columns. Vectorized functions take vectors as input and return vectors of the same length as output.

vectorized function

OFFSETS

dplyr::**lag()** - Offset elements by 1
dplyr::**lead()** - Offset elements by -1

CUMULATIVE AGGREGATES

dplyr::**cumall()** - Cumulative all()
dplyr::**cumany()** - Cumulative any()
cummax() - Cumulative max()
dplyr::**cummean()** - Cumulative mean()
cummin() - Cumulative min()
cumprod() - Cumulative prod()
cumsum() - Cumulative sum()

RANKINGS

dplyr::**cume_dist()** - Proportion of all values <=
dplyr::**dense_rank()** - rank with ties = min, no gaps
dplyr::**min_rank()** - rank with ties = min
dplyr::**ntile()** - bins into n bins
dplyr::**percent_rank()** - min_rank scaled to [0,1]
dplyr::**row_number()** - rank with ties = "first"

MATH

+, - , *, /, ^, %/%, %% - arithmetic ops
log(), log2(), log10() - logs
<, <=, >, >=, !=, == - logical comparisons
dplyr::**between()** - x >= left & x <= right
dplyr::**near()** - safe == for floating point numbers

MISC

dplyr::**case_when()** - multi-case if_else()
dplyr::**coalesce()** - first non-NA values by element across a set of vectors
dplyr::**if_else()** - element-wise if() + else()
dplyr::**na_if()** - replace specific values with NA
pmax() - element-wise max()
pmin() - element-wise min()
dplyr::**recode()** - Vectorized switch()
dplyr::**recode_factor()** - Vectorized switch() for factors

Summary Functions

TO USE WITH SUMMARISE ()

summarise() applies summary functions to columns to create a new table. Summary functions take vectors as input and return single values as output.

summary function

COUNTS

dplyr::**n()** - number of values/rows
dplyr::**n_distinct()** - # of uniques
sum(!is.na()) - # of non-NA's

LOCATION

mean() - mean, also **mean(!is.na())**
median() - median

LOGICALS

mean() - Proportion of TRUE's
sum() - # of TRUE's

POSITION/ORDER

dplyr::**first()** - first value
dplyr::**last()** - last value
dplyr::**nth()** - value in nth location of vector

RANK

quantile() - nth quantile
min() - minimum value
max() - maximum value

SPREAD

IQR() - Inter-Quartile Range
mad() - median absolute deviation
sd() - standard deviation
var() - variance

Row Names

Tidy data does not use rownames, which store a variable outside of the columns. To work with the rownames, first move them into a column.

rownames_to_column()
Move row names into col.
a <- rownames_to_column(iris, var = "C")

column_to_rownames()
Move col in row names.
column_to_rownames(a, var = "C")

Also **has_rownames()**, **remove_rownames()**

Combine Tables

COMBINE VARIABLES

Use **bind_cols()** to paste tables beside each other as they are.

bind_cols(…) Returns tables placed side by side as a single table.
BE SURE THAT ROWS ALIGN.

Use a "**Mutating Join**" to join one table to columns from another, matching values with the rows that they correspond to. Each join retains a different combination of values from the tables.

left_join(x, y, by = NULL, copy=FALSE, suffix=c(".x",".y"),…)
Join matching values from y to x.

right_join(x, y, by = NULL, copy = FALSE, suffix=c(".x",".y"),…)
Join matching values from x to y.

inner_join(x, y, by = NULL, copy = FALSE, suffix=c(".x",".y"),…)
Join data. Retain only rows with matches.

full_join(x, y, by = NULL, copy=FALSE, suffix=c(".x",".y"),…)
Join data. Retain all values, all rows.

Use **by = c("col1", "col2", …)** to specify one or more common columns to match on.
left_join(x, y, by = "A")

Use a named vector, **by = c("col1" = "col2")**, to match on columns that have different names in each table.
left_join(x, y, by = c("C" = "D"))

Use **suffix** to specify the suffix to give to unmatched columns that have the same name in both tables.
left_join(x, y, by = c("C" = "D"), suffix = c("1", "2"))

COMBINE CASES

Use **bind_rows()** to paste tables below each other as they are.

bind_rows(…, .id = NULL)
Returns tables one on top of the other as a single table. Set .id to a column name to add a column of the original table names (as pictured)

intersect(x, y, …)
Rows that appear in both x and y.

setdiff(x, y, …)
Rows that appear in x but not y.

union(x, y, …)
Rows that appear in x or y. (Duplicates removed). union_all() retains duplicates.

Use **setequal()** to test whether two data sets contain the exact same rows (in any order).

EXTRACT ROWS

Use a "**Filtering Join**" to filter one table against the rows of another.

semi_join(x, y, by = NULL, …)
Return rows of x that have a match in y.
USEFUL TO SEE WHAT WILL BE JOINED.

anti_join(x, y, by = NULL, …)
Return rows of x that do not have a match in y. USEFUL TO SEE WHAT WILL NOT BE JOINED.

Figura 14. Cartão de referência de operações em dados com tabulares com `dplyr`.

Programação funcional com purrr

Anatomia do purrr

- O `purrr` fornece um conjunto **completo e consistente** para **programação funcional**.
- São uma sofisticação da *família `apply`*.
- Várias função do tipo `map` para cada tipo de input/output.
- Percorrem vetores, listas, colunas, linhas, etc.
- Permitem filtar, concatenar, parear listas, etc.
- Tem funções para tratamento de exceções: falhas/erros, avisos.
- Cartão de referência: https://github.com/rstudio/cheatsheets/raw/master/purrr.pdf.

```r
# library(purrr)
ls("package:purrr") %>% str_c(collapse = ", ") %>% strwrap()
```

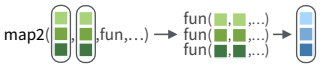
```
##  [1] "%>%, %||%, %@%, accumulate, accumulate_right, array_branch,"
##  [2] "array_tree, as_function, as_mapper, as_vector, at_depth,"
##  [3] "attr_getter, auto_browse, compact, compose, cross, cross2,"
##  [4] "cross3, cross_d, cross_df, cross_n, detect, detect_index,"
##  [5] "discard, every, flatten, flatten_chr, flatten_dbl, flatten_df,"
##  [6] "flatten_dfc, flatten_dfr, flatten_int, flatten_lgl,"
##  [7] "has_element, head_while, imap, imap_chr, imap_dbl, imap_dfc,"
##  [8] "imap_dfr, imap_int, imap_lgl, invoke, invoke_map,"
##  [9] "invoke_map_chr, invoke_map_dbl, invoke_map_df, invoke_map_dfc,"
## [10] "invoke_map_dfr, invoke_map_int, invoke_map_lgl, is_atomic,"
## [11] "is_bare_atomic, is_bare_character, is_bare_double,"
## [12] "is_bare_integer, is_bare_list, is_bare_logical,"
## [13] "is_bare_numeric, is_bare_vector, is_character, is_double,"
## [14] "is_empty, is_formula, is_function, is_integer, is_list,"
## [15] "is_logical, is_null, is_numeric, is_scalar_atomic,"
## [16] "is_scalar_character, is_scalar_double, is_scalar_integer,"
## [17] "is_scalar_list, is_scalar_logical, is_scalar_numeric,"
## [18] "is_scalar_vector, is_vector, iwalk, keep, lift, lift_dl,"
## [19] "lift_dv, lift_ld, lift_lv, lift_vd, lift_vl, list_along,"
## [20] "list_merge, list_modify, lmap, lmap_at, lmap_if, map, map2,"
## [21] "map2_chr, map2_dbl, map2_df, map2_dfc, map2_dfr, map2_int,"
## [22] "map2_lgl, map_at, map_call, map_chr, map_dbl, map_df, map_dfc,"
## [23] "map_dfr, map_if, map_int, map_lgl, modify, modify_at,"
## [24] "modify_depth, modify_if, negate, partial, pluck, pmap,"
## [25] "pmap_chr, pmap_dbl, pmap_df, pmap_dfc, pmap_dfr, pmap_int,"
## [26] "pmap_lgl, possibly, prepend, pwalk, quietly, rbernoulli,"
## [27] "rdunif, reduce, reduce2, reduce2_right, reduce_right,"
## [28] "rep_along, rerun, safely, set_names, simplify, simplify_all,"
```

Apply functions with purrr : : **CHEAT SHEET**

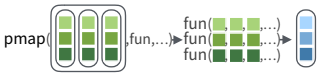
Apply Functions

Map functions apply a function iteratively to each element of a list or vector.

map(.x, .f, …) Apply a function to each element of a list or vector. *map(x, is.logical)*



map2(.x, .y, .f, …) Apply a function to pairs of elements from two lists, vectors. *map2(x, y, sum)*



pmap(.l, .f, …) Apply a function to groups of elements from list of lists, vectors. *pmap(list(x, y, z), sum, na.rm = TRUE)*

invoke_map(.f, .x = list(NULL), …, .env=NULL) Run each function in a list. Also **invoke**. *l <- list(var, sd); invoke_map(l, x = 1:9)*

lmap(.x, .f, ...) Apply function to each list-element of a list or vector.
imap(.x, .f, ...) Apply .f to each element of a list or vector and its index.

OUTPUT

map(), map2(), pmap(), imap and **invoke_map** each return a list. Use a suffixed version to return the results as a specific type of flat vector, e.g. **map2_chr**, **pmap_lgl**, etc.

Use **walk**, **walk2**, and **pwalk** to trigger side effects. Each return its input invisibly.

function	returns
map	list
map_chr	character vector
map_dbl	double (numeric) vector
map_dfc	data frame (column bind)
map_dfr	data frame (row bind)
map_int	integer vector
map_lgl	logical vector
walk	triggers side effects, returns the input invisibly

SHORTCUTS - within a purrr function:

"name" becomes **function(x) x[["name"]]**, e.g. *map(l, "a")* extracts *a* from each element of *l*

~ .x becomes **function(x) x**, e.g. *map(l, ~ 2 +.x)* becomes *map(l, function(x) 2 + x)*

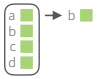
~ .x .y becomes **function(.x, .y) .x .y**, e.g. *map2(l, p, ~ .x +.y)* becomes *map2(l, p, function(l, p) l + p)*

~ ..1 ..2 etc becomes **function(..1, ..2,** etc**) ..1 ..2** etc, e.g. *pmap(list(a, b, c), ~ ..3 + ..1 - ..2)* becomes *pmap(list(a, b, c), function(a, b, c) c + a - b)*

RStudio

Work with Lists

FILTER LISTS

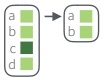


pluck(.x, ..., .default=NULL) Select an element by name or index, *pluck(x,"b")* ,or its attribute with **attr_getter**. *pluck(x,"b",attr_getter("n"))*

keep(.x, .p, …) Select elements that pass a logical test. *keep(x, is.na)*

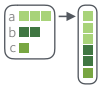
discard(.x, .p, …) Select elements that do not pass a logical test. *discard(x, is.na)*

compact(.x, .p = identity) Drop empty elements. *compact(x)*

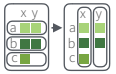


head_while(.x, .p, …) Return head elements until one does not pass. Also **tail_while**. *head_while(x, is.character)*

RESHAPE LISTS



flatten(.x) Remove a level of indexes from a list. Also **flatten_chr**, **flatten_dbl**, **flatten_dfc**, **flatten_dfr**, **flatten_int**, **flatten_lgl**. *flatten(x)*



transpose(.l, .names = NULL) Transposes the index order in a multi-level list. *transpose(x)*

SUMMARISE LISTS

every(.x, .p, …) Do all elements pass a test? *every(x, is.character)*

some(.x, .p, …) Do some elements pass a test? *some(x, is.character)*

has_element(.x, .y) Does a list contain an element? *has_element(x, "foo")*

detect(.x, .f, ..., .right=FALSE, .p) Find first element to pass. *detect(x, is.character)*

detect_index(.x, .f, ..., .right = FALSE, .p) Find index of first element to pass. *detect_index(x, is.character)*

vec_depth(x) Return depth (number of levels of indexes). *vec_depth(x)*

JOIN (TO) LISTS

append(x, values, after = length(x)) Add to end of list. *append(x, list(d = 1))*

prepend(x, values, before = 1) Add to start of list. *prepend(x, list(d = 1))*

splice(…) Combine objects into a list, storing S3 objects as sub-lists. *splice(x, y, "foo")*

TRANSFORM LISTS

modify(.x, .f, ...) Apply function to each element. Also **map**, **map_chr**, **map_dbl**, **map_dfc**, **map_dfr**, **map_int**, **map_lgl**. *modify(x, ~.+2)*

modify_at(.x, .at, .f, ...) Apply function to elements by name or index. Also **map_at**. *modify_at(x, "b", ~.+2)*

modify_if(.x, .p, .f, ...) Apply function to elements that pass a test. Also **map_if**. *modify_if(x, is.numeric,~.+2)*

modify_depth(.x,.depth,.f,...) Apply function to each element at a given level of a list. *modify_depth(x, 1, ~.+2)*

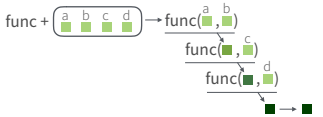
WORK WITH LISTS

array_tree(array, margin = NULL) Turn array into list. Also **array_branch**. *array_tree(x, margin = 3)*

cross2(.x, .y, .filter = NULL) All combinations of .x and .y. Also **cross**, **cross3**, **cross_df**. *cross2(1:3, 4:6)*

set_names(x, nm = x) Set the names of a vector/list directly or with a function. *set_names(x, c("p", "q", "r"))* *set_names(x, tolower)*

Reduce Lists



reduce(.x, .f, ..., .init) Apply function recursively to each element of a list or vector. Also **reduce_right**, **reduce2**, **reduce2_right**. *reduce(x, sum)*

accumulate(.x, .f, ..., .init) Reduce, but also return intermediate results. Also **accumulate_right**. *accumulate(x, sum)*

Modify function behavior

compose() Compose multiple functions.

lift() Change the type of input a function takes. Also **lift_dl**, **lift_dv**, **lift_ld**, **lift_lv**, **lift_vd**, **lift_vl**.

rerun() Rerun expression n times.

negate() Negate a predicate function (a pipe friendly !)

partial() Create a version of a function that has some args preset to values.

safely() Modify func to return list of results and errors.

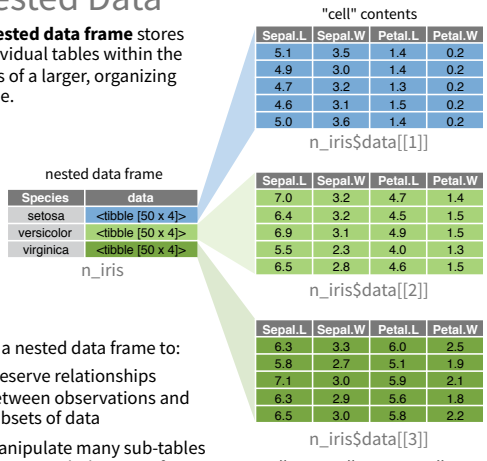
quietly() Modify function to return list of results, output, messages, warnings.

possibly() Modify function to return default value whenever an error occurs (instead of error).

Figura 15. Cartão de referência de programação funcional com purrr.

Nested Data

A **nested data frame** stores individual tables within the cells of a larger, organizing table.

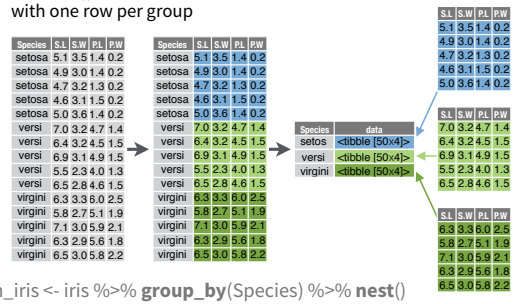


Use a nested data frame to:

- preserve relationships between observations and subsets of data
- manipulate many sub-tables at once with the **purrr** functions **map()**, **map2()**, or **pmap()**.

Use a two step process to create a nested data frame:

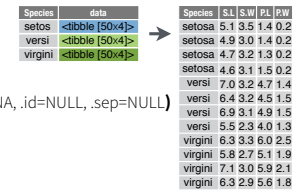
1. Group the data frame into groups with **dplyr::group_by()**
2. Use **nest()** to create a nested data frame with one row per group



n_iris <- iris %>% **group_by**(Species) %>% **nest**()

tidyr::**nest(**data, ..., .key = data**)**
For grouped data, moves groups into cells as data frames.

Unnest a nested data frame with **unnest()**:



n_iris %>% **unnest**()

tidyr::**unnest(**data, ..., .drop = NA, .id=NULL, .sep=NULL**)**
Unnests a nested data frame.

RStudio

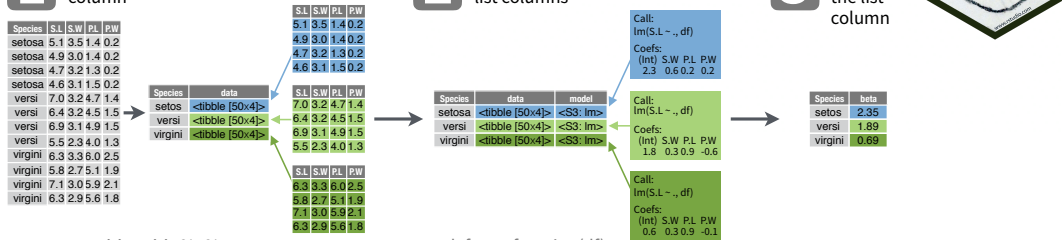
List Column Workflow

Nested data frames use a **list column**, a list that is stored as a column vector of a data frame. A typical **workflow** for list columns:

1 **Make** a list column

2 **Work with** list columns

3 **Simplify** the list column



n_iris <- iris %>%
group_by(Species) %>%
nest()

mod_fun <- function(df)
lm(Sepal.Length ~ ., data = df)

m_iris <- n_iris %>%
mutate(model = **map**(data, mod_fun))

b_fun <- function(mod)
coefficients(mod)[[1]]

m_iris %>% **transmute**(Species,
beta = **map_dbl**(model, b_fun))

1. MAKE A LIST COLUMN - You can create list columns with functions in the **tibble** and **dplyr** packages, as well as **tidyr**'s nest()

tibble::**tribble(**...**)**
Makes list column when needed

```
tribble( ~max, ~seq,
  3,   1:3,
  4,   1:4,
  5,   1:5)
```

max	seq
3	<int [3]>
4	<int [4]>
5	<int [5]>

tibble::**tibble(**...**)**
Saves list input as list columns
tibble(max = c(3, 4, 5), seq = list(1:3, 1:4, 1:5))

tibble::**enframe(**x, name="name", value="value"**)**
Converts multi-level list to tibble with list cols
enframe(list('3'=1:3, '4'=1:4, '5'=1:5), 'max', 'seq')

dplyr::**mutate(**.data, ...**)** Also **transmute()**
Returns list col when result returns list.
mtcars %>% **mutate**(seq = **map**(cyl, seq))

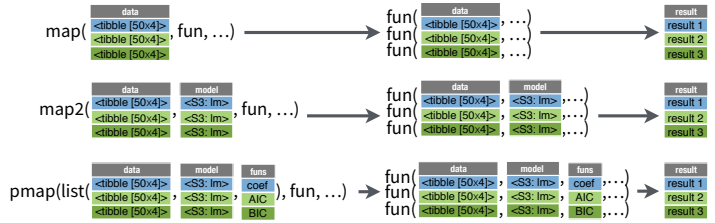
dplyr::**summarise(**.data, ...**)**
Returns list col when result is wrapped with **list()**
mtcars %>% group_by(cyl) %>%
summarise(q = **list**(quantile(mpg)))

2. WORK WITH LIST COLUMNS - Use the purrr functions **map()**, **map2()**, and **pmap()** to apply a function that returns a result element-wise to the cells of a list column. **walk()**, **walk2()**, and **pwalk()** work the same way, but return a side effect.

purrr::**map(**.x, .f, ...**)**
Apply .f element-wise to .x as .f(.x)
n_iris %>% **mutate**(n = **map**(data, dim))

purrr::**map2(**.x, .y, .f, ...**)**
Apply .f element-wise to .x and .y as .f(.x, .y)
m_iris %>% **mutate**(n = **map2**(data, model, list))

purrr::**pmap(**.l, .f, ...**)**
Apply .f element-wise to vectors saved in .l
m_iris %>%
mutate(n = **pmap**(list(data, model, data), list))



3. SIMPLIFY THE LIST COLUMN (into a regular column)

Use the purrr functions **map_lgl()**, **map_int()**, **map_dbl()**, **map_chr()**, as well as tidyr's **unnest()** to reduce a list column into a regular column.

purrr::**map_lgl(**.x, .f, ...**)**
Apply .f element-wise to .x, return a logical vector
n_iris %>% **transmute**(n = **map_lgl**(data, is.matrix))

purrr::**map_int(**.x, .f, ...**)**
Apply .f element-wise to .x, return an integer vector
n_iris %>% **transmute**(n = **map_int**(data, nrow))

purrr::**map_dbl(**.x, .f, ...**)**
Apply .f element-wise to .x, return a double vector
n_iris %>% **transmute**(n = **map_dbl**(data, nrow))

purrr::**map_chr(**.x, .f, ...**)**
Apply .f element-wise to .x, return a character vector
n_iris %>% **transmute**(n = **map_chr**(data, nrow))

Figura 16. Cartão de referência de programação funcional com purrr.

Gráficos com ggplot2

Anatomia do ggplot2

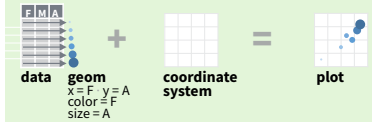
- O ggplot2 é o pacote gráfico mais adotado em ciência de dados.
- Sua implementação é baseada no *The Gammar of Graphics* (WILKINSON et al., 2013).
- A gramática faz com que a construção dos gráficos seja por camadas.
- Cartão de referência: https://github.com/rstudio/cheatsheets/raw/master/data-visualization-2.1.pdf.
- Um tutorial de ggplot2 apresentado no R Day: http://rday.leg.ufpr.br/materiais/intro_ggplo2_tomas.pdf.

Data Visualization with ggplot2 : : CHEAT SHEET

Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data** set, a **coordinate system**, and geoms—visual marks that represent data points.

To display values, map variables in the data to visual properties of the geom (**aesthetics**) like **size**, **color**, and **x** and **y** locations.



Complete the template below to build a graph.

```
ggplot (data = <DATA>) +                                   required
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
 stat = <STAT> , position = <POSITION> ) +                 Not required, sensible defaults supplied
<COORDINATE_FUNCTION>+
<FACET_FUNCTION>+
<SCALE_FUNCTION>+
<THEME_FUNCTION>
```

ggplot(data = mpg, **aes**(x = cty, y = hwy)) Begins a plot that you finish by adding layers to. Add one geom function per layer.

aesthetic mappings | data | geom

qplot(x = cty, y = hwy, data = mpg, geom = "point") Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

last_plot() Returns the last plot

ggsave("plot.png", width = 5, height = 5) Saves last plot as 5' x 5' file named "plot.png" in working directory. Matches file type to file extension.

Geoms

Use a geom function to represent data points, use the geom's aesthetic properties to represent variables. Each function returns a layer.

GRAPHICAL PRIMITIVES

a <- ggplot(economics, aes(date, unemploy))
b <- ggplot(seals, aes(x = long, y = lat))

a + geom_blank()
(Useful for expanding limits)

b + geom_curve(aes(yend = lat + 1, xend=long+1,curvature=z)) - x, xend, y, yend, alpha, angle, color, curvature, linetype, size

a + geom_path(lineend="butt", linejoin="round", linemitre=1)
x, y, alpha, color, group, linetype, size

a + geom_polygon(aes(group = group))
x, y, alpha, color, fill, group, linetype, size

b + geom_rect(aes(xmin = long, ymin=lat, xmax= long + 1, ymax = lat + 1)) - xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size

a + geom_ribbon(aes(ymin=unemploy - 900, ymax=unemploy + 900)) - x, ymax, ymin, alpha, color, fill, group, linetype, size

LINE SEGMENTS

common aesthetics: x, y, alpha, color, linetype, size

b + geom_abline(aes(intercept=0, slope=1))
b + geom_hline(aes(yintercept = lat))
b + geom_vline(aes(xintercept = long))

b + geom_segment(aes(yend=lat+1, xend=long+1))
b + geom_spoke(aes(angle = 1:1155, radius = 1))

ONE VARIABLE continuous

c <- ggplot(mpg, aes(hwy)); c2 <- ggplot(mpg)

c + geom_area(stat = "bin")
x, y, alpha, color, fill, linetype, size

c + geom_density(kernel = "gaussian")
x, y, alpha, color, fill, group, linetype, size, weight

c + geom_dotplot()
x, y, alpha, color, fill

c + geom_freqpoly() x, y, alpha, color, group, linetype, size

c + geom_histogram(binwidth = 5) x, y, alpha, color, fill, linetype, size, weight

c2 + geom_qq(aes(sample = hwy)) x, y, alpha, color, fill, linetype, size, weight

discrete

d <- ggplot(mpg, aes(fl))

d + geom_bar()
x, alpha, color, fill, linetype, size, weight

TWO VARIABLES

continuous x , continuous y

e <- ggplot(mpg, aes(cty, hwy))

e + geom_label(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE) x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

e + geom_jitter(height = 2, width = 2)
x, y, alpha, color, fill, shape, size

e + geom_point(), x, y, alpha, color, fill, shape, size, stroke

e + geom_quantile(), x, y, alpha, color, group, linetype, size, weight

e + geom_rug(sides = "bl"), x, y, alpha, color, linetype, size

e + geom_smooth(method = lm), x, y, alpha, color, fill, group, linetype, size, weight

e + geom_text(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE), x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

discrete x , continuous y

f <- ggplot(mpg, aes(class, hwy))

f + geom_col(), x, y, alpha, color, fill, group, linetype, size

f + geom_boxplot(), x, y, lower, middle, upper, ymax, ymin, alpha, color, fill, group, linetype, shape, size, weight

f + geom_dotplot(binaxis = "y", stackdir = "center"), x, y, alpha, color, fill, group

f + geom_violin(scale = "area"), x, y, alpha, color, fill, group, linetype, size, weight

discrete x , discrete y

g <- ggplot(diamonds, aes(cut, color))

g + geom_count(), x, y, alpha, color, fill, shape, size, stroke

continuous bivariate distribution

h <- ggplot(diamonds, aes(carat, price))

h + geom_bin2d(binwidth = c(0.25, 500))
x, y, alpha, color, fill, linetype, size, weight

h + geom_density2d()
x, y, alpha, colour, group, linetype, size

h + geom_hex()
x, y, alpha, colour, fill, size

continuous function

i <- ggplot(economics, aes(date, unemploy))

i + geom_area()
x, y, alpha, color, fill, linetype, size

i + geom_line()
x, y, alpha, color, group, linetype, size

i + geom_step(direction = "hv")
x, y, alpha, color, group, linetype, size

visualizing error

df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)
j <- ggplot(df, aes(grp, fit, ymin = fit-se, ymax = fit+se))

j + geom_crossbar(fatten = 2)
x, y, ymax, ymin, alpha, color, fill, group, linetype, size

j + geom_errorbar(), x, ymax, ymin, alpha, color, group, linetype, size, width (also **geom_errorbarh()**)

j + geom_linerange()
x, ymin, ymax, alpha, color, group, linetype, size

j + geom_pointrange()
x, y, ymin, ymax, alpha, color, fill, group, linetype, shape, size

maps

data <- data.frame(murder = USArrests$Murder, state = tolower(rownames(USArrests)))
map <- map_data("state")
k <- ggplot(data, aes(fill = murder))

k + geom_map(aes(map_id = state), map = map) **+ expand_limits**(x = map$long, y = map$lat), map_id, alpha, color, fill, linetype, size

THREE VARIABLES

seals$z <- with(seals, sqrt(delta_long^2 + delta_lat^2))l <- ggplot(seals, aes(long, lat))

l + geom_contour(aes(z = z))
x, y, z, alpha, colour, group, linetype, size, weight

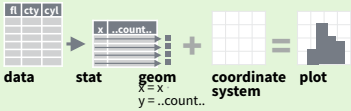
l + geom_raster(aes(fill = z), hjust=0.5, vjust=0.5, interpolate=FALSE)
x, y, alpha, fill

l + geom_tile(aes(fill = z)), x, y, alpha, color, fill, linetype, size, width

Figura 17. Cartão de referência de gráficos com `ggplot2`.

Stats An alternative way to build a layer

A stat builds new variables to plot (e.g., count, prop).



Visualize a stat by changing the default stat of a geom function, **geom_bar(stat="count")** or by using a stat function, **stat_count(geom="bar")**, which calls a default geom to make a layer (equivalent to a geom function). Use **..name..** syntax to map stat variables to aesthetics.

geom to use | stat function | geommappings

i + stat_density2d(aes(fill = ..level..), geom = "polygon")

variable created by stat

c + stat_bin(binwidth = 1, origin = 10)
x, y | ..count.., ..ncount.., ..density.., ..ndensity..

c + stat_count(width = 1) **x, y,** | ..count.., ..prop..

c + stat_density(adjust = 1, kernel = "gaussian")
x, y, | ..count.., ..density.., ..scaled..

e + stat_bin_2d(bins = 30, drop = T)
x, y, fill | ..count.., ..density..

e + stat_bin_hex(bins=30) **x, y, fill** | ..count.., ..density..

e + stat_density_2d(contour = TRUE, n = 100)
x, y, color, size | ..level..

e + stat_ellipse(level = 0.95, segments = 51, type = "t")

l + stat_contour(aes(z = z)) **x, y, z, order** | ..level..

l + stat_summary_hex(aes(z = z), bins = 30, fun = max)
x, y, z, fill | ..value..

l + stat_summary_2d(aes(z = z), bins = 30, fun = mean)
x, y, z, fill | ..value..

f + stat_boxplot(coef = 1.5) **x, y** | ..lower.., ..middle.., ..upper.., ..width.. , ..ymin.., ..ymax..

f + stat_ydensity(kernel = "gaussian", scale = "area") **x, y** | ..density.., ..scaled.., ..count.., ..n.., ..violinwidth.., ..width..

e + stat_ecdf(n = 40) **x, y** | ..x.., ..y..

e + stat_quantile(quantiles = c(0.1, 0.9), formula = y ~ log(x), method = "rq") **x, y** | ..quantile..

e + stat_smooth(method = "lm", formula = y ~ x, se=T, level=0.95) **x, y** | ..se.., ..x.., ..y.., ..ymin.., ..ymax..

ggplot() + stat_function(aes(x = -3:3), n = 99, fun = dnorm, args = list(sd=0.5)) **x** | ..x.., ..y..

e + stat_identity(na.rm = TRUE)

ggplot() + stat_qq(aes(sample=1:100), dist = qt, dparam=list(df=5)) **sample, x, y** | ..sample.., ..theoretical..

e + stat_sum() **x, y, size** | ..n.., ..prop..

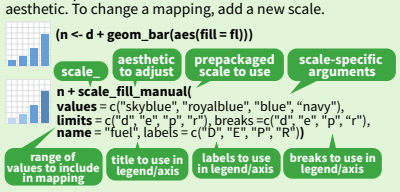
e + stat_summary(fun.data = "mean_cl_boot")

h + stat_summary_bin(fun.y = "mean", geom = "bar")

e + stat_unique()

Scales

Scales map data values to the visual values of an aesthetic. To change a mapping, add a new scale.



(n <- d + geom_bar(aes(fill = fl)))

scale_ | aesthetic to adjust | prepackaged scale to use | scale-specific arguments

n + scale_fill_manual(
values = c("skyblue", "royalblue", "blue", "navy"),
limits = c("d", "e", "p", "r"), breaks =c("d", "e", "p", "r"),
name = "fuel", labels = c("D", "E", "P", "R"))

range of values to include in mapping | title to use in legend/axis | labels to use in legend/axis | breaks to use in legend/axis

GENERAL PURPOSE SCALES

Use with most aesthetics

scale_*_continuous() - map cont' values to visual ones
scale_*_discrete() - map discrete values to visual ones
scale_*_identity() - use data values **as** visual ones
scale_*_manual(values = c()) - map discrete values to manually chosen visual ones
scale_*_date(date_labels = "%m/%d"), date_breaks = "2 weeks") - treat data values as dates.
scale_*_datetime() - treat data x values as date times. Use same arguments as scale_x_date(). See ?strptime for label formats.

X & Y LOCATION SCALES

Use with x or y aesthetics (x shown here)

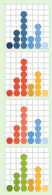
scale_x_log10() - Plot x on log10 scale
scale_x_reverse() - Reverse direction of x axis
scale_x_sqrt() - Plot x on square root scale

COLOR AND FILL SCALES (DISCRETE)

n <- d + geom_bar(aes(fill = fl))

n + scale_fill_brewer(palette = "Blues")
For palette choices:
RColorBrewer::display.brewer.all()
n + scale_fill_grey(start = 0.2, end = 0.8, na.value = "red")

COLOR AND FILL SCALES (CONTINUOUS)



o <- c + geom_dotplot(aes(fill = ..x..))

o + scale_fill_distiller(palette = "Blues")

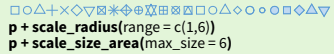
o + scale_fill_gradient(low="red", high="yellow")

o + scale_fill_gradient2(low="red", high="blue", mid = "white", midpoint = 25)

o + scale_fill_gradientn(colours=topo.colors(6))
Also: rainbow(), heat.colors(), terrain.colors(), cm.colors(), RColorBrewer::brewer.pal()

SHAPE AND SIZE SCALES

p <- e + geom_point(aes(shape = fl, size = cyl))
p + scale_shape() + scale_size()
p + scale_shape_manual(values = c(3:7))



p + scale_radius(range = c(1,6))
p + scale_size_area(max_size = 6)

Coordinate Systems

r <- d + geom_bar()

r + coord_cartesian(xlim = c(0, 5))
xlim, ylim
The default cartesian coordinate system

r + coord_fixed(ratio = 1/2)
ratio, xlim, ylim
Cartesian coordinates with fixed aspect ratio between x and y units

r + coord_flip()
xlim, ylim
Flipped Cartesian coordinates

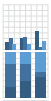
r + coord_polar(theta = "x", direction=1)
theta, start, direction
Polar coordinates

r + coord_trans(ytrans = "sqrt")
xtrans, ytrans, limx, limy
Transformed cartesian coordinates. Set xtrans and ytrans to the name of a window function.

π + coord_quickmap()
π + coord_map(projection = "ortho", orientation=c(41, -74, 0))projection, orienztation, xlim, ylim
Map projections from the mapproj package (mercator (default), azequalarea, lagrange, etc.)

Position Adjustments

Position adjustments determine how to arrange geoms that would otherwise occupy the same space.



s <- ggplot(mpg, aes(fl, fill = drv))

s + geom_bar(position = "dodge")
Arrange elements side by side

s + geom_bar(position = "fill")
Stack elements on top of one another, normalize height

e + geom_point(position = "jitter")
Add random noise to X and Y position of each element to avoid overplotting

e + geom_label(position = "nudge")
Nudge labels away from points

s + geom_bar(position = "stack")
Stack elements on top of one another

Each position adjustment can be recast as a function with manual **width** and **height** arguments
s + geom_bar(position = position_dodge(width = 1))

Themes

r + theme_bw()
White background with grid lines

r + theme_gray()
Grey background (default theme)

r + theme_dark()
dark for contrast

r + theme_classic()
r + theme_light()
r + theme_linedraw()
r + theme_minimal()
Minimal themes
r + theme_void()
Empty theme

Faceting

Facets divide a plot into subplots based on the values of one or more discrete variables.

t <- ggplot(mpg, aes(cty, hwy)) + geom_point()

t + facet_grid(cols = vars(fl))
facet into columns based on fl

t + facet_grid(rows = vars(year))
facet into rows based on year

t + facet_grid(rows = vars(year), cols = vars(fl))
facet into both rows and columns

t + facet_wrap(vars(fl))
wrap facets into a rectangular layout

Set **scales** to let axis limits vary across facets

t + facet_grid(rows = vars(drv), cols = vars(fl), scales = "free")
x and y axis limits adjust to individual facets
"free_x" - x axis limits adjust
"free_y" - y axis limits adjust

Set **labeller** to adjust facet labels

t + facet_grid(cols = vars(fl), labeller = label_both)

fl: c	fl: d	fl: e	fl: p	fl: r

t + facet_grid(rows = vars(fl), labeller = label_bquote(alpha ^ .(fl)))

α^c	α^d	α^e	α^p	α^r

Labels

t + labs(**x** = "New x axis label", **y** = "New y axis label",
title ="Add a title above the plot",
subtitle = "Add a subtitle below title",
caption = "Add a caption below plot",
<AES> = "New <AES> legend title")

Use scale functions to update legend labels

t + annotate(geom = "text", x = 8, y = 9, label = "A")

geom to place | manual values for geom's aesthetics

Legends

n + theme(legend.position = "bottom")
Place legend at "bottom", "top", "left", or "right"

n + guides(fill = "none")
Set legend type for each aesthetic: colorbar, legend, or none (no legend)

n + scale_fill_discrete(name = "Title", labels = c("A", "B", "C", "D", "E"))
Set legend title and labels with a scale function.

Zooming

Without clipping (preferred)
t + coord_cartesian(
xlim = c(0, 100), ylim = c(10, 20))

With clipping (removes unseen data points)
t + xlim(0, 100) **+ ylim**(10, 20)
t + scale_x_continuous(limits = c(0, 100)) **+ scale_y_continuous(**limits = c(0, 100))

RStudio

Figura 18. Cartão de referência de gráficos com ggplot2.

```
u <- ls("package:ggplot2")
u %>% str_subset("^geom_")
```

```
##  [1] "geom_abline"     "geom_area"       "geom_bar"
##  [4] "geom_bin2d"      "geom_blank"      "geom_boxplot"
##  [7] "geom_col"        "geom_contour"    "geom_count"
## [10] "geom_crossbar"   "geom_curve"      "geom_density"
## [13] "geom_density2d"  "geom_density_2d" "geom_dotplot"
## [16] "geom_errorbar"   "geom_errorbarh"  "geom_freqpoly"
## [19] "geom_hex"        "geom_histogram"  "geom_hline"
## [22] "geom_jitter"     "geom_label"      "geom_line"
## [25] "geom_linerange"  "geom_map"        "geom_path"
## [28] "geom_point"      "geom_pointrange" "geom_polygon"
## [31] "geom_qq"         "geom_qq_line"    "geom_quantile"
## [34] "geom_raster"     "geom_rect"       "geom_ribbon"
## [37] "geom_rug"        "geom_segment"    "geom_sf"
## [40] "geom_sf_label"   "geom_sf_text"    "geom_smooth"
## [43] "geom_spoke"      "geom_step"       "geom_text"
## [46] "geom_tile"       "geom_violin"     "geom_vline"
```

```
u %>% str_subset("^theme_")
```

```
##  [1] "theme_bw"       "theme_classic"  "theme_dark"     "theme_get"
##  [5] "theme_gray"     "theme_grey"     "theme_light"    "theme_linedraw"
##  [9] "theme_minimal"  "theme_replace"  "theme_set"      "theme_test"
## [13] "theme_update"   "theme_void"
```

```
u %>% str_subset("^stat_")
```

1

```
##  [1] "stat_bin"             "stat_bin2d"           "stat_bin_2d"
##  [4] "stat_binhex"          "stat_bin_hex"         "stat_boxplot"
##  [7] "stat_contour"         "stat_count"           "stat_density"
## [10] "stat_density2d"       "stat_density_2d"      "stat_ecdf"
## [13] "stat_ellipse"         "stat_function"        "stat_identity"
## [16] "stat_qq"              "stat_qq_line"         "stat_quantile"
## [19] "stat_sf"              "stat_sf_coordinates" "stat_smooth"
## [22] "stat_spoke"           "stat_sum"             "stat_summary"
## [25] "stat_summary2d"       "stat_summary_2d"      "stat_summary_bin"
## [28] "stat_summary_hex"     "stat_unique"          "stat_ydensity"
```

```
u %>% str_subset("^(scale|coord)_")
```

1

```
##   [1] "coord_cartesian"          "coord_equal"
##   [3] "coord_fixed"              "coord_flip"
##   [5] "coord_map"                "coord_munch"
##   [7] "coord_polar"              "coord_quickmap"
##   [9] "coord_sf"                 "coord_trans"
##  [11] "scale_alpha"              "scale_alpha_continuous"
##  [13] "scale_alpha_date"         "scale_alpha_datetime"
##  [15] "scale_alpha_discrete"     "scale_alpha_identity"
##  [17] "scale_alpha_manual"       "scale_alpha_ordinal"
##  [19] "scale_color_brewer"       "scale_color_continuous"
##  [21] "scale_color_discrete"     "scale_color_distiller"
##  [23] "scale_color_gradient"     "scale_color_gradient2"
##  [25] "scale_color_gradientn"    "scale_color_grey"
##  [27] "scale_color_hue"          "scale_color_identity"
##  [29] "scale_color_manual"       "scale_color_viridis_c"
```

Manipulação de strings com `stringr`

Anatomia do `stringr`

- O `stringr` é uma coleção de funções para operações com strings.
- Ele foi construído sobre o `stringi`.
- Cartão de referência: https://github.com/rstudio/cheatsheets/raw/master/strings.pdf.

```
ls("package:stringr")
```

1

```
##  [1] "%>%"             "boundary"        "coll"
##  [4] "fixed"           "fruit"           "invert_match"
##  [7] "regex"           "sentences"       "str_c"
## [10] "str_conv"        "str_count"       "str_detect"
## [13] "str_dup"         "str_extract"     "str_extract_all"
## [16] "str_flatten"     "str_glue"        "str_glue_data"
## [19] "str_interp"      "str_length"      "str_locate"
## [22] "str_locate_all"  "str_match"       "str_match_all"
## [25] "str_order"       "str_pad"         "str_remove"
## [28] "str_remove_all"  "str_replace"     "str_replace_all"
## [31] "str_replace_na"  "str_sort"        "str_split"
## [34] "str_split_fixed" "str_squish"      "str_sub"
## [37] "str_sub<-"       "str_subset"      "str_to_lower"
## [40] "str_to_title"    "str_to_upper"    "str_trim"
## [43] "str_trunc"       "str_view"        "str_view_all"
## [46] "str_which"       "str_wrap"        "word"
## [49] "words"
```

String manipulation with stringr : : **CHEAT SHEET**

The **stringr** package provides a set of internally consistent tools for working with character strings, i.e. sequences of characters surrounded by quotation marks.

Detect Matches

str_detect(string, **pattern**) Detect the presence of a pattern match in a string. *str_detect(fruit, "a")*

str_which(string, **pattern**) Find the indexes of strings that contain a pattern match. *str_which(fruit, "a")*

str_count(string, **pattern**) Count the number of matches in a string. *str_count(fruit, "a")*

str_locate(string, **pattern**) Locate the positions of pattern matches in a string. Also **str_locate_all**. *str_locate(fruit, "a")*

Subset Strings

str_sub(string, start = 1L, end = -1L) Extract substrings from a character vector. *str_sub(fruit, 1, 3); str_sub(fruit, -2)*

str_subset(string, **pattern**) Return only the strings that contain a pattern match. *str_subset(fruit, "b")*

str_extract(string, **pattern**) Return the first pattern match found in each string, as a vector. Also **str_extract_all** to return every pattern match. *str_extract(fruit, "[aeiou]")*

str_match(string, **pattern**) Return the first pattern match found in each string, as a matrix with a column for each ( ) group in pattern. Also **str_match_all**. *str_match(sentences, "(a|the) ([^]+)")*

Manage Lengths

str_length(string) The width of strings (i.e. number of code points, which generally equals the number of characters). *str_length(fruit)*

str_pad(string, width, side = c("left", "right", "both"), pad = " ") Pad strings to constant width. *str_pad(fruit, 17)*

str_trunc(string, width, side = c("right", "left", "center"), ellipsis = "...") Truncate the width of strings, replacing content with ellipsis. *str_trunc(fruit, 3)*

str_trim(string, side = c("both", "left", "right")) Trim whitespace from the start and/or end of a string. *str_trim(fruit)*

Mutate Strings

str_sub() **<-** value. Replace substrings by identifying the substrings with str_sub() and assigning into the results. *str_sub(fruit, 1, 3) <- "str"*

str_replace(string, **pattern**, replacement) Replace the first matched pattern in each string. *str_replace(fruit, "a", "-")*

str_replace_all(string, **pattern**, replacement) Replace all matched patterns in each string. *str_replace_all(fruit, "a", "-")*

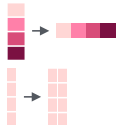
str_to_lower(string, locale = "en")[1] Convert strings to lower case. *str_to_lower(sentences)*

str_to_upper(string, locale = "en")[1] Convert strings to upper case. *str_to_upper(sentences)*

str_to_title(string, locale = "en")[1] Convert strings to title case. *str_to_title(sentences)*

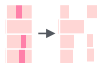
Join and Split

str_c(..., sep = "", collapse = NULL) Join multiple strings into a single string. *str_c(letters, LETTERS)*



str_c(..., sep = "", **collapse = NULL**) Collapse a vector of strings into a single string. *str_c(letters, collapse = "")*

str_dup(string, times) Repeat strings times times. *str_dup(fruit, times = 2)*



str_split_fixed(string, **pattern**, n) Split a vector of strings into a matrix of substrings (splitting at occurrences of a pattern match). Also **str_split** to return a list of substrings. *str_split_fixed(fruit, " ", n=2)*

str_glue(…, .sep = "", .envir = parent.frame()) Create a string from strings and {expressions} to evaluate. *str_glue("Pi is {pi}")*

str_glue_data(.x, ..., .sep = "", .envir = parent.frame(), .na = "NA") Use a data frame, list, or environment to create a string from strings and {expressions} to evaluate. *str_glue_data(mtcars, "{rownames(mtcars)} has {hp} hp")*

Order Strings

str_order(x, decreasing = FALSE, na_last = TRUE, locale = "en", numeric = FALSE, ...)[1] Return the vector of indexes that sorts a character vector. *x[str_order(x)]*

str_sort(x, decreasing = FALSE, na_last = TRUE, locale = "en", numeric = FALSE, ...)[1] Sort a character vector. *str_sort(x)*

Helpers

str_conv(string, encoding) Override the encoding of a string. *str_conv(fruit,"ISO-8859-1")*

str_view(string, **pattern**, match = NA) View HTML rendering of first regex match in each string. *str_view(fruit, "[aeiou]")*

str_view_all(string, **pattern**, match = NA) View HTML rendering of all regex matches. *str_view_all(fruit, "[aeiou]")*

str_wrap(string, width = 80, indent = 0, exdent = 0) Wrap strings into nicely formatted paragraphs. *str_wrap(sentences, 20)*

[1] See bit.ly/ISO639-1 for a complete list of locales.

Figura 19. Cartão de referência para manipulação de strings com `stringr`.

Need to Know

Pattern arguments in stringr are interpreted as regular expressions *after any special characters have been parsed.*

In R, you write regular expressions as *strings*, sequences of characters surrounded by quotes (**""**) or single quotes(**''**).

Some characters cannot be represented directly in an R string . These must be represented as **special characters**, sequences of characters that have a specific meaning., e.g.

Special Character	Represents
\\	\
\"	"
\n	new line

Run **?"'"** to see a complete list

Because of this, whenever a \ appears in a regular expression, you must write it as \\ in the string that represents the regular expression.

Use **writeLines**() to see how R views your string after all special characters have been parsed.

```
writeLines("\\.")
# \.

writeLines("\\ is a backslash")
# \ is a backslash
```

INTERPRETATION

Patterns in stringr are interpreted as regexs To change this default, wrap the pattern in one of:

regex(pattern, ignore_case = FALSE, multiline = FALSE, comments = FALSE, dotall = FALSE, ...) Modifies a regex to ignore cases, match end of lines as well of end of strings, allow R comments within regex's , and/or to have . match everything including \n.
str_detect("i", regex("i", TRUE))

fixed() Matches raw bytes but will miss some characters that can be represented in multiple ways (fast). *str_detect("\u0130", fixed("i"))*

coll() Matches raw bytes and will use locale specific collation rules to recognize characters that can be represented in multiple ways (slow). *str_detect("\u0130", coll("i", TRUE, locale = "tr"))*

boundary() Matches boundaries between characters, line_breaks, sentences, or words. *str_split(sentences, boundary("word"))*

Regular Expressions -

Regular expressions, or *regexps*, are a concise language for describing patterns in strings.

MATCH CHARACTERS

see <- function(rx) str_view_all("abc ABC 123\t.!?\\(){}\n", rx)

string (type this)	regexp (to mean this)	matches (which matches this)	example	
	a (etc.)	a (etc.)	see("a")	abc ABC 123 .!?\(){}
\\.	\.	.	see("\\.")	abc ABC 123 .!?\(){}
\\!	\!	!	see("\\!")	abc ABC 123 .!?\(){}
\\?	\?	?	see("\\?")	abc ABC 123 .!?\(){}
\\\\	\\	\	see("\\\\")	abc ABC 123 .!?\(){}
\\(	\(	(	see("\\(")	abc ABC 123 .!?\(){}
\\)	\)	)	see("\\)")	abc ABC 123 .!?\(){}
\\{	\{	{	see("\\{")	abc ABC 123 .!?\(){}
\\}	\}	}	see("\\}")	abc ABC 123 .!?\(){}
\\n	\n	new line (return)	see("\\n")	abc ABC 123 .!?\(){}
\\t	\t	tab	see("\\t")	abc ABC 123 .!?\(){}
\\s	\s	any whitespace (\S *for non-whitespaces*)	see("\\s")	abc ABC 123 .!?\(){}
\\d	\d	any digit (\D *for non-digits*)	see("\\d")	abc ABC 123 .!?\(){}
\\w	\w	any word character (\W *for non-word chars*)	see("\\w")	abc ABC 123 .!?\(){}
\\b	\b	word boundaries	see("\\b")	abc ABC 123 .!?\(){}
	[:digit:] [1]	digits	see("[:digit:]")	abc ABC 123 .!?\(){}
	[:alpha:] [1]	letters	see("[:alpha:]")	abc ABC 123 .!?\(){}
	[:lower:] [1]	lowercase letters	see("[:lower:]")	abc ABC 123 .!?\(){}
	[:upper:] [1]	uppercase letters	see("[:upper:]")	abc ABC 123 .!?\(){}
	[:alnum:] [1]	letters and numbers	see("[:alnum:]")	abc ABC 123 .!?\(){}
	[:punct:] [1]	punctuation	see("[:punct:]")	abc ABC 123 .!?\(){}
	[:graph:] [1]	letters, numbers, and punctuation	see("[:graph:]")	abc ABC 123 .!?\(){}
	[:space:] [1]	space characters (i.e. \s)	see("[:space:]")	abc ABC 123 .!?\(){}
	[:blank:] [1]	space and tab (but not new line)	see("[:blank:]")	abc ABC 123 .!?\(){}
	.	every character except a new line	see(".")	abc ABC 123 .!?\(){}

[1] Many base R functions require classes to be wrapped in a second set of **[ ]**, e.g. **[[:digit:]]**

[:space:] new line

[:blank:] space tab

.

[:graph:]

[:punct:]

. , : ; ? ! \ | / ` = * + - ^ _ ~ " ' [ ] { } ( ) < > @ # $

[:alnum:]

[:digit:]

0 1 2 3 4 5 6 7 8 9

[:alpha:]

[:lower:]

a b c d e f g h i j k l m n o p q r s t u v w x z

[:upper:]

A B C D E F G H I J K L M N O P Q R S T U V W X Z

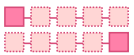
ALTERNATES

alt <- function(rx) str_view_all("abcde", rx)

regexp	matches	example	
ab|d	or	alt("ab|d")	abcde
[abe]	one of	alt("[abe]")	abcde
[^abe]	anything but	alt("[^abe]")	abcde
[a-c]	range	alt("[a-c]")	abcde

ANCHORS

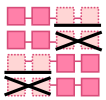
anchor <- function(rx) str_view_all("aaa", rx)



regexp	matches	example	
^a	start of string	anchor("^a")	aaa
a$	end of string	anchor("a$")	aaa

LOOK AROUNDS

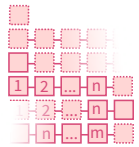
look <- function(rx) str_view_all("bacad", rx)



regexp	matches	example	
a(?=c)	followed by	look("a(?=c)")	bacad
a(?!c)	not followed by	look("a(?!c)")	bacad
(?<=b)a	preceded by	look("(?<=b)a")	bacad
(?<!b)a	not preceded by	look("(?<!b)a")	bacad

QUANTIFIERS

quant <- function(rx) str_view_all(".a.aa.aaa", rx)



regexp	matches	example	
a?	zero or one	quant("a?")	.a.aa.aaa
a*	zero or more	quant("a*")	.a.aa.aaa
a+	one or more	quant("a+")	.a.aa.aaa
a{n}	exactly **n**	quant("a{2}")	.a.aa.aaa
a{n,}	**n** or more	quant("a{2,}")	.a.aa.aaa
a{n, m}	between **n** and **m**	quant("a{2,4}")	.a.aa.aaa

GROUPS

ref <- function(rx) str_view_all("abbaab", rx)

Use parentheses to set precedent (order of evaluation) and create groups

regexp	matches	example	
(ab|d)e	sets precedence	alt("(ab|d)e")	abcde

Use an escaped number to refer to and duplicate parentheses groups that occur earlier in a pattern. Refer to each group by its order of appearance

string (type this)	regexp (to mean this)	matches (which matches this)	example (the result is the same as ref("abba"))	
\\1	\1 (etc.)	first () group, etc.	ref("(a)(b)\\2\\1")	abbaab

Figura 20. Cartão de referência para manipulação de strings com `stringr`.

Manipulação de fatores com `forcats`

Anatomia do `forcats`

- O `forcats` é uma coleção de funções para operações com fatores.
- Permite renomear, reordenar, aglutinar níveis, etc.
- Cartão de referência: https://github.com/rstudio/cheatsheets/raw/master/factors.pdf.

```
ls("package:forcats")
```

1

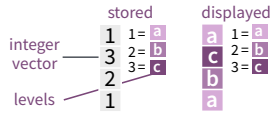
```
##  [1] "%>%"           "as_factor"     "fct_anon"
##  [4] "fct_c"         "fct_collapse"  "fct_count"
##  [7] "fct_drop"      "fct_expand"    "fct_explicit_na"
## [10] "fct_infreq"    "fct_inorder"   "fct_lump"
## [13] "fct_other"     "fct_recode"    "fct_relabel"
## [16] "fct_relevel"   "fct_reorder"   "fct_reorder2"
## [19] "fct_rev"       "fct_shift"     "fct_shuffle"
## [22] "fct_unify"     "fct_unique"    "gss_cat"
## [25] "last2"         "lvls_expand"   "lvls_reorder"
## [28] "lvls_revalue"  "lvls_union"
```

Factors with forcats : : CHEAT SHEET

The **forcats** package provides tools for working with factors, which are R's data structure for categorical data.

Factors

R represents categorical data with factors. A **factor** is an integer vector with a **levels** attribute that stores a set of mappings between integers and categorical values. When you view a factor, R displays not the integers, but the values associated with them.



Create a factor with factor()

factor(x = character(), levels, labels = levels, exclude = NA, ordered = is.ordered(x), nmax = NA) Convert a vector to a factor. Also **as_factor**.

```
f <- factor(c("a", "c", "b", "a"),
            levels = c("a", "b", "c"))
```

Return its levels with levels()

levels(x) Return/set the levels of a factor. *levels(f); levels(f) <- c("x","y","z")*

Use unclass() to see its structure

Inspect Factors

fct_count(f, sort = FALSE) Count the number of values with each level. *fct_count(f)*

fct_unique(f) Return the unique values, removing duplicates. *fct_unique(f)*

Combine Factors

fct_c(…) Combine factors with different levels.

```
f1 <- factor(c("a", "c"))
f2 <- factor(c("b", "a"))
fct_c(f1, f2)
```

fct_unify(fs, levels = lvls_union(fs)) Standardize levels across a list of factors. *fct_unify(list(f2, f1))*

Change the order of levels

fct_relevel(.f, ..., after = 0L) Manually reorder factor levels. *fct_relevel(f, c("b", "c", "a"))*

fct_infreq(f, ordered = NA) Reorder levels by the frequency in which they appear in the data (highest frequency first).

```
f3 <- factor(c("c", "c", "a"))
fct_infreq(f3)
```

fct_inorder(f, ordered = NA) Reorder levels by order in which they appear in the data. *fct_inorder(f2)*

fct_rev(f) Reverse level order.

```
f4 <- factor(c("a","b","c"))
fct_rev(f4)
```

fct_shift(f) Shift levels to left or right, wrapping around end. *fct_shift(f4)*

fct_shuffle(f, n = 1L) Randomly permute order of factor levels. *fct_shuffle(f4)*

fct_reorder(.f, .x, .fun=median, ..., .desc = FALSE) Reorder levels by their relationship with another variable.

```
boxplot(data = iris, Sepal.Width ~
  fct_reorder(Species, Sepal.Width))
```

fct_reorder2(.f, .x, .y, .fun = last2, ..., .desc = TRUE) Reorder levels by their final values when plotted with two other variables.

```
ggplot(data = iris,
  aes(Sepal.Width, Sepal.Length,
    color = fct_reorder2(Species,
      Sepal.Width, Sepal.Length))) +
  geom_smooth()
```

Change the value of levels

fct_recode(.f, ...) Manually change levels. Also **fct_relabel** which obeys purrr::map syntax to apply a function or expression to each level.

```
fct_recode(f, v = "a", x = "b", z = "c")
fct_relabel(f, ~ paste0("x", .x))
```

fct_anon(f, prefix = "")) Anonymize levels with random integers. *fct_anon(f)*

fct_collapse(.f, ...) Collapse levels into manually defined groups.

```
fct_collapse(f, x = c("a", "b"))
```

fct_lump(f, n, prop, w = NULL, other_level = "Other", ties.method = c("min", "average", "first", "last", "random", "max")) Lump together least/most common levels into a single level. Also **fct_lump_min**.

```
fct_lump(f, n = 1)
```

fct_other(f, keep, drop, other_level = "Other") Replace levels with "other."

```
fct_other(f, keep = c("a", "b"))
```

Add or drop levels

fct_drop(f, only) Drop unused levels.

```
f5 <- factor(c("a","b"),c("a","b","x"))
f6 <- fct_drop(f5)
```

fct_expand(f, …) Add levels to a factor. *fct_expand(f6, "x")*

fct_explicit_na(f, na_level="(Missing)") Assigns a level to NAs to ensure they appear in plots, etc.

```
fct_explicit_na(factor(c("a", "b", NA)))
```


Figura 21. Cartão de referência para manipulação de factores com `forcats`.

Dados cronológicos com `lubridate` e `hms`

Anatomia dos pacotes

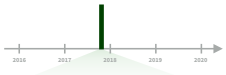
- Recursos para manipulação de dados *date-time*.
- Fácil decomposição de datas: dia, mês, semana, dia da semana, etc.
- Lida com fusos horários, horários de verão, etc.
- Extende para outras classes de dados baseados em *date-time*: duração, período, intervalos.
- Cartão de referência: https://rawgit.com/rstudio/cheatsheets/master/lubridate.pdf.
- **Não** é carregado junto com o `tidyverse`.

```r
library(lubridate)
ls("package:lubridate") %>% str_c(collapse = ", ") %>% strwrap()
```

```
##  [1] "%--%, add_with_rollback, am, Arith, as_date, as_datetime,"
##  [2] "as.difftime, as.duration, as.interval, as.period, ceiling_date,"
##  [3] "Compare, date, date<-, date_decimal, day, day<-, days,"
##  [4] "days_in_month, ddays, decimal_date, dhours, dmicroseconds,"
##  [5] "dmilliseconds, dminutes, dmy, dmy_h, dmy_hm, dmy_hms,"
##  [6] "dnanoseconds, dpicoseconds, dseconds, dst, duration, dweeks,"
##  [7] "dyears, dym, edays, ehours, emicroseconds, emilliseconds,"
##  [8] "eminutes, enanoseconds, epicoseconds, epiweek, epiyear,"
##  [9] "eseconds, eweeks, eyears, fast_strptime, fit_to_timeline,"
## [10] "floor_date, force_tz, force_tzs, guess_formats, here, hm, hms,"
## [11] "hour, hour<-, hours, int_aligns, int_diff, int_end, int_end<-,"
## [12] "intersect, interval, int_flip, int_length, int_overlaps,"
## [13] "int_shift, int_standardize, int_start, int_start<-, is.Date,"
## [14] "is.difftime, is.duration, is.instant, is.interval, isoweek,"
## [15] "isoyear, is.period, is.POSIXct, is.POSIXlt, is.POSIXt,"
## [16] "is.timepoint, is.timespan, lakers, leap_year, local_time, %m-%,"
## [17] "%m+%, make_date, make_datetime, make_difftime, mday, mday<-,"
## [18] "mdy, mdy_h, mdy_hm, mdy_hms, microseconds, milliseconds,"
## [19] "minute, minute<-, minutes, month, month<-, ms, myd,"
## [20] "nanoseconds, new_difftime, new_duration, new_interval,"
## [21] "new_period, now, olson_time_zones, origin, parse_date_time,"
## [22] "parse_date_time2, period, period_to_seconds, picoseconds, pm,"
## [23] "pretty_dates, qday, qday<-, quarter, reclass_date,"
## [24] "reclass_timespan, rollback, round_date, second, second<-,"
## [25] "seconds, seconds_to_period, semester, setdiff, show, stamp,"
## [26] "stamp_date, stamp_time, time_length, today, tz, tz<-, union,"
## [27] "wday, wday<-, week, week<-, weeks, %within%, with_tz, yday,"
## [28] "yday<-, ydm, ydm_h, ydm_hm, ydm_hms, year, year<-, years, ymd,"
```

Dates and times with lubridate : : CHEAT SHEET

Date-times



2017-11-28 12:00:00

A **date-time** is a point on the timeline, stored as the number of seconds since 1970-01-01 00:00:00 UTC

*dt <- **as_datetime**(1511870400)*
"2017-11-28 12:00:00 UTC"

2017-11-28

A **date** is a day stored as the number of days since 1970-01-01

*d <- **as_date**(17498)*
"2017-11-28"

12:00:00

An hms is a **time** stored as the number of seconds since 00:00:00

*t <- hms::**as.hms**(85)*
00:01:25

PARSE DATE-TIMES (Convert strings or numbers to date-times)

1. Identify the order of the year (**y**), month (**m**), day (**d**), hour (**h**), minute (**m**) and second (**s**) elements in your data.
2. Use the function below whose name replicates the order. Each accepts a wide variety of input formats.

2017-11-28T14:02:00 — **ymd_hms**(), **ymd_hm**(), **ymd_h**(). *ymd_hms("2017-11-28T14:02:00")*

2017-22-12 10:00:00 — **ydm_hms**(), **ydm_hm**(), **ydm_h**(). *ydm_hms("2017-22-12 10:00:00")*

11/28/2017 1:02:03 — **mdy_hms**(), **mdy_hm**(), **mdy_h**(). *mdy_hms("11/28/2017 1:02:03")*

1 Jan 2017 23:59:59 — **dmy_hms**(), **dmy_hm**(), **dmy_h**(). *dmy_hms("1 Jan 2017 23:59:59")*

20170131 — **ymd**(), **ydm**(). *ymd(20170131)*

July 4th, 2000 — **mdy**(), **myd**(). *mdy("July 4th, 2000")*

4th of July '99 — **dmy**(), **dym**(). *dmy("4th of July '99")*

2001: Q3 — **yq**() Q for quarter. *yq("2001: Q3")*

2:01 — hms::**hms**() Also lubridate::**hms**(), **hm**() and **ms**(), which return periods.* *hms::hms(sec = 0, min= 1, hours = 2)*

2017.5 — **date_decimal**(decimal, tz = "UTC") *date_decimal(2017.5)*

now(tzone = "") Current time in tz (defaults to system tz). *now()*

today(tzone = "") Current date in a tz (defaults to system tz). *today()*

fast_strptime() Faster strptime. *fast_strptime('9/1/01', '%y/%m/%d')*

parse_date_time() Easier strptime. *parse_date_time("9/1/01", "ymd")*

GET AND SET COMPONENTS

Use an accessor function to get a component. *d ## "2017-11-28"* *day(d) ## 28*

Assign into an accessor function to change a component in place. *day(d) <- 1* *d ## "2017-11-01"*

2018-01-31 11:59:59 — **date**(x) Date component. *date(dt)*

2018-01-31 11:59:59 — **year**(x) Year. *year(dt)* **isoyear**(x) The ISO 8601 year. **epiyear**(x) Epidemiological year.

2018-01-31 11:59:59 — **month**(x, label, abbr) Month. *month(dt)*

2018-01-31 11:59:59 — **day**(x) Day of month. *day(dt)* **wday**(x,label,abbr) Day of week. **qday**(x) Day of quarter.

2018-01-31 11:59:59 — **hour**(x) Hour. *hour(dt)*

2018-01-31 11:59:59 — **minute**(x) Minutes. *minute(dt)*

2018-01-31 11:59:59 — **second**(x) Seconds. *second(dt)*

week(x) Week of the year. *week(dt)* **isoweek**() ISO 8601 week. **epiweek**() Epidemiological week.

quarter(x, with_year = FALSE) Quarter. *quarter(dt)*

semester(x, with_year = FALSE) Semester. *semester(dt)*

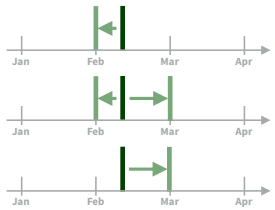
am(x) Is it in the am? *am(dt)* **pm**(x) Is it in the pm? *pm(dt)*

dst(x) Is it daylight savings? *dst(d)*

leap_year(x) Is it a leap year? *leap_year(d)*

update(object, ..., simple = FALSE) *update(dt, mday = 2, hour = 1)*

Round Date-times



floor_date(x, unit = "second") Round down to nearest unit. *floor_date(dt, unit = "month")*

round_date(x, unit = "second") Round to nearest unit. *round_date(dt, unit = "month")*

ceiling_date(x, unit = "second", change_on_boundary = NULL) Round up to nearest unit. *ceiling_date(dt, unit = "month")*

rollback(dates, roll_to_first = FALSE, preserve_hms = TRUE) Roll back to last day of previous month. *rollback(dt)*

Stamp Date-times

stamp() Derive a template from an example string and return a new function that will apply the template to date-times. Also **stamp_date**() and **stamp_time**().

1. Derive a template, create a function
   sf <- stamp("Created Sunday, Jan 17, 1999 3:34")
2. Apply the template to dates
   sf(ymd("2010-04-05"))
   ## [1] "Created Monday, Apr 05, 2010 00:00"

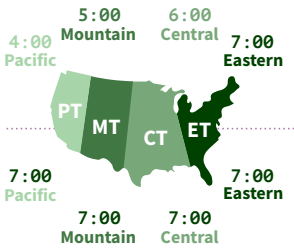
Tip: use a date with day > 12

Time Zones

R recognizes ~600 time zones. Each encodes the time zone, Daylight Savings Time, and historical calendar variations for an area. R assigns *one* time zone per vector.

Use the **UTC** time zone to avoid Daylight Savings.

OlsonNames() Returns a list of valid time zone names. *OlsonNames()*



with_tz(time, tzone = "") Get the **same date-time** in a new time zone (a new clock time). *with_tz(dt, "US/Pacific")*

force_tz(time, tzone = "") Get the **same clock time** in a new time zone (a new date-time). *force_tz(dt, "US/Pacific")*

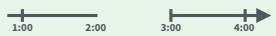
Figura 22. Cartão de referência para manipulação de *date-time* com `lubridate`

Math with Date-times – Lubridate provides three classes of timespans to facilitate math with dates and date-times

Math with date-times relies on the **timeline**, which behaves inconsistently. Consider how the timeline behaves during:

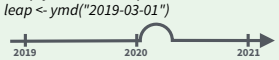
A normal day
nor <- ymd_hms("2018-01-01 01:30:00",tz="US/Eastern")

The start of daylight savings (spring forward)
gap <- ymd_hms("2018-03-11 01:30:00",tz="US/Eastern")



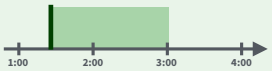
The end of daylight savings (fall back)
lap <- ymd_hms("2018-11-04 00:30:00",tz="US/Eastern")

Leap years and leap seconds
leap <- ymd("2019-03-01")

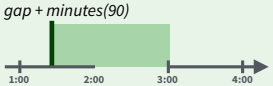


Periods track changes in clock times, which ignore time line irregularities.

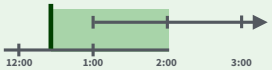
nor + minutes(90)



gap + minutes(90)



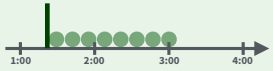
lap + minutes(90)



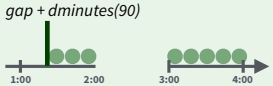
leap + years(1)

Durations track the passage of physical time, which deviates from clock time when irregularities occur.

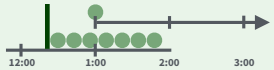
nor + dminutes(90)



gap + dminutes(90)



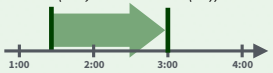
lap + dminutes(90)



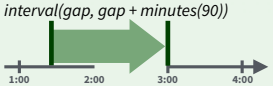
leap + dyears(1)

Intervals represent specific intervals of the timeline, bounded by start and end date-times.

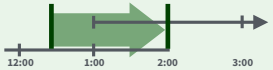
interval(nor, nor + minutes(90))



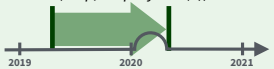
interval(gap, gap + minutes(90))



interval(lap, lap + minutes(90))



interval(leap, leap + years(1))



Not all years are 365 days due to **leap days**.

Not all minutes are 60 seconds due to **leap seconds**.

It is possible to create an imaginary date by adding **months**, e.g. February 31st

jan31 <- ymd(20180131)
jan31 + months(1)
NA

%m+% and **%m-%** will roll imaginary dates to the last day of the previous month.

jan31 %m+% months(1)
"2018-02-28"

add_with_rollback(e1, e2, roll_to_first = TRUE) will roll imaginary dates to the first day of the new month.

add_with_rollback(jan31, months(1), roll_to_first = TRUE)
"2018-03-01"

PERIODS

Add or subtract periods to model events that happen at specific clock times, like the NYSE opening bell.

Make a period with the name of a time unit ***pluralized***, e.g.

p <- months(3) + days(12)
p
"3m 12d 0H 0M 0S"

Number of months | Number of days | etc.

years(x = 1) x years.
months(x) x months.
weeks(x = 1) x weeks.
days(x = 1) x days.
hours(x = 1) x hours.
minutes(x = 1) x minutes.
seconds(x = 1) x seconds.
milliseconds(x = 1) x milliseconds.
microseconds(x = 1) x microseconds
nanoseconds(x = 1) x nanoseconds.
picoseconds(x = 1) x picoseconds.

period(num = NULL, units = "second", ...) An automation friendly period constructor. *period(5, unit = "years")*

as.period(x, unit) Coerce a timespan to a period, optionally in the specified units. Also **is.period**(). *as.period(i)*

period_to_seconds(x) Convert a period to the "standard" number of seconds implied by the period. Also **seconds_to_period**(). *period_to_seconds(p)*

DURATIONS

Add or subtract durations to model physical processes, like battery life. Durations are stored as seconds, the only time unit with a consistent length. **Difftimes** are a class of durations found in base R.

Make a duration with the name of a period prefixed with a ***d***, e.g.

dd <- ddays(14)
dd
"1209600s (~2 weeks)"

Exact length in seconds | Equivalent in common units

dyears(x = 1) 31536000x seconds.
dweeks(x = 1) 604800x seconds.
ddays(x = 1) 86400x seconds.
dhours(x = 1) 3600x seconds.
dminutes(x = 1) 60x seconds.
dseconds(x = 1) x seconds.
dmilliseconds(x = 1) x $\times 10^{-3}$ seconds.
dmicroseconds(x = 1) x $\times 10^{-6}$ seconds.
dnanoseconds(x = 1) x $\times 10^{-9}$ seconds.
dpicoseconds(x = 1) x $\times 10^{-12}$ seconds.

duration(num = NULL, units = "second", ...) An automation friendly duration constructor. *duration(5, unit = "years")*

as.duration(x, …) Coerce a timespan to a duration. Also **is.duration**(), **is.difftime**(). *as.duration(i)*

make_difftime(x) Make difftime with the specified number of units. *make_difftime(99999)*

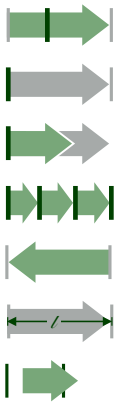
INTERVALS

Divide an interval by a duration to determine its physical length, divide an interval by a period to determine its implied length in clock time.

Make an interval with **interval**() or **%--%**, e.g.

Start Date | End Date

*i <- **interval**(ymd("2017-01-01"), d)* *## 2017-01-01 UTC--2017-11-28 UTC*
*j <- d **%--%** ymd("2017-12-31")* *## 2017-11-28 UTC--2017-12-31 UTC*



a **%within%** b Does interval or date-time *a* fall within interval *b*? *now() %within% i*

int_start(int) Access/set the start date-time of an interval. Also **int_end**(). *int_start(i) <- now(); int_start(i)*

int_aligns(int1, int2) Do two intervals share a boundary? Also **int_overlaps**(). *int_aligns(i, j)*

int_diff(times) Make the intervals that occur between the date-times in a vector. *v <-c(dt, dt + 100, dt + 1000); int_diff(v)*

int_flip(int) Reverse the direction of an interval. Also **int_standardize**(). *int_flip(i)*

int_length(int) Length in seconds. *int_length(i)*

int_shift(int, by) Shifts an interval up or down the timeline by a timespan. *int_shift(i, days(-1))*

as.interval(x, start, …) Coerce a timespans to an interval with the start date-time. Also **is.interval**(). *as.interval(days(1), start = now())*

RStudio

Figura 23. Cartão de referência para manipulação de *date-time* com `lubridate`

Encadeando com operadores do `magrittr`

Anatomia

- O operador permite expressar de forma mais direta as operações.
- É uma ideia inspirada no Shell.
- A lógica é bem simples:
  - `x %>% f` é o mesmo que `f(x)`.
  - `x %>% f(y)` é o mesmo que `f(x, y)`.
  - `x %>% f %>% g %>% h` é o mesmo que `h(g(f(x)))`.

Anatomia do magrittr

```r
library(magrittr)

# Operadores "pipe".
ls("package:magrittr") %>%
    str_subset("%")
```

```
## [1] "%<>%" "%>%"  "%$%"  "%T>%"
```

```r
# Outras funções/objetos.
ls("package:magrittr") %>%
    str_subset("^[^%]*$")
```

```
##  [1] "add"                      "and"
##  [3] "debug_fseq"               "debug_pipe"
##  [5] "divide_by"                "divide_by_int"
##  [7] "equals"                   "extract"
##  [9] "extract2"                 "freduce"
## [11] "functions"                "inset"
## [13] "inset2"                   "is_greater_than"
## [15] "is_in"                    "is_less_than"
## [17] "is_weakly_greater_than"   "is_weakly_less_than"
## [19] "mod"                      "multiply_by"
## [21] "multiply_by_matrix"       "n'est pas"
## [23] "not"                      "or"
## [25] "raise_to_power"           "set_colnames"
## [27] "set_names"                "set_rownames"
## [29] "subtract"                 "undebug_fseq"
## [31] "use_series"
```

Exemplos do uso do pipe (1)

```
x <- precip
mean(sqrt(x - min(x)))
```

```
## [1] 5.020078
```

```
x <- x - min(x)
x <- sqrt(x)
mean(x)
```

```
## [1] 5.020078
```

```
precip %>%
    `-`(min(.)) %>% # o mesmo que subtract(min(.))
    sqrt() %>%
    mean()
```

```
## [1] 5.020078
```

Exemplos de uso do pipe (2)

```
x <- precip
x <- sqrt(x)
x <- x[x > 5]
x <- mean(x)
x
```

```
## [1] 6.364094
```

```
precip %>%
    sqrt() %>%
    .[is_greater_than(., 5)] %>% # o mesmo que .[`>`(., 5)]
    mean()
```

```
## [1] 6.364094
```

Mãos à obra!

Instalar o tidyverse

```
# Do CRAN.
install.packages("tidyverse")

# Do GitHub.
# install.packages("devtools")
devtools::install_github("hadley/tidyverse")

# Atualizar caso já tenha instalado.
tidyverse_update()
```

O que vem agora?

- Uma visão aprofundada de cada pacote do `tidyverse`.
- Exemplos didáticos seguidos de desafios práticos.
- *Happy coding*.

Referências

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