Data management

Data wrangling

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What is in a dataset?

Dataset terminology

- Each row is an **observation**
- Each column is a **variable**

`starwars` is a data from the `dplyr` pkg

```
starwars
```

```
## # A tibble: 87 × 14
##   name    height  mass hair_color skin_color eye_color birth_year
##   <chr>    <int> <dbl> <chr>      <chr>      <chr>           <dbl>
## 1 Luke S…    172    77 blond      fair       blue             19
## 2 C-3PO      167    75 <NA>       gold       yellow          112
## 3 R2-D2       96    32 <NA>       white, bl… red              33
## 4 Darth …    202   136 none       white      yellow           41.9
## 5 Leia O…    150    49 brown      light      brown            19
## 6 Owen L…    178   120 brown, gr… light      blue             52
## # ℹ 81 more rows
## # ℹ 7 more variables: sex <chr>, gender <chr>, homeworld <chr>,
## #   species <chr>, films <list>, vehicles <list>,
## #   starships <list>
```

What's in the Star Wars data?

Take a `glimpse` at the data:

```
glimpse(starwars)
```

```
## Rows: 87
## Columns: 14
## $ name       <chr> "Luke Skywalker", "C-3PO", "R2-D2", "Darth V…
## $ height     <int> 172, 167, 96, 202, 150, 178, 165, 97, 183, 1…
## $ mass       <dbl> 77.0, 75.0, 32.0, 136.0, 49.0, 120.0, 75.0, …
## $ hair_color <chr> "blond", NA, NA, "none", "brown", "brown, gr…
## $ skin_color <chr> "fair", "gold", "white, blue", "white", "lig…
## $ eye_color  <chr> "blue", "yellow", "red", "yellow", "brown", …
## $ birth_year <dbl> 19.0, 112.0, 33.0, 41.9, 19.0, 52.0, 47.0, N…
## $ sex        <chr> "male", "none", "none", "male", "female", "m…
## $ gender     <chr> "masculine", "masculine", "masculine", "masc…
## $ homeworld  <chr> "Tatooine", "Tatooine", "Naboo", "Tatooine",…
## $ species    <chr> "Human", "Droid", "Droid", "Human", "Human",…
## $ films      <list> <"The Empire Strikes Back", "Revenge of the…
## $ vehicles   <list> <"Snowspeeder", "Imperial Speeder Bike">, <…
## $ starships  <list> <"X-wing", "Imperial shuttle">, <>, <>, "TI…
```

What does each row represent? What does each column represent?

```
?starwars
```

starwars {dplyr} R Documentation

Starwars characters

Description

This data comes from SWAPI, the Star Wars API, https://swapi.dev/

Usage

```
starwars
```

Format

A tibble with 87 rows and 14 variables:

name
: Name of the character

height
: Height (cm)

mass
: Weight (kg)

hair_color,skin_color,eye_color
: Hair, skin, and eye colors

birth_year
: Year born (BBY = Before Battle of Yavin)

Luke Skywalker

```
height = 172 cm
weight = 77 kg
eye_color = "blue"
skin_color = "fair"
species = "Human"
sex = "male"
gender = "masculine"
homeworld = "Tatooine"
```

```
name = "Luke Skywalker"
hair_color = "blond"
birth_year = 19 BBY
films = c("The Empire Strikes Back",
          "Revenge of the Sith",
          "Return of the Jedi",
          "A New Hope",
          "The Force Awakens")
vehicles = c("Snowspeeder",
             "Imperial Speeder Bike")
starships = c("X-wing",
              "Imperial shuttle")
```

> How many rows and columns does this dataset have?

```
nrow(starwars) # number of rows
```

```
## [1] 87
```

```
ncol(starwars) # number of columns
```

```
## [1] 14
```

```
dim(starwars)  # dimensions (row column)
```

```
## [1] 87 14
```

Exploratory data analysis

What is EDA?

- Exploratory data analysis (EDA) is an approach to analysing data sets to summarize its main characteristics
- Often, this is visual -- this is what we'll focus on next
- But we might also calculate summary statistics and perform data wrangling/manipulation/transformation at (or before) this stage of the analysis -- this is what we'll focus on first

Tidy data

> Happy families are all alike; every unhappy family is unhappy in its own way.
>
> Leo Tolstoy

> Le serie di dati ordinate sono tutte uguali, ma ogni serie di dati disordinata è disordinata a modo suo".
>
> Hadley Wickham

Characteristics of tidy data:

1. Ogni variabile deve avere la propria colonna.
2. Ogni osservazione deve avere la sua riga.
3. Ogni valore deve avere la propria cella.

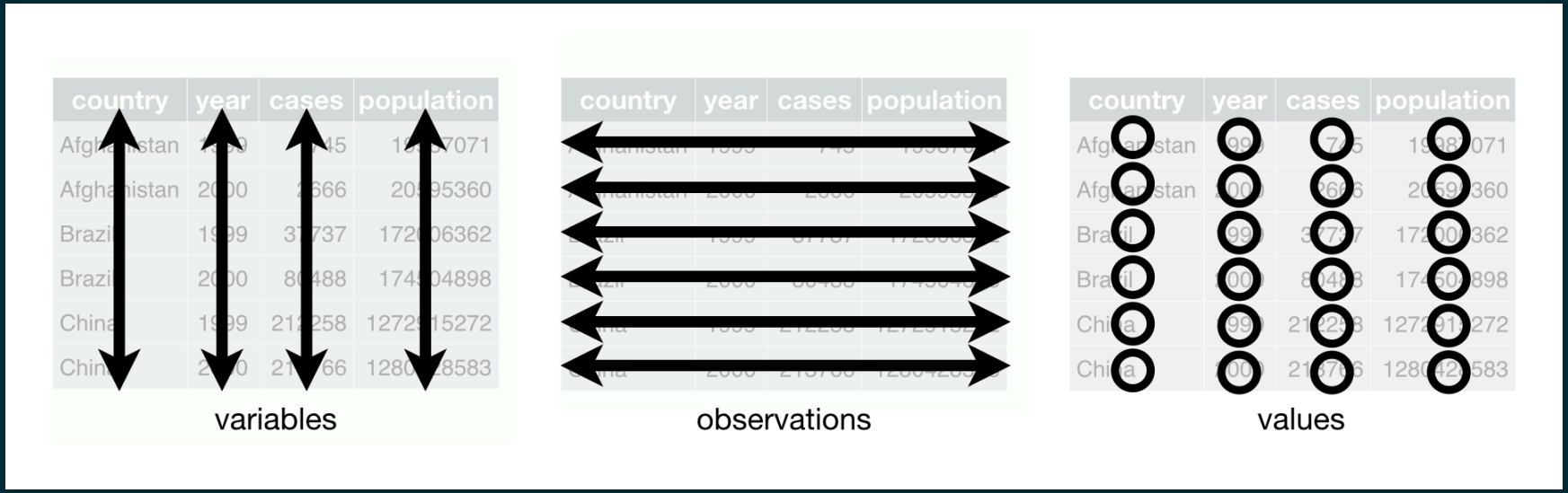
- Ogni tipo di unità d'osservazione forma una tabella (`tibble`).

Characteristics of untidy data:

!@#$%^&*()

Tidy data

(dati ordinati, organizzati)

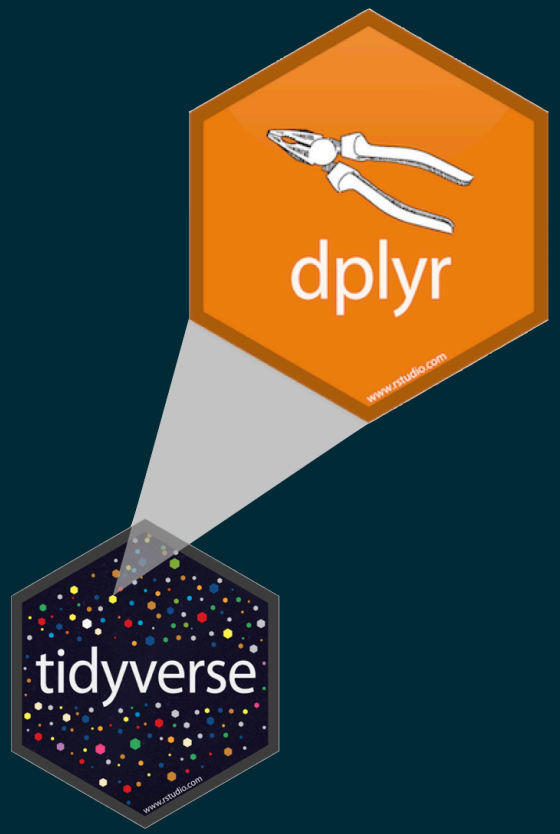


Una volta che avete dati ordinati con gli strumenti forniti dai pacchetti del `tidyverse`, passerete molto meno tempo a gestire i dati (eventualmente cambiando rappresentazione quando necessario), permettendovi di dedicare più tempo alle domande analitiche che avete a disposizione.

Grammar of data wrangling

A grammar of data wrangling...

... based on the concepts of functions as verbs that manipulate data frames



- `select`: pick columns by name
- `arrange`: reorder rows
- `slice`: pick rows using index(es)
- `filter`: pick rows matching criteria
- `distinct`: filter for unique rows
- `mutate`: add new variables
- `summarise`: reduce variables to values
- `group_by`: for grouped operations
- ... (many more)

Rules of dplyr functions

- First argument is *always* a data frame
- Subsequent arguments say what to do with that data frame
- Always return a data frame
- Don't modify in place

Data: Hotel bookings

- Data from two hotels: one resort and one city hotel
- Observations: Each row represents a hotel booking
- Goal for original data collection: Development of prediction models to classify a hotel booking's likelihood to be cancelled (Antonia et al., 2019)

```
hotels <- read_csv("data/hotels.csv")
```

Source: TidyTuesday

First look: Variables

```
names(hotels)
```

```
##  [1] "hotel"
##  [2] "is_canceled"
##  [3] "lead_time"
##  [4] "arrival_date_year"
##  [5] "arrival_date_month"
##  [6] "arrival_date_week_number"
##  [7] "arrival_date_day_of_month"
##  [8] "stays_in_weekend_nights"
##  [9] "stays_in_week_nights"
## [10] "adults"
## [11] "children"
## [12] "babies"
## [13] "meal"
## [14] "country"
## [15] "market_segment"
## [16] "distribution_channel"
## [17] "is_repeated_guest"
## [18] "previous_cancellations"
...
```

Second look: Overview

```
glimpse(hotels)
```

```
## Rows: 119,390
## Columns: 32
## $ hotel                         <chr> "Resort Hotel", "Resort …
## $ is_canceled                   <dbl> 0, 0, 0, 0, 0, 0, 0, 0, …
## $ lead_time                     <dbl> 342, 737, 7, 13, 14, 14,…
## $ arrival_date_year             <dbl> 2015, 2015, 2015, 2015, …
## $ arrival_date_month            <chr> "July", "July", "July", …
## $ arrival_date_week_number      <dbl> 27, 27, 27, 27, 27, 27, …
## $ arrival_date_day_of_month     <dbl> 1, 1, 1, 1, 1, 1, 1, 1, …
## $ stays_in_weekend_nights       <dbl> 0, 0, 0, 0, 0, 0, 0, 0, …
## $ stays_in_week_nights          <dbl> 0, 0, 1, 1, 2, 2, 2, 2, …
## $ adults                        <dbl> 2, 2, 1, 1, 2, 2, 2, 2, …
## $ children                      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, …
## $ babies                        <dbl> 0, 0, 0, 0, 0, 0, 0, 0, …
## $ meal                          <chr> "BB", "BB", "BB", "BB", …
## $ country                       <chr> "PRT", "PRT", "GBR", "GB…
## $ market_segment                <chr> "Direct", "Direct", "Dir…
## $ distribution_channel          <chr> "Direct", "Direct", "Dir…
...
```

Select a single column

View only `lead_time` (number of days between booking and arrival date):

```
select(hotels, lead_time)
```

```
## # A tibble: 119,390 × 1
##   lead_time
##       <dbl>
## 1       342
## 2       737
## 3         7
## 4        13
## 5        14
## 6        14
## # ℹ 119,384 more rows
```

Select a single column

```
select(
  hotels,
  lead_time
  )
```

- Start with the function (a verb): `select()`

Select a single column

```
select(
  hotels,
  lead_time
  )
```

- Start with the function (a verb): `select()`
- First argument: data frame we're working with , `hotels`

Select a single column

```
select(
  hotels,
  lead_time
  )
```

- Start with the function (a verb): `select()`
- First argument: data frame we're working with , `hotels`
- Second argument: variable we want to select, `lead_time`

Select a single column

```
select(
  hotels,
  lead_time
  )
```

```
## # A tibble: 119,390 × 1
##   lead_time
##       <dbl>
## 1       342
## 2       737
## 3         7
## 4        13
## 5        14
## 6        14
## # ℹ 119,384 more rows
```

- Start with the function (a verb): `select()`
- First argument: data frame we're working with , `hotels`
- Second argument: variable we want to select, `lead_time`
- Result: data frame with 119390 rows and 1 column

> dplyr functions always expect a data frame and always yield a data frame.

```
select(hotels, lead_time)
```

```
## # A tibble: 119,390 × 1
##   lead_time
##       <dbl>
## 1       342
## 2       737
## 3         7
## 4        13
## 5        14
## 6        14
## # ℹ 119,384 more rows
```

Select multiple columns

View only the `hotel` type and `lead_time`:

```
select(hotels, hotel, lead_time)
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       342
## 2 Resort Hotel       737
## 3 Resort Hotel         7
## 4 Resort Hotel        13
## 5 Resort Hotel        14
## 6 Resort Hotel        14
## # ℹ 119,384 more rows
```

> What if we wanted to select these columns, and then arrange the data in descending order of lead time?

Data wrangling, step-by-step

Select:

```
hotels %>%
  select(hotel, lead_time)
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       342
## 2 Resort Hotel       737
## 3 Resort Hotel         7
## 4 Resort Hotel        13
## 5 Resort Hotel        14
## 6 Resort Hotel        14
## # ℹ 119,384 more rows
```

Select, then arrange:

```
hotels %>%
  select(hotel, lead_time) %>%
  arrange(desc(lead_time))
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       737
## 2 Resort Hotel       709
## 3 City Hotel         629
## 4 City Hotel         629
## 5 City Hotel         629
## 6 City Hotel         629
## # ℹ 119,384 more rows
```

Pipes

What is a pipe?

In programming, a pipe is a technique for passing information from one process to another.

- Start with the data frame `hotels`, and pass it to the `select()` function,

```
hotels %>%
  select(hotel, lead_time) %>%
  arrange(desc(lead_time))
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       737
## 2 Resort Hotel       709
## 3 City Hotel         629
## 4 City Hotel         629
## 5 City Hotel         629
## 6 City Hotel         629
## # ℹ 119,384 more rows
```

What is a pipe?

In programming, a pipe is a technique for passing information from one process to another.

- Start with the data frame `hotels`, and pass it to the `select()` function,
- then we select the variables `hotel` and `lead_time`,

```
hotels %>%
  select(hotel, lead_time) %>%
  arrange(desc(lead_time))
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       737
## 2 Resort Hotel       709
## 3 City Hotel         629
## 4 City Hotel         629
## 5 City Hotel         629
## 6 City Hotel         629
## # ℹ 119,384 more rows
```

What is a pipe?

In programming, a pipe is a technique for passing information from one process to another.

- Start with the data frame `hotels`, and pass it to the `select()` function,
- then we select the variables `hotel` and `lead_time`,
- and then we arrange the data frame by `lead_time` in descending order.

```
hotels %>%
  select(hotel, lead_time) %>%
  arrange(desc(lead_time))
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       737
## 2 Resort Hotel       709
## 3 City Hotel         629
## 4 City Hotel         629
## 5 City Hotel         629
## 6 City Hotel         629
## # ℹ 119,384 more rows
```

Aside

The pipe operator is implemented in the package **magrittr**, though we don't need to load this package explicitly since **tidyverse** does this for us.

> Any guesses as to why the package is called magrittr?

How does a pipe work?

- You can think about the following sequence of actions - find keys, unlock car, start car, drive to work, park.
- Expressed as a set of nested functions in R pseudocode this would look like:

```
park(drive(start_car(find("keys")), to = "work"))
```

- Writing it out using pipes give it a more natural (and easier to read) structure:

```
find("keys") %>%
  start_car() %>%
  drive(to = "work") %>%
  park()
```

A note on piping and layering

- %>% used mainly in **dplyr** pipelines, *we pipe the output of the previous line of code as the first input of the next line of code*
- + used in **ggplot2** plots is used for "layering", *we create the plot in layers, separated by +*

dplyr

❌

```
hotels +
  select(hotel, lead_time)
```

```
## Error in eval(expr, envir, enclos): oggetto 'hotel' non trovato
```

✅

```
hotels %>%
  select(hotel, lead_time)
```

```
## # A tibble: 119,390 × 2
##   hotel        lead_time
##   <chr>            <dbl>
## 1 Resort Hotel       342
## 2 Resort Hotel       737
## 3 Resort Hotel         7
...
```

ggplot2

❌

```
ggplot(hotels, aes(x = hotel, fill = deposit_type)) %>%
  geom_bar()
```

```
## Error in `geom_bar()`:
## ! `mapping` must be created by `aes()`
## ℹ Did you use `%>%` or `|>` instead of `+`?
```

✅

```
ggplot(hotels, aes(x = hotel, fill = deposit_type)) +
  geom_bar()
```

Code styling

Many of the styling principles are consistent across %>% and +:

- always a space before
- always a line break after (for pipelines with more than 2 lines)

❌

```
ggplot(hotels,aes(x=hotel,y=deposit_type))+geom_bar()
```

✅

```
ggplot(hotels, aes(x = hotel, y = deposit_type)) +
  geom_bar()
```