Data and visualisation

Ggplot2 ❤️

Filippo Chiarello, Ph.D.

What is in a dataset?

Let's open RStudio Cloud

LINK

Dataset terminology

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

```
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
## # … with 81 more rows, and 7 more variables: sex <chr>,
## #   gender <chr>, homeworld <chr>, species <chr>, films <list>,
## #   vehicles <list>, starships <list>
```

Luke Skywalker

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…
```

How many rows and columns does this dataset have? 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)

> 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
```

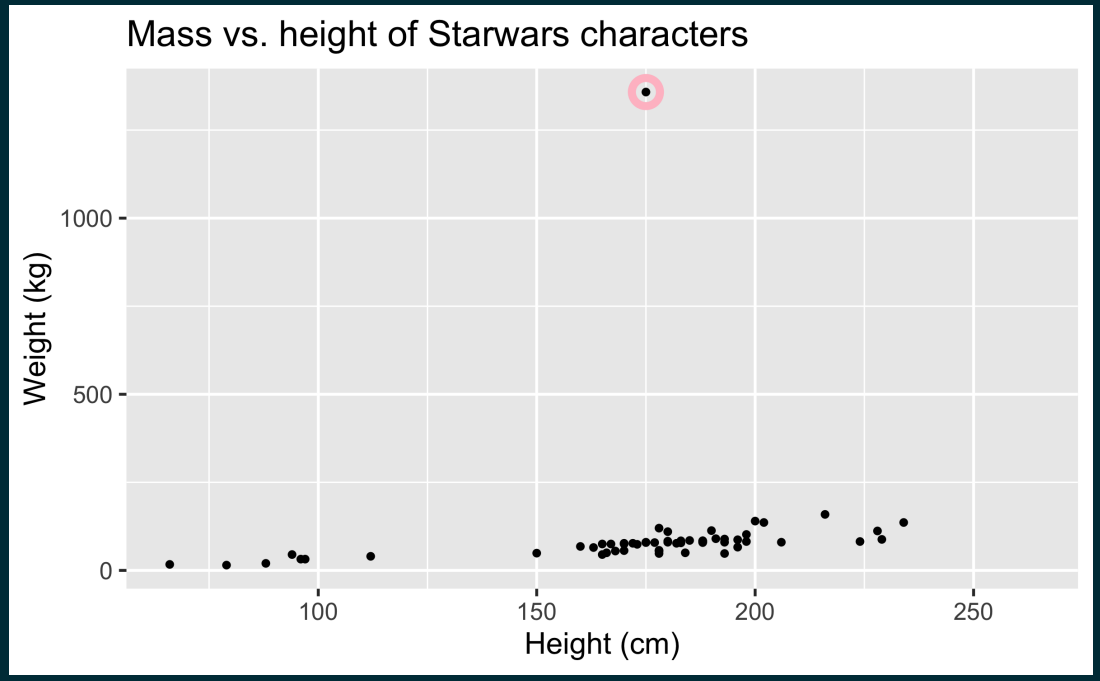
Exploratory data analysis

What is EDA?

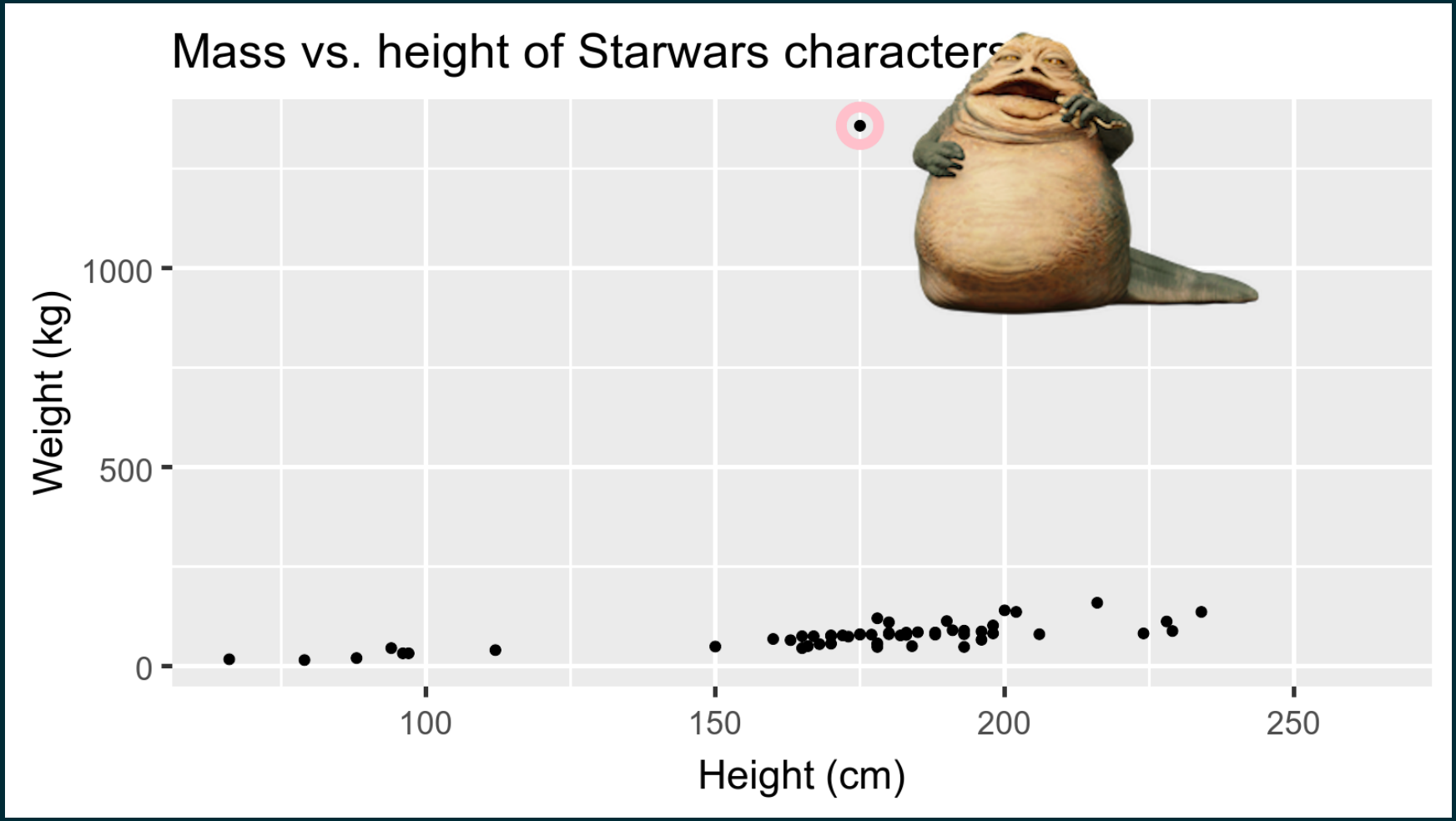
- Exploratory data analysis (EDA) is an approach to analysing data sets to summarize its main characteristics
- Often, this is visual -- this is what we'll focus on first
- But we might also calculate summary statistics and perform data wrangling/manipulation/transformation at (or before) this stage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

Mass vs. height

How would you describe the relationship between mass and height of Starwars characters? What other variables would help us understand data points that don't follow the overall trend? Who is the not so tall but really chubby character?



Jabba!


Mass vs. height of Starwars characters
Weight (kg)
1000
500
0
100
150
200
250
Height (cm)

Data visualization

Data visualization

> *"The simple graph has brought more information to the data analyst's mind than any other device." --- John Tukey*

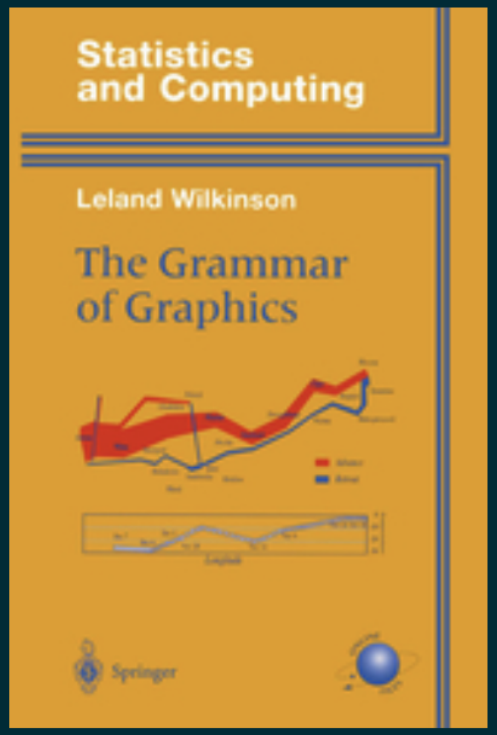
- Data visualization is the creation and study of the visual representation of data
- Many tools for visualizing data -- R is one of them
- Many approaches/systems within R for making data visualizations -- **ggplot2** is one of them, and that's what we're going to use

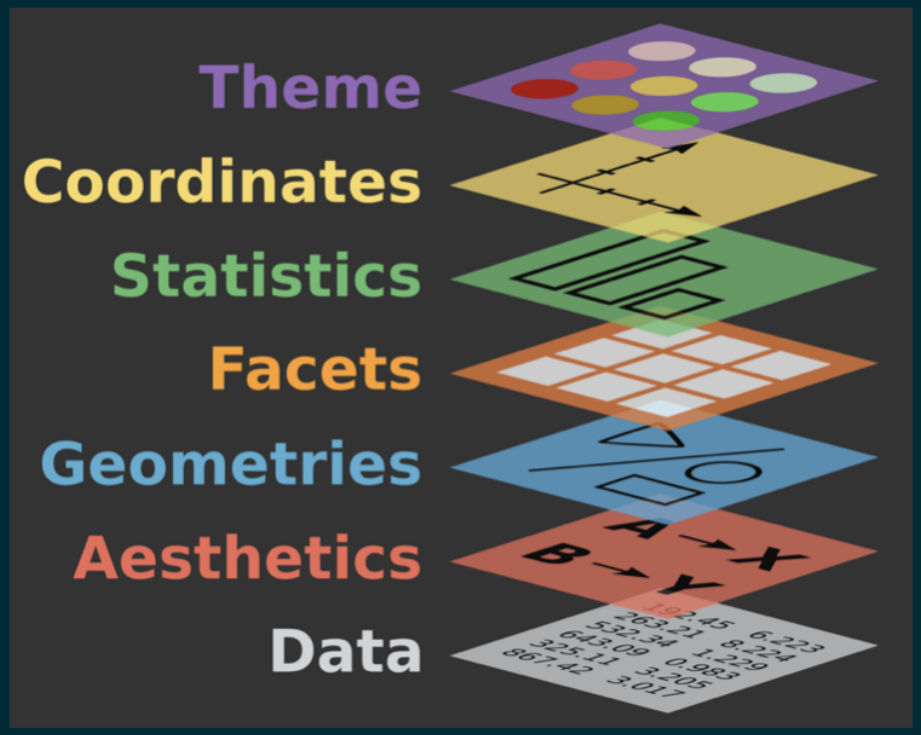
ggplot2 ∈ tidyverse

- **ggplot2** is tidyverse's data visualization package
- gg in "ggplot2" stands for Grammar of Graphics
- Inspired by the book **Grammar of Graphics** by Leland Wilkinson

Grammar of Graphics

A grammar of graphics is a tool that enables us to concisely describe the components of a graphic



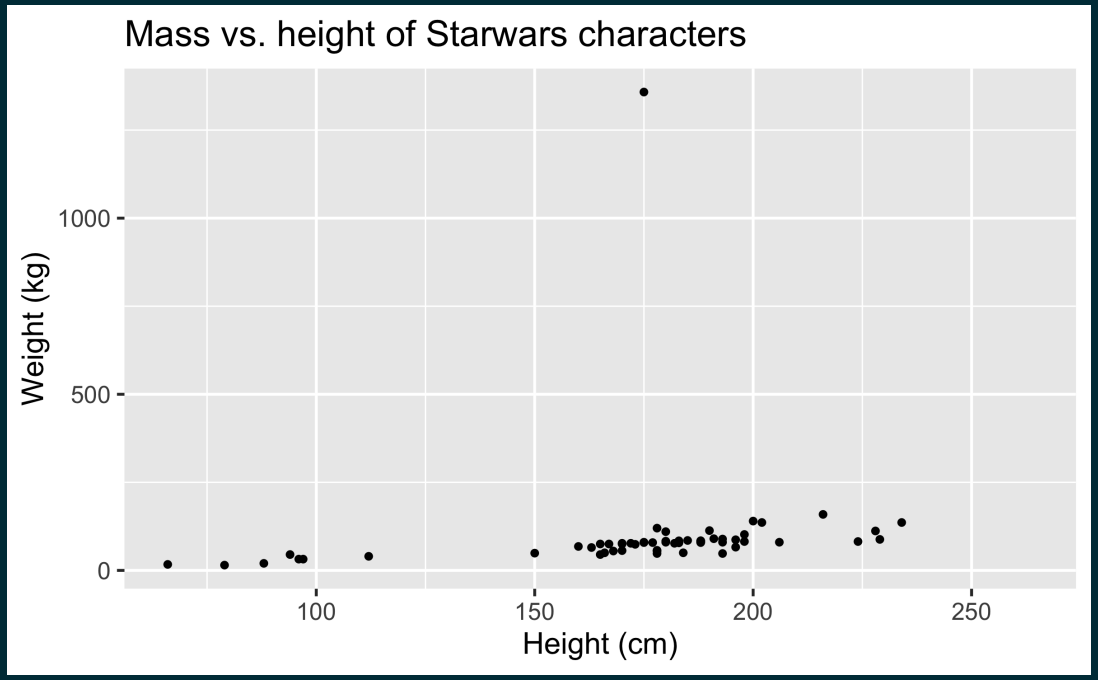


Source: BloggoType

Mass vs. height

```
ggplot(data = starwars, mapping = aes(x = height, y = mass)) +
  geom_point() +
  labs(title = "Mass vs. height of Starwars characters",
       x = "Height (cm)", y = "Weight (kg)")
```

```
## Warning: Removed 28 rows containing missing values (geom_point).
```



- What are the functions doing the plotting?
- What is the dataset being plotted?
- Which variables map to which features (aesthetics) of the plot?
- What does the warning mean?[+]

```
ggplot(data = starwars, mapping = aes(x = height, y = mass)) +
  geom_point() +
  labs(title = "Mass vs. height of Starwars characters",
       x = "Height (cm)", y = "Weight (kg)")
```

```
## Warning: Removed 28 rows containing missing values (geom_point).
```

[+]Suppressing warning to subsequent slides to save space

Hello ggplot2!

- `ggplot()` is the main function in ggplot2
- Plots are constructed in layers
- Structure of the code for plots can be summarized as

```
ggplot(data = [dataset],
       mapping = aes(x = [x-variable], y = [y-variable])) +
   geom_xxx() +
   other options
```

- The ggplot2 package comes with the tidyverse

```
library(tidyverse)
```

- For help with ggplot2, see ggplot2.tidyverse.org

Why do we visualize?

Anscombe's quartet

	set	x	y
1	I	10	8.04
2	I	8	6.95
3	I	13	7.58
4	I	9	8.81
5	I	11	8.33
6	I	14	9.96
7	I	6	7.24
8	I	4	4.26
9	I	12	10.84
10	I	7	4.82
11	I	5	5.68
12	II	10	9.14
13	II	8	8.14
14	II	13	8.74
15	II	9	8.77
16	II	11	9.26
17	II	14	8.10
18	II	6	6.13
19	II	4	3.10
20	II	12	9.13
21	II	7	7.26
22	II	5	4.74

	set	x	y
23	III	10	7.46
24	III	8	6.77
25	III	13	12.74
26	III	9	7.11
27	III	11	7.81
28	III	14	8.84
29	III	6	6.08
30	III	4	5.39
31	III	12	8.15
32	III	7	6.42
33	III	5	5.73
34	IV	8	6.58
35	IV	8	5.76
36	IV	8	7.71
37	IV	8	8.84
38	IV	8	8.47
39	IV	8	7.04
40	IV	8	5.25
41	IV	19	12.50
42	IV	8	5.56
43	IV	8	7.91
44	IV	8	6.89

Summarising Anscombe's quartet

```
quartet %>%
  group_by(set) %>%
  summarise(
    mean_x = mean(x),
    mean_y = mean(y),
    sd_x = sd(x),
    sd_y = sd(y),
    r = cor(x, y)
  )
```

```
## # A tibble: 4 × 6
##   set   mean_x mean_y  sd_x  sd_y     r
##   <fct>  <dbl>  <dbl> <dbl> <dbl> <dbl>
## 1 I          9   7.50  3.32  2.03 0.816
## 2 II         9   7.50  3.32  2.03 0.816
## 3 III        9   7.5   3.32  2.03 0.816
## 4 IV         9   7.50  3.32  2.03 0.817
```

Visualizing Anscombe's quartet