DATA VISUALIZATION

ggplot2 & Grammar of Graphics

CONTENT

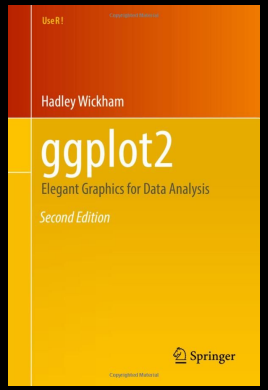
- Credits & References
- Pleas for Data Visualization
- The Grammar of Graphics
  - Basic Layers (data, aesthetics, geometry)
  - Advanced Layers (statistics, scales, facets, coordinates, themes)
- What to plot? Important visualizations for different applications

CREDITS

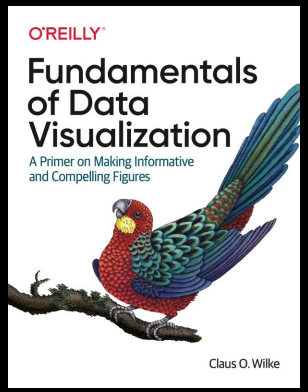
This slide deck is heavily inspired by the workshop “**Plotting anything with ggplot2**” by Tomas Lin Pedersen:

- Workshop video part 1
- Workshop video part 2
- Slides

REFERENCES



Wickham, Hadley. ggplot2. Springer Science + Business Media, LLC, 2016. Online verfügbar: https://ggplot2-book.org/



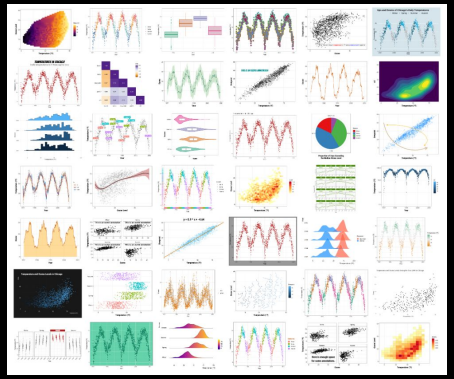
Wilke, C. Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures. First edition, O'Reilly Media, 2019.

Online verfügbar: https://clauswilke.com/dataviz/index.html

REFERENCES

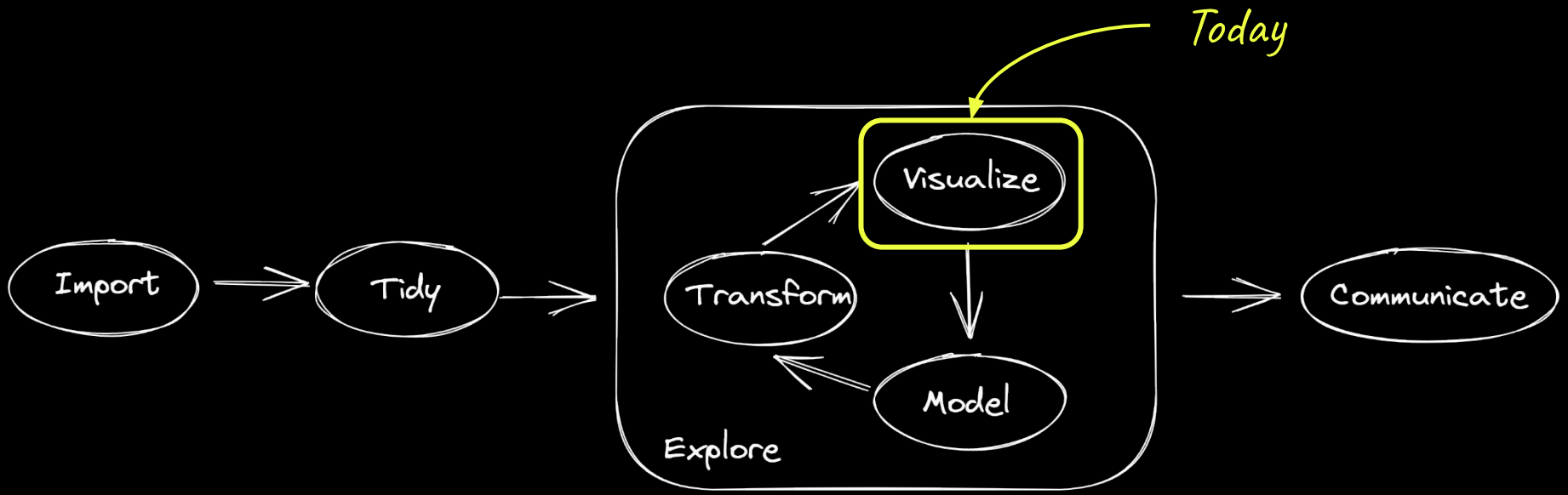
A `ggplot2` Tutorial for Beautiful Plotting in R

https://cedricscherer.netlify.app/2019/08/05/a-ggplot2-tutorial-for-beautiful-plotting-in-r/



DATA ANALYTICS PROCESS

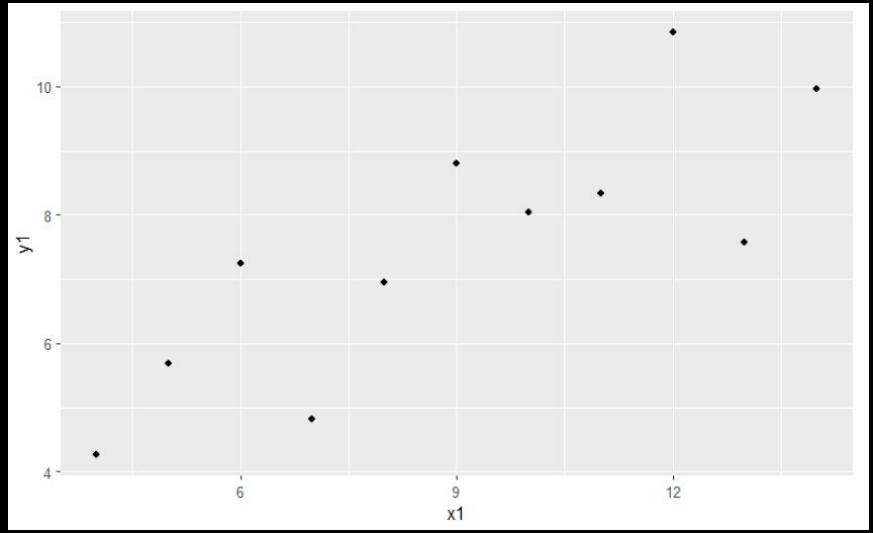
DATA VISUALIZATION



PLEAS FOR DATA VISUALIZATION

PLEAS FOR DATA VISUALIZATION

- Find two examples here



THE GRAMMAR OF GRAPHICS

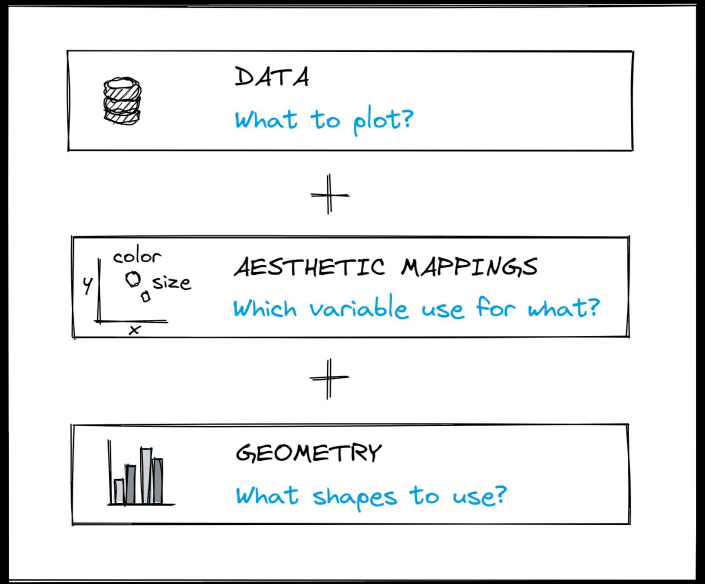
BASIC LAYERS

THE GRAMMAR OF GRAPHICS

BASIC LAYERS

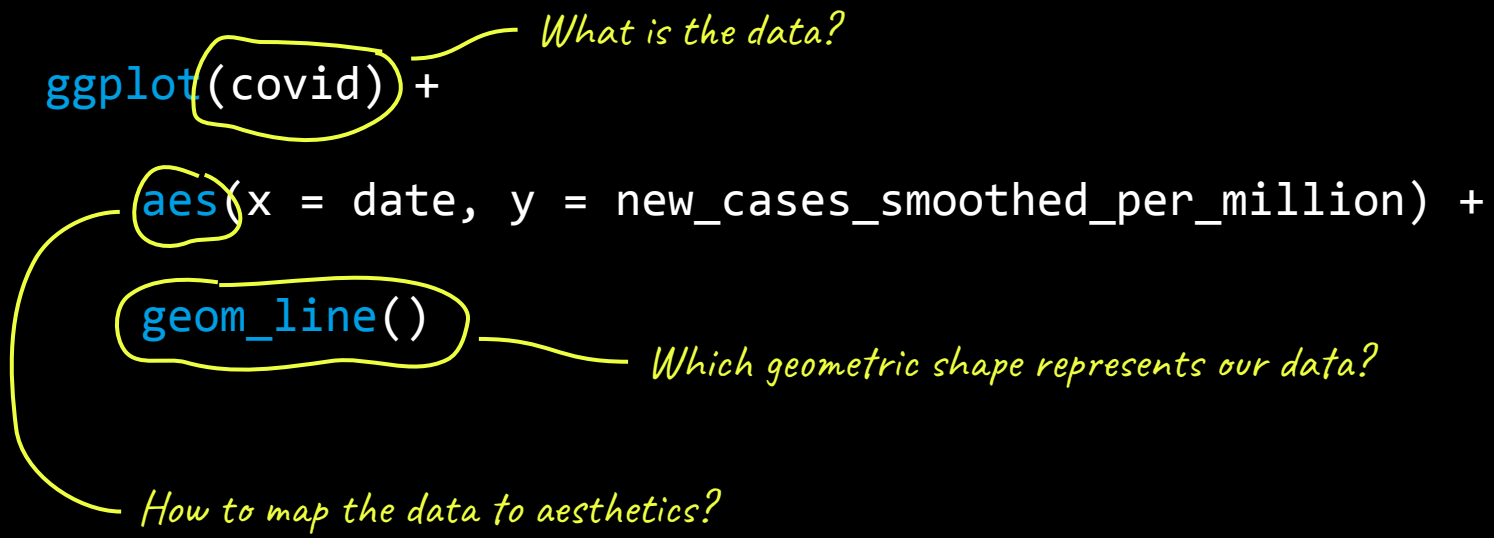
Read more: https://ggplot2-book.org/layers.html

- In the Grammar of Graphics, a visualization consists of a minimum of three layers:
  - Data
  - Mapping of data to aesthetic elements
  - Geometric shapes
- `ggplot2` implements this idea → Visualizations are built as a stack of theses layers



THE GRAMMAR OF GRAPHICS

EXAMPLE FOR BASIC LAYERS



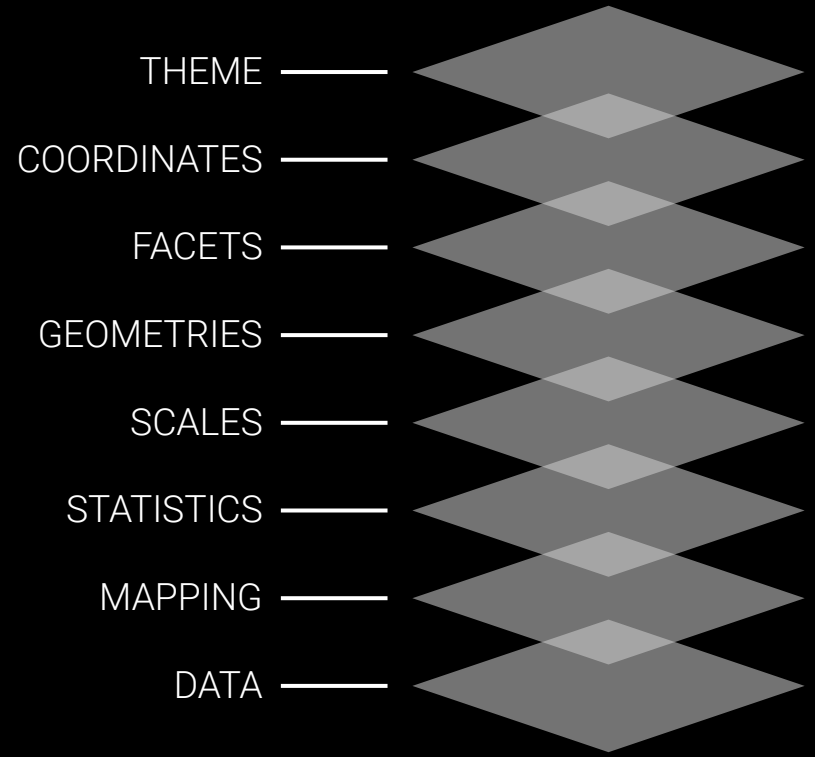
THE GRAMMAR OF GRAPHICS

ALL LAYERS

THE GRAMMAR OF GRAPHICS

COMPOSITION CONCEPT

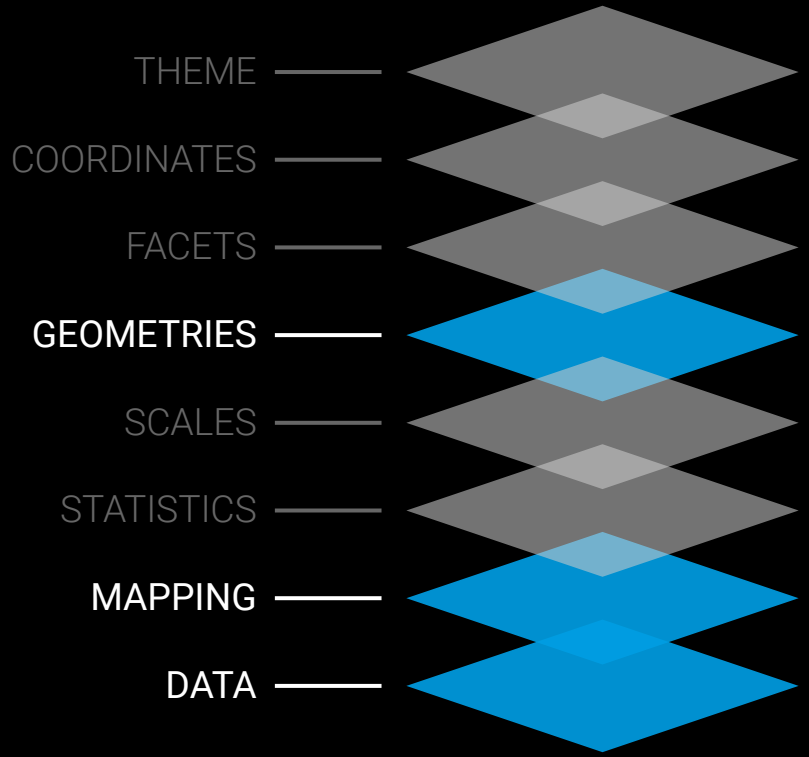
Any data visualization =



THE GRAMMAR OF GRAPHICS

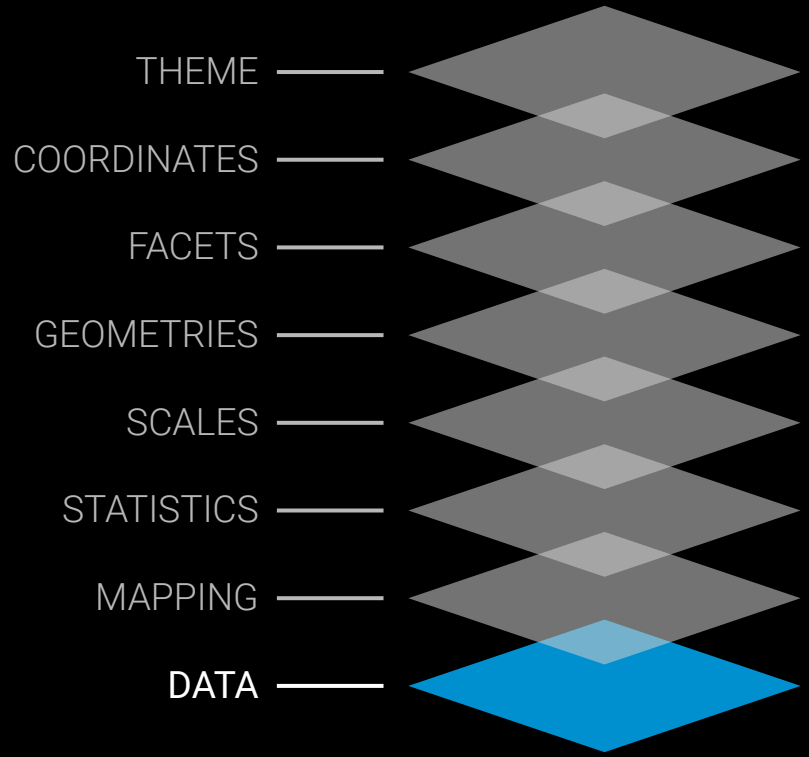
COMPOSITION CONCEPT

Only those 3 are needed!
Everything else has a default!



THE DATA LAYER

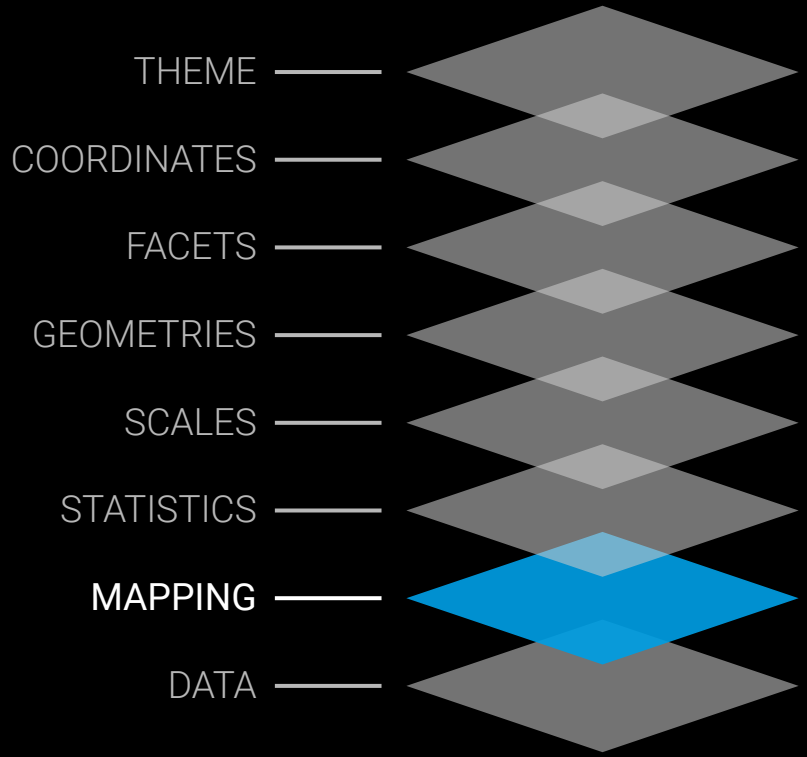
- Data must be provided as a data frame (`tibble`)
- Contains only
  - necessary variables
  - relevant rows and
  - the right level of aggregation
  - pre-computed statistics
- Toolset for data transformation (`dplyr`)



THE MAPPING LAYER

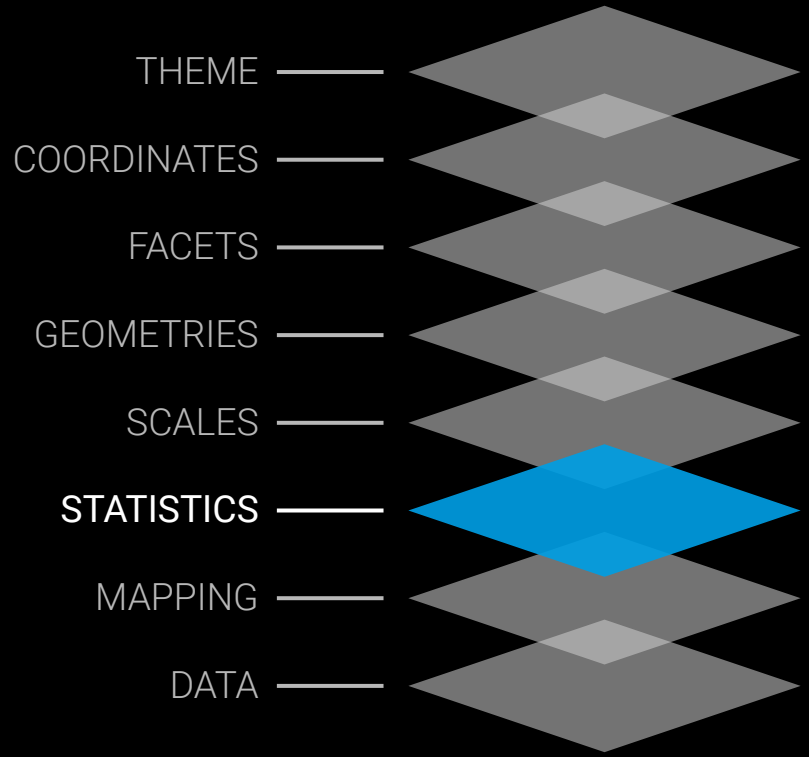
Check out: https://ggplot2tutor.com/aesthetics

- The aesthetics mapping (`aes`) links variables in the data to graphics properties
- Most important: What should be shown on x and y-axis?
- More mappings:
  - Line color & style
  - Fill color
  - Point size & shape
  - Alpha
  - ...



THE STATISTICS LAYER

- If not pre-computed, statistics can be calculated by the visualization
- All geometries are assigned a default statistic (and vice versa)
- Example statistics:
  - `identity` → The value provided as is
  - `count` → Count rows
  - `bin` → Bin continuous variables
  - `density` → Estimate density
  - Many more…

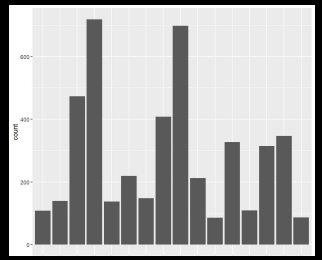


THE STATISTICS LAYER

STATS & GEOMS

```
tweets %>%
  ggplot() +
  stat_count(aes(x = screen_name))
```

```
tweets %>%
  ggplot() +
  geom_bar(aes(x = screen_name))
```



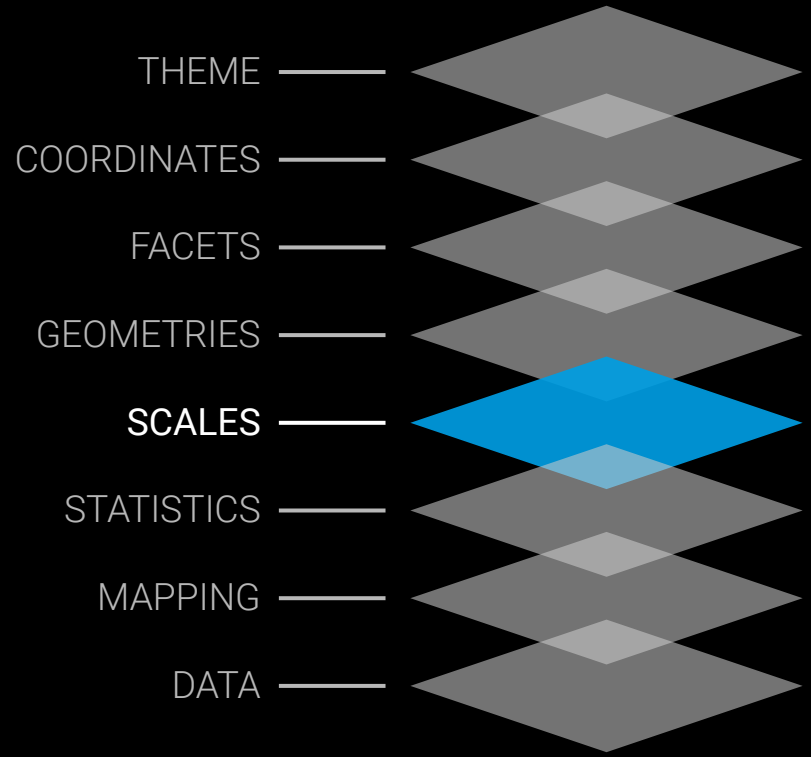
The count statistics uses bars per default

The bar geometry uses the count statistic per default

THE SCALES LAYER

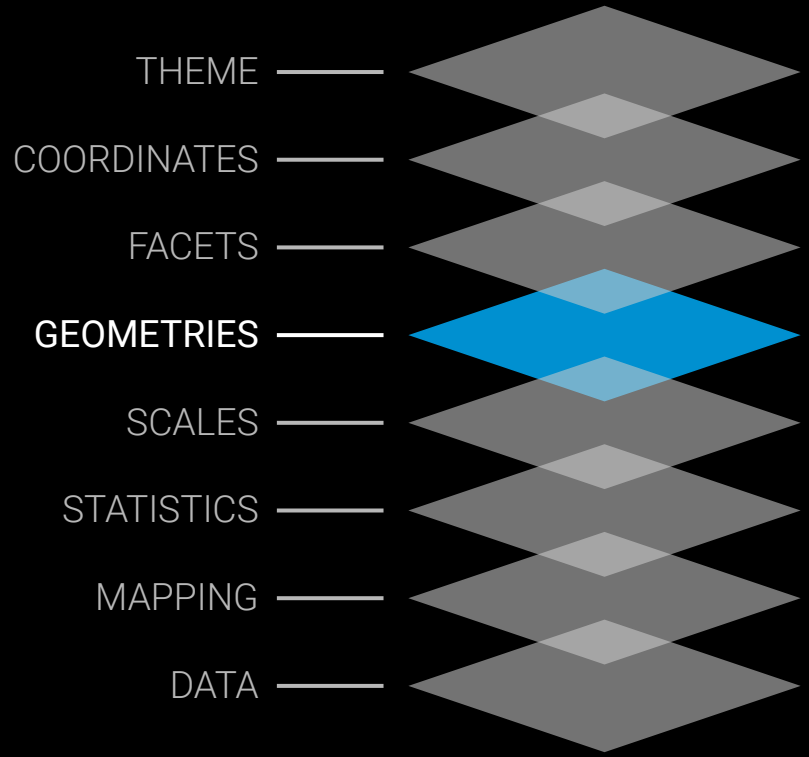
Check out: https://ggplot2tutor.com/scales

- All aesthetics mappings have a **scale** attached
- A **scale** maps values in the data to the x and y-axis, colors or sizes for shapes
- All scale functions follow the same naming scheme:
  - `scale_<aes>_<type>()`
- We use scales mainly for:
  - Color palettes
  - Axis labeling (breaks, formatting)



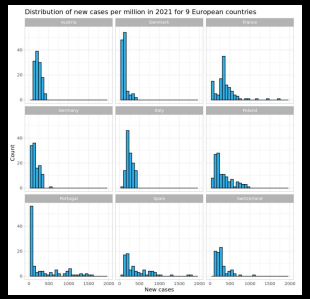
THE GEOMETRY LAYER

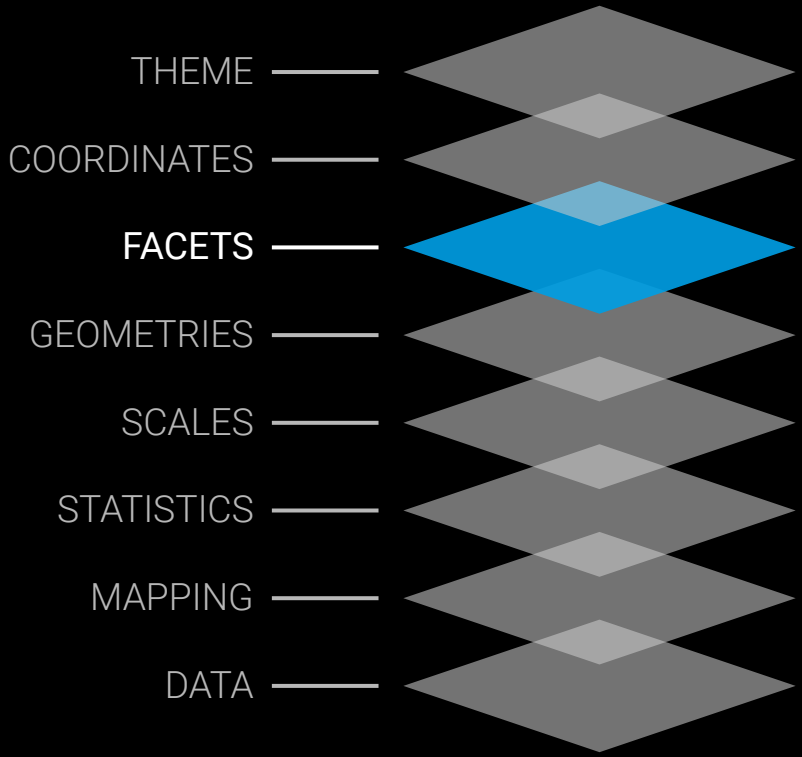
- The geometry is central to how the plot visualizes data
- Depending on the geometry, different aesthetics can or must be mapped
- We can add more than one geometry to a plot
- `geom_<type>()`



THE FACETS LAYER

- Create small panels with the same visualizations for different data
- Panel logic determined by variable in the data
- Good to avoid overplotting and maintain readability!
- `facet_wrap()` vs `facet_grid()`

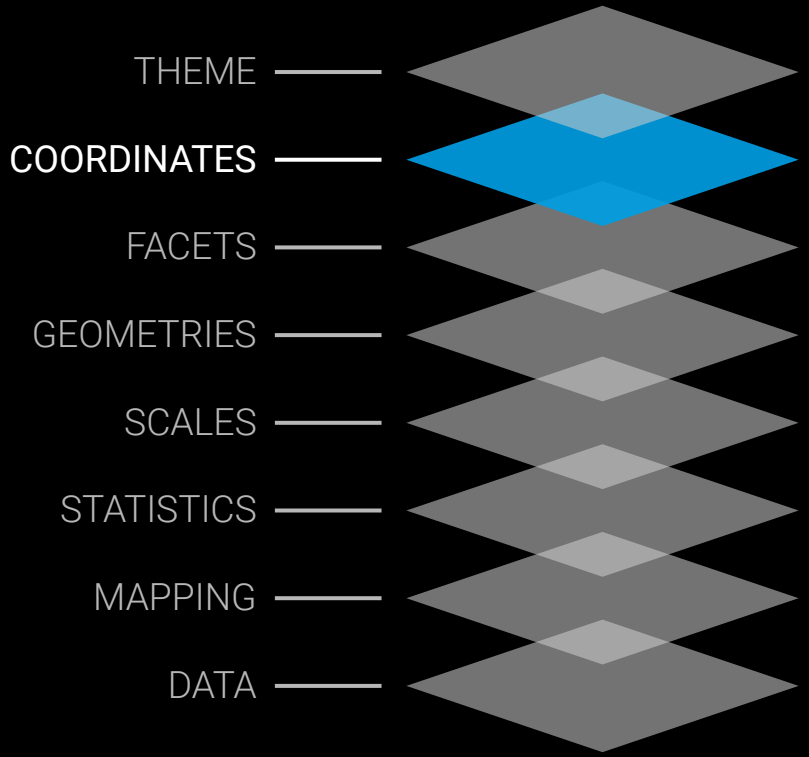




THE COORDINATES LAYER

- Specify the coordinate system underlying the visualization:
  - Cartesian (default)
  - Polar
- Allows for changing axis limits (just like scales)
- `coord_flip()` is useful to quickly flip x and y

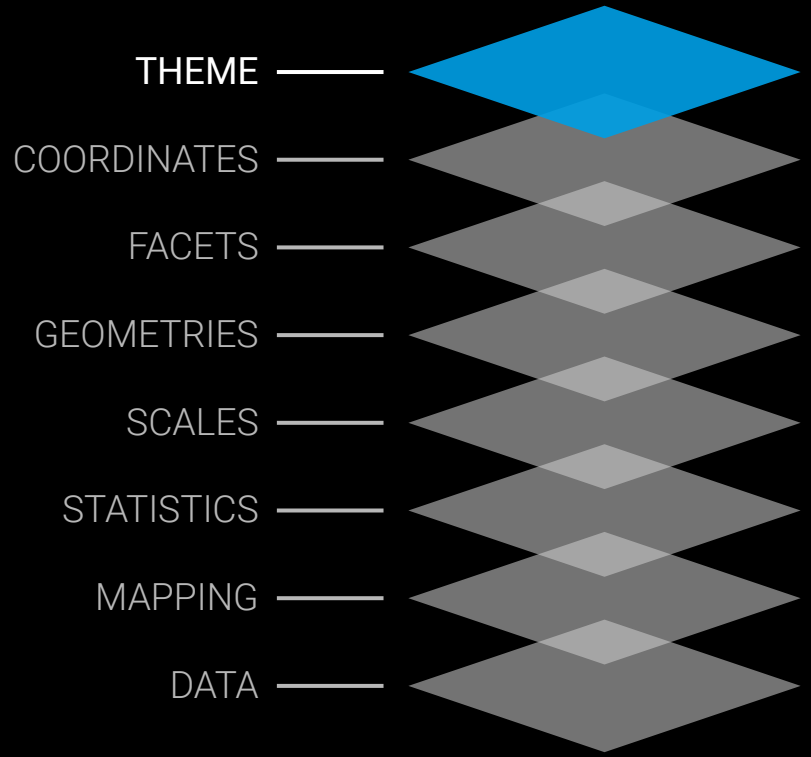
We will rarely use this layer!



THE THEME LAYER

Check out: https://ggplot2tutor.com/theme

- Style the plot
  - Background colors
  - Fonts (axis, titles)
  - Legends
  - ...
- There are predefined themes for us to use:
  - `theme_bw()`
  - `theme_light()`
  - `theme_dark()`



WHAT TO PLOT?

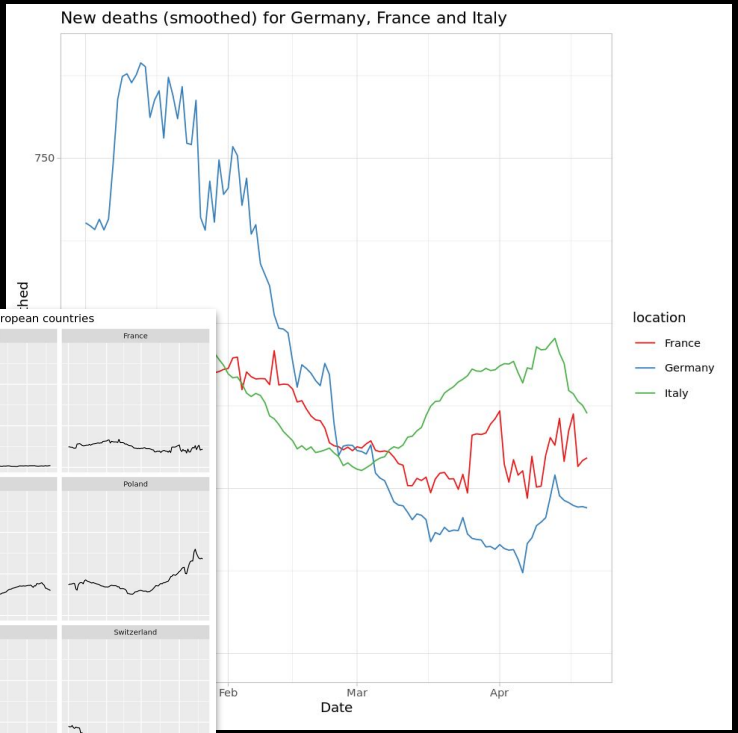
WHAT TO PLOT?

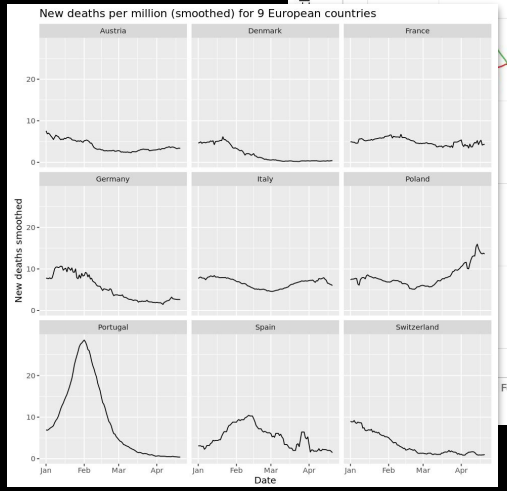
TRENDS & DEVELOPMENTS

Read more: https://clauswilke.com/dataviz/time-series.html

- x-axis displays the time (usually), the y-axis some value over time:
  - Line chart
  - Area Chart
  - One vs. multiple series
  - Facets

- Example: Covid19

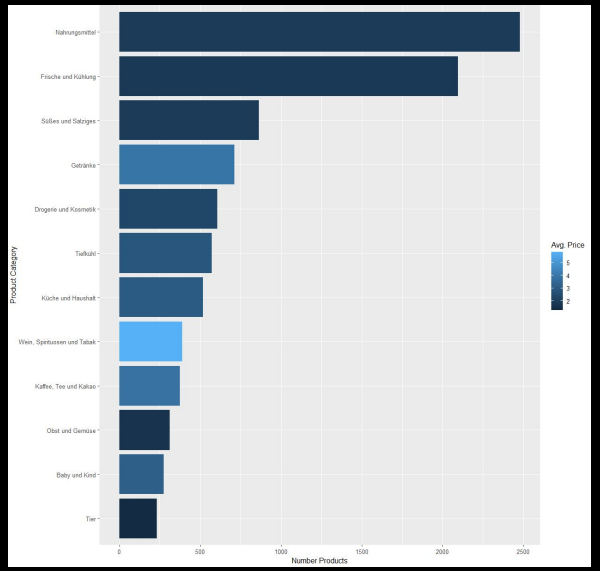




WHAT TO PLOT?
AMOUNTS & PROPORTIONS

Read more:
https://clauswilke.com/dataviz/visualizing-proportions.html

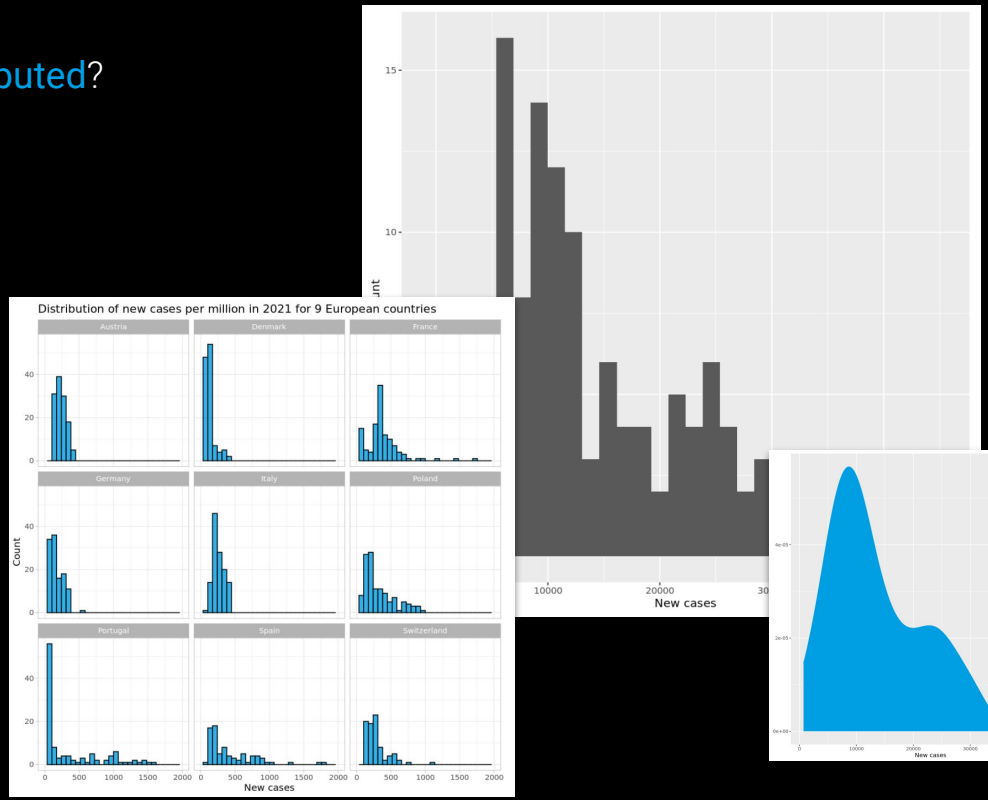
- A geometry's size (height, width, area) represents values in the data for easy comparison:
  - Bar Chart
    - next to each other
    - stacked
  - ~~Pie chart~~



WHAT TO PLOT?
DISTRIBUTIONS

Read more:
https://clauswilke.com/dataviz/histograms-density-plots.html

- How are observations of a variable distributed?
  - Histogram (one vs. multiple series)
  - Density plot
  - Ridgeline Plots
  - Box plots



WHAT TO PLOT?
ASSOCIATIONS

Read more:
https://clauswilke.com/dataviz/visualizing-associations.html

- What associations between variables can we find in the data?
  - Point diagram (*scatter plot*)
  - Trendlines
  - Heat maps