

Data Visualization with RStudio and Jupyter

Infra4NextGen Webinar

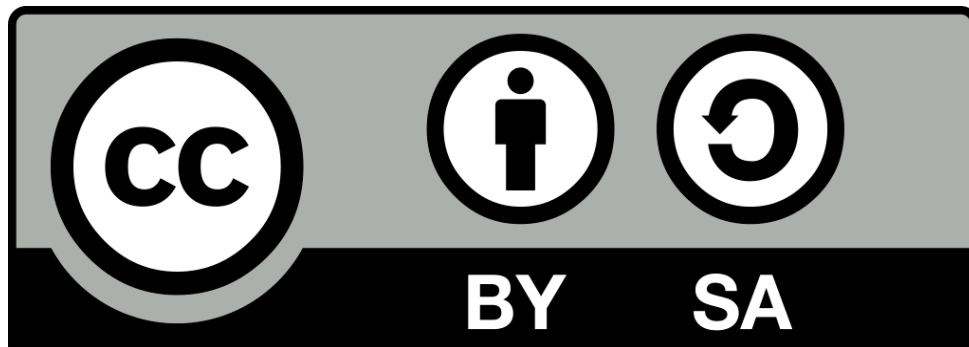
Franz Eder

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Department of Political Science | University of Innsbruck

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About me



Dr. Franz Eder



Assoc. Prof. for International Relations

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research methods (v.a. QTA, DNA); academic writing and
presentation; open and reproducible science

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News



Wer soll dieses Land verteidigen?

Martin Senn spricht mit Der Standard über Neutralität und Solidarität

OCT 26, 2024



Wie sieht die 'multipolare Welt' aus

Martin Senn im Gespräch mit Der Standard

OCT 22, 2024



New FWF Project!

Congratulations to Stefanie Kirchweger and Franz Eder

OCT 8, 2024

AFP3


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HOME

Willkommen auf dem Dashboard des Austrian Foreign Policy Panel Projects (AFP3)

Welche Einstellungen haben Österreicher:innen zur Außen- und Sicherheitspolitik ihres Landes? Was wissen sie über die Vereinten Nationen? Woher beziehen sie ihr außenpolitisches Wissen? Welche Parteien sehen sie als kompetent in der Außenpolitik an? Welchen Stellenwert hat die Neutralität für sie und inwiefern wären sie bereit, einen Beitrag zur militärischen Landesverteidigung zu leisten? All diese Fragen und noch viele mehr werden in unserem **Austrian Foreign Policy Panel Project (AFP3)** untersucht.



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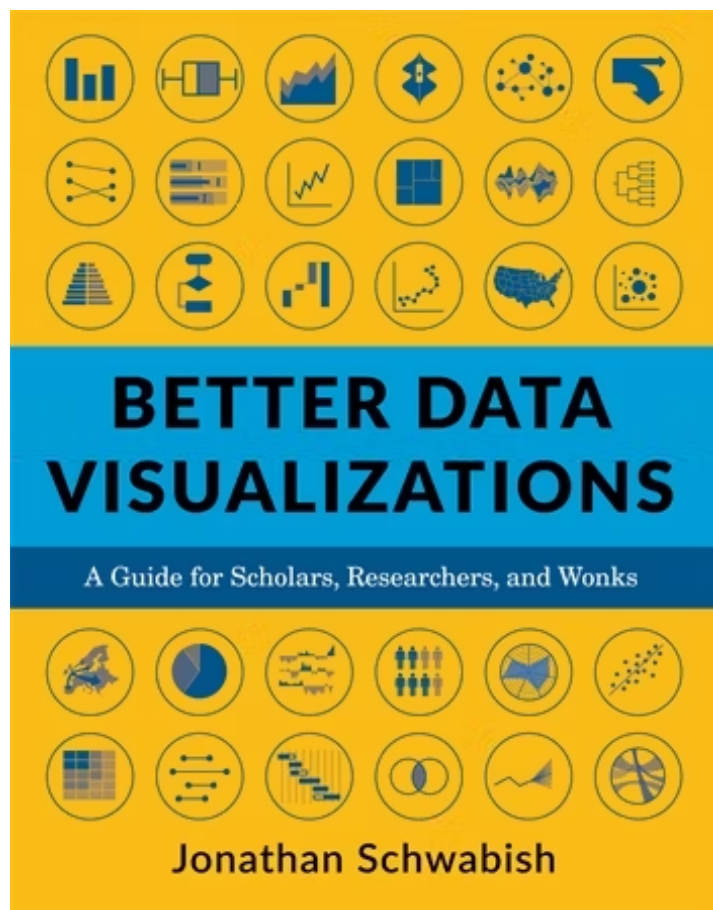
Postal address:
Universitätsring 1
1010 Vienna

T: +43 1 4277 15323
info@aussda.at


Structure

- 1 What is a “visualization”?
- 2 Process of visualizing data
- 3 RStudio/Jupyter and ggplot2
- 4 Example from European Values Study

Books



Schwabish ([2021](#))

ggplot2: Elegant Graphics for Data Analysis (3e) 

[Welcome](#)

[Preface to the third edition](#)

[Preface to the second edition](#)

Getting Started 

1 Introduction

2 First steps

Layers 

3 Individual geoms

4 Collective geoms

5 Statistical summaries

6 Maps

7 Networks

8 Annotations

9 Arranging plots

Scales 

10 Position scales and axes

11 Colour scales and legends

12 Other aesthetics

ggplot2: Elegant Graphics for Data Analysis (3e)

Welcome

This is the on-line version of work-in-progress **3rd edition** of “ggplot2: elegant graphics for data analysis” published by Springer. You can learn what’s changed from the 2nd edition in the [Preface](#).

While this book gives some details on the basics of ggplot2, its primary focus is explaining the Grammar of Graphics that ggplot2 uses, and describing the full details. It is not a [cookbook](#), and won’t necessarily help you create any specific graphic that you need. But it will help you understand the details of the underlying theory, giving you the power to tailor any plot specifically to your needs.

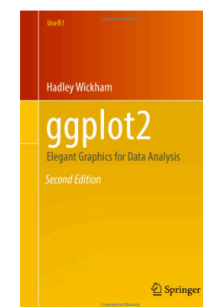
The book is written by [Hadley Wickham](#), [Danielle Navarro](#), and [Thomas Lin Pedersen](#).

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Wickham ([2024](#))

What is “visualization”?

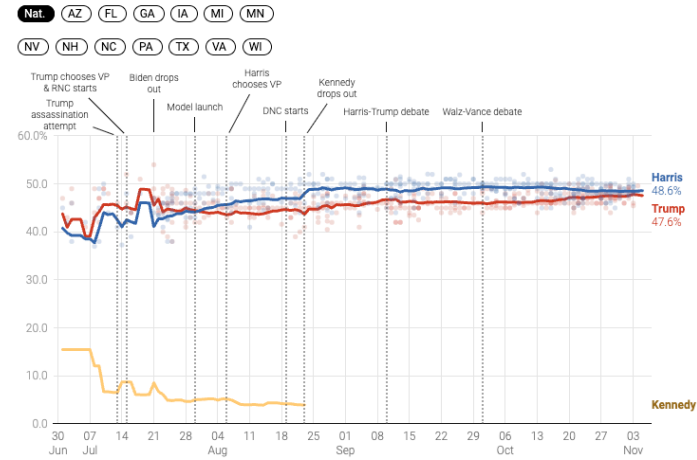
Definitions

Visualization

“A visualization is any kind of **visual representation of information** designed to **enable communication**, analysis, discovery, exploration, etc” [emphasis by FE] (Cairo 2016, 28).

Who's ahead in the polls?

An updating average of 2024 presidential general election polls, accounting for each poll's quality, sample size and recency. Click the buttons to see the polling average in different contests



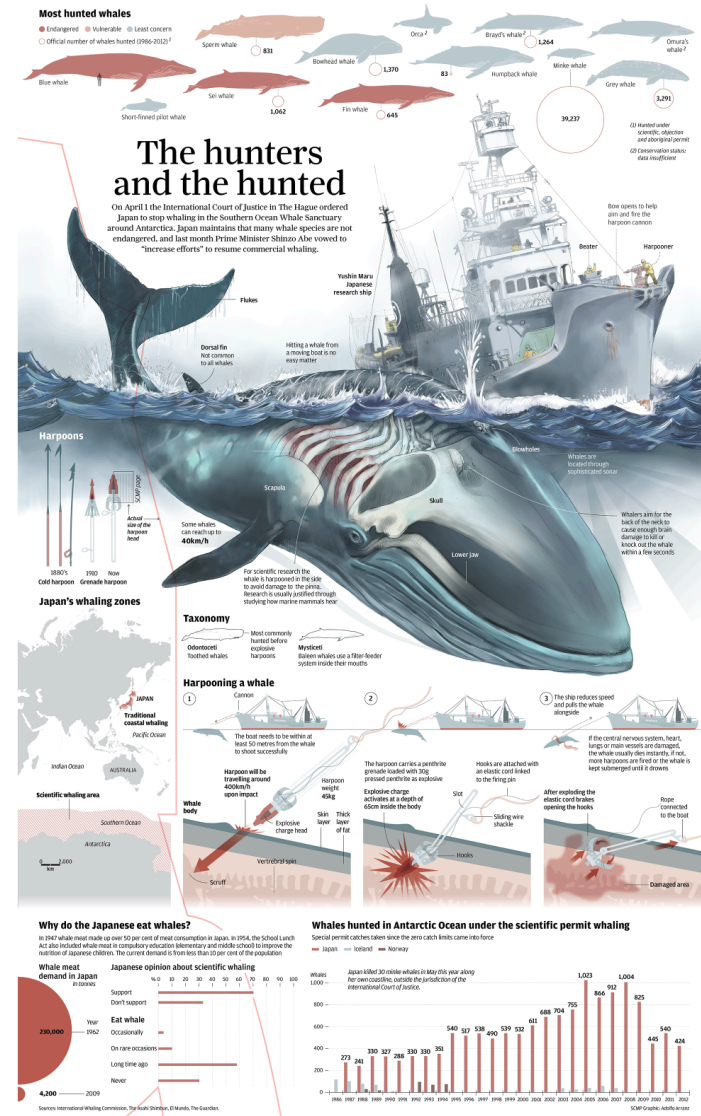
Note: Polling averages are adjusted based on trends in both state and national polls. Updated November 5, 2024 • [Get the data](#)

SILVER BULLETIN

Source: Final Silver Bulletin 2024 presidential election forecast

Infographics

“An infographic is a **multi-section visual representation** of information intended to communicate one or more specific messages. Infographics are made of a mix of charts, maps, illustrations, and text (or sound) that provides explanation and context.” [emphasis by FE] ([Cairo 2016, 31](#)).



Source: [South China Morning Post](#)

Purpose of visualizations

“The purpose of infographics and data visualizations is to enlighten people—not to entertain them, not to sell them products, services, or ideas, but to **inform** them.” [Hervorhebung durch FE] ([Cairo 2016, 13](#)).

Communication

“[It, FE] is about drawing and organizing lines and shapes to communicate a specific bit of science-related information to another person... [It, FE] is about using imagery in the service of communication” ([Christiansen 2023, 13](#)).

Understanding

“data visualisation aims to facilitate understanding” ([Kirk 2019, 20](#)).

Three phases of understanding (Kirk 2019, 20)

perceiving

interpreting

comprehending

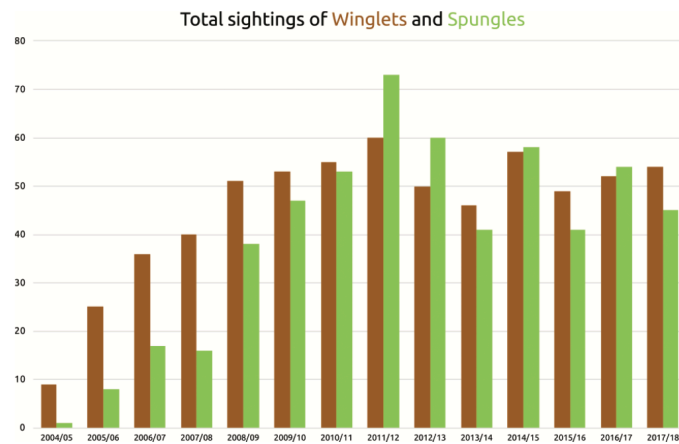


Figure 1.6 Total Sightings of Winglets and Spungles

source: Kirk (2019), p. 23

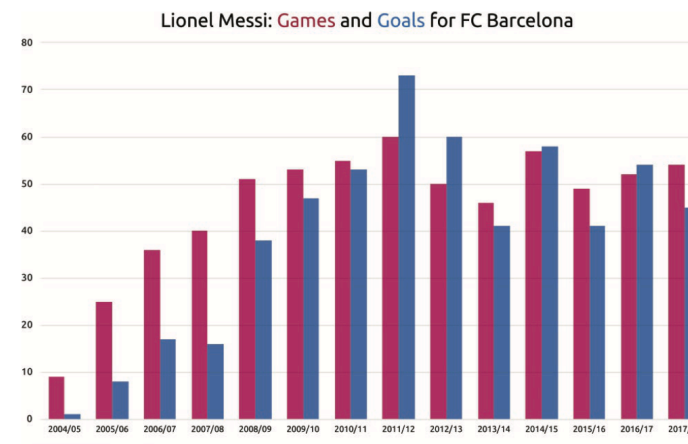


Figure 1.5 Lionel Messi: Games and Goals for FC Barcelona

Source: Data from transfermarkt.com

source: Kirk (2019), p. 21

Criteria for good visualizations

Principles of Graphical Excellence (Tufte 2007, 51)

- 1 “Graphical excellence is the well-designed presentation of interesting data—a matter of substance, of statistics, and of design.”
- 2 “Graphical excellence consists of complex ideas communicated with clarity, precision, and efficiency.”
- 3 “Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.”

Cairo (2016), p. 12 und Kirk (2019), p. 38

- truthful (see also D’Ignazio and Klein (2020))
- functional and accessible
- insightful and enlightening
- elegant and beautiful

Simplicity vs complexity

“Any visualization is a model” ([Cairo 2016, 69](#))

- “Good models abstract reality while keeping its essence at the same time... The more adequately a model fits whatever it stands for without being needlessly complex, and the easier it is for its intended audience to interpret it correctly, the better it will be.” ([Cairo 2016, 70](#))
- “Simplicity is about subtracting the obvious and adding the meaningful.” ([Cairo 2016, 97](#))
- “Good visualizations shouldn’t oversimplify information. They need to clarify it. In many cases, clarifying a subject requires increasing the amount of information, not reducing it.” ([Cairo 2016, 78](#))
- “Simplicity isn’t just about reduction. It can (and should) also be about augmentation. It consists of removing what isn’t relevant from our models but also of bringing in those elements that are essential to making those models truer.” ([Cairo 2016, 97](#))

Preattentive Processing

Use **preattentive attributes** to direct observer's focus.

Table 1. Our sales grew to \$600 million this year

	Q1	Q2	Q3	Q4
Bob	26	35	72	84
Ellie	22	15	61	35
Gerrie	19	20	71	55
Jack	22	95	13	64
Jon	83	62	46	48
Karen	30	65	98	82
Ken	38	28	45	71
Lauren	98	81	41	63
Steve	16	50	23	41
Valerie	46	24	30	57
Total	\$400	\$475	\$500	\$600

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Total	\$400	\$475	\$500	\$600

source: Schwabish (2021), p. 26

Process of visualizing data

Building blocks

Visual “[r]epresentation involves making decisions about how you are going to portray your data visually so that the subject understanding it offers can be made accessible to your audience. In simple terms, this is all about charts and the act of selecting the right chart to show the features of your data that you think are most relevant.” (Kirk 2019, 17)



Source: <https://www.datylon.com/>

Building blocks of any visualization (Kirk 2019, 17–18):

- **marks**: Elements used to represent items of data (i.e. points, columns, lines, etc.)
- **attributes**: visual variations of marks to represent the values associated with each (text, color, shape, etc.)

4 phases of the visualization design process

see Kirk ([2019, 32](#))

Phase 1: concept

planing and defining project

Phase 2: data

gathering, handling and preparing your data; getting to know the data

Phase 3: "editorial thinking"

defining what you will show your audience; what do we want to communicate (main message)

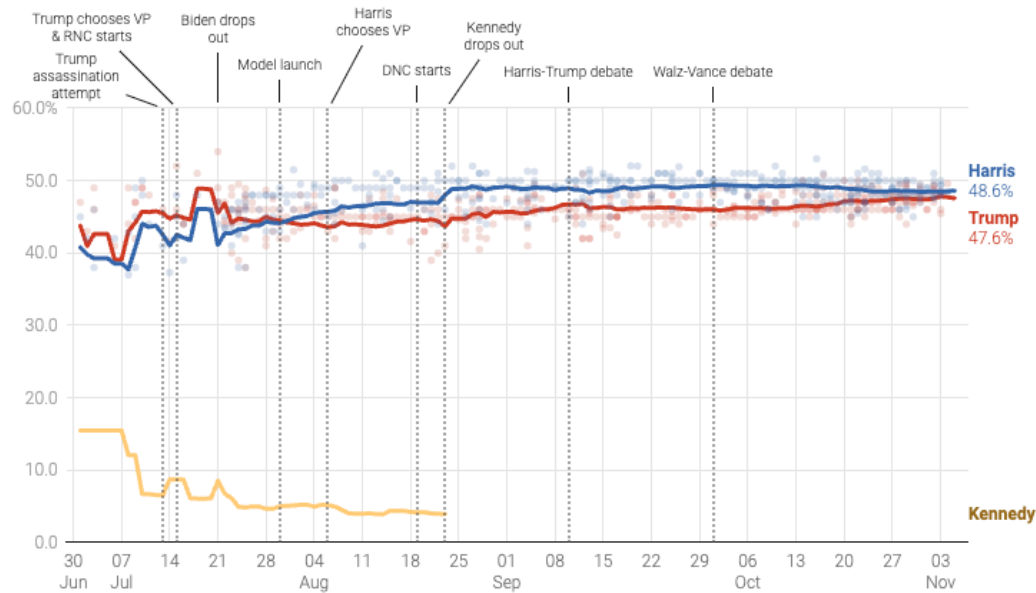
Phase 4: "Design" (see [Schwabish 2021, 29-45](#))

- show the data

Who's ahead in the polls?

An updating average of 2024 presidential general election polls, accounting for each poll's quality, sample size and recency. Click the buttons to see the polling average in different contests

- Nat.** (AZ) (FL) (GA) (IA) (MI) (MN)
- (NV) (NH) (NC) (PA) (TX) (VA) (WI)

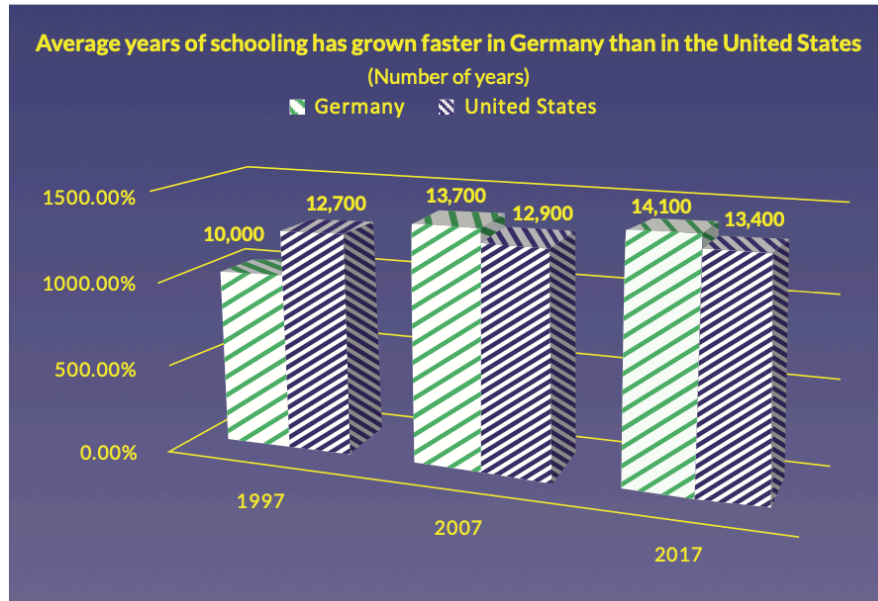


Note: Polling averages are adjusted based on trends in both state and national polls.
 Updated November 5, 2024 - [Get the data](#)

SILVER BULLETIN

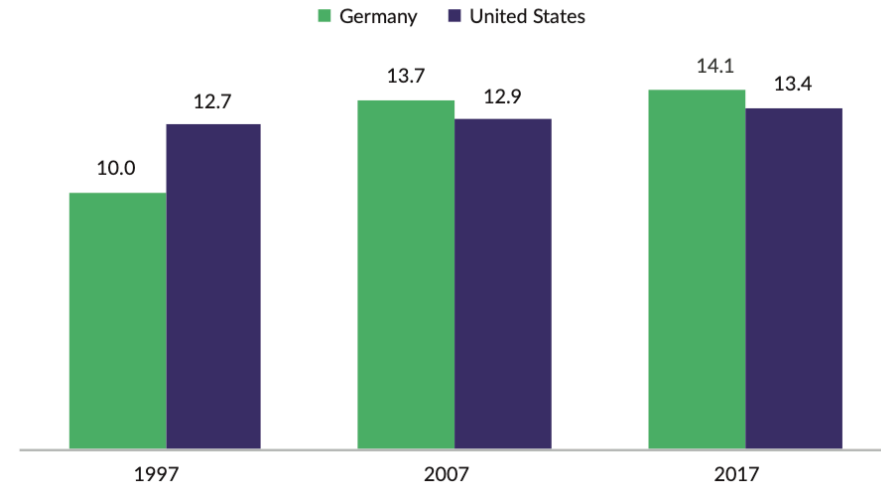
Source: [Final Silver Bulletin 2024 presidential election forecast](#)

- reduce the clutter



source: Schwabish (2021), p. 32

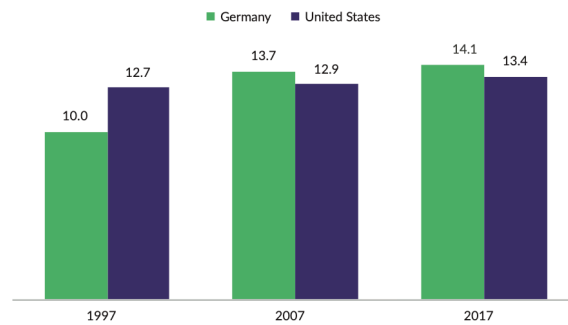
Average years of schooling has grown faster in Germany than in the United States
(Number of years)



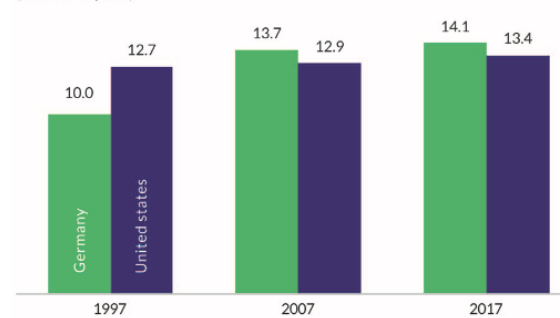
source: Schwabish (2021), p. 33

- integrate the graphics and text
 - remove legend (if possible) and label data directly
 - titles like newspaper headlines
 - add explainers

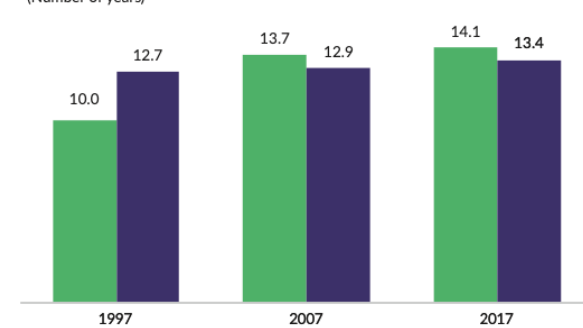
Average years of schooling has grown faster in Germany than in the United States
(Number of years)



Average years of schooling in Germany and the United States
(Number of years)

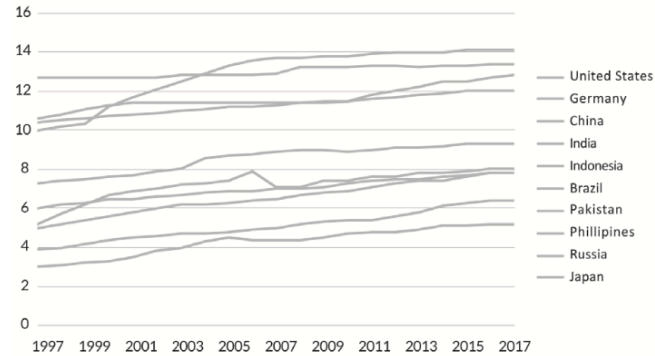


Average years of schooling in Germany and the United States
(Number of years)



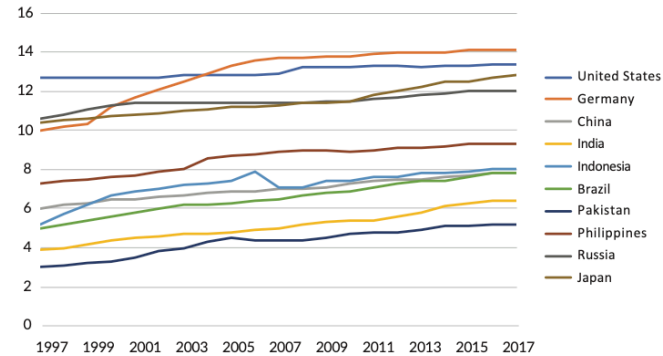
- avoid the “spaghetti chart”
- start with gray

Average years of schooling has increased around the world
(Number of years)



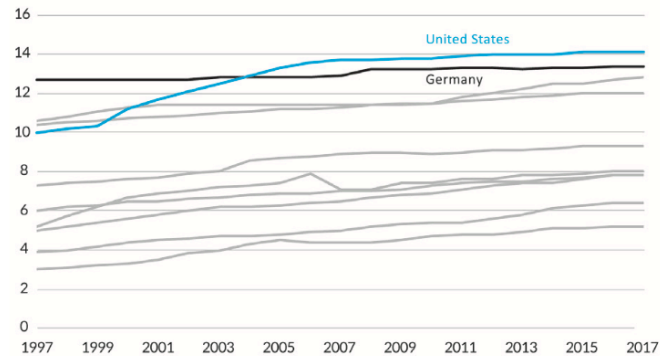
Source: Our World in Data

Average years of schooling has increased around the world
(Number of years)



Source: Our World in Data

Germany and the United States have the highest average years of completed schooling
(Number of years)



Source: Our World in Data

RStudio/Jupyter and ggplot2

Grammar of Graphics

- graphic packages in R (base, lattice/trellis, grid graphics)
- ggplot2 part of tidyverse
- based on the idea of “Grammar of Graphics” (Wilkinson 2005; Wickham 2010)

“A grammar of graphics is a tool that enables us to concisely describe the components of a graphic. Such a grammar allows us to move beyond named graphics (e.g., the “scatterplot”) and gain insight into the deep structure that underlies statistical graphics.” (Wickham 2010, 3)

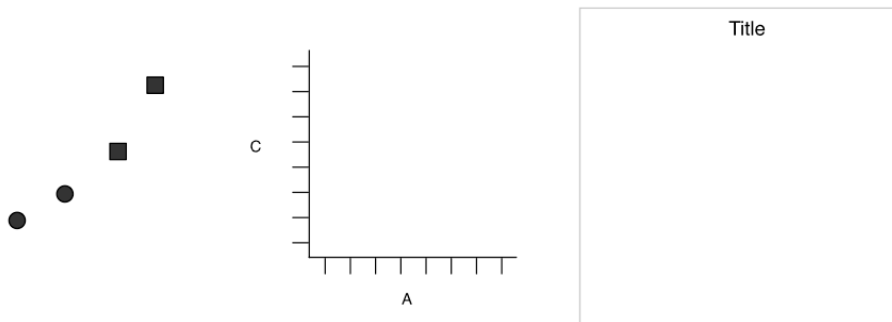


Figure 1. Graphics objects produced by (from left to right): geometric objects, scales and coordinate system, plot annotations.

Wickham (2010), p. 6

ggplot2 – layered graphics

plot = data n mapping

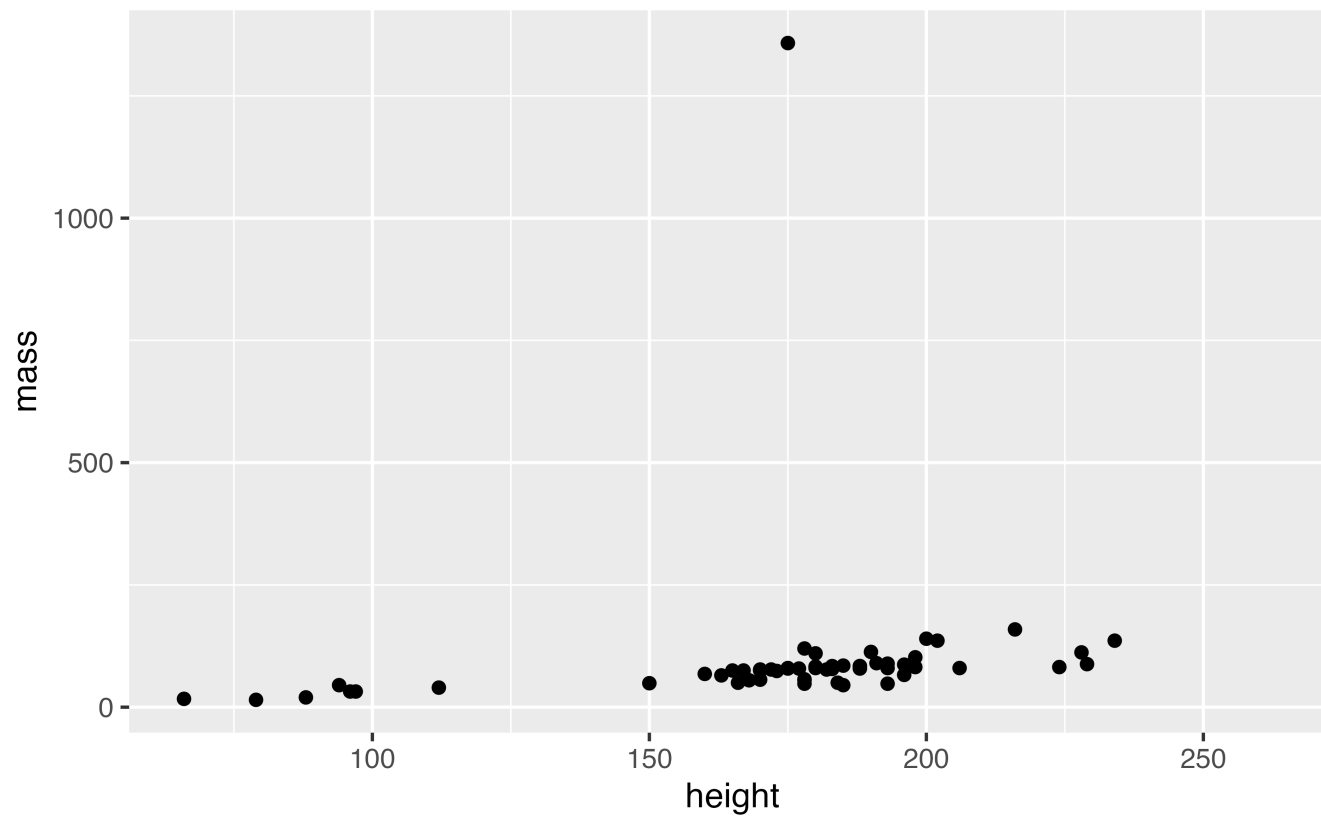
mappings comprise 5 elements

- **layer**: collection of geometric elements (**geoms**) und statistical transformations (**stats**)
- **scales**: display of values (colors, shapes, size) and axis
- **coord**: coordination system
- **facet**: splitting data into subsets
- **theme**: “design” of the plots (background color, fonts, etc.)

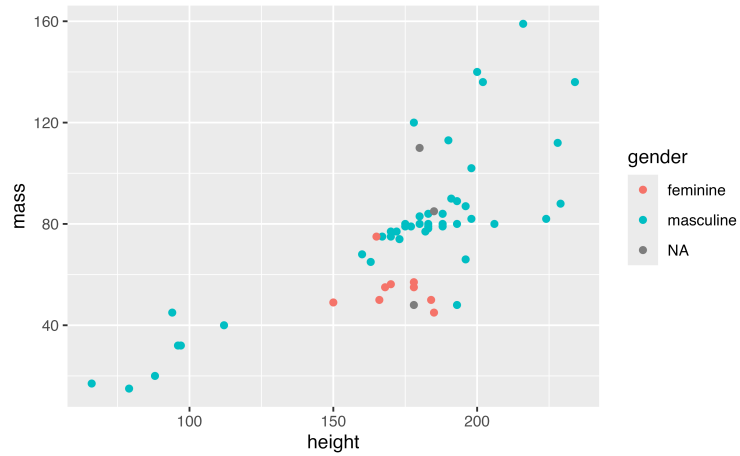
Plotting with ggplot2

- ggplot2 code consists of three components: (1) data, (2) aesthetic mapping, (3) geom function

```
1 require(tidyverse) # loading the tidyverse package
2
3 ggplot(data = starwars, aes(x = height, y = mass)) +
4   geom_point()
```



```
1 starwars |> filter(mass < 500) |>
2   ggplot(aes(height, mass, color = gender)) +
3   geom_point()
```



```
1 ggplot(starwars, aes(gender, height)) +
2   geom_violin() +
3   geom_jitter(color = "#005c8b", alpha = 0.5) +
4   theme_minimal()
```



Example from European Values Study

Phase 1: Concept

Research question: “How tolerant has Austrian society become over time?”

How to measure tolerance?

Phase 2: Data

AUSSDA AUSTRIAN SOCIAL SCIENCE DATA ARCHIVE

Public We make social science data accessible and reusable. (AUSSDA)

AUSSDA > Public >

European Values Study 1990-2018 Austria Longitudinal Data (SUF edition)

Version 1.1

Kritzinger, Sylvia; Aichholzer, Julian; Glavanovits, Josef; Hajdinjak, Sanja; Klaiber, Judith; Seewann, Lena; Friesl, Christian; Zulehner, Paul M., 2019, "European Values Study 1990-2018 Austria Longitudinal Data (SUF edition)", <https://doi.org/10.11587/C4YBOT>, AUSSDA, V1, UNF:6:AxP/dfTpO2hObtNnyJlQ= [fileUNF]

Cite Dataset - Learn about [Data Citation Standards](#).

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Dataset Metrics 1,691 Downloads

Description Full edition for scientific use. The EVS 1990-2018 Austria Longitudinal Data Study is part of a EVS longitudinal study that focuses on values in European countries. The dataset includes surveys for the EVS waves in which Austria participated in the years 1990, 1999, 2008, and 2018.

Keyword Children, Democracy, Environment, Identity, Marriage, Partnerships (personal), Political interest, Political participation, Political parties, Political systems, Population migration, Religious beliefs, Religious practice, Tolerance, Trust, Work attitude

Related Publication Aichholzer, J., Friesl, C., Hajdinjak, S., & Kritzinger, S. (Hg.). (2019). *Quo vadis, Österreich? Wertewandel 1990-2018*. Wien: Czernin.

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10044_co_en_v1_0.pdf	Adobe PDF - 974.0 KB	Published Jul 18, 2019	207 Downloads	MDS: 6c2..757	Method report and codebook English (EVS 2018)	Codebook Documentation Method report	Download
10044_qu_de_v1_0.pdf							

Kritzinger, Sylvia; Aichholzer, Julian; Glavanovits, Josef; Hajdinjak, Sanja; Klaiber, Judith; Seewann, Lena; Friesl, Christian; Zulehner, Paul M., 2019, “European Values Study 1990-2018 Austria Longitudinal Data (SUF edition)”, <https://doi.org/10.11587/C4YBOT>, AUSSDA, V1.

Questionnaire: 10044_qu_en_v1_0.pdf

Q44 Please tell me for each of the following whether you think it can always be justified, never be justified, or something in between, using this card.

		never										always	DK	NA
v149	Claiming state benefits which you are not entitled to	1	2	3	4	5	6	7	8	9	10		88	99
v150	Cheating on tax if you have the chance	1	2	3	4	5	6	7	8	9	10		88	99
v151	Taking the drugs marijuana or hashish	1	2	3	4	5	6	7	8	9	10		88	99
v152	Someone accepting a bribe in the course of their duties	1	2	3	4	5	6	7	8	9	10		88	99
v153	Homosexuality	1	2	3	4	5	6	7	8	9	10		88	99
v154	Abortion	1	2	3	4	5	6	7	8	9	10		88	99
v155	Divorce	1	2	3	4	5	6	7	8	9	10		88	99
v156	Euthanasia (terminating the life of the incurably sick)	1	2	3	4	5	6	7	8	9	10		88	99
v157	Suicide	1	2	3	4	5	6	7	8	9	10		88	99
v158	Having casual sex	1	2	3	4	5	6	7	8	9	10		88	99
v159	Avoiding a fare on public transport	1	2	3	4	5	6	7	8	9	10		88	99
v160	Prostitution	1	2	3	4	5	6	7	8	9	10		88	99
v161	Artificial insemination or in-vitro fertilization	1	2	3	4	5	6	7	8	9	10		88	99
v162	Political violence	1	2	3	4	5	6	7	8	9	10		88	99
v163	Death penalty	1	2	3	4	5	6	7	8	9	10		88	99

Codebook/Method report

Variable: **Justifiable: homosexuality**

F117	Justifiable: someone accepting a bribe
F118	Justifiable: homosexuality
F119	Justifiable: prostitution

Variable: **Wave**

Indicator for the four **waves**

The variable **S002EVS** is the indicator for which **wave** respondents were asked. The value labels are structured as follows:

- 2 „1990“
- 3 „1999“
- 4 „2008“
- 5 „2018“

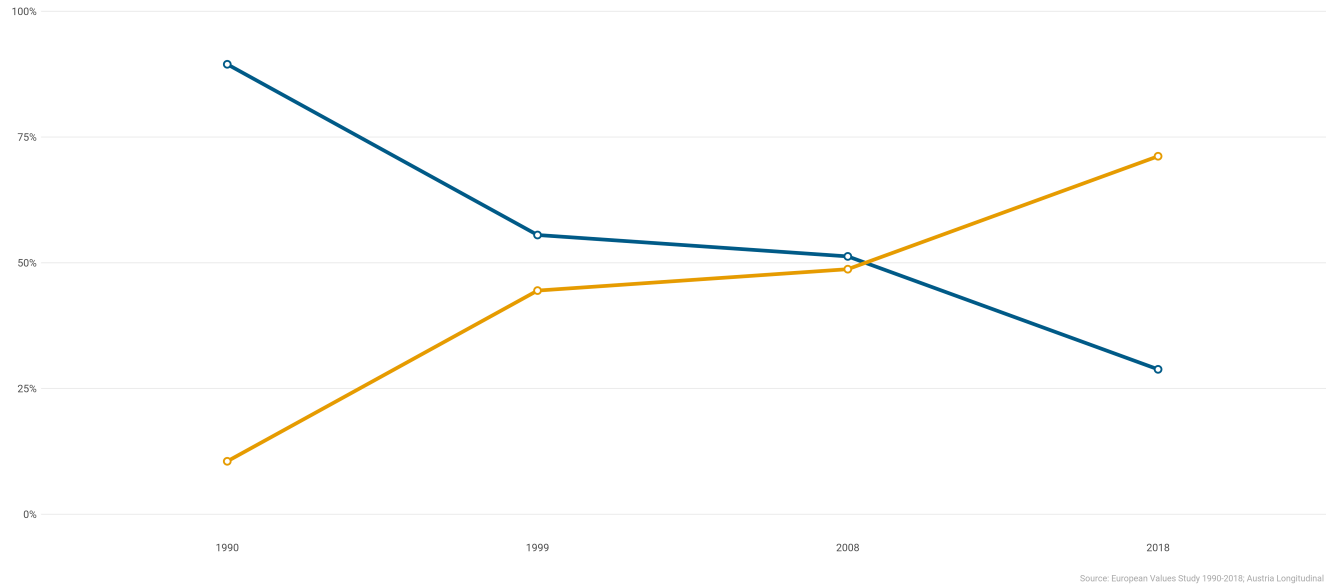
Variable: **Sex**

W011	Dependency on social security during last 5 years spouse/partner
X001	Sex
X002	Year of birth

Phase 3: “Editorial thinking”

Austrians have become more tolerant over time

Q: Please tell me whether you think homosexuality can **always be justified**, **never be justified** or something in between.



see [Section 6.1](#) for code

- only 2 out of 10 categories
- variance by gender?
- danger of spaghetti chart (2 x 10 categories)
- show the data?

Phase 4: Design

Configuration

```
1 require(pacman) # R package management tool
2
3 p_load(tidyverse,
4       showtext, # using non-standard fonts in R graphs (extrafonts)
5       Cairo, # embed fonts in graphs
6       ggtext, # for coloring title in plots
7       sjlabelled, # for using SPSS labels
8       dataverse # for API access to AUSSDA/Dataverse
9 )
```

Load and tidy data

```

1 ## Specifying the API Token we received from AUSSDA
2 Sys.setenv("DATAVERSE_KEY" = "xyz")
3
4 df_evs <-
5   get_dataframe_by_name(
6     filename   = "10048_da_en_v1_0-1.tab",
7     dataset    = "10.11587/C4YBOT",
8     .f         = haven::read_dta, # for reading SPSS tab file
9     original   = TRUE,
10    server     = "data.aussda.at")
11
12 df <- df_evs |> select(Year = S002EVS,
13                      Sex = X001,
14                      Homosexuality = F118) # select variables and rename them

```

```
1 head(df)
```

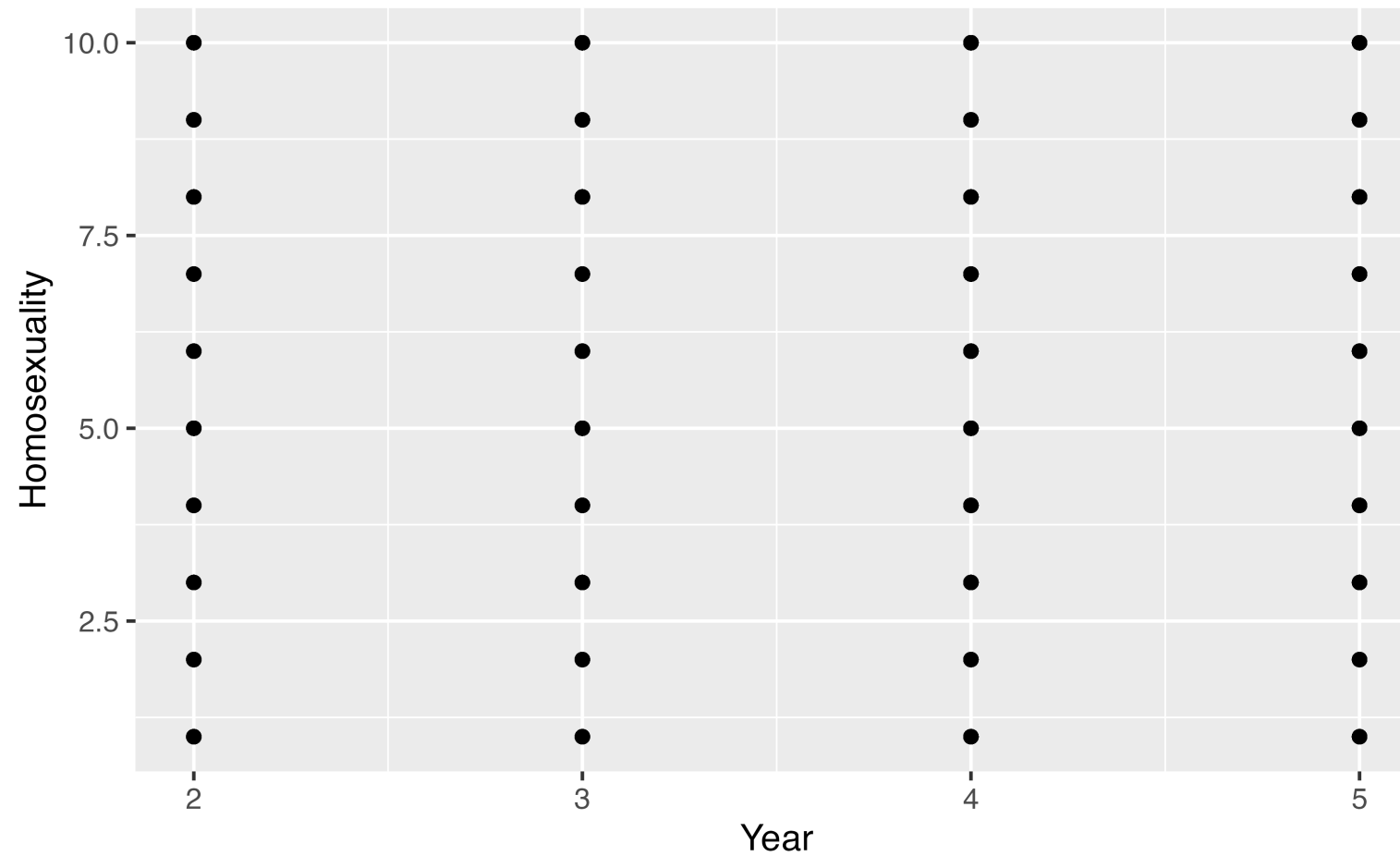
```

# A tibble: 6 × 3
  Year      Sex      Homosexuality
<dbl+lbl> <dbl+lbl> <dbl+lbl>
1 3 [1999] 1 [Male] 10 [Always justifiable]
2 5 [2018] 2 [Female] 6 [6]
3 3 [1999] 1 [Male] 10 [Always justifiable]
4 3 [1999] 2 [Female] 10 [Always justifiable]
5 2 [1990] 2 [Female] 3 [3]
6 4 [2008] 2 [Female] 3 [3]

```

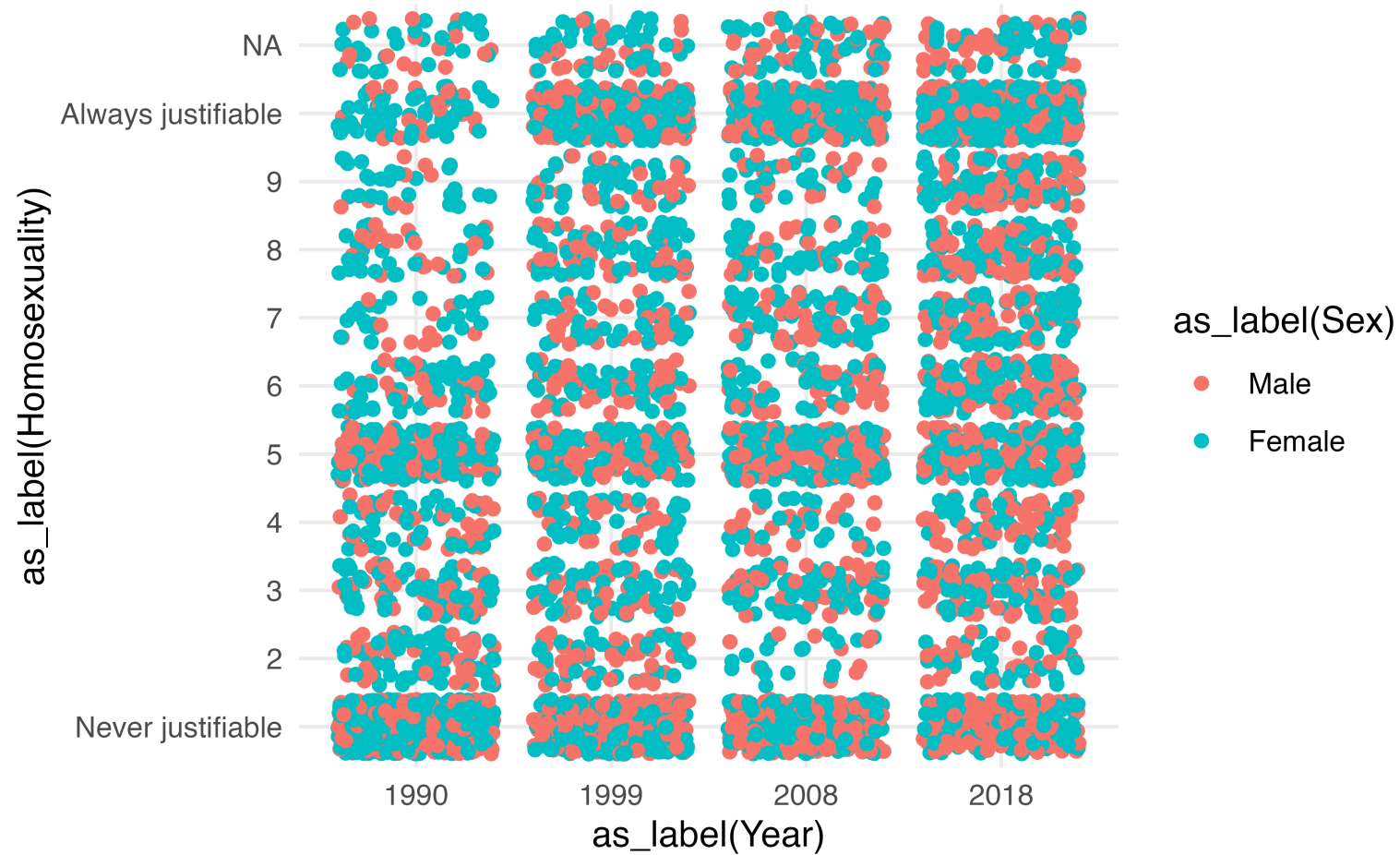

Step 1

```
1 df |> group_by(Sex, Year) |>  
2   ggplot(aes(Year, Homosexuality)) +  
3   geom_point()
```



Step 2

```
1 df |> group_by(Sex, Year) |>
2   ggplot(aes(as_label(Year), as_label(Homosexuality), color = as_label(Sex))) +
3   geom_jitter() +
4   theme_minimal()
```

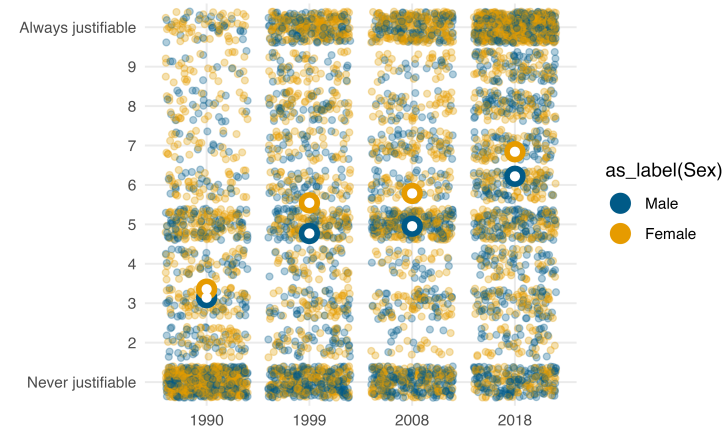


Step 3

```

1 p <- df |>
2   filter(!is.na(Homosexuality)) |>
3   group_by(Sex, Year) |>
4
5   mutate(mean_Homosexuality =
6     mean(Homosexuality,
7         na.rm = TRUE)) |>
8
9   ggplot(aes(as_label(Year),
10    as_label(Homosexuality),
11    color = as_label(Sex))) +
12
13   scale_color_manual(values =
14     c("#005c8b",
15       "#E69F00")) +
16
17   geom_jitter(alpha = .3) +
18
19   geom_point(aes(y = mean_Homosexuality,
20    color = as_label(Sex)),
21    size = 5) +
22
23   geom_point(aes(y = mean_Homosexuality),
24    size = 2, color = "white") +
25
26   labs(x = "", y = "") +
27   theme_minimal()
28
29 p

```



- Also check [COLORBREWER 2.0](#) for “colorblind safe” colors.

Step 4

```

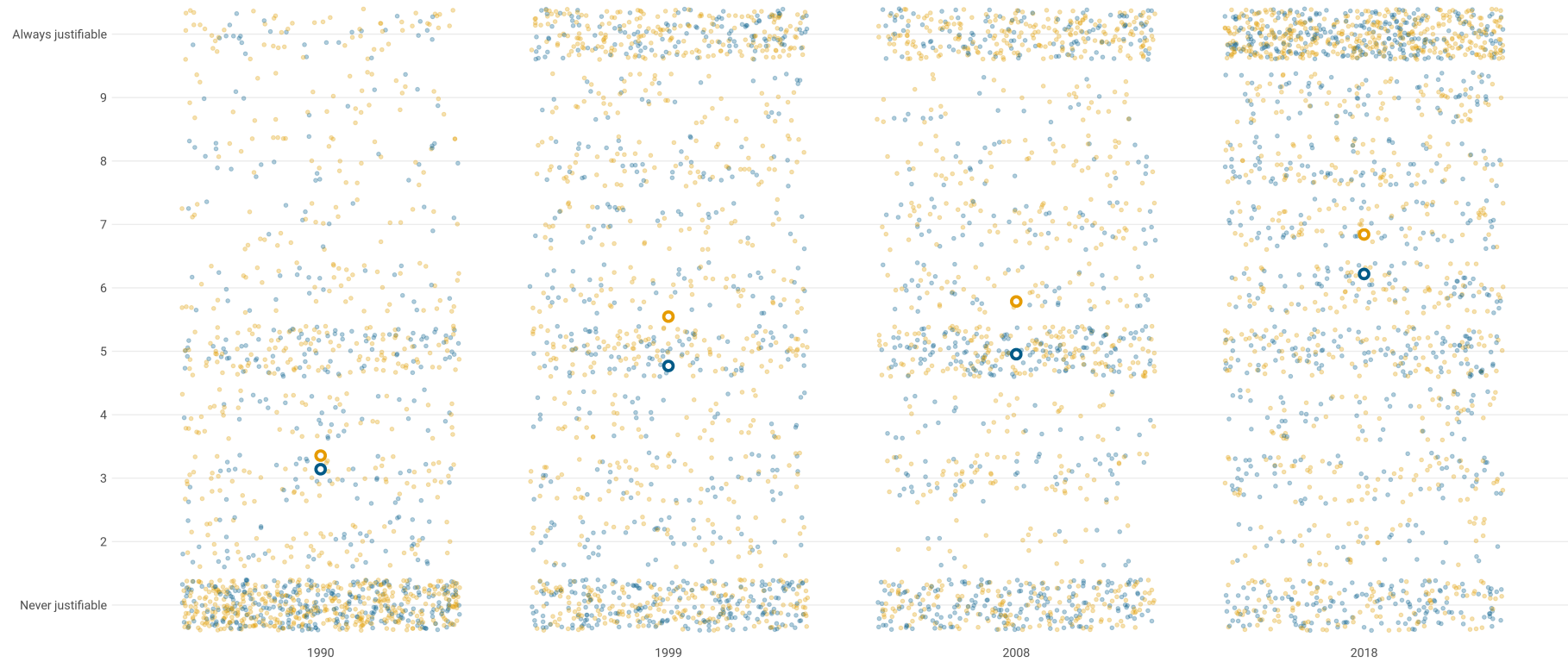
1 fontfamily1 <- "Roboto" # fonts have to be installed on the computer
2 fontfamily2 <- "Roboto Condensed"
3
4 p <- p + labs(title = "<b>Austrian <span style = 'color: #E69F00;'>women</span>
5           lead the way for <span style = 'color: #005c8b;'>men</span> towards more
6           tolerance</b>") +
7   labs(subtitle = "Q: Please tell me whether you think homosexuality can always be justified,
8           never be justified or something in between.") +
9   labs(caption = "Source: European Values Study 1990-2018; Austria Longitudinal Data") +
10  theme(text = element_text(size = 14, family = fontfamily1),
11        title = element_text(size = 18, family = fontfamily1),
12        plot.title = element_text(size = 18, family = fontfamily1),
13        plot.subtitle = element_markdown(size = 14, family = fontfamily2,
14                                         margin = ggplot2::margin(1, 0, 1, 0)),
15        axis.text.x = element_text(size = 12, family = fontfamily1),
16        axis.text.y = element_text(size = 12, family = fontfamily1),
17        plot.caption = element_text(size = 10, family = fontfamily1, color = "darkgrey")) +
18  theme(plot.title = element_markdown(),
19        plot.subtitle = element_markdown(),
20        plot.caption = element_markdown(),
21        panel.grid.major.x = element_blank(),
22        panel.grid.minor.y = element_blank(),
23        legend.position="none")

```

Final Plot

Austrian women lead the way for men towards more tolerance

Q: Please tell me whether you think homosexuality can always be justified, never be justified or something in between.



Source: European Values Study 1990-2018; Austria Longitudinal Data

Final code (including saving plot)

```

1  png(filename = "plots/plot_homosexuality-final.png",
2     width = 21.7,
3     height = 10.2,
4     units = "in",
5     res = 300,
6     bg = "#ffffff",
7     type = "cairo-png"
8  )
9
10 df |> filter(!is.na(Homosexuality)) |>
11   group_by(Sex, Year) |>
12   mutate(mean_Homosexuality = mean(Homosexuality, na.rm = TRUE)) |>
13   ggplot(aes(as_label(Year), as_label(Homosexuality), color = as_label(Sex))) +
14   scale_color_manual(values = c("#005c8b", "#E69F00")) +
15   geom_jitter(alpha = .3) +
16   geom_point(aes(y = mean_Homosexuality, color = as_label(Sex)), size = 5) +
17   geom_point(aes(y = mean_Homosexuality), size = 2, color = "white") +
18   labs(x = "", y = "") +
19   labs(title = "<b>Austrian <span style = 'color: #E69F00;'>women</span> lead the way for <span style = 'color: #005c8b;'>men
20   labs(subtitle = "Q: Please tell me whether you think homosexuality can always be justified, never be justified</span> or so
21   labs(caption = "Source: European Values Study 1990-2018; Austria Longitudinal Data") +
22   theme_minimal() +
23   theme(text = element_text(size = 14, family = fontfamily1),
24         title = element_text(size = 18, family = fontfamily1),
25         plot.title = element_text(size = 18, family = fontfamily1),
26         plot.subtitle = element_markdown(size = 14, family = fontfamily2, margin = ggplot2::margin(1, 0, 1, 0)),
27         axis.text.x = element_text(size = 12, family = fontfamily1),
28         axis.text.y = element_text(size = 12, family = fontfamily1),
29         plot.caption = element_text(size = 10, family = fontfamily1, color = "darkgrey")) +
30   theme(plot.title = element_markdown(),
31         plot.subtitle = element_markdown().

```

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Q & A

Feedback

Feedback Webinar: Data Visualization with R and Jupyter

Load unfinished survey

Resume later

Exit and clear survey

Feedback Webinar: Data Visualization with R and Jupyter

There are 2 questions in this survey.

What did you like?

What could be improved?

Submit

<https://umfrage.uibk.ac.at/limesurvey/allgemein/index.php/693916?lang=en>

Upcoming Events



[About Infra4NextGen](#) [Who's involved](#) [NextGenEU](#)

Events

Workshop: Open Science and Reproducible Research in RStudio and Jupyter Notebook

28 November 2024 - 29 November 2024

Venue: Online

Day 1: 9-11.30am; Day 2: 9.30am-1.30pm (CET)

[Register via Zoom](#)

[Register](#)



[About Infra4NextGen](#) [Who's involved](#) [NextGenEU](#)

Events

Hackathon: Transform your ideas into graphs! Visualization of research data

3 December 2024 - 5 December 2024

Venue: Online

9am-3pm (CET)

[Register via Zoom](#)

[Register](#)

Appendix

geom_line plot

```

1 # define font families for title, subtitle and annotations
2 fontfamily1 <- "Roboto"
3 fontfamily2 <- "Roboto Condensed"
4
5 df |> filter(Homosexuality == 10 | Homosexuality == 1) |>
6   pivot_longer(cols = c(Homosexuality)) |>
7   group_by(Year, value) |>
8   summarise(n = n()) |>
9   mutate(N = max(cumsum(n)), freq = n/N) |>
10  ggplot(aes(x = as_label(Year), y = freq, group = as_label(value), color = as_label(value))) +
11  scale_color_manual(values = c("#005c8b", "#E69F00")) +
12  geom_line(linewidth = 2) +
13  geom_point(size = 4) +
14  geom_point(size = 2, color = "white") +
15  scale_y_continuous(labels = scales::percent, limits = c(0,1)) +
16  labs(x = "", y = "") +
17  labs(title = "<b>Austrians have become more tolerant over time</b>") +
18  labs(subtitle = "Q: Please tell me whether you think homosexuality can <b><span style = 'color: #E69F00;'>always be justifi
19  labs(caption = "Source: European Values Study 1990-2018; Austria Longitudinal Data") +
20  theme_minimal() +
21  theme(text = element_text(size = 14, family = fontfamily1),
22        title = element_text(size = 18, family = fontfamily1),
23        plot.title = element_text(size = 18, family = fontfamily1),
24        plot.subtitle = element_markdown(size = 14, family = fontfamily2, margin = ggplot2::margin(1, 0, 1, 0)),
25        axis.text.x = element_text(size = 12, family = fontfamily1),
26        axis.text.y = element_text(size = 12, family = fontfamily1),
27        plot.caption = element_text(size = 10, family = fontfamily1, color = "darkgrey")) +
28  theme(plot.title = element_markdown(),
29        plot.subtitle = element_markdown(),
30        panel.grid.major.x = element_blank(),
31        panel.grid.minor.y = element_blank()).

```