



# Datenvizualisierung in der Wissenschaft

## Eleganz der visuellen Form

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RPTU Nachwuchsring  
3., 10. und 17. Juli 2025



# Visuelle Form

## Eleganz der Grafik



# Prinzipien der visuellen Wahrnehmung



# Ein **Ikonisches Gedächtnis**

ist eine Form des **sensorischen Gedächtnisses**, das visuelle Informationen für einen sehr kurzen Zeitraum vorübergehend speichert.

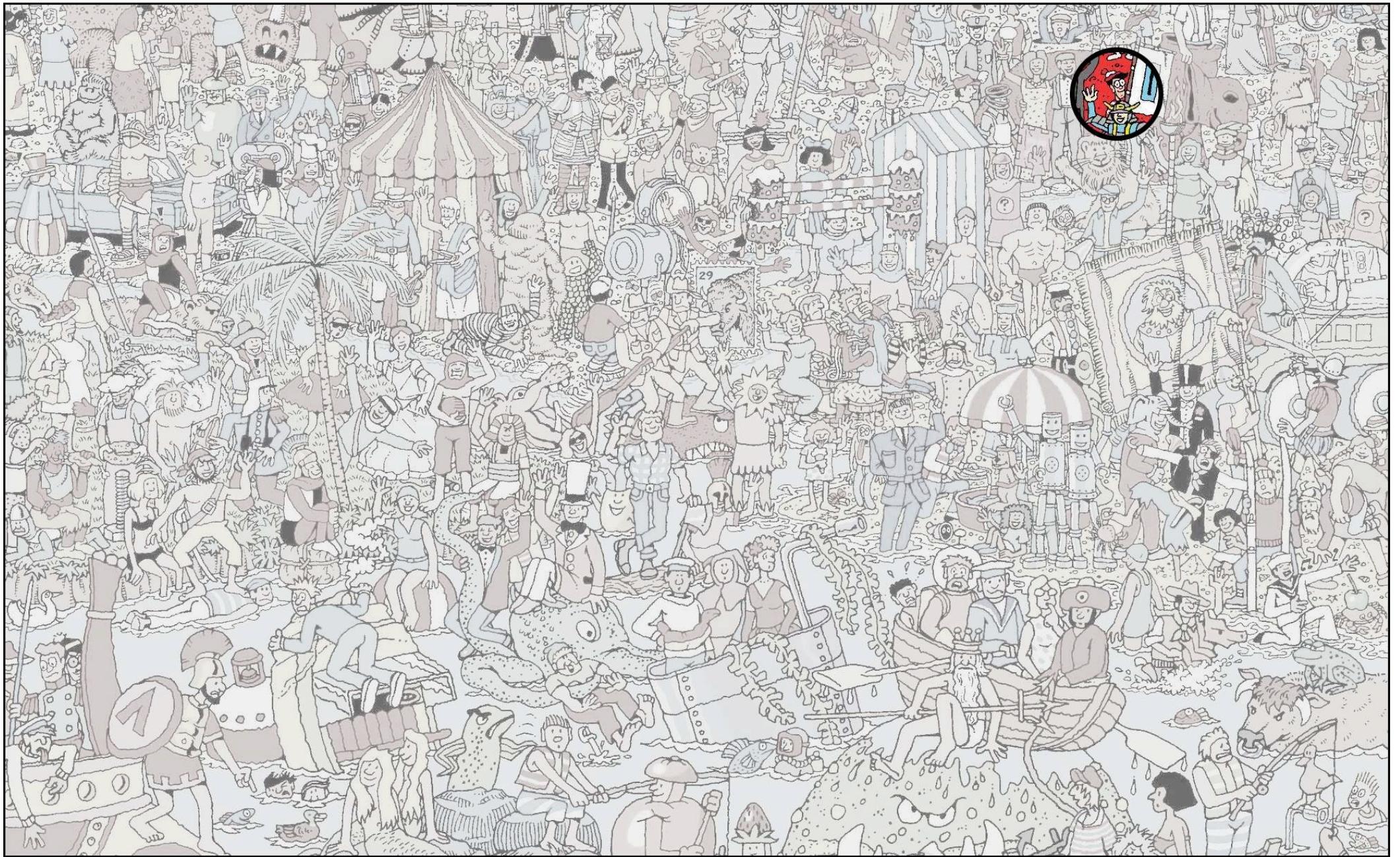
Es arbeitet auf einer präattentiven Ebene – das heißt, es reagiert, bevor bewusste Aufmerksamkeit auf die visuellen Reize gerichtet wird.





Quelle: "Where's Waldo?" von Martin Handford © Kilburn & Strode LLP





Quelle: "Where's Waldo?" von Martin Handford © Kilburn & Strode LLP

Cédric Scherer Data Visualization & Information Design



5 3 7 2 0 9 4 8 1 3  
9 4 5 4 3 5 2 5 4 6  
1 0 4 5 8 2 6 8 5 0  
7 3 2 9 6 0 2 5 9 1  
4 8 2 1 0 7 0 2 4 3

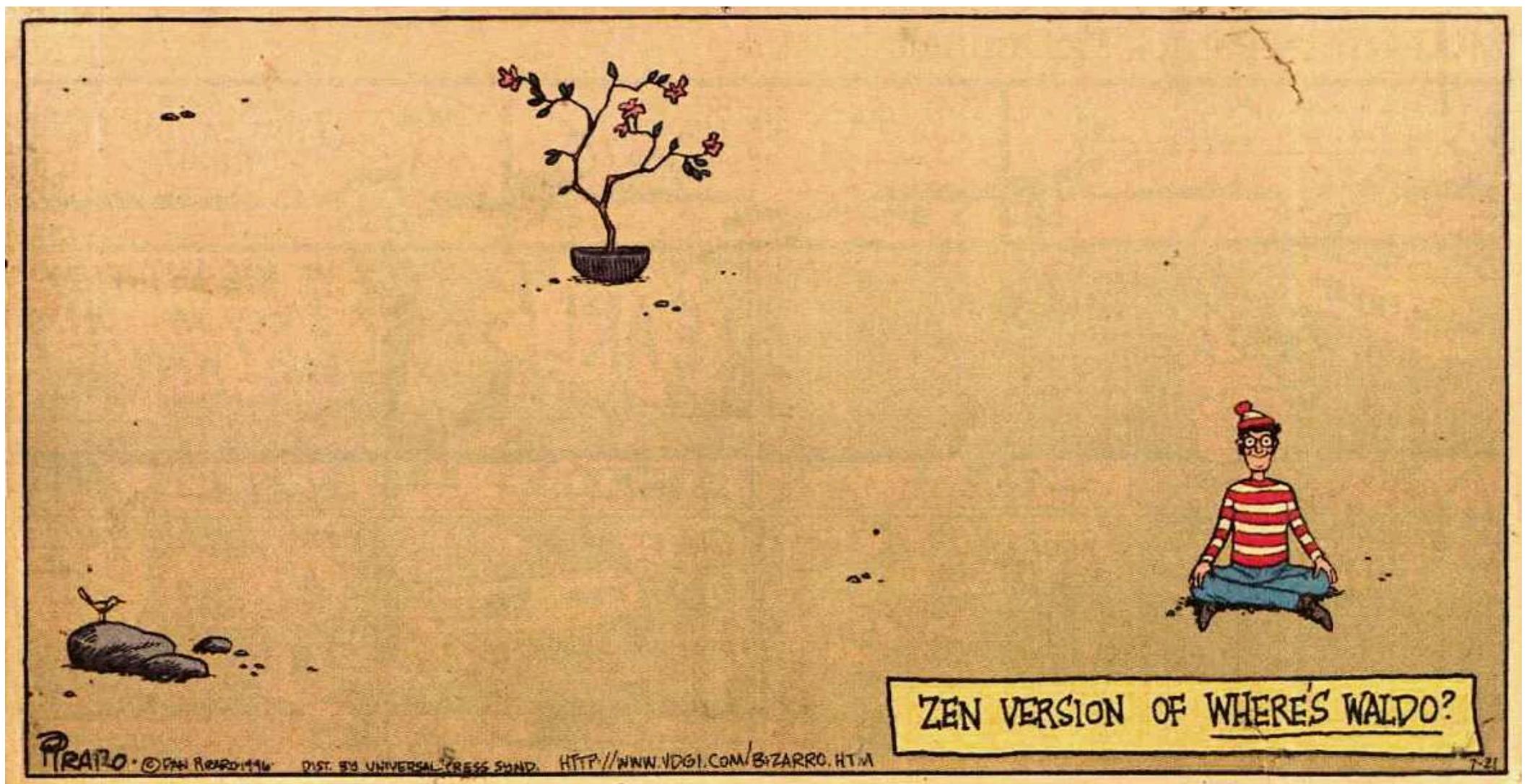


1 5 9 7 4 5 0 2 0 1  
4 7 6 9 3 5 1 3 6 0  
6 9 3 1 2 4 9 7 5 4  
5 6 4 3 8 0 2 3 4 1  
8 4 1 3 7 2 9 6 1 2



7	4	1	3	8	7	2	6	5	0
6	3	0	2	1	9	7	5	4	8
1	7	5	4	3	1	4	0	8	7
9	2	1	5	8	7	3	4	5	6
4	6	2	8	1	4	7	2	3	0





Quelle: Zen-Version von "Where's Waldo?" von Dan Piraro

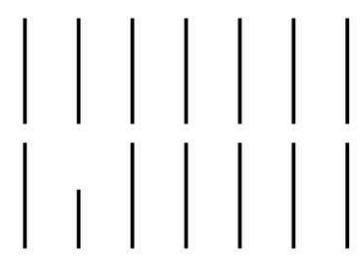


# Preattentive Attribute

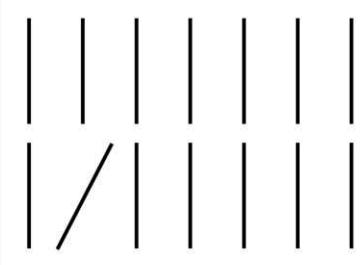
Visuelle Eigenschaften, die das menschliche Gehirn  
unmittelbar und unterbewusst verarbeitet.



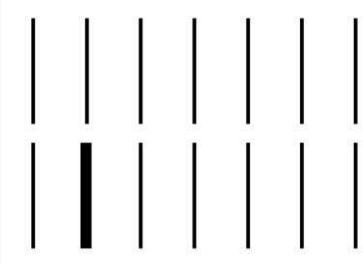
**Length**



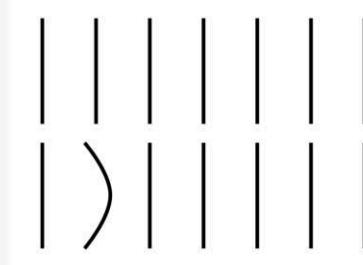
**Orientation / Direction**



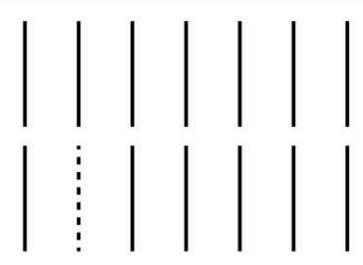
**Width / Size**



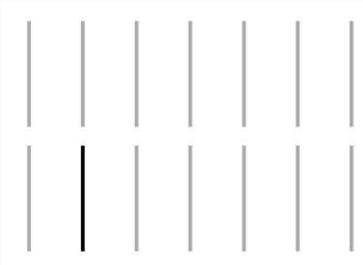
**Curvature**



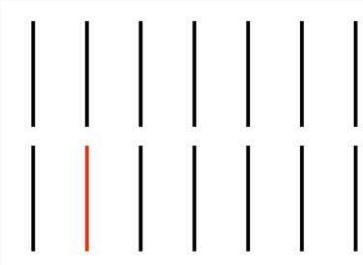
**Shape / Linetype**



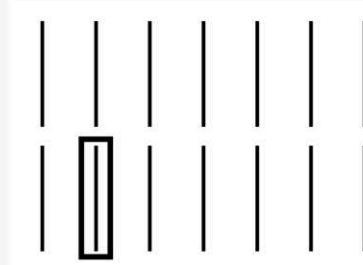
**Intensity**



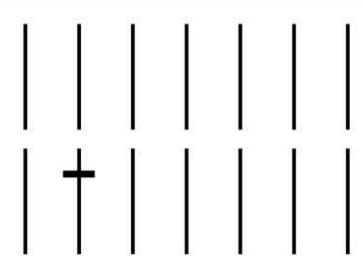
**Hue**



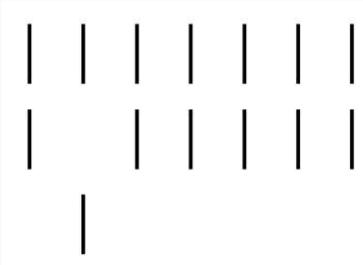
**Enclosure**



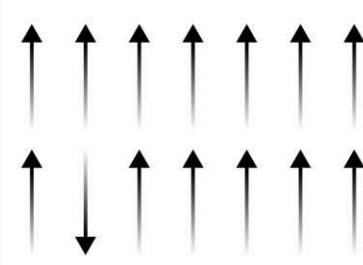
**Added Marks**



**Position**



**Direction of Motion**



Basierend auf Grafiken von Stephen Few und anderen



# Keep it simple

In his book [Information Visualization: Perception for Design](#), Colin Ware states:

“It is easy to spot a hawk in a sky full of pigeons, but as the variety of birds increases the hawk becomes harder to pick out.”

In other words, **the more things are made different, the less any of them stand out.**

So, it is *good practice* to start with figuring out an item of interest you want to emphasise, and then trying to make it the one thing that is different, thus leveraging your contrast strategically.

Source: Deya Milcheva (5rdata.com)



# Keep it simple

size, weight, type + spacing  
color + added mark

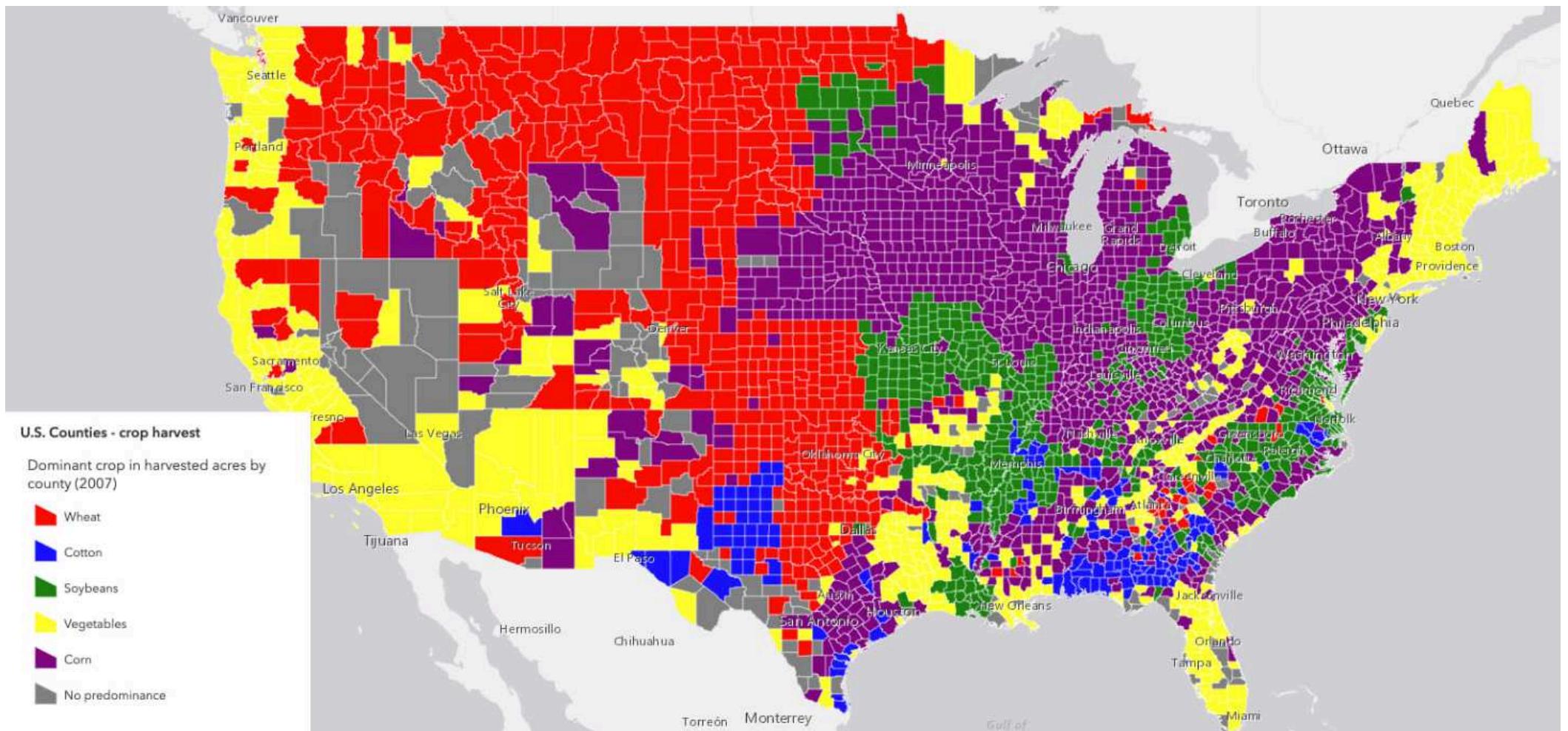
In his book Information Visualization: Perception for Design, Colin Ware states:  
added mark

“It is easy to spot a hawk in a sky full of pigeons, but as the variety of birds increases the hawk becomes harder to pick out.”  
↔ position                          ↑ spacing                          type + style  
In other words, the more things are made different, the less any of them stand out.

style                          ↑ spacing                          weight  
So, it is *good practice* to start with figuring out an item of interest you want to emphasise, and then trying to make it the one thing that is different, thus leveraging your contrast strategically.

Source: Deya Milcheva (5rdata.com) ← size, color + spacing





Quelle: ESRI



# **“Decluttering”**

**Überflüssige Elemente entfernen, Klarheit fördern.**



# **clutter**

auch bekannt als

## **"Chart Junk"**

sind visuelle Elemente, die Platz einnehmen  
aber das Verständnis nicht verbessern.

Noch schlimmer:  
Sie erhöhen die kognitive Belastung.



**“The larger the share of a graphic’s ink devoted to data, the better.”**

Edward Tufte (1983)



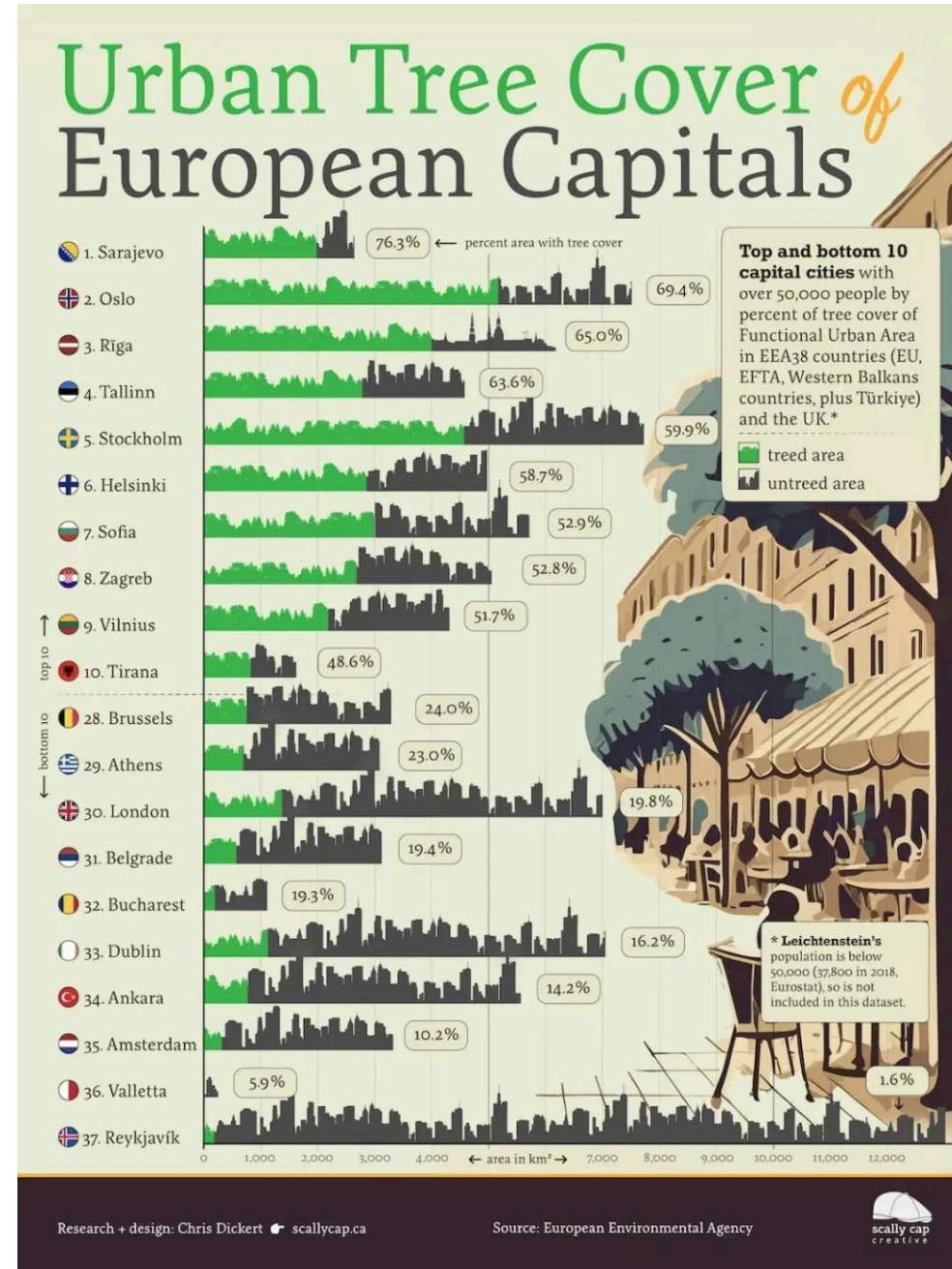
# Chart junk



Gefunden in "News that fit to print" von Arturo Perez-Reyes

Cédric Scherer Data Visualization & Information Design



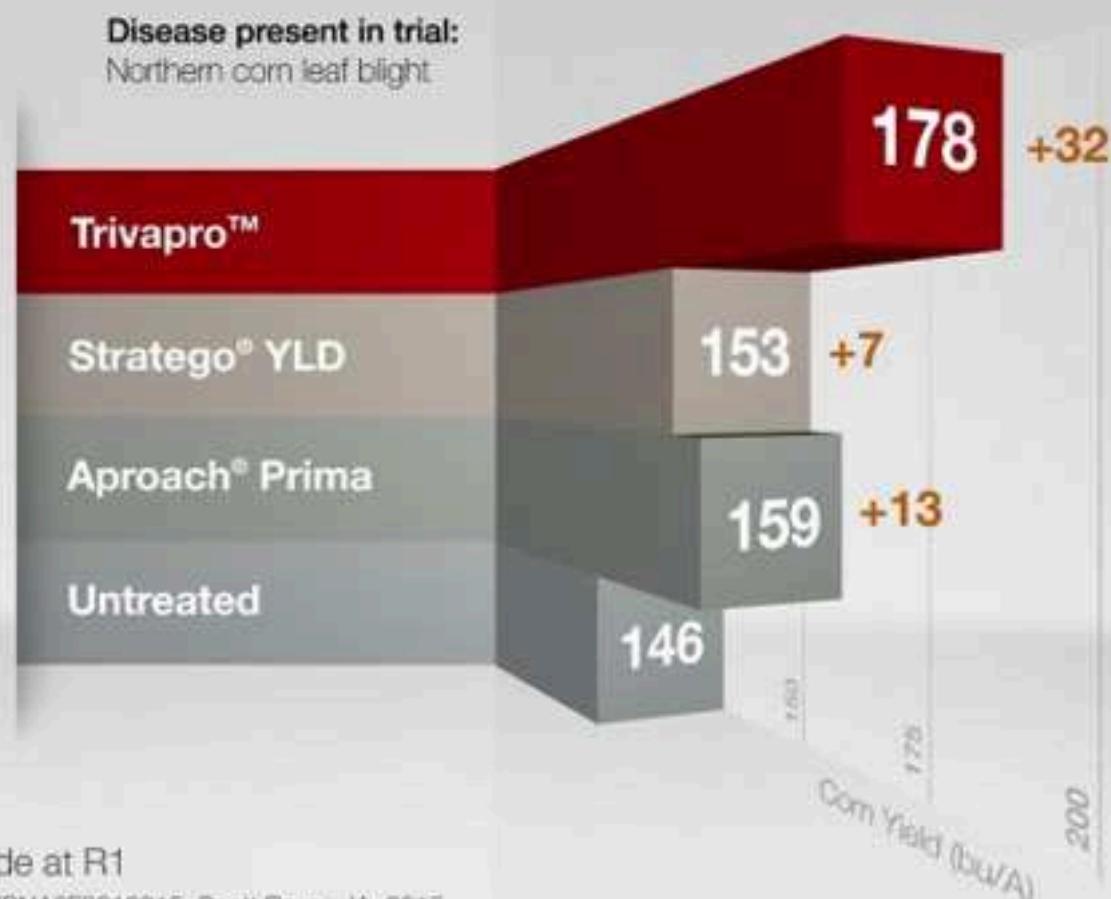


"Urban Tree Cover of European Capital Cities" von Chris Dickert  
 Cédric Scherer Data Visualization & Information Design



# Trivapro corn yield response

In Boone, IA



All applications made at R1

FSF001A4-2015JS, Trial USNA0F8012015, Scott Payne, IA, 2015

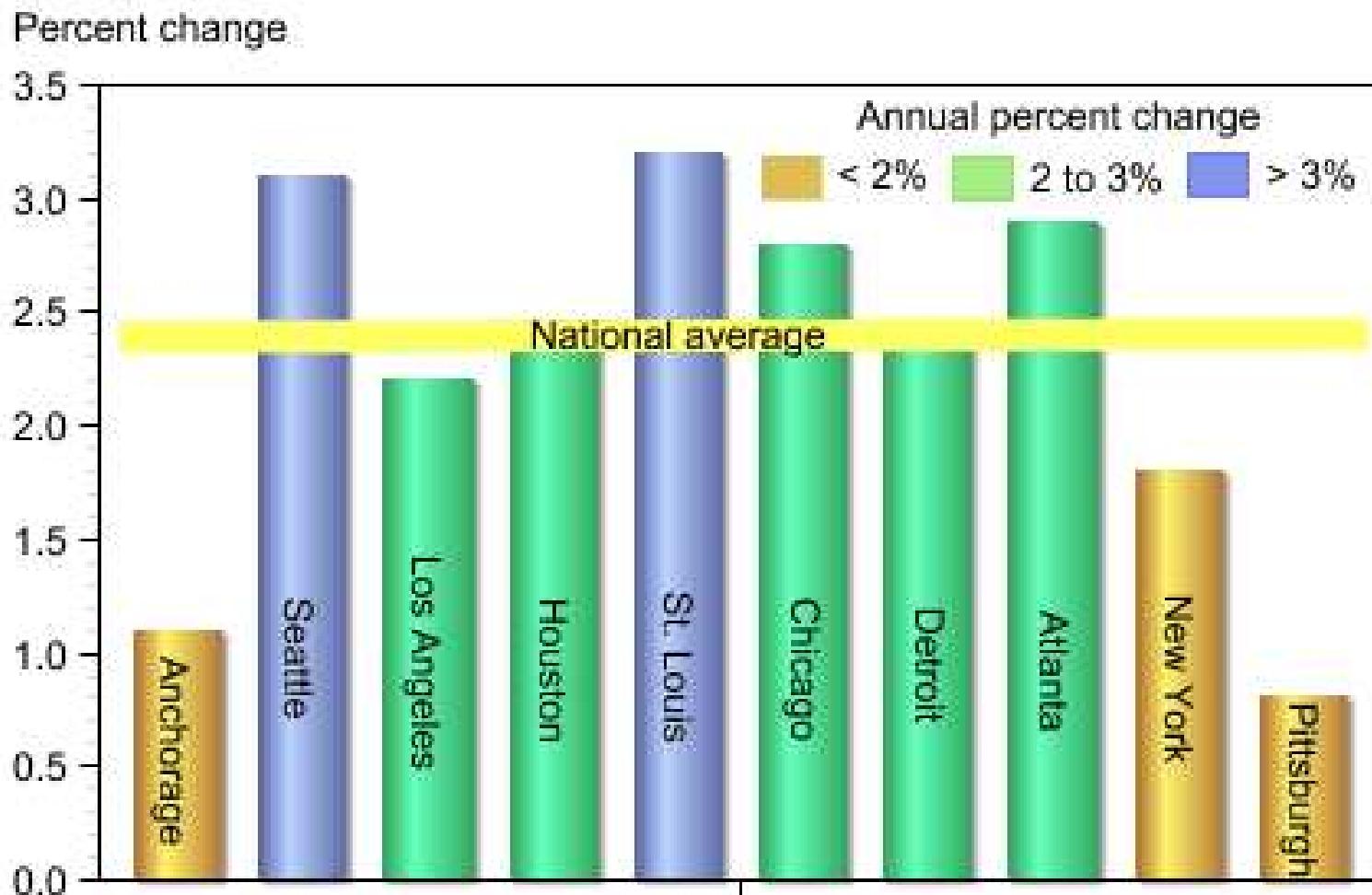
Quelle: Syngenta

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## Annual grocery store inflation by city, 2014

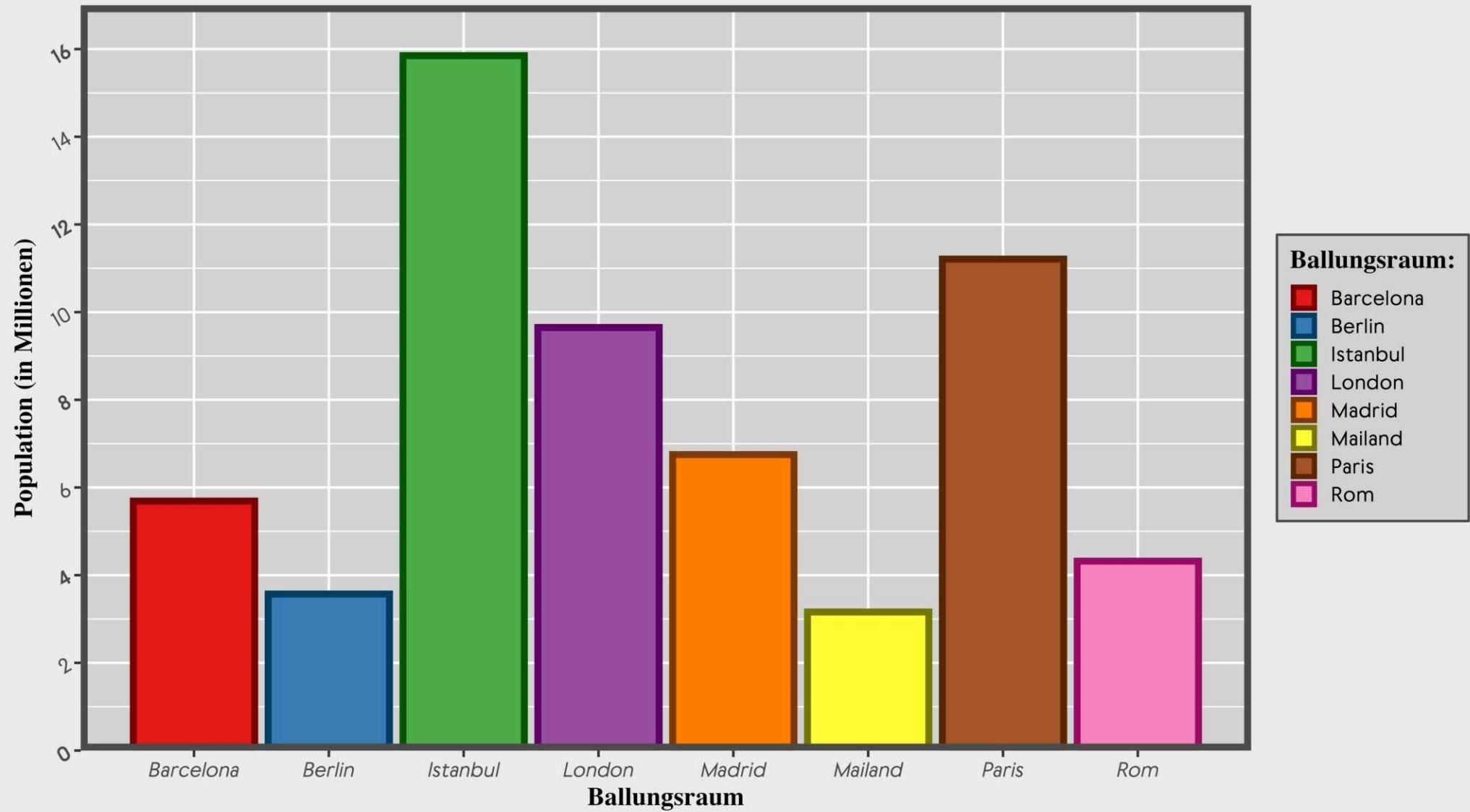
*In 2014, food price inflation was higher in Seattle, St. Louis, Chicago, and Atlanta than in other metropolitan areas*



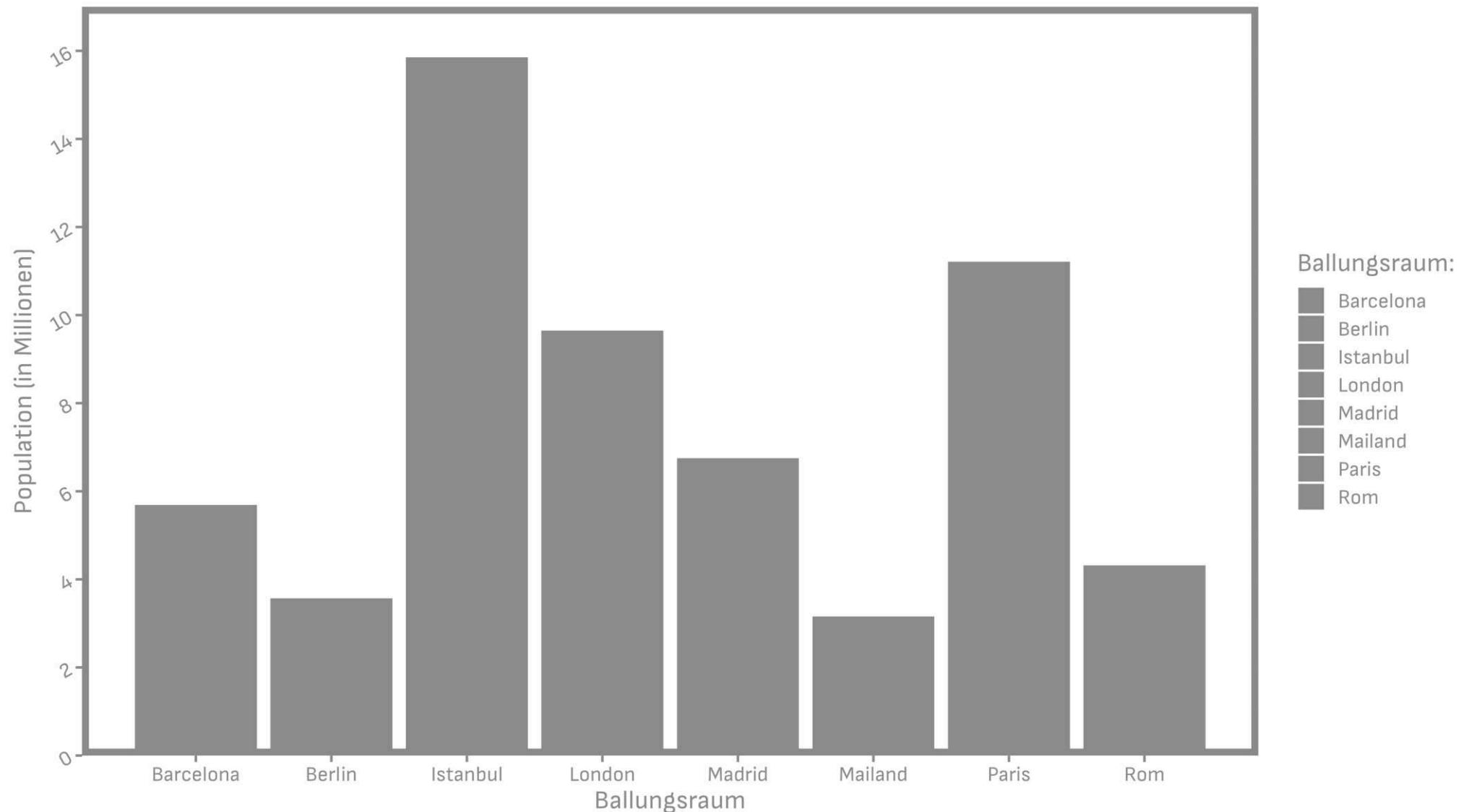
Source: Calculated by ERS, USDA, using Bureau of Labor Statistics (BLS) data.



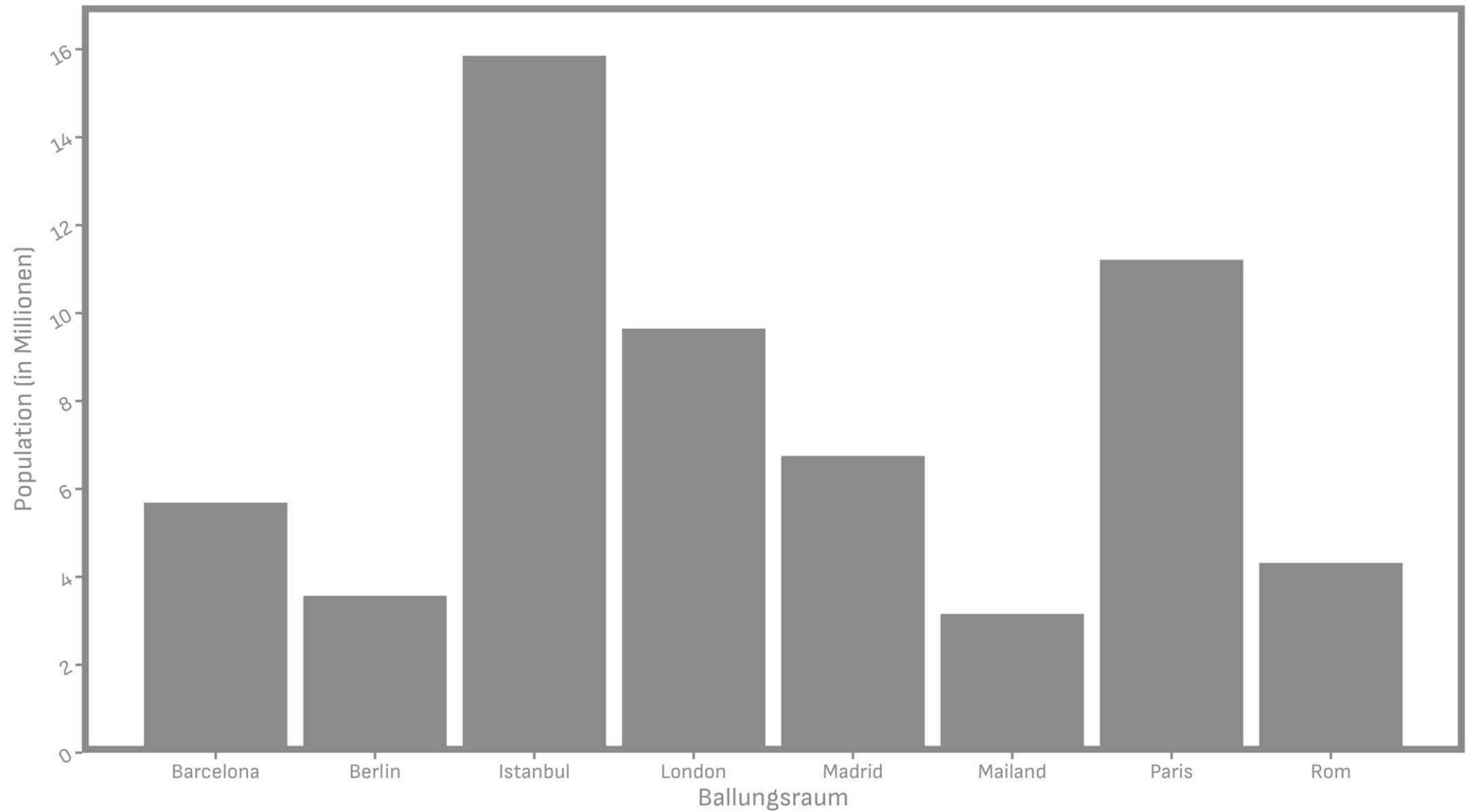
## Population in Europa (Stand: 2023)



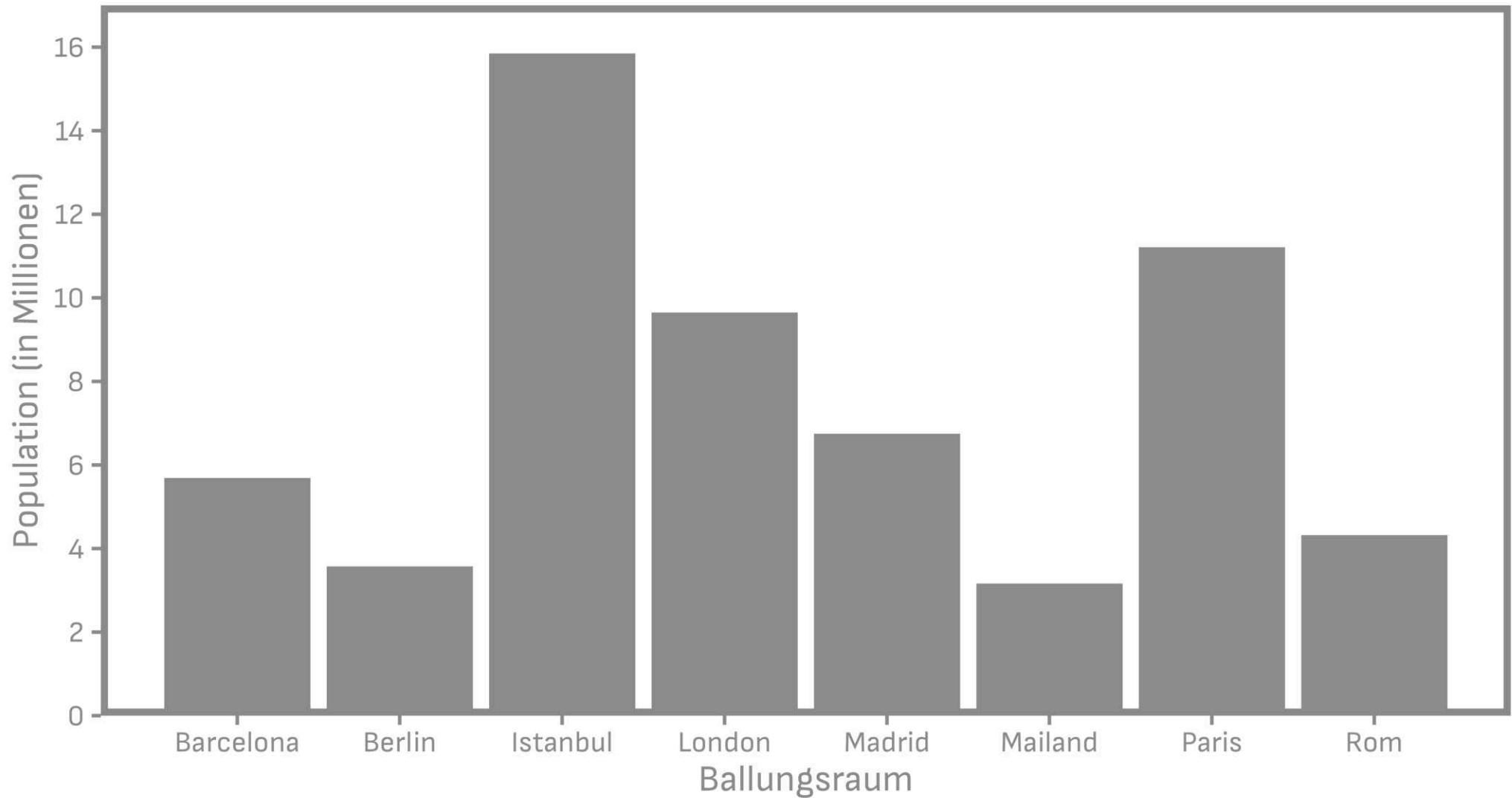
## Population in Europa (Stand: 2023)



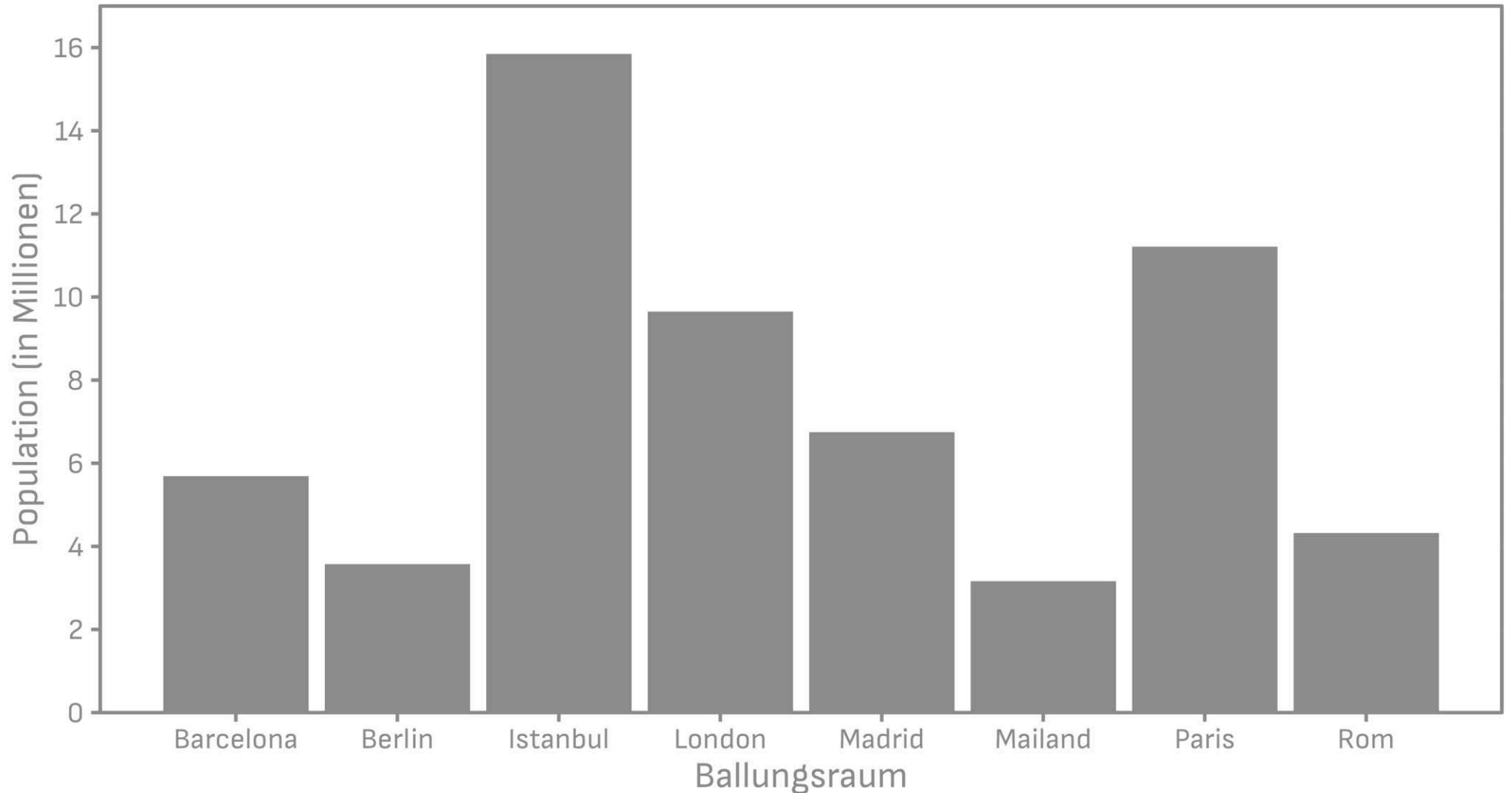
## Population in Europa (Stand: 2023)



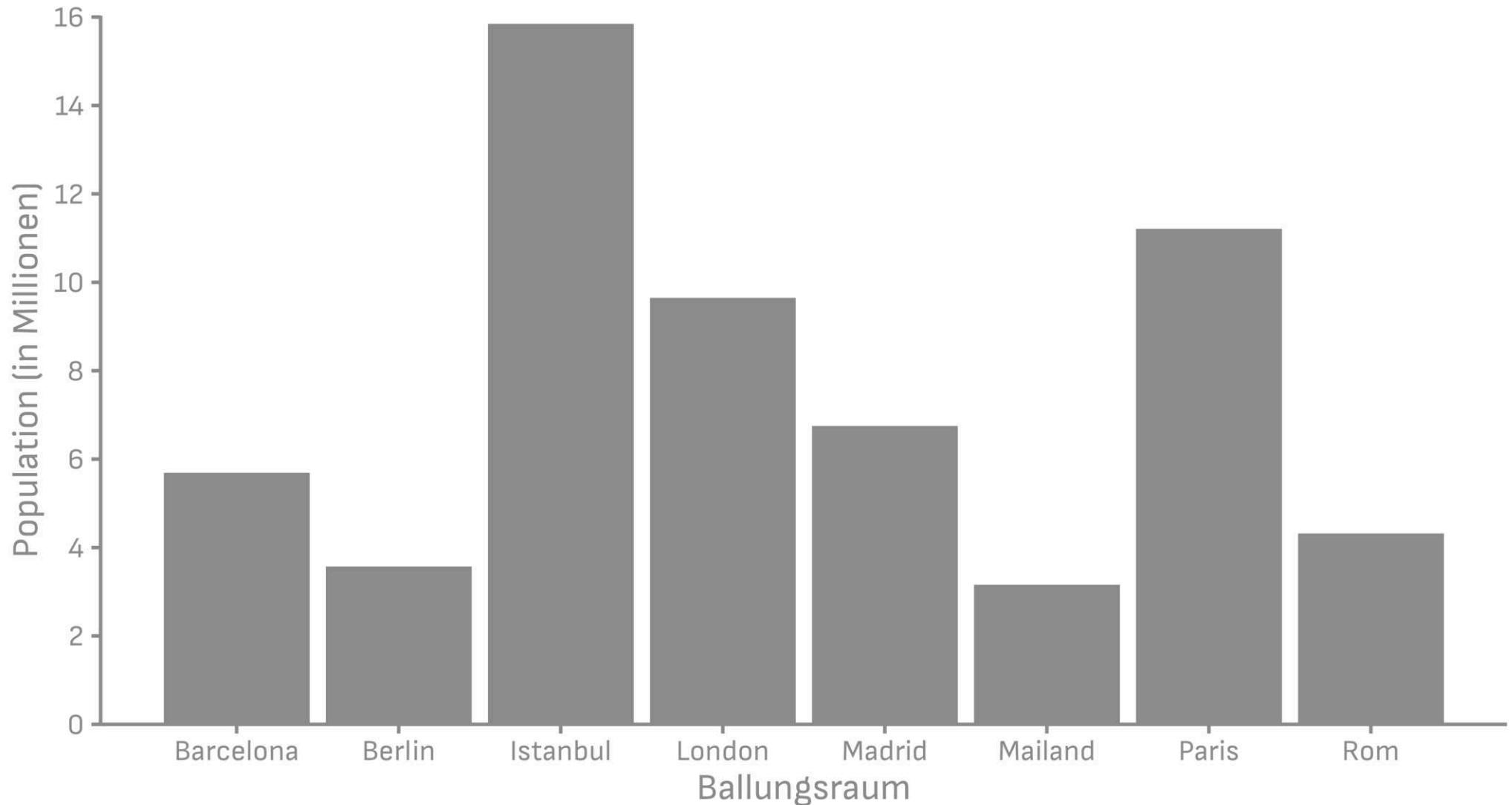
## Population in Europa (Stand: 2023)



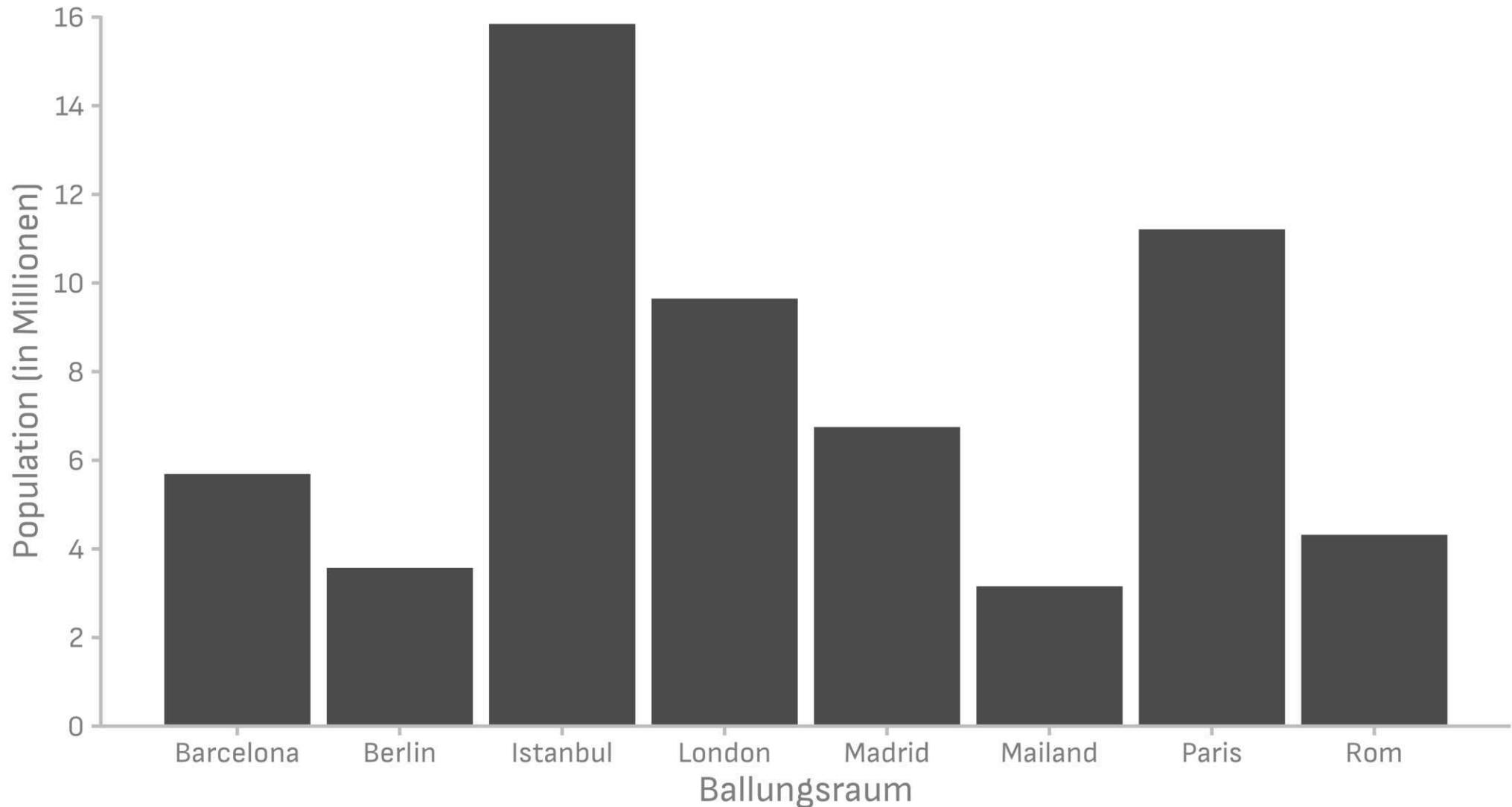
## Population in Europa (Stand: 2023)



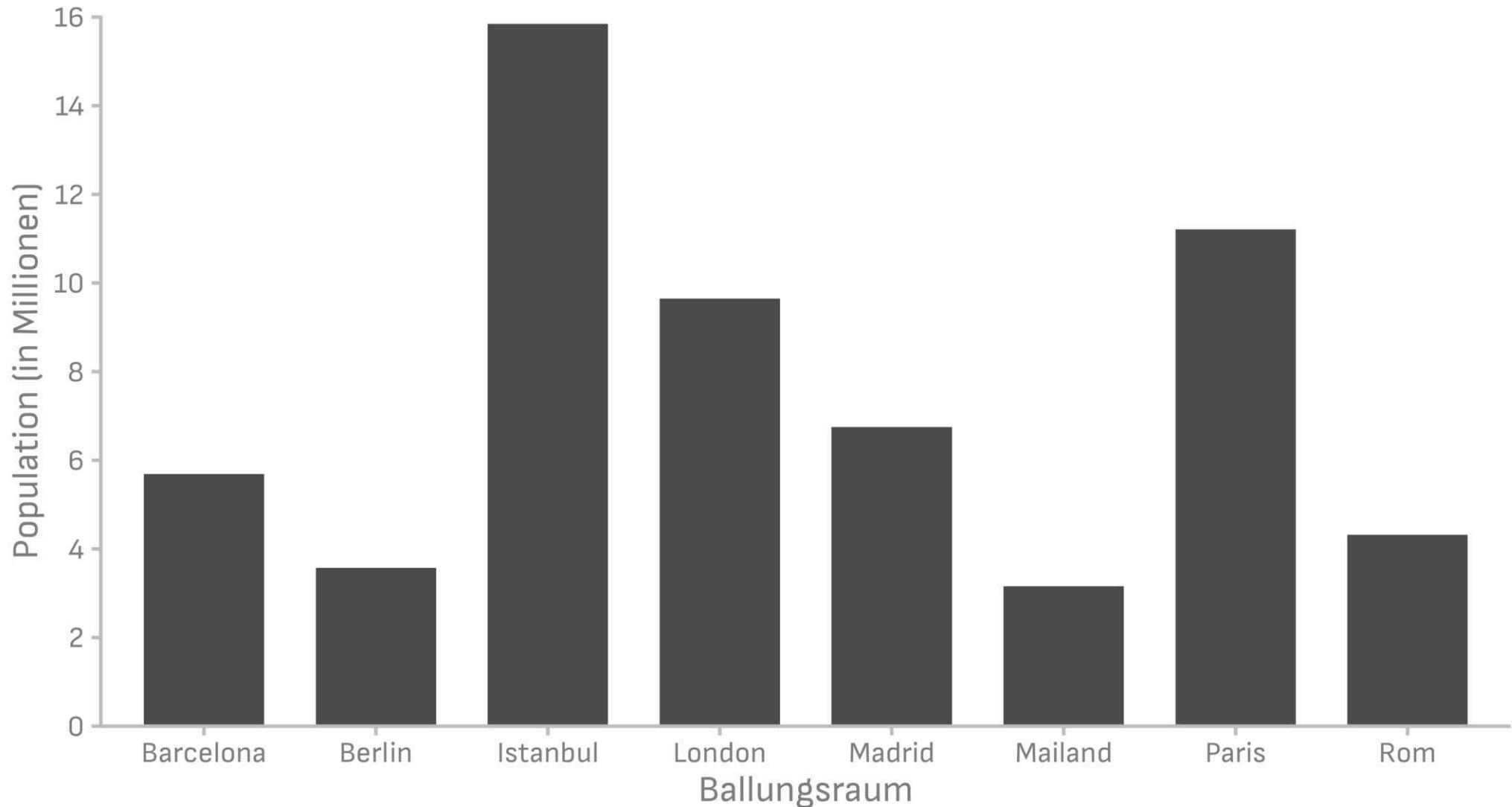
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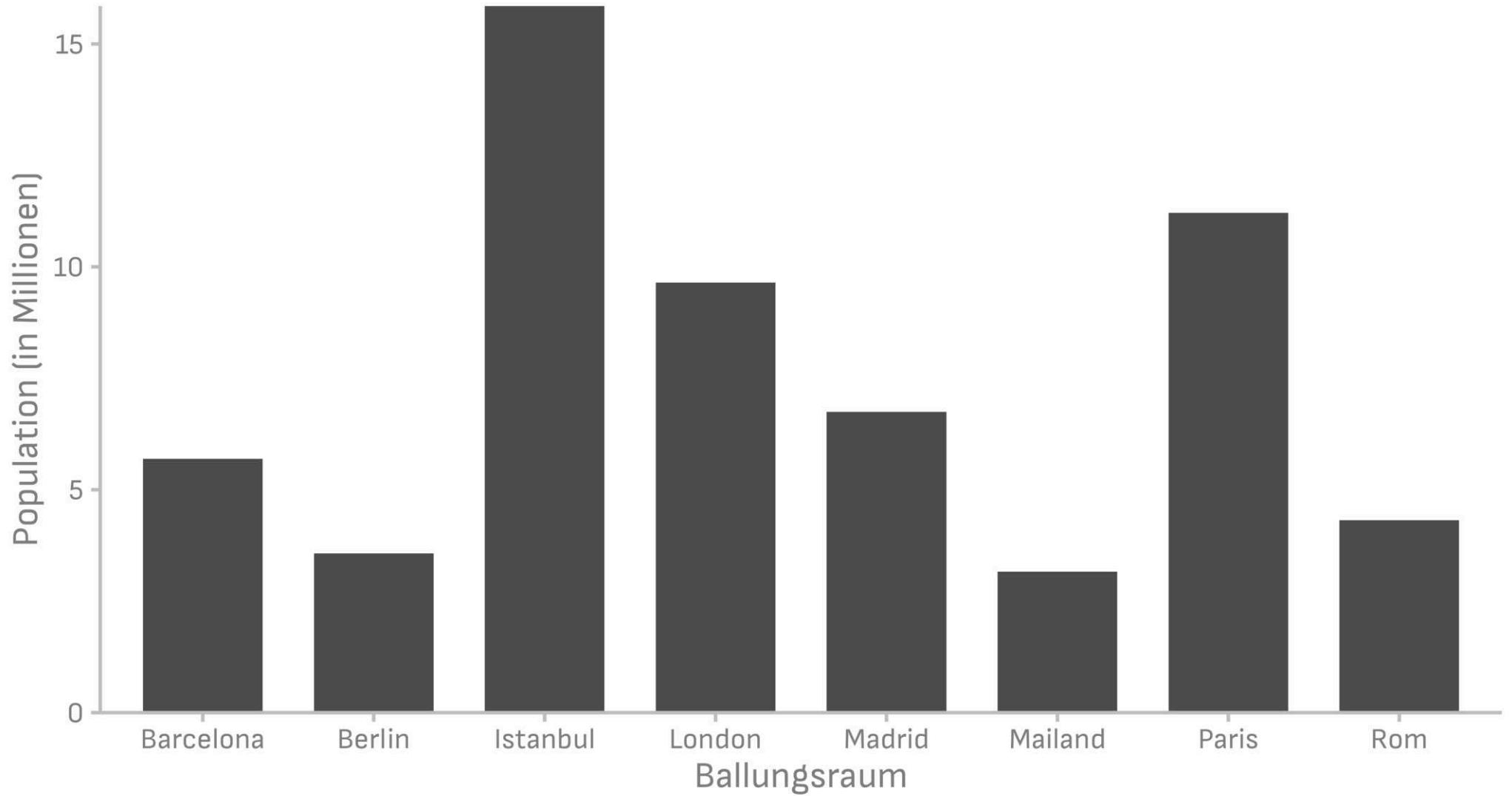
# Population in Europa (Stand: 2023)



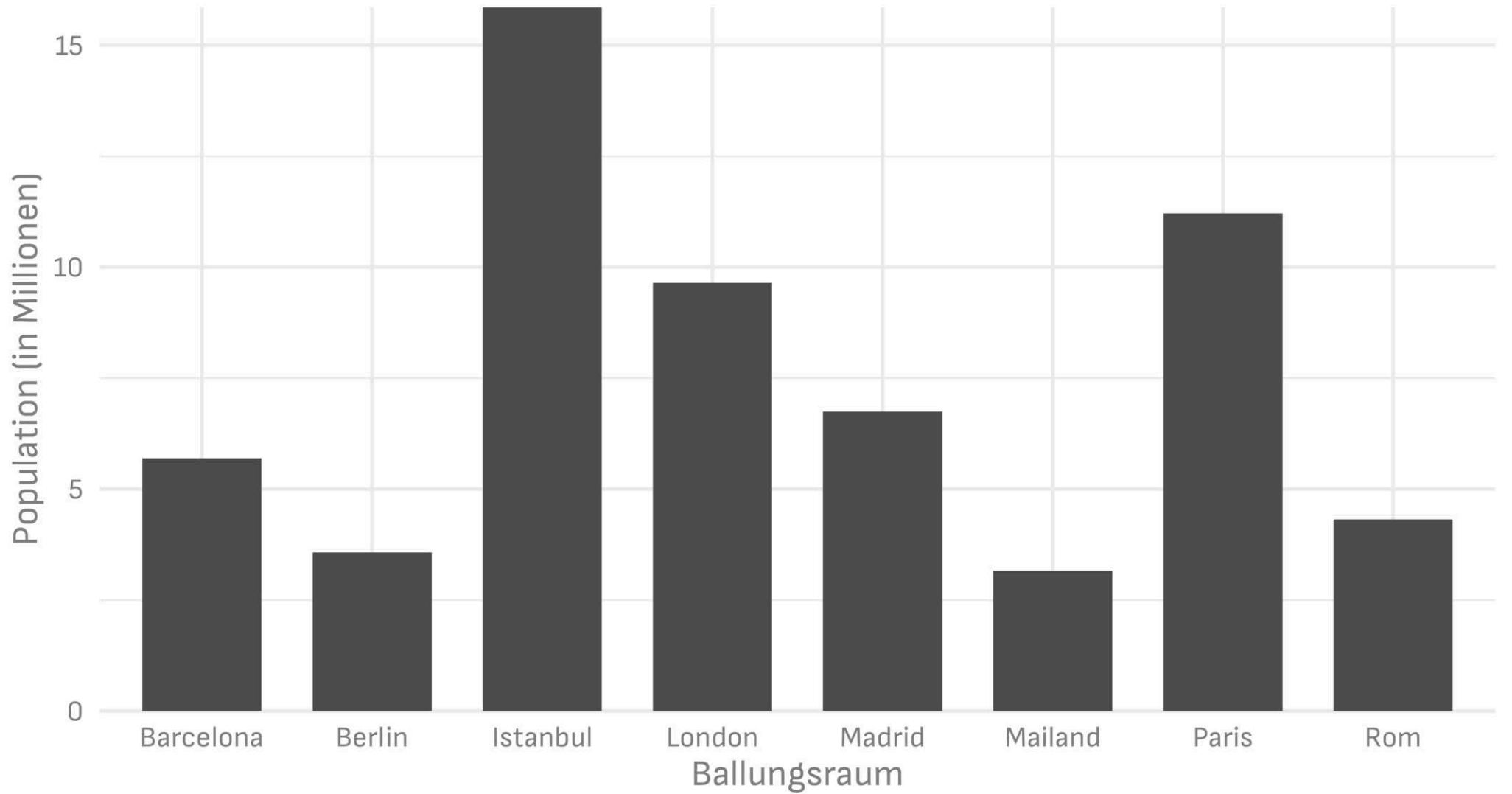
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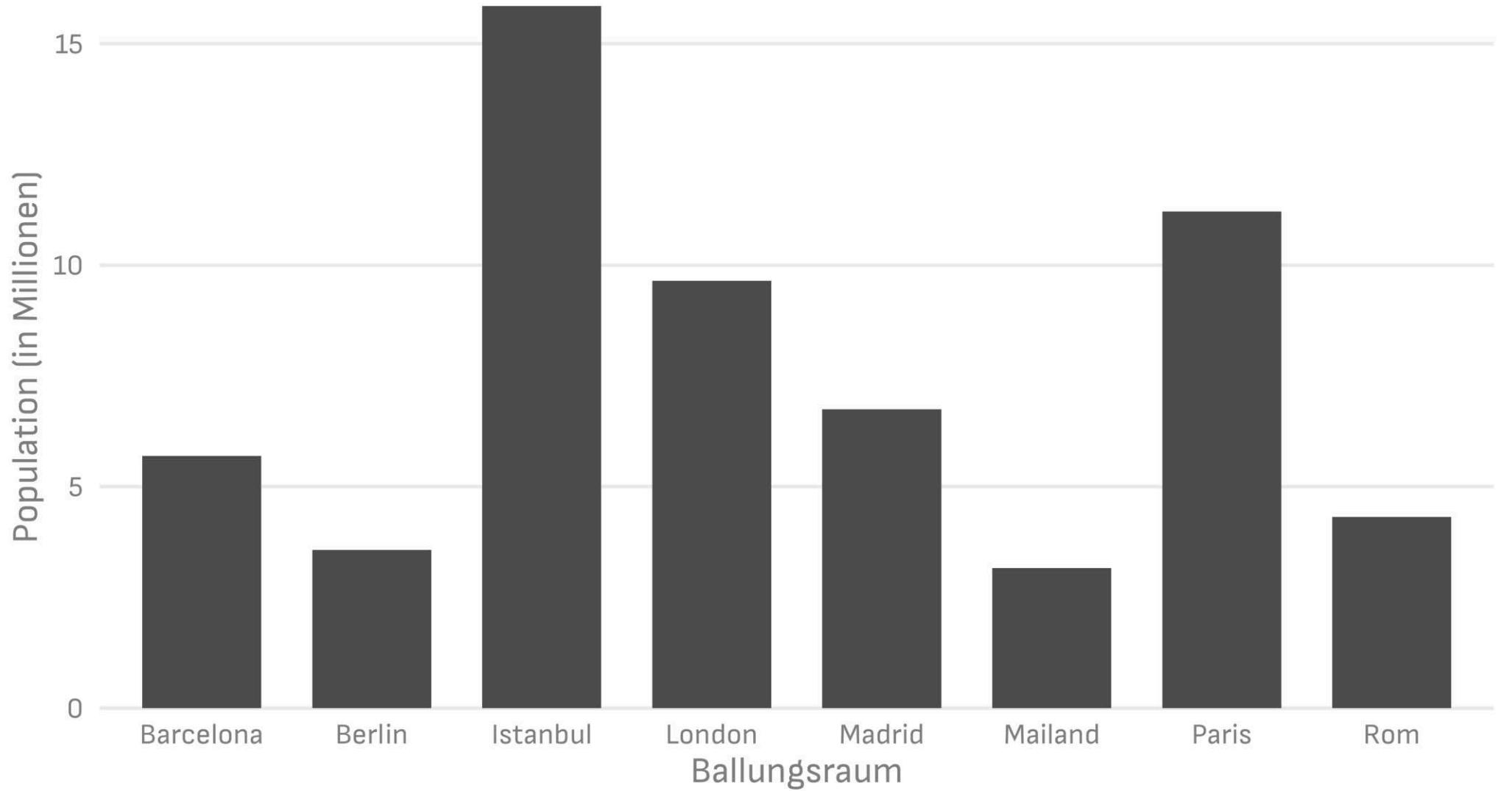
# Population in Europa (Stand: 2023)

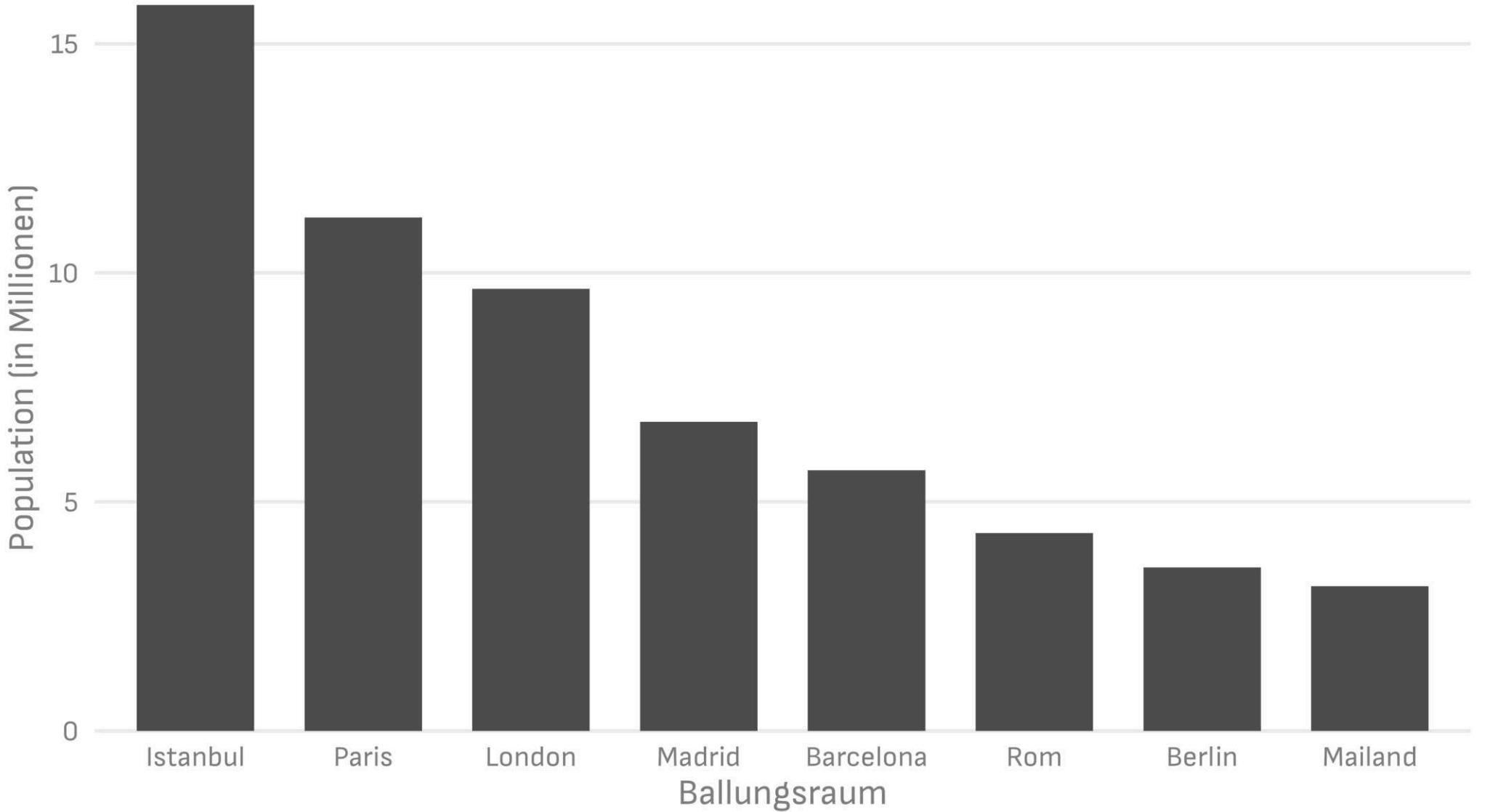


## Population in Europa (Stand: 2023)



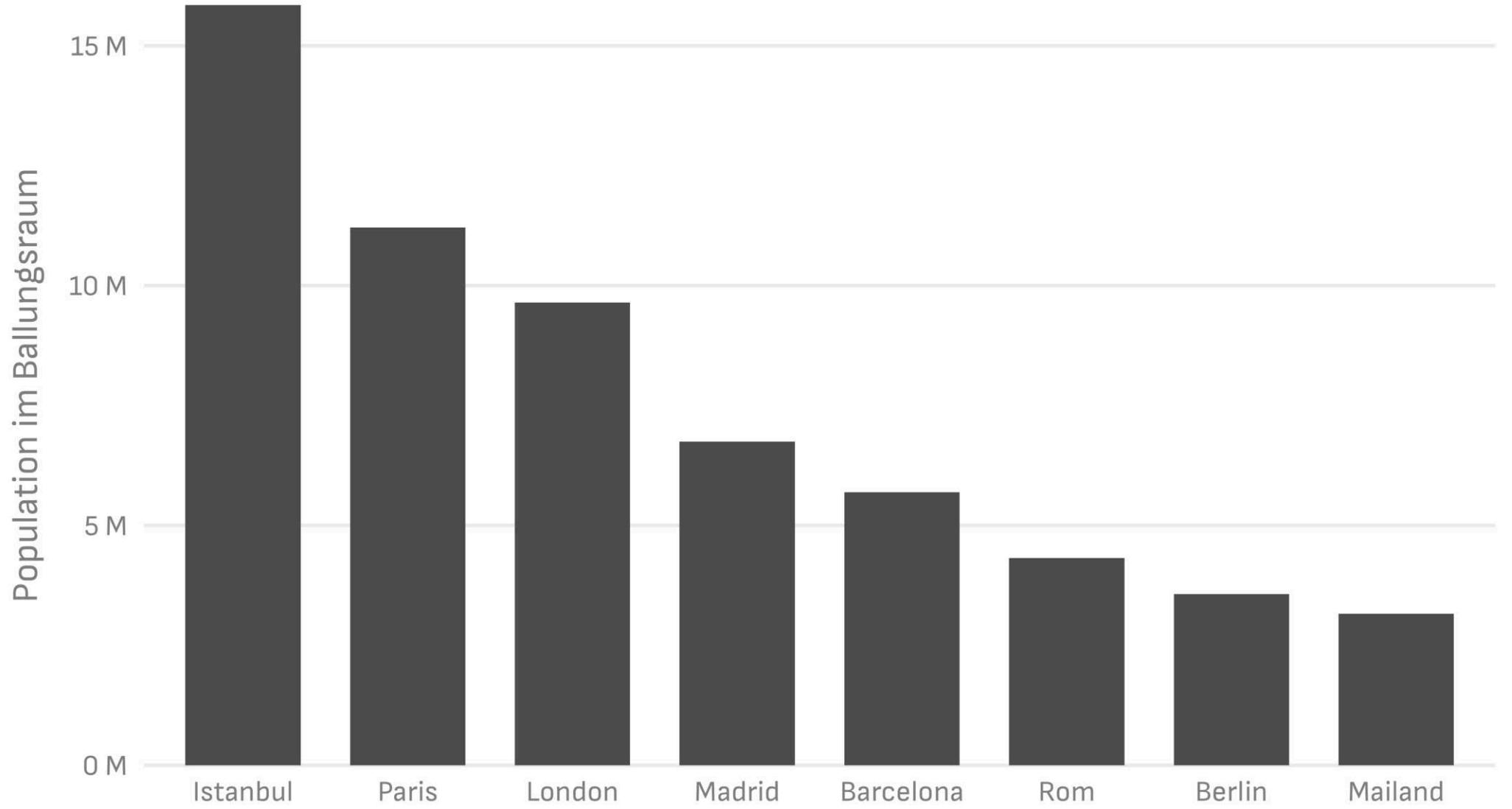
## Population in Europa (Stand: 2023)





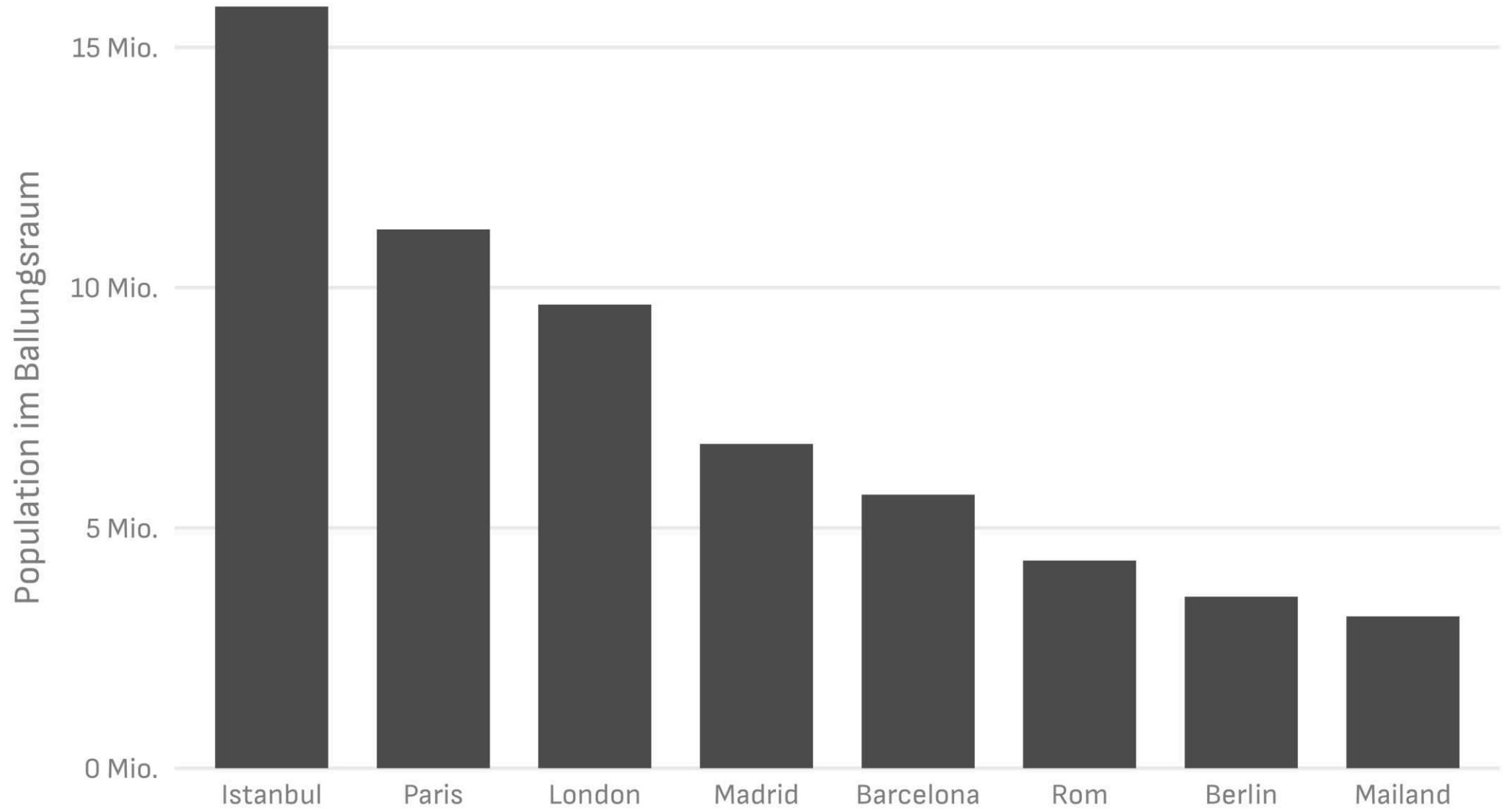
Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)





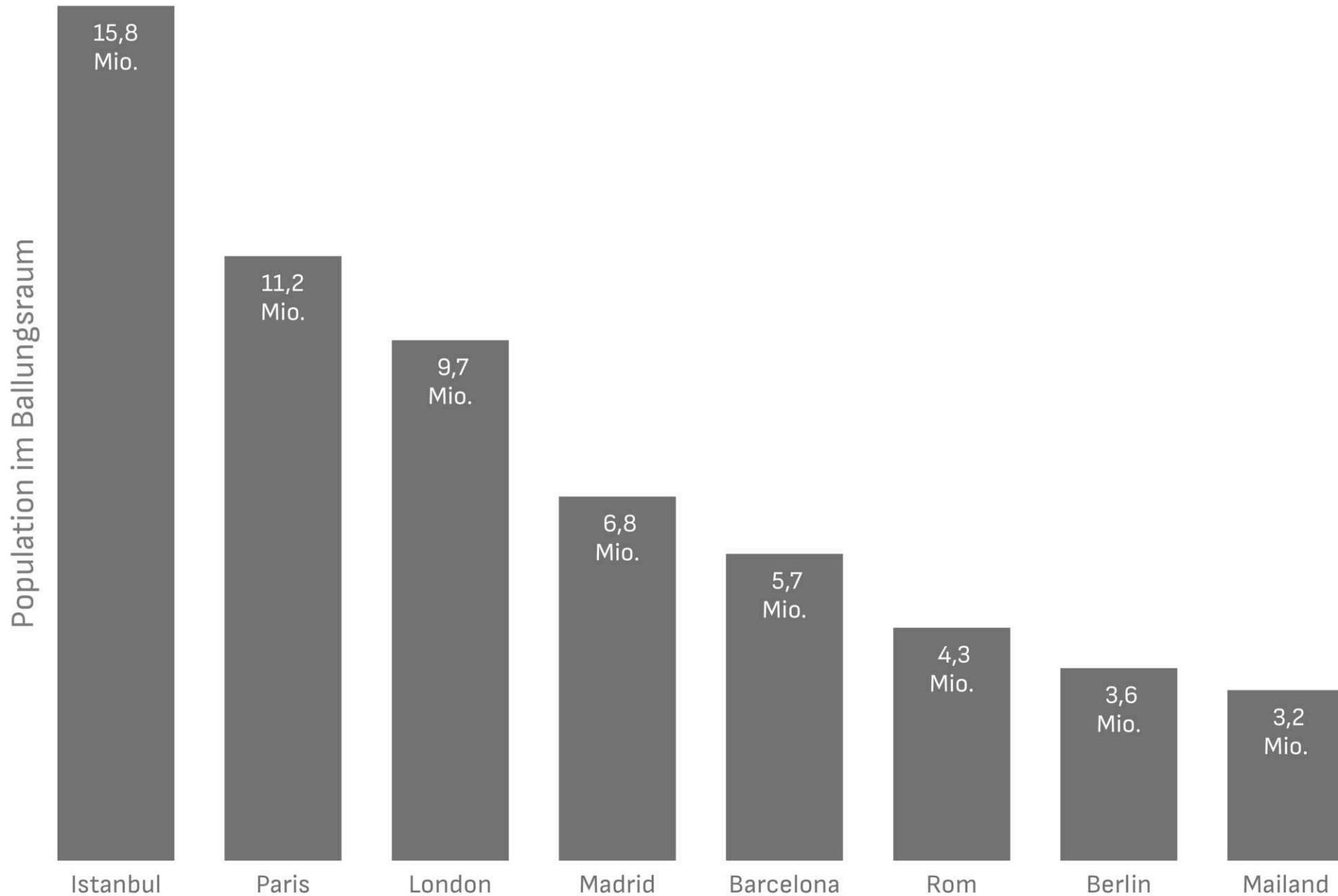
Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)





Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)

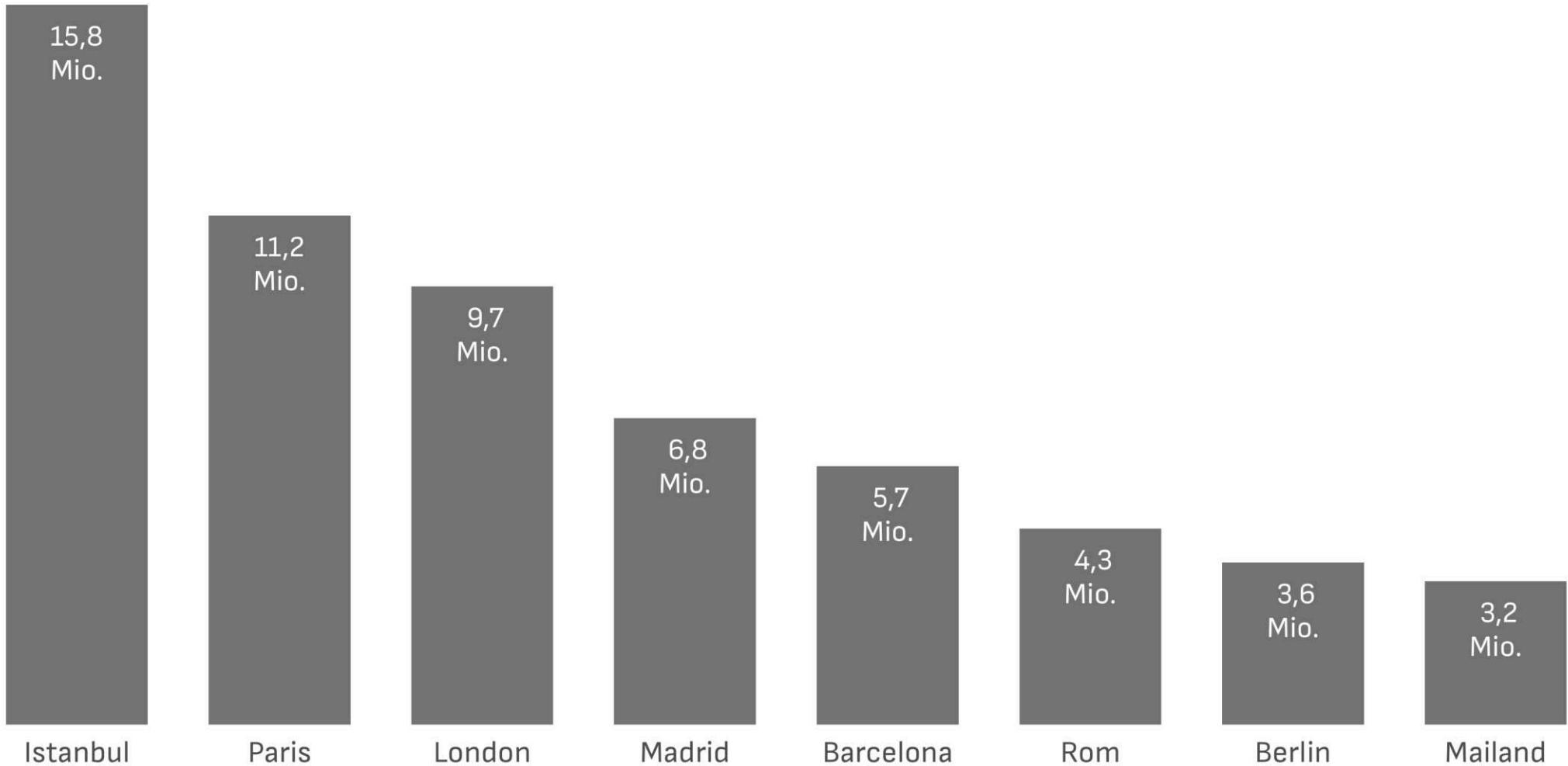




Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)



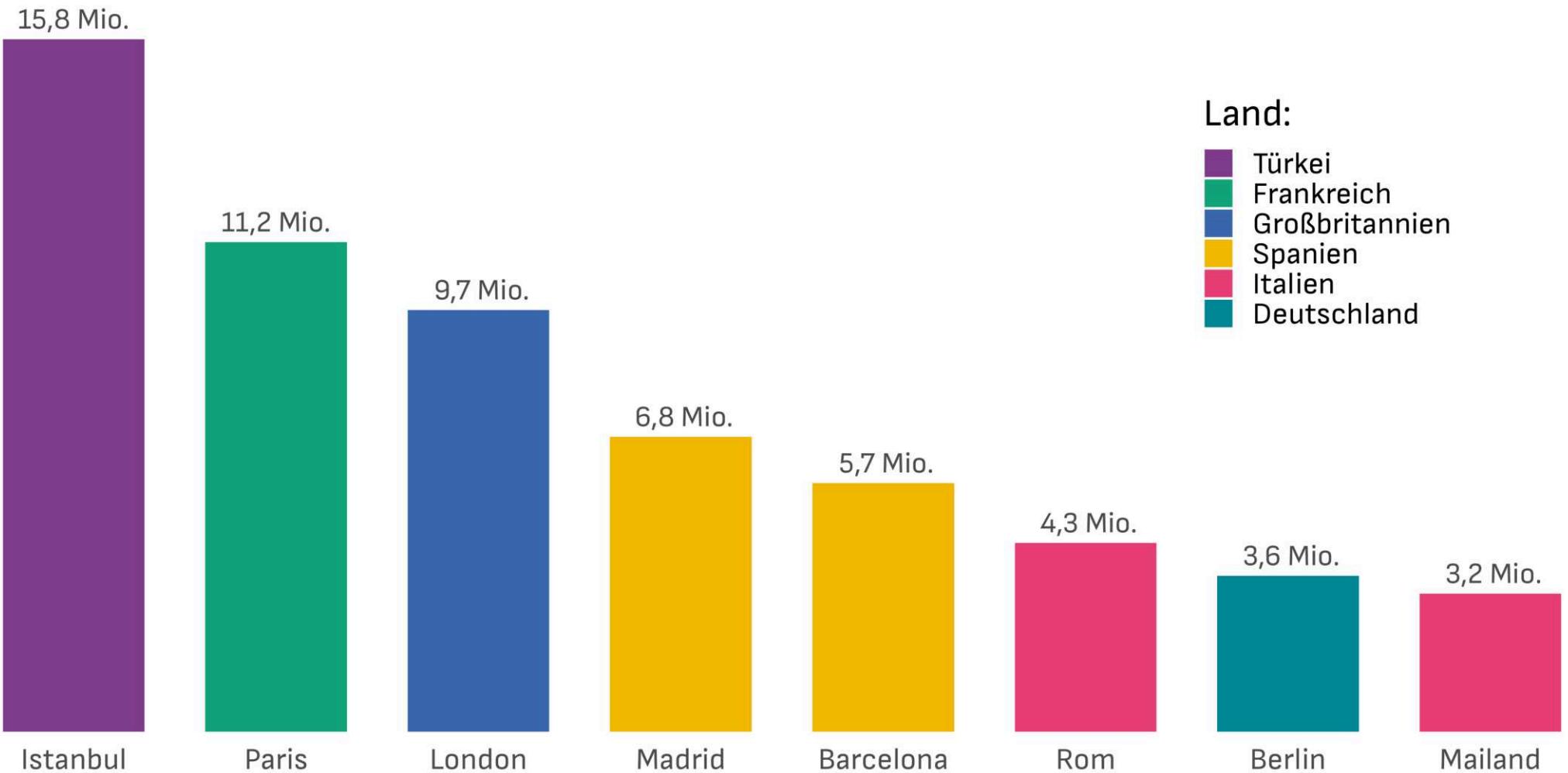
# Die bevölkerungsreichsten Ballungsräume Europas



Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)



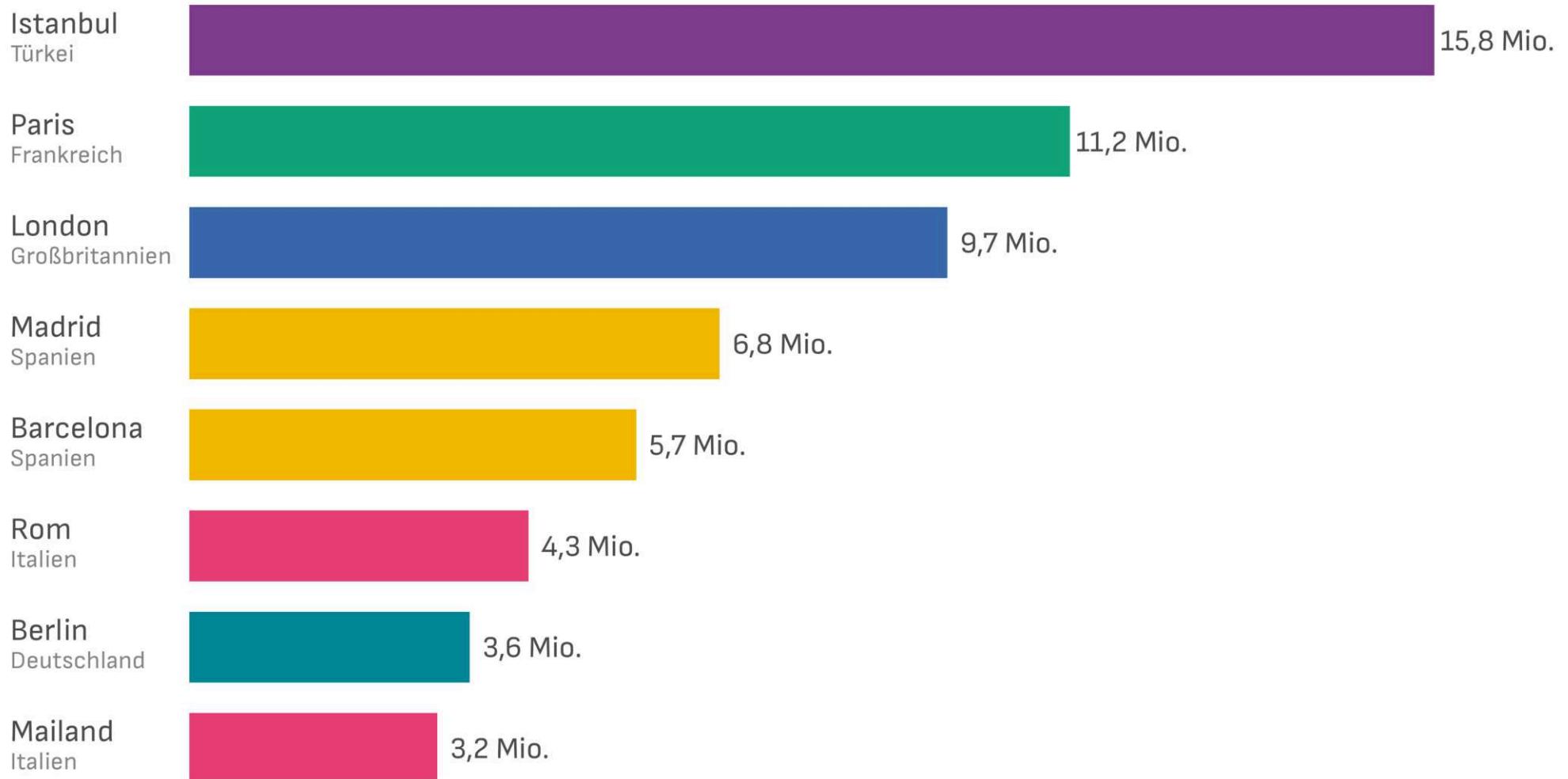
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Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)



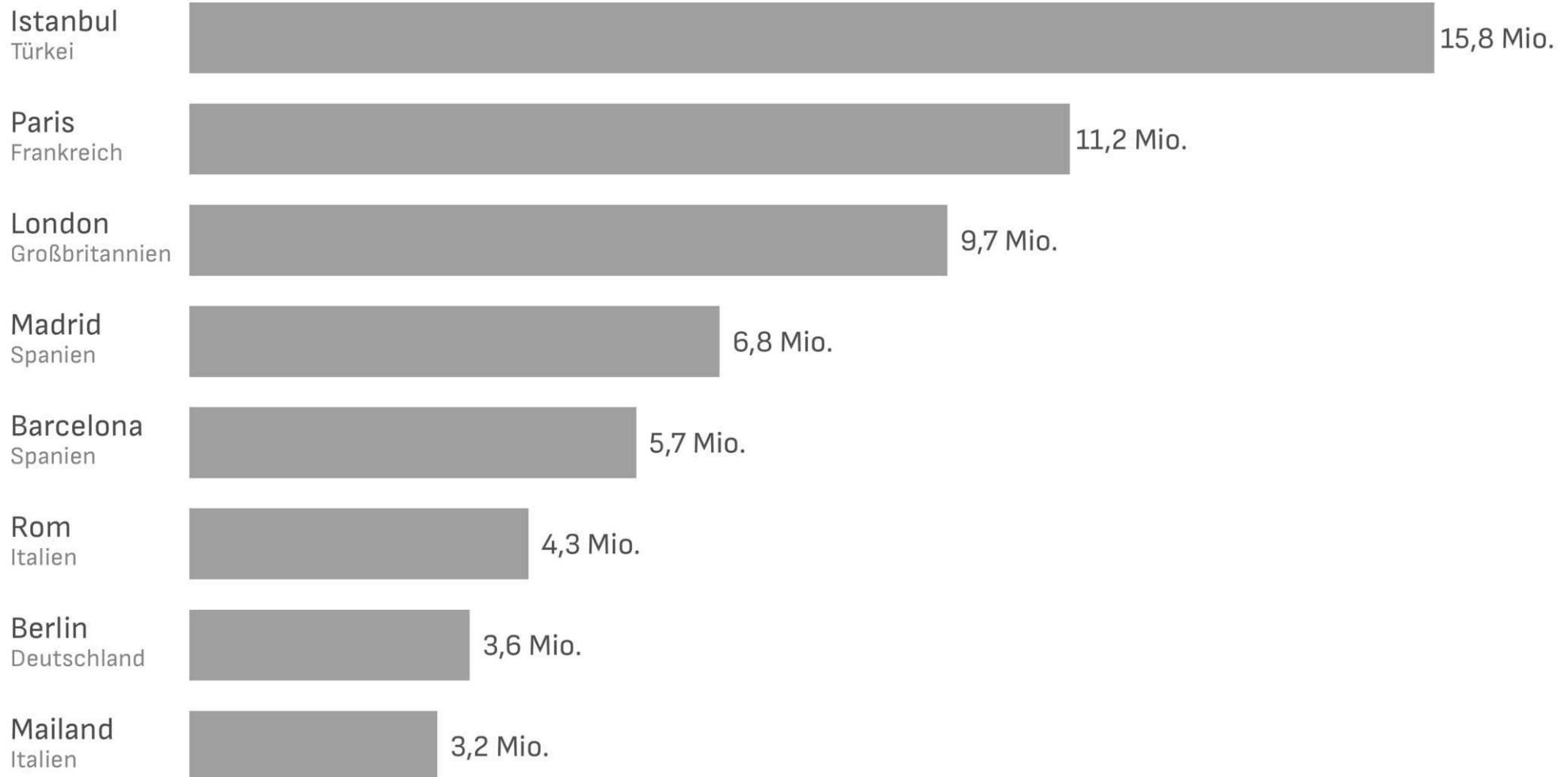
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Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)



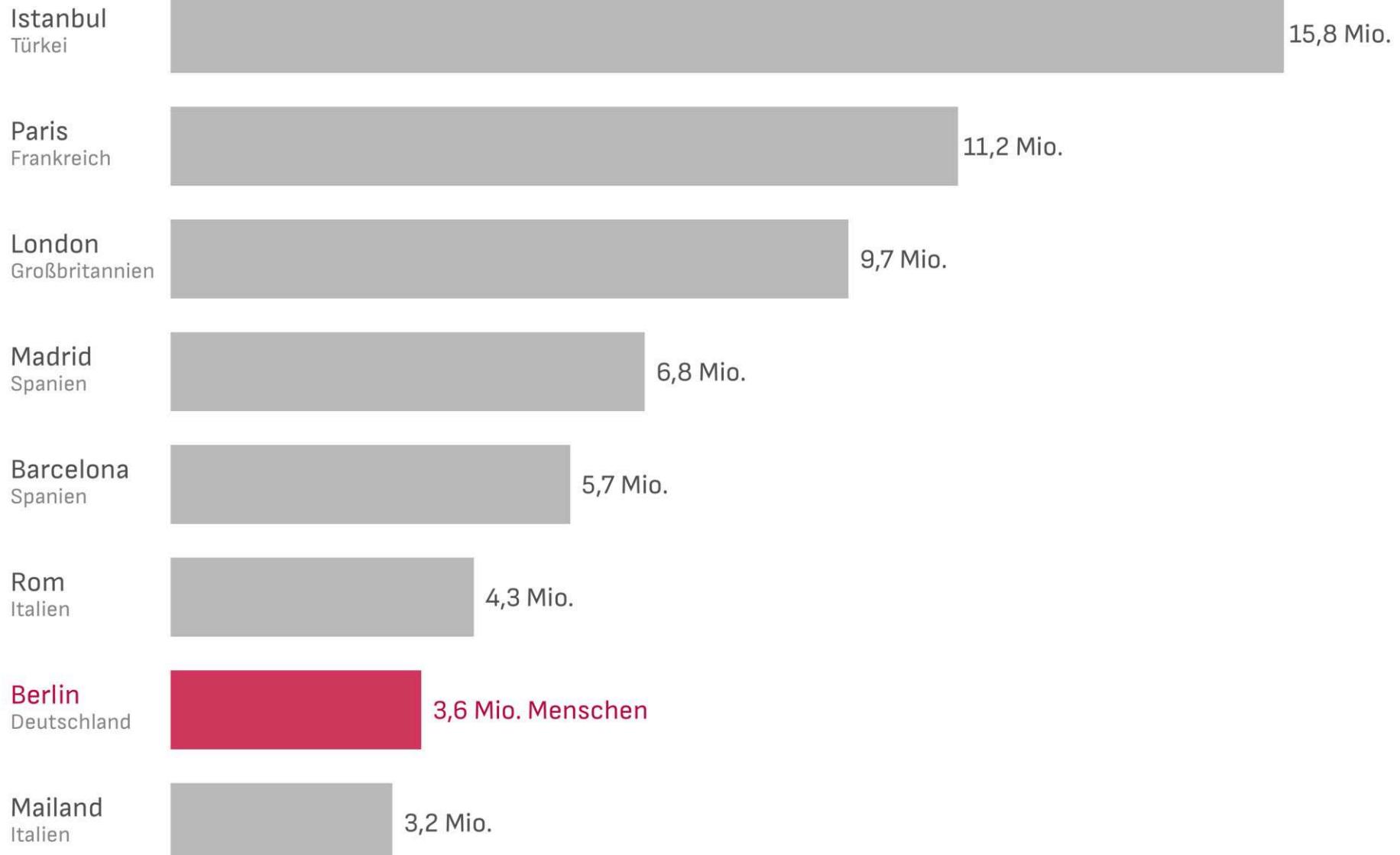
# Die bevölkerungsreichsten Ballungsräume Europas



Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)



## Bei den bevölkerungsreichsten Ballungsräume Europas rangiert Berlin auf Platz 7

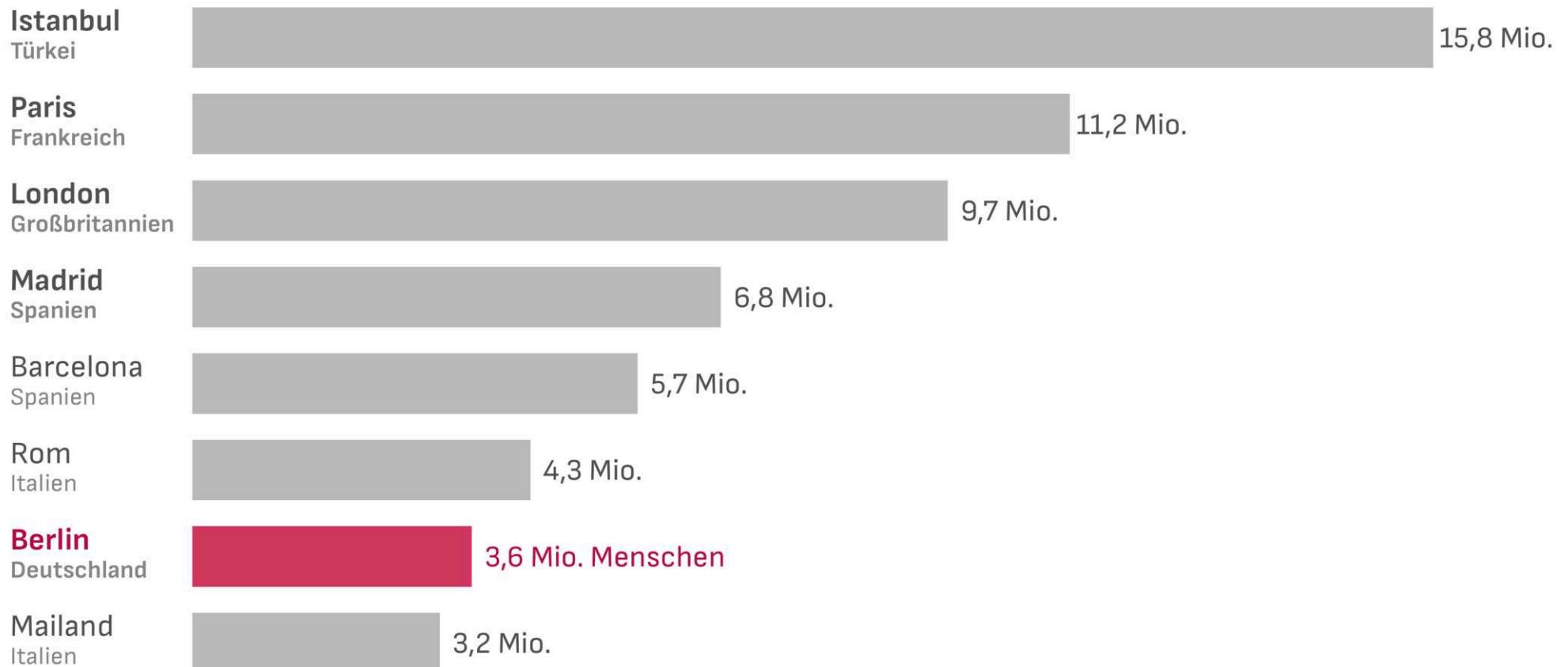


Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)



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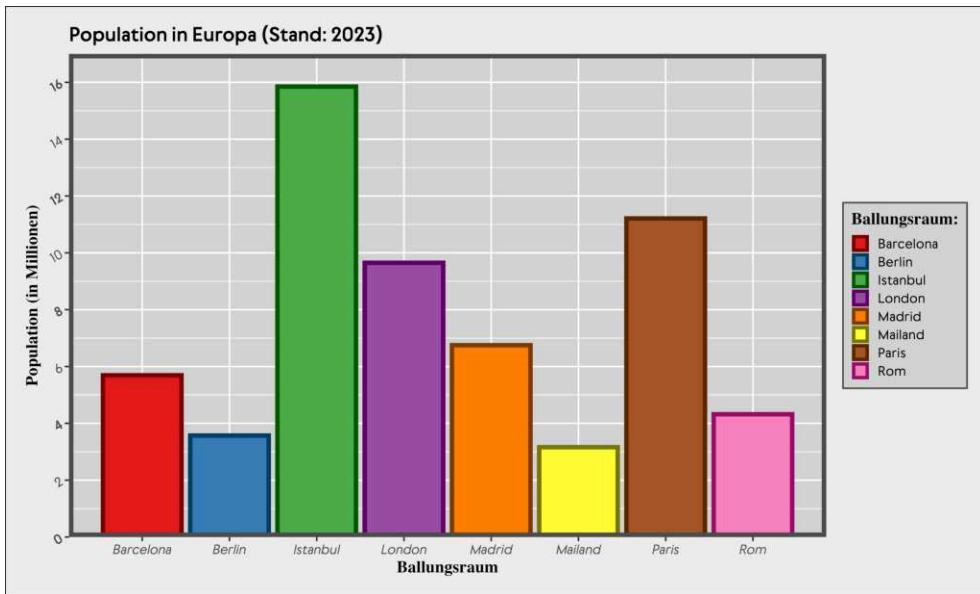
Die Hauptstadtregion Deutschlands liegt mit 3,6 Millionen Menschen deutlich hinter **Istanbul und den Hauptstadtmetropolen Frankreichs, Großbritanniens und Spaniens** — aber nur knapp hinter der Italiens.



Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN (Stand 2023)

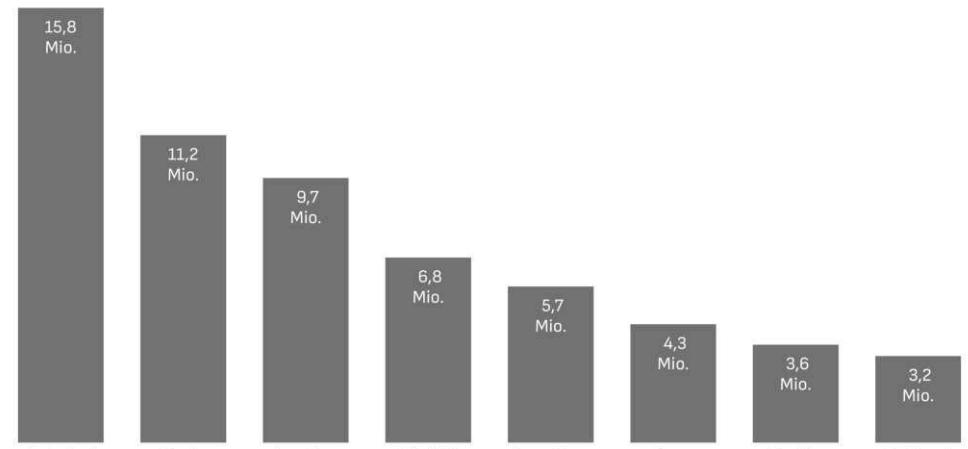


# Vorher



# Nachher

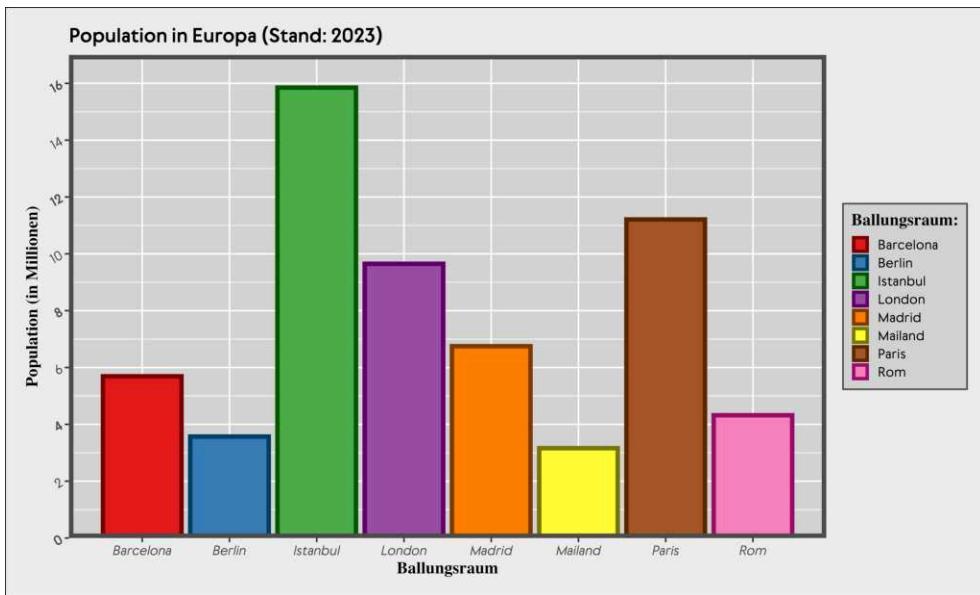
Die bevölkerungsreichsten Ballungsräume Europas



Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN [Stand 2023]

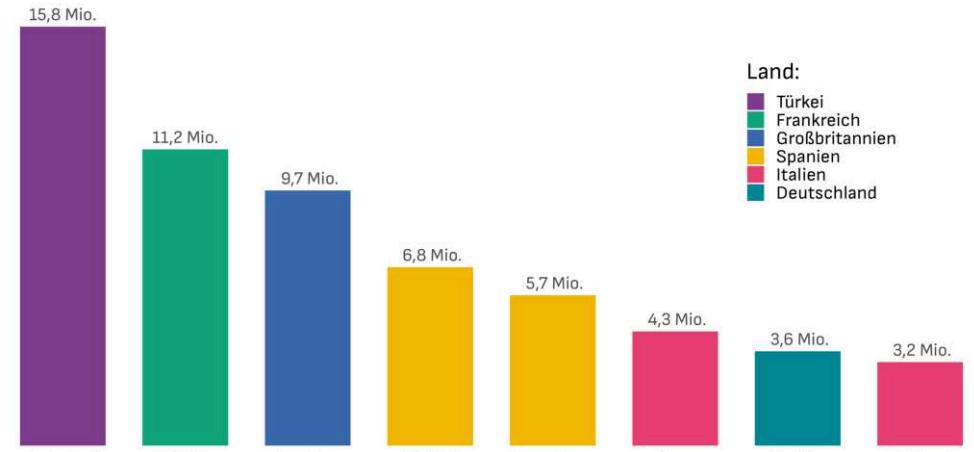


# Vorher



# Nachher

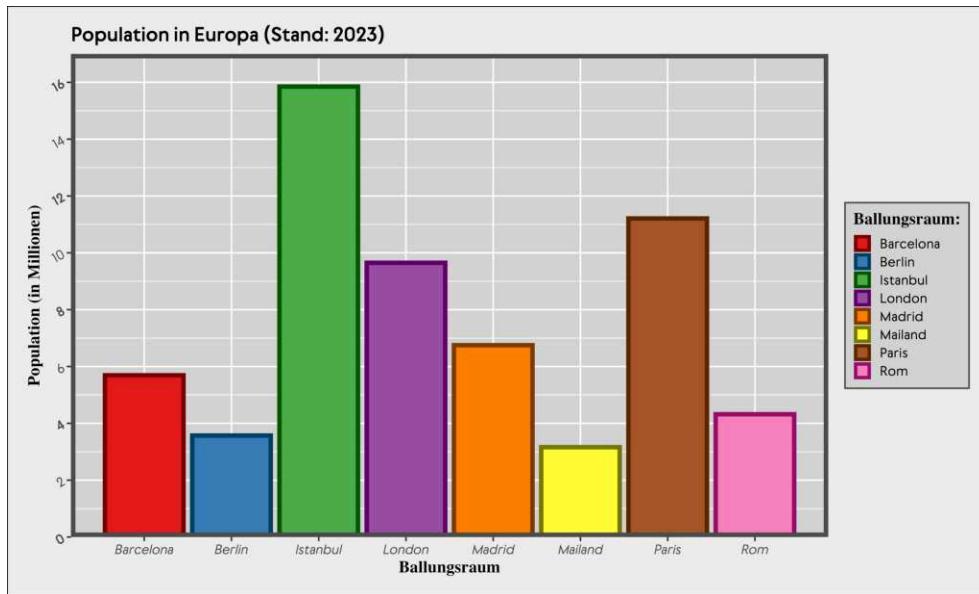
Die bevölkerungsreichsten Ballungsräume Europas



Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN [Stand 2023]



# Vorher



# Nachher

## Bei den bevölkerungsreichsten Ballungsräume Europas rangiert Berlin auf Platz 7

Die Hauptstadtregion Deutschlands liegt mit 3,6 Millionen Menschen deutlich hinter Istanbul und den Hauptstadtmetropolen Frankreichs, Großbritanniens und Spaniens — aber nur knapp hinter der Italiens.



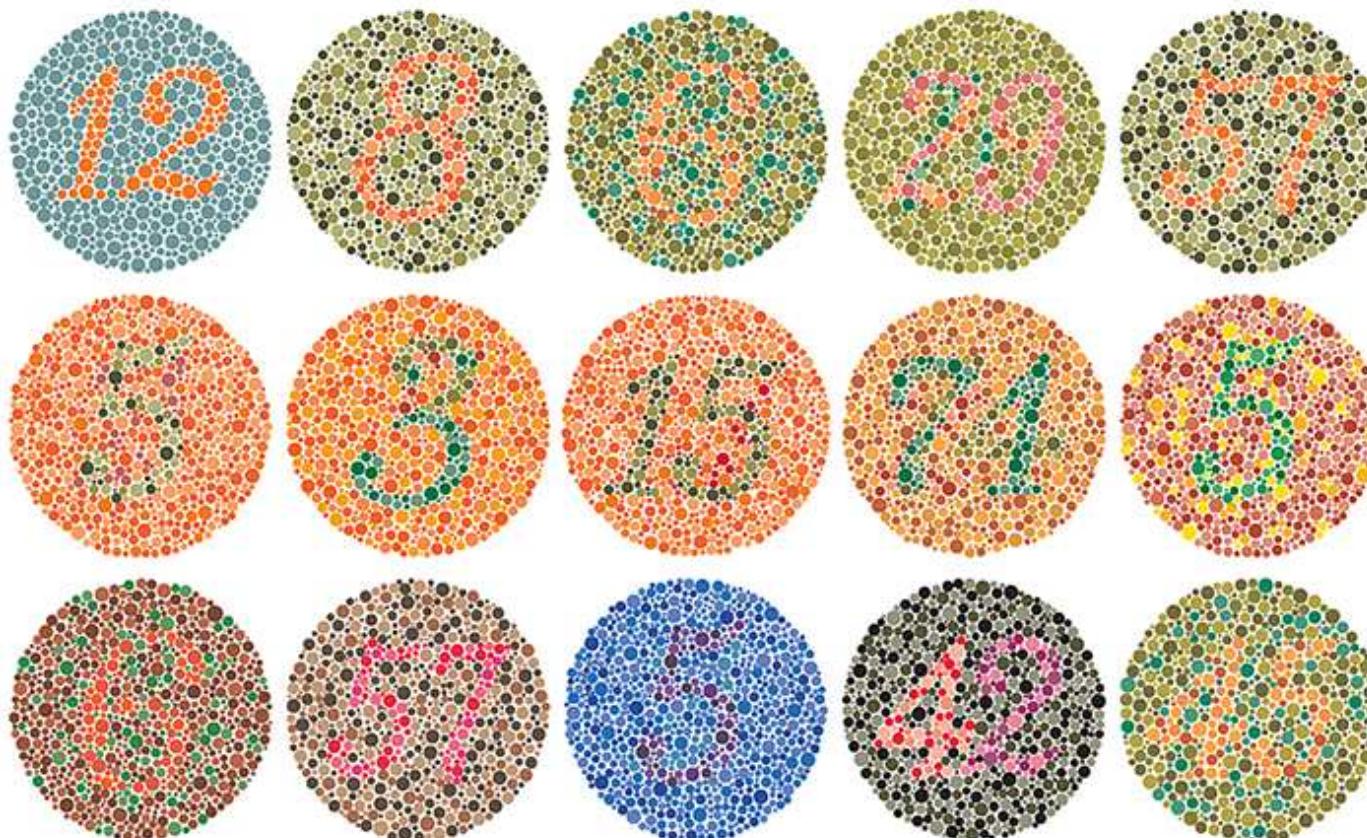
Quelle: Hauptabteilung Wirtschaftliche und Soziale Angelegenheiten der UN [Stand 2023]



# Farbsehschwächen



# Gestalten für Menschen mit Farbsehschwächen

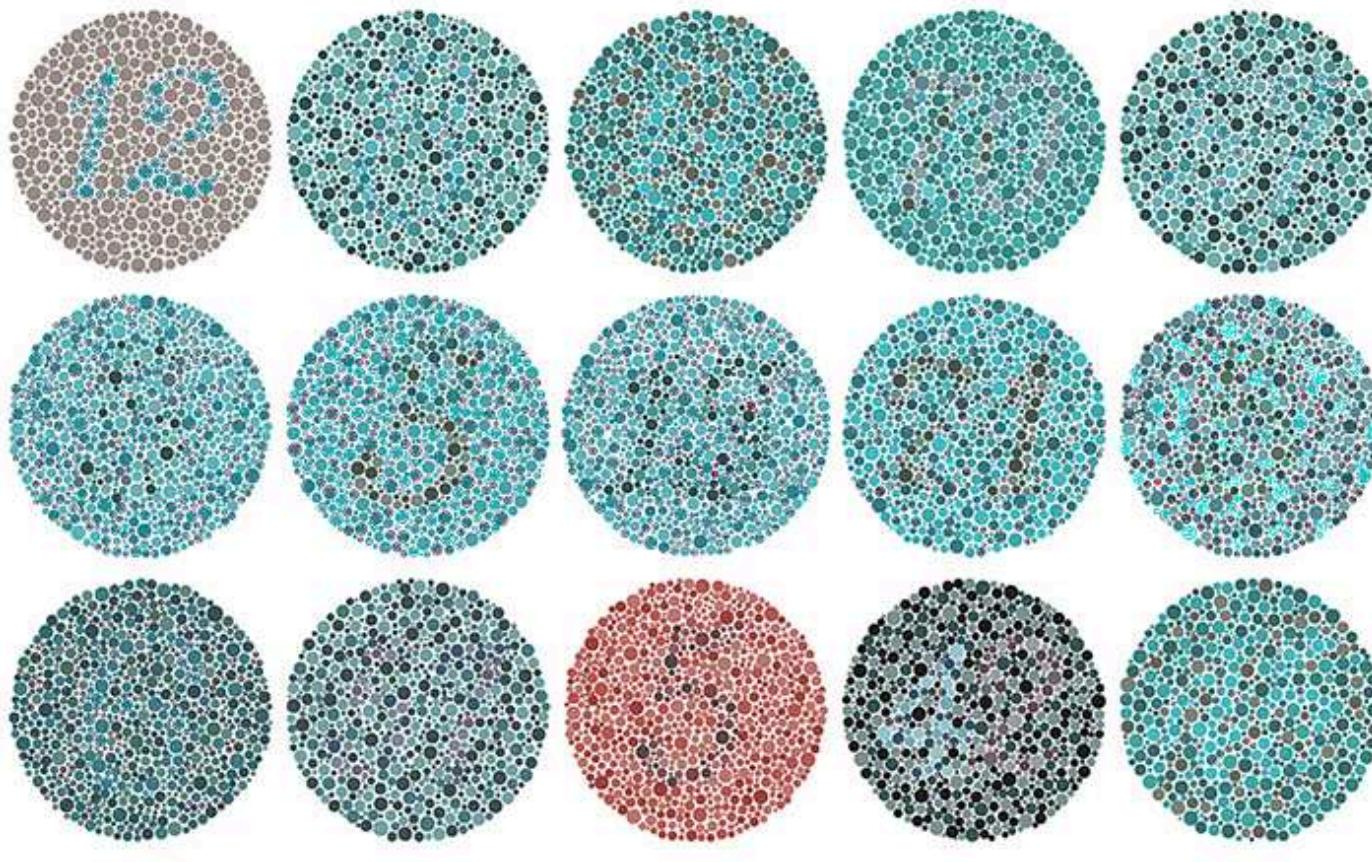


Source: Sarjak Thakkar

Cédric Scherer Data Visualization & Information Design



# Gestalten für Menschen mit Farbsehschwächen



Source: Sarjak Thakkar

Cédric Scherer Data Visualization & Information Design



# Gestalten für Menschen mit Farbsehschwächen

original



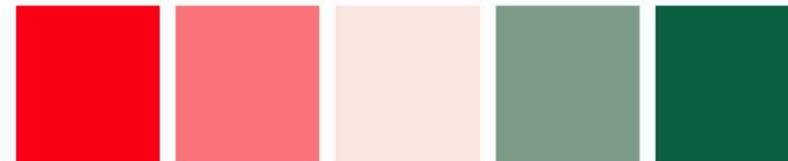
deuteranomaly



protanomaly



tritanomaly



original



deuteranomaly



protanomaly



tritanomaly



Source: "Fundamentals of Data Visualization" by Claus O. Wilke

Cédric Scherer Data Visualization & Information Design



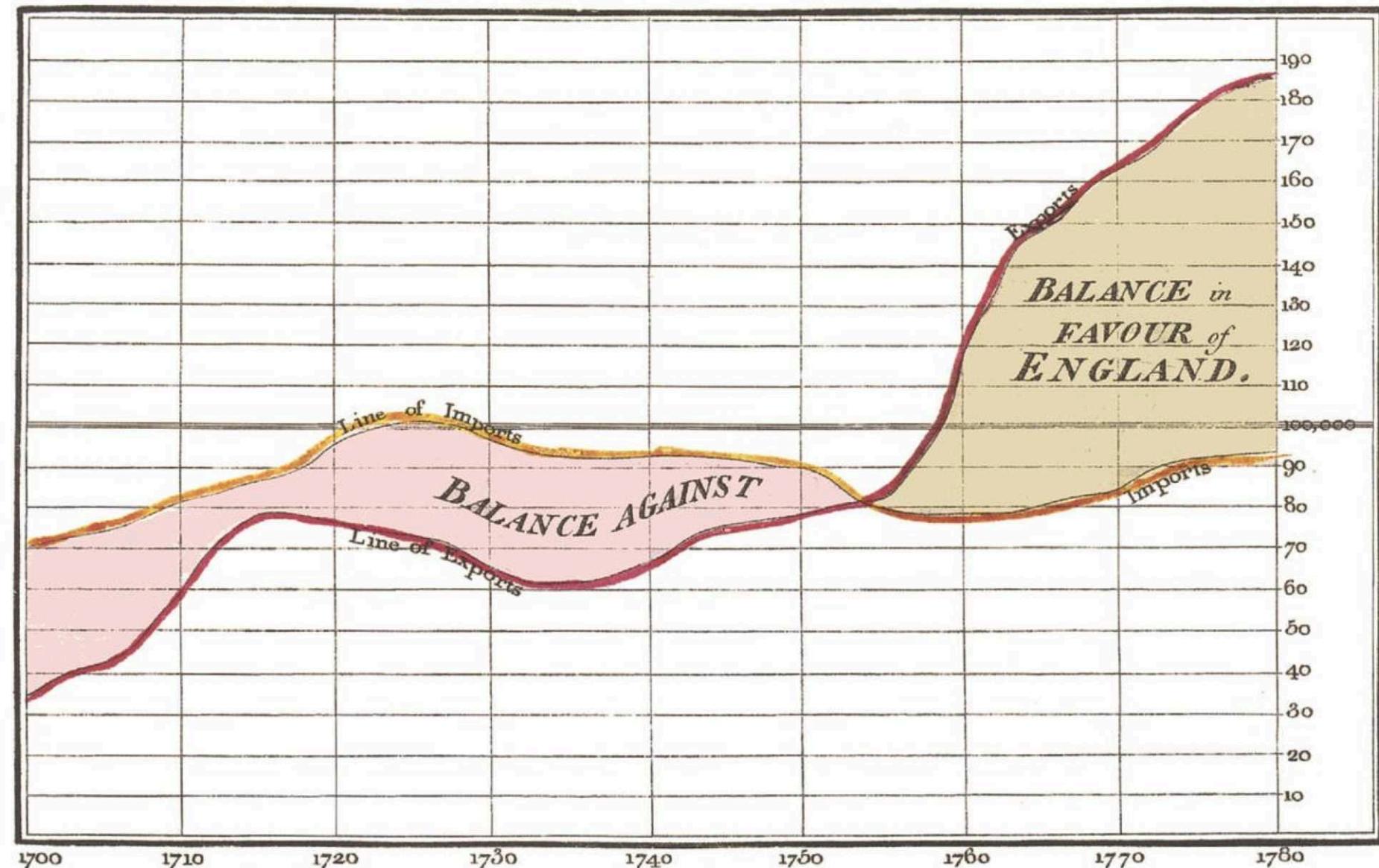
# Teste Farbpaletten!

- **SimDaltonism**
- **ColourSimulations**
- **Coblis**
- **Color Oracle**
- **Vischeck**
- **colorBlindness package für R**





Exports and Imports to and from DENMARK & NORWAY from 1700 to 1780.



Time series with annotations by William Playfair from "The Commercial and Political Atlas and Statistical Breviary" (1786)



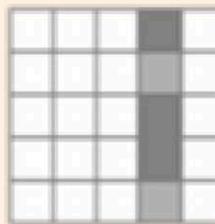
## The Brexit banking matrix: The contenders lining up for London's crown

Bank

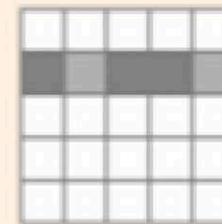
Branch

Other\*

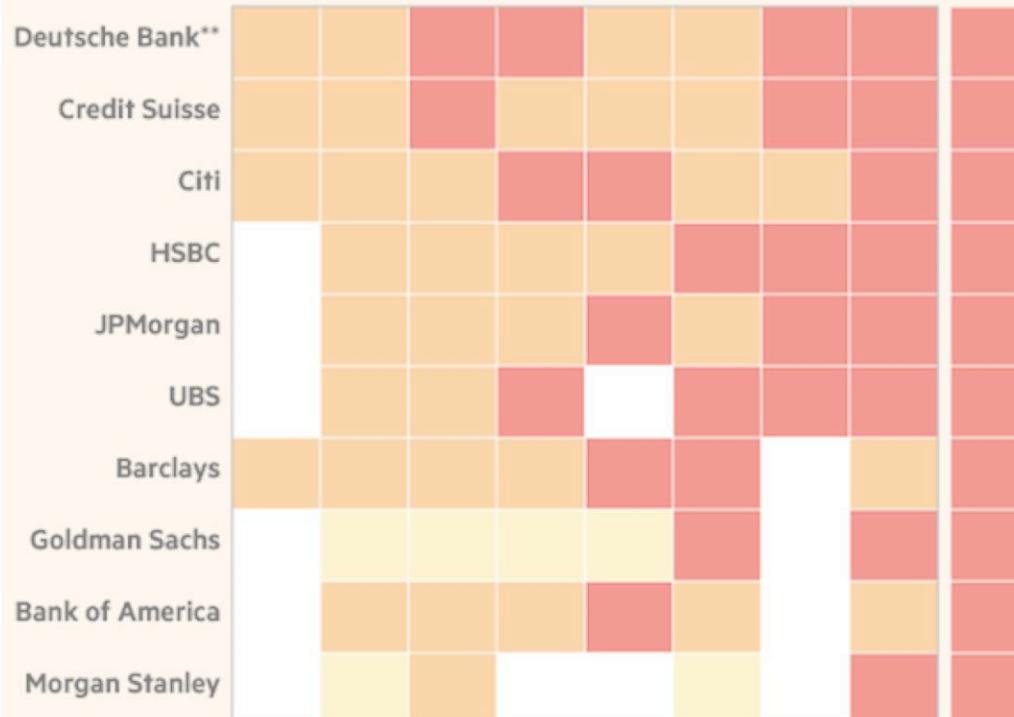
The highest level  
of presence in  
each city



Darker columns  
indicate strong  
presence in  
a city



Darker rows  
indicate broad  
presence of  
a bank



\* Broker dealer branches are included for Morgan Stanley and Goldman Sachs as they are a significant part of their European network

\*\* Deutsche Bank has a London subsidiary but its main entity is a branch

FT graphic Alan Smith, Laura Noonan Source: FT research

FT

"Frankfurt vies for UK banking jobs post-Brexit" by Alan Smith & Laura Noonan (Financial Times)

Cédric Scherer Data Visualization & Information Design



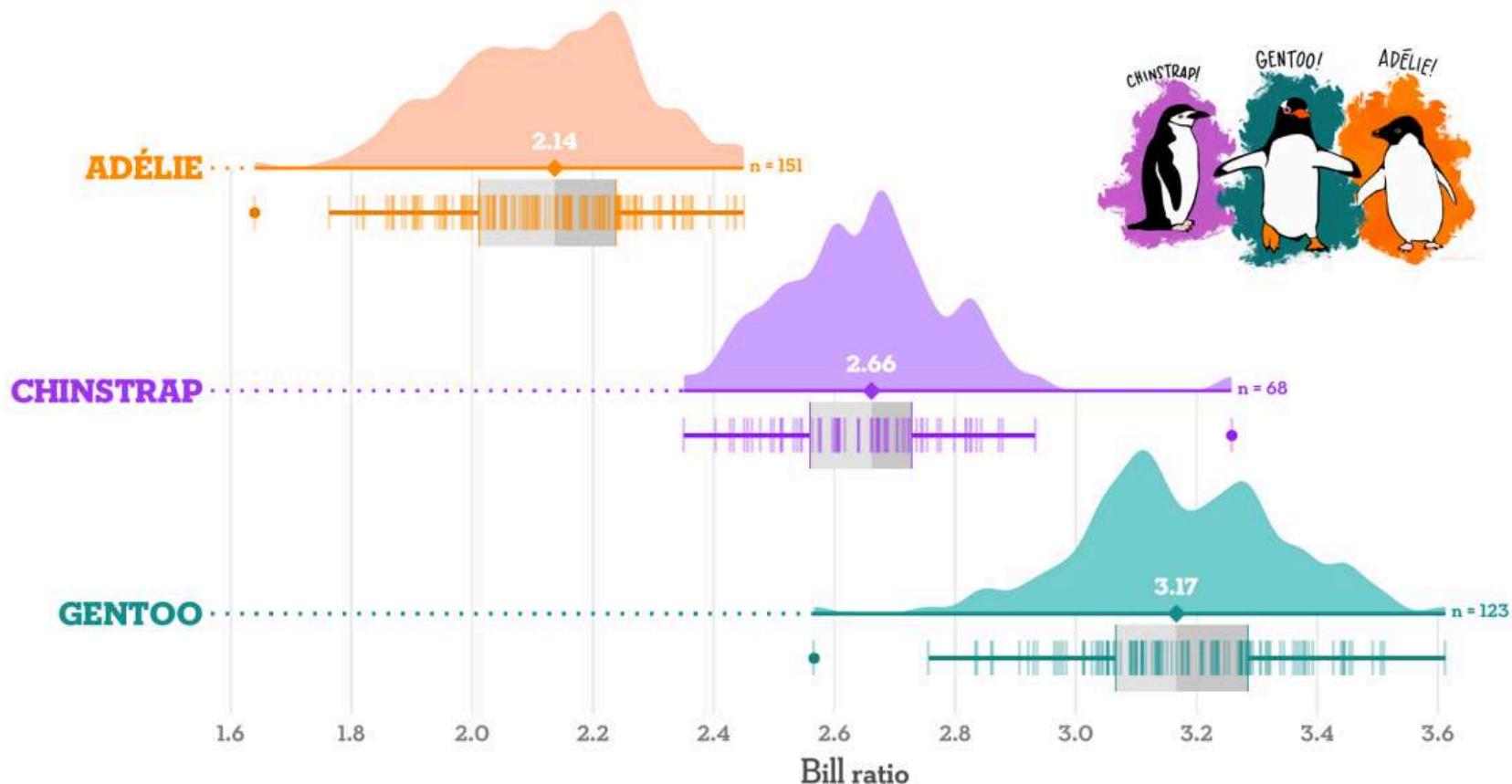
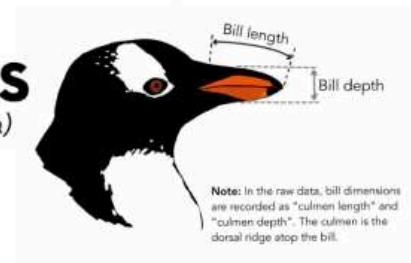
# Supplementary supermarket shopping



# BILL DIMENSIONS OF BRUSH-TAILED PENGUINS

*Pygoscelis adélieae* (Adélie penguin) • *P. antarctica* (Chinstrap penguin) • *P. papua* (Gentoo penguin)

Distribution of the bill ratio, estimated as bill length divided by bill depth



Note: In the original data, bill dimensions are recorded as "culmen length" and "culmen depth". The culmen is the dorsal (upper) ridge of a bird's bill.  
Visualization: Cédric Scherer • Data: Gorman, Williams & Fraser (2014) DOI: [10.1371/journal.pone.0090081](https://doi.org/10.1371/journal.pone.0090081) • Illustrations: Allison Horst

Modified #TidyTuesday Contribution | Images: Allison Horst

Cédric Scherer Data Visualization & Information Design



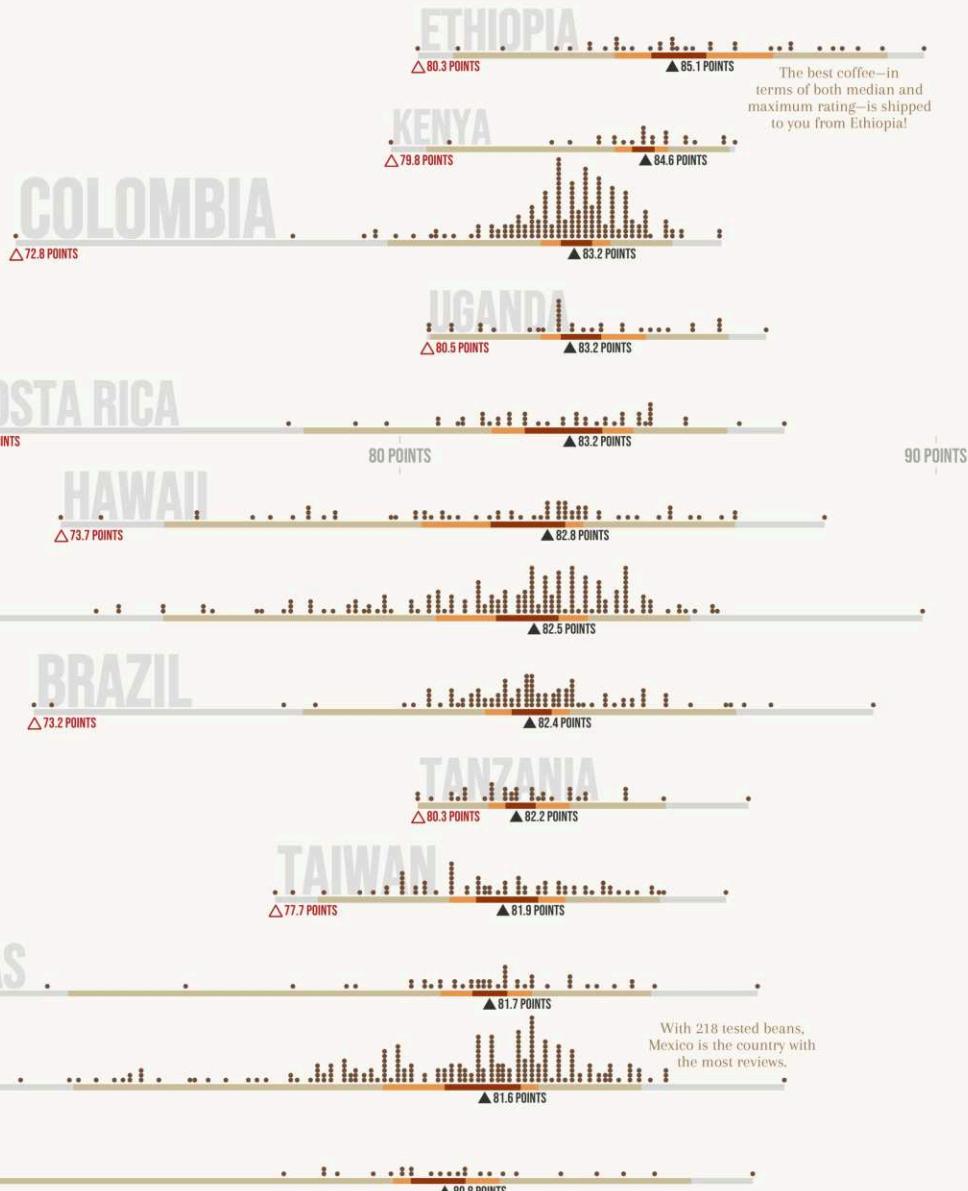
## **Not my cup of coffee...**

Each dot depicts one coffee bean rated by Coffee Quality Institute's trained reviewers. In addition, the multiple interval stripes show where 25%, 50%, 95%, and 100% of the beans fall along the rating gradient from 0 to 100 points. The rated coffee beans range from 59.8 points (Guatemala) to 89.9 (Ethiopia). Only countries of origin with 25 or more tested beans are shown. The red empty triangle marks the minimum rating, the black filled triangle indicates each country's median score.

Visualization by Cédric Scherer



The coffee bean with the lowest rating has its origin in Guatemala.



**“Not my Cup of Coffee” (#TidyTuesday Contribution)**

Cédric Scherer Data Visualization & Information Design



# 100 Years of Streamflow Droughts

These are the 1000 most severe streamflow droughts at gages from 1920 to 2020 by region and decade.

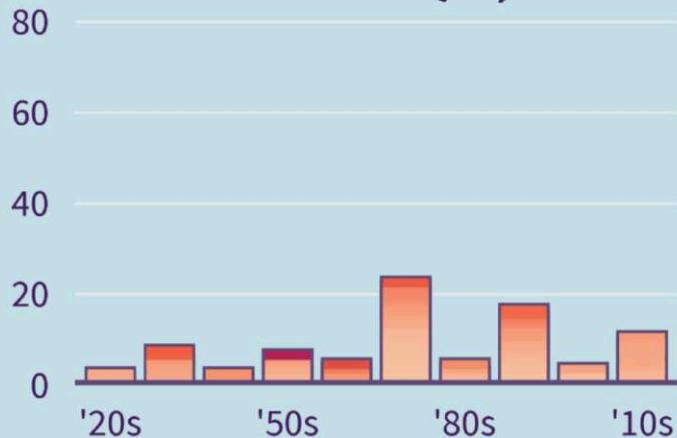
Northwest 

North Central 

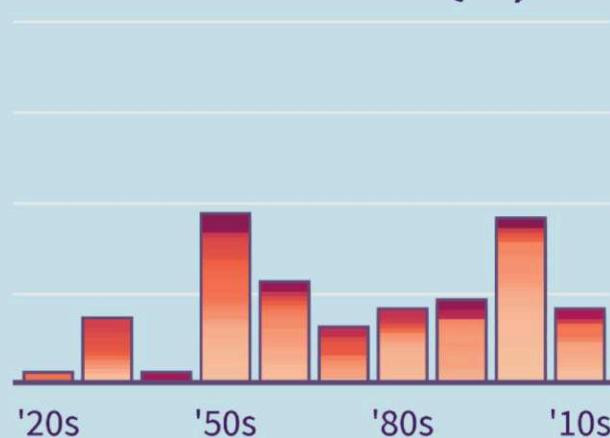
Midwest 

Northeast 

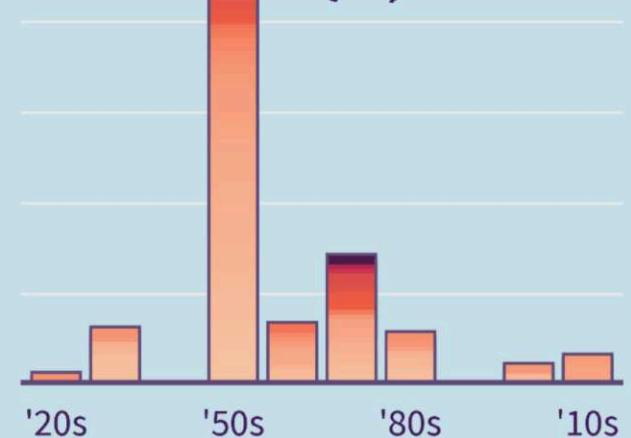
## Northwest



## North Central

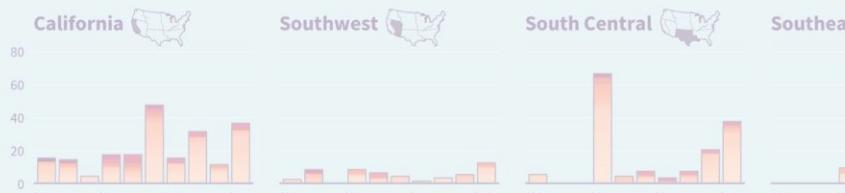


## Midwest

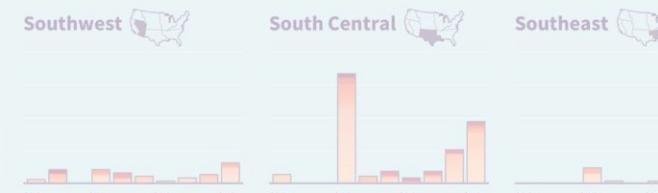


The most severe streamflow drought in this gage record happened in California. It was also the longest, lasting from March 10, 1924 to February 12, 1926.

California 



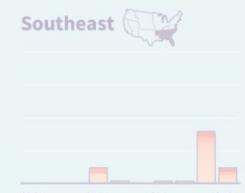
Southwest 



South Central 



Southeast 



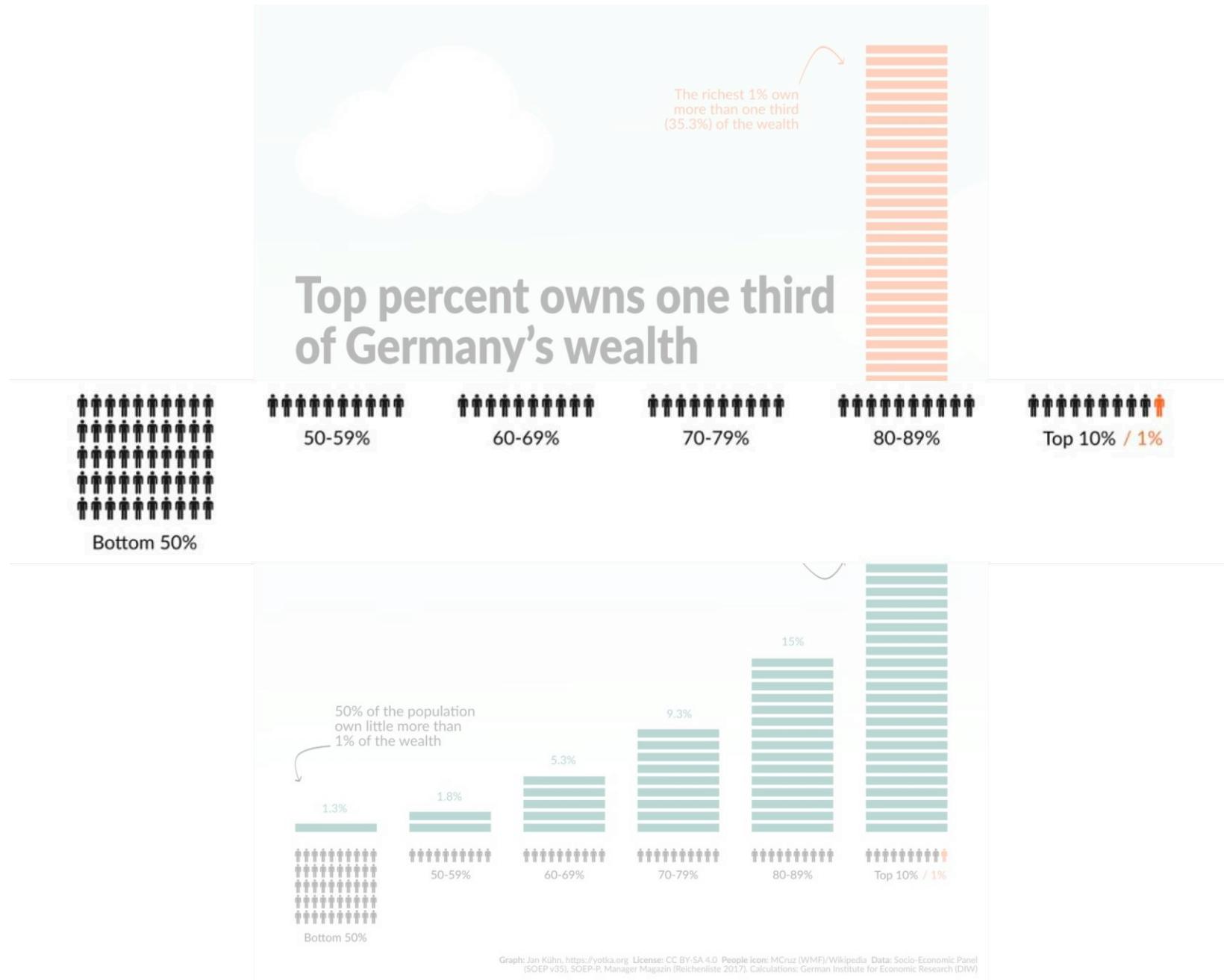
USGS  
U.S. Geological Survey

Chart by Cédric Scherer. Data based on streamflow gage records from 3,196 gauges (purple dots) assessed from 1920 to 2020: <https://doi.org/10.5066/P92FAASD>. Colored points represent gauges with the most severe streamflow droughts, which were defined with 2% variable 7-day thresholds.

"100 Years of Streamflow Drought", in collaboration with USGS

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Quelle: Jan Kühn

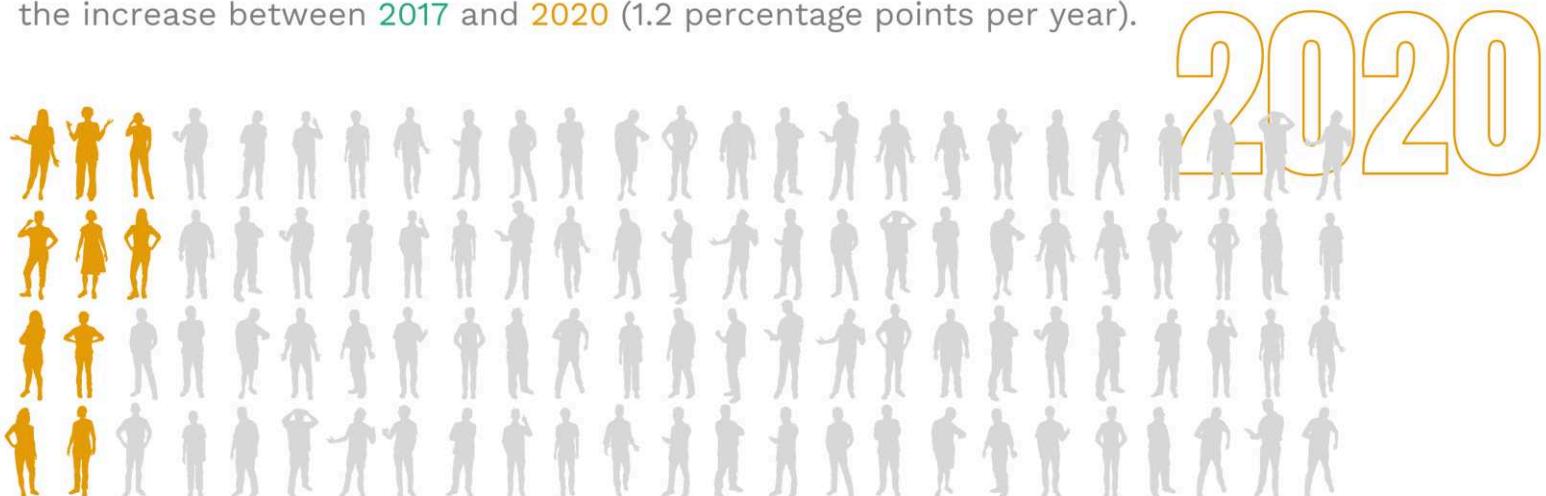
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# The proportion of female chairs in board or CEOs in German companies remains vanishingly low



If the growth continues at the same pace, it will take more than 30 years to achieve gender parity on Germany's boards, assuming a linear progression of the increase between **2017** and **2020** (1.2 percentage points per year).



Visualization: Cédric Scherer | Data Source: BCG Gender Diversity Index 2017 and 2020 | Silhouettes: Wee People by ProPublica  
#30DayChartChallenge 2021 | Day 2: Pictogram

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# **Special Topic: Graphical Abstracts**



# A well-designed graphical abstract...

- is an **advertisement for your paper**
- shows the key points, not the full story
- attracts interest by standing out in the TOC or image search
- helps readers decide if they want to read the entire article
- is distinct from figures and diagrams in the paper—do not simply use a figure from your manuscript



# Golden Rules

1. Focus on the Message
2. Guide the View with Visual Hierarchy
3. Show Just Enough Detail
4. Maintain a Unified Visual Language
5. Ensure Readability & Accessibility



# Focus on the Core Message



## Checklist

- ☐ Identify the **one key message** before designing.  
Avoid competing **focal points** that dilute the core idea.  
Remove **unnecessary parts** that do not support the message.



# Guide the View with Visual Hierarchy

## Checklist

Use **size and boldness** to highlight key elements.

Arrange elements **logically** (e.g., left to right, top to bottom).

Use **color and contrast** intentionally, not just as decoration.



# Show Just Enough Detail

## Checklist

Keep visuals **clean and minimal**—remove excess labels, text, and decorative elements.

Use **simplified illustrations** rather than complex images.

Provide only **essential data**, not full datasets or detailed metrics.



# Maintain a Unified Visual Language

## Checklist

Ensure **consistent fonts and icon styles**.

Choose a **limited color palette** that enhances readability.

**Avoid mixing** different illustration styles and palettes.



# Ensure Readability and Accessibility



## Checklist

Set text in a **large, readable typefaces**—  
do not make use of decorative or overly small text.

Ensure **sufficient contrast** for readability.



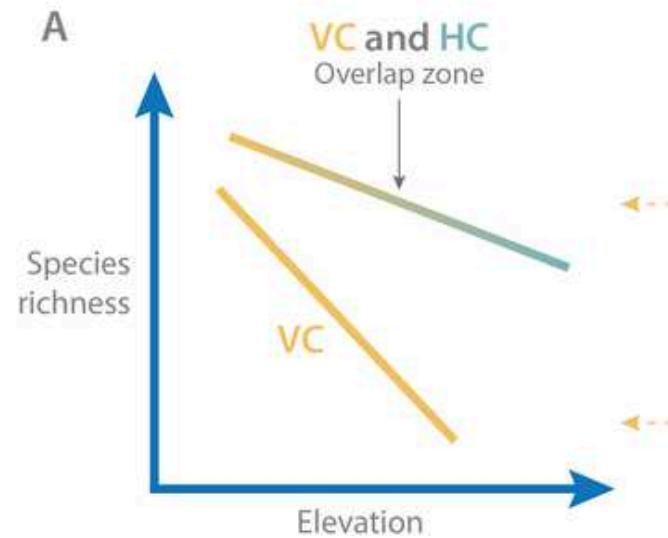
Design with the **colorblind** in mind—  
test your graphics with CVD simulators.



## Vertical colonization (VC)



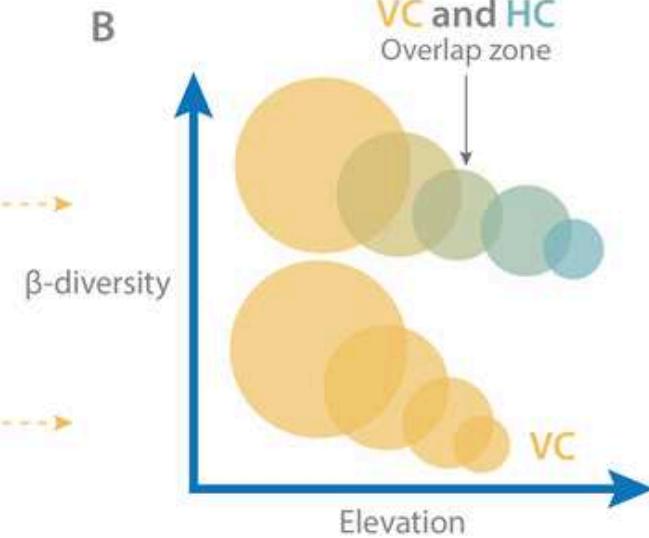
A



Larger spatial replacement

Larger richness differences

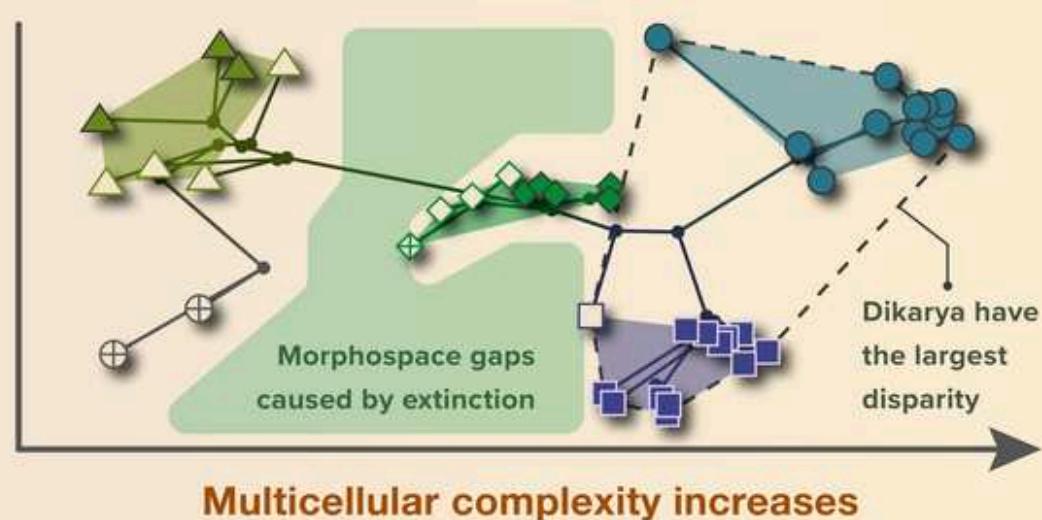
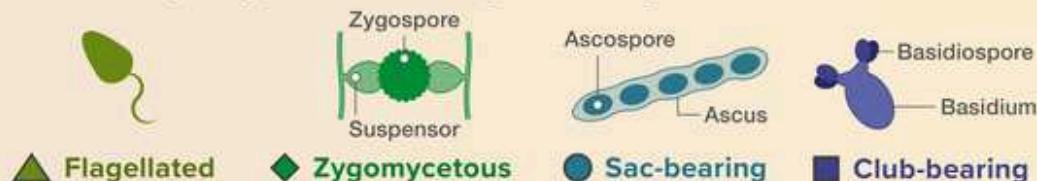
B



# How did fungi evolve their amazing anatomical variety of today?

We found that four morphotypes define the disparity of fungi

These morphotypes are distinguished by cellular characters



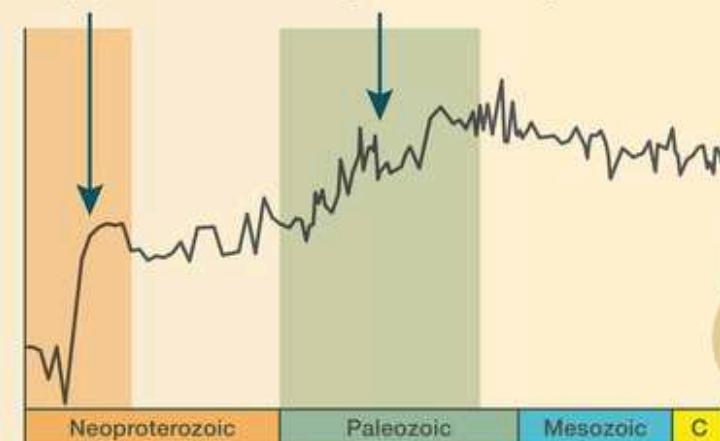
Fungal disparity expands episodically through time

End-Tonian

First multicellular body plans

Cambrian- Carboniferous

Diversification of complex fruiting bodies in Dikarya



Increases in disparity relate to **organismal complexity**, not gene number, genome size or taxonomic diversity

Increasing their multicellular complexity coincided with a drastic increase in fungal anatomical variety



# Übungsteil



# Übung

Schau dir die Datenvisualisierung „How People Get Their News“ genau an.

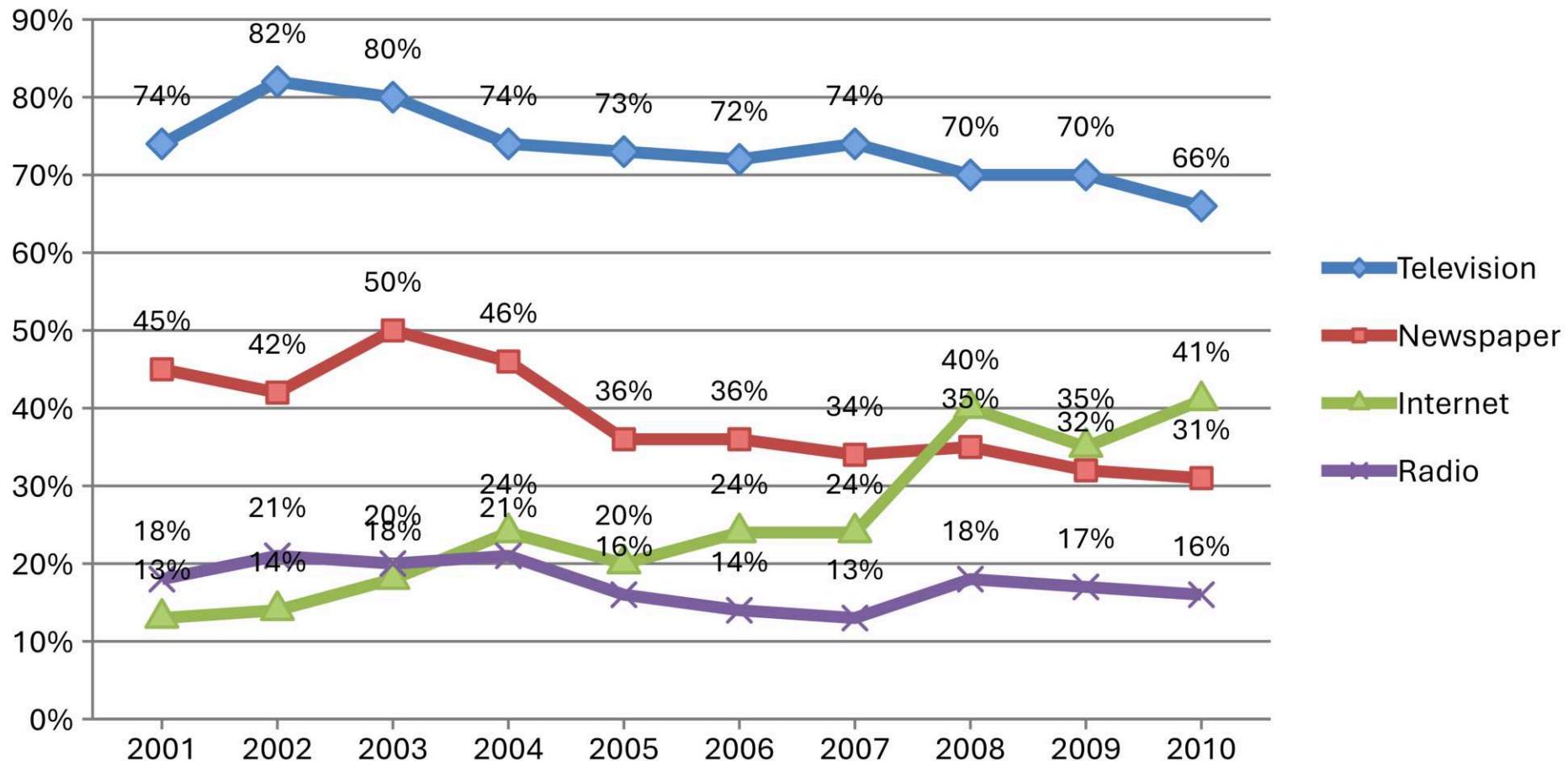
- Was ist die zentrale Botschaft der Grafik?
- Sind alle Informationen relevant?
- Welche Details lenken dich als Betrachter:in ab?

Verbessere die Grafik, um den Fokus zu schärfen.

- Entferne überflüssige Elemente.
- Nutze präattitive Merkmale, um die Hauptaussage hervorzuheben.
- Formulierte einen Titel, der die Botschaft wiedergibt.



# How People Get Their News



**AN INCREASING PROPORTION CITE THE INTERNET AS THEIR PRIMARY NEWS SOURCE.**

DATA Quelle: PEW RESEARCH CENTER. REPRESENTS RESPONSES TO THE QUESTION "WHERE DO YOU GET MOST OF YOUR NEWS ABOUT NATIONAL AND INTERNATIONAL ISSUES? FIGURES SUM TO MORE THAN 100% BECAUSE RESPONDENTS COULD VOLUNTEER UP TO TWO MAIN SOURCES.



# Projektarbeit

Betrachte deine aktuelle Grafik:

- Wie ist das Verhältnis von Text, Theme-Elementen und Daten?
- Welche Möglichkeiten gibt es, die Daten mehr in den Vordergrund zu stellen?
- Welche anderen Details sollten sofort wahrgenommen werden?
- Kannst du die Botschaft durch das Nutzen preattentiver Attribute und Call-Outs hervorheben?



# Wrap-Up



# G.R.A.P.H.I.C. Guidelines

developed for infographics in general by Stones & Gent (2015)

- **G** – Get to know your audience
- **R** – Restrict use of colours
- **A** – Align elements
- **P** – Prioritise parts
- **H** – Highlight the heading
- **I** – Invest in imagery (wisely)
- **C** – Choose charts carefully



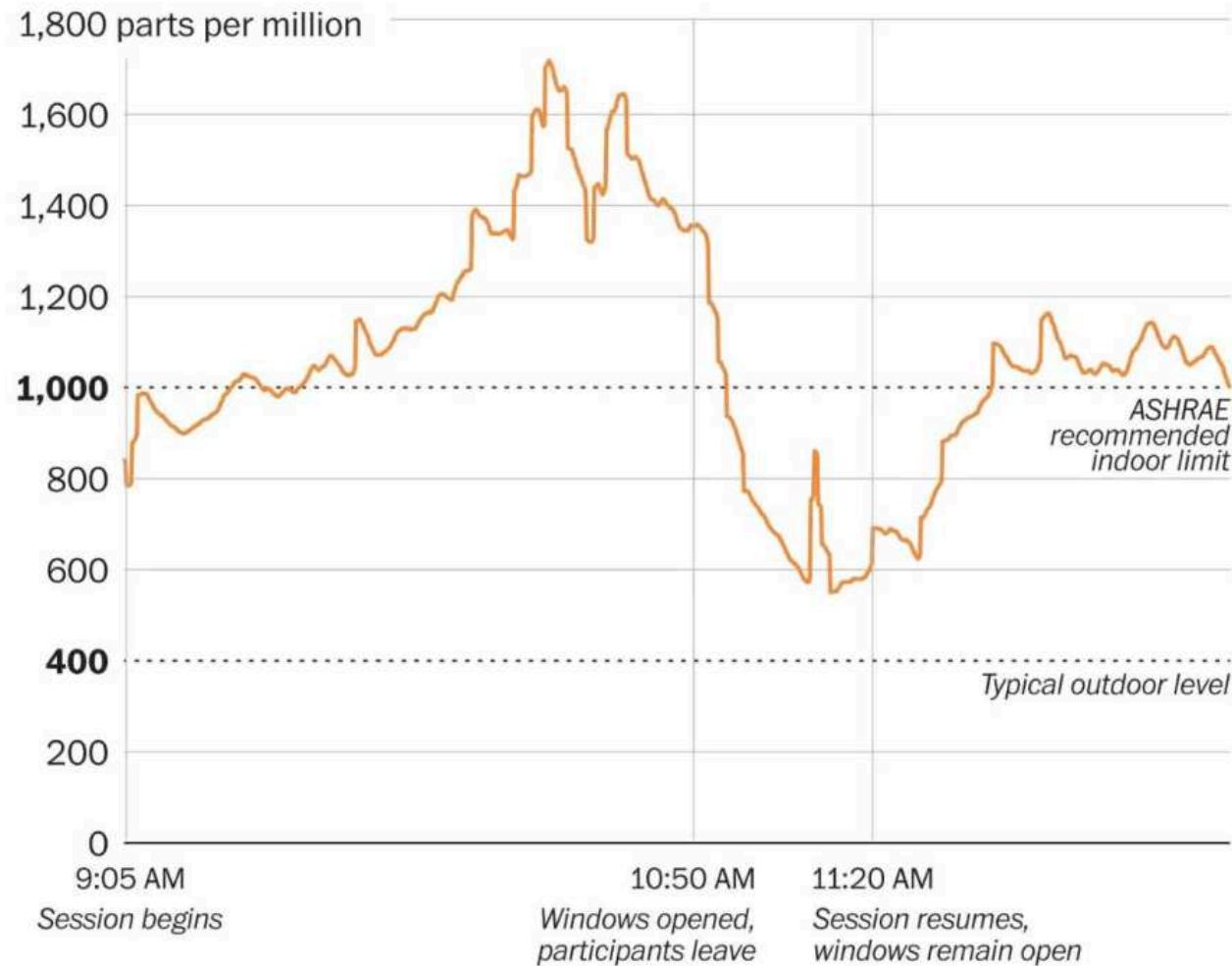
# **Was macht eine gute Datenvisualisierung aus?**

- » **Information (Integrität)**
- » **Erzählung (Bedeutsamkeit)**
- » **Ziel (Zweckmäßigkeit)**
- » **Eleganz (Visuelle Form)**



# Clearing the air

CO<sub>2</sub> levels in an occupied conference room on June 4, 2019



Source: Adam Ginsburg

THE WASHINGTON POST

Quelle: "Clearing the Air" by Adam Ginsburg (Washington Post) | Commented version by Francis Gagnon

Cédric Scherer Data Visualization & Information Design



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## Comment

<https://doi.org/10.1038/s41556-025-01684-z>

# A checklist for designing and improving the visualization of scientific data

Helena Klara Jambor



Check for updates

Creating clear and engaging scientific figures is crucial to communicate complex data. In this Comment, I condense principles from design, visual perception and data visualization research in a checklist that can help researchers to improve their data visualization, by focusing on clarity, accessibility and design best practices.

The visualization of data accelerates comprehension by revealing trends and patterns. Figures have always been fundamental in the natural sciences, translating complex data into visual insights. Early scientific illustrations documented specimens and concepts, while modern data visualization evolved through pioneers such as William Playfair, who introduced graphical methods for numerical data<sup>1</sup>. Biomedical scientists, including John Snow and Florence Nightingale, expanded this approach to reveal patterns in public health.

Foundational works in information design offer general guidance<sup>2</sup>, but visualizing biological data requires additional considerations. Modern biological research relies on a wide range of

involves categories, distributions, time series, or proportions. Common charts – such as bar, line and pie charts – are widely understood, while specialized charts (such as boxplots or Kaplan–Meier plots) may require domain-specific knowledge. Consider your audience's familiarity, and follow best practices for clarity.

Research in computational sciences continues to explore how humans interpret charts. Studies show that people excel at reading charts with a common scale, such as bar charts (*x* axis) and scatter plots (*x* and *y* axes), whereas interpreting charts without a shared axis, such as line and pie charts, is more challenging. Studies also highlight concerns with commonly used charts, and, for example, advocate against bar charts for statistical distributions, as they obscure data variability<sup>14</sup>.

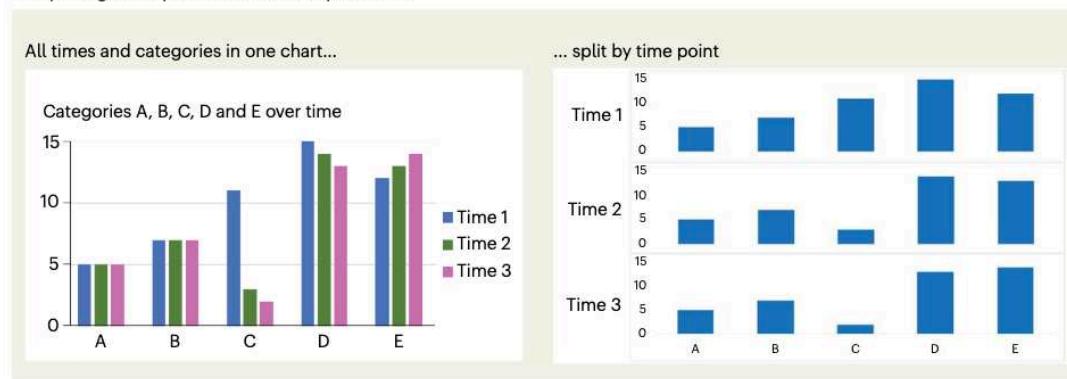
**Simplify charts.** Even with a suitable chart type, your visualization may still be difficult to understand. If you chose a basic chart but the message is complex, focus the audience's attention by improving annotations, labels, and layout, or by reducing the data shown to emphasize the key message. Splitting data into two or multiple charts can help separate insights, and zoomed views can highlight both overall trends and details. For complex datasets, 'small multiples' – a series of identical charts sharing the same axis layout – can simplify interpretation by showing one grouping factor at a time (for example gene expression in

Jambor (2025) *Nature Cell Biology* doi: [10.1038/s41556-025-01684-z](https://doi.org/10.1038/s41556-025-01684-z)

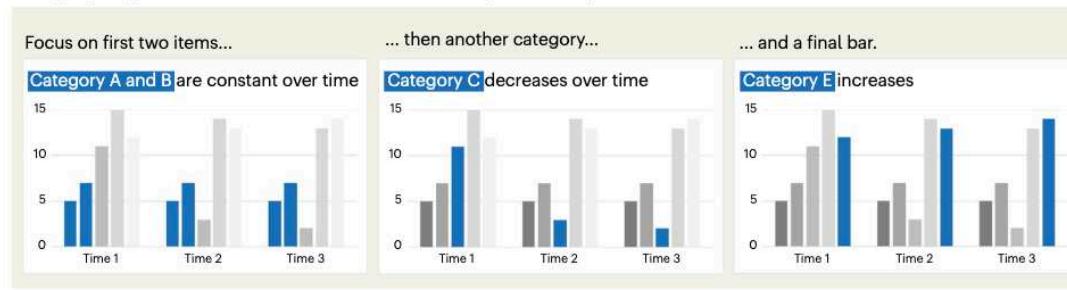
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**a** Splitting a complex chart into multiple charts



**b** Highlighting different elements in successive charts to present complex data



**c** Testing abbreviations. Two examples with interpretations, sized by number of responses.



**Fig. 1| Basics for figures. a,** Breaking up complex charts into several charts with a shared axis layout as small multiples is a possibility for simplifying complex messages. Note that this usually does not require more space. **b,** Presenting successive charts that each highlight a different aspect is another strategy for simplifying complex messages. Note that this works in presentations but may be

limited in publications because of space restrictions. **c,** A strategy for querying the meaning of abbreviations before using them in charts. Note that even if legends and/or the text provide explanations, any uninterpretable abbreviation reduces comprehension.



## From Zero to figure hero: A Checklist for figures with data

Helena Jambor, <https://orcid.org/0000-0003-3397-1842>

Use this checklist to design & improve your figures or review others. When starting from scratch, make sure that you know the key message and target audiences of each figure you create.



### BASICS

Choose chart

- Suitable for data and message?
- Suitable for audiences? Consult resources for chart types, e.g., Datavizcatalogue.com, Python-graph-gallery.com, Datavizproject.com

Simplify charts: Too much data

- Split data across 2 charts
- Consider small multiples for many categories/observations
- Present complex charts gradually reveal different aspects in successive charts e.g., with color

Simplify charts: Uncommon chart type

- Include help on how-to-read e.g., in title, subtitle, legend,...
- Use intuitive guides e.g., direct data labels, color similarity, regions-of-interest

Text

- Label axes
- Label tick marks, choose easy intervals 0, 5, 10, 15 > 0, 8, 16, 24
- Explain colors, marks, shades e.g. legends
- Use title, subtitle to orient readers
- Avoid abbreviations if necessary: test
- Typography: choose legible font and style regular > bold, italic

### DESIGN

Layout

- Aim for horizontal text, avoid text rotation
- Label data directly. Otherwise place legend close to data
- Align text elements title best: top left/center
- Use white space to visually separate panel elements

Color schemes, Encode data with color

- Are colors necessary?
- Pick color palettes for data type. Sequential data: 1 color, vary saturation/lightness; Diverging data: 2 colors with neutral center; Categorical data: vary color.
- Use consistent color schemes
- Ensure high contrast of data to background color, use darker shades for smaller data points
- Ensure colors are accessible. Color-blind safe, high contrast foreground/background. Double encode color information. Best, information is also visible in greyscale.
- Explain all colors e.g., legend

On beauty

- Align and organize with a grid
- Use white space to separate elements
- Strive for symmetry
- Consider using icons for memorability

### FEEDBACK

The 1-second test. Ask "What do you see first?" Evaluates if data is visible at first glance

Reverse feedback. Ask: "Explain to me what you see." Get feedback on chart type, text, layout, colors

Then focus the attention

- Axes, boxes, tick marks. Remove or mute?
- Legend necessary? Direct data label or title possible?
- Gridlines. Remove or mute? Necessary for log-scales/ precise values
- Use color sparingly. Remove unnecessary colors, use grey instead of black
- Align chart elements and multi-panel figures ticks, text, titles, legends, axes, labels
- Aim for symmetry, evenly filled space, separate elements in multi-panel figures gaps/white space

Quelle: Helena Jambor

Cédric Scherer Data Visualization & Information Design



# Publikum (wer)

- An wen richtet sich die Kommunikation?
- Was ist die eigene Position und Beziehung?

# Inhalt (was)

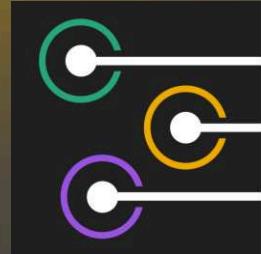
- Welche Erkenntnisse sollen die Zuhörenden mitnehmen?
- Auf welchem Weg findet die Kommunikation statt?

# Grundlage (wie)

- Sind die Kodierung und der Diagrammtyp geeignet?
- Welchen Detailgrad benötige ich für meine Aussage?



# Dankeschön!



**CÉDRIC SCHERER**  
Data Visualization & Information Design

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