Chapter Title: DEVELOPING A DATA VISUALIZATION STYLE GUIDE

Book Title: Better Data Visualizations
Book Subtitle: A Guide for Scholars, Researchers, and Wonks
Book Author(s): Jonathan Schwabish
Published by: Columbia University Press. (2021)
Stable URL: https://www.jstor.org/stable/10.7312/schw19310.15

PART THREE

DESIGNING AND REDESIGNING YOUR VISUAL

DEVELOPING A DATA VISUALIZATION STYLE GUIDE

A data visualization style guide does for graphs what the *Chicago Manual of Style* does for English grammar. It defines the components of a graph and their proper, consistent use. Like a writing style guide, a comprehensive data visualization style guide breaks down the parts of graphs, charts, and tables to demonstrate best practices and strategies to design and style your charts. Elements like font and color, the widths of lines and style gridlines, and the use of tick marks are all choices that determine whether a graph is clear, engaging, and consistent—or whether it isn't.

The difference between a grammar guide and a data visualization guide is that many of our data style decisions are subjective. While the word *their* is objectively different than *they're*, and the use of one in a particular case is either correct or incorrect, there is no objectively correct or incorrect line thickness for a chart. There are, however, certain principles to consider, many of which we have covered so far. But for the most part, the styles you choose will reflect you and your organization's preferences.

THE ELEMENTS OF A DATA VISUALIZATION GUIDE

In organizations, a data visualization style guide serves three purposes.

First, it provides team members with the detailed styles and expectations about what should and should not be included in a visualization. Where should the title go? How large should it be? What font? What color?

Second, it guides those who may not be familiar with (or care about) all the styling and branding guidelines the organization may value. Instead of asking researchers and analysts to compile the data, create the graph, and then worry about which colors and fonts to use, a style guide makes those decisions easier. Building these styles into software tools streamlines the process and automates the application of graph styles.

Finally, a style guide sets the tone and expectations for people in the organization that the style, look, and details about data visualization are as important as other branding materials.

Even if you're an individual working with data, a style guide can be worthwhile. A custom style guide will make your work more consistent and efficient, and it will build your individual brand so your work stands out. A good style guide handles the basic style decisions for you, so you can focus on more important aspects of creating data visualizations.

As you build your style guide, test the components to make sure you or your team members can use and implement them. The style needs of your charts may differ from those of other branding materials. Colors that might look great in a logo may not work in a line chart or bar chart. Also remember to treat your data visualization style guide as a living document, just as you would a style guide for text or design. The guide should change as your personal or organizational aesthetic changes and evolve alongside changes in publication types and software tools.
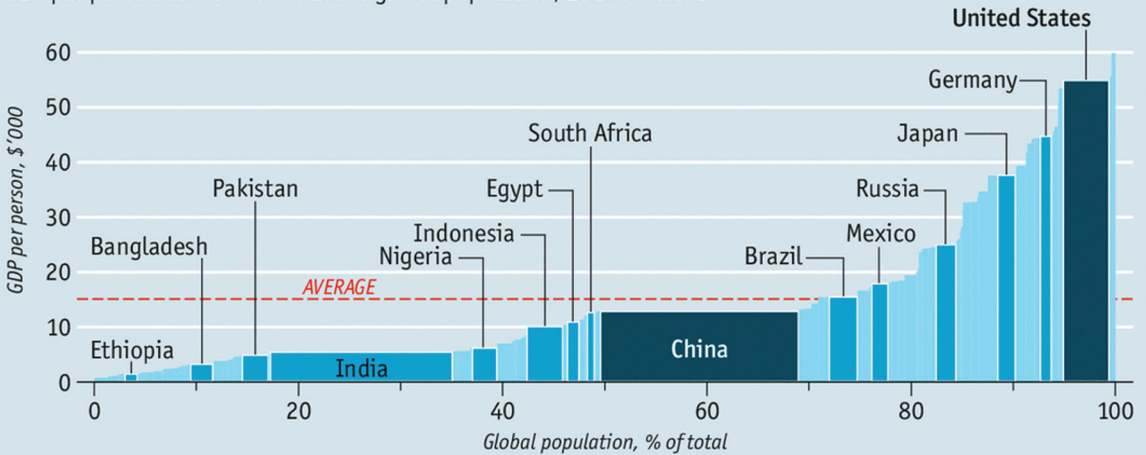
Consider these Marimekko charts from the *Economist* and the *Financial Times*. Both publications have a distinct look and feel, and even those who are not regular readers may recognize the style. This branding is an important aspect of the organization's identity.

There can be many sections to a detailed style guide, which we'll cover in detail in this chapter, but here are the basics that any data visualization style guide should cover.

1. **Graph Anatomy.** Where should labels, titles, and other elements be placed? What is the proper size of charts and should this size differ for different types of output?
2. **Color Palette.** What colors should be used across graph and data types? Does the color palette vary across graph types? Does it vary for print and digital products?
3. **Font.** What font should be used and how should its size, boldness, and position vary? Should there be one font style for the title and another for the text in the body of the graph?

A world of difference

GDP per person at PPP* and share of global population, 2014 forecast

GDP per person, $'000

United States
Germany
Japan
South Africa
Pakistan
Egypt
Russia
Bangladesh
Indonesia
Nigeria
Mexico
Brazil
Ethiopia
AVERAGE
India
China

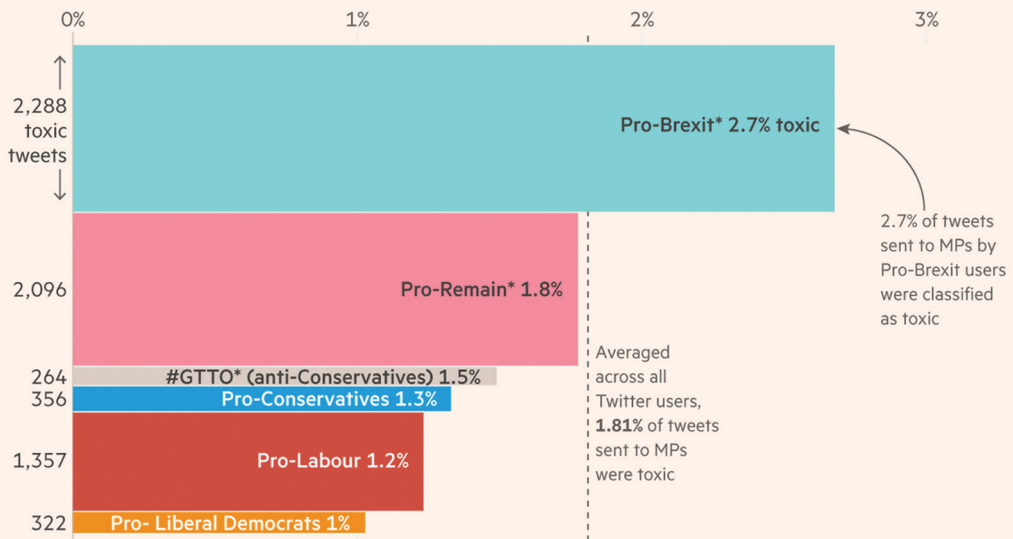Global population, % of total

Sources: International Comparison Programme; IMF; *The Economist*   *Purchasing-power parity

Self-described pro-Brexit tweeters directed the most toxicity at MPs

Percentage and number of tweets sent to MPs that were classified as toxic, grouped by the senders' use of political terminology

2,288 toxic tweets

Pro-Brexit* 2.7% toxic

2.7% of tweets sent to MPs by Pro-Brexit users were classified as toxic

2,096   Pro-Remain* 1.8%

Averaged across all Twitter users, **1.81%** of tweets sent to MPs were toxic

264   #GTTO* (anti-Conservatives) 1.5%
356   Pro-Conservatives 1.3%
1,357   Pro-Labour 1.2%
322   Pro- Liberal Democrats 1%

*Pro-Brexit tweeters are those using any of the following terms in their Twitter bio: Brexit party, #Brexit, #StandUp4Brexit, #GetBrexitDone, Pro-Brexit, Brexiteer. Pro-Remain tweeters used any of: #FBPE, Pro-EU, #RevokeA50, #Remain, #PeoplesVote, #StopBrexit, Revoke.
#FBPE = 'Follow back pro-European; #GTTO = 'Get the Tories out'
Source: FT research
© FT

The color, fonts, and overall style of these Marimekko charts from the *Economist* (top) and the *Financial Times* (bottom) make them easily identifiable.

4. **Graph Types.** Are there special considerations for specific graphs? For example, are pie charts forbidden in all situations? Is there a maximum number of series allowed in a line chart?

5. **Exporting Images.** How should team members move graphs from their software tool to the final report or website? Should they use PNG, JPEG, or some other image format? How should people create those image formats if they are not native to their software tool?

6. **Accessibility, Diversity, and Inclusion.** What steps do you and your organization need to take to make your graphs accessible to people with vision impairments or intellectual or other disabilities? Are you being mindful of how you're presenting results for different races, genders, and other groups?

THE ANATOMY OF A GRAPH

To set graph styles, we should first define each part of a graph. To illustrate how this can be done in practice, we can use the basic template in the style guide published by the Urban Institute, a nonprofit research institution in Washington, DC.

1. OVERALL DIMENSIONS

Specify the overall size of the chart. This may differ for different product types—an online graph, for example, is often measured in pixels, while a chart for a print document is typically measured in inches or centimeters. The dimensions may depend on the tools and workflow your organization uses. In the Urban Institute guide, the horizontal dimensions for a print graphic are specified at the top (6.5 inches) to fit on an 8.5 × 11 inch page.

2. FIGURE NUMBER

Figures and tables can either be numbered, lettered, or left alone. You can place it above the chart title, centered or left-aligned, in a different font size and color. You could also leave it in-line with the chart title like, "Figure 1. Chart Title." As you can see in the image, the Urban style is to put the figure number above the chart title in all capital letters in its standard blue color. The note includes details for font (Lato Regular), font size (9 pt), capitalization (Uppercase), and color (RGB: 22 150 210).

IN PRINT

6.5 in

Title
Lato Regular
12 pt
Title case
RGB: 0 0 0

Figure Number
Lato Regular
9 pt
Uppercase
RGB: 22 150 210

FIGURE X

This is the Title of the Chart and it Should be in Title Case and it Should be as
Short as Possible but Definitely Not Longer than Two Lines

Subtitle
Lato Regular
9.5 pt
Sentence case
RGB: 0 0 0

This is a subtitle that's in sentence case

Y Axis Title (unit)
Label

Y Axis Title
Lato Italic
8.5 pt
Sentence case
Always horizontal,
above the top axis label
Include units or multipliers
in parenthesis
(millions), ($2014)
RGB: 0 0 0

Horizontal Gridlines
Weight: 1pt
Dashed: round dot (2nd from top)
Cap type: Square
Join type: Miter
RGB: 217 217 217

Label

Align all elements

Label

Label

Axis Labels
Lato Regular
8.5 pt
Sentence case
Always horizontal
RGB: 0 0 0

Label

X-Axis Line
Weight: 1pt
Solid
RGB: 0 0 0

Label

Ticks
Major tick marks: Outside
Minor tick marks: none
RGB: 0 0 0

Label

X Axis Title
Lato Italic
8.5 pt
Sentence case
Always horizontal,
centered below axis labels
Include units or multipliers
in parenthesis
(millions), ($2014)
RGB: 0 0 0

Label   Label   Label   Label   Label   Label   Label   Label   Label   Label   Label

X Axis Title (unit)

Sources and Notes
Lato Regular
8 pt
Sentence case
RGB: 0 0 0
**Bold the words "Source" and "Notes," as
well as any statistical significance notes**

Source: Lorem ipsum dolor sit amet, metus mi mauris vulputate morbi feugiat.
Notes: Lorem ipsum dolor sit amet, metus mi mauris vulputate morbi feugiat. Nec dignissim duis parturient et est. Orci ultricies lectus vivamus
eius diam, massa non suspendisse nibh ullamcorper, lacus tortor libero luctus risus ligula, torquent fringilla fermentum lacinia sollicitudin.
*/**/***: Lorem ipsum dolor sit amet, metus mi mauris vulputate morbi feugiat.

Urban Tagline   URBAN INSTITUTE
Lato Black
7 pt
Uppercase
'Urban' is blue: RGB: 22 150 210; 'Institute'
is black: RGB: 0 0 0
Letter spacing is expanded by 1px
Place in the bottom-right corner of figure

The Urban Institute style guide defines each part of the chart and style
choices that apply to them.

3. TITLE

Will the title be aligned with the left side of the chart or centered over the plot space? Left-aligning the title (and other text objects) has the advantage of creating a vertical grid along the left edge, which makes it appear more organized and therefore easier to read. You should also lay out a basic style for the tone of the titles. Will they be purely descriptive or more active, summarizing the important points of the chart? Will you use sentence case or title case? The Urban style is to use title case, as detailed in the sample title. Notice also how the

use of the title is a direction to the user—it should be title case, short as possible, and no more than two lines.

4. SUBTITLE

If there are going to be subtitles, how will they be used in the chart? Is this a place to insert a more active statement or is it a place to list the units in the chart? The subtitle is a good place to include the vertical axis title because, when left-aligned, it's located close to the top of the axis. To offset it from the title, you might place it in parentheses, make the size smaller, or even change the color. In the Urban example, the subtitle is written out in sentence case with a smaller size and black color.

5. AXIS TITLES

Where will the vertical and horizontal axis titles go? In many software tools, the vertical axis title is rotated and placed alongside the vertical axis. A better position is to have it horizontally oriented and positioned above the vertical axis, aligned with the title and subtitle (or, as mentioned, it might be the subtitle). For the horizontal axis title, you might need to decide how far below the axis labels it will sit. There are cases—such as months or years—where the units are obvious and a horizontal axis title can be omitted. Axis titles can be differentiated by using smaller text or different colors. You should also decide whether to spell out and capitalize units like "dollar" or "percent," or to use a symbol. The Urban style is to place the vertical (y-) axis title above the axis and to have units in parentheses; the horizontal axis label sits below the axis in 8.5 pt Lato Italic font, horizontal, and centered.

6. AXIS LABELS

How these should be formatted? Boldface, italics, different font size? The vertical axis labels (as distinct from the title) typically sit to the left of the chart, though they can also be added to the right side if the chart is very wide. For the horizontal axis labels, are there specific formats for certain units? For example, when using years along the axis, would a series like 2000, '01, '02 . . . be acceptable or should each number be written out in full?

7. AXIS LINES AND TICK MARKS

What color and thickness will you use for the axis lines? Will the tick marks be inside or outside the chart? Some organizations leave out the vertical axis line altogether, but the horizontal axis line is typically included to give the chart a consistent anchor. I prefer to make the zero-axis line slightly darker than the other gridlines because it acts as a baseline. This is especially true in cases with negative values: We want to make it clear that the zero-axis line is not at the bottom of the chart. Tick marks are likely not needed in the space between the bars in a bar chart, but may be necessary in a line chart. In the Urban example, there is no vertical axis line, but the horizontal axis line is a 1 pt black line with major tick marks that are outside the chart.

8. GRIDLINES

Many charts include horizontal gridlines, though the exact formatting varies. Will they be solid, dashed, or dotted? How thick will they be? And what color? At what increments will they be added? Many charts do not include vertical gridlines, though the occasional scatterplot will include them to create a visible grid.

9. SOURCES AND NOTES

Data sources should be documented and note any important modeling or modifications. A box for sources and notes is typically found at the bottom of the chart, left-aligned with the vertical axis labels, title, and subtitle. In many cases, the word *Source* and *Note* are boldfaced. The Chicago Manual of Style (section 3.20), for example, suggests placing the source line above the note line. In the Urban style, the words *Source* and *Notes* are in bold face and ordered in that way.

10. LOGO

If you want to include a logo on the graph, decide where it will go and what size it will be (and be sure to use a high-resolution image). Logos are often placed in the bottom-right corner, but sometimes in other places. The advantage of placing it in the bottom-right corner is that

it is out of the way of the title/subtitle and sources/notes areas. Urban adds one of its logo formats to the bottom-right area of the graph, with specific instructions for color and spacing.

11. LEGEND

Will a legend be used and if so, where will it go, what size will it be, and what markers will be used? It is not labeled on this image, but the Urban style guide includes a separate section that specifies font sizes for other elements of graphs, including the legend.

12. DATA MARKERS

Will graphs, especially line graphs, include data markers, like circles or squares? Will the markers be filled or hollow? When will data values be labeled? You may want to set rules about using data markers for graphs with some number of values.

13. DATA LABELS

Determine when data points should be labeled and how they should be placed and formatted. The Urban guide has a separate table of font sizes that describes how these labels should appear.

14. DATA SERIES

This will vary by chart type—thickness of lines, space between bars and columns, colors for each element. You may need a separate section of the style guide to address issues of specific chart types, depending on the complexity of the charts your organization uses.

► ► ► ► ►

As just two other examples of how published style guides define different parts of a chart, the first image is from the data visualization style guide published by the London Datastore, an effort by the city of London to open and share its data and resources. Similarly, the Sunlight Foundation, a nonpartisan organization that advocates for open government, has a style guide that defines each part of their charts to reflect their styling preferences.

CHART DESIGN
STYLING & LAYOUT

Consistent layout, labels & lines

For ease of comprehension, it's important that your charts are presented consistently, and are as clean and uncluttered as possible.

A descriptive chart title in 18pt Bold #353d42
More detailed explanation matching the document body copy in 14pt
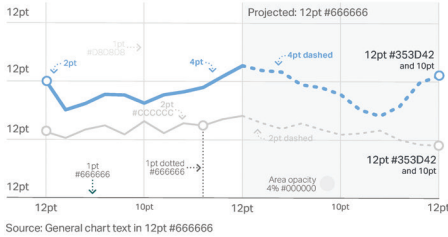
Remember, your charts should feel part of the document they are displayed within, and so text sizes should relate to the document text hierarchy and all chart text should be consistent across the document.

Shown are typical text and line weight settings derived from the London Datastore's body copy. Depending on your tools, device / document context, and resolution, you may want to change the specific settings, but the relative relationships between lines & type settings should be similar.

A descriptive chart title in 18pt Bold #FFFFFF
More detailed explanation matching the document body copy in 14pt

Left chart labels: 12pt; Projected: 12pt #666666; 2pt; 4pt; 4pt dashed; 12pt #353D42 and 10pt; 2pt #CCCCCC; 2pt dashed; 1pt #666666; 1pt dotted #666666; Area opacity 4% #000000; 12pt #353D42 and 10pt; 12pt; 10pt; 12pt; 10pt; 12pt

Source: General chart text in 12pt #666666

Right chart labels: 12pt; Projected: 12pt #FFFFFF; 2pt; 4pt; 4pt dashed; 12pt #FFFFFF and 10pt; 2pt #FFFFFF; 2pt dashed; 1pt #FFFFFF; 1pt dotted #FFFFFF; Area opacity 4% #FFFFFF; 12pt #FFFFFF and 10pt; 12pt; 10pt; 12pt; 10pt; 12pt

Source: General chart text in 12pt #FFFFFF

CITY INTELLIGENCE

Source: Mike Brondbjerg of the Greater London Authority, reproduced under the Open Government License

Basic Structure

EXAMPLE

650px max for a regular blog post (900px max for a feature post)

12px

Title of the **chart**

For explanatory text that's not very long.

100px

SUNLIGHT FOUNDATION
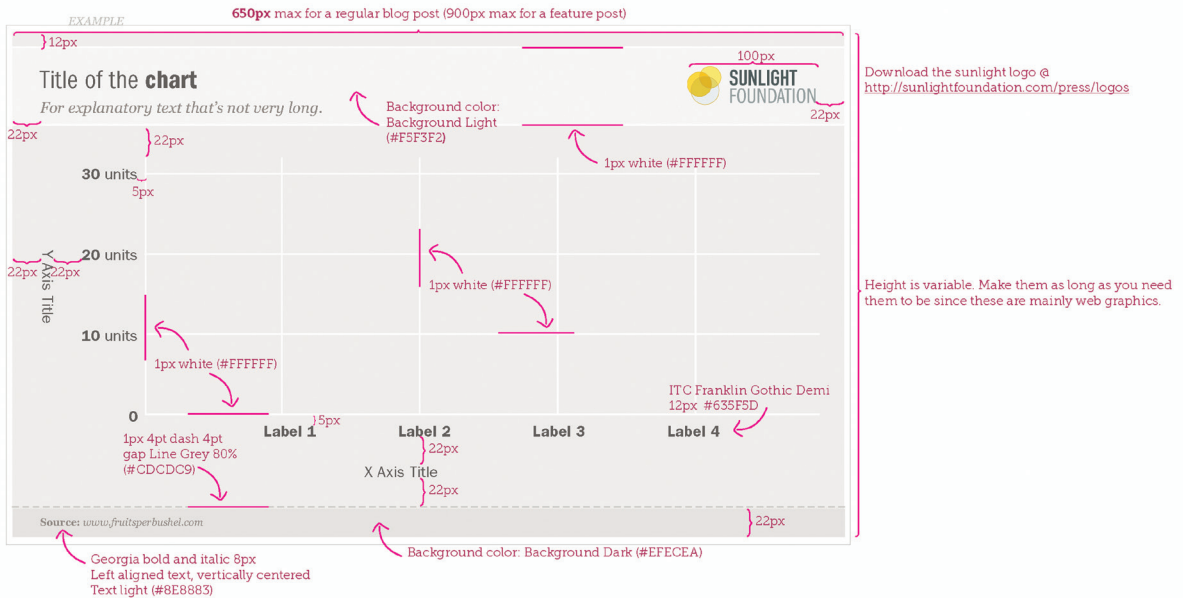
Download the sunlight logo @ http://sunlightfoundation.com/press/logos

22px

22px / 22px

Background color: Background Light (#F5F3F2)

1px white (#FFFFFF)

30 units
5px

20 units

Y Axis Title
22px / 22px

1px white (#FFFFFF)

10 units

1px white (#FFFFFF)

0

15px

Label 1   Label 2   Label 3   Label 4

ITC Franklin Gothic Demi 12px #635F5D

1px 4pt dash 4pt gap Line Grey 80% (#CDCDC9)

22px

X Axis Title

22px

Height is variable. Make them as long as you need them to be since these are mainly web graphics.

Source: www.fruitsperbushel.com

22px

Georgia bold and italic 8px
Left aligned text, vertically centered
Text light (#8E8883)

Background color: Background Dark (#EFECEA)

Source: Sunlight Foundation

A data visualization style guide should lay out specific chart fonts, styles, colors, and sizes.

COLOR PALETTES

Color has unmistakable power in our visualizations. It may be the first thing people notice about our graphs. Color can evoke emotions and draw attention. As Vincent van Gogh wrote to his brother in 1885, "Color expresses something in itself. One can't do without it; one must make use of it."

Successful brands have recognizable color palettes for everything from their logo and letterhead to their data visualizations. But a palette that works for company letterhead or website may not necessarily work for a line chart with five lines. There are a number of free online color tools to develop color palettes: Adobe Color, Color Brewer, Colour Lovers, and Design Seeds are a few examples, and the Appendix contains a longer list. Besides the basic colors, we will also need different shades and tints for each color in the palette.

A style guide should contain different schemes to guide chart creators in their color choices. The easier you make it for an analyst to apply the branding and design elements, the more time they have to work with the data and develop the best graph for their purpose.

There are five primary color schemes you can apply to your data visualizations.

Binary. Nominal differences divided into two (binary) categories: urban-rural, Democrat-Republican, agree-disagree.
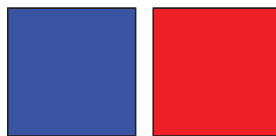
Sequential. Data values that are logically arranged from low to high should use sequential color schemes. Low values are usually represented by light colors, and high values by

Low   High
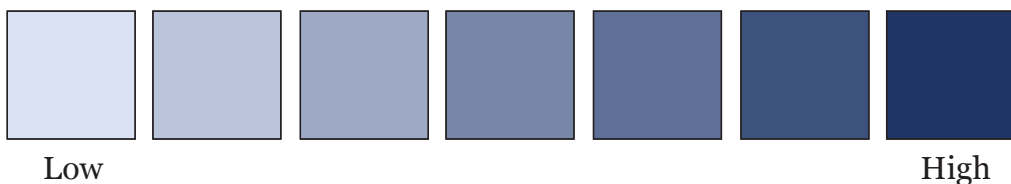
dark colors. Choropleth maps that show poverty rates or population, for example, would use sequential color palettes.

Diverging. In this scheme, the colors progress outward, growing darker from a central midpoint. A diverging color palette will share sequential schemes on two different colors and diverge from a shared, lighter color, for example, deviations from zero or a central number.

Midpoint
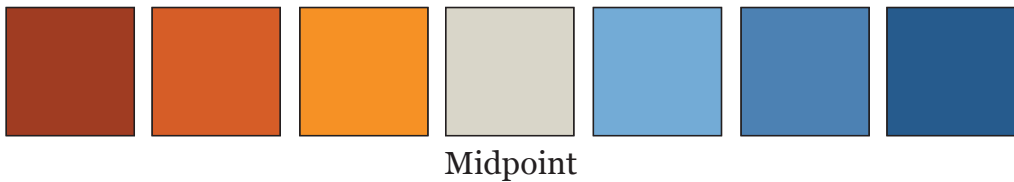
Categorical. Color schemes that use separate colors to represent nominal differences, for example, different race or gender groups.

Highlighting. This is a special case of the categorical color scheme. These color schemes highlight a certain value or group within the visualization. For example, we could use this palette to emphasize a single or small group of points in a scatterplot.

Transparency. Not so much a color scheme but a technique for using color, transparency in graph objects lets us (and our reader) see the object behind it. We've seen this technique a few times already (see the area chart section on page 157 as an example). You can use transparent colors—with or without a solid border—to make overlapping objects visible.
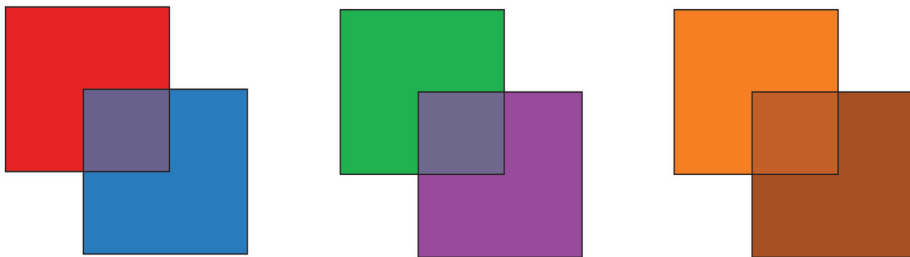
As an example of how color palettes are defined in practice, this section of the National Cancer Institute style guide shows primary and secondary color palettes along with a full list of tints and shades. The Consumer Finance Protection Bureau (CFPB) style guide includes sets of colors to "maintain CFPB brand cohesion."

We should also be mindful of readers with color vision deficiency (CVD) or color blindness. About 300 million people around the world have some form of CVD, most of them

There are many ways to define branded colors and styles. The National Cancer Institute (left) and the Consumer Finance Protection Bureau (right) are demonstrations of two such ways.

men, and most of them have difficulty discerning between reds and greens, though there are other forms as well. There are a variety of online color and color contrast checking tools such as Vischeck.com and WebAim that can be used to test colors.

AVOID THE RAINBOW

When choosing a color palette, avoid the rainbow color palette. In most cases, the rainbow palette is a poor choice for visualizing your data for at least three reasons. First, while a color ramp from light blue (small data values) to dark blue (large data values) makes logical sense, it isn't really logical to say that "purple" means more than "orange." Second, and more importantly, the rainbow color palette does not map to our number system. Notice how wide the green area is in the rainbow palette below compared with the thin light blue area. If we were to show a unit change from, say, 1 to 2, we might not see a change in greens; but the same unit change from, say, 9 to 10, in the blue spectrum might shift all the way from teal to

Avoid the rainbow color palette. It doesn't map to our number system, isn't logical when mapped to data, is not comprehensible for people with color vision deficiency, and does not translate to grayscale.

navy. Finally, the rainbow palette is not consistent for people with CVD (the middle image) or when printed in black and white (the last image).

COLORS AND CULTURE

Finally, be mindful that colors can reinforce stereotypes or hold different meanings in different cultures. For many years, pink and blue colors were used to differentiate data values for women and men. But in modern-day western cultures, these colors come with gendered stereotype baggage: pink suggests weakness and blue suggests strength. Interestingly, this was not always the case—up until about the mid-twentieth century, it was the opposite. In her book, *The Secret Lives of Color*, Kassia St. Clair writes, "Pink is, after all, just faded red, which in the era of scarlet-jacketed soldiers and red-robed cardinals was the most masculine color, while blue was the signature hue of the Virgin Mary." Instead of the standard pink-blue pairing, consider using other color combinations such as purples and greens (as in the *Telegraph* newspaper) or blues and oranges (as in the *Guardian*).

More generally, also consider how different cultures use and perceive different colors. In western cultures, for example, the color red may evoke emotions of passion and excitement and has both positive and negative associations. In eastern cultures, however, the color red represents happiness, joy, and celebration. In India, red relates to purity, and in Japan it is associated with life, anger, and danger.

DEFINING FONTS FOR THE STYLE GUIDE

A data visualization style guide should define typefaces (or fonts) for each part of the chart. You probably don't need more than two different fonts, and one will usually suffice. Also remember that you can vary the look of a single font by changing its thickness (thin, bold), angle (italics), and color.

BE WARY OF CUSTOM FONTS

A custom font can differentiate your style from the standard fonts found in, for instance, the Microsoft Office package. But beware: using custom fonts requires that they be installed on any machine that shows the graph. While custom fonts make your graphs stand out,

A data visualization style guide should also define appropriate fonts to use and when to use them. The BBC (left) and US Department of Agriculture (right) are just two examples of how to provide this guidance.

they can also raise trouble when sharing files or presenting from a laptop different from your own.

Default fonts like Century Gothic, Tahoma, Trebuchet MS, and Verdana are examples of effective fonts for data visualization that are available on most operating systems but are less commonly used and therefore appear more novel.

The BBC style guide for data visualization in Tableau (on the left) includes a typography section that demonstrates which fonts to use, where, and how to align them to the broader chart space. Their Reith Sans font is not a default font type, and they must therefore make sure that everyone in the organization has that font installed on their computers. The *Visuals Standards Guide* from the U.S. Department of Agriculture (on the right) features a broad set of fonts that are used across their publication types and at least two of the three (Arial and Times New Roman) are typically default fonts.

GUIDANCE FOR SPECIFIC GRAPH TYPES

Another section you might want to include in your style guide is a set of examples or instructions about specific chart types. Your organization may want to specify certain styling or data visualization best practices that differ chart to chart. You might also include examples of less common chart types to broaden your organization's data visualization toolbox, just like you did while reading this book.

Start by constructing guidelines for the most common chart types your organization uses. For example, you might specify that dual-axis line charts should never be used (see page 143) or that pie charts should have some upper limit of series (see page 289). There are also more granular specifications, such as where exactly labels should sit in a stacked bar chart or whether data points on a line chart sit on or between the tick marks. Or you might specify never to include tick marks on bar charts, or that whenever data labels are included, gridlines and tick marks must be omitted.

Another issue you might address in the specific chart area is how to manage the color palette among different data series. If the main colors in your palette are blue, red, and orange, the order of those colors may change if you have two or three series or may vary for, say, a paired bar chart versus a stacked bar chart.

TIPS FROM THE URBAN INSTITUTE STYLE GUIDE

▶ All of Urban's charts will be full-width (685px), so it is important to keep the data density as high as possible. Always include a text reference to your figure to give the data context to the content of the report/brief/blog post. If your chart has only two or three values, consider a couple sentences of text to explain the figure.

▶ If you find your explanatory sentences do a better job of distilling the information, you might want to consider going without a chart.

▶ Title: Keep it short and simple. Try to explain the chart in a few words. If you need to add qualifiers (e.g., years, dollars) or further clarification, use a subtitle

▶ Source and Notes: This is where the technical information about methodology can go. Try to avoid putting this information in the title, labels, or on the chart.

▶ Legends: Stretch legends across the top of the chart, or to the right. Order them in a logical way, mirroring the order of the data in the charts.

*Source: The Urban Institute Style Guide, accessed January 2020.*

You might also include data visualization tips and tricks. These five tips are listed at the very top of the Urban Institute's guide. You can develop your own rules and tips or borrow those published by other groups and organizations.

EXPORTING IMAGES

Once a visualization is ready for external consumption, the chart creator must export it to a usable file format. This is another opportunity for things to go wrong: improper exporting might compress the resolution and pixelate the whole image. You can see the difference in resolution between these two versions of the same chart from Chapter 4. You can spend all the time you want creating a great, effective graph with clear colors and fonts, so don't waste all that effort with a blurry, hard-to-read final image.

Choosing the right file format for your visualizations is key. There are many file formats from which to choose, each with its own advantages and disadvantages. The biggest difference between image file formats is whether they are bitmap or vector. Images in bitmap format (also called raster) are stored as a series of squares (called pixels), each assigned a specific color. When you take a bitmap image and stretch it out, the pixels get larger and the resolution falls. You may have seen something like this if you put a photograph in a document and then tried to make it bigger—each pixel is now larger, and the crispness of the image deteriorates.

The other image format is vector. As opposed to bitmap images, vector images contain information about the actual shape in the image. A vector image is recreated when you
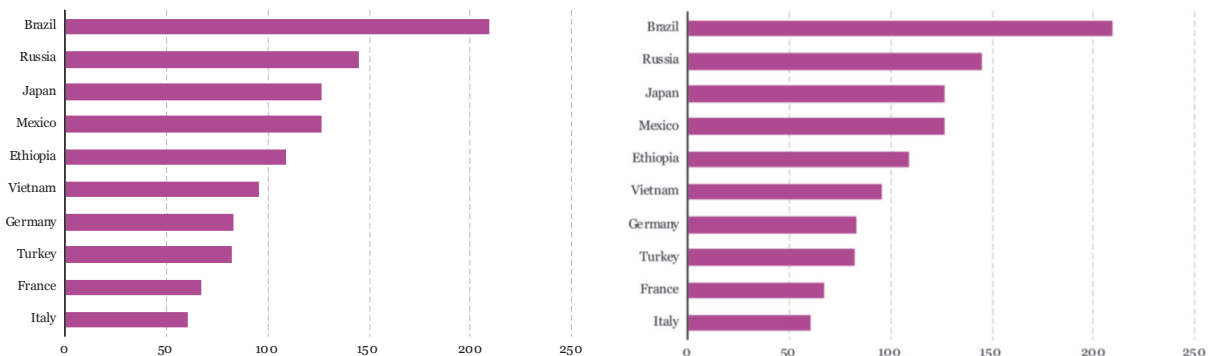
When moving images from your data visualization tool to your final product—either a report or web image—be sure the image has a sufficiently high resolution. The key is to test the image before you publish or post it.

Type	Acronym	Name	Application
vector	pdf	Portable Document Format	general purpose
	eps	Encapsulated PostScript	general purpose
	svg	Scalable Vector Graphics	online
bitmap	png	Portable Network Graphics	optimized for line drawings
	jpeg	Joint Photographic Experts Group	optimized for photographic images
	tiff	Tagged Image File Format	print production; better color reproduction
	gif	Graphics Interchange Format	typically used for animations

Source: Adapted from Claus O. Wilke, *Fundamentals of Data Visualization*

stretch it, so it won't lose resolution the way bitmap images do. Vector images are also called "resolution-independent" because they can be stretched forever without ever losing sharpness or detail. It might not surprise you to learn, then, that one of the biggest downsides of vector images is that the file size can be surprisingly large.

How you and your organization guide the export of graphs from software tool to the final product depends on a variety of factors, including the primary data visualization software tool, operating system, and where the final output will appear: Will it be in a PDF report? A standalone image on a website? Embedded in a tweet? The best strategy is to try a variety of approaches, but double-check the final product to make sure you have the sharpest, clearest image possible.

ACCESSIBILITY, DIVERSITY, AND INCLUSION

Many people with vision impairments rely on screen readers to navigate the internet. A screen reader reads the content on a screen aloud to the user, so if you post a graph with the filename "Image1.png," that is what the user will hear. People with other physical, cognitive, or intellectual disabilities may have difficulty reading your work or using your website if you have not taken into account their accessibility needs. Accessibility also extends to whether people can access the internet and the speed of their Internet connection. It is worth considering how your content (and website more generally) can be made more accessible by users who may require different levels of assistance.

To create accessible content, you might follow the guidelines laid out in Section 508 of the Rehabilitation Act of 1973. Section 508 requires U.S. federal government agencies to

develop, procure, maintain, and use information and communications technology (ICT) that is accessible to people with disabilities. This means that federal agencies that fall under Section 508 compliance rules must make their ICT—such as online training and websites—accessible for everyone.

One 508 standard for images that we can all apply is to use "alternative text" (commonly called "alt text") in our images. Alt text succinctly describes the content in the image. For data visualizations, this might be text communicating the general conclusion or message of the chart. In other words, what is the single concise sentence that summarizes your chart?

You can find some basic issues to consider by following the recommendations of the Web Content Accessibility Guidelines (WCAG), an international group charged with leading "the Web to its full potential." With respect to accessibility, WCAG defines four main areas:

1. **Perceivable.** Information must be presented in ways that users can perceive them. This might mean making non-text content available to other forms people need such as speech, symbols, or large print. Text should have sufficient color contrast with the background and images should have information ("alt tags") that will make them readable by screen readers and other assistive technology.
2. **Operable.** Make all functionality available from a keyboard. This means, for example, that using the tab, enter, and space bar keys enables the user to navigate the page and each interaction can be triggered.
3. **Understandable.** Text content should be readable and understandable, and web pages should operate in predictable ways. For example, significantly rearranging the content on the page can make content more difficult to read and understand.
4. **Robust.** Online content should be robust enough to be compatible with current and future users as well as assistive technologies. This might mean, for example, developing the website in such ways that screen readers and other assistive technologies can accurately interpret the content.

To date, there are no concrete rules about how to make a website completely accessible, though there are existing threads of research exploring how to use different assistive technologies to make visual content more accessible. Computer operating systems, browsers, and programming languages change and evolve, and any accessibility guide would be trying to hit a moving target. What we *can* do, however, is to consider how people with different abilities can or cannot access our content. A lot of these strategies are just good practices we

can use to more effectively communicate our work with text and explanations. Considering better accessibility then leads to better usability for everyone.

Another issue to keep in mind in data visualization is how you refer to different groups. You may have considered this when using terms like "Black," "African American," or "Hispanic" in your writing, tables, or graphs. Use the phrasing accepted and recognized by your audience and the communities you are studying. Consider the lived experiences of the people and groups you study and write about. Also consider using "people-first" language, such as "people with disabilities" instead of "disabled people." It is important to remember that data are a reflection of the lives of real people.

This also applies to the layout of your graphs and the language you use. How do you order the bars or lines in your tables and graphs? Is it alphabetical, based on sample size, or is it based on some unknown, arbitrary decision? Again, there are not many answers to these questions, but it is worth taking some time to consider approaches and strategies to make your work more accessible and inclusive of different groups.

PUTTING IT ALL TOGETHER

There are not necessarily right or wrong answers to some of these questions and style decisions. Whether the thickness of your gridlines is 1 pt or 2 pt, one shade of gray or another— these are primarily style decisions, but they are also functional decisions. As you saw in the first chapter, the goal is to emphasize the data over the gridlines, tick marks, and markers.

An effective, comprehensive data visualization style guide is best developed at the organizational level. If possible, bring your design and data teams together to determine branding guidelines that meet the needs of your organization, including data visualization. If your organization does not have these divisions, or if you are working to develop your own individual style guide, you might reach out to experts or refer to other published style guides to develop branding guidelines and styles.

Remember to treat your data visualization style guide as a living document. Revisit the guide as technologies and trends change. And remember to be flexible to the different needs, tools, and skills in your organization. Creating an instructive and clear guide that can be accessed and implemented by everyone can serve you, your organization, and your reader.