

Data Visualization

Visualization with Purpose: Accessible Data Visualization

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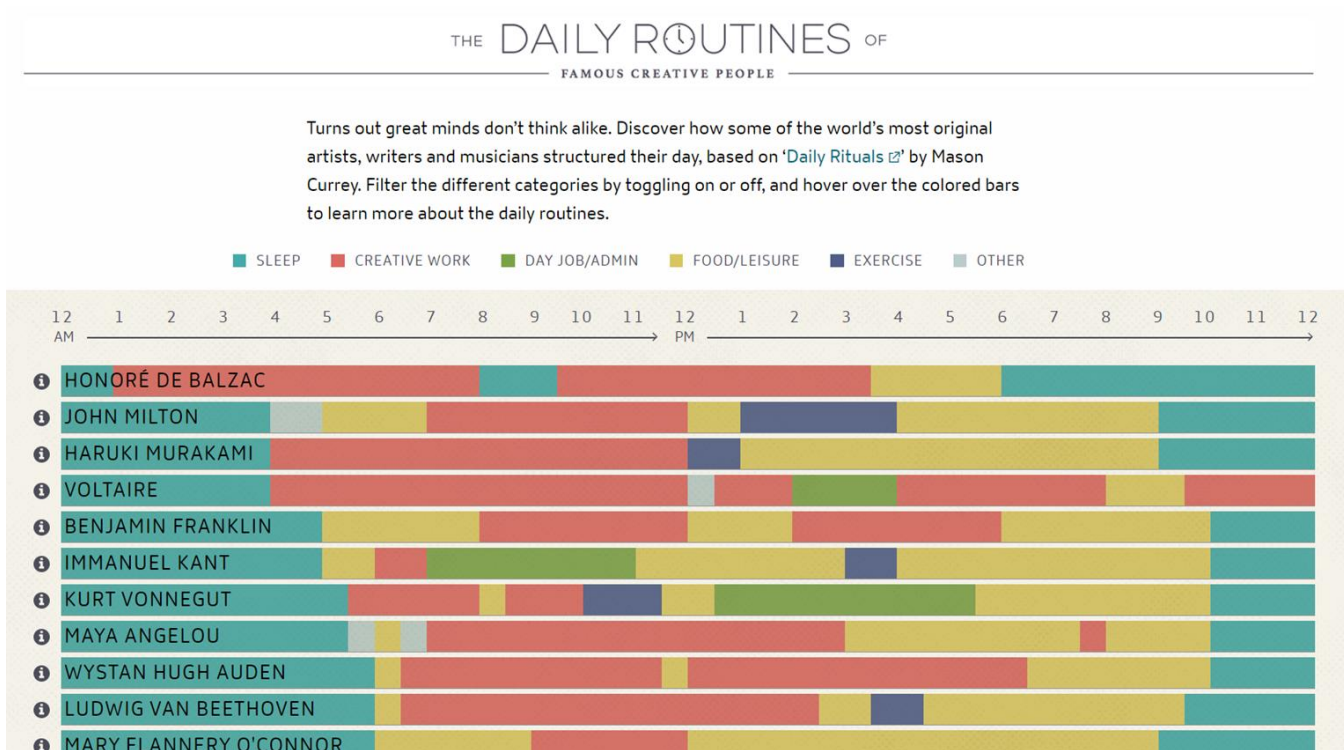
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Today, we will...

- Discuss the real-world impacts of inaccessible data visualization
- Explore practical tips and resources that we can use to improve the accessibility of our data visualizations, especially relating to:
 - Colour
 - Text
 - Image Descriptions
 - Getting our visualizations to the intended audiences

Case Study: Who gets to use data visualizations?

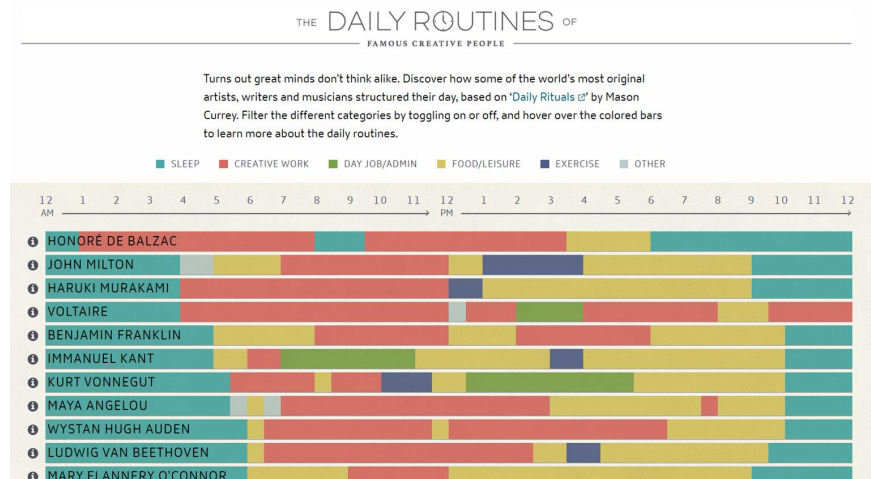
'The Daily Routines of Famous Creative People' Visualization



(Click image to view interactive visualization)

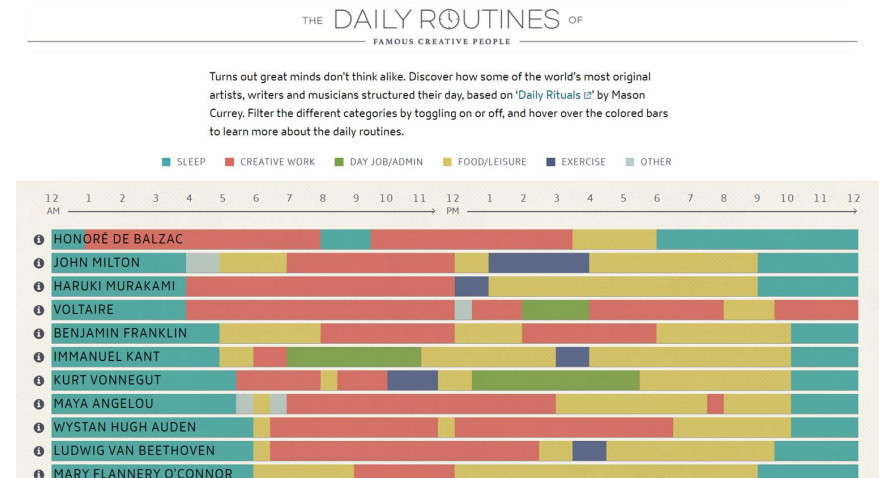
'The Daily Routines of Famous Creative People' Visualization

- The 'Daily Routines' plot is often used as an example of 'good' data visualization
- It includes its data source (substantive qualities), uses an appropriate plot type for comparison (perceptual qualities), and limits its colour scheme (aesthetic qualities)

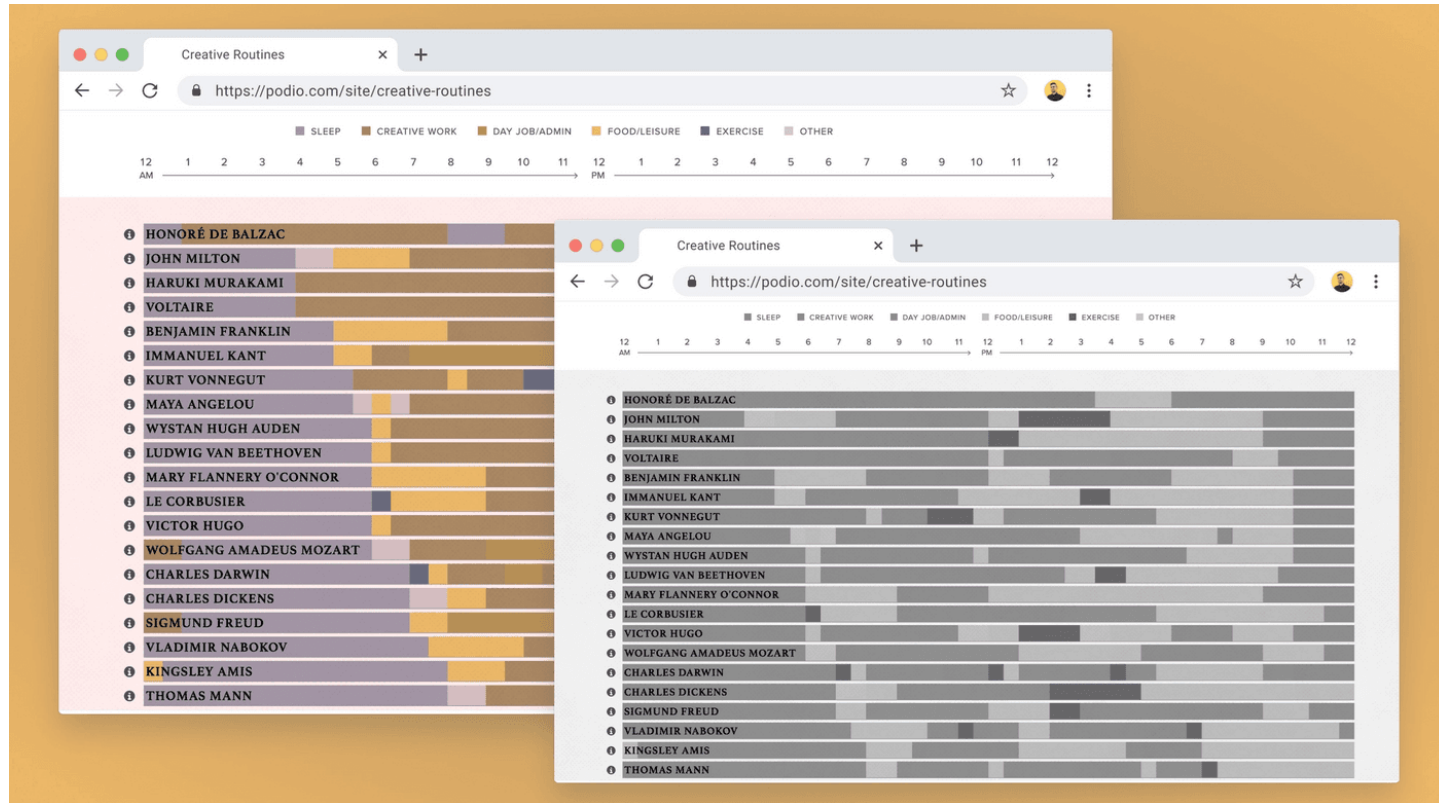


Questioning assumptions

- Sarah L. Fossheim, a developer and designer, [was curious](#) about how the visualization would be perceived by people with [deuteranopia](#) (a type of red-green colourblindness) and [achromatopsia](#) (partial or total lack of colour vision)

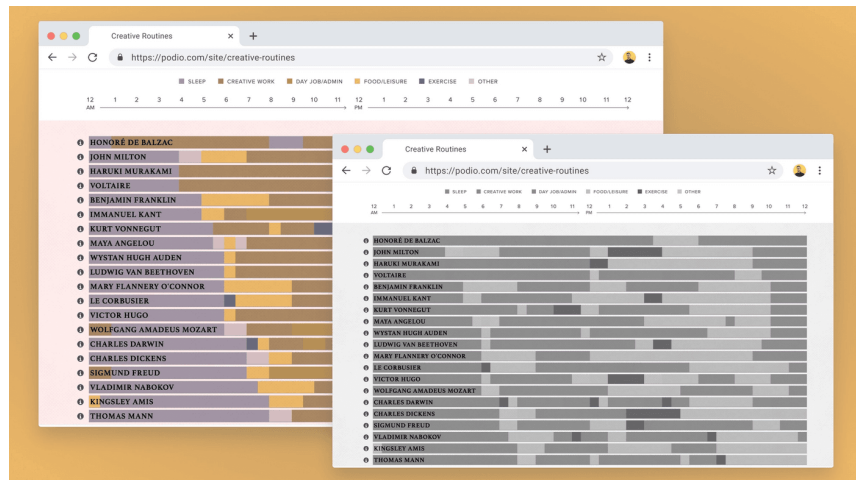


A different picture



A different picture

- Some of the colours end up looking similar or the same, and the lack of specific labels on the plot makes it impossible for individuals with either form of colourblindness to make sense of the data the creator was trying to present
- This data visualization is **not accessible** to certain people

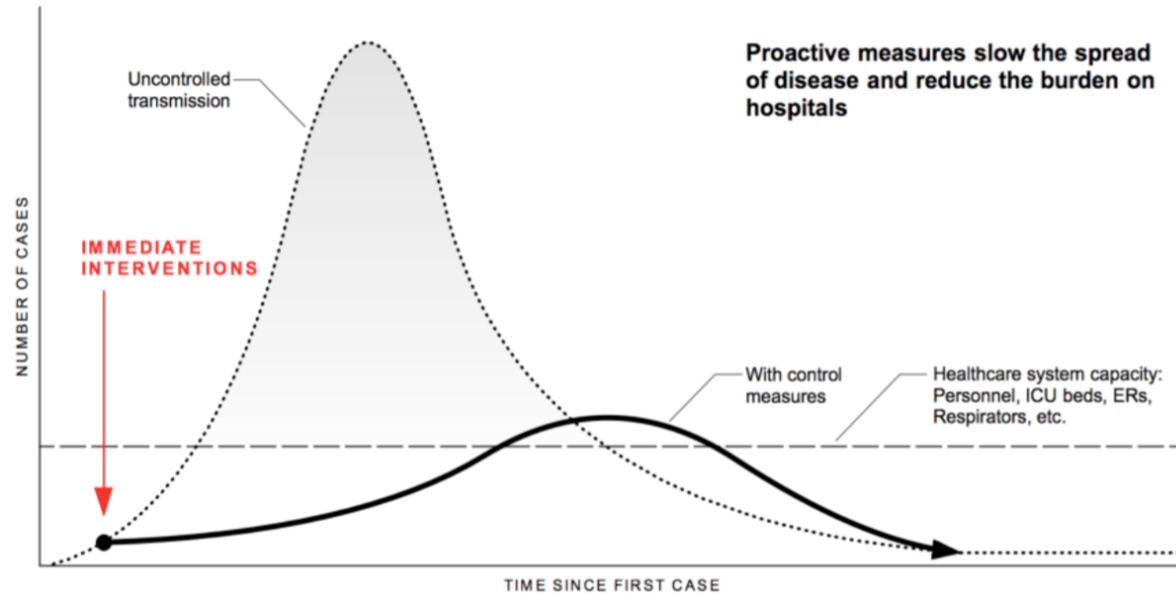


- In the case of the 'Daily Routines of Famous Creative People' visualization, a lack of accessibility is an inconvenience, but one with a relatively limited scope
- **But** what about when the ability to make sense of the data being shared visually has an impact on people's daily lives and wellbeing?

'Flattening the Curve'

LOWER AND DELAY THE EPIDEMIC PEAK

A



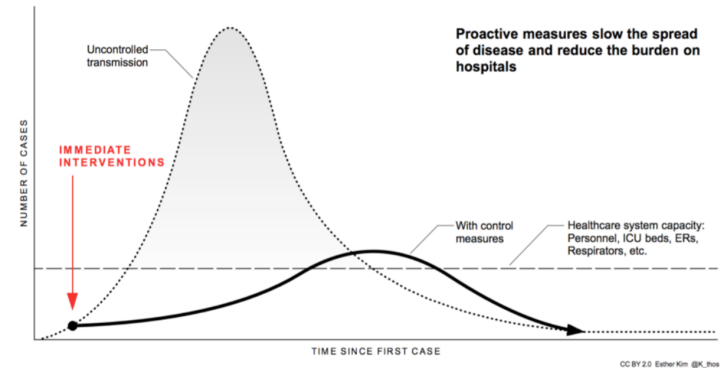
CC BY 2.0 Esther Kim @K_thos

‘Flattening the Curve’

- Data visualizations such as this one are an efficient and effective form of communicating public health information, but not to everyone
- **Activity:** In what ways is this data visualization inaccessible, and to whom? Let’s discuss!

LOWER AND DELAY THE EPIDEMIC PEAK

A



Pandemic information and people with visual impairments

- Graphical and spatial visualizations of pandemic data are everywhere, and help the public see epidemiological trends at a glance, but most of these images are inaccessible
 - Lack of alternative descriptive text means that people using screen readers [cannot access the data](#)
 - Tactile or braille versions of COVID-19 data visualizations are [rare and often expensive](#) to create
- From Lundgard & Satyanarayan (2022), “for readers with visual disabilities... inaccessible visualizations are, at best, demeaning and, at worst, damaging to health.”

- Failing to consider best practices for accessible design means that our data visualization will not have the desired positive effect on all of our audience, and may even have a harmful effect by excluding them from important data
- As professionals and academics who want to communicate our data visually, we have a responsibility to prioritize accessibility

Government of Canada Principles for Accessible Design

- The Government of Canada provides four broad goals for what we should try to accomplish with accessible design:
 - Make information clear, concise and easy to use
 - Present information in predictable, barrier-free ways
 - Provide barrier-free ways for people to interact with you
 - Make sure technology-based products work with assistive technologies and devices

So how do we incorporate these accessibility goals into our data visualization practices?

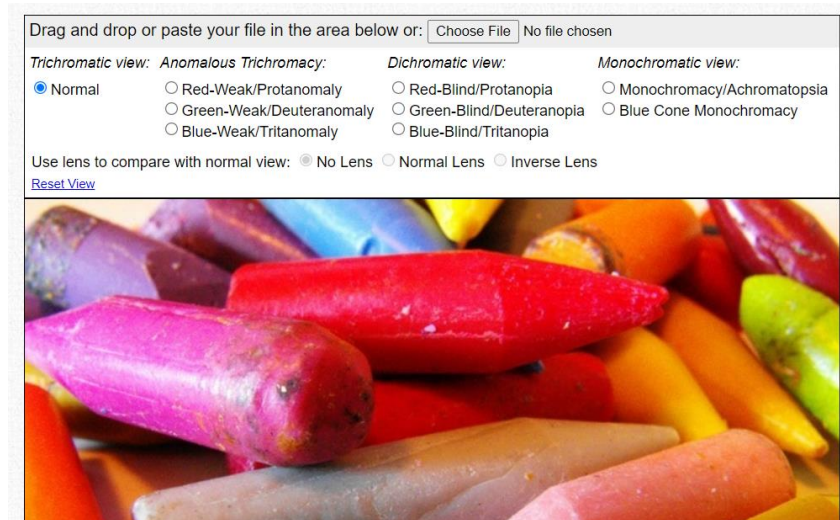
Colour

Using colour

- Colour is one of the most useful features of many data visualizations
- We have to be aware of the ways that colour can be perceived differently by the audiences of our images

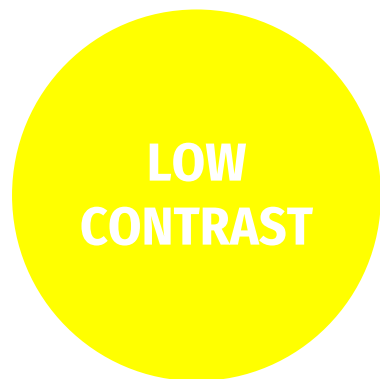
Resource: Colour Blindness Simulator

- The [Colour Blindness Simulator](#) allows you to upload an image and apply various filters to check how its colours would be perceived by people with various types of colourblindness



Brightness and Contrast

- Overly bright colours can be painful to look at, and overwhelming for people with sensory issues and people [on the autism spectrum](#)
- **Contrast** is the ratio between the brightness of two different colours
- A higher contrast generally makes colours and objects in our data visualizations easier to tell apart





Resource: Check Contrast



- WebAIM offers an [online tool](#) that lets you enter in two colour values and check if they are a 'pass' or 'fail' according to [Web Content Accessibility Guidelines](#) standards for contrast
- Colours can be picked from a dropper or using hexadecimal code
- The tool delivers separate contrast scores for normal text, large text, and graphical components

Check Contrast

[Home](#) > [Resources](#) > Contrast Checker

Foreground Color
#0000FF 
Lightness 

↔

Background Color
#FFFFFF 
Lightness 

Contrast Ratio

8.59:1

[permalink](#)

- [Contrast and Color Accessibility](#)
- [Quick Reference: Testing Web Content for Accessibility](#)
- [Web Accessibility for Designers](#)
- [Link Contrast Checker](#)

Normal Text

WCAG AA: **Pass**

WCAG AAA: **Pass**

The five boxing wizards jump quickly.

Large Text

WCAG AA: **Pass**

WCAG AAA: **Pass**

The five boxing wizards jump quickly.

Graphical Objects and User Interface Components

WCAG AA: **Pass**

Text Input 

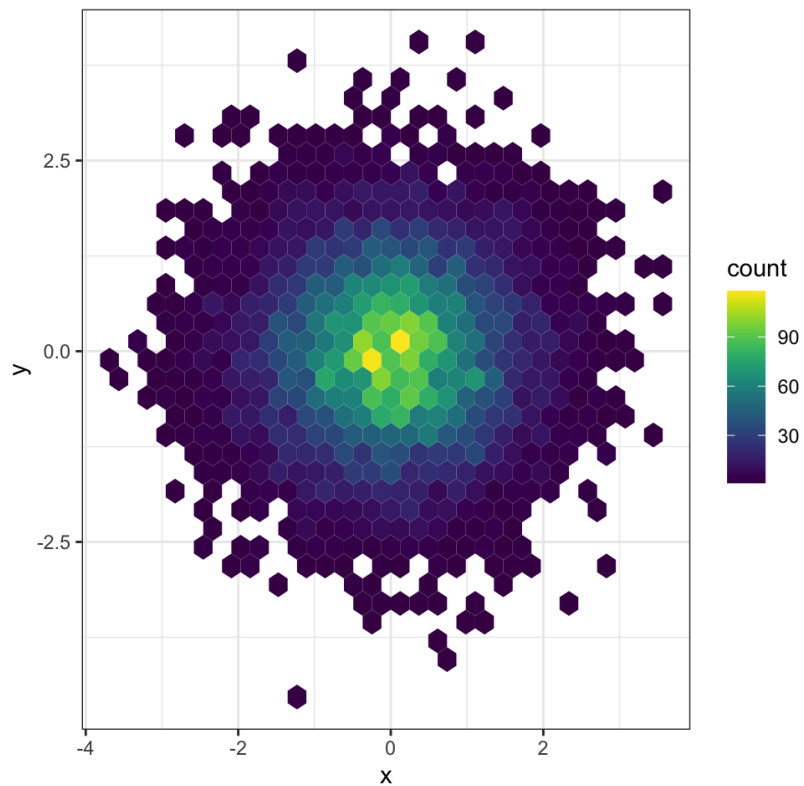
Resource: Viridis package

- Viridis is a package for R that is designed to make plots easier to read by those with colourblindness, and to maintain contrast so plots are readable in grayscale (eg. in print)









```
install.packages("viridis")  
library(viridis)
```

- Viridis can be used with ggplot by using `+ scale_color_viridis()` and `+ scale_fill_viridis()`

Viridis package - Example

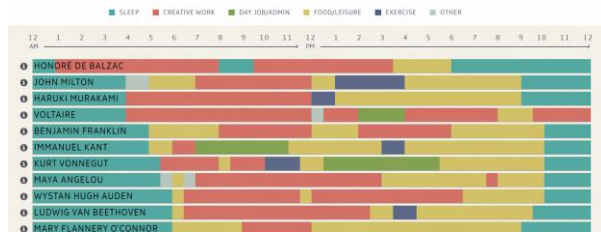


Viridis package - As perceived with colourblindness

	ggplot Default Colour Palettes	viridis Default Colour Palette
Base		
Green-Blind (Deuteranopia)		
Red-Blind (Protanopia)		
Desaturated		

Moving beyond colour

- Even when we make use of best practice for accessible use of colour in our data visualization, we should **avoid relying only on colour, where possible**
- Think back to our 'Daily Habits' example - use of patterns or textures in addition to colour on our bars could have made the visualization more accessible to people with visual impairments, even with the current colour scheme



Text

Labels and legends

- If we want to minimize colours and patterns, data labels (on individual data points or on bars in a bar graph) can make visualizations easier to follow
- Every visual element on our graph should be clearly described in a legend; additional, brief written descriptions of visual elements can also reduce anxiety for our audiences

Fonts and typefaces

- A **typeface** is a set of text characters (eg. Arial, Times New Roman)
- A **font** is a subset of a typeface (eg. 12 point Arial in italic)
- Certain typefaces and fonts are considered more accessible than others in design and data visualization contexts

Typeface

- There is no single ‘right’ typeface or font to use, but generally sans-serif fonts are more accessible for [people with cognitive disabilities](#)
- Typefaces [identified](#) as easier to read for people with dyslexia include:

Helvetica

Courier

Arial

Verdana

- We should [also](#) avoid overwhelming users by switching between too many different typefaces in one graphic

Font size and spacing

- Text on our data visualizations should be at least 12 point size or greater, if possible
- Spacing also affects the readability of text on our visualizations
 - **Monospaced** text (each character takes the same amount of space) is more widely accessible than **proportionally spaced** text (each character only takes the space it needs)

A black rectangular box containing the white digits 0 through 9. Below each digit is a yellow horizontal line of uniform length, demonstrating that in monospaced text, every character occupies the same amount of horizontal space.

Monospaced Text

A black rectangular box containing the white digits 0 through 9. Below each digit is a yellow horizontal line of varying length, demonstrating that in proportionally spaced text, the width of each character is proportional to its own shape.

Proportionally Spaced Text

Describing data visualizations

Alt-text

- To ensure that our data visualizations are accessible to people using a screen reader or unable to see the image, we include **alternate text (alt-text)**
- Alt-text should convey all the essential information conveyed by an image
- Generally, alt-text consists of a description of the image; if there is text in the image, alt-text should include the text
- Alt-text should be in plain language and simple sentences, when possible

Activity: Alt-text

What would be suitable alt-text for this image?



Activity: Alt-text



- The most appropriate alt-text can depend on the intended purpose of an image or visualization:
 - **If the image is only for decoration:** “Two scientists in discussion”
 - **If the focus is on specific individuals:** “From left-to-right: Eugenia Duodo and Patrick Gunning”
 - **If the focus is on the actual events or contents of an image:** “Professor Patrick Gunning and doctoral student Eugenia Duodo talking by a chemistry fume hood”

Alt-text for graphs and plots of data

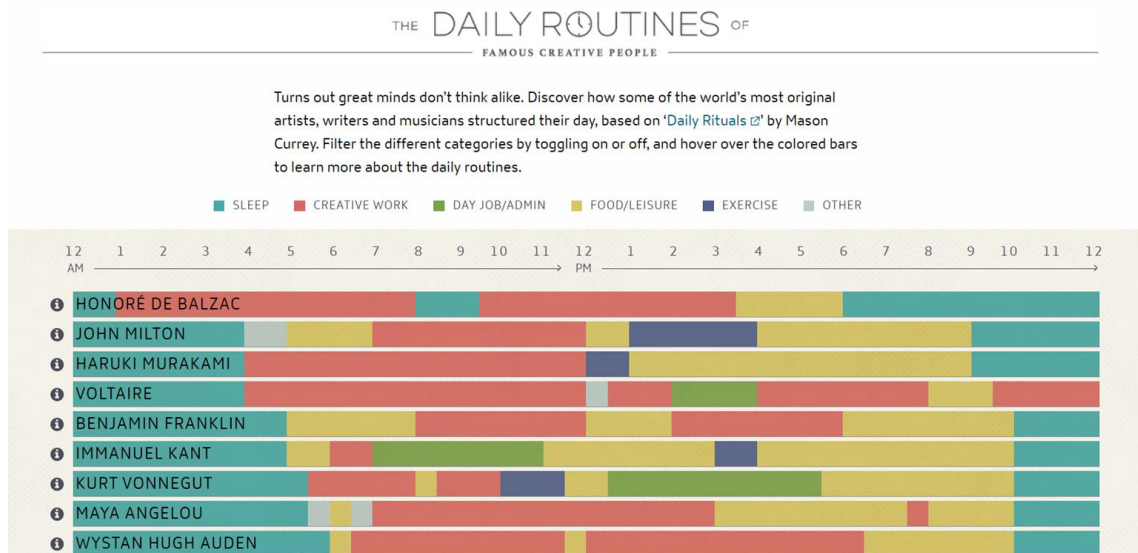
- Accessibly describing data-centric images for alt-text and figure captions requires additional considerations compared to describing photos such as the previous example
- Lundgard & Satyanarayan (2022) collected descriptions of sample data visualizations from graduate students and found that the descriptions could be grouped into four categories

Four types of descriptive content

Level	Semantic Content and Keywords
1	<ul style="list-style-type: none">● Focus on chart elements such as chart type, title, axis ranges, labels, colours
2	<ul style="list-style-type: none">● Descriptive statistics (eg. mean), outliers, max and min points, correlations, comparing points
3	<ul style="list-style-type: none">● Complex trends, pattern synthesis, clusters, exceptions, common concepts● Perceptual interpretations of the data
4	<ul style="list-style-type: none">● Context and domain insights, social and political context and explanations● Subjective interpretations that go beyond the data

Activity: Four types of descriptive content

Describe the data visualization on this slide according to each of the four types of descriptive content (click to visit website).



Alt-text for graphs and plots of data

- The four types of descriptive text are **not** equally helpful!
- Both blind and sighted participants in the original study found level 1 content on its own the least helpful
- Blind participants found level 4 content the least useful
 - Blind participants preferred descriptions to contain facts about the data, giving them the agency to interpret it for themselves, rather than editorializing by the creator
- 40% of blind participants thought that the most useful descriptions would combine content from multiple levels (2 and 3)

**Can people actually access our
data visualizations?**

Cross-browser functionality

- If our data visualization is going to be embedded in a web page or otherwise accessible online, it is important to check for cross-browser functionality
- Our data visualization should be functional and visible in:
 - Chrome
 - Firefox
 - Internet Explorer 11, Microsoft Edge (Windows)
 - Safari (Mac/iOS)
- This is especially important in some professional contexts, where browser use may be limited/regulated

Cost and accessibility

- If our data visualization is intended to reach the public or a particular subgroup of the public, the cost of accessing our visualization (and surrounding content) is an accessibility issue
 - Eg. Most academic publications require a subscription
- To maximize the accessibility of our data products, we can consider:
 - **Open Access** (Per [University of BC Libraries](#), “a range of practices through which research outputs are distributed online, free of cost or other access barriers”)
 - **Creative Commons licenses** (standard and simple [licenses](#) to facilitate sharing and reuse of work)

- When in doubt about the accessibility of our data visualizations...
- ...show somebody!
- **User testing and gathering feedback**, even informally, is the best way to understand whether our data visualizations are accessible and understandable to our intended audiences

For more resources...

- The Government of Canada's [Digital Accessibility Toolkit](#) contains guides and graphics in plain language to facilitate designing with accessibility in mind
- The [AccessAbility handbook](#) is a detailed guide to accessible practices in graphic design, with useful insights for data visualization

Assignment 3



Next...

- Data Visualization as Advocacy
- Examples of data visualization used for advocacy, and best practices
- Form, representation, and giving credit as means of incorporating advocacy into our own data visualization practices
- Back to R! Working with models in ggplot.
 - (drink your coffee before class)