

2025

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# Visualization and accessibility: The state of the art, 2025



Frank Elavsky, PhD Candidate



[hcii.cmu.edu](http://hcii.cmu.edu), [axle-lab.com](http://axle-lab.com), [dig.cmu.edu](http://dig.cmu.edu)



# Visualization and accessibility: The state of the art, 2025



I'm on the job market!

Frank Elavsky, PhD Candidate



Human-  
Computer  
Interaction  
Institute



hcii.cmu.edu, axle-lab.com, dig.cmu.edu

# 2024: SotA in tech + innovation

**2025: SotA in *techniques*, too!**

# 2025: SotA in *techniques*, too!



(Many of these are based on my professional experience!)

# Identifying access barriers

# *Chartability* to evaluate accessibility



F. Elavsky, C. Bennett, and D. Moritz, “How accessible is my visualization? Evaluating visualization accessibility with *Chartability*,” Computer Graphics Forum, 2022.

# Bokeh's ~200 page open source, open access, accessibility audit

## Elavsky et al "Bokeh accessibility audit," 2025.

The screenshot shows the Bokeh Accessibility Audit website. At the top, there is a navigation bar with links for "Bokeh Accessibility Audit", "Plot tools", "Plotting interface", and "Annotations". A search bar is also present. The main content area features a large title "Bokeh Accessibility Audit Summary" and a subtitle "[Date of latest draft: February 2025]". Below this, there is a section titled "# Introduction" which discusses the lack of previous audits and the grant from CZI EOSS. It also mentions the findings and suggestions section, the number of documents (76), and the three main themes found. The right sidebar contains a "Table of contents" for the page, including sections like "Introduction", "Methodology", "Credits", "Overview of findings: problems and themes", and "Suggested directions for remediation". It also lists some specific recommendations: "Focus on text experiences: explanations, descriptions, and labels", "Use better building materials", "Build a flexible system", and "Help developers succeed". At the bottom, there is a link to "Edit on GitHub".

Bokeh Accessibility Audit

Plot tools Plotting interface Annotations

Search

## Bokeh Accessibility Audit Summary

[Date of latest draft: February 2025]

### # Introduction

Previously, no large-scale audits or evaluations of the accessibility of a data visualization library have been made publicly available.

Thanks to [CZI Essential Open Source Software \(EOSS\)](#) Cycle 6 grant "Accessible interactive data visualizations in Python with Bokeh," we have conducted a thorough, ecosystem-wide audit of the accessibility capabilities of the Python data visualization library, [Bokeh](#).

We present our audit's [Findings](#) and [Suggestions](#) in this summary document. There are a total of 76 documents that contain evidence of different accessibility barriers in Bokeh's ecosystem.

**Findings:** To make sense of this volume of information, the first section of this summary ([Findings](#)) focuses on providing an overview of problems and themes present in all of the evidence we gathered from Bokeh's [plotting interface](#) (+30 tests with evidence of failure), [plot tools](#) (+20), and [annotations](#) (+26) artifacts.

**Themes:** The subsections of [Findings](#) below each represent higher level themes that emerged across the evidence we have gathered. Each theme's subsection contains an explanation of that theme, evidence of that theme (with links), and an example demonstration of what an accessibility barrier related to that theme looks like.

**Evidence citations:** Each of the evidence documents are cited using a prefix, A-, PI-, or PT- referring each to the abbreviations for "Annotations," "Plotting Interface," and "Plot Tools." We conducted full, systematic audits for each of these subsystems within Bokeh's ecosystem, as they are each responsible for different aspects of Bokeh's capabilities. A given evidence document then also has a suffix, which is the number corresponding to the listed number of failures within that subsystem. So in our audit of Bokeh's annotations subsystem, evidence "[A-2](#)" would correspond to the second test type that contained an error.

**Evidence documents:** Each citation to evidence links to a document of that evidence. Each evidence document contains

On this page

- # Introduction
- # Methodology
- # Credits
- # Overview of findings: problems and themes
  - # 1. Finding: Lacks *foundational* accessibility
  - # 2. Finding: Perceivability and understandability have barriers
  - # 3. Finding: System is fragile
- # Suggested directions for remediation
  - Focus on text experiences: explanations, descriptions, and labels
  - Use better building materials
  - Build a flexible system
  - Help developers succeed

Edit on GitHub

# Dev Support

# Automatic accessibility validation

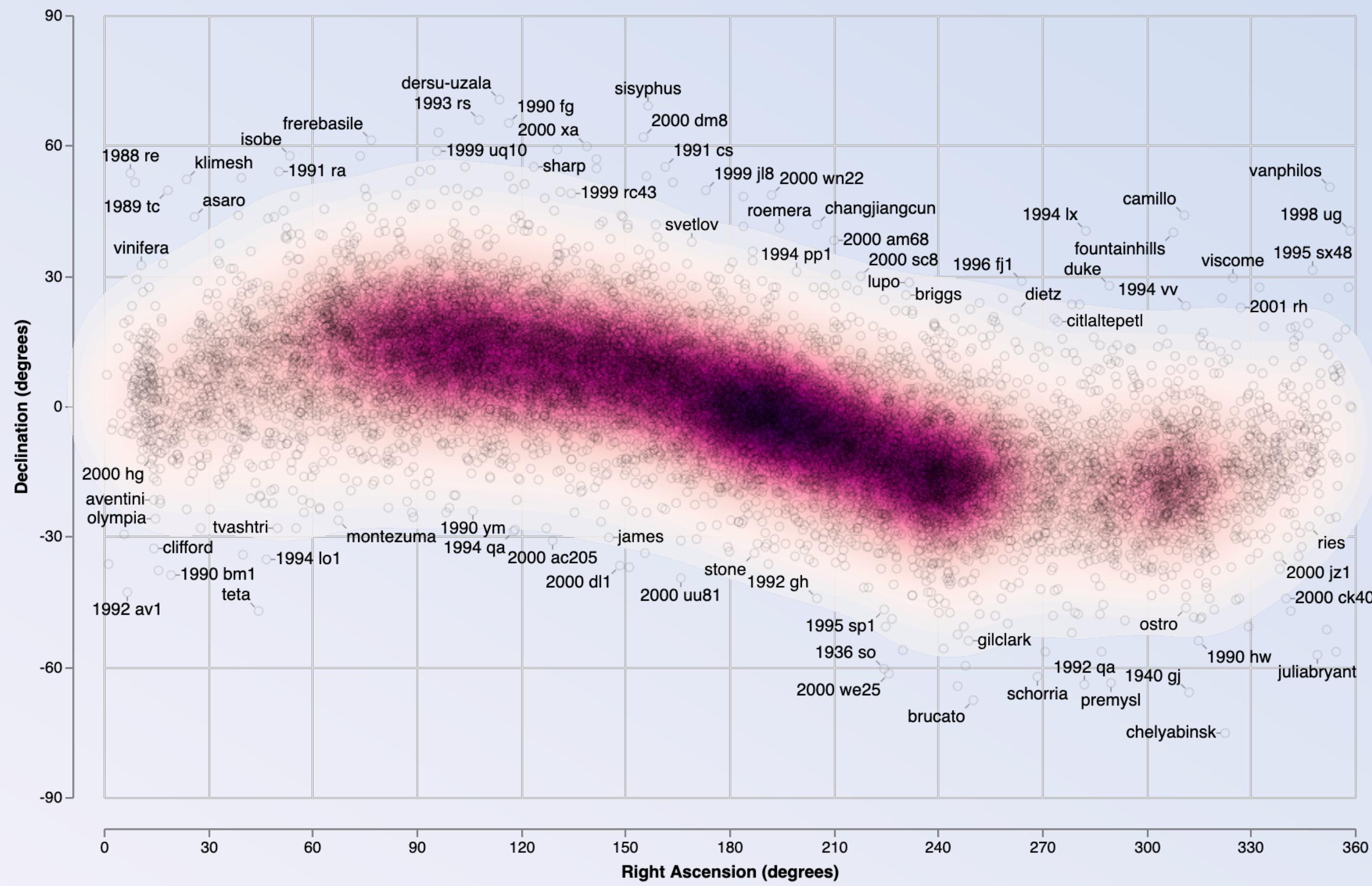
Source: Visa Chart Components, Frank Elavsky (2017-2019)

▶ bar-chart-1 has strong accessibility recommendations	<a href="#">bar-chart.entry.js:49478</a>
▼ bar-chart-2 has accessibility warnings and other messages	<a href="#">bar-chart.entry.js:49497</a>
⚠ ▶ longDescription: Either accessibility.longDescription or accessibility.contextExplanation is required	<a href="#">bar-chart.entry.js:49499</a>
⚠ ▶ executiveSummary: Either accessibility.purpose or accessibility.executiveSummary is required	<a href="#">bar-chart.entry.js:49499</a>
⚠ ▶ elementsAreInterface: elementsAreInterface must be a `boolean` type, but the final value was: `null`. If "null" is intended as an empty value be sure to mark the schema as `nullable()`	<a href="#">bar-chart.entry.js:49499</a>
longDescription: Either accessibility.longDescription or accessibility.contextExplanation should have minimum 40 characters and a combined length between 40 and 500 characters	<a href="#">bar-chart.entry.js:49481</a>
executiveSummary: Either accessibility.purpose or accessibility.executiveSummary should have minimum 40 characters and a combined length between 40 and 250 characters	<a href="#">bar-chart.entry.js:49481</a>
statisticalNotes: accessibility.statisticalNotes should have length between 40 and 250 characters	<a href="#">bar-chart.entry.js:49481</a>
structureNotes: accessibility.structureNotes should have length between 40 and 250 characters	<a href="#">bar-chart.entry.js:49481</a>

# Text Treatment

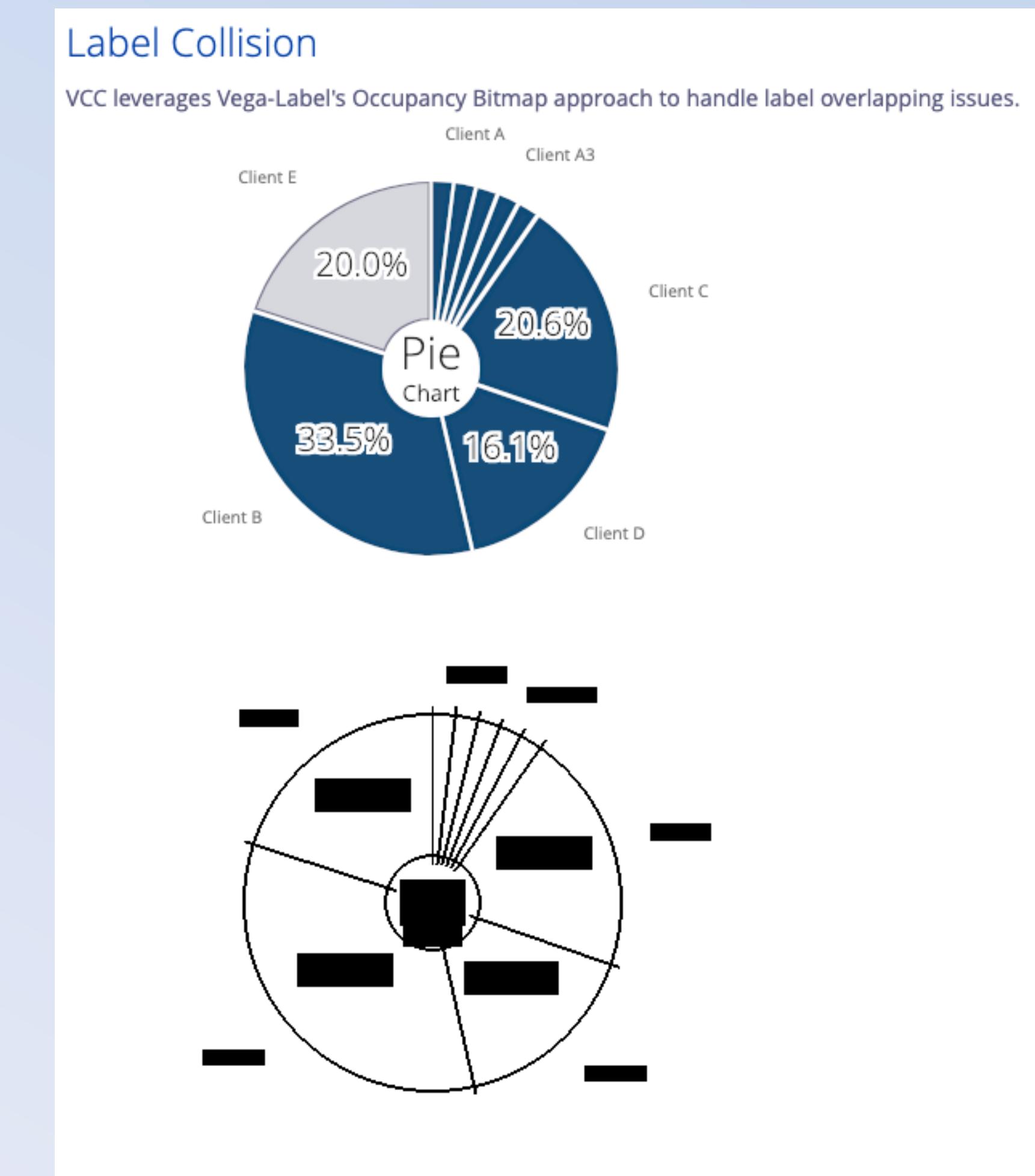
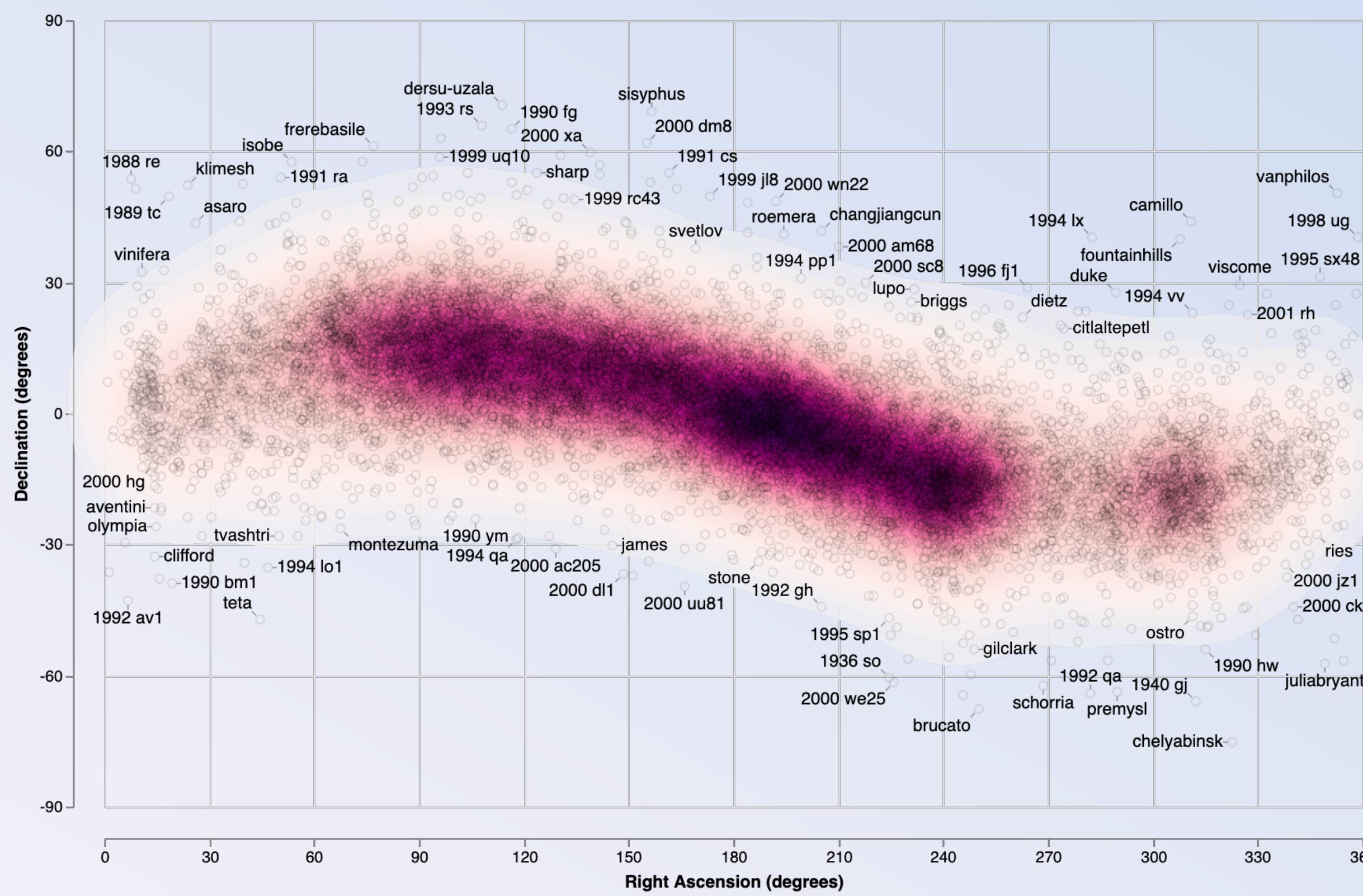
# Label collision detection

Source: Moritz et al?, Vega-label (2018-2020)



# Label collision detection

**Source: Moritz et al?, Vega-label (2018-2020)**



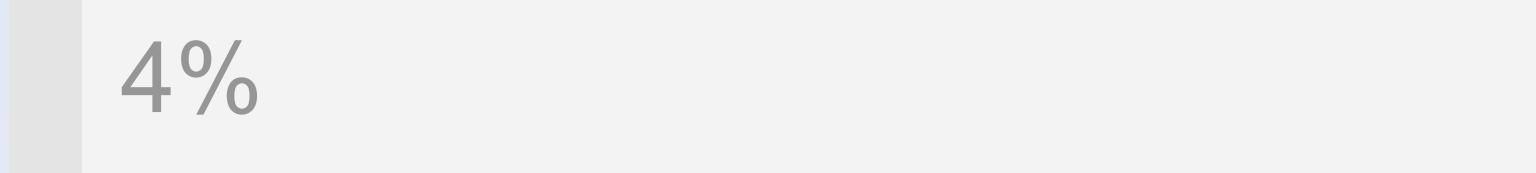
# Color and Contrast

# Understanding contrast

Based on web standards and simple, deterministic algorithms

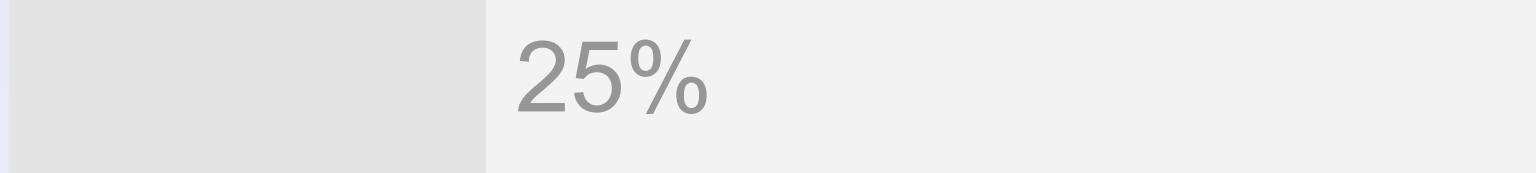
**Colorblindness Disproportionately Overrepresented in A11y Resources**

Colorblindness: % of People



4%

Low Vision: % of People



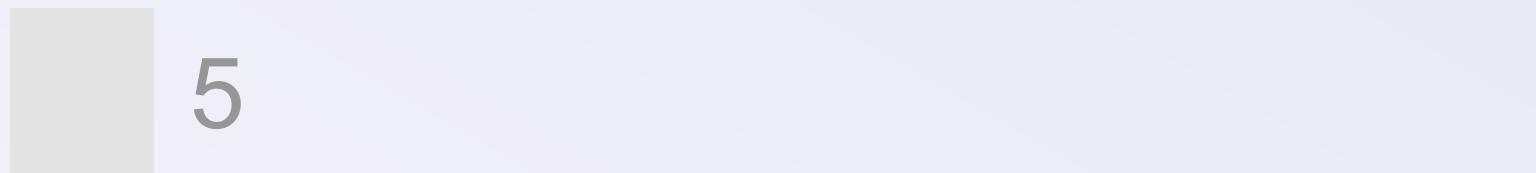
25%

Colorblindness: # of Resources



51

Low Vision: # of Resources



5

**Colorblindness Disproportionately Overrepresented in A11y Resources**

Colorblindness: % of People



4%

Low Vision: % of People



Colorblindness: # of Resources



51

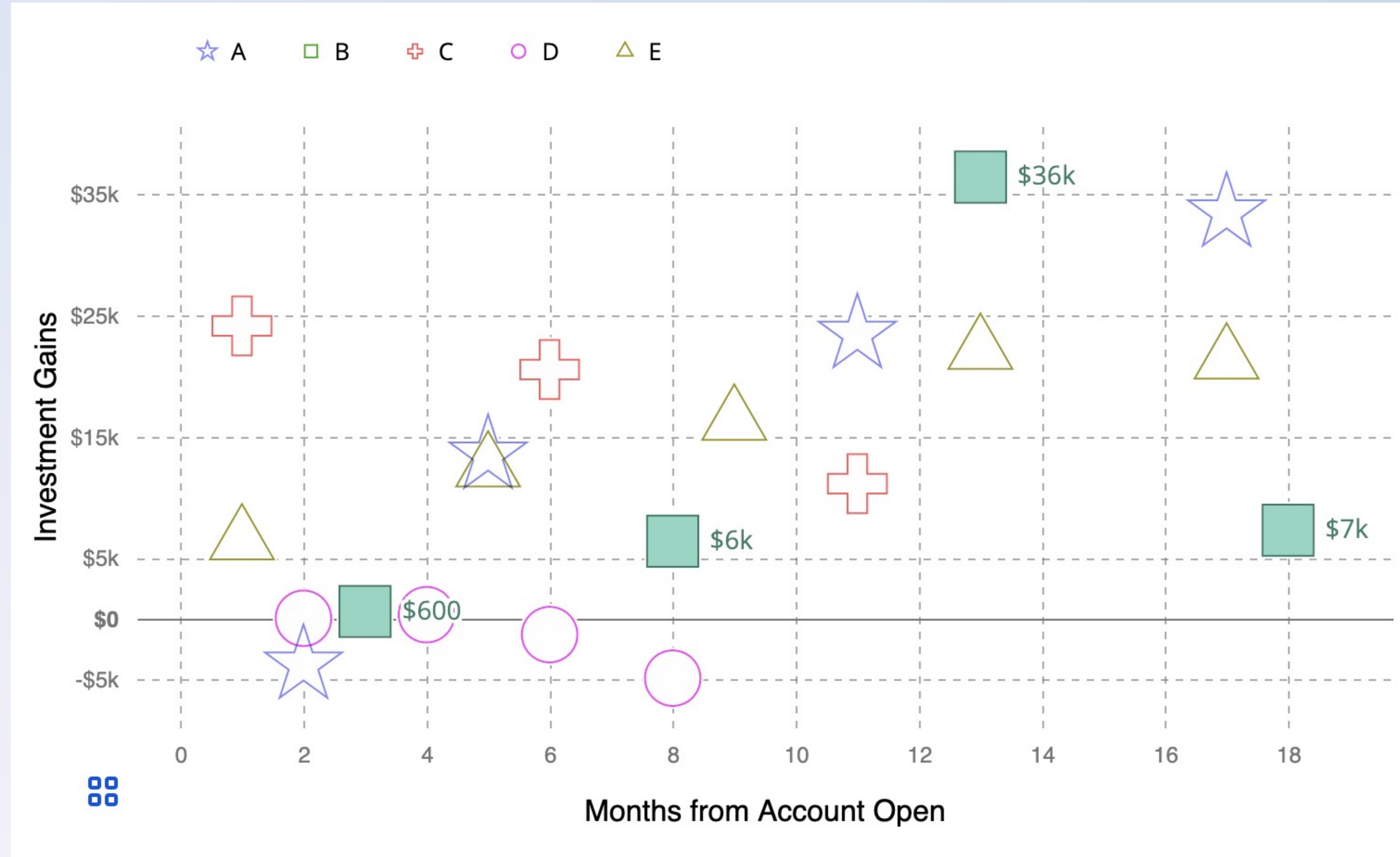
Low Vision: # of Resources



5

# Automatic contrast adjustment

Source: Visa Chart Components, Frank Elavsky (2017-2019)



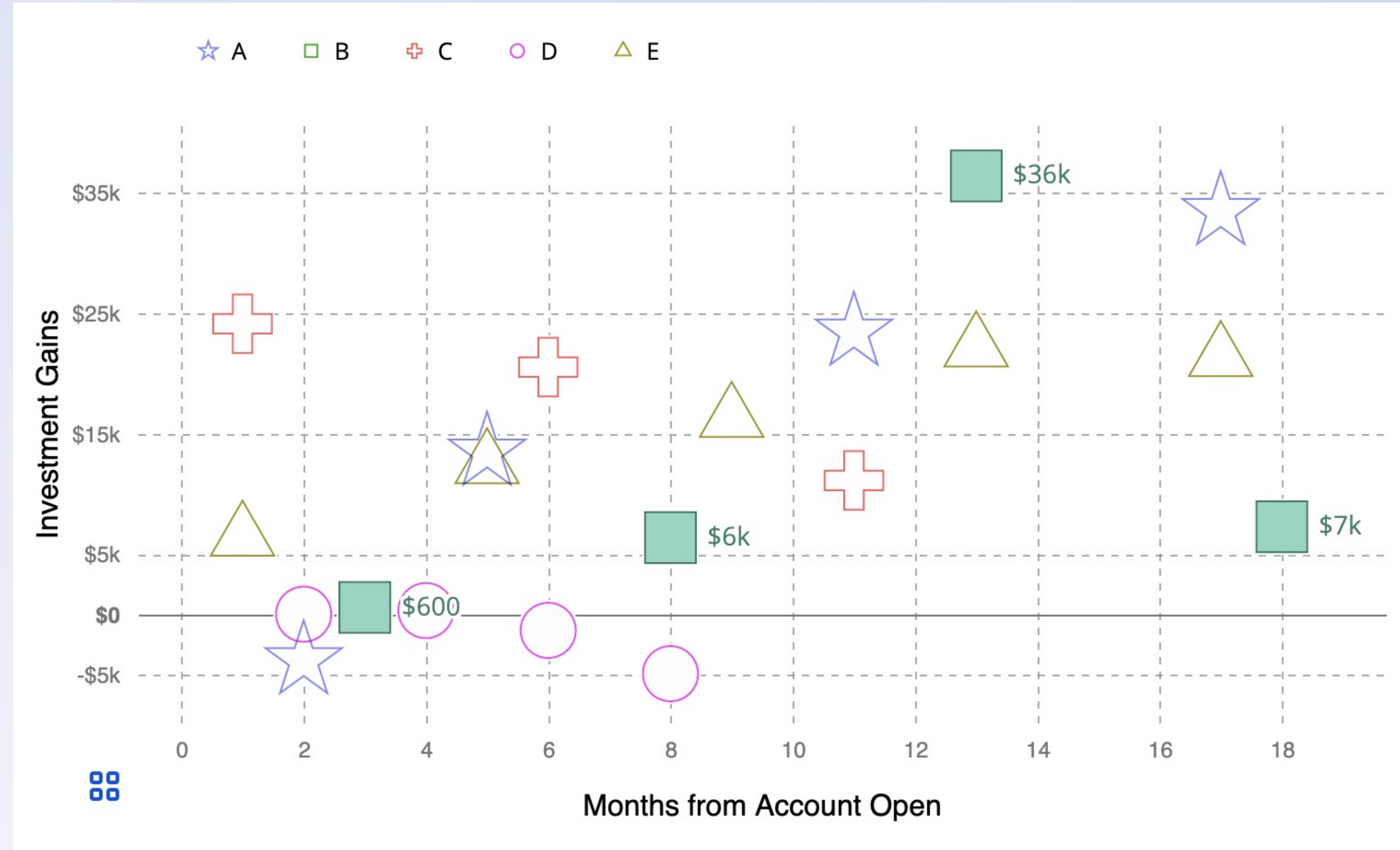
# Automatic contrast adjustment

Source: Visa Chart Components, Frank Elavsky (2017-2019)



# Automatic contrast adjustment

Source: Visa Chart Components, Frank Elavsky (2017-2019)



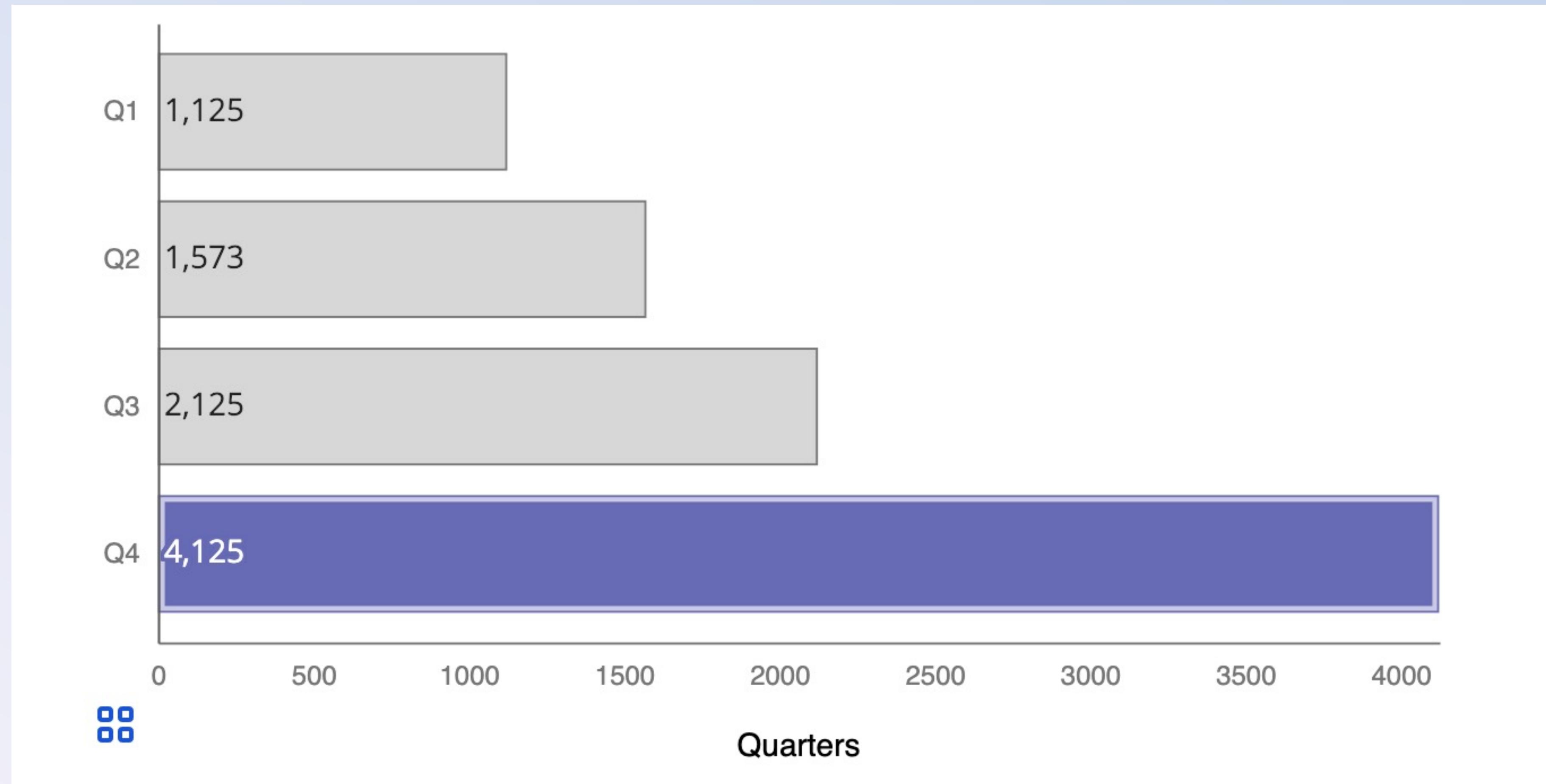
Input color: nearly white,  
but slightly more blue



Border added via  
HSL transform  
(retain H, but darken  
L until passing)

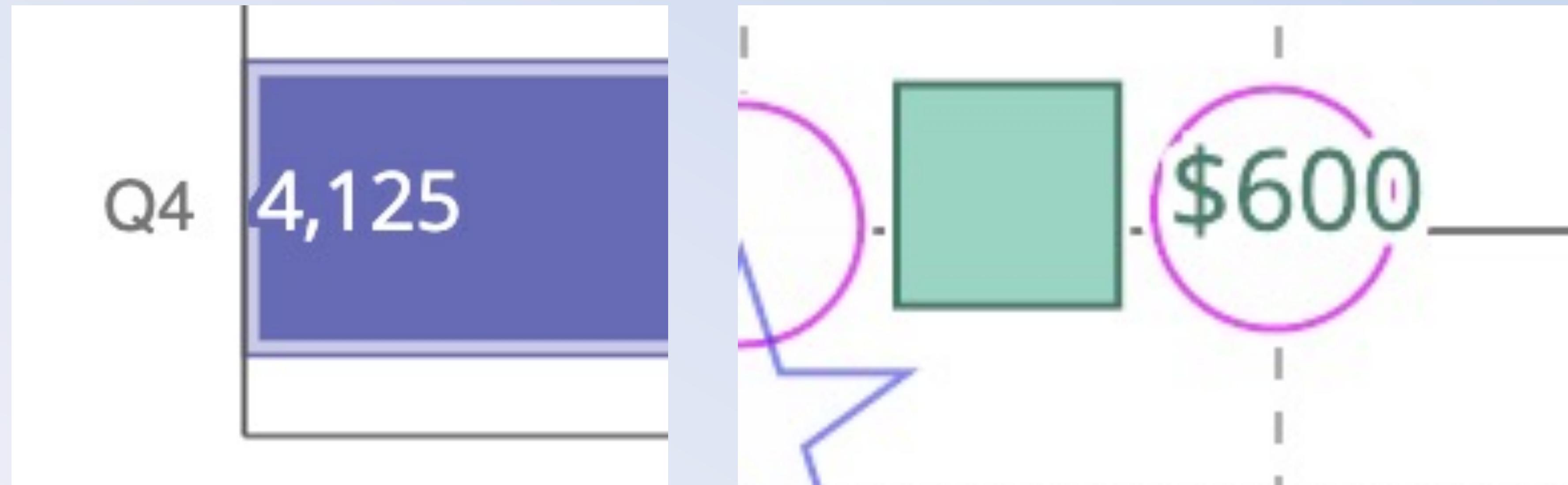
# Automatic text color

Source: Visa Chart Components, Frank Elavsky (2017-2019)



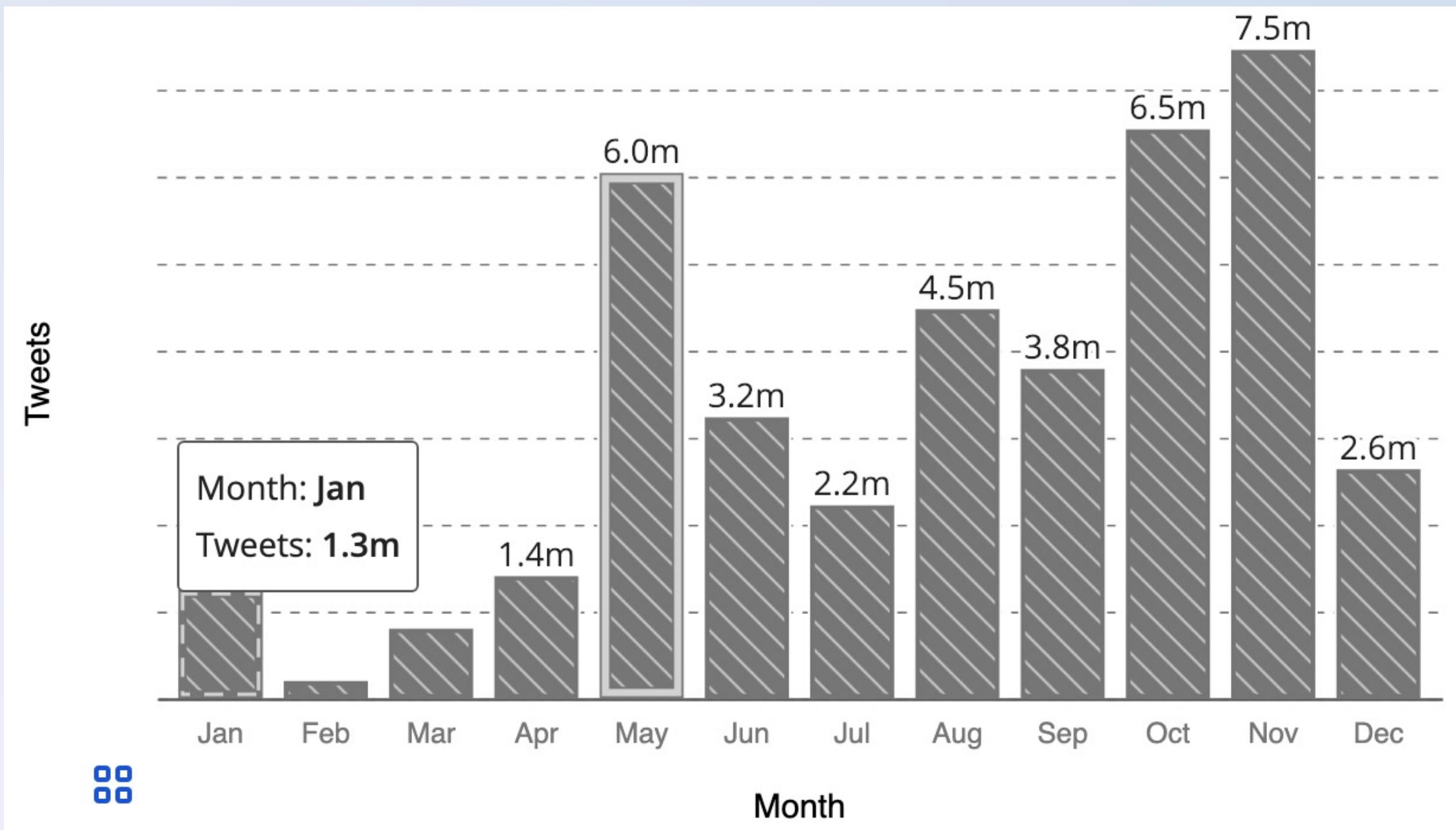
# Automatic text outlines

Source: Visa Chart Components, Frank Elavsky (2017-2019)



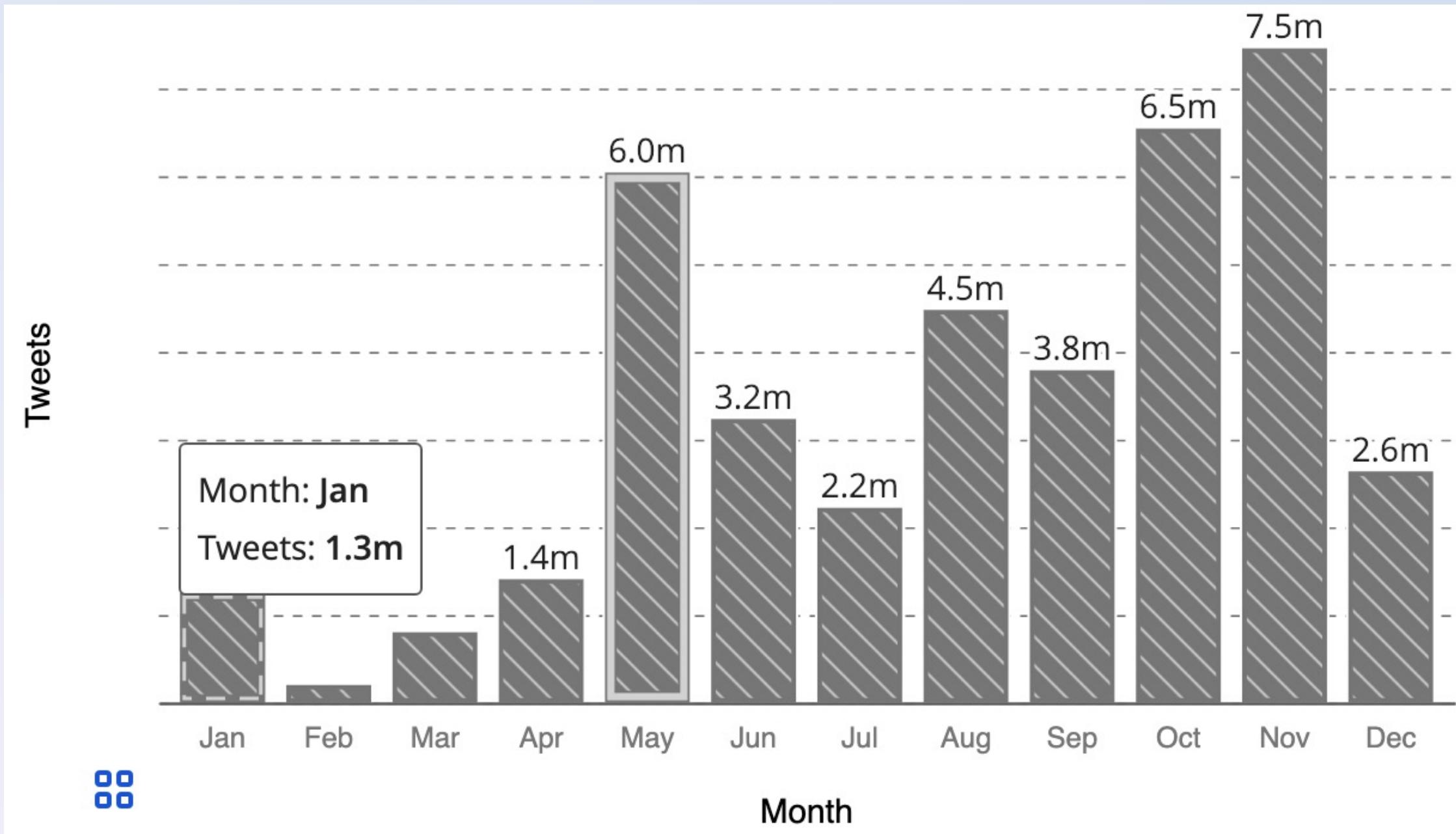
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



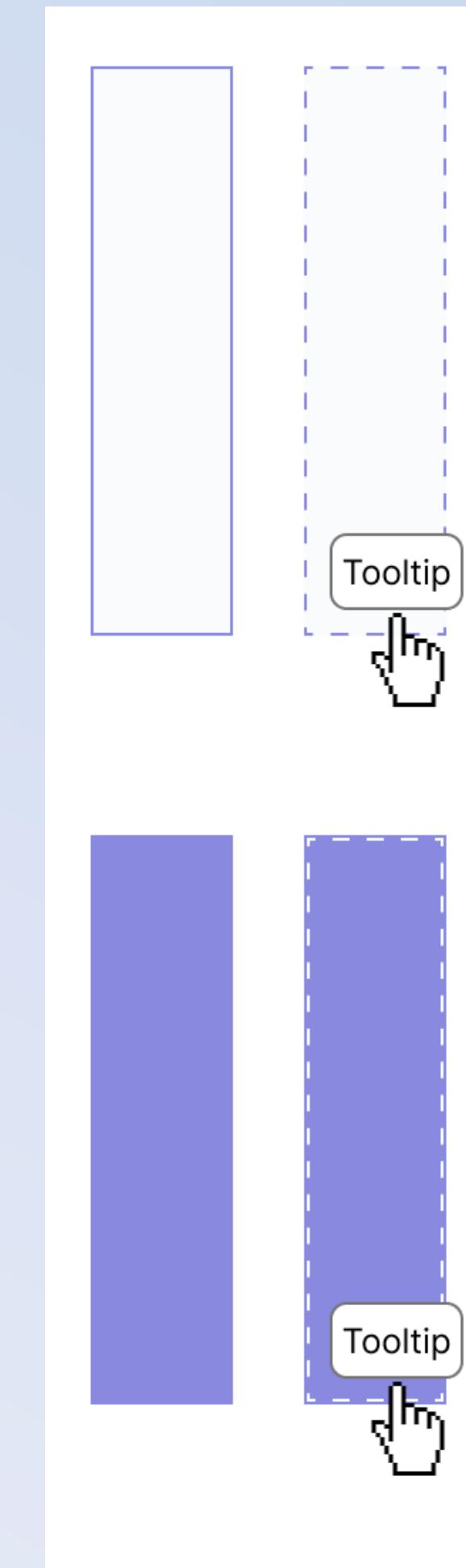
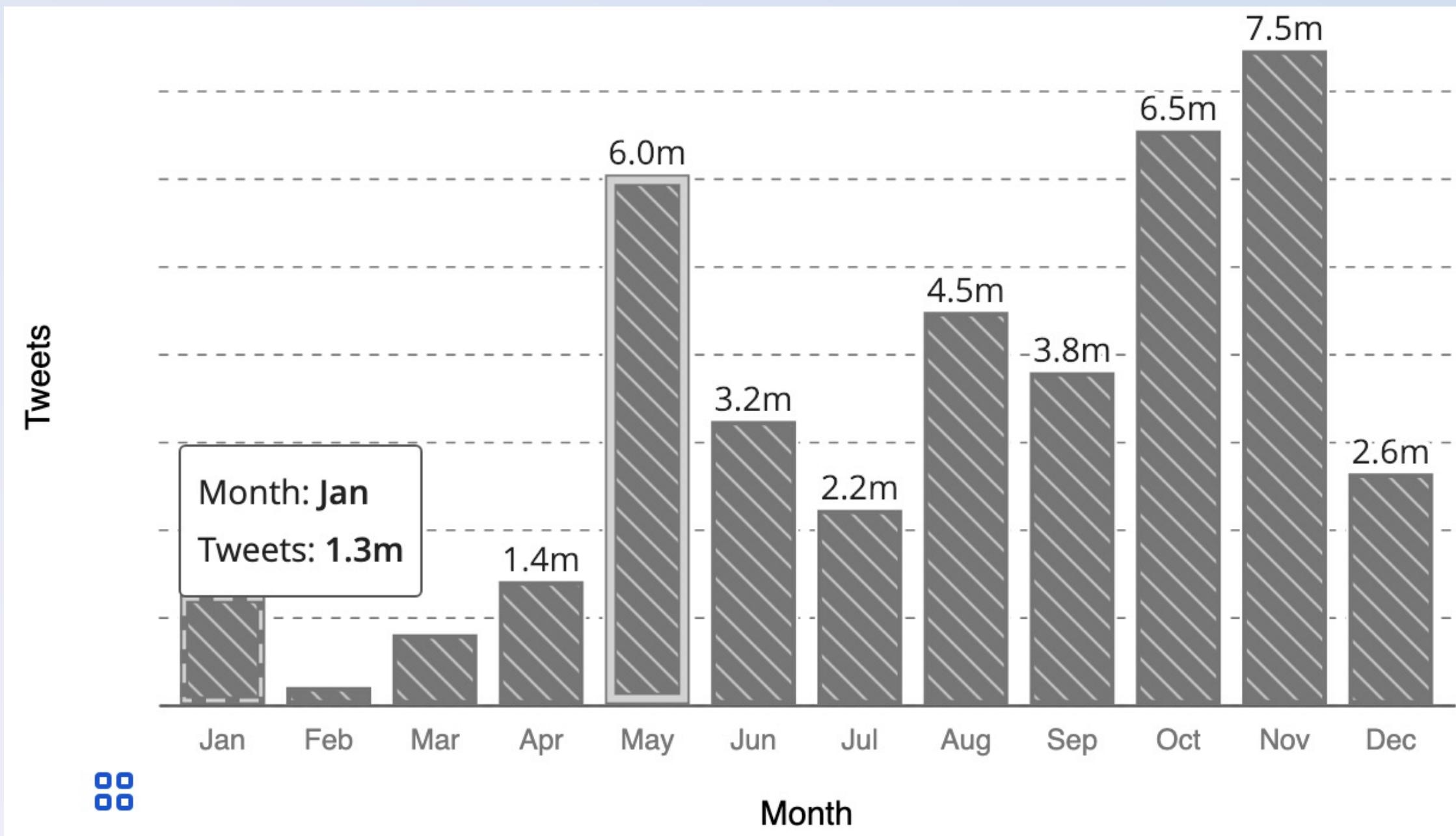
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



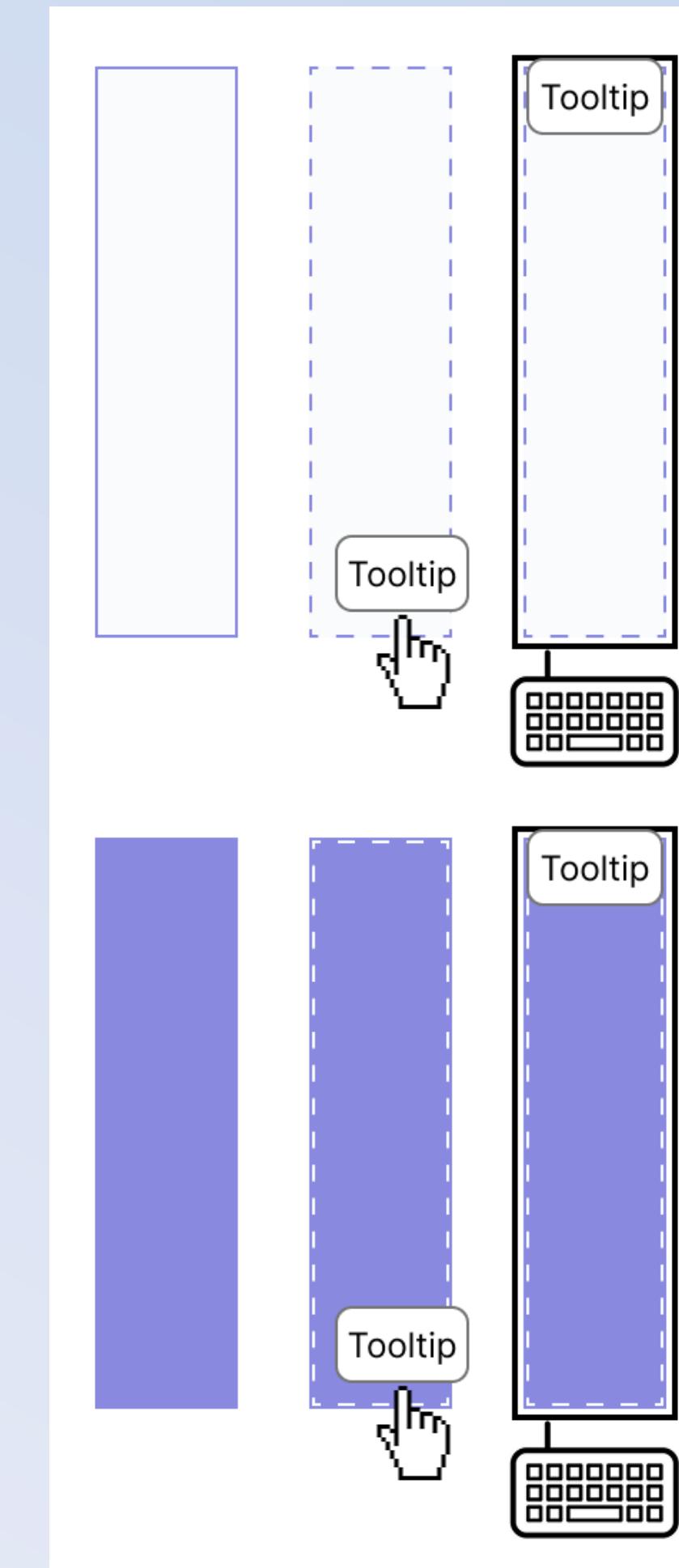
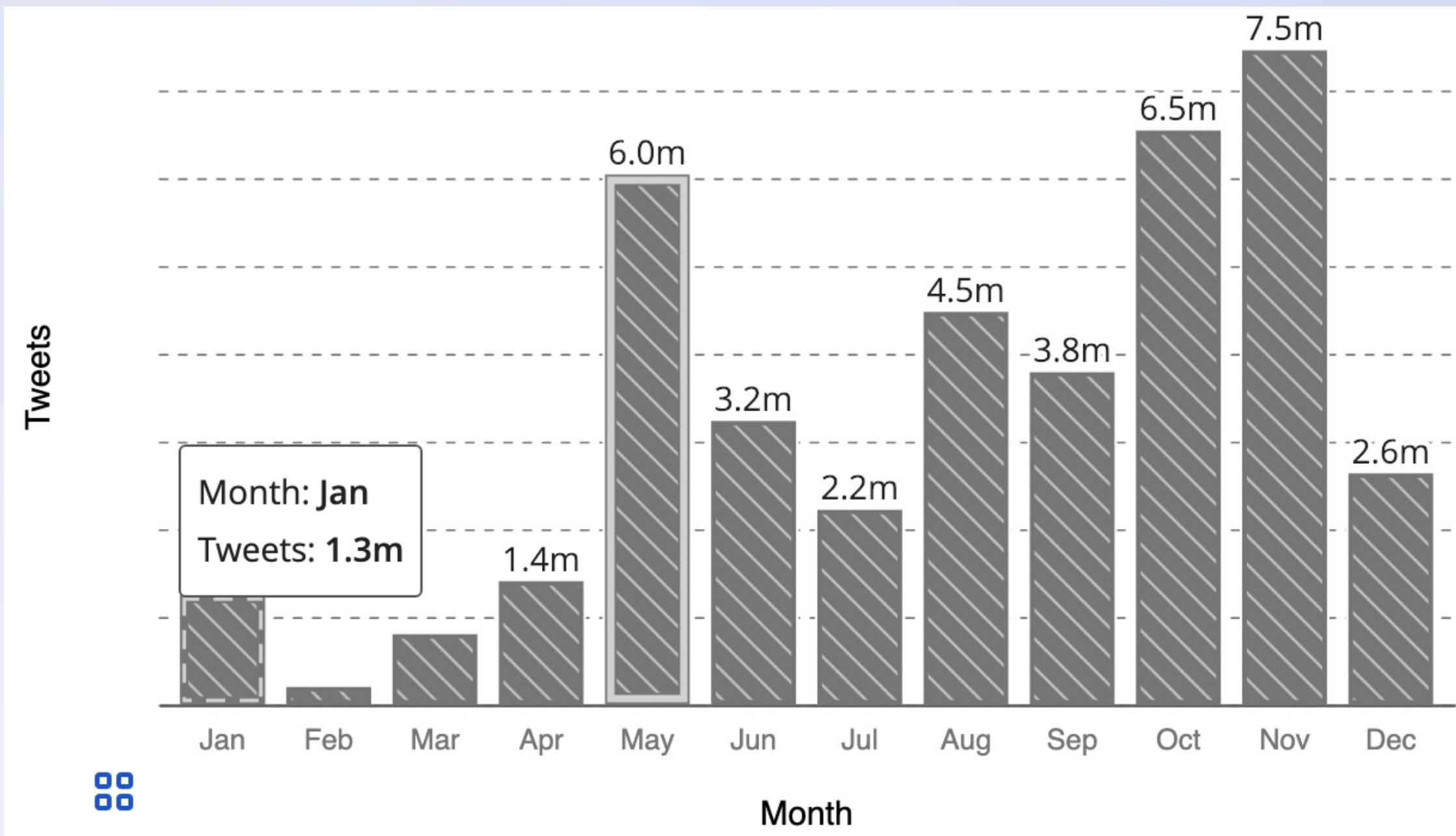
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



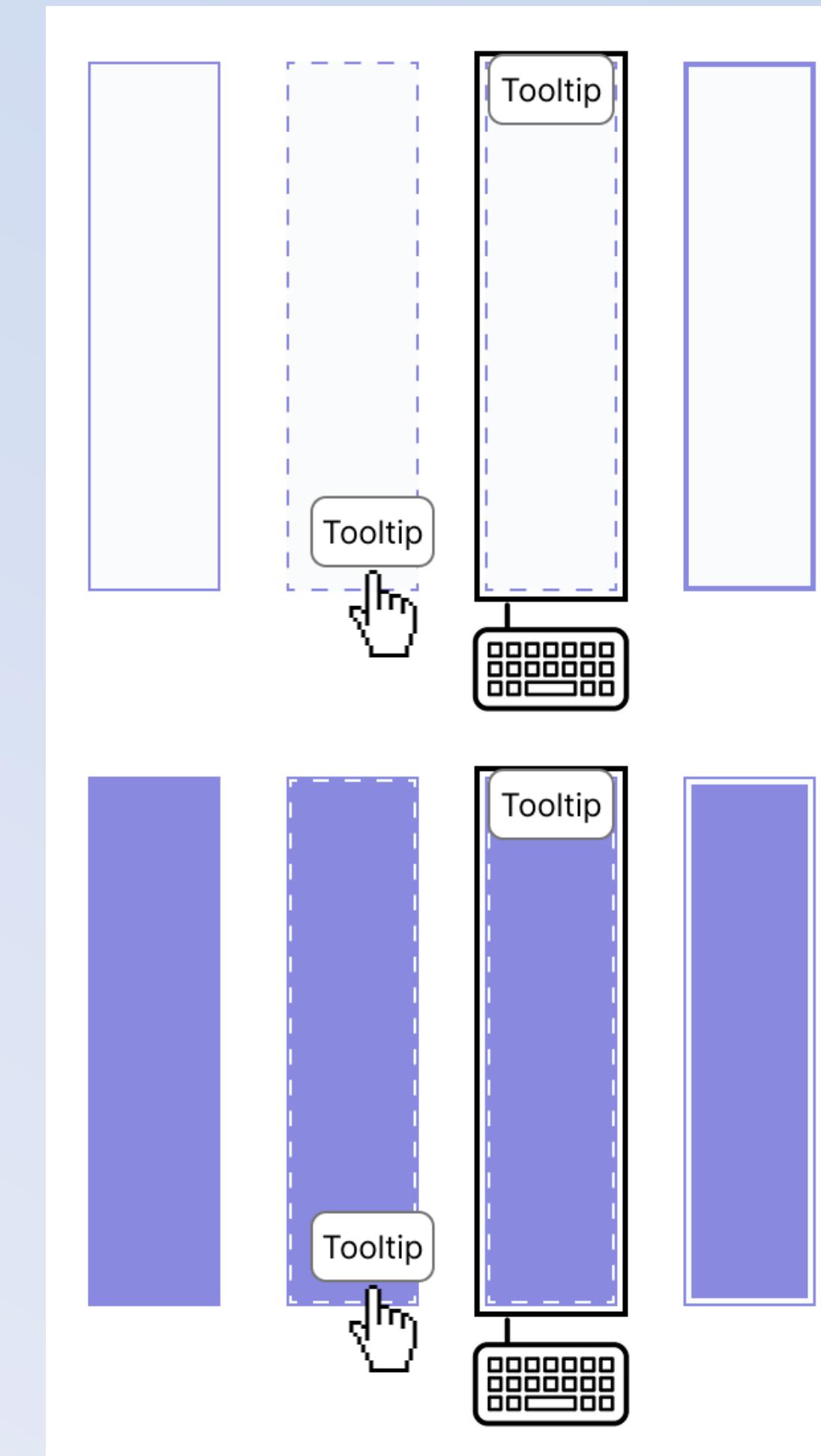
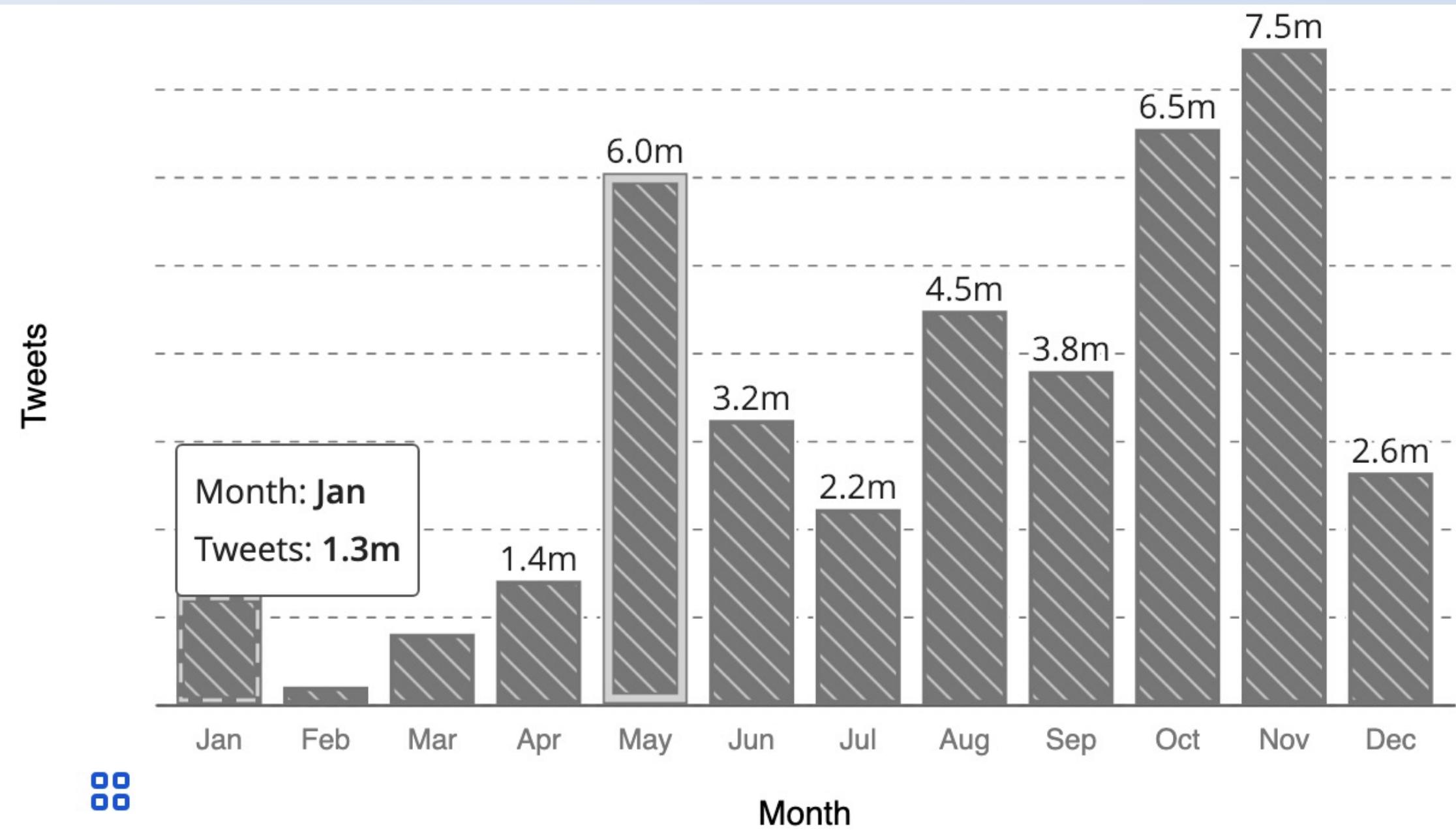
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



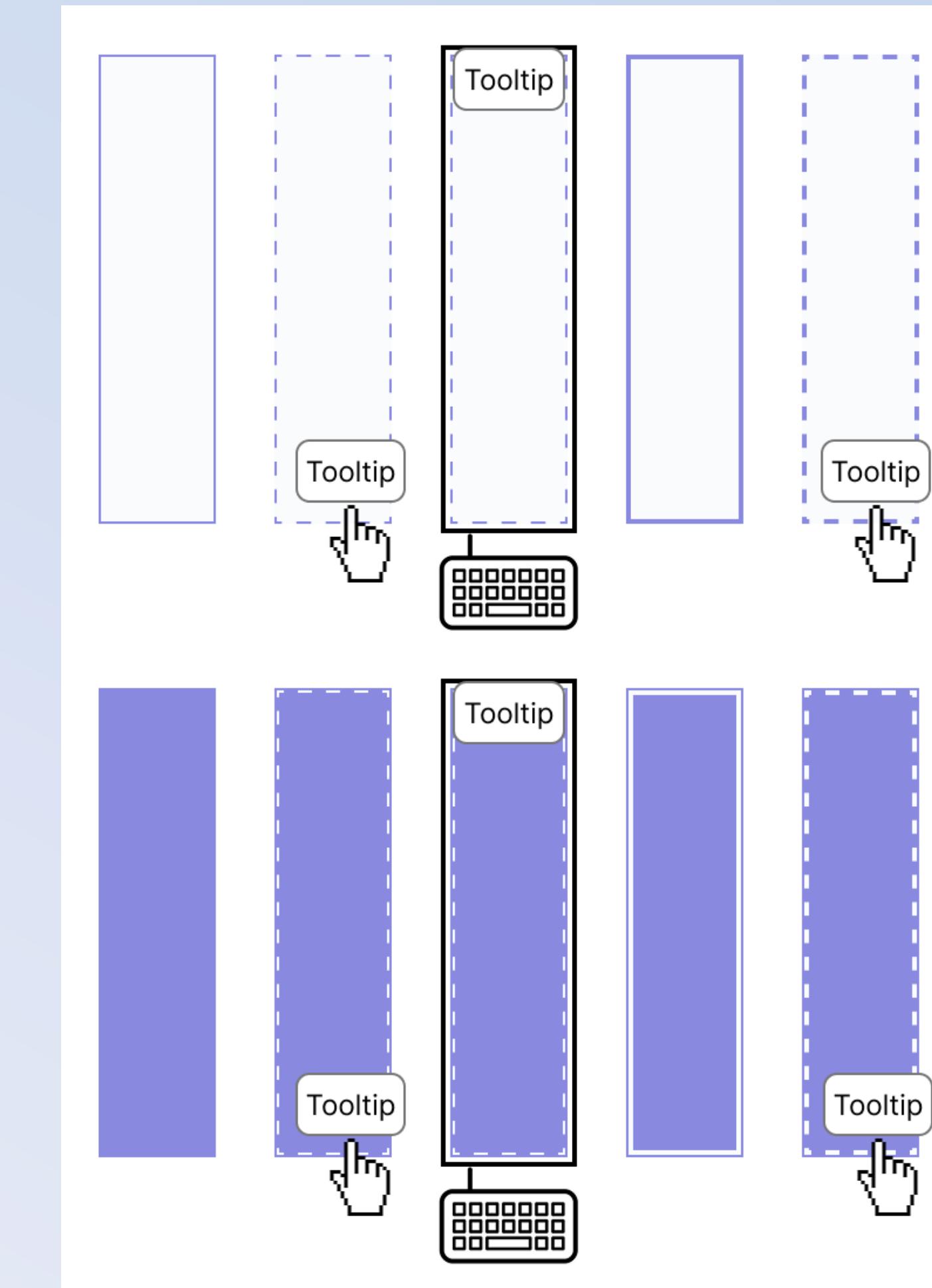
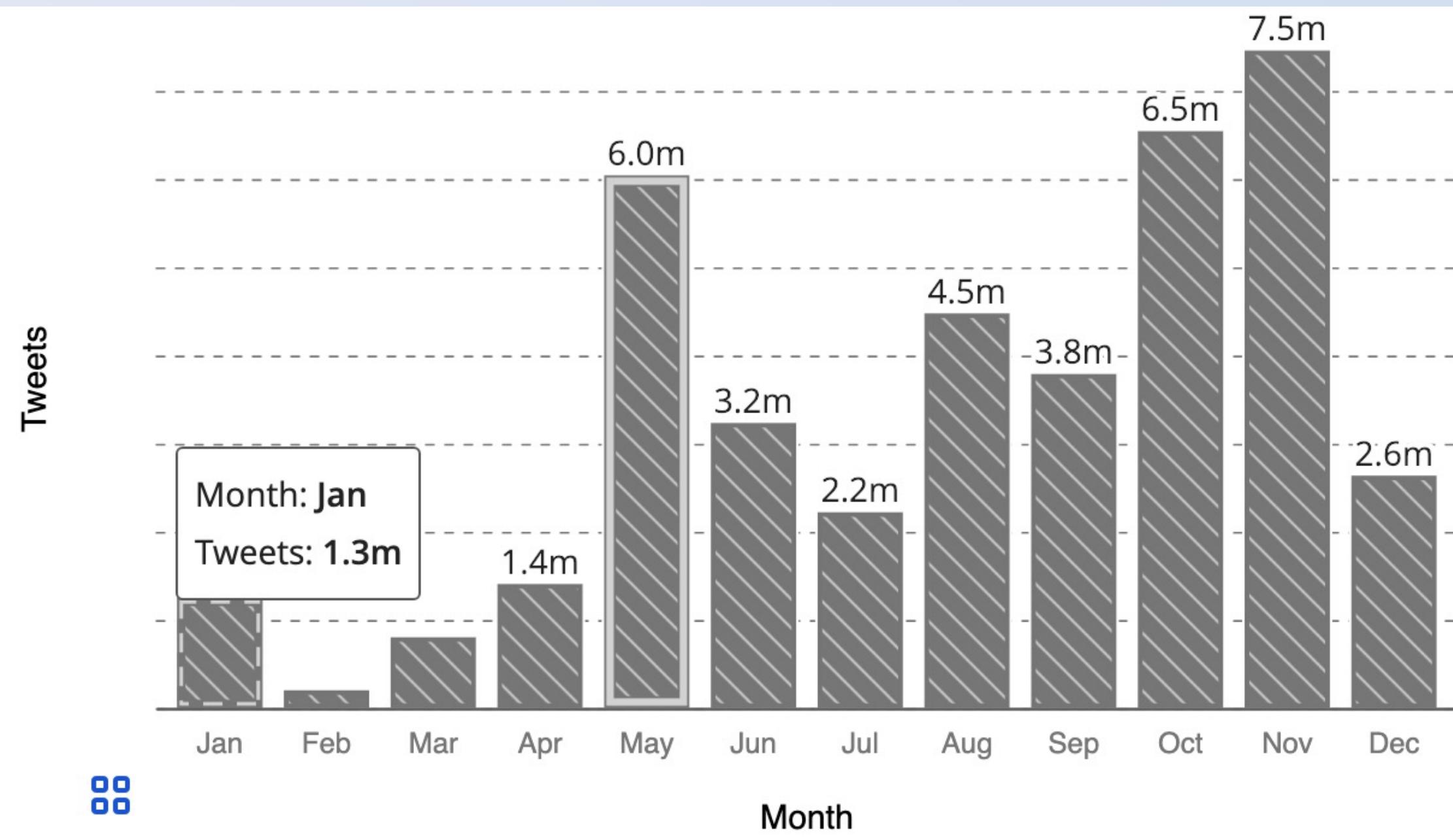
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



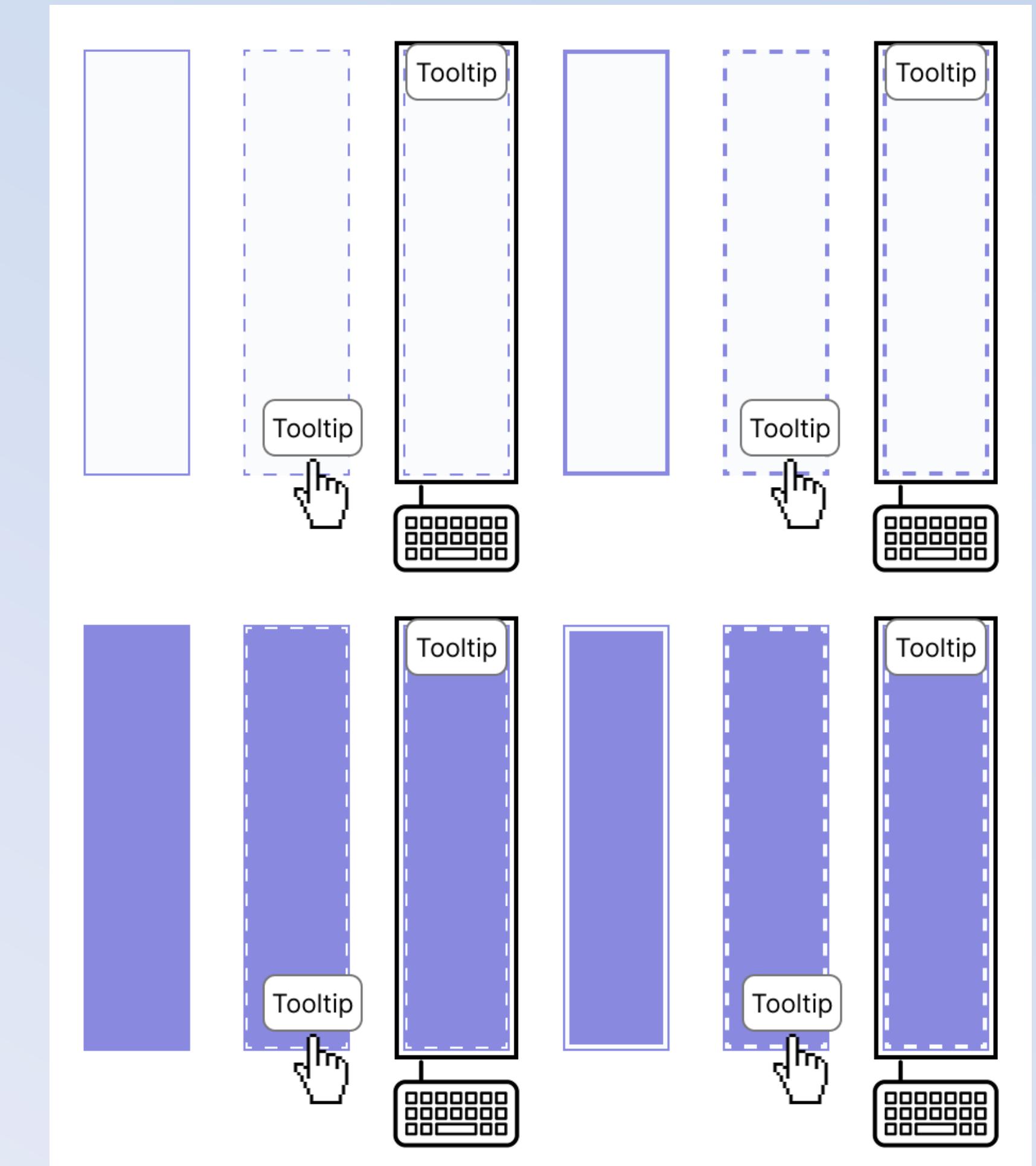
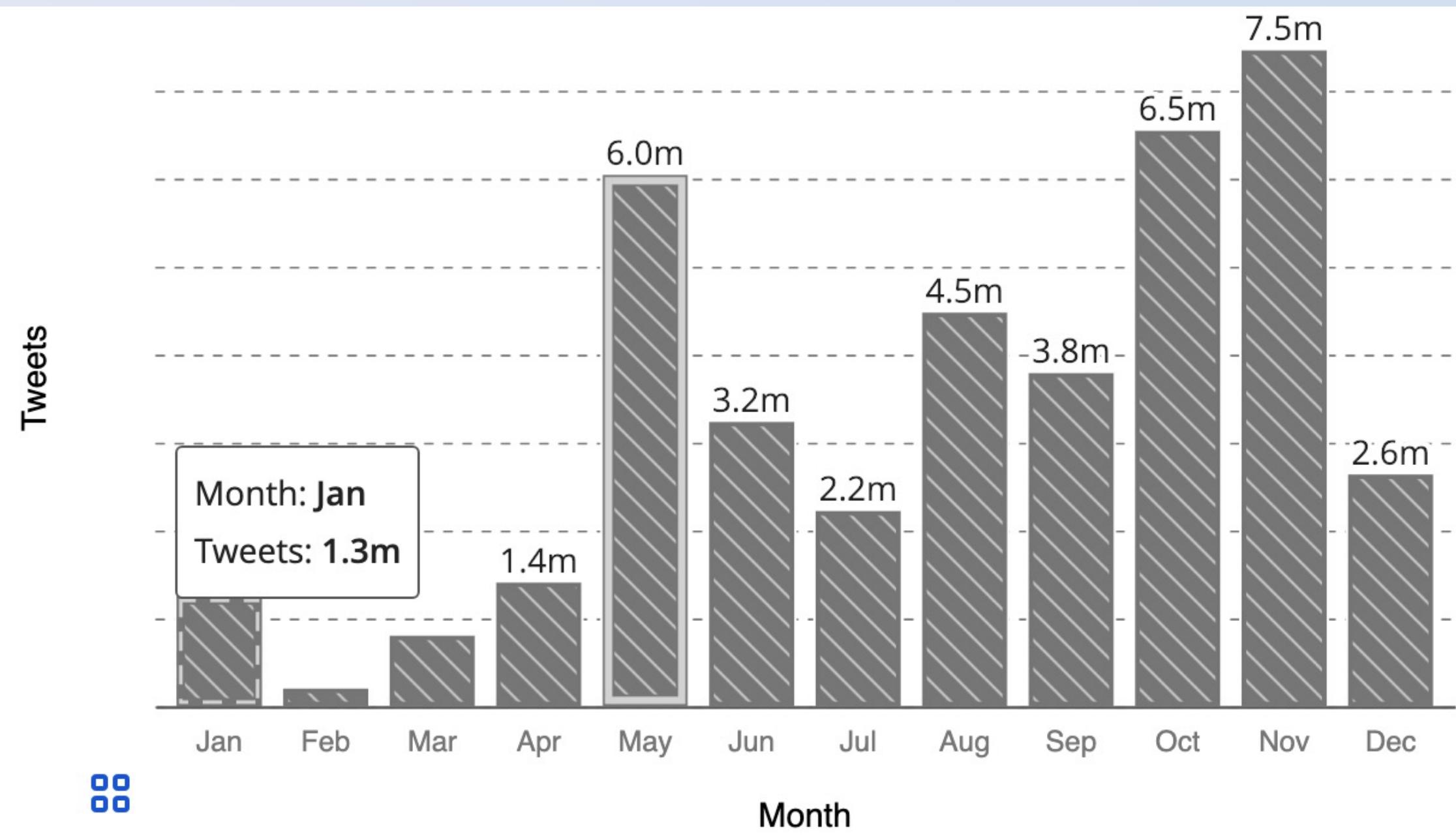
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



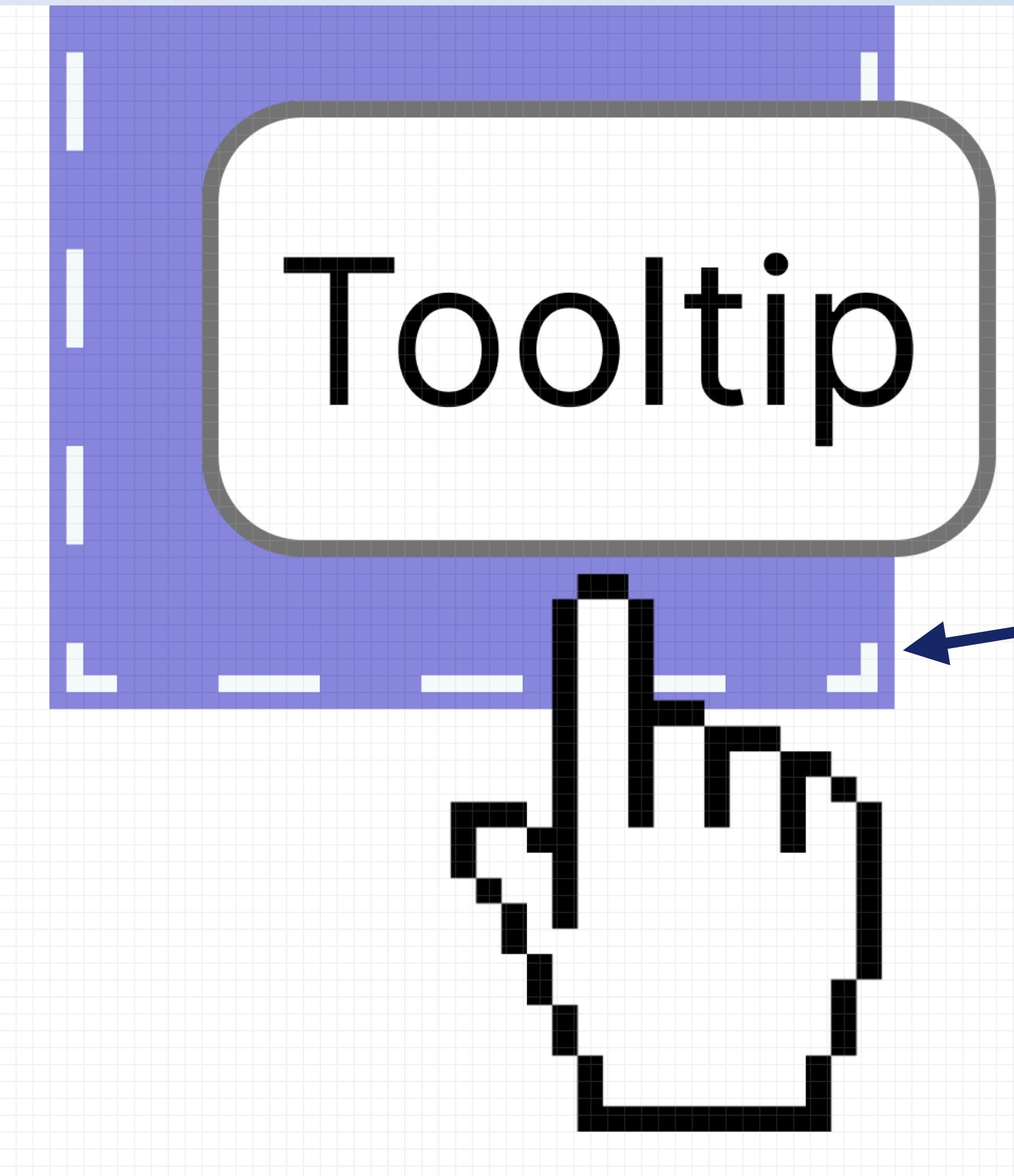
# Stroke interaction states

Source: Visa Chart Components, Frank Elavsky (2017-2019)



# Stroke interaction states

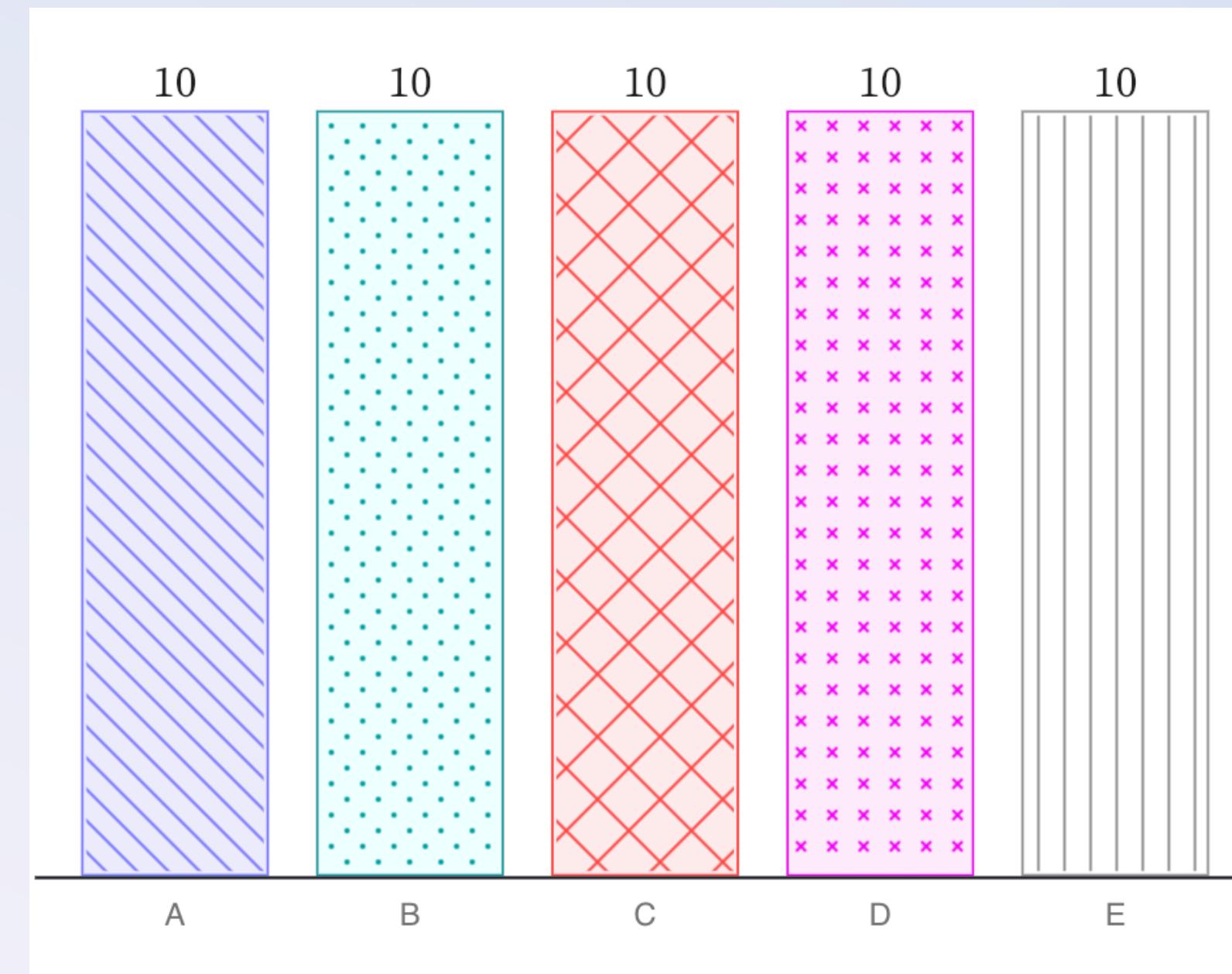
Source: Visa Chart Components, Frank Elavsky (2017-2019)



I spent weeks on  
this border design!!

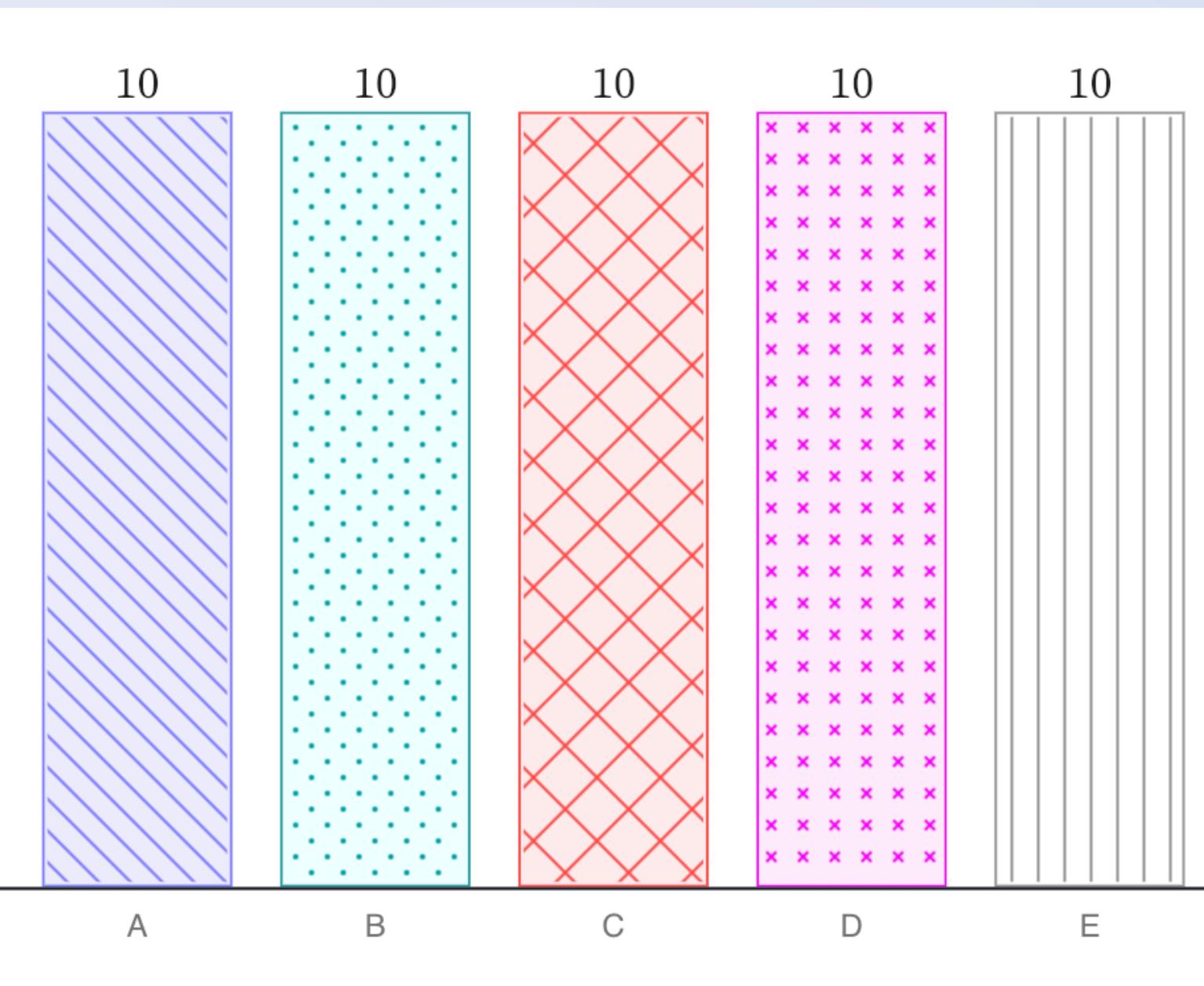
# Textures, patterns, and fills: categorical

Source: Visa Chart Components, Frank Elavsky (2017-2019)



# Textures, patterns, and fills: categorical

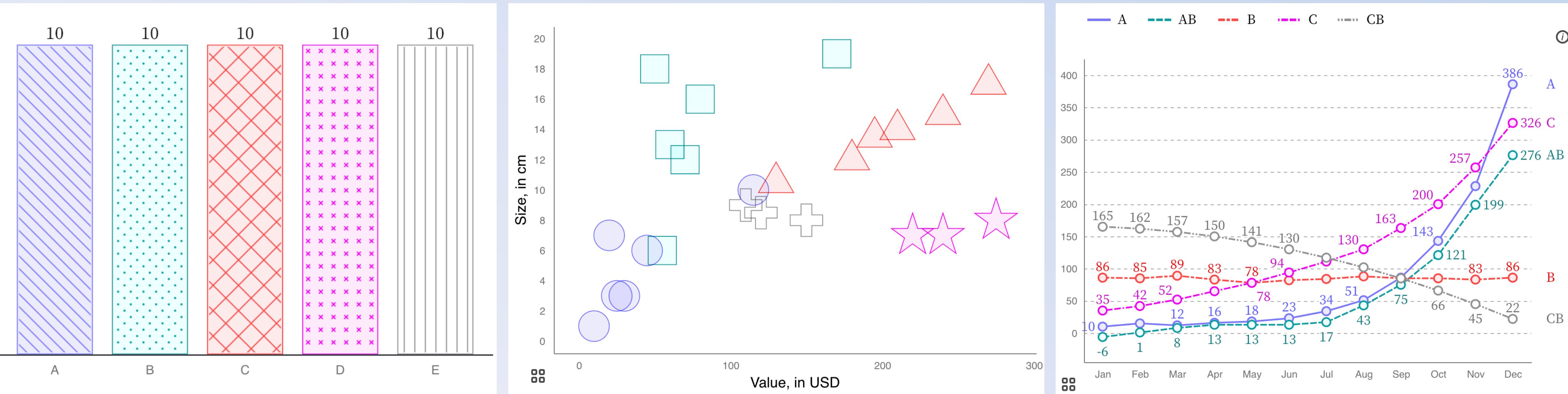
Source: Visa Chart Components, Frank Elavsky (2017-2019)



I also spent weeks on  
the border spacing in  
our texture design!!

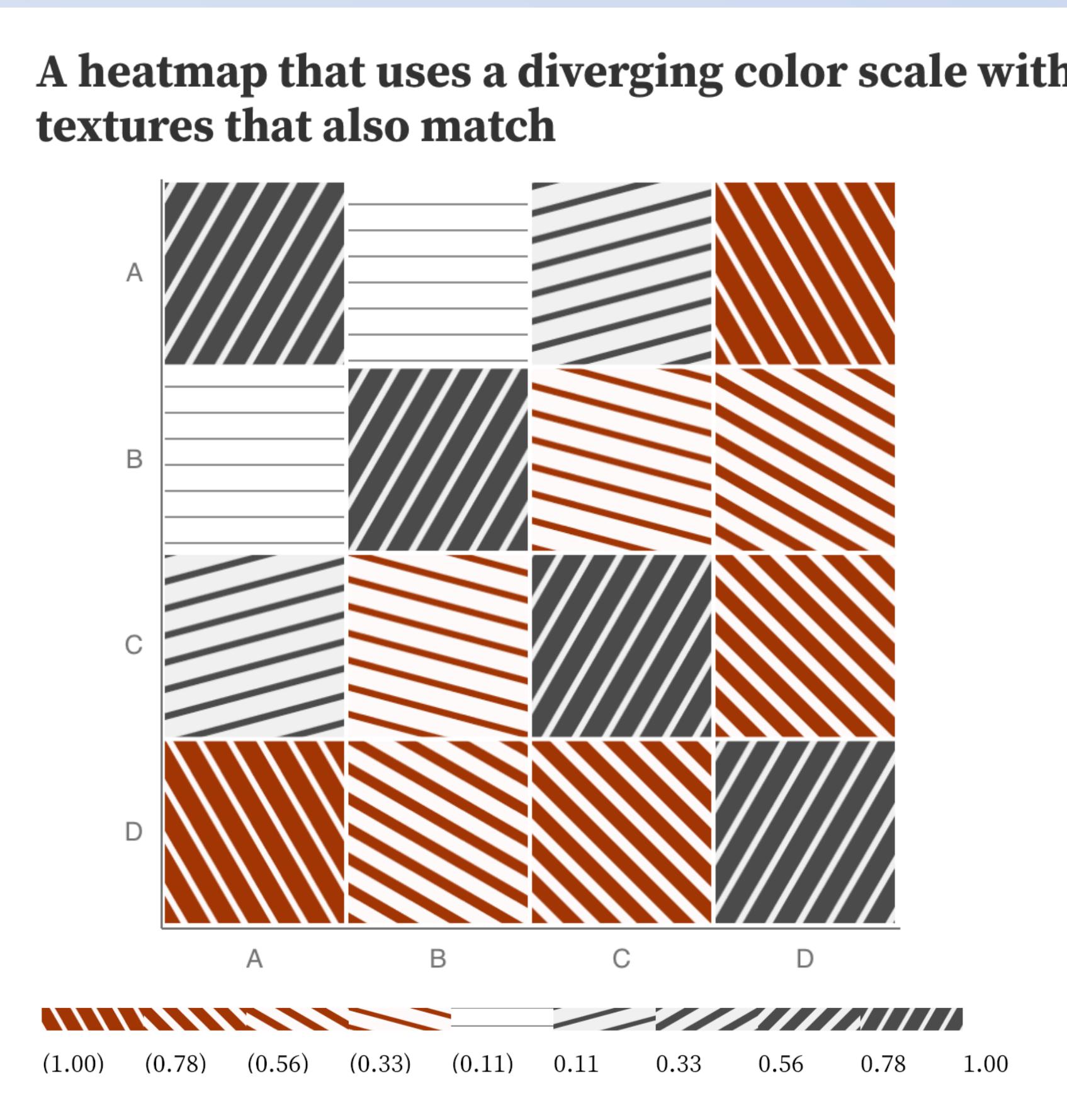
# Textures, patterns, and fills: categorical

Source: Visa Chart Components, Frank Elavsky (2017-2019)



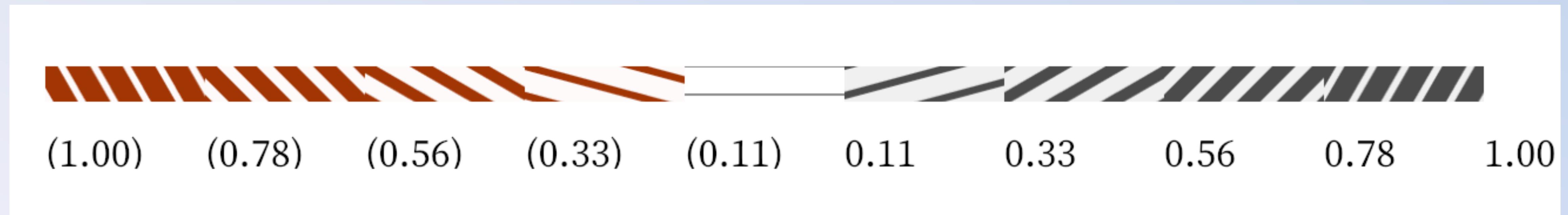
# Textures, patterns, and fills: numerical?

Source: Visa Chart Components, Frank Elavsky (2020)



# Textures, patterns, and fills: numerical?

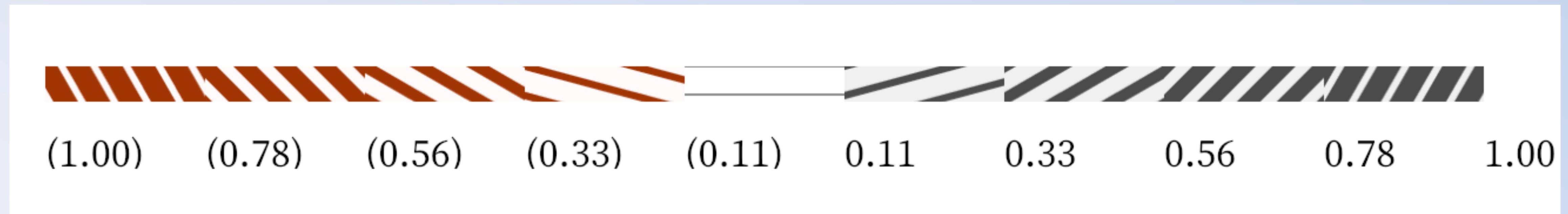
Source: Visa Chart Components, Frank Elavsky (2017-2019)



# Textures, patterns, and fills: numerical?

Source: Visa Chart Components, Frank Elavsky (2017-2019)

(Probably not useful, but  
was a fun experiment)



# Selecting colors for CVD and contrast

## Source: Chroma.js by Gregor Aisch, circa 2011-2013ish?

### Chroma.js Color Palette Helper

This [chroma.js](#)-powered tool is here to help us [mastering multi-hued, multi-stops color scales](#).

- 1 What kind of palette do you want to create?

Palette type:  sequential  diverging

Number of colors: 9

- 2 Select and arrange input colors

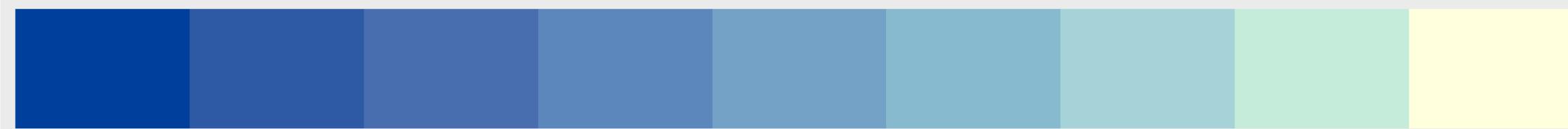
00429d 96ffea fffffe0

- 3 Check and configure the resulting palette

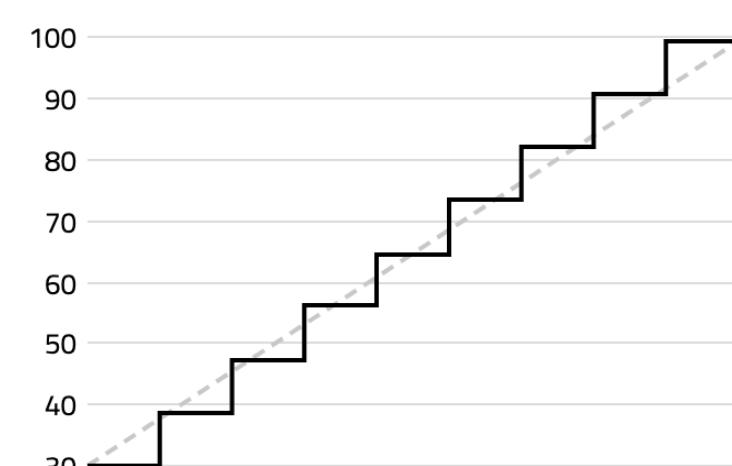
correct lightness  bezier interpolation

✓ This palette is colorblind-safe.

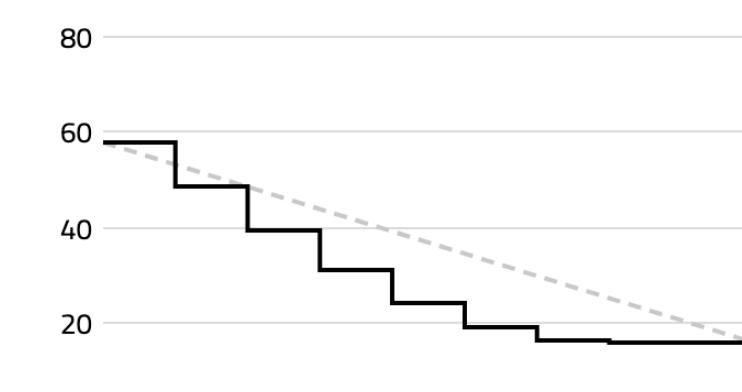
simulate:  normal  deut.  prot.  trit.



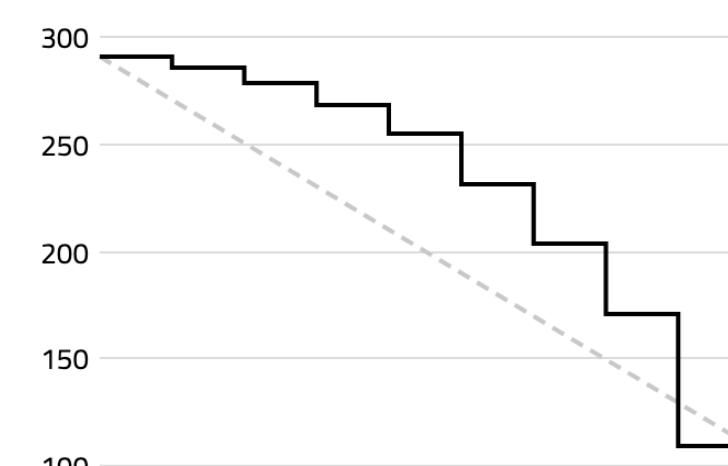
lightness



saturation



hue



# Selecting colors for CVD and contrast

## Source: Chroma.js by Gregor Aisch, circa 2011-2013ish?

### Chroma.js Color Palette Helper

This [chroma.js](#)-powered tool is here to help us [mastering multi-hued, multi-stops color scales](#).

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Palette type:  sequential  diverging

Number of colors: 9

- 2 Select and arrange input colors

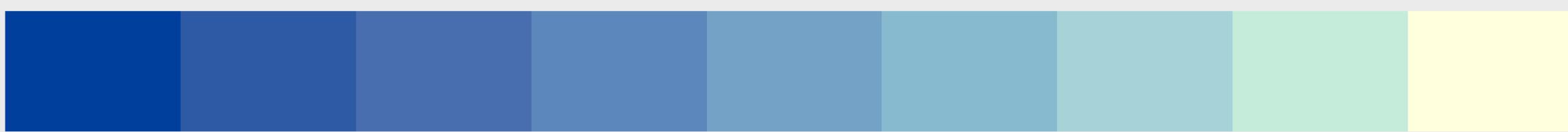
00429d 96ffea fffffe0

- 3 Check and configure the resulting palette

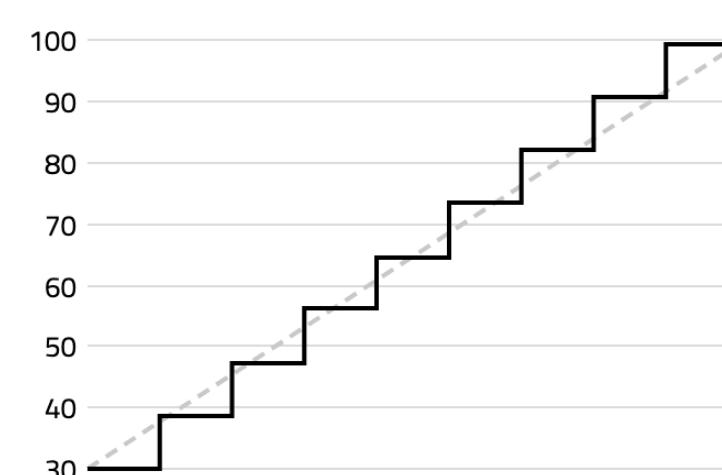
correct lightness  bezier interpolation

✓ This palette is colorblind-safe.

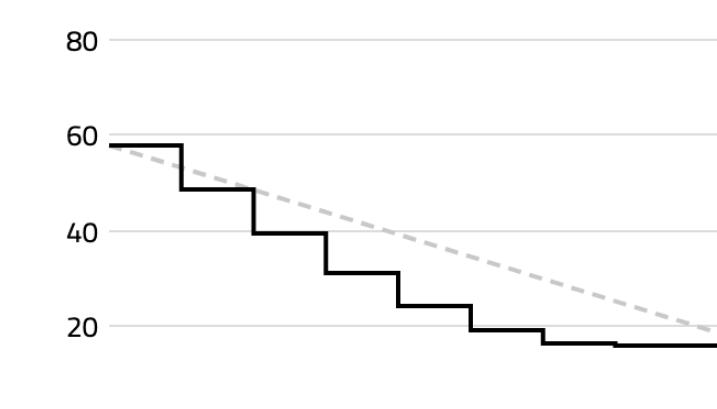
simulate:  normal  deut.  prot.  trit.



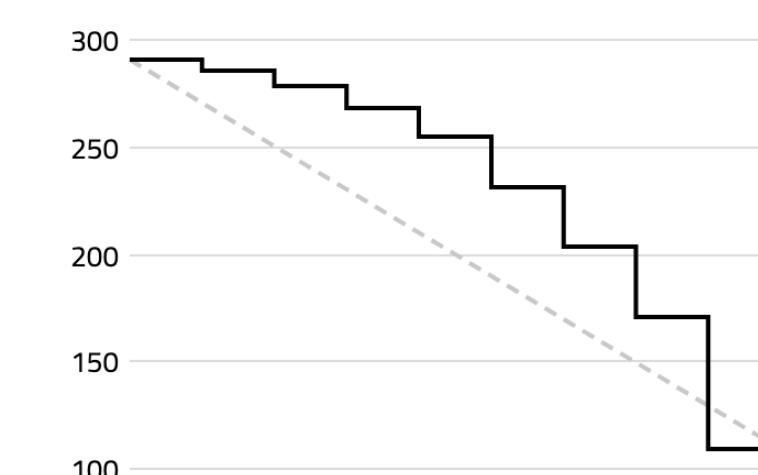
lightness



saturation



hue



### Chroma.js Color Palette Helper

This [chroma.js](#)-powered tool is here to help us [mastering multi-hued, multi-stops color scales](#).

- 1 What kind of palette do you want to create?

Palette type:  sequential  diverging

Number of colors: 4

- 2 Select and arrange input colors

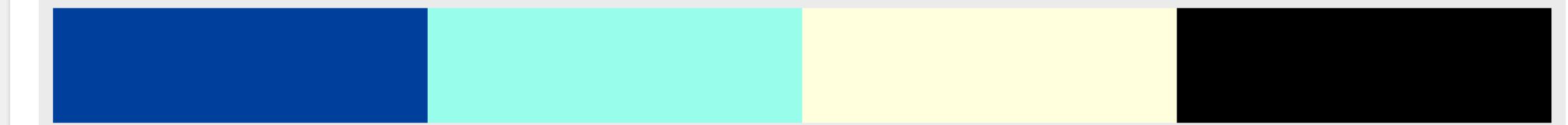
00429d 96ffea fffffe0 000000

- 3 Check and configure the resulting palette

correct lightness  bezier interpolation

✓ This palette is colorblind-safe.

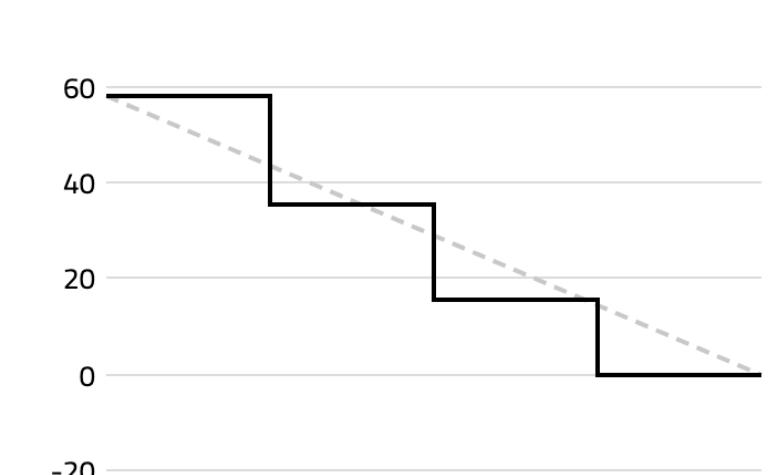
simulate:  normal  deut.  prot.  trit.



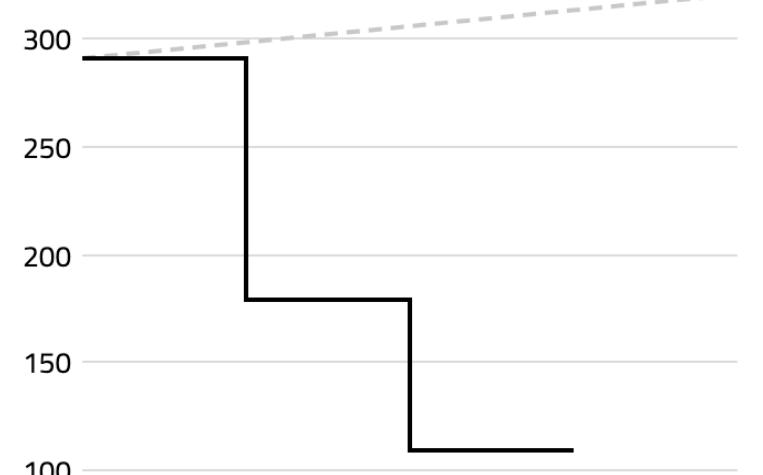
lightness



saturation



hue



# Selecting colors for CVD

Source: Susie Lu + Elijah Meeks, circa 2017ish?

### VIZ PALETTE

By: Elijah Meeks & Susie Lu

#### PICK

Use Chroma.js  
Add Replace

#### EDIT

7 Colors  
Add  hex  rgb  
 hsl  
≡ 1 #ffd700  
≡ 2 #ffb14e  
≡ 3 #fa8775  
≡ 4 #ea5f94  
≡ 5 #cd34b5  
≡ 6 #9d02d7  
≡ 7 #0000ff

#### GET

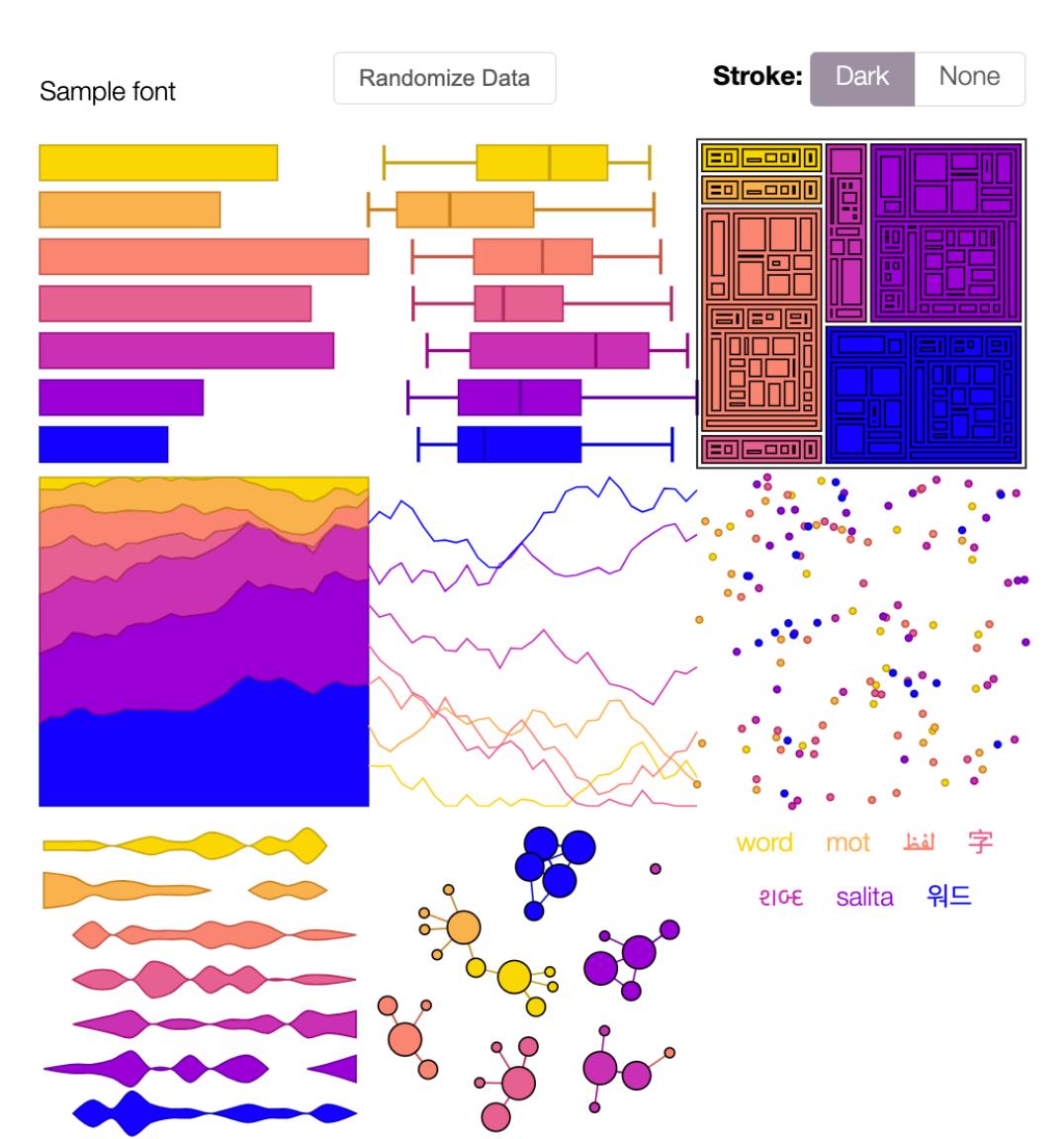
String quotes  
 Object with metadata  
["#ffd700", "#ffb14e", "#fa8775", "#ea5f94", "#cd34b5", "#9d02d7", "#0000ff"]

### COLORS IN ACTION

Background color: #ffffff  
Font color: #000000  
Charts made with Semiotic

Color Population:  
No Color Deficiency - 96% Deuteranomaly - 2.7% Protanomaly - 0.66% Protanopia - 0.59%  
Deuteranopia - 0.56% Greyscale

Sample font Randomize Data Stroke: Dark None



### VIZ PALETTE

By: Elijah Meeks & Susie Lu

#### PICK

Use Chroma.js  
Add Replace

#### EDIT

7 Colors  
Add  hex  rgb  
 hsl  
≡ 1 #ffd700  
≡ 2 #ffb14e  
≡ 3 #fa8775  
≡ 4 #ea5f94  
≡ 5 #cd34b5  
≡ 6 #9d02d7  
≡ 7 #0000ff

#### GET

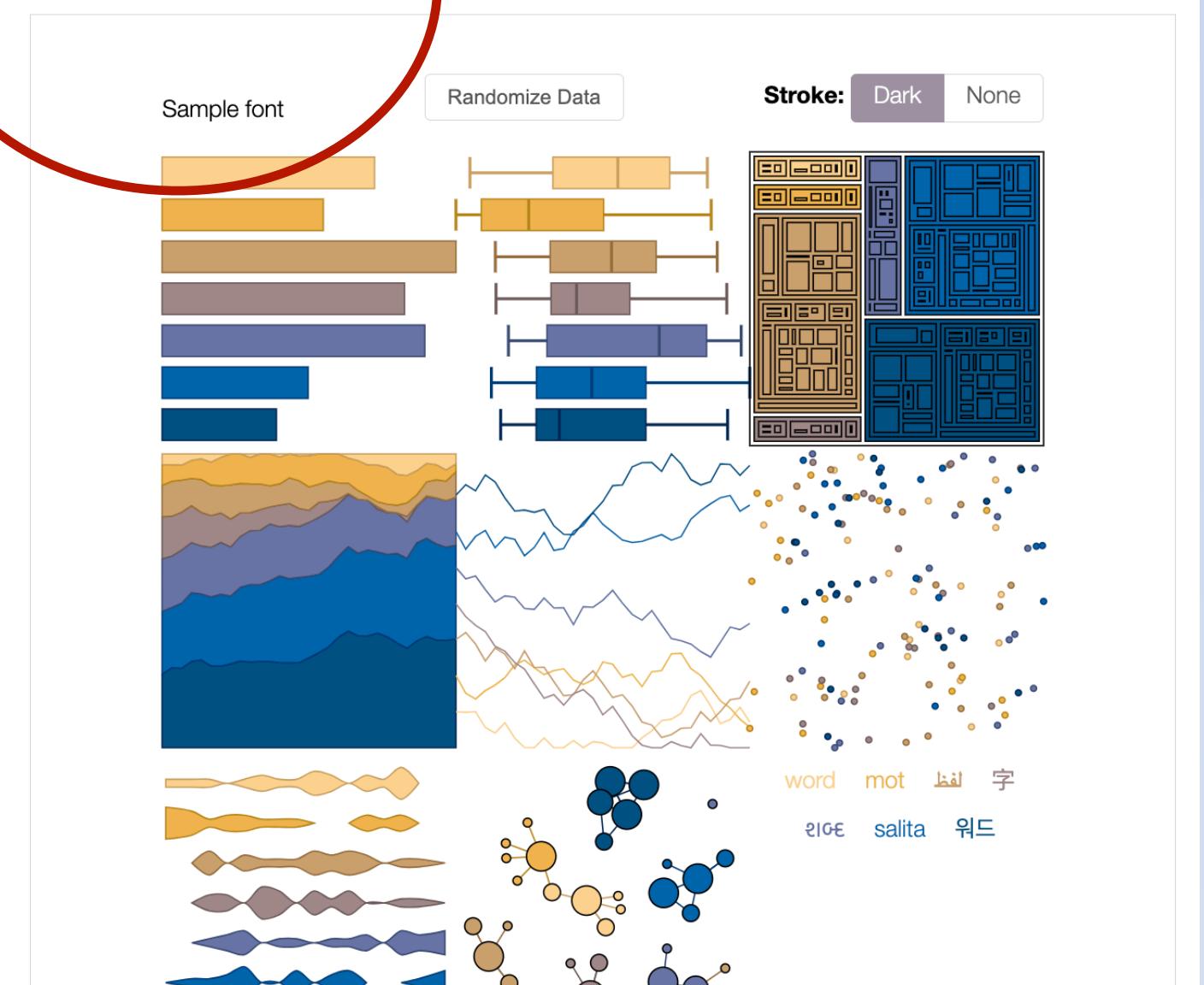
String quotes  
 Object with metadata  
["#ffd700", "#ffb14e", "#fa8775", "#ea5f94", "#cd34b5", "#9d02d7", "#0000ff"]

### COLORS IN ACTION

Background color: #ffffff  
Font color: #000000  
Charts made with Semiotic

Color Population:  
No Color Deficiency - 96% Deuteranomaly - 2.7% Protanomaly - 0.66% Protanopia - 0.59%  
Deuteranopia - 0.56% Greyscale

Sample font Randomize Data Stroke: Dark None



# Selecting colors for semantic distinguishability

Source: Susie Lu + Elijah Meeks, circa 2017ish?

**VIZ PALETTE** By: Elijah Meeks & Susie Lu

**PICK**

- Use Chroma.js
- Add
- Replace

**EDIT**

7 Colors

- 1 yellow #ffd700
- 2 orange #ffb14e
- 3 pink #fa8775
- 4 magenta #ea5f94
- 5 purple #cd34b5
- 6 blue #9d02d7
- 7 black #0000ff

**GET**

String quotes  
 Object with metadata

```
[ "#ffd700",
  "#ffb14e",
  "#fa8775",
  "#ea5f94",
  "#cd34b5",
  "#9d02d7",
  "#0000ff" ]
```

**COLOR REPORT**

Arcs link colors difficult to tell apart as:

- Lines or small points
- Medium areas
- Large areas

#ea5f94 pink

#fa8775 light orange

#ffb14e orange

#ffd700 gold

#0000ff indigo

#cd34b5 magenta •

#9d02d7 magenta •

• Minimize name conflicts for categorical palettes

## COLOR REPORT

Arcs link colors difficult to tell apart as:

- Lines or small points
- Medium areas
- Large areas

#ea5f94 pink

#fa8775 light orange

#ffb14e orange

#ffd700 gold

#0000ff indigo

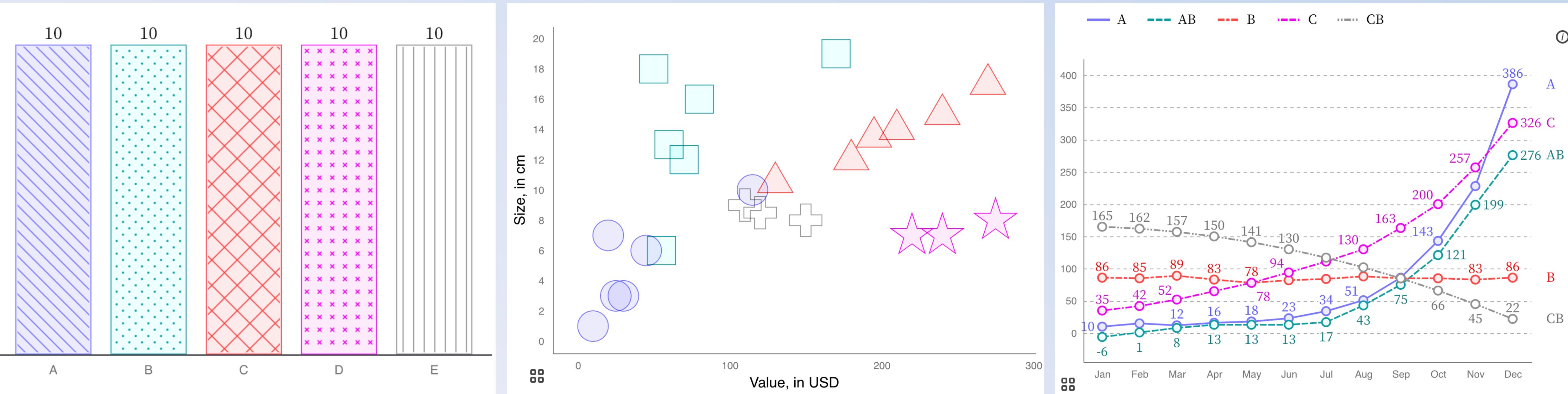
#cd34b5 magenta •

#9d02d7 magenta •

• Minimize name conflicts for categorical palettes

# Selecting *textures* for semantic distinguishability

Source: Visa Chart Components, Frank Elavsky (2017-2019)



# Selecting colors for JND

Source: Susie Lu + Elijah Meeks, circa 2017ish?

## VIZ PALETTE

By: Elijah Meeks & Susie Lu

### PICK

Use Chroma.js

### EDIT

7 Colors

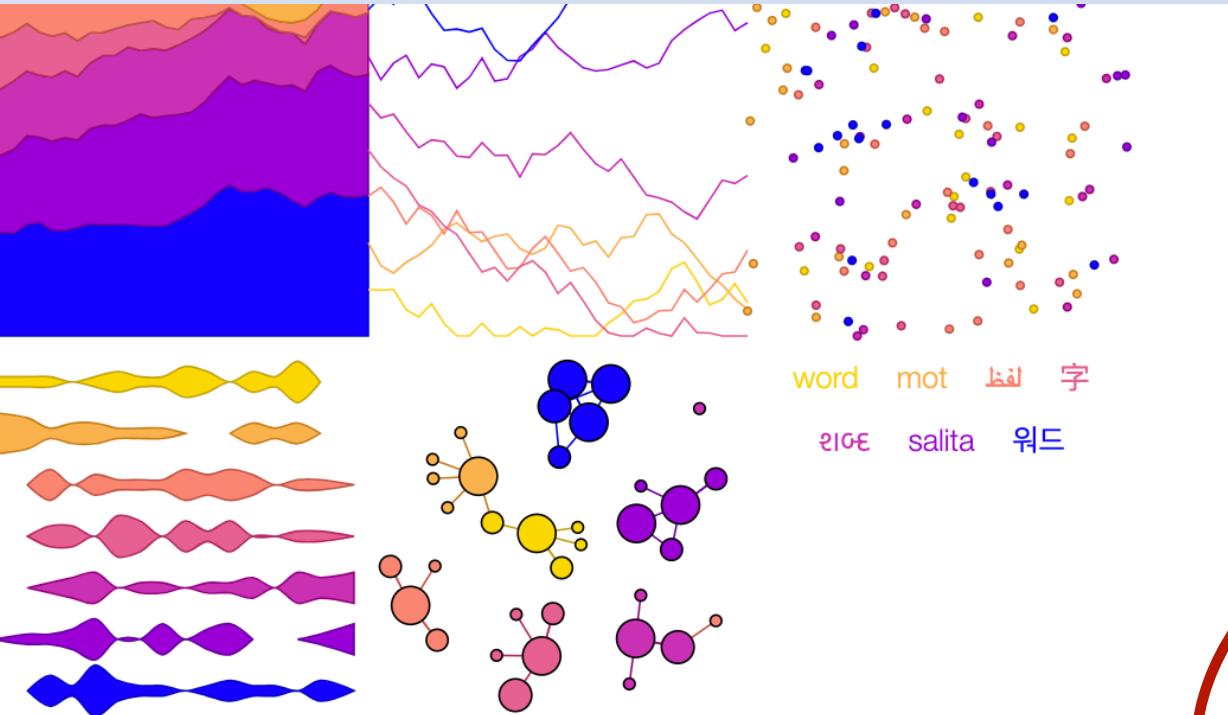
1	yellow	#ffd700	<input type="button" value="x"/>
2	orange	#ffb14e	<input type="button" value="x"/>
3	light orange	#fa8775	<input type="button" value="x"/>
4	pink	#ea5f94	<input type="button" value="x"/>
5	magenta	#cd34b5	<input type="button" value="x"/>
6	purple	#9d02d7	<input type="button" value="x"/>
7	blue	#0000ff	<input type="button" value="x"/>

hex  rgb  
 hsl

### GET

String quotes  Object with metadata

```
[ "#ffd700",
  "#ffb14e",
  "#fa8775",
  "#ea5f94",
  "#cd34b5",
  "#9d02d7",
  "#0000ff" ]
```



The visualization palette displays a grid of color swatches and several data points represented by small circles connected by lines. The colors range from blue and purple at the bottom to yellow and orange at the top. The data points are scattered across the right side of the palette.

## COLOR REPORT

Arcs link colors difficult to tell apart as:

- Lines or small points
- Medium areas
- Large areas

• Minimize name conflicts for categorical palettes

#ea5f94	pink	<input type="radio"/>
#fa8775	light orange	<input type="radio"/>
#ffb14e	orange	<input type="radio"/>
#ffd700	gold	<input type="radio"/>
#0000ff	indigo	<input type="radio"/>
#cd34b5	magenta •	<input checked="" type="radio"/>
#9d02d7	magenta •	<input checked="" type="radio"/>

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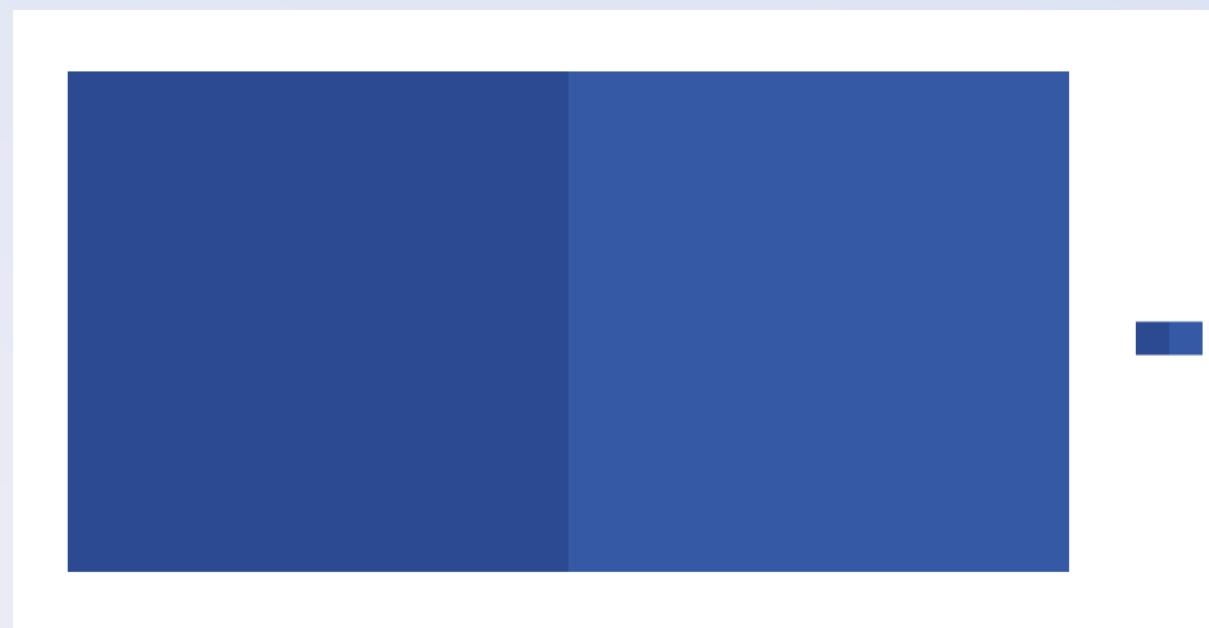
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40

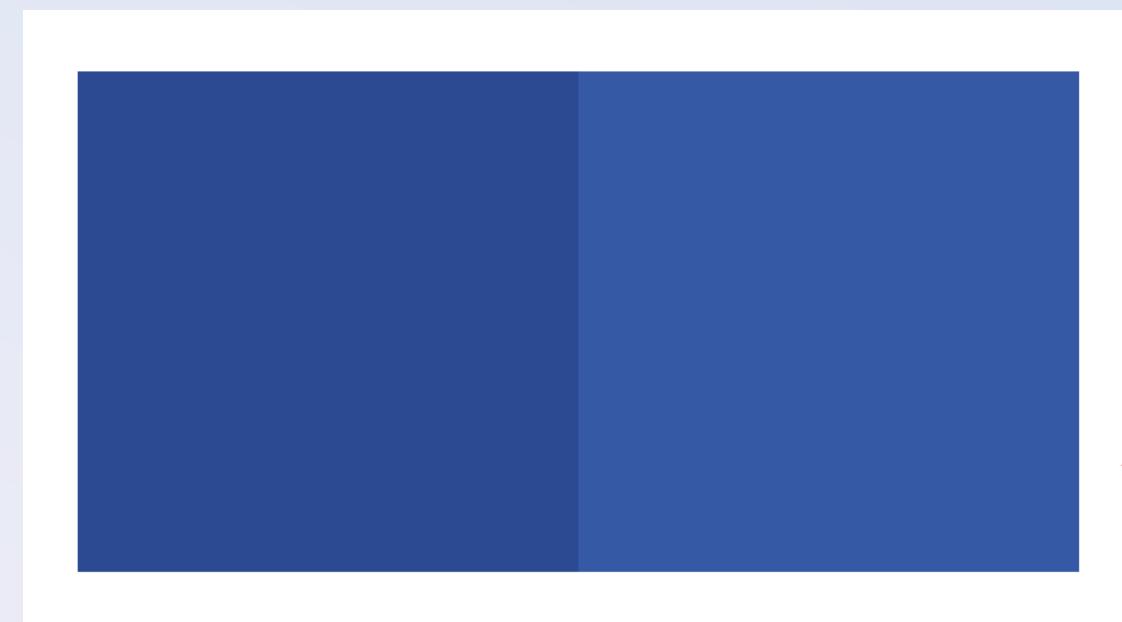
# What is JND? (+ why does this matter for visualization accessibility in 2025?)

Source: Connor Gramazio, circa 2016ish?



# What is JND? (+ why does this matter for visualization accessibility in 2025?)

Source: Connor Gramazio, circa 2016ish?



**These both have the same  
contrast score! Yikes!**

## Contrast Checker

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

### Foreground

Hex Value  
**#374E90**

Color Picker Alpha

Lightness

### Background

Hex Value  
**#415AA4**

Color Picker

Lightness

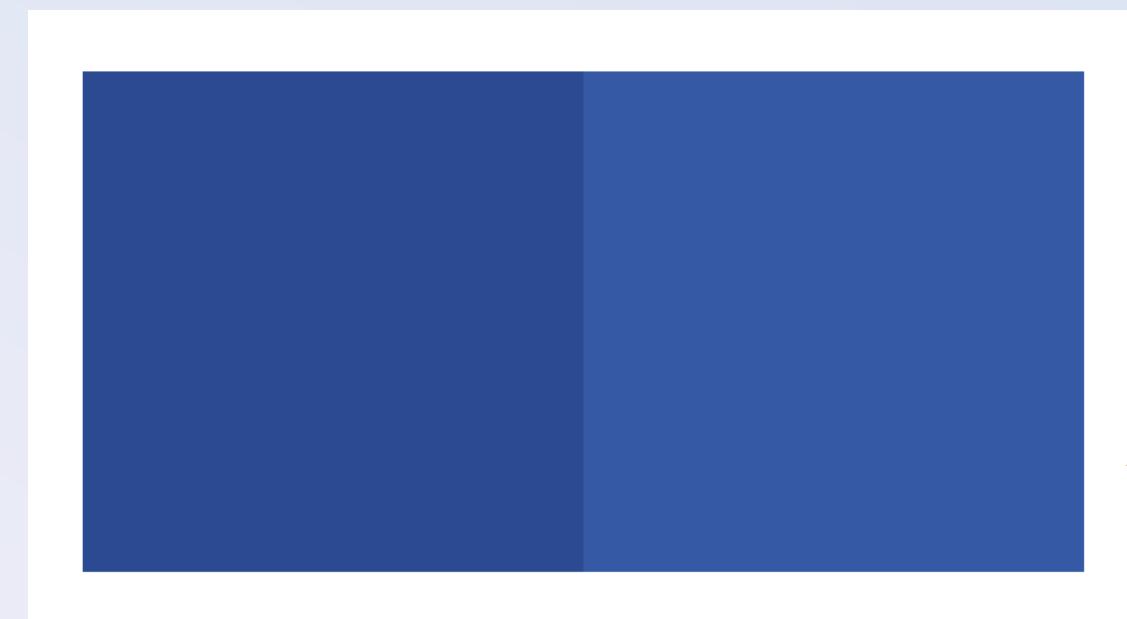
### Contrast Ratio

**1.21:1**

[permalink](#)

# What is JND? (+ why does this matter for visualization accessibility in 2025?)

Source: Connor Gramazio, circa 2016ish?



**Seriously: these standards affect accessibility policy for ~55% of the world**

Contrast Checker

Home > Resources > Contrast Checker

**Foreground**

Hex Value: #374E90  
Color Picker Alpha: 1  
Lightness:

**Background**

Hex Value: #415AA4  
Color Picker  
Lightness:

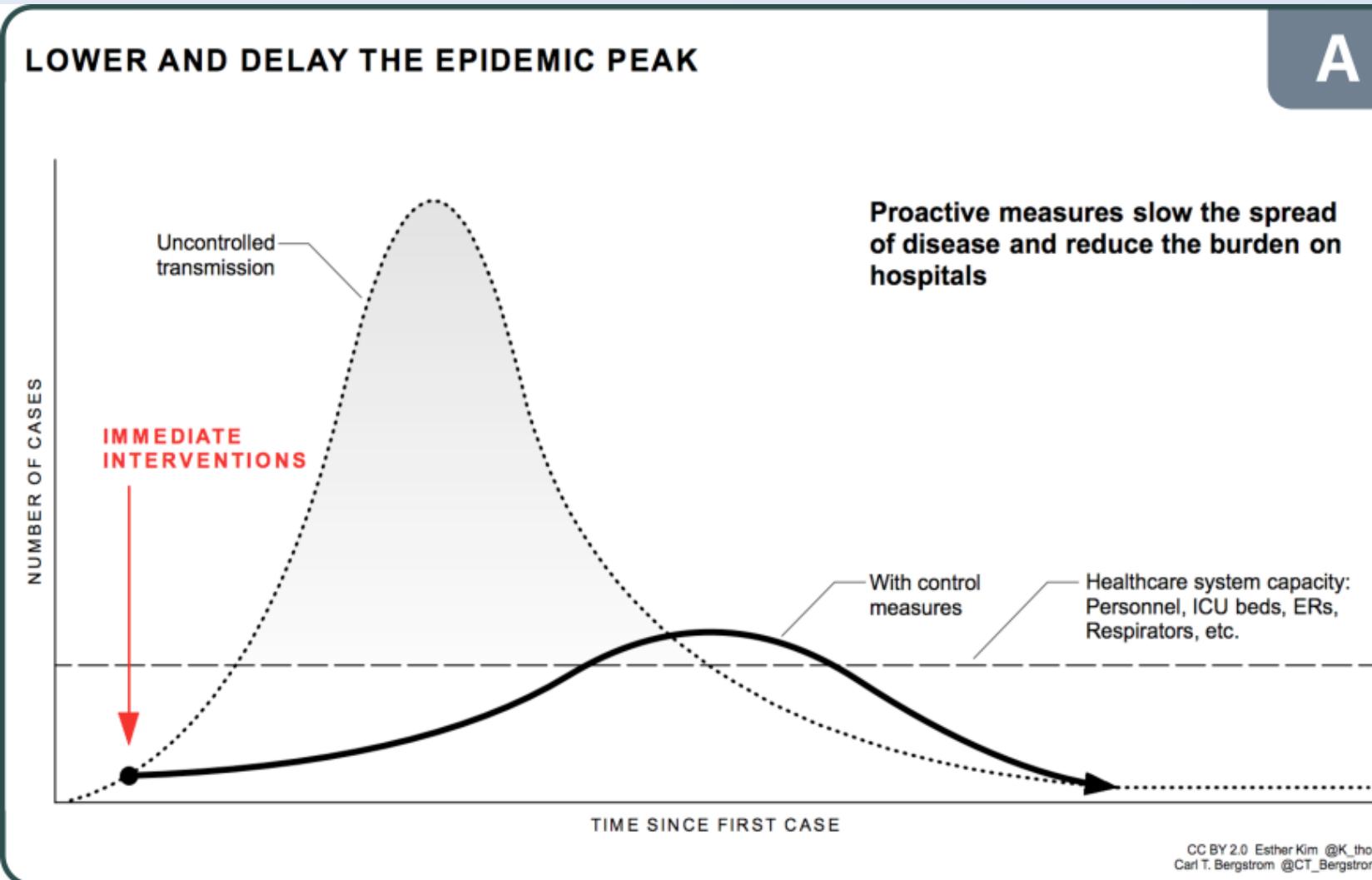
Contrast Ratio: 1.21:1

[permalink](#)

# Describing things

# Chart descriptions with multi-layered semantics

## Lundgard et al's *Semantic Levels* (2021)



A

A multi-line chart entitled "Lower and Delay the Epidemic Peak" that plots the Number of Cases by the Time Since First Case. The Number of Cases is plotted on the vertical y-axis. The Time Since First Case is plotted on the horizontal x-axis. The chart shows two possible extremes of the rate of rise and decline of COVID-19 cases. If the transmission is uncontrolled, there are more simultaneous cases. If the transmission is controlled, there are fewer simultaneous cases. If the transmission is controlled, the healthcare system can support all the cases.

B

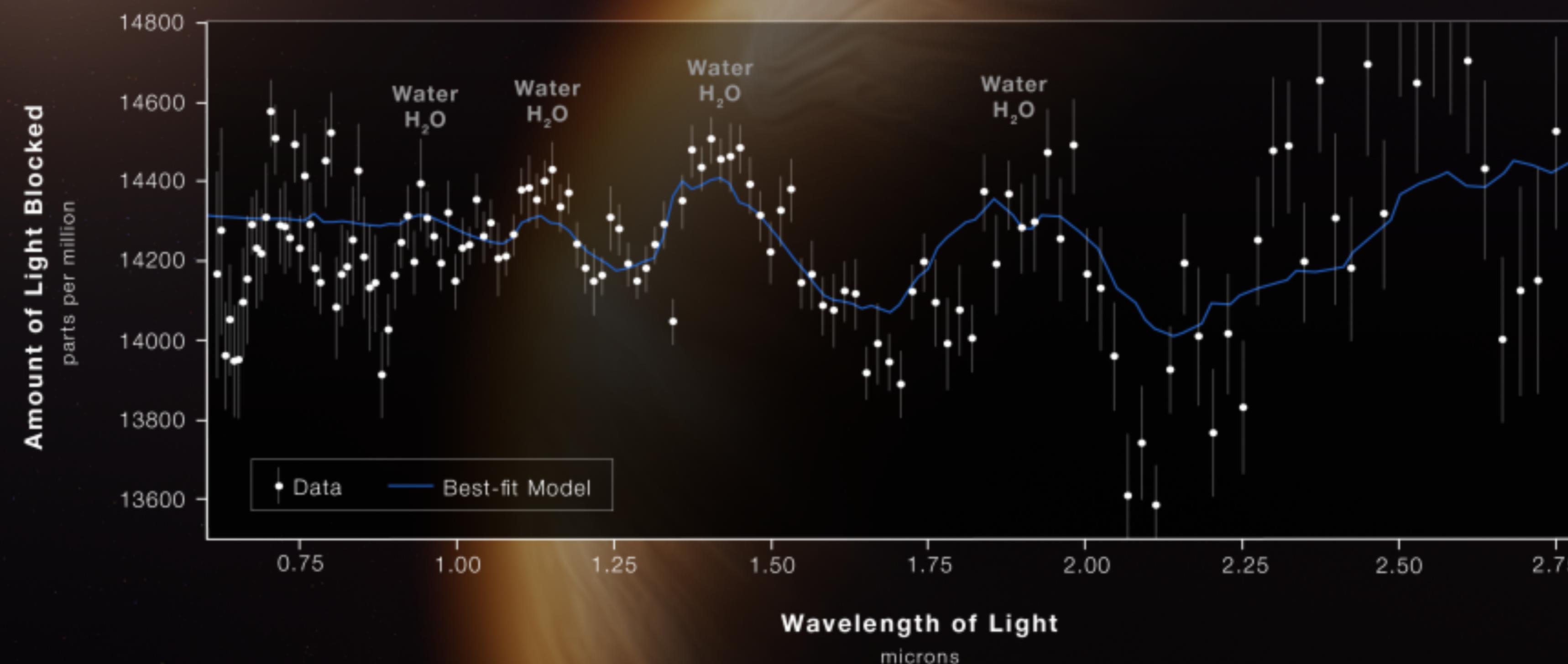
The purpose of the chart is not to provide exact numbers, but to communicate to the public that there are multiple ways the current crisis can play out. Without control measures the spread of the disease increases exponentially, making it harder to slow down and creating a big overload in the healthcare system. The number of cases is dramatically higher without controls, and this will likely lead to many deaths. In contrast, when controlled, the healthcare system capacity can handle all of the cases over a longer period of time, and this will save lives.

C



# HOT GAS GIANT EXOPLANET WASP-96 b ATMOSPHERE COMPOSITION

NIRISS | Single-Object Slitless Spectroscopy



# Exoplanet WASP-96 b (NIRISS Transmission Spectrum)

## Extended Description

Graphic titled "Hot Gas Giant Exoplanet WASP-96 b Atmosphere Composition, NIRISS Single-Object Slitless Spectroscopy."

The graphic shows a transmission spectrum in the form of a graph of the Amount of Light Blocked by the planet's atmosphere in parts per million on the vertical *y*-axis versus Wavelength of Light in microns on the horizontal *x*-axis.

### Graph

#### Axes

The *y*-axis ranges from 13,500 parts per million (less light blocked) at the bottom to 14,800 parts per million (more light blocked) at the top, with labeled tick marks are labeled every 200 parts per million, starting at 13,600.

The *x*-axis ranges from 0.6 microns on the left to 2.8 microns on the right, with labeled tick marks every 0.25 microns, starting at 0.75 microns.

#### Key

The graph includes a key showing that the solid white circles centered on gray vertical lines represent data points, and a blue solid line represents a best-fit model.

#### Data and Model

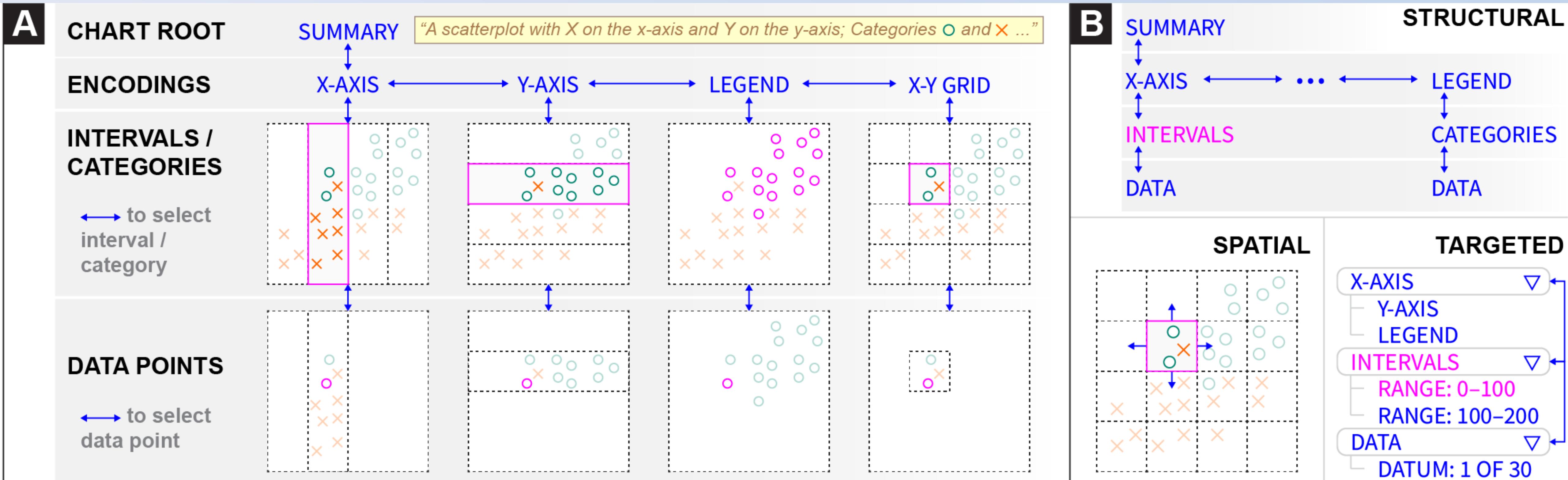
The graph consists of 141 data points, each with a gray error bar. The points range in value from 13,589 to 14,883 parts per million. The data points are not connected. They follow a jagged trend from left to right, with a number of broad peaks and valleys. The lengths of the error bars vary from a minimum of plus or minus 43 to a maximum of plus or minus 314. The error bars are smallest between about 1 and 1.3 microns, generally increasing in length toward the left from 1 to 0.6 microns, and toward the right from about 1.3 to 2.8 microns.

A solid blue line with several prominent peaks and valleys represents the best-fit model. The model begins at the far left with a very slight downward slope toward the right with a small peak around 0.95 microns, and another peak at about 1.15 microns. The line then becomes more sinuous, forming a taller, broader peak centered at about 1.4 microns and a slightly shorter broad peak at 1.9 microns. Starting around 2.15 microns, the line trends back upward with a wavy slope of about 30 degrees.

The blue best-fit model line generally follows the trend of the data. It intersects some data points, but does not match the data perfectly. The match between the model and data is clearest between about 0.9 and 1.65 microns.

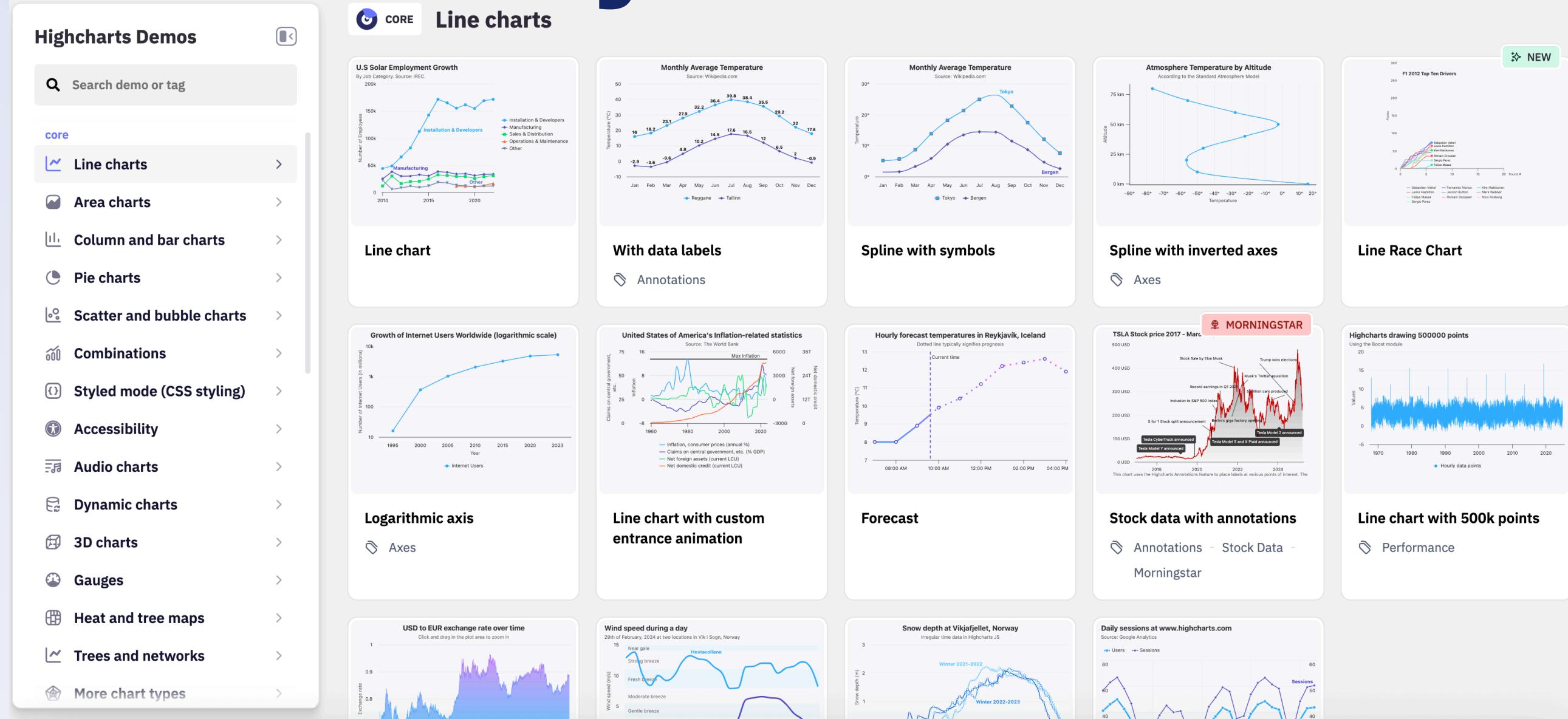
# “Structural” and “spatial” navigation

Zong et al's *Rich Screen Reader Experiences* (2022)



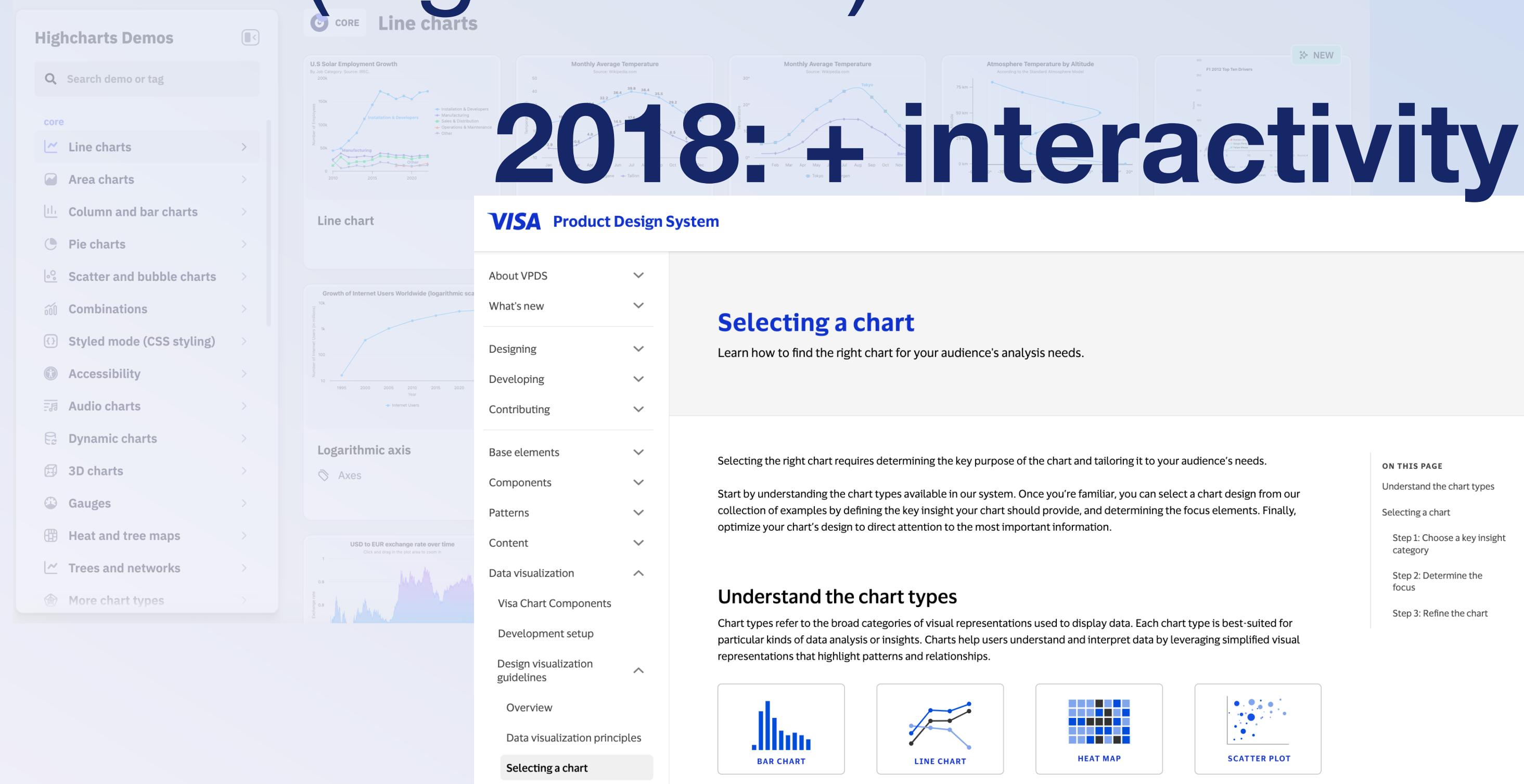
# Rich navigation (a short history)

## 2015: “beyond the table” (highcharts)



# Rich navigation (a short history)

# 2015 (highcharts)

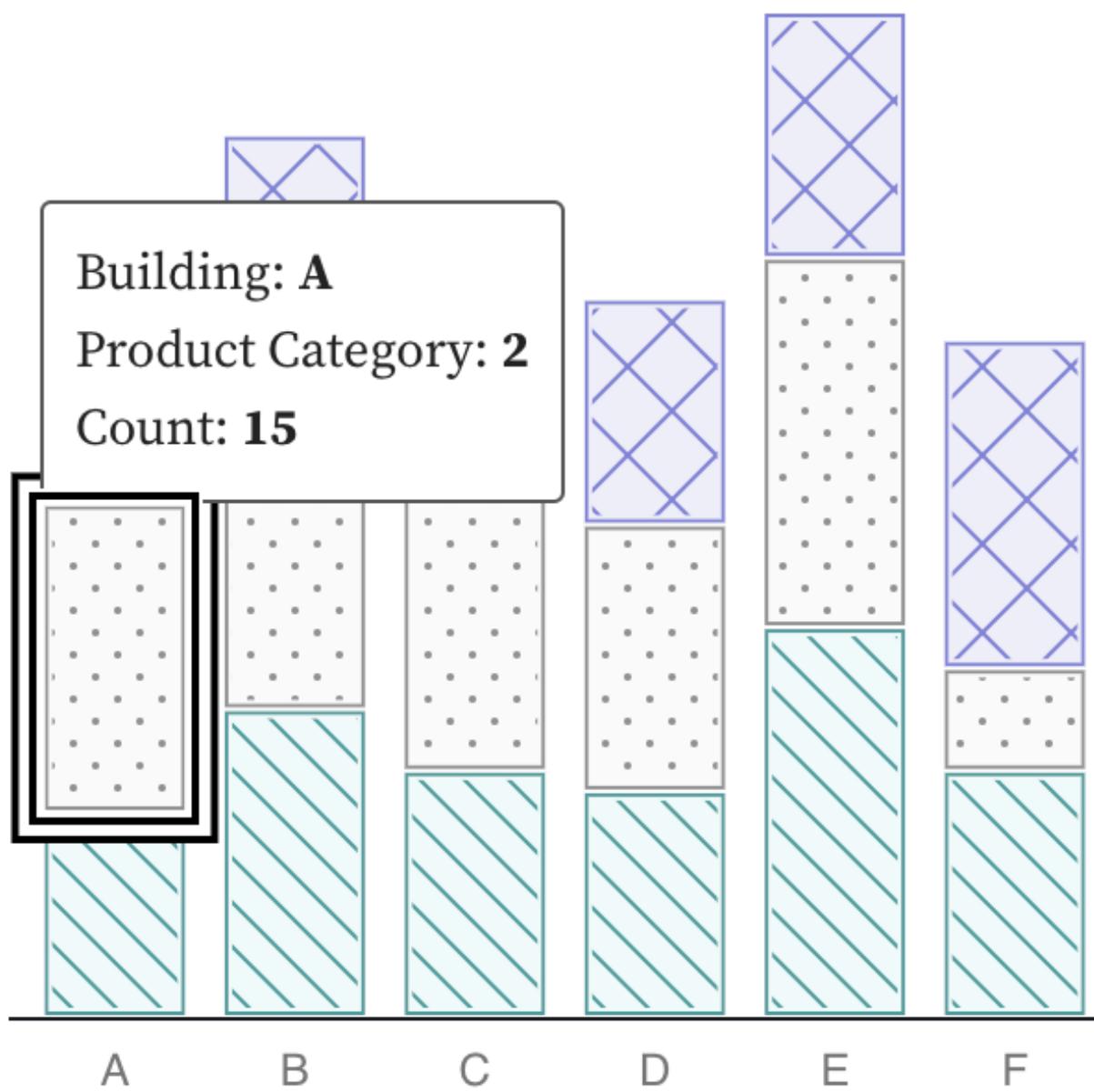


# 2018: + interactivity (visa charts)

# Alt text should communicate operability

Source: Visa Chart Components, Frank Elavsky (2017-2019)

1 2 3

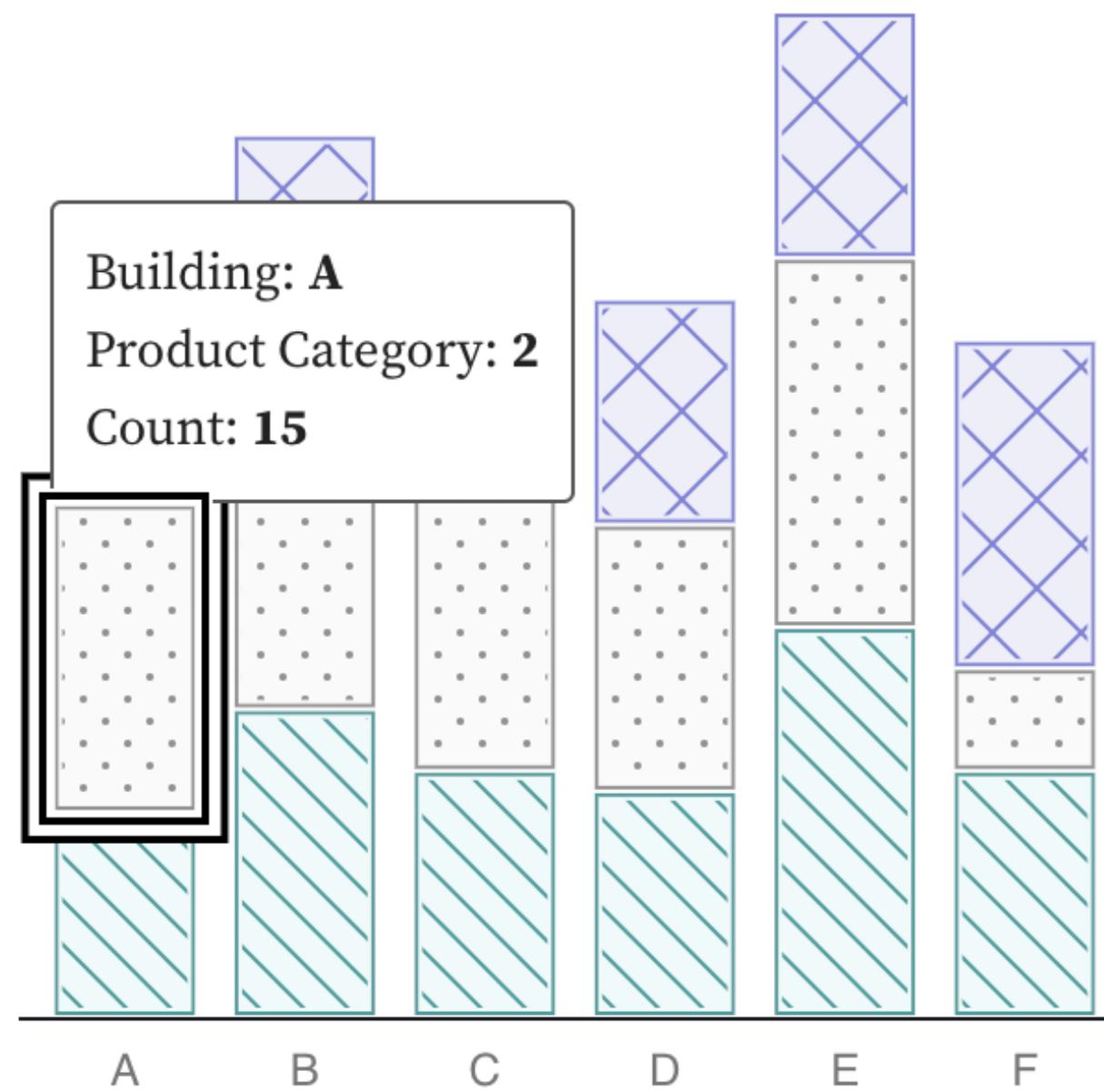


✖ Building A. Product Category 2.  
Count 15. Bar 2 of 3. Image.

# Semantics matter

Source: Visa Chart Components, Frank Elavsky (2017-2019)

1 2 3



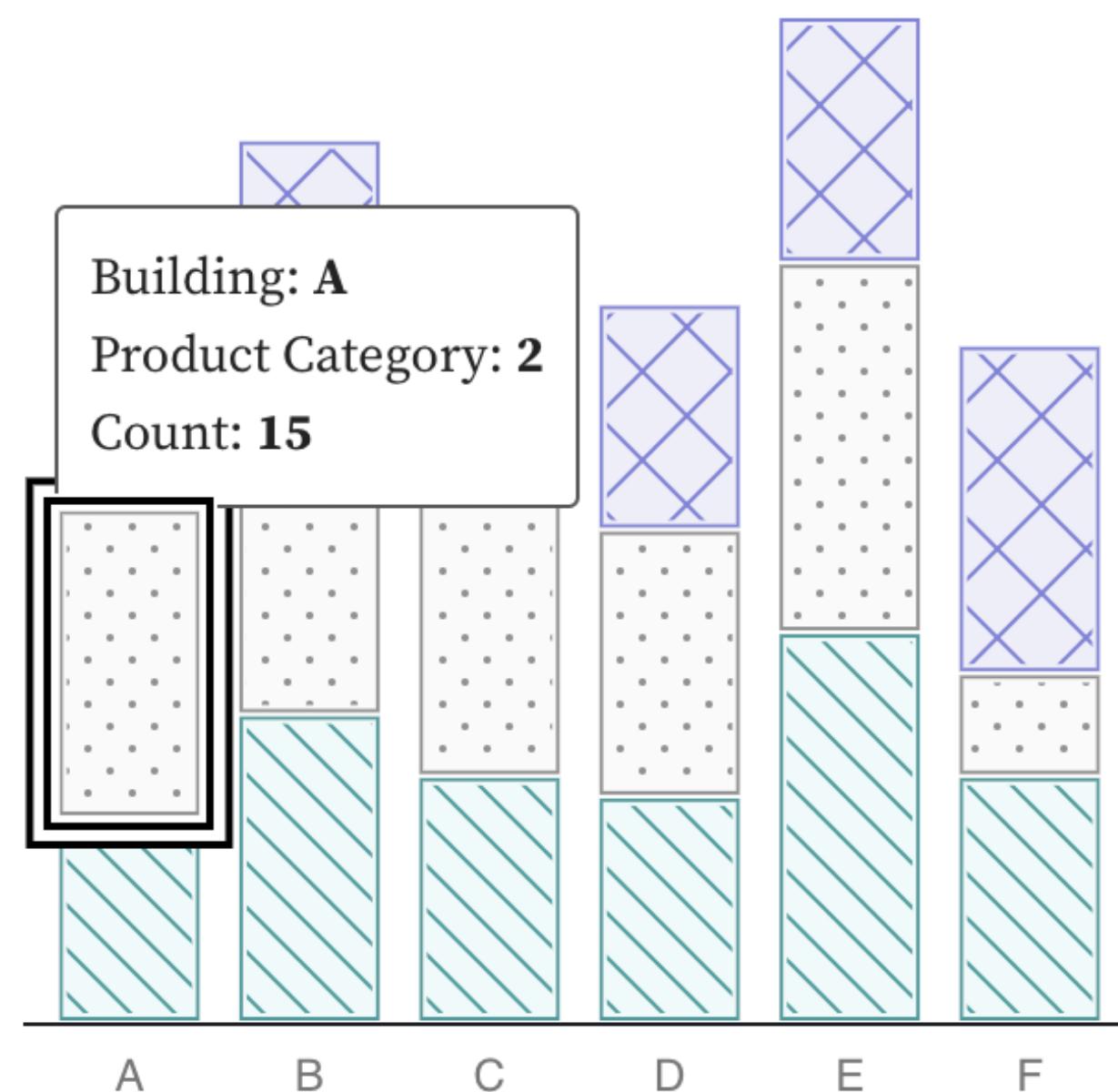
✗ Building A. Product Category 2.  
Count 15. Bar 2 of 3. Image.

“Image” doesn’t signal interactivity!

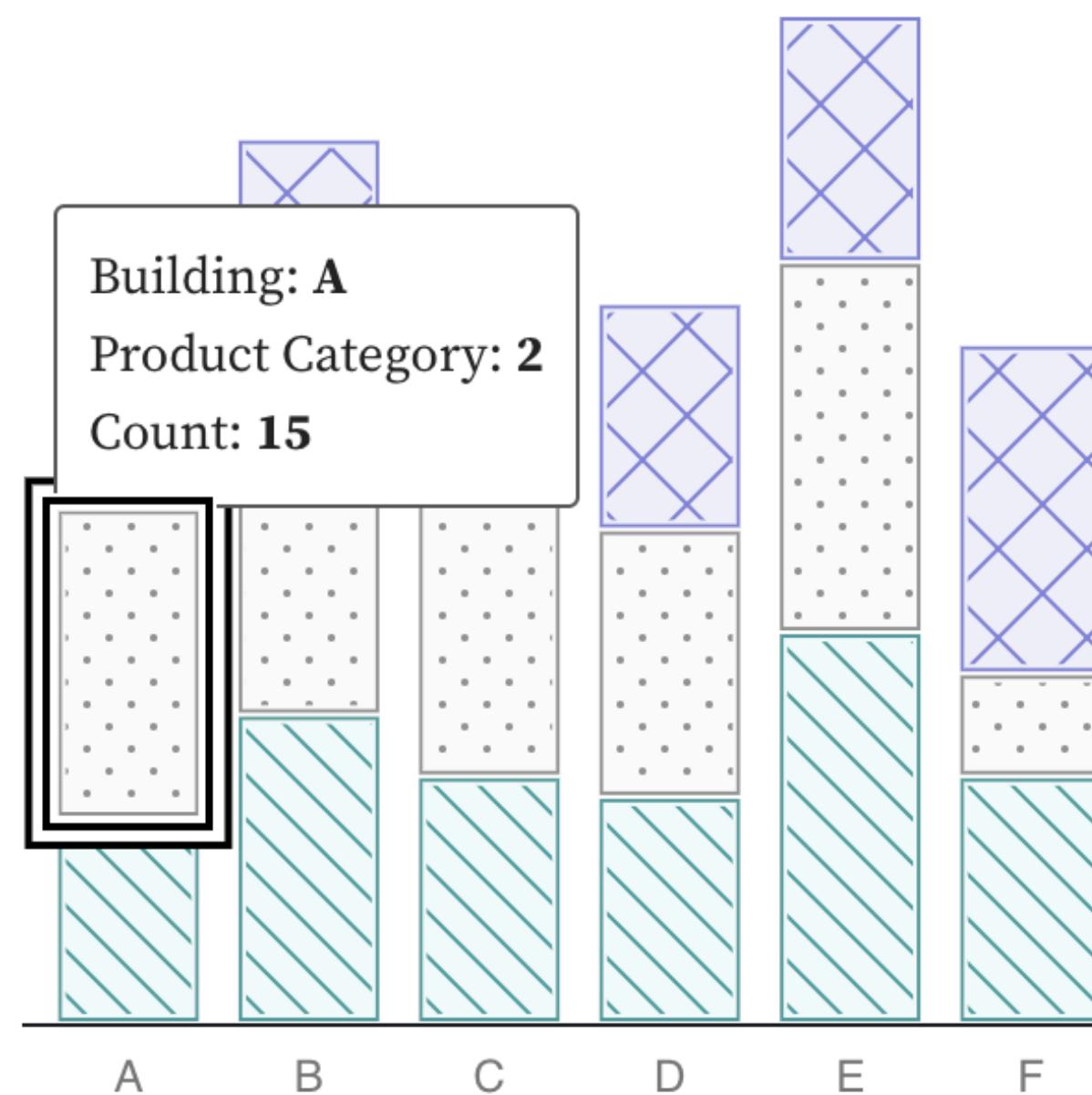
# ARIA semantics are standardized

Source: Visa Chart Components, Frank Elavsky (2017-2019)

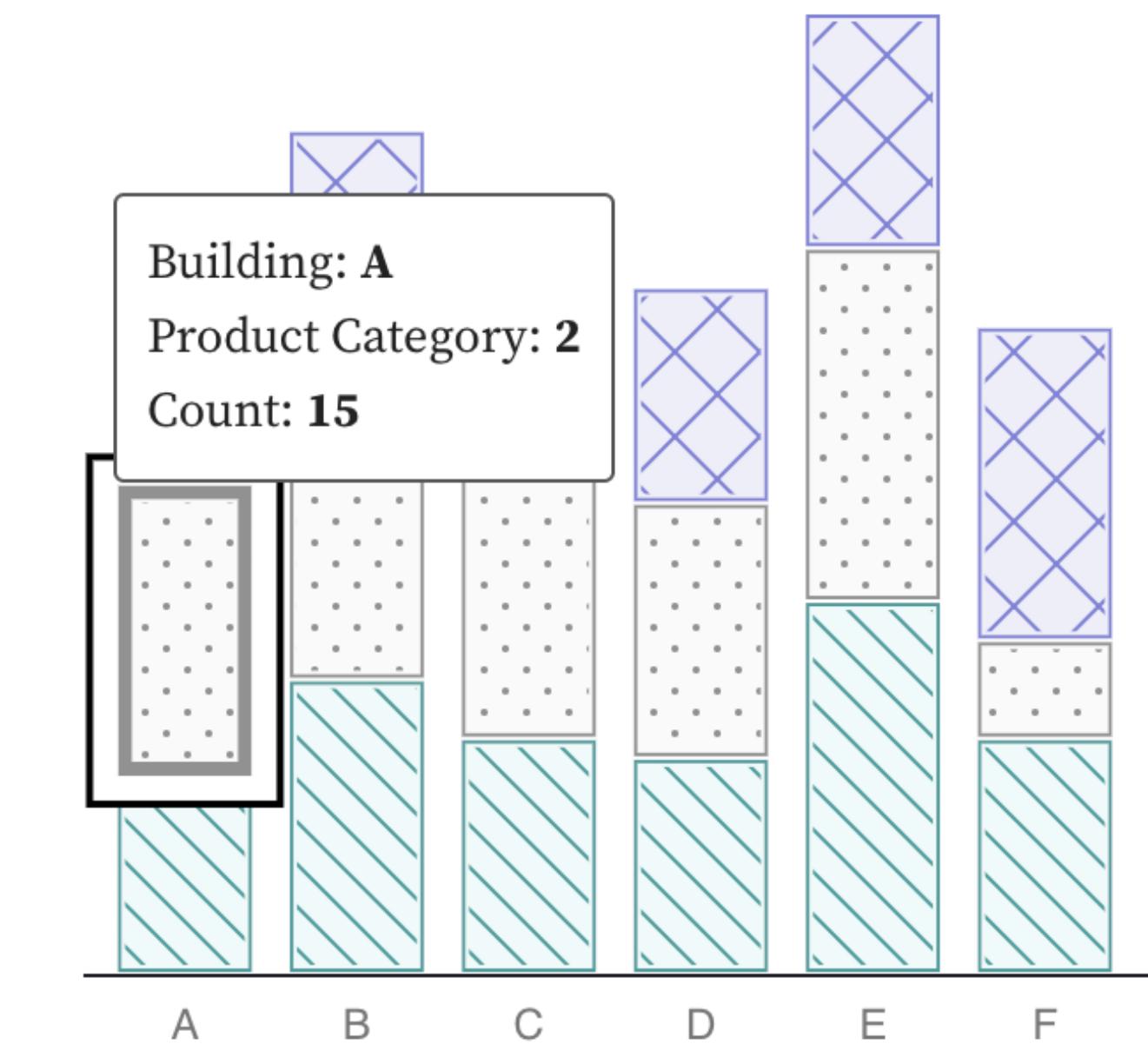
1 2 3



1 2 3



1 2 3



× Building A. Product Category 2.  
Count 15. Bar 2 of 3. Image.

× Building A. Product Category  
2. Count 15. Bar 2 of 3., toggle  
button

× selected, Building A. Product  
Category 2. Count 15. Bar 2 of  
3., toggle button

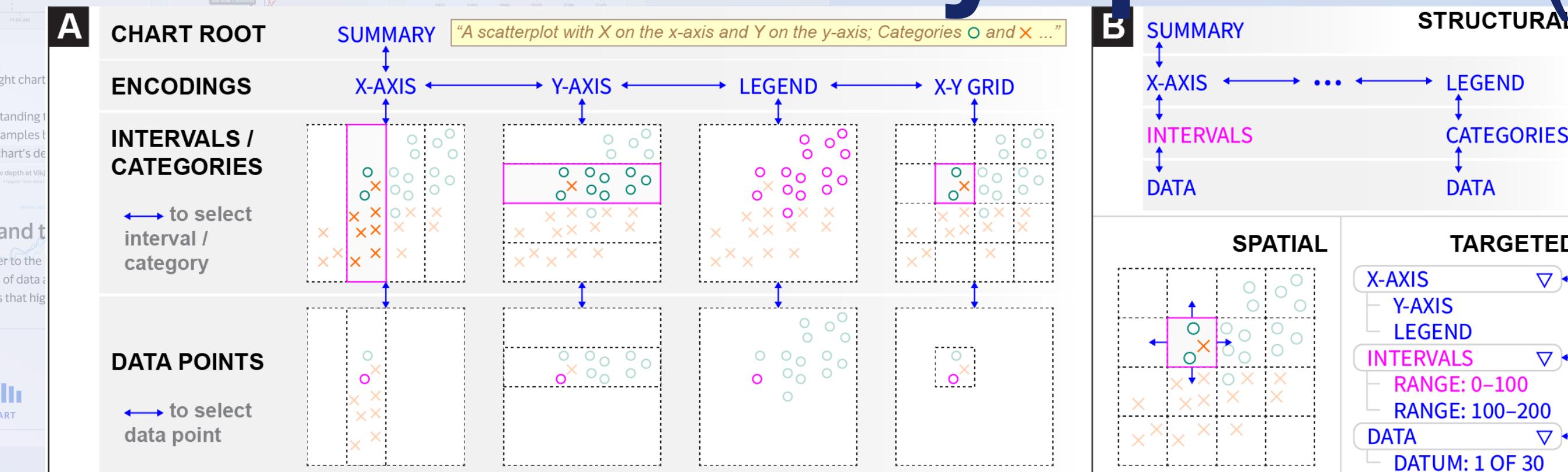
# Rich navigation (a short history)

## 2015 (highcharts)

The screenshot shows the Highcharts Demos website. On the left is a sidebar menu under 'core' with sections like Line charts, Area charts, Column and bar charts, Pie charts, Scatter and bubble charts, Combinations, Styled mode (CSS styling), Accessibility, Audio charts, Dynamic charts, 3D charts, Gauges, Heat and tree maps, Trees and networks, and More chart types. The main area displays several chart examples: U.S Solar Employment Growth, Monthly Average Temperature, Atmosphere Temperature by Altitude, F1 2012 Top Ten Drivers, Line chart, Spline with symbols, Spline with inverted axes, Line Race Chart, Logarithmic axis, and USD to EUR exchange rate over time.

## 2018 (visa charts)

## 2022: not library specific (olli)

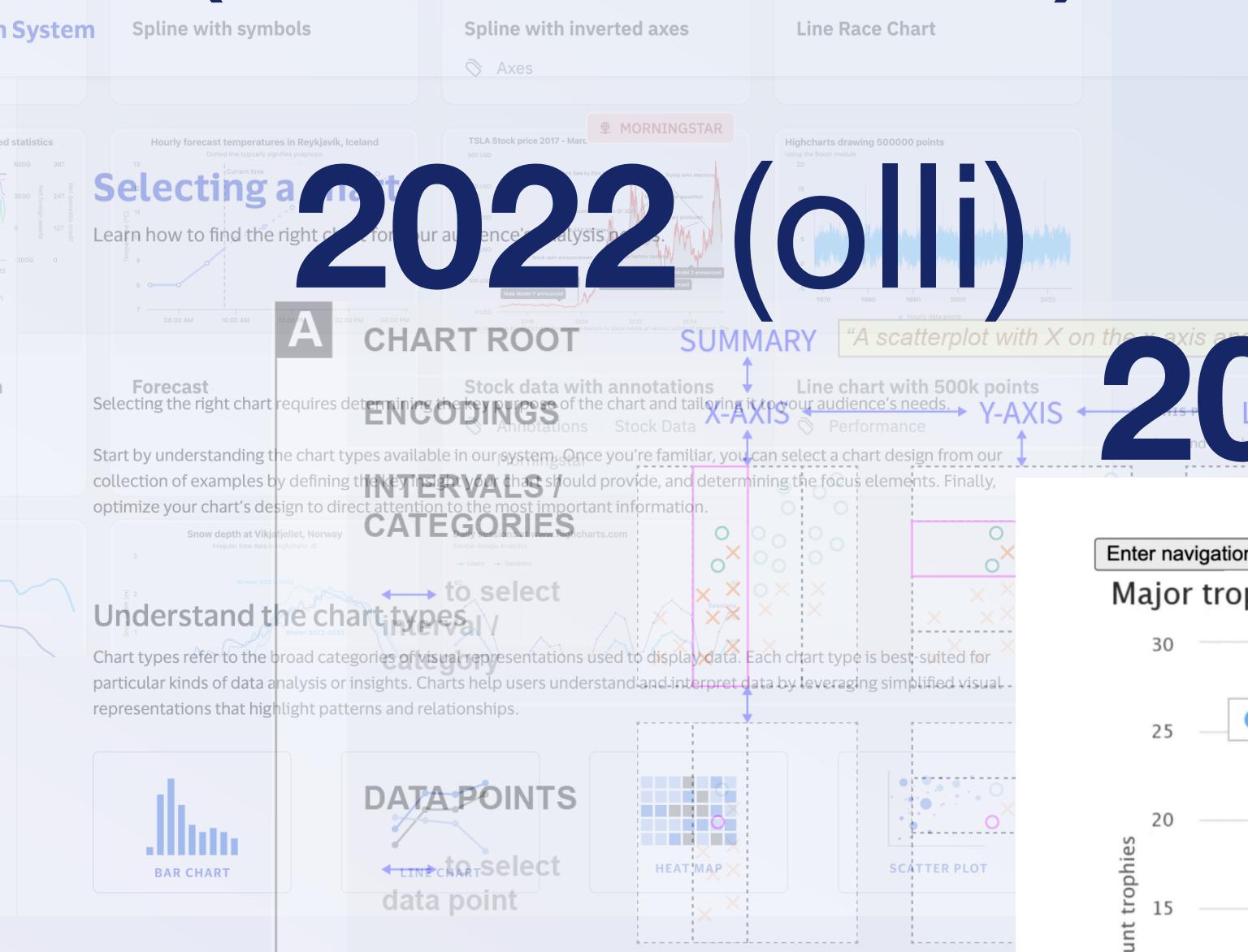


# Rich navigation (a short history)

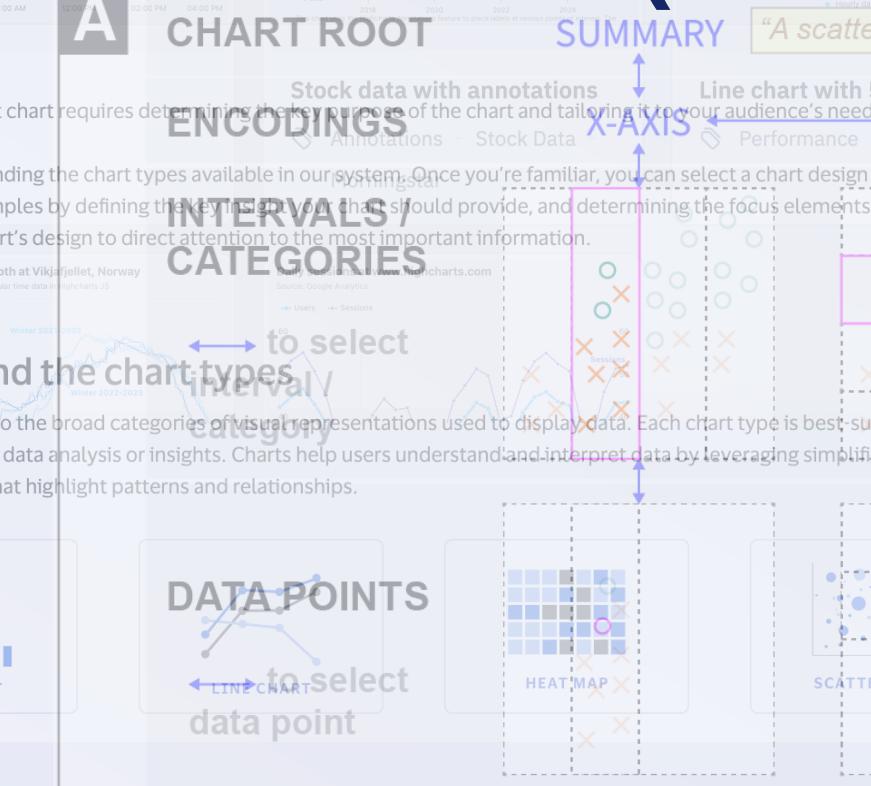
## 2015 (highcharts)



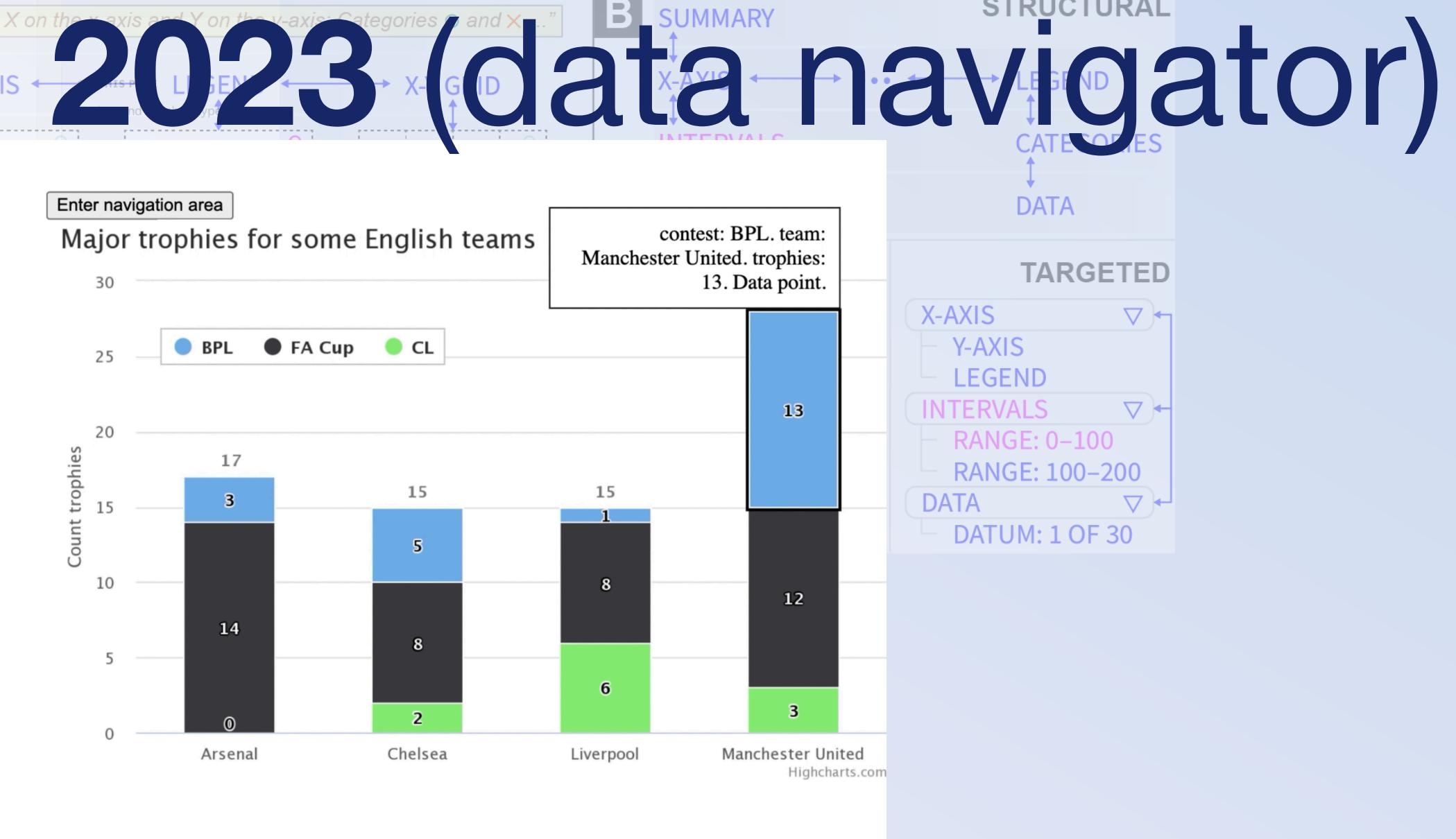
## 2018 (visa charts)



## 2022 (olli)



## 2023 (data navigator)



# Rich navigation (a short history)

# 2015 (highcharts)



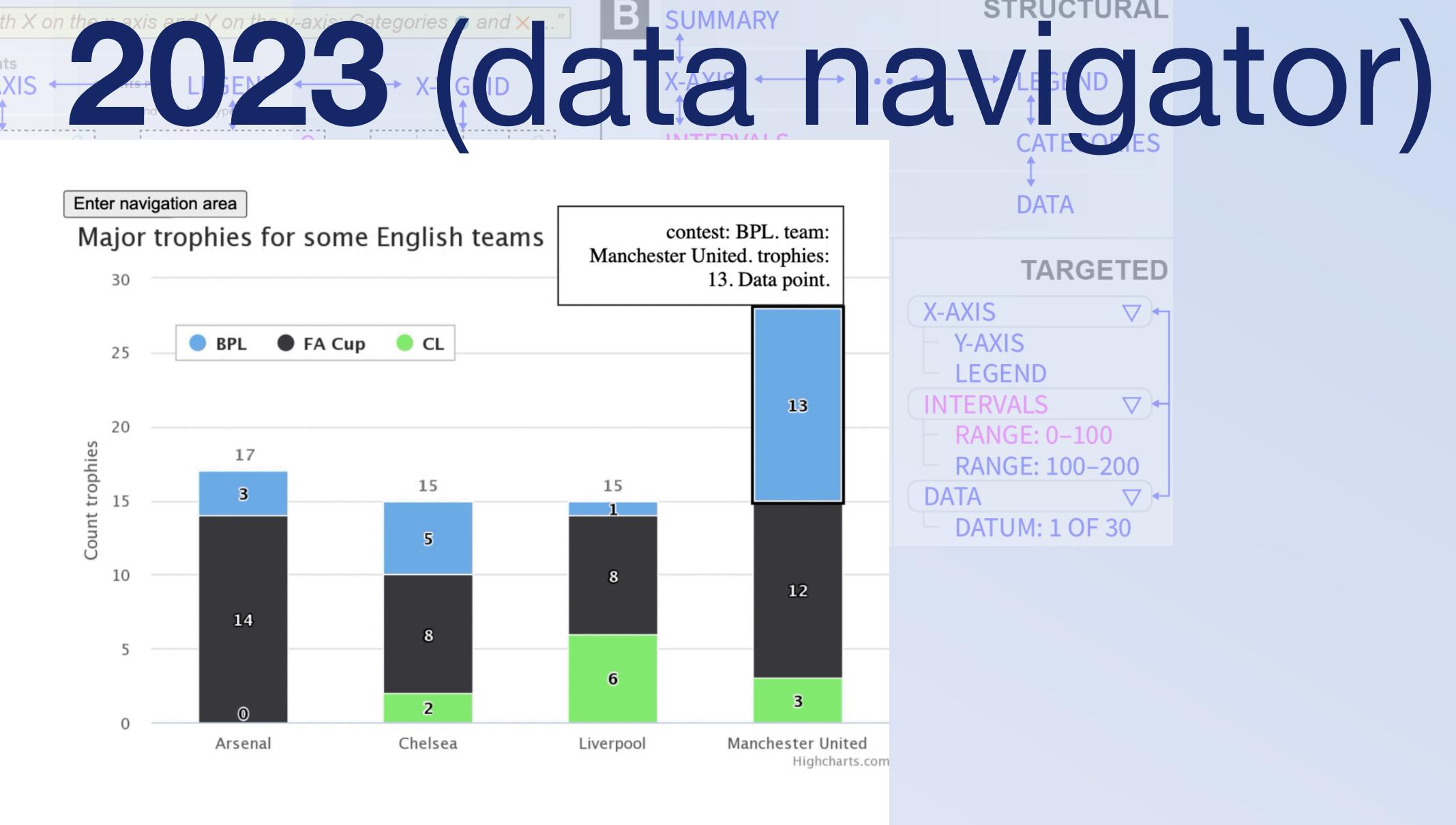
2018 (visa charts)

VISA Product Design System

Spline with symbols

Spline with inverted axes

Line Race Chart

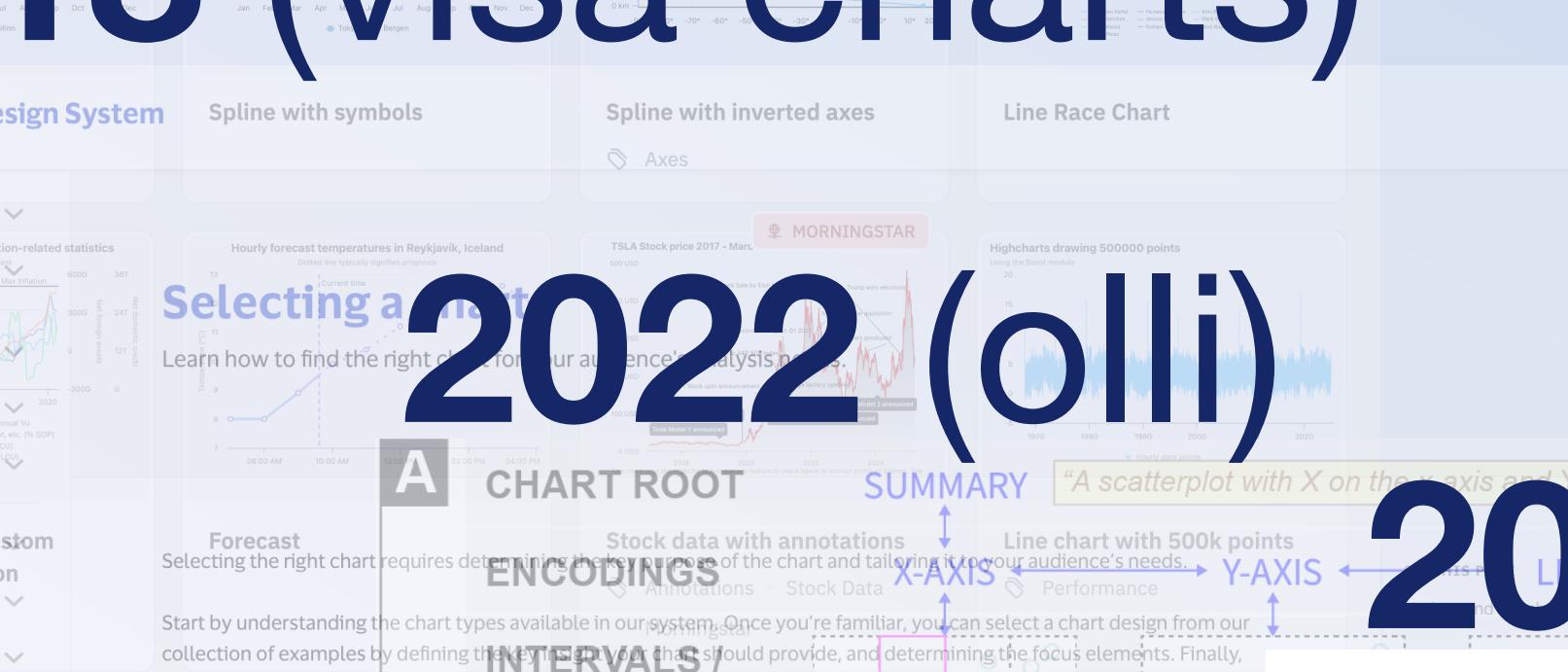


# Rich navigation (a short history)

## 2015 (highcharts)



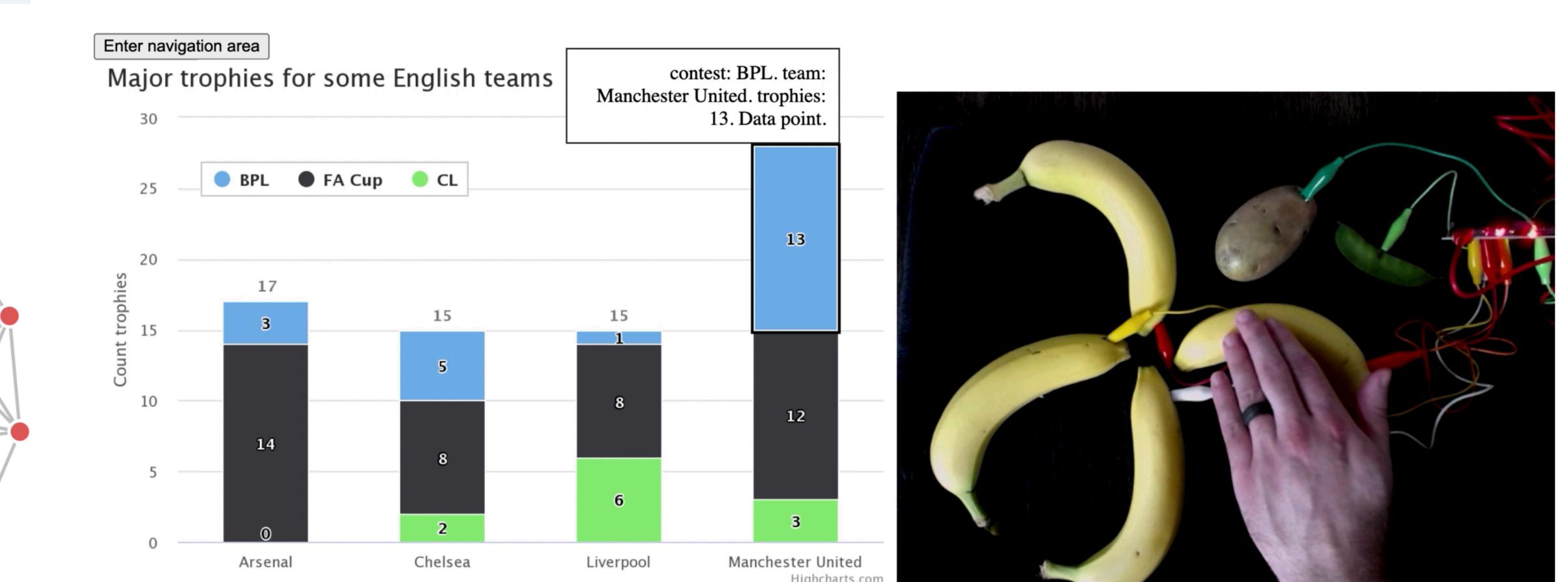
## 2018 (visa charts)



## 2022 (olli)

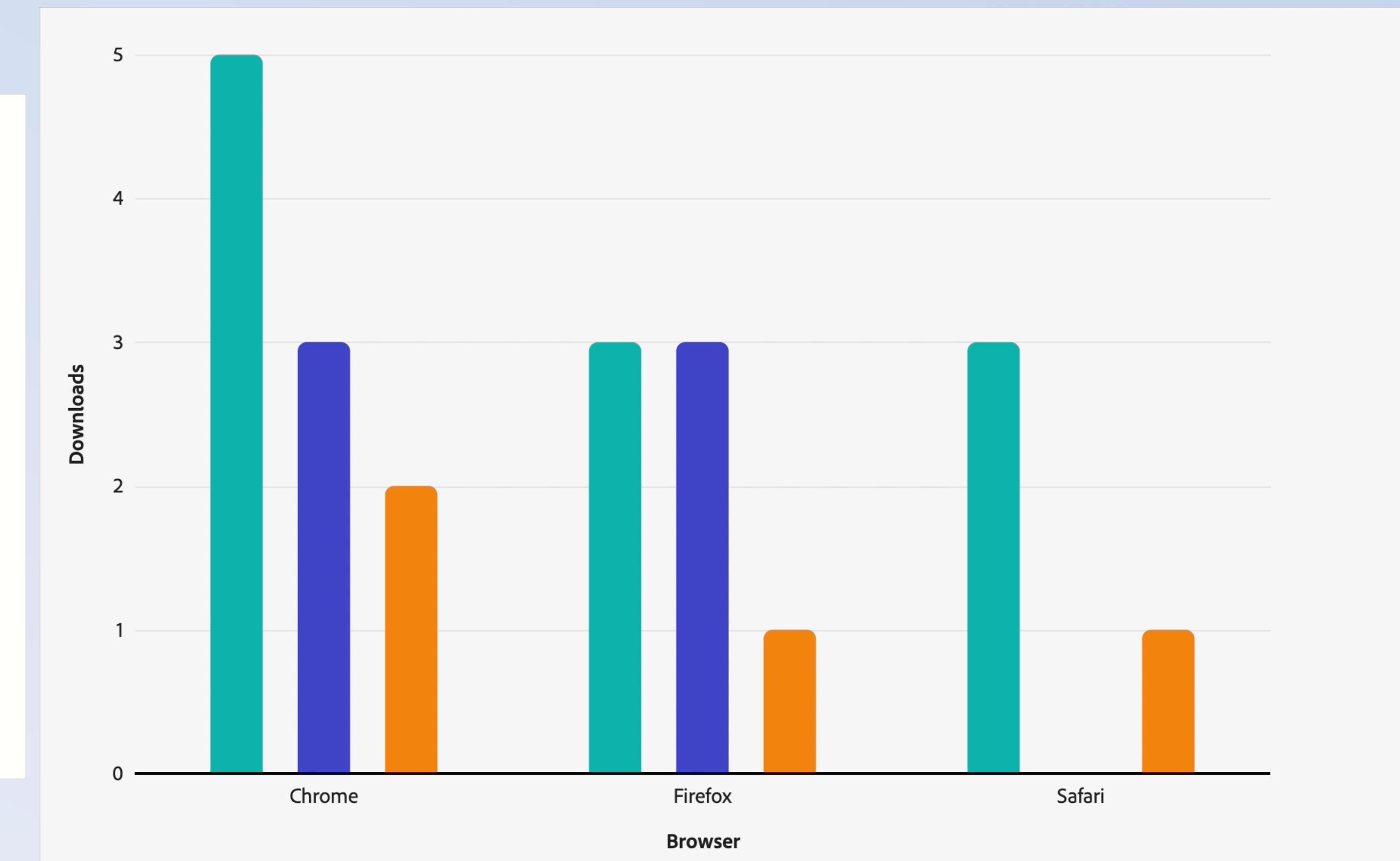
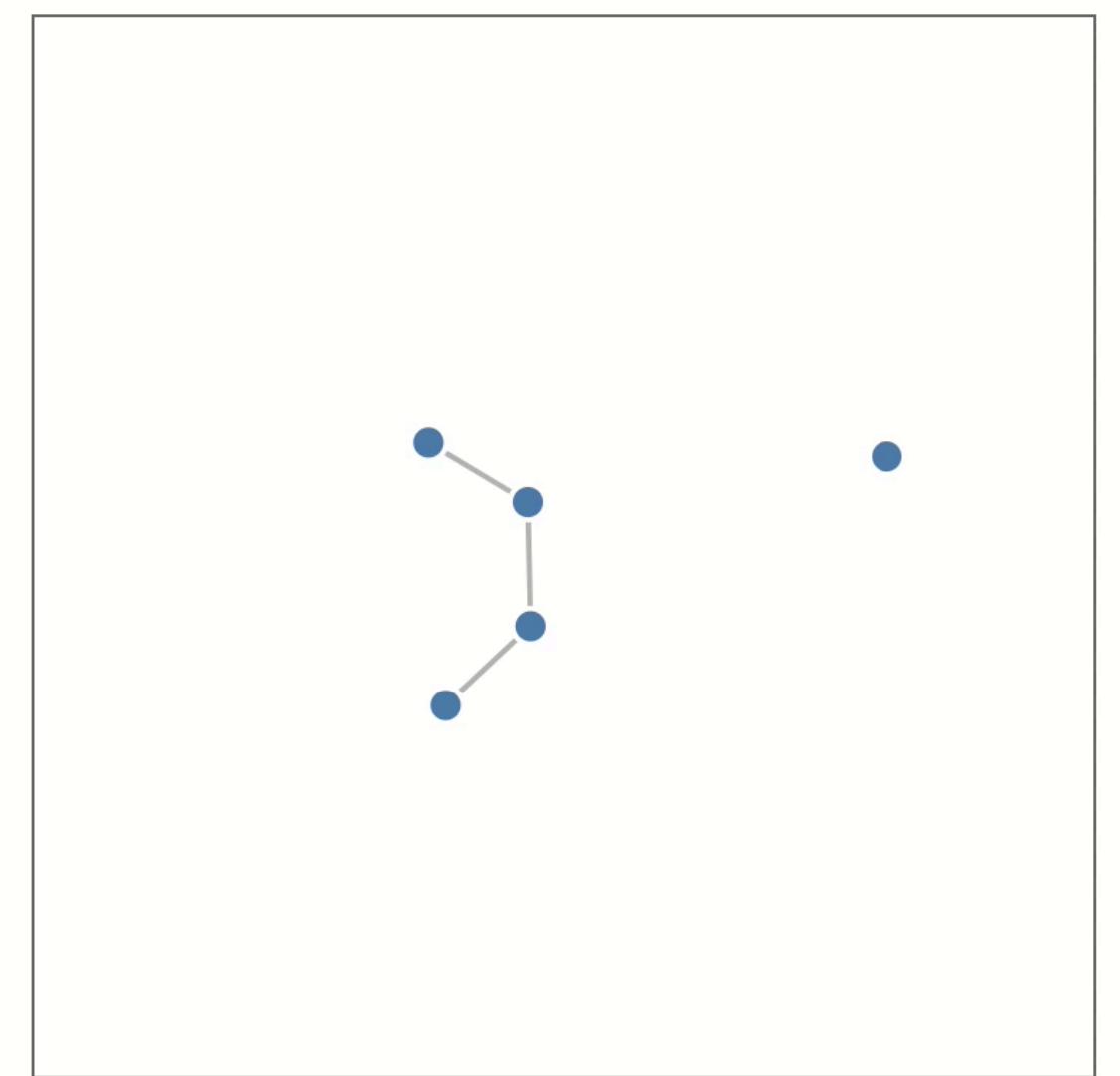
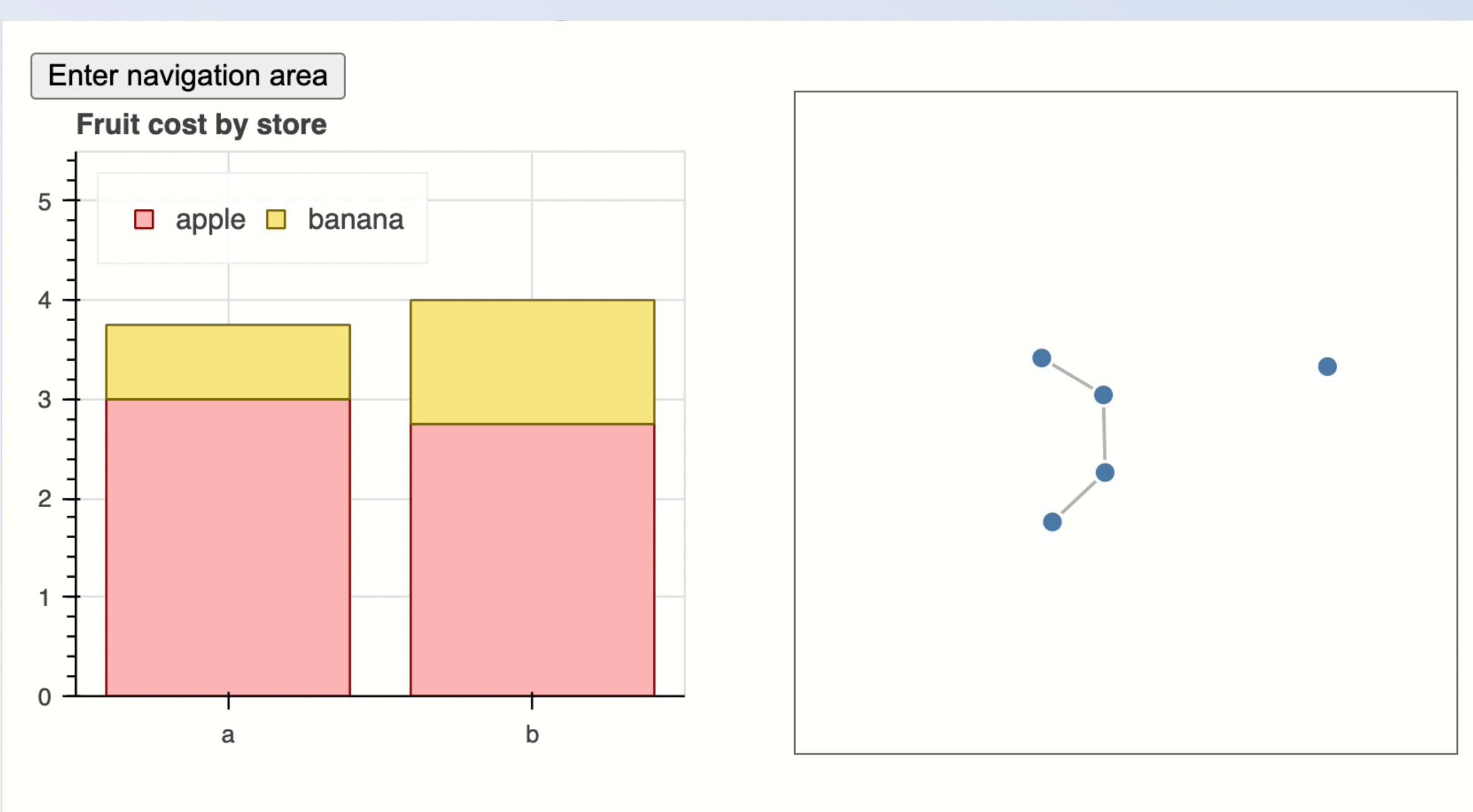


## 2023 (data navigator)



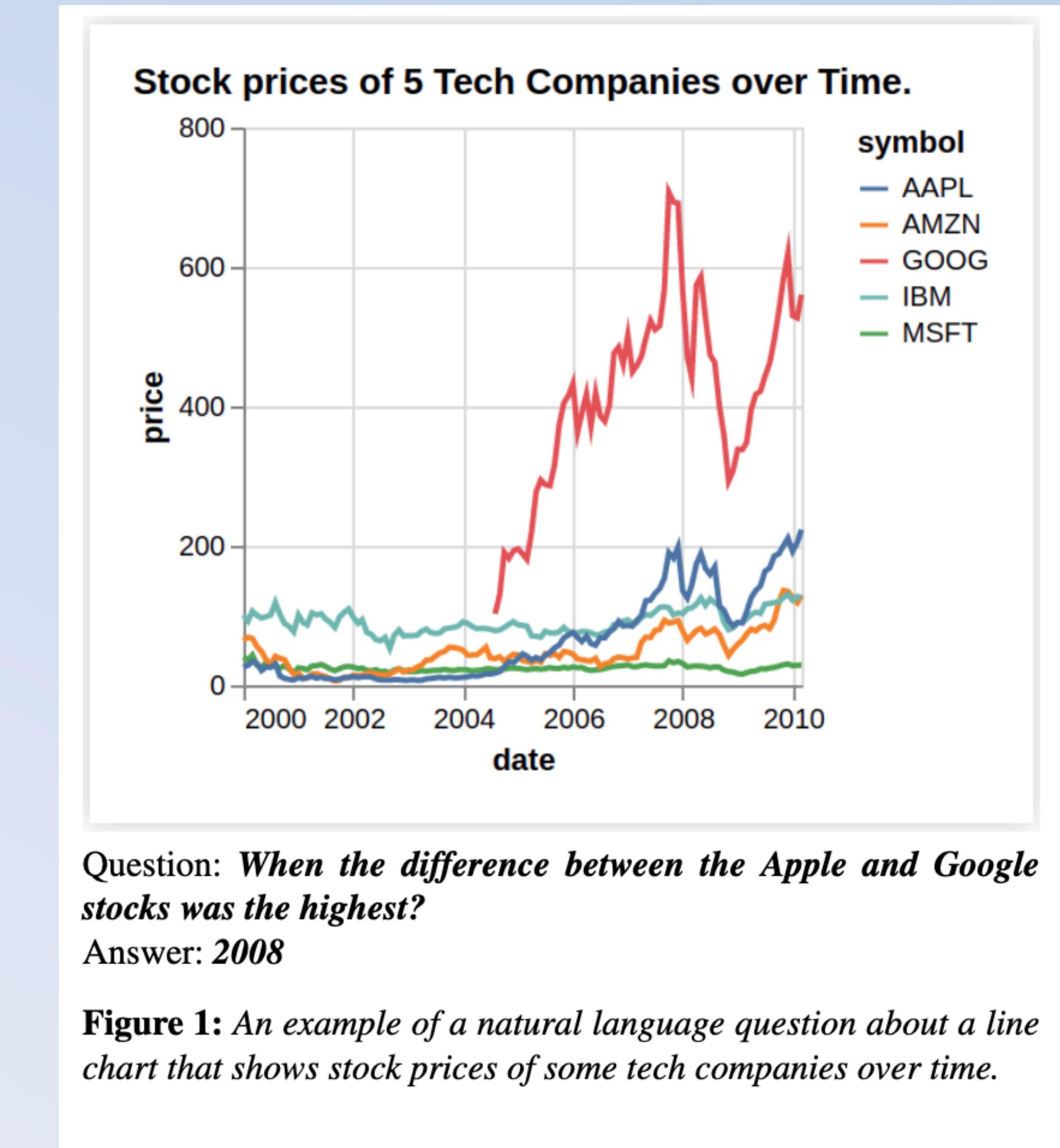
# Data Navigator: Empowering practitioners

*Bokeh, a python visualization library, and  
React Spectrum Charts, Adobe's visualization design system*



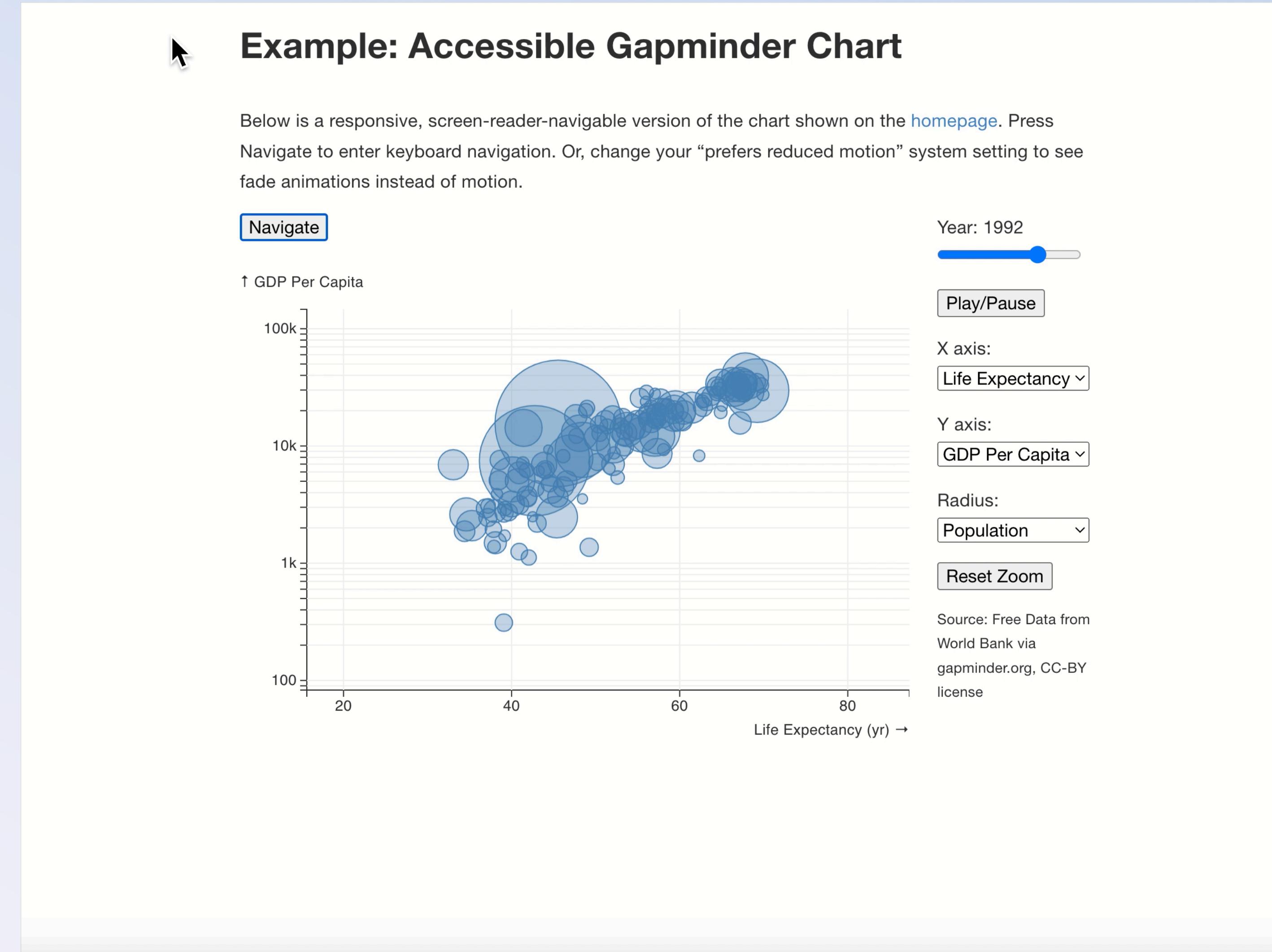
I have yet to see conversational visualizations in the wild, but the research is there!

VoxLens, VizAbility, “Blind question answering,” etc



# Counterpoint: navigating animations

## Sivaraman's Counterpoint (2024)



# Opt-out of visualization scrollytelling

## Amaka, Thomas, + Elavsky (2021)

The Pudding

# THE N a k e d T r u t h

**Story by**  
[Ofunne Amaka](#)

**Data & Code by**  
[Amber Thomas](#)

**March 2021**

HOW THE NAMES OF 6,816 COMPLEXION PRODUCTS CAN REVEAL BIAS IN BEAUTY

First Place. Lead Role. Number One. When things are arranged in a sequence, we have a mild obsession with being the “first.” You want the blue ribbon. To be on the

## NUDE & NATURAL

As a siloed event, there is absolutely nothing wrong with describing the color of a foundation shade as “nude” or “natural”. After all, a foundation is meant to mimic the color of your skin. But problems can arise if these words aren’t used to name shades consistently across the color spectrum.

The next graphics in this story will utilize scroll-driven animations.  
Use this toggle to disable this and view static graphics instead.

Animations are  on  off

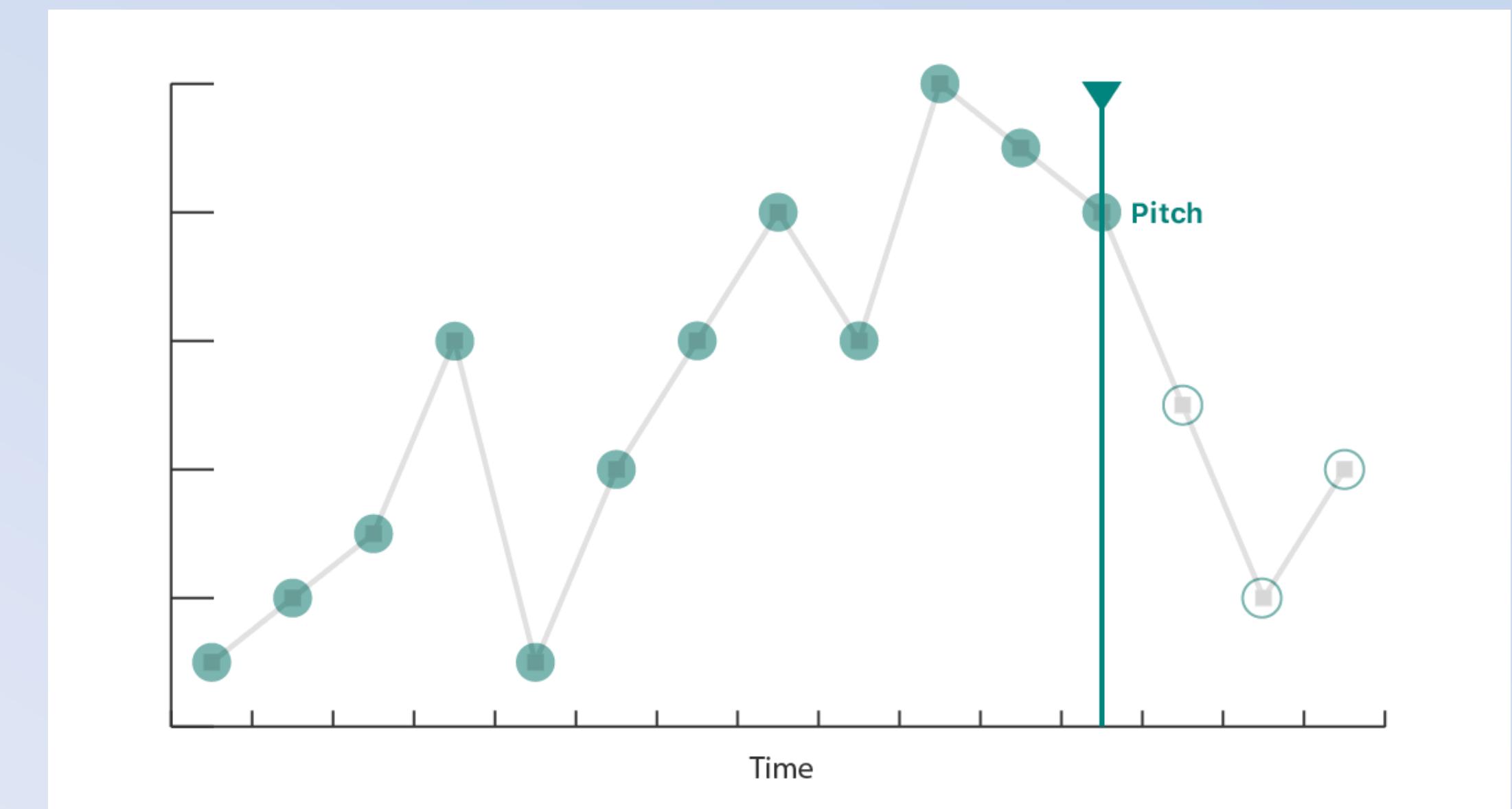
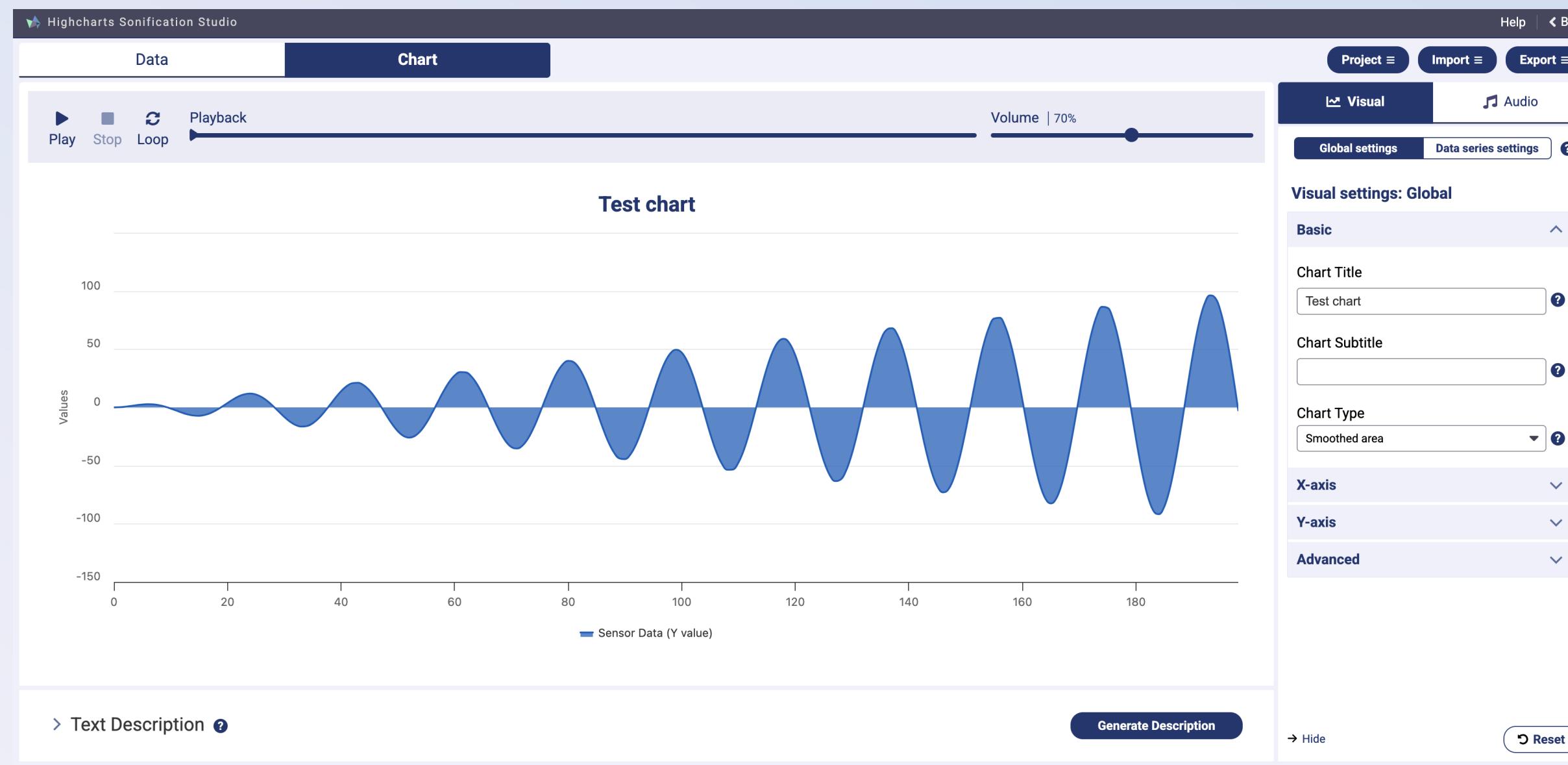
110 shades with “nude” in the name

We identified 110 shades from 73 products that contained the word “nude” in the name.

# **Non-visual, non-text modalities**

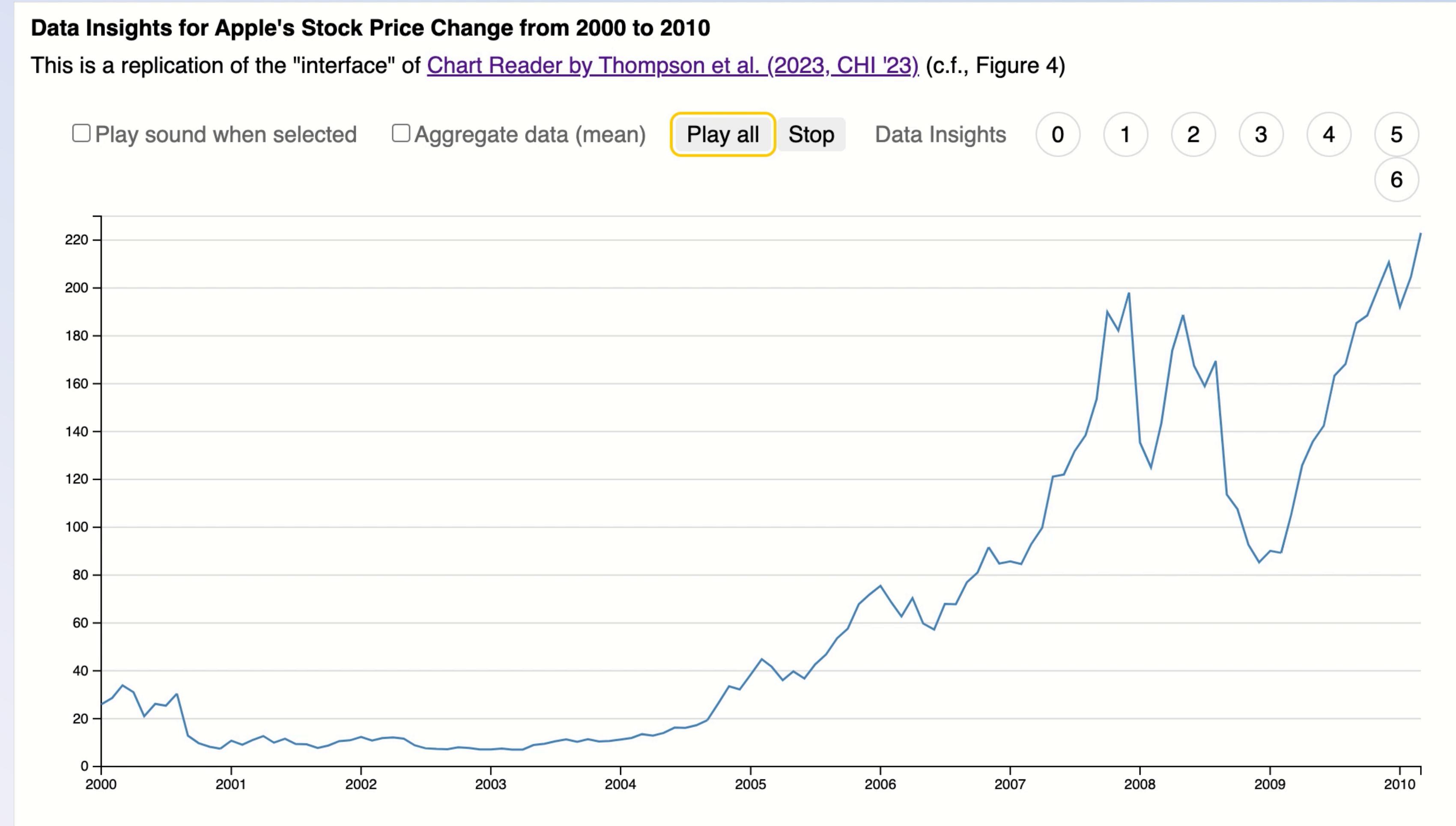
# Sonification at scale

## Highcharts (2018ish), Apple (WWDC 2021)



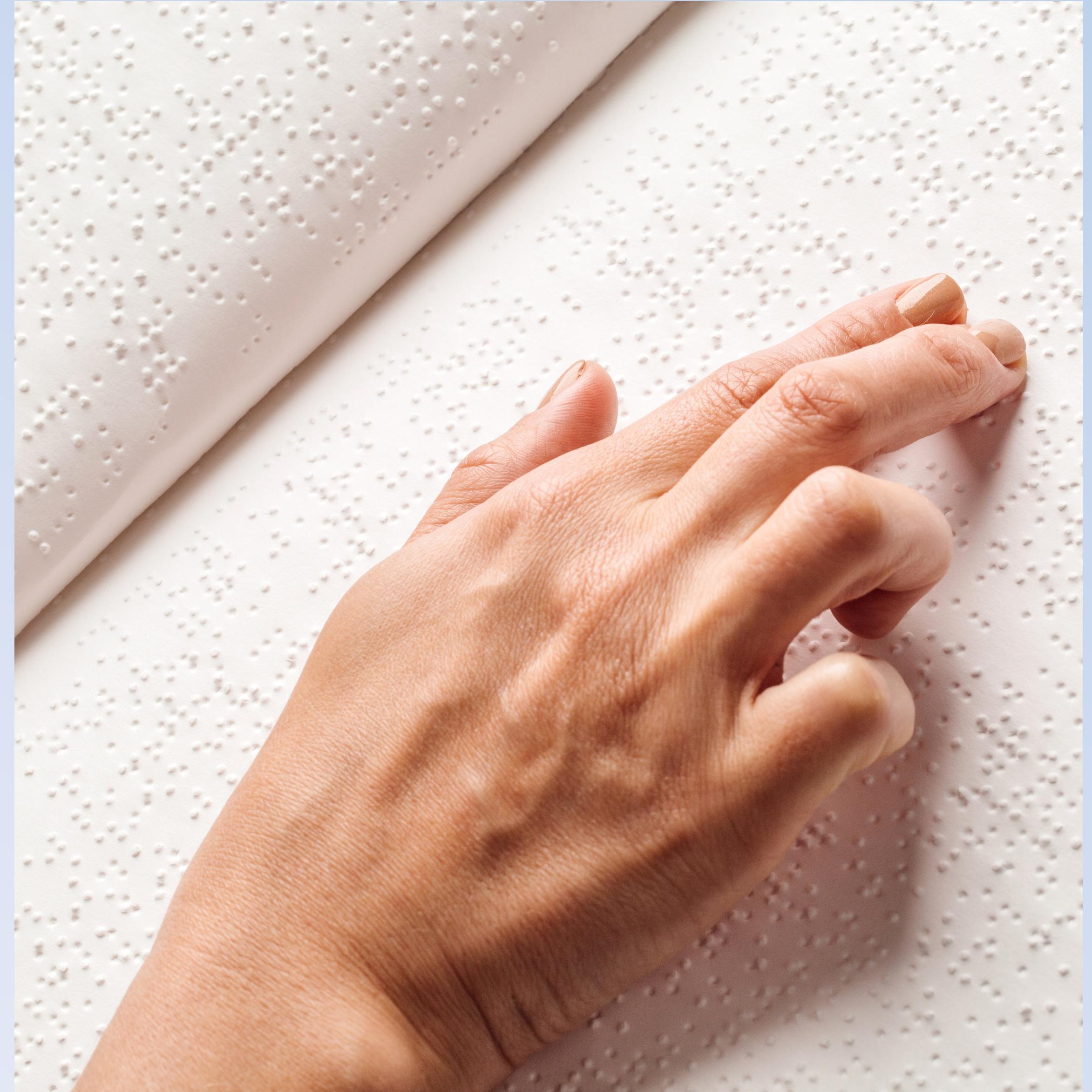
# Sonification for *any* web visualization library

## Kim et al's *Erie* (2024)



# **Embossing visualizations on paper**

**Still one of the best  
technologies out there!**



# Refreshable tactile displays

Great work by Holloway,  
also: Reinders, Butler,  
Marriott, and crew



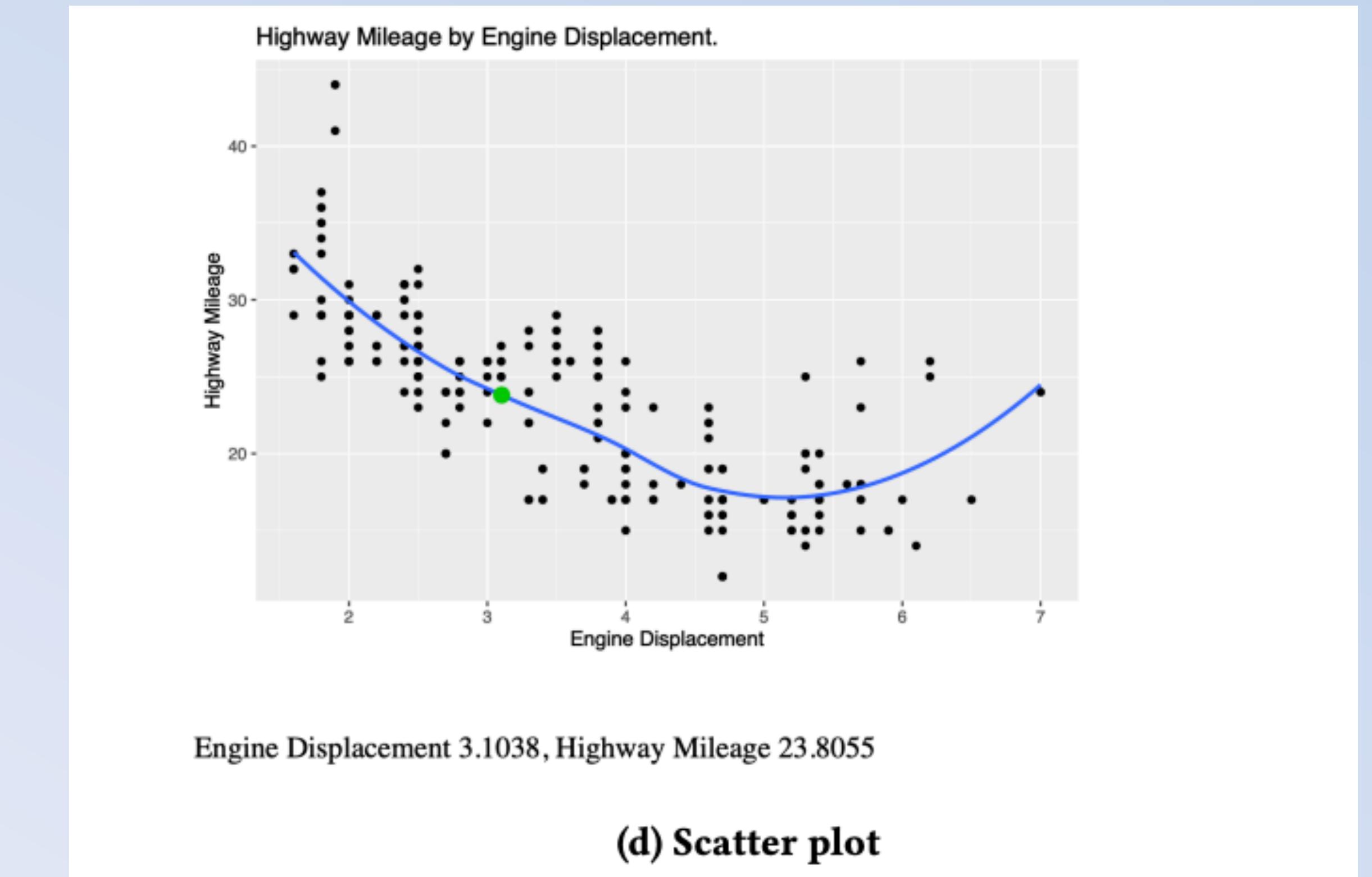
20,000 USD???

## Refreshable tactile displays

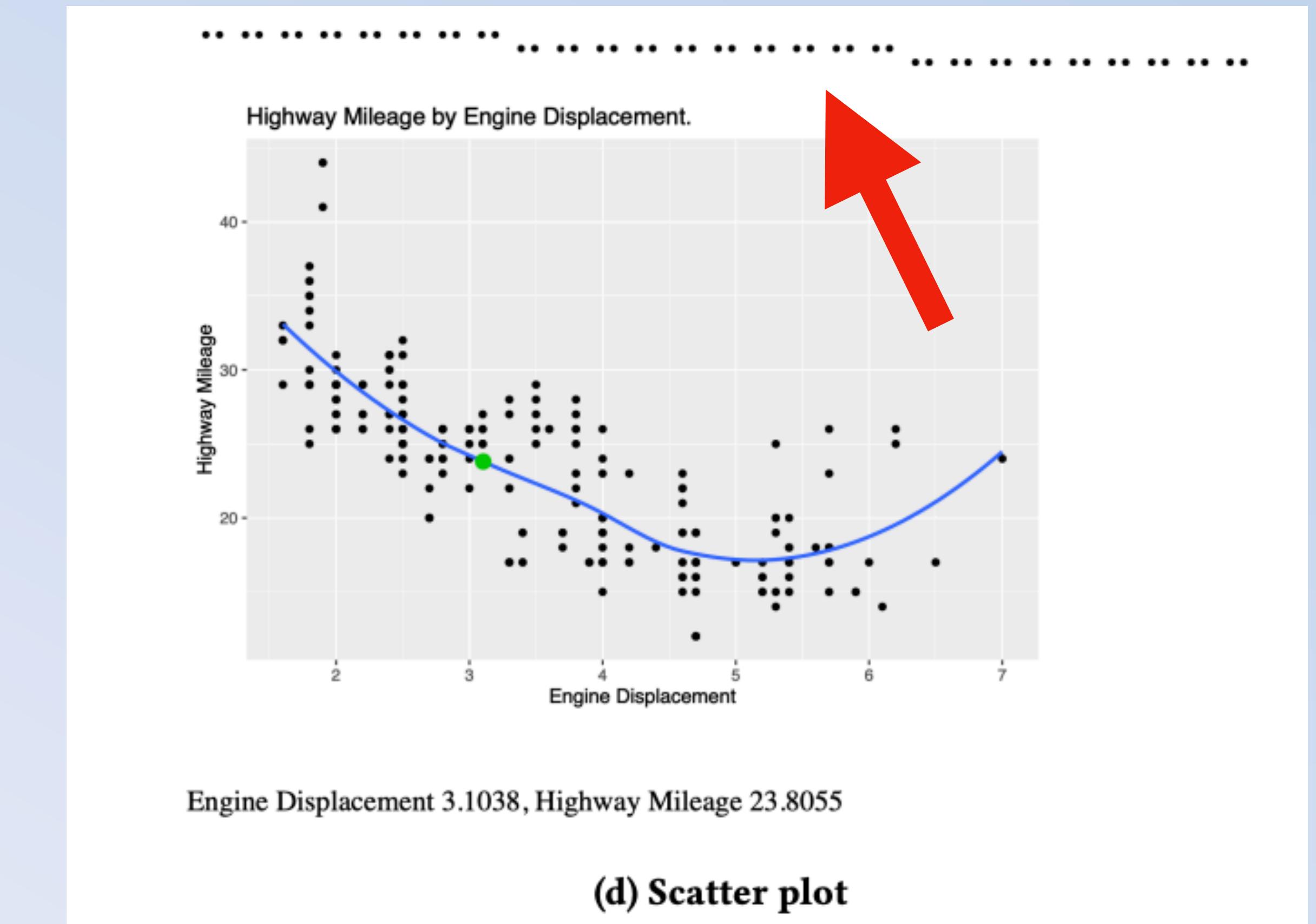
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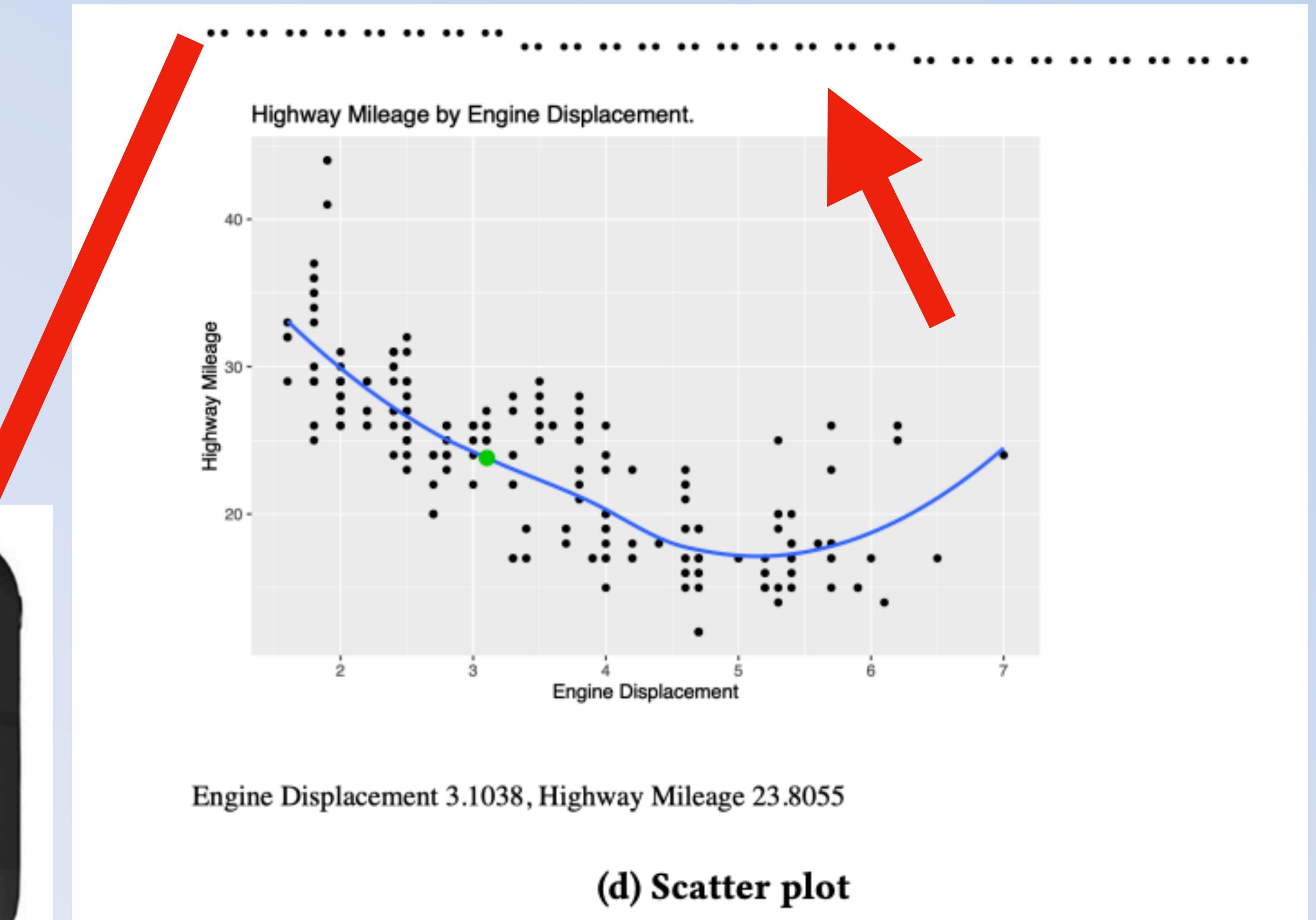
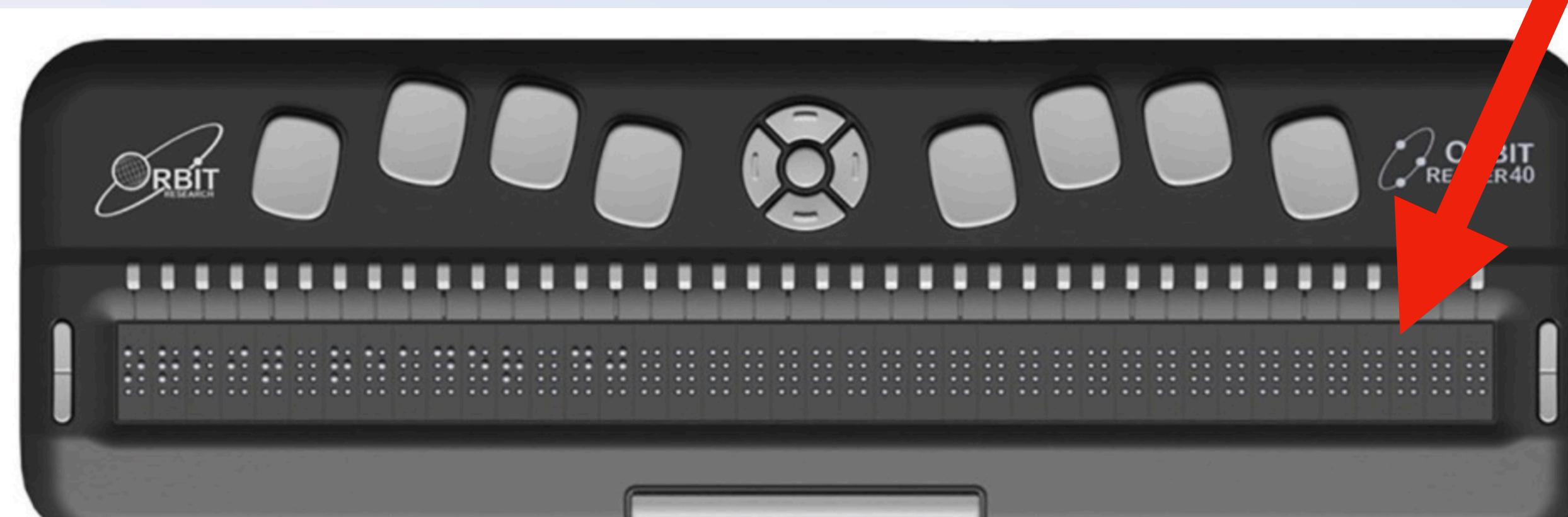
# Micro-tactiles (MAIDR, SparkBraille, etc)



# Micro-tactiles (MAIDR, SparkBraille, etc)

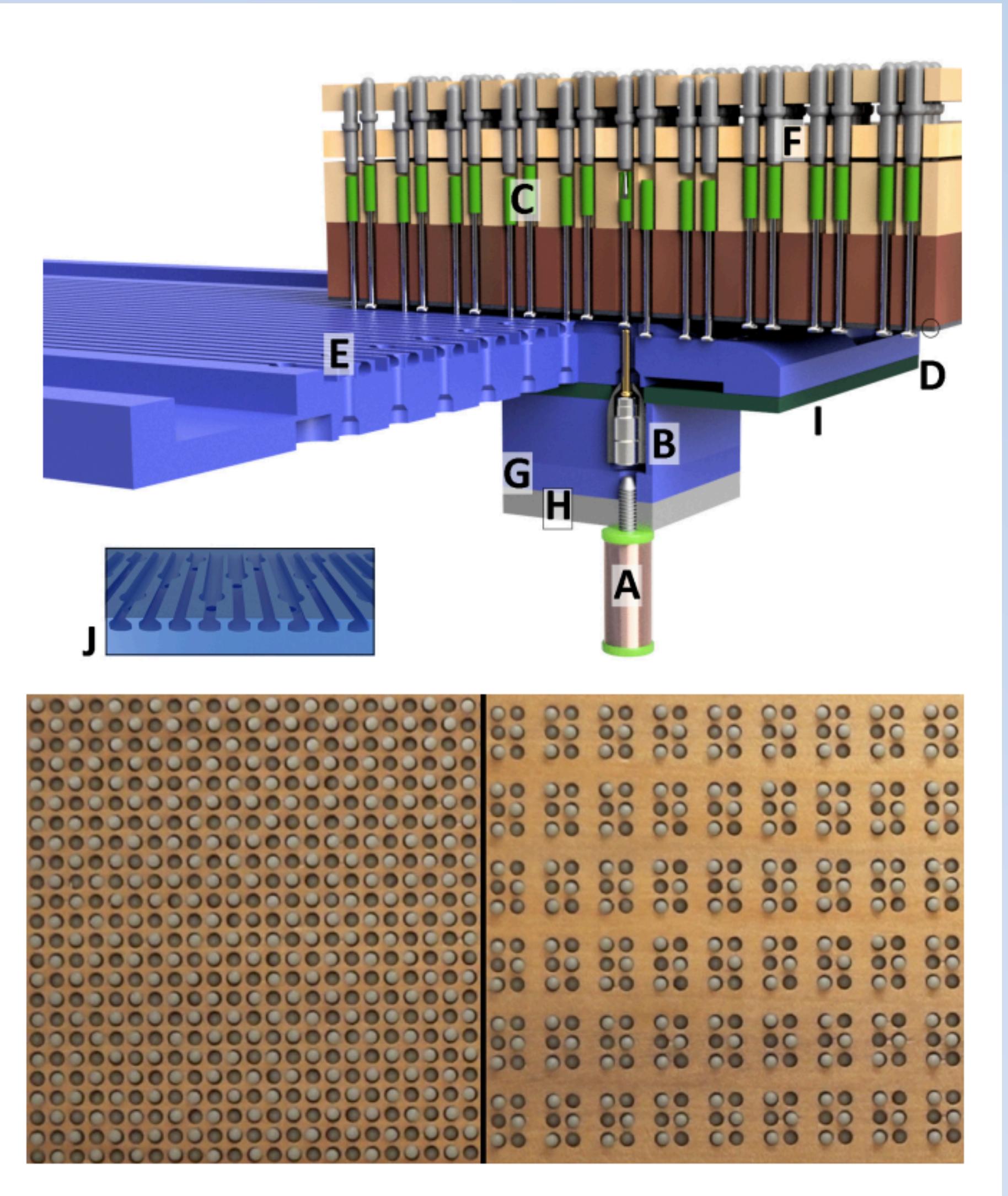


# Micro-tactiles (MAIDR, SparkBraille, etc)



# DIY, refreshable, low-cost pin displays

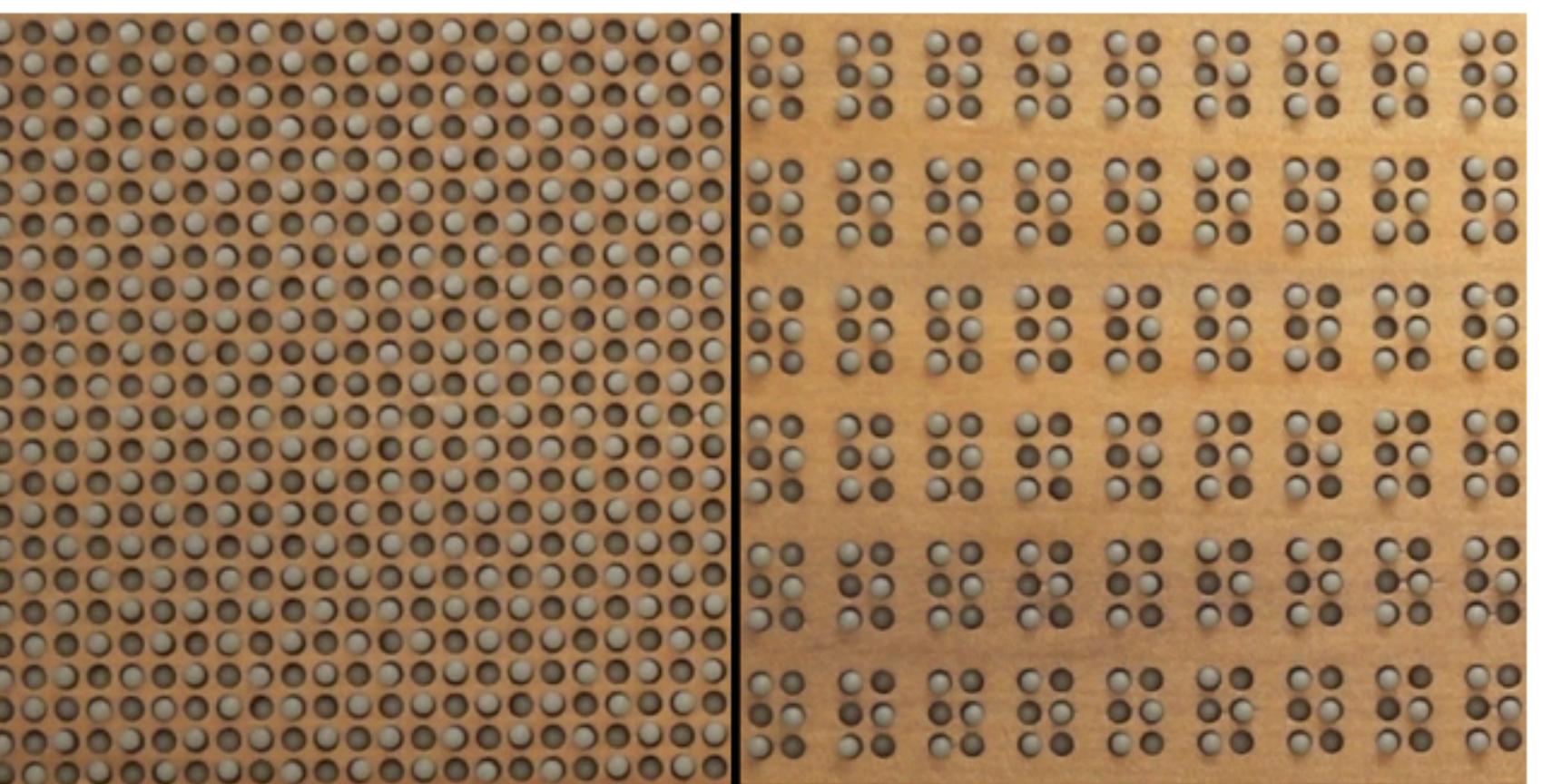
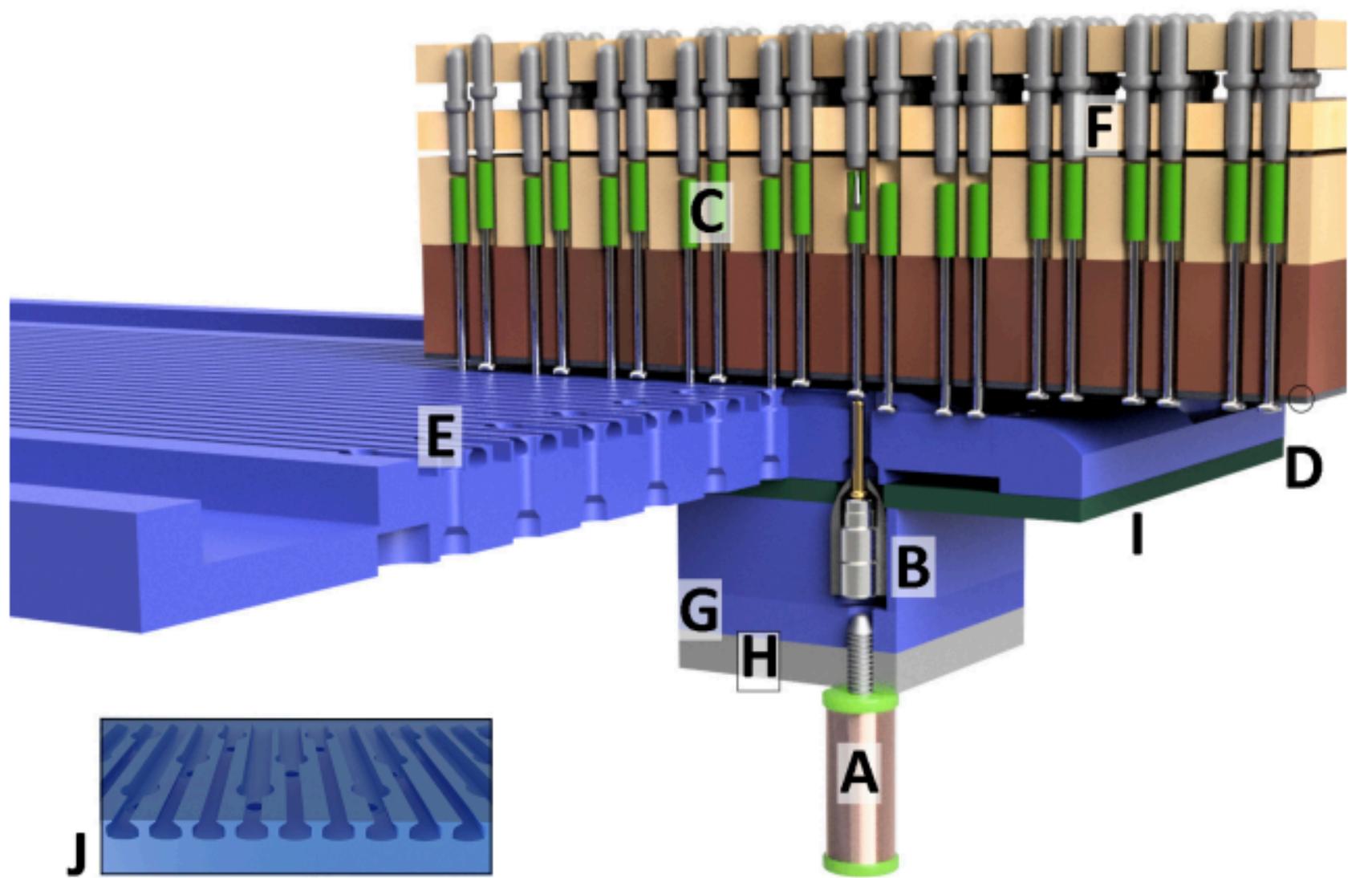
Smiley et al, “MagnePins”  
(2025)



**~250 USD!!!**

## DIY, refreshable, low-cost pin displays

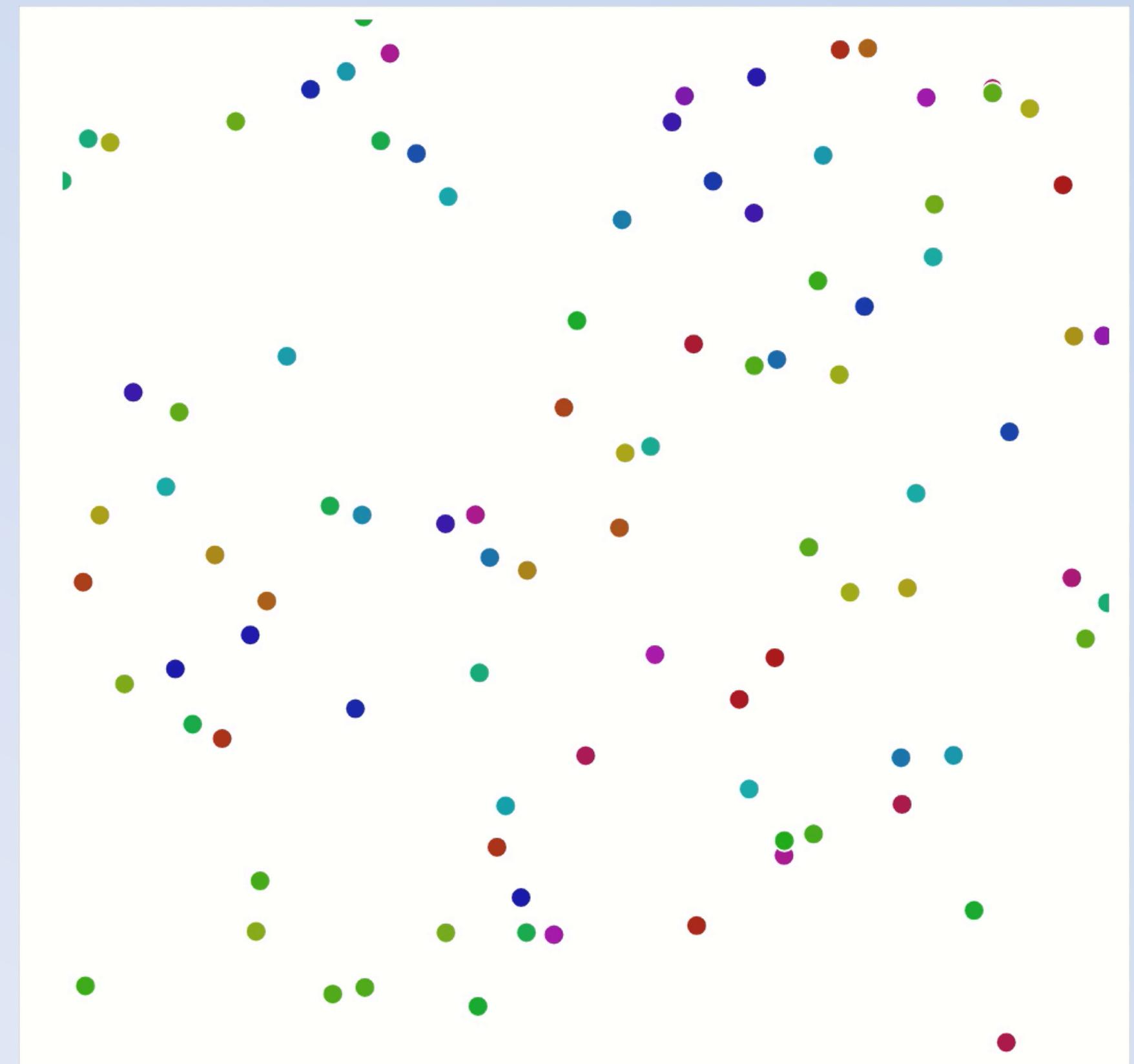
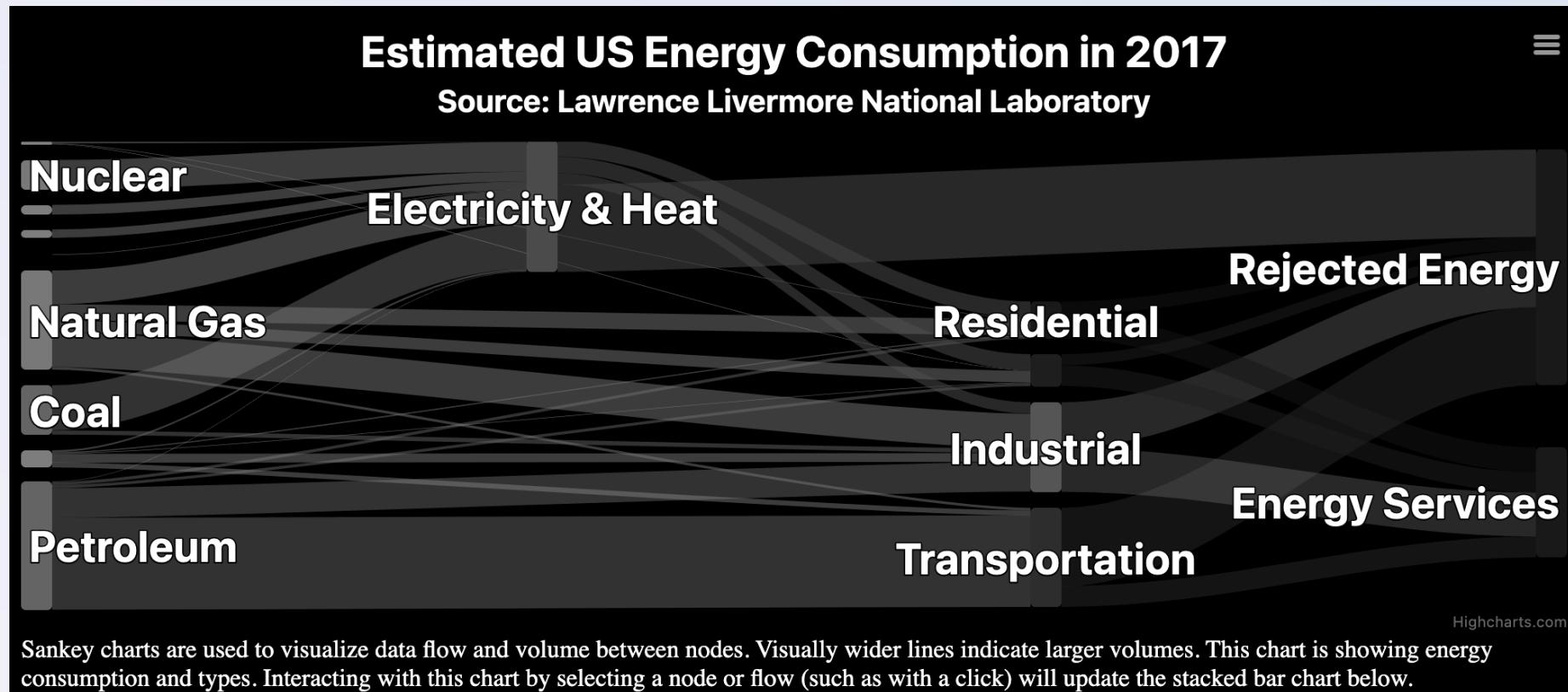
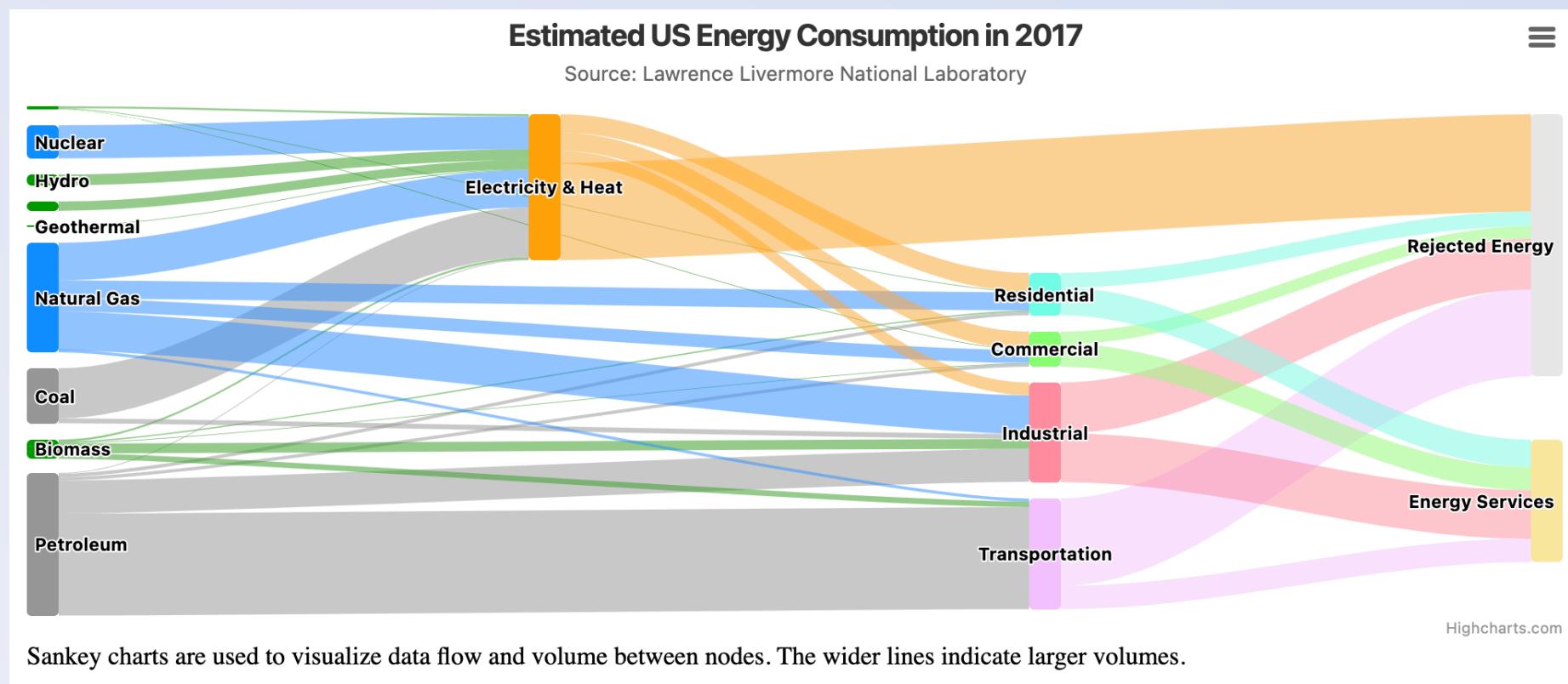
Smiley et al, “MagnePins”  
(2025)



# Personalization

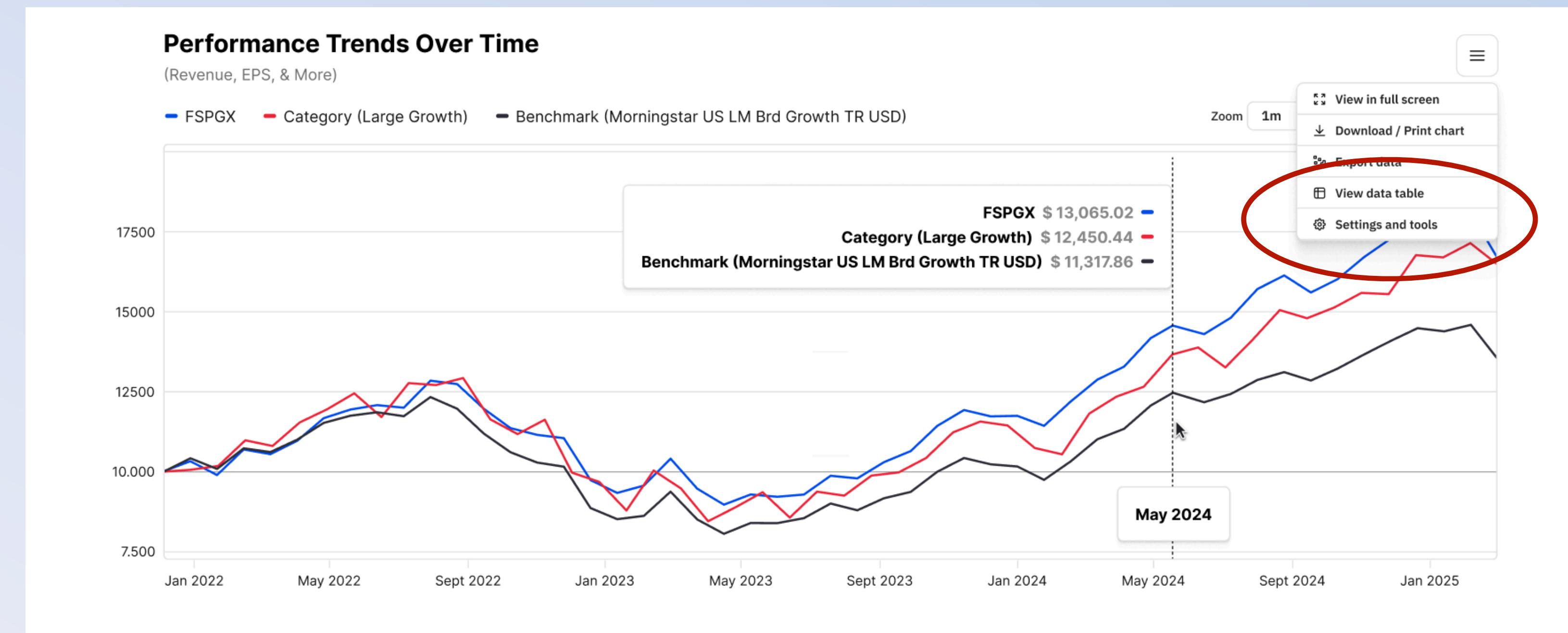
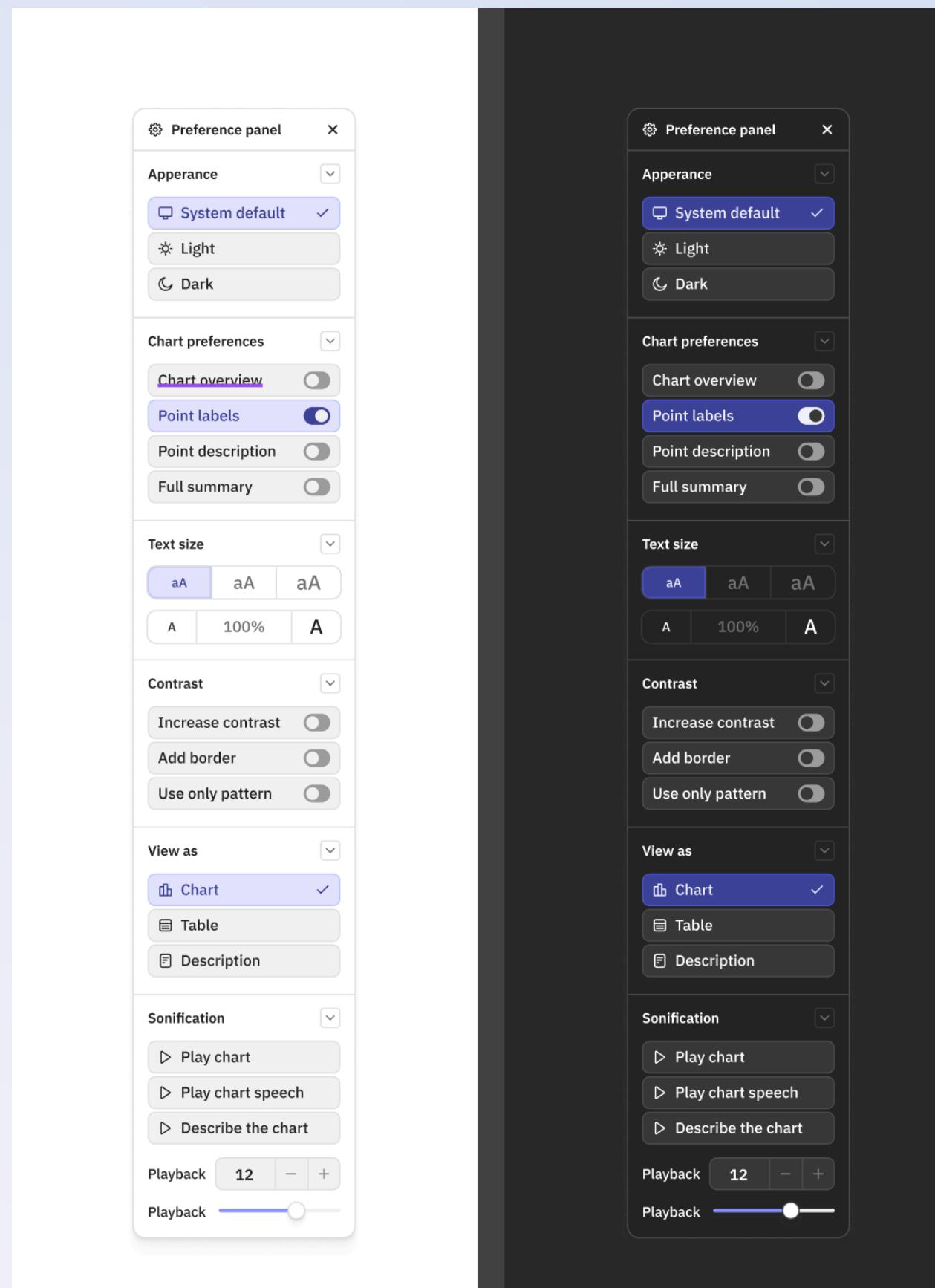
# Adjusting to system settings: font size, dark mode, motion reduction

Source: Highcharts, 2016ish?, Visa Chart Components (2017-2019), Counterpoint (2024)



# Enabling user profiles

Source: Highcharts 2025+, Elavsky et al, *Software*, 2025



2025

Slides here → [frank.computer](http://frank.computer)

# Visualization and accessibility: The state of the art, 2025



I'm on the job market!

Frank Elavsky, PhD Candidate



Human-  
Computer  
Interaction  
Institute



[hcii.cmu.edu](http://hcii.cmu.edu), [axle-lab.com](http://axle-lab.com), [dig.cmu.edu](http://dig.cmu.edu)