

2025

frank.computer

Tools for Accessible Data Interaction



Frank Elavsky



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





Credit: Jeff Kubina, [Wikimedia](#)

Tools matter

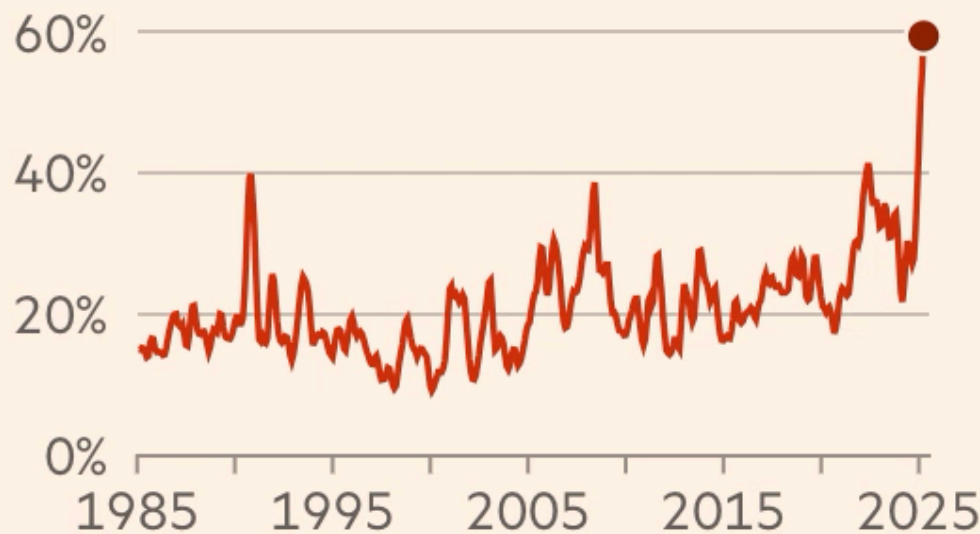
US consumers are rapidly souring on Trump's economic plan

Share of adults who...

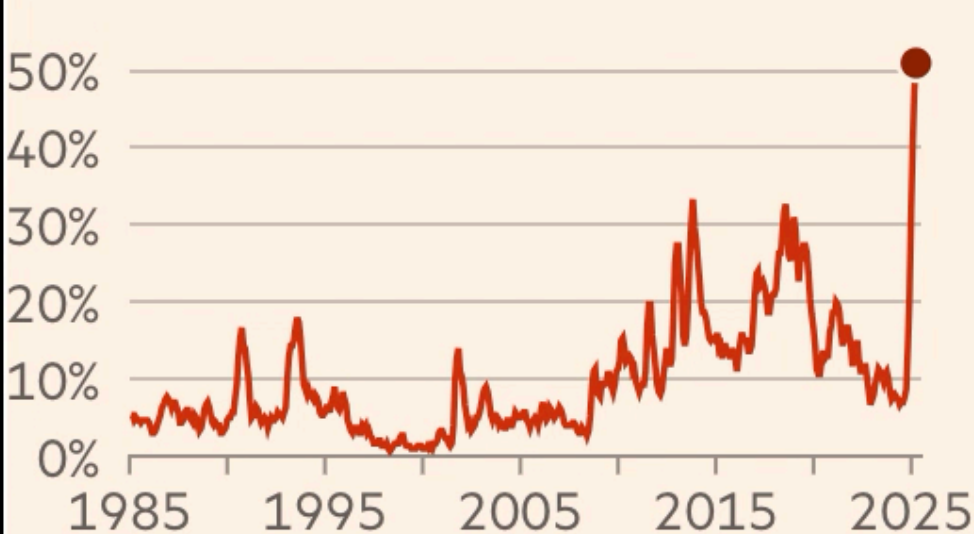
Have a negative opinion of government's economic policy



Expect business conditions to worsen over next year



Have heard unfavourable business news coverage of government



Expect their income will grow faster than inflation in next 5 years



Source: [University of Michigan consumer sentiment survey](#).

FT graphic: John Burn-Murdoch / @jburnmurdoch

©FT


✕ You are currently on a frame. To enter the web area, press Control-Option-Shift-Down Arrow.

Republican. No need to take that from me: it's a well-evidenced


Some change is easier to make happen than others

[Flourish] Re: Accessibility feedback | Ticket#: 12779061


Inbox x




Flourish
##- Please type your reply above this line -## We've received your Flourish support request . To add additional comments, reply to this email. Please note we op




Georgie (Flourish)
Your Flourish support ticket has been updated. To add additional comments, reply to this email. Georgie (Flourish) May 20, 2025, 19:00 GMT+8 Hi Frank Firstly, t




Frank Elavsky
Thanks so much, Georgie! Looking forward to the discussion from this. Thanks also for being so responsive.




Luisa Bider
Hi Frank, Thanks so much for taking the time to share this thoughtful feedback on Flourish's accessibility features. We've been following your work for some tim




Frank Elavsky
Hi Luisa, (and hi Rachel and Becky) Apologies for not emailing sooner! I've been under a tight deadline. But I have a bit of breathing room right now. I love th




Luisa Bider
Hi Frank, Thanks so much for the reply and no worries at all :) Could you clarify the time zones of the meeting times you've proposed? I unfortunately won't be




Frank Elavsky
Oh yes, of course! I'm Eastern Time here in the US.



Luisa Bider
Hi Frank, Perfect! I've just sent across a calendar invite for Friday 10am your time / 3pm our time. Looking forward to chatting! Best, Luisa



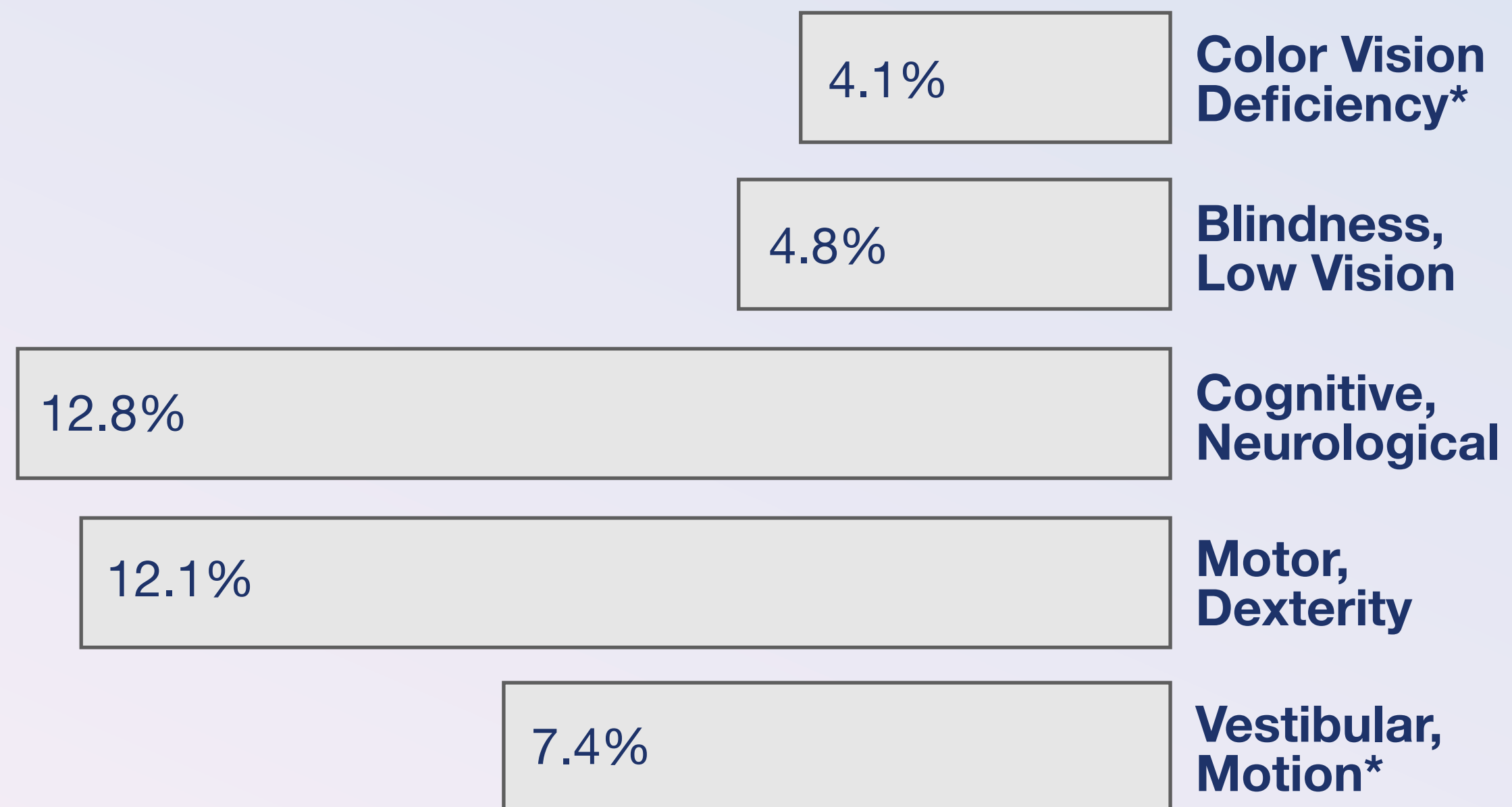
Frank Elavsky
Howdy team, just sharing some good news: we've decided to add Flourish to our shortlist resources of libraries and tools. You're doing really good work, so plea

**Luisa Bider** <luisa@canva.com>
to Georgia, me, Becky, Rachel ▾

Hi Frank,

Oh my gosh this is amazing news! Thank you **so much** for adding **Flourish** to the shortlist! It's so encouraging to see our accessibility work recognized, especially by fo
fixes and features over the summer:

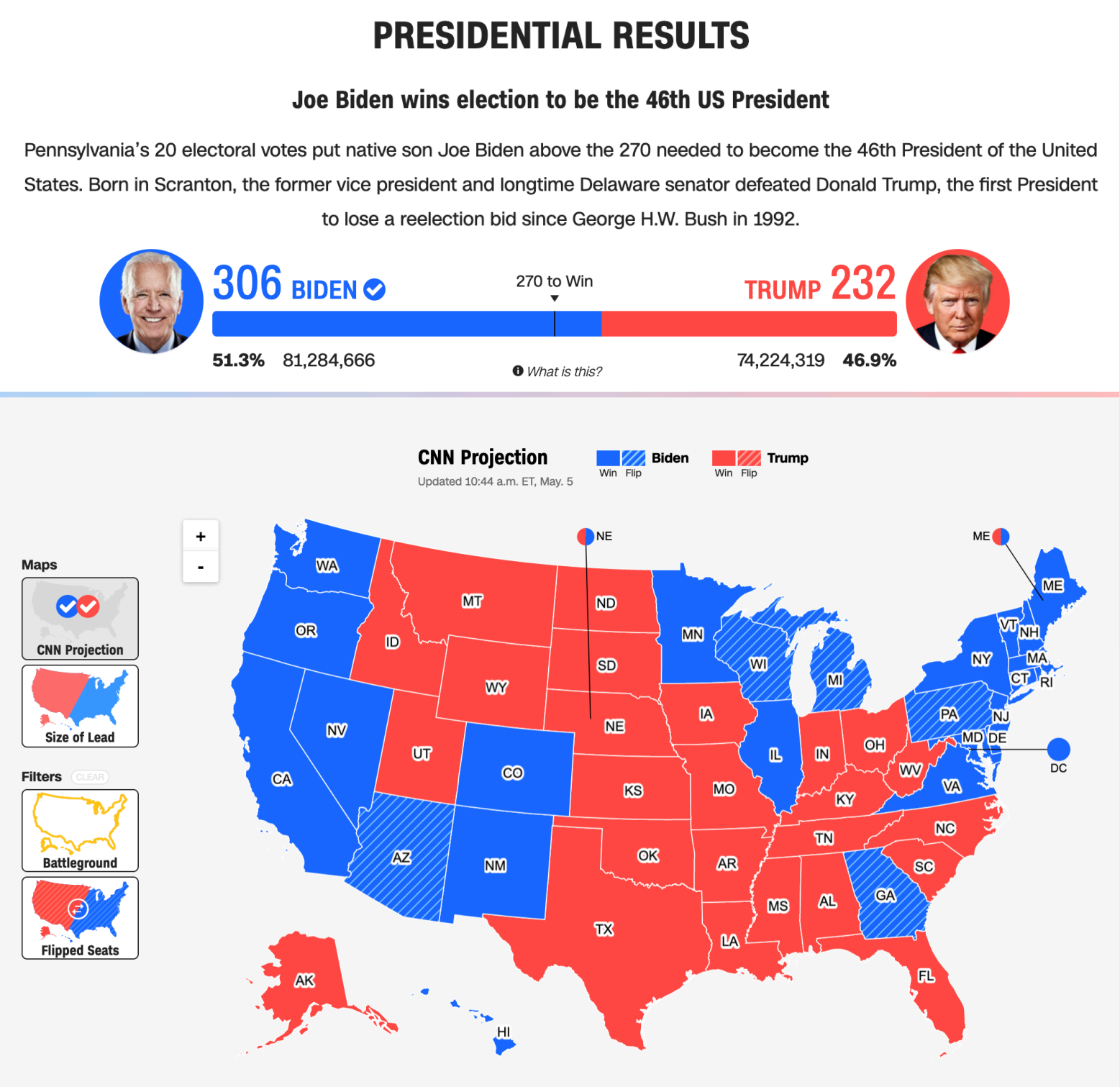
~27% of people living in the United States self-report living with a disability that affects their daily life (2023)



Centers for Disease Control and Prevention. Disability and Health Data System (DHDS). 2023. Available from: <http://dhds.cdc.gov>
*No new data

People with disabilities deserve to:

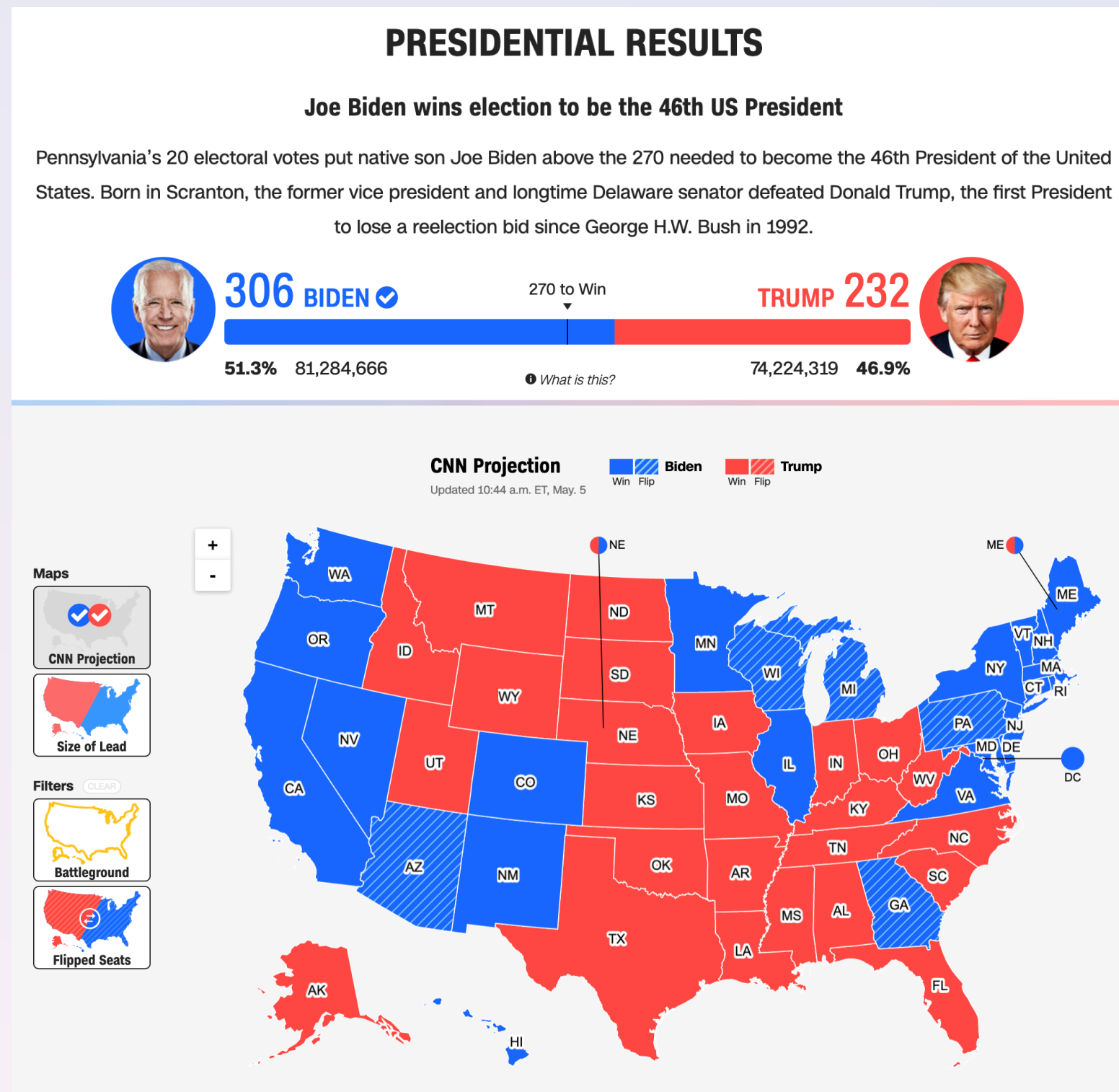
Participate in politics



Credit: [CNN](#)

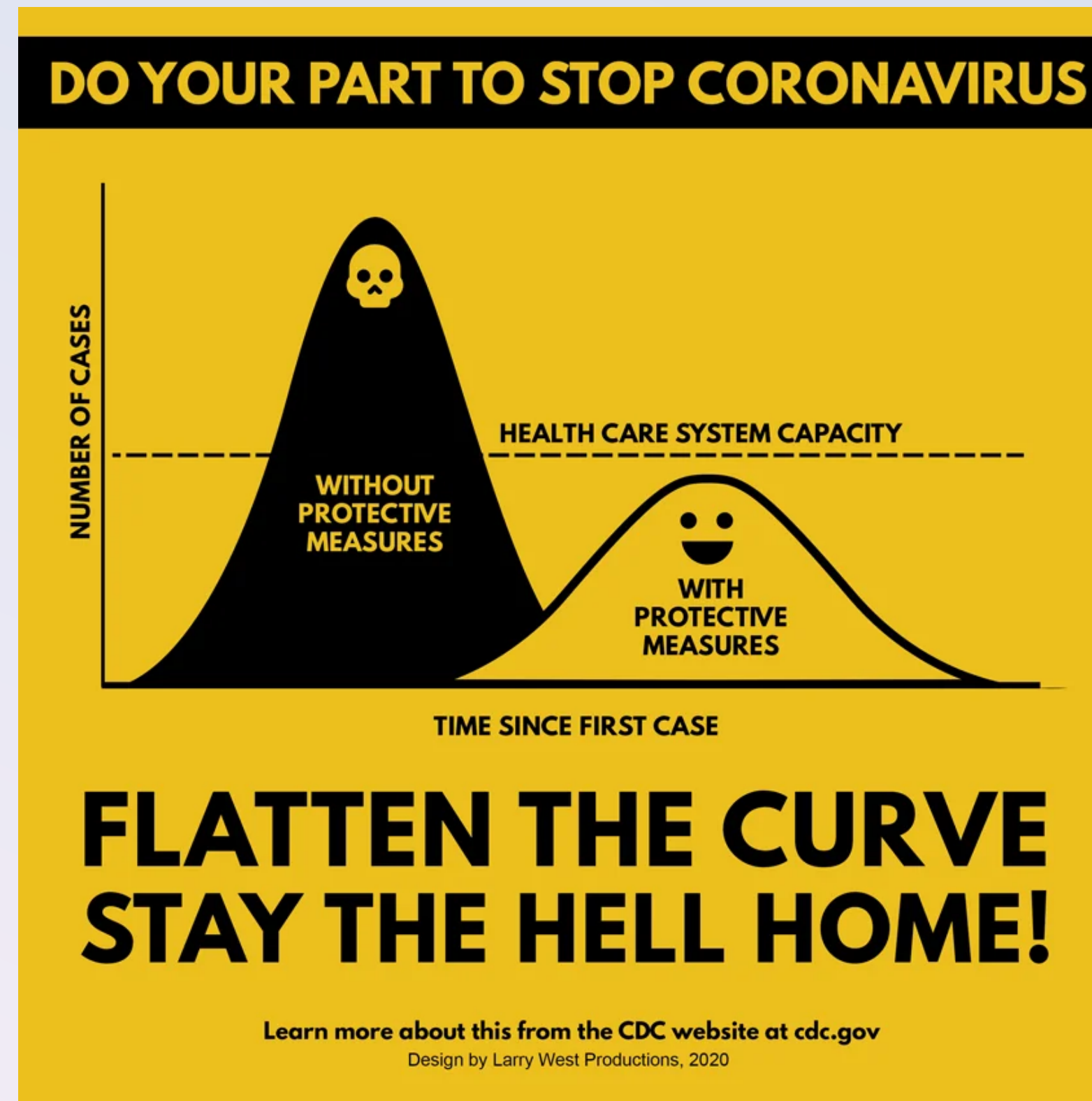
People with disabilities deserve to:

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Credit: [CNN](#)

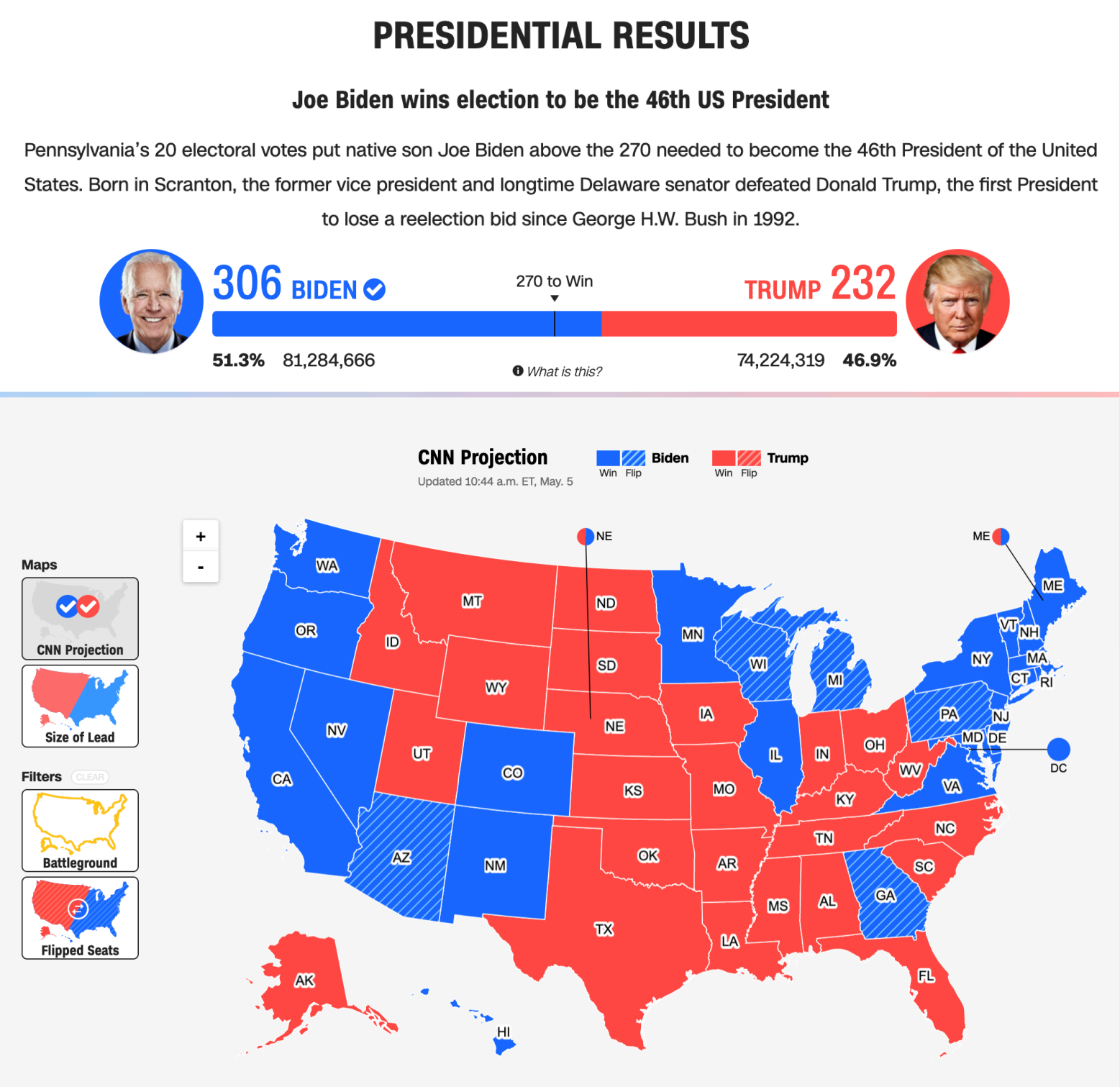
Make informed decisions



Credit: [Reddit](#)

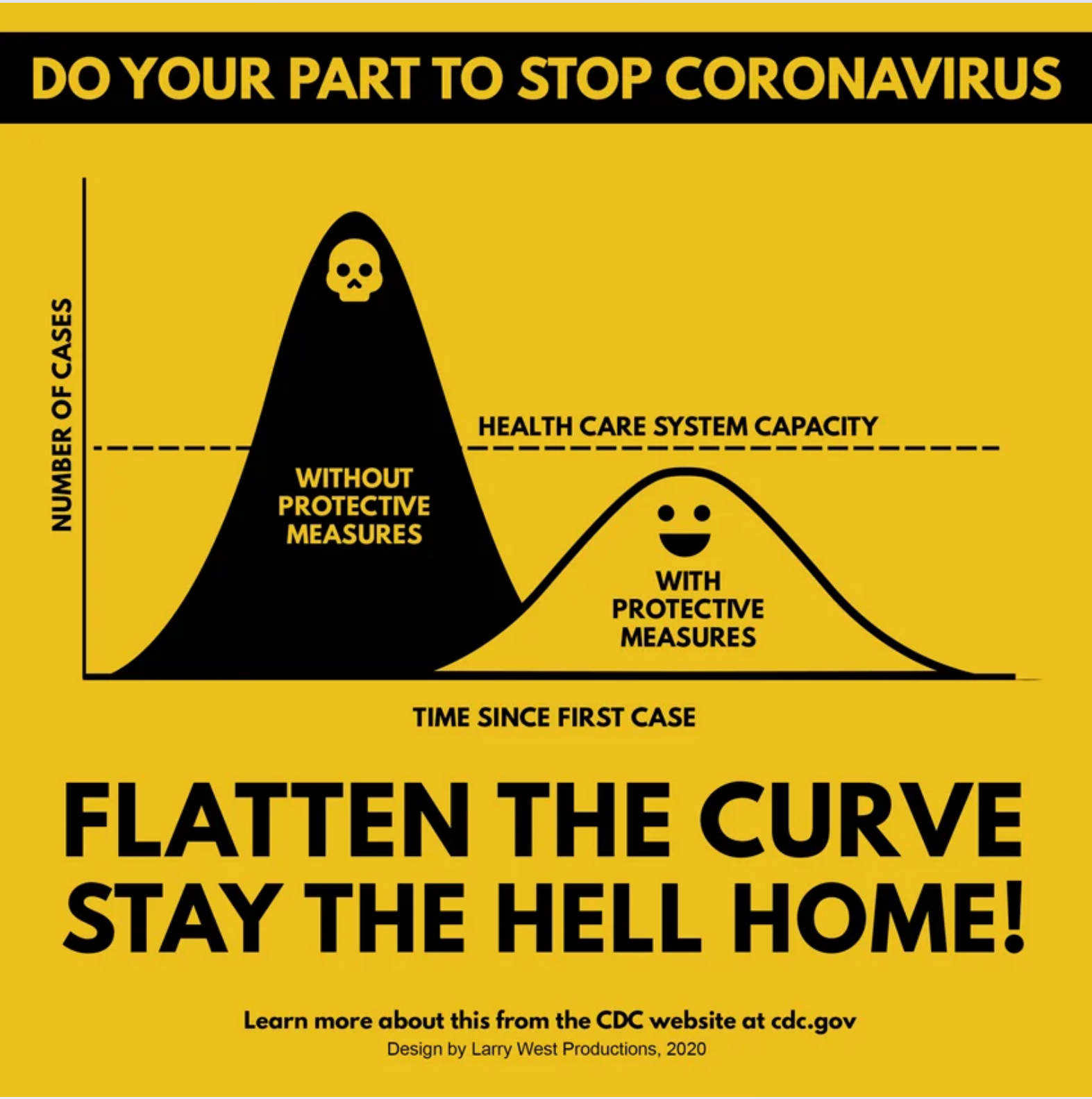
People with disabilities deserve to:

Participate in politics



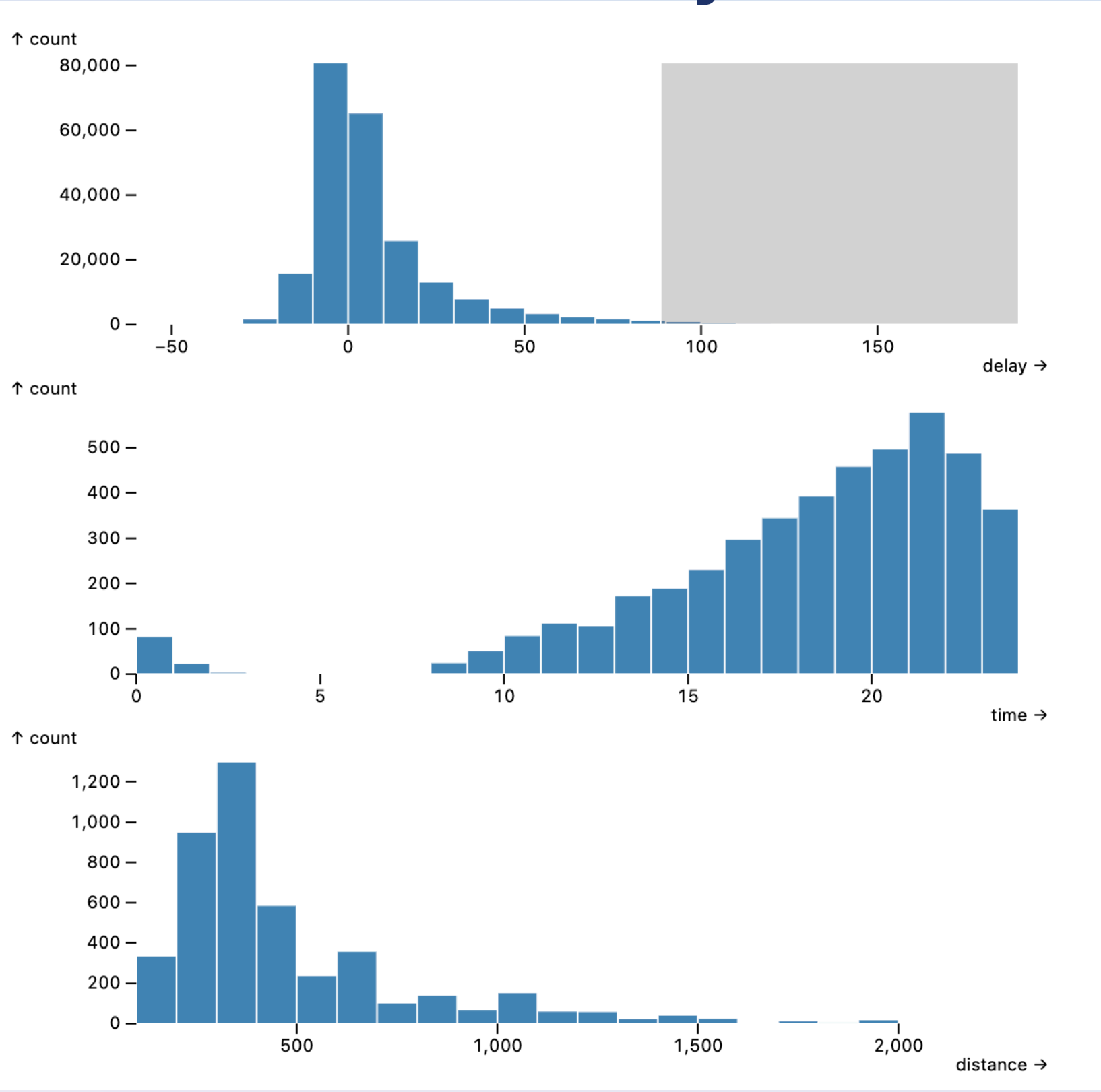
Credit: [CNN](#)

Make informed decisions

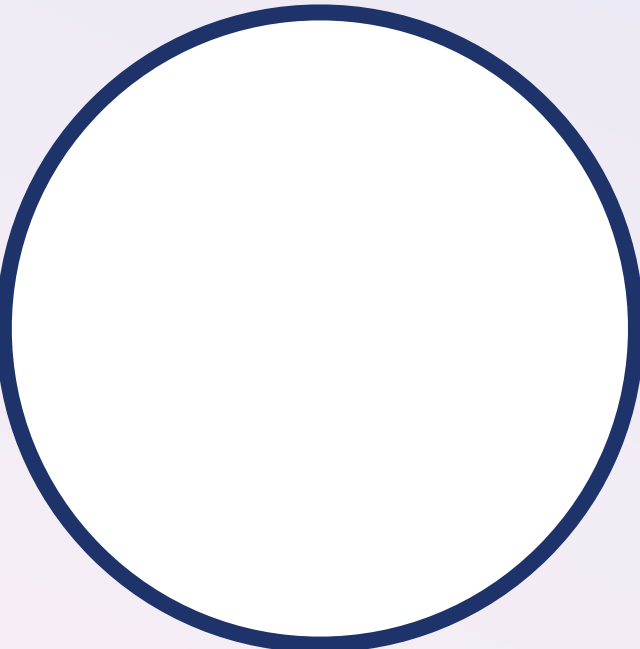


Credit: [Reddit](#)

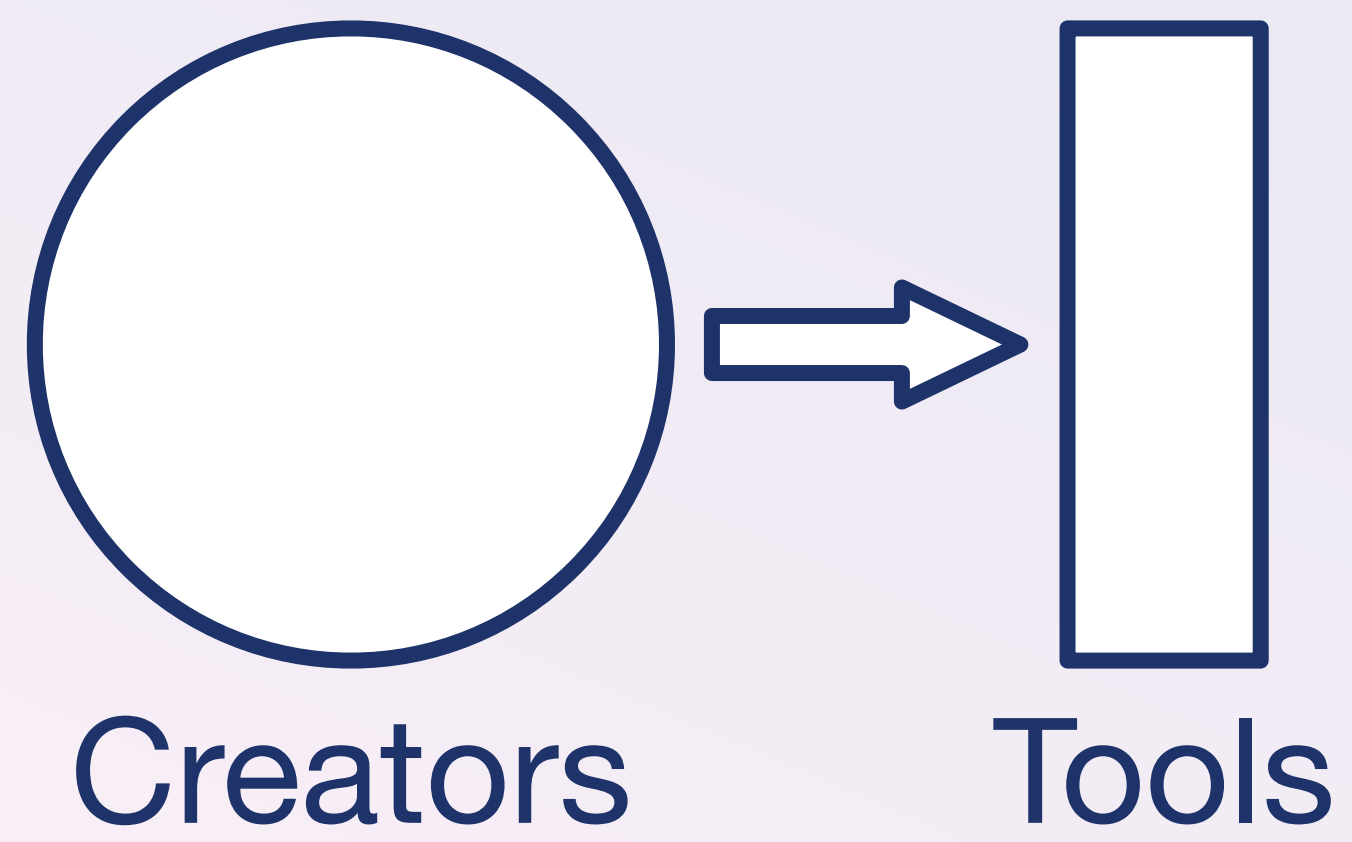
Analyze data quickly and efficiently

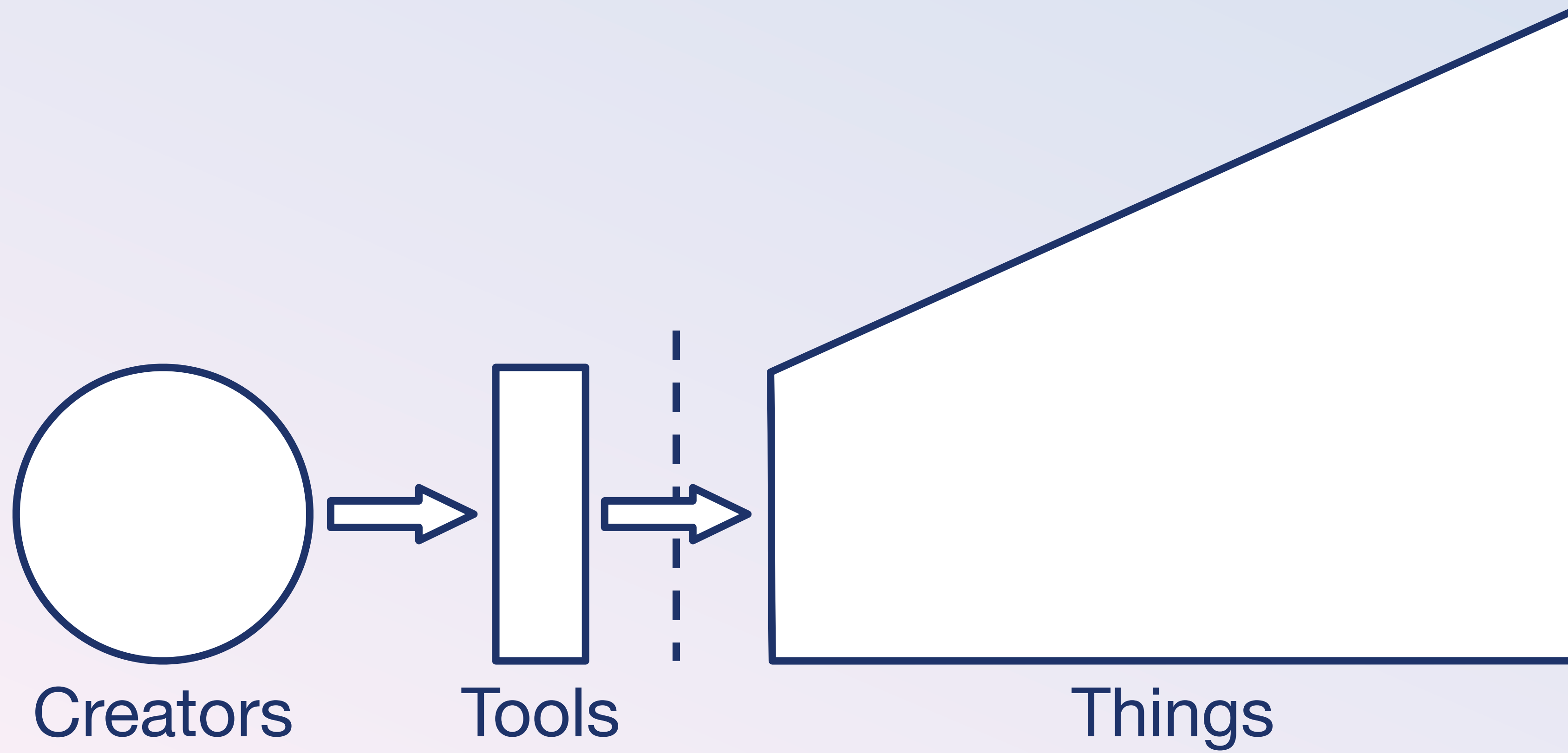


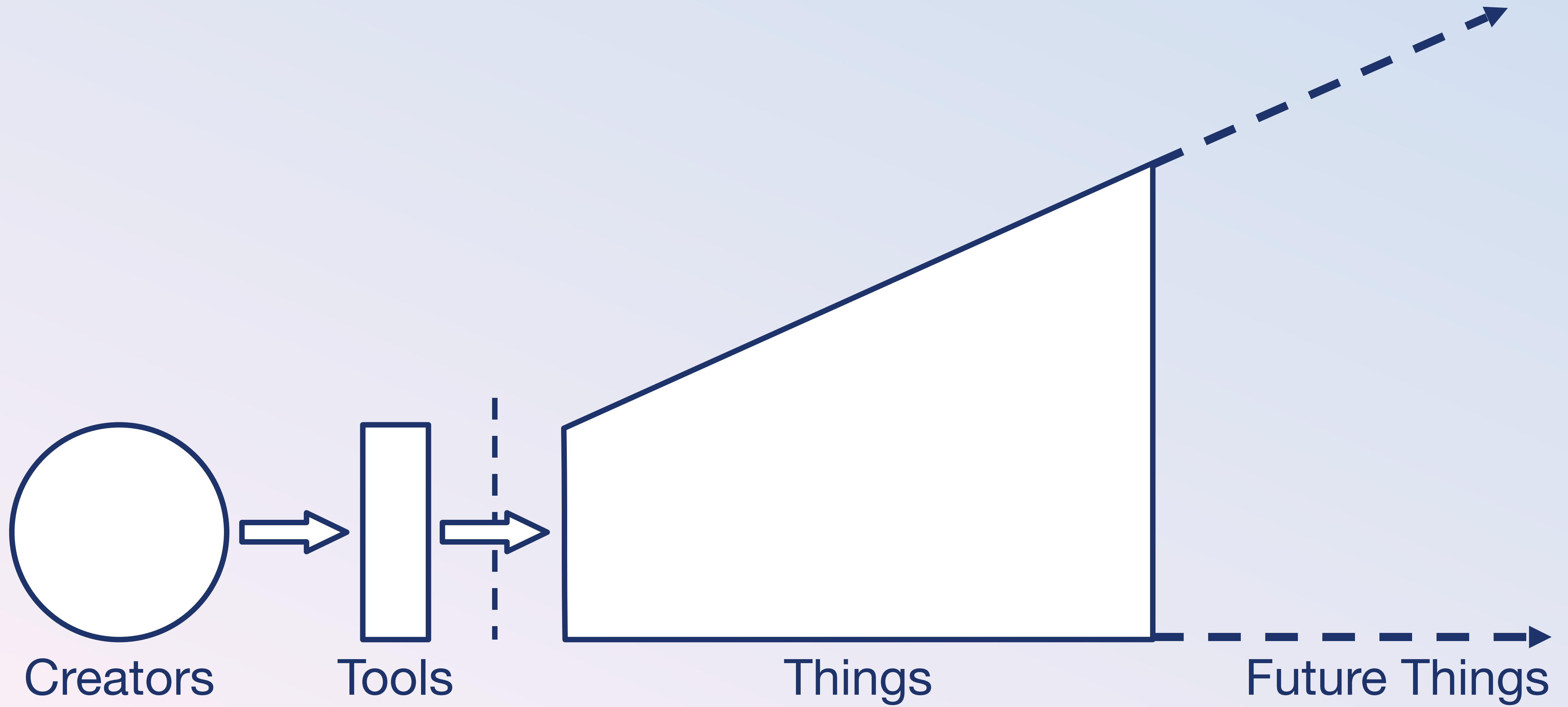
Credit: [Our research](#)



Creators





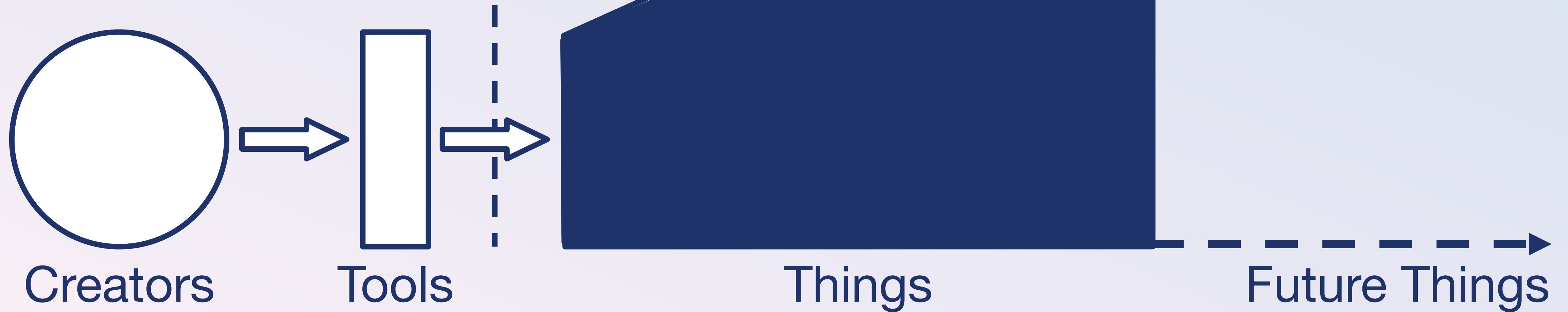


**But how much of this is
inaccessible?**



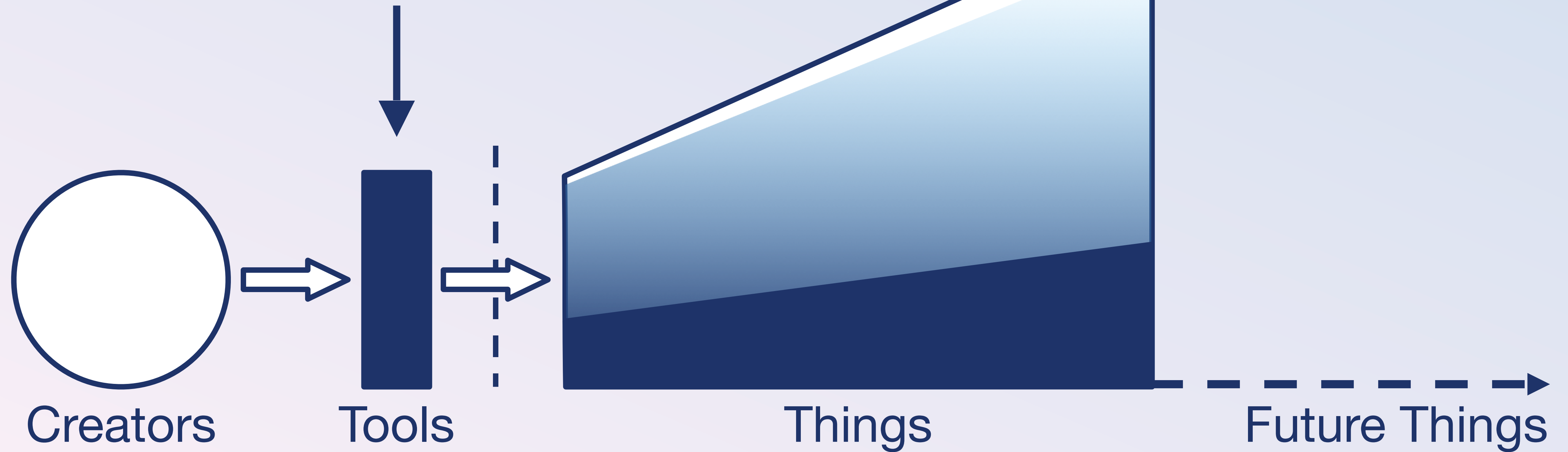
97-99%

Source: World Wide Web Consortium. "The WebAIM Million Report." 2019-2025



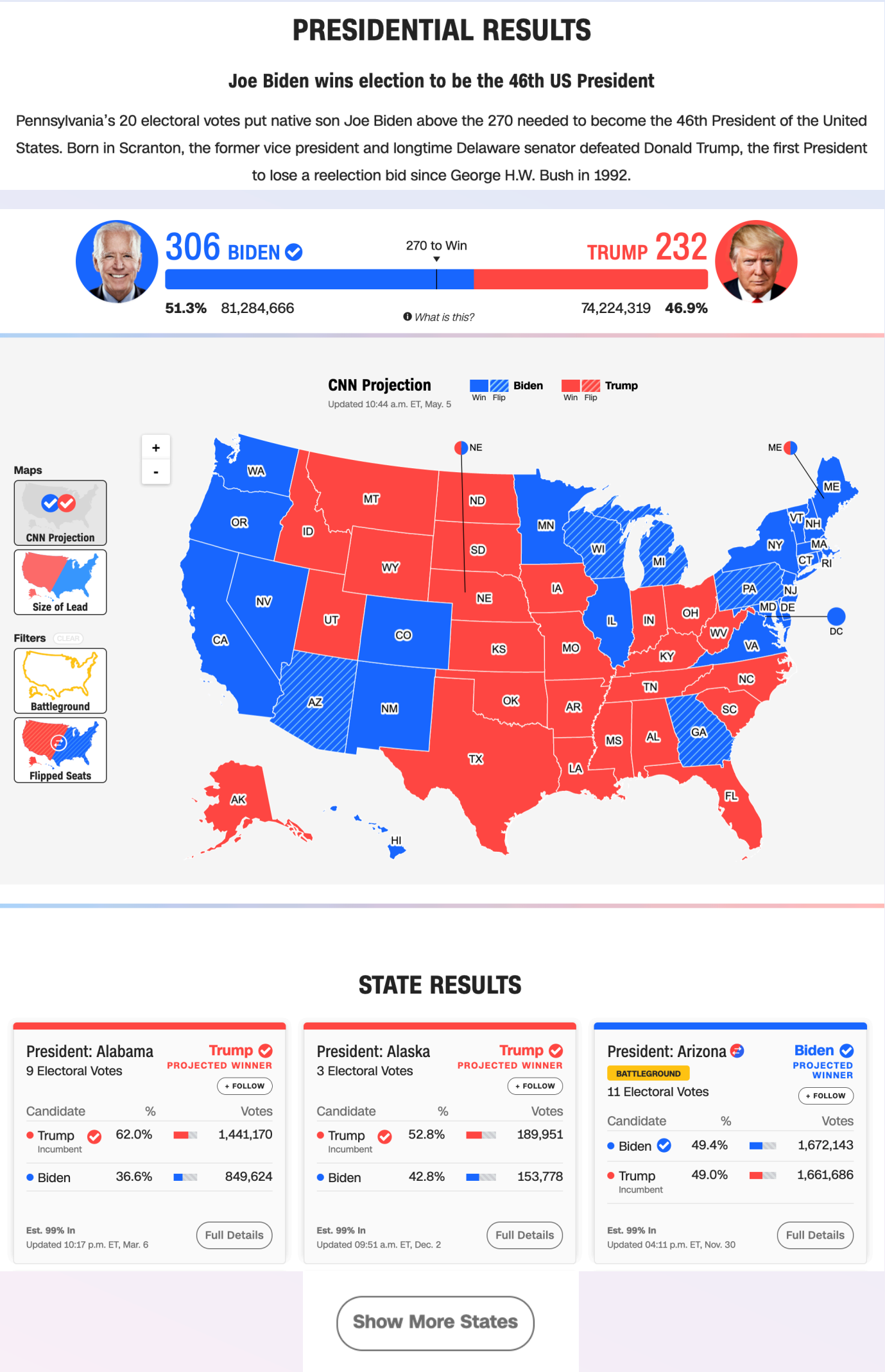
The builders and the makers (*that's us*) are responsible for access.

Can better tools reduce inaccessibility?



Section 1:

Helping practitioners consider accessibility

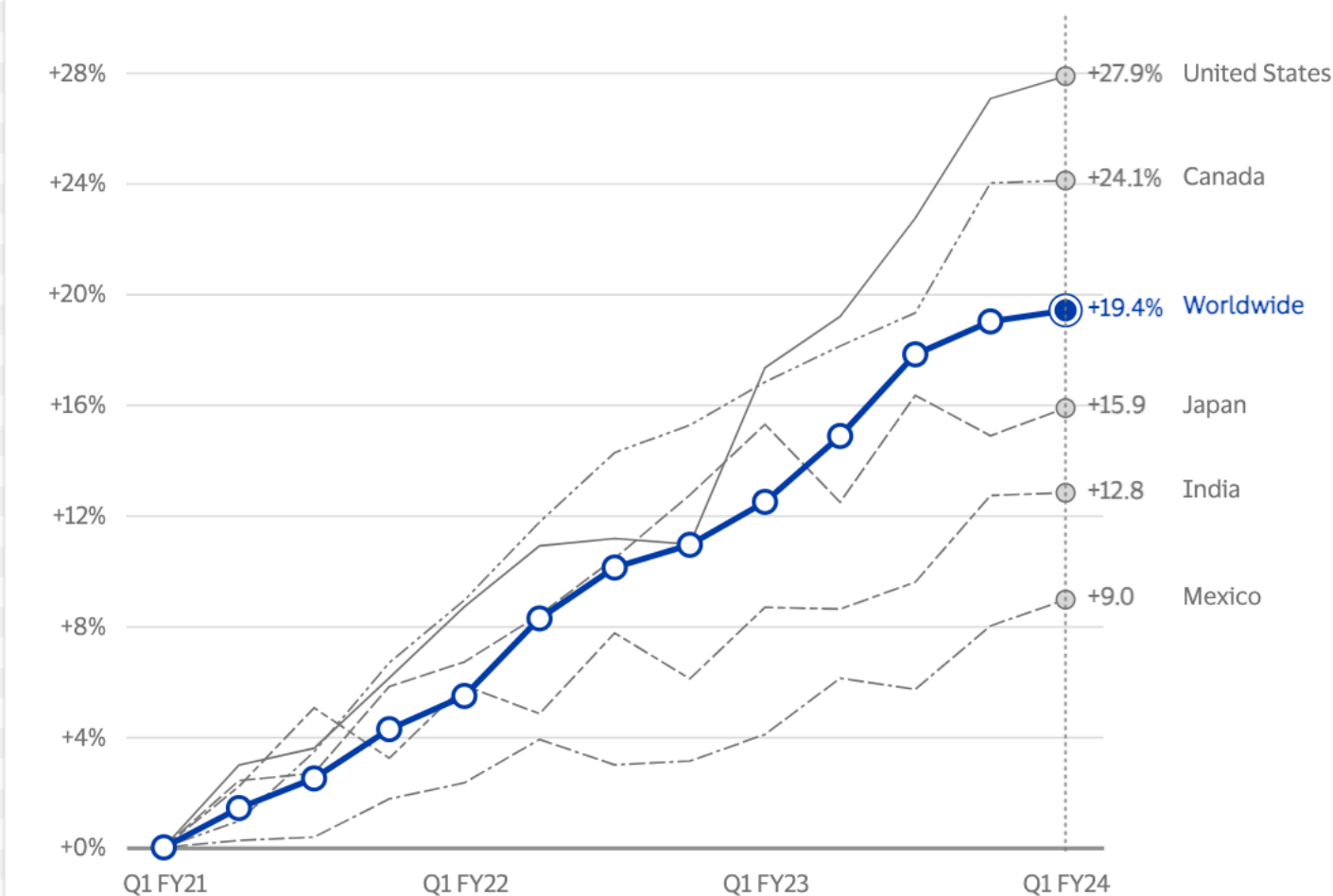


Research problem:
How do you find and
evaluate access
barriers in interactive
visualizations?

Prior work: Staff-level engineer making a visualization library

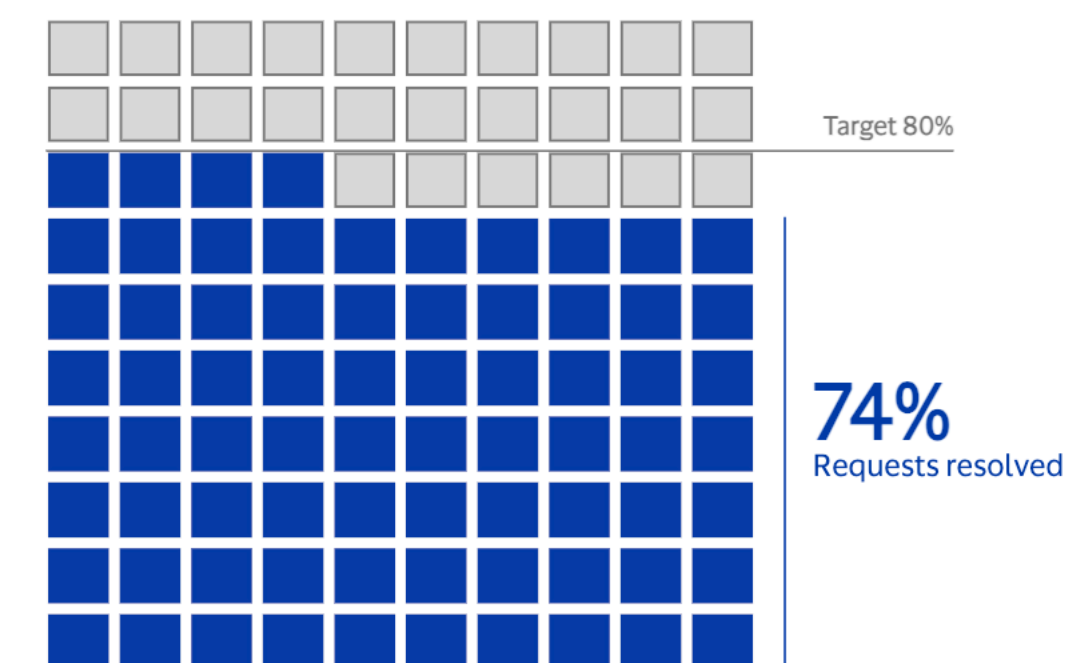
Customer growth global and regional trends

Compare the pace of [worldwide](#) customer growth to the top 5 fastest growing countries. Displaying quarterly growth in active cardholders, relative to FY21 Q1.



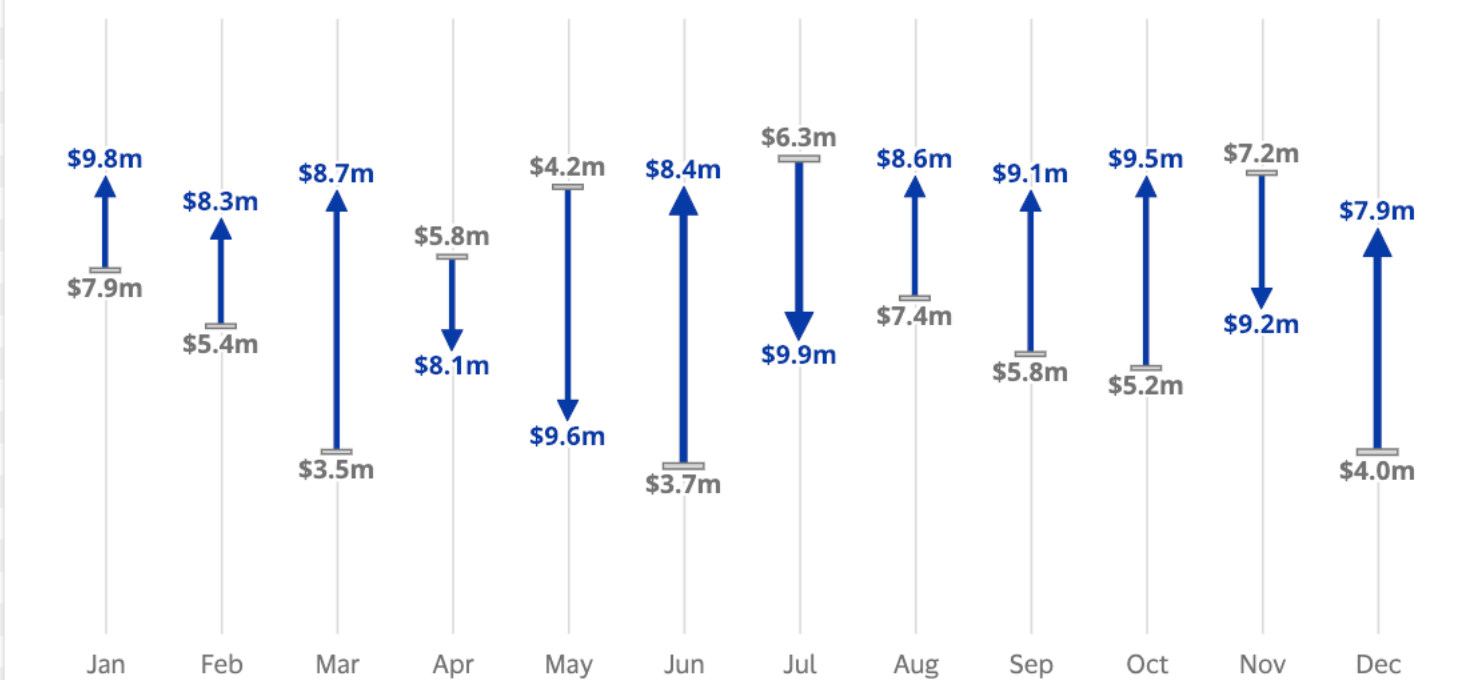
Backlog summary

Out of 220 requests submitted in the last quarter, 74% have been resolved.

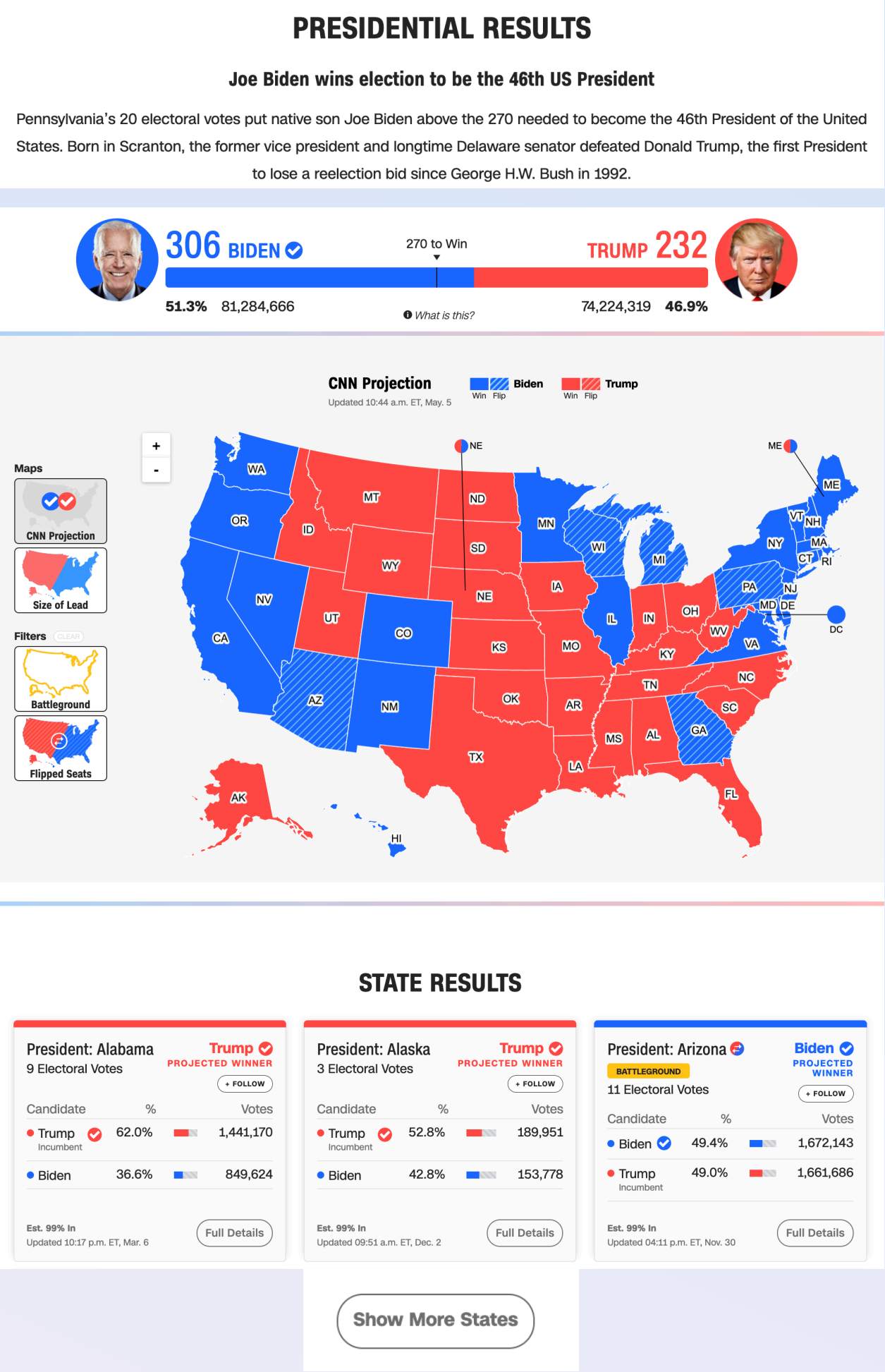


Payment volume trends

Monthly payment volume for [this](#) year compared to last year.



Chartability is a workbook of tests, tools, and principles



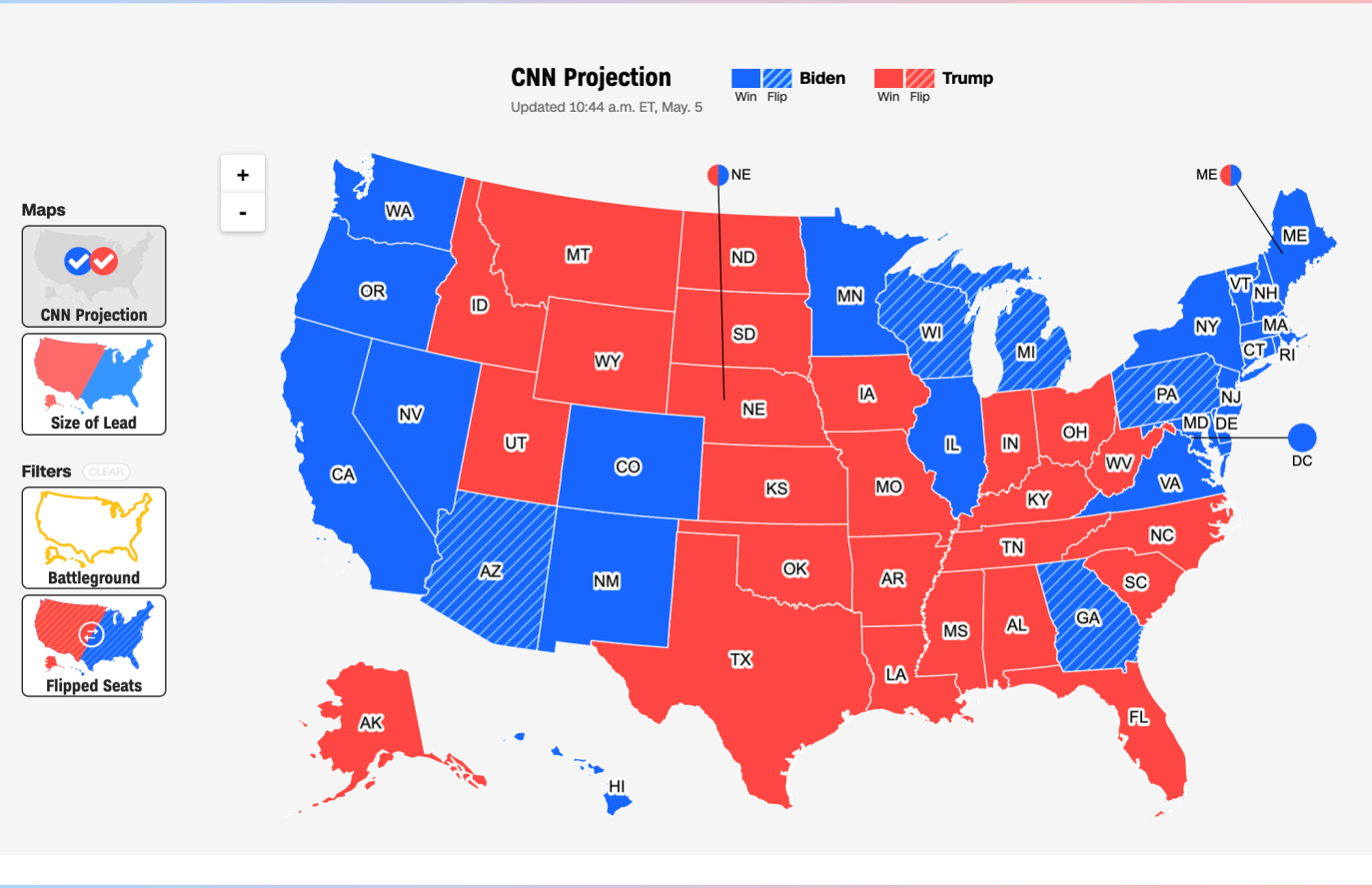
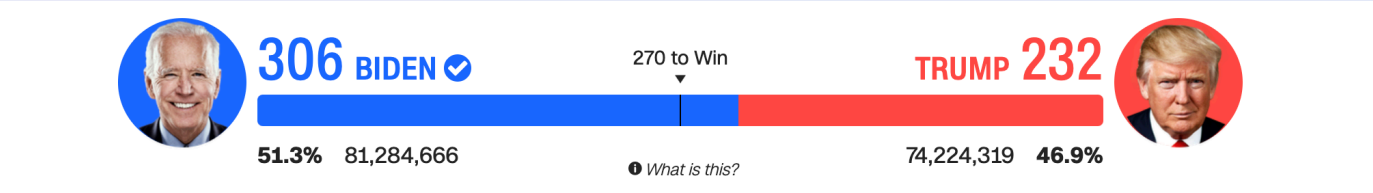
F. Elavsky, C. Bennett, and D. Moritz, “How accessible is my visualization? Evaluating visualization accessibility with *Chartability*,” Computer Graphics Forum, 2022.

PRESIDENTIAL RESULTS

Joe Biden wins election to be the 46th US President

Pennsylvania's 20 electoral votes put native son Joe Biden above the 270 needed to become the 46th President of the United States. Born in Scranton, the former vice president and longtime Delaware senator defeated Donald Trump, the first President to lose a reelection bid since George H.W. Bush in 1992.


Pennsylvania's 20 electoral votes put native son Joe Biden above the 270 needed to become the 46th President of the United States. Born in Scranton, the former vice president and longtime Delaware senator defeated Donald Trump, the first President to lose a reelection bid since George H.W. Bush in 1992.








STATE RESULTS

President: Alabama

9 Electoral Votes

Trump 
PROJECTED WINNER

[+ FOLLOW](#)


Candidate	%	Votes
 Trump  Incumbent	62.0% 	1,441,170
 Biden	36.6% 	849,624

Est. 99% In
Updated 10:17 p.m. ET, Mar. 6






[Full Details](#)

President: Alaska

3 Electoral Votes

Trump 
PROJECTED WINNER

[+ FOLLOW](#)

Candidate	%	Votes
 Trump  Incumbent	52.8% 	189,951
 Biden	42.8% 	153,778

Est. 99% In
Updated 09:51 a.m. ET, Dec. 2






[Full Details](#)

President: Arizona

Battleground

11 Electoral Votes

[+ FOLLOW](#)

Candidate	%	Votes
 Biden  Incumbent	49.4% 	1,672,143
 Trump Incumbent	49.0% 	1,661,686

Est. 99% In
Updated 04:11 p.m. ET, Nov. 30

[Full Details](#)

[Show More States](#)

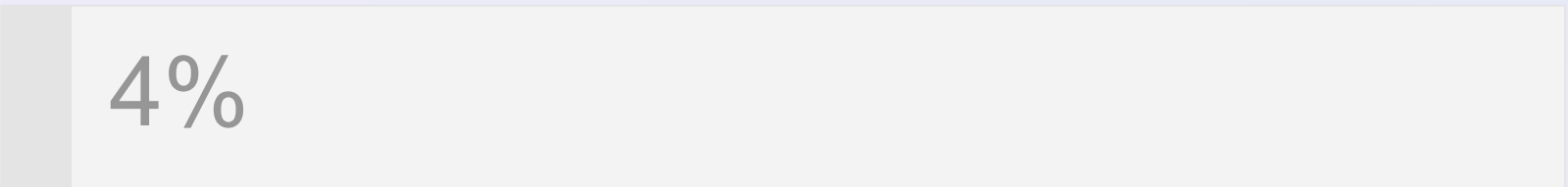
Show More States

Let's evaluate this map from CNN with Chartability.

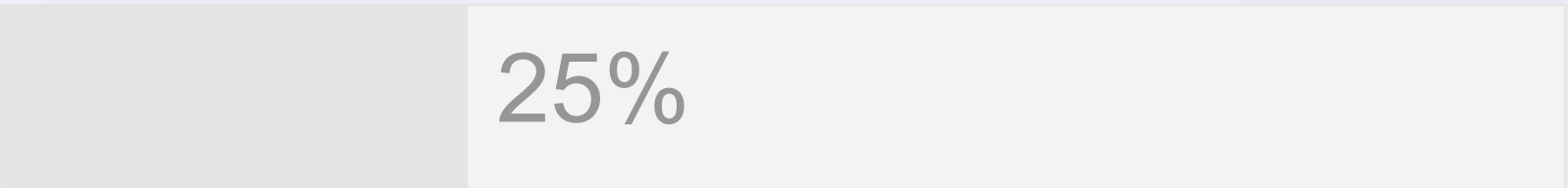
Design with high contrast

Colorblindness Disproportionately Overrepresented in A11y Resources

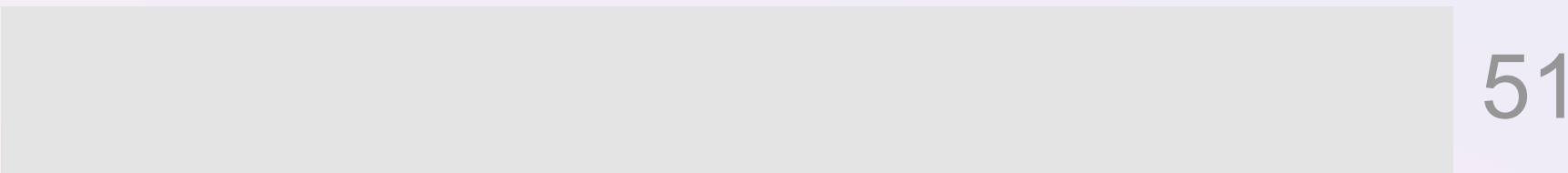
Colorblindness: % of People



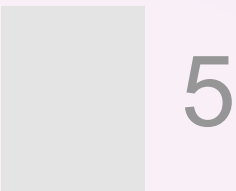
Low Vision: % of People



Colorblindness: # of Resources



Low Vision: # of Resources



Colorblindness Disproportionately Overrepresented in A11y Resources

Colorblindness: % of People



Low Vision: % of People



Colorblindness: # of Resources



Low Vision: # of Resources




Use High Contrast Text


Text needs at least 4.5:1 contrast against its background.

Large text (bold and 16pt or larger) can be 3:1 or higher.

Contrast Checker

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

Foreground Color
#969696
Lightness


Background Color
#FFFFFF
Lightness


Contrast Ratio
2.95:1
[permalink](#)

Normal Text

WCAG AA: **Fail**
WCAG AAA: **Fail**

The five boxing wizards jump quickly.

Large Text

WCAG AA: **Fail**
WCAG AAA: **Fail**

The five boxing wizards jump quickly.

Use High Contrast Geometries

Chart elements need at least 3:1 contrast against their background.

Contrast Checker

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

Foreground Color

#E4E4E4

Lightness



Background Color

#F3F3F3

Lightness



Contrast Ratio

1.14:1

[permalink](#)

Graphical Objects and User Interface Components

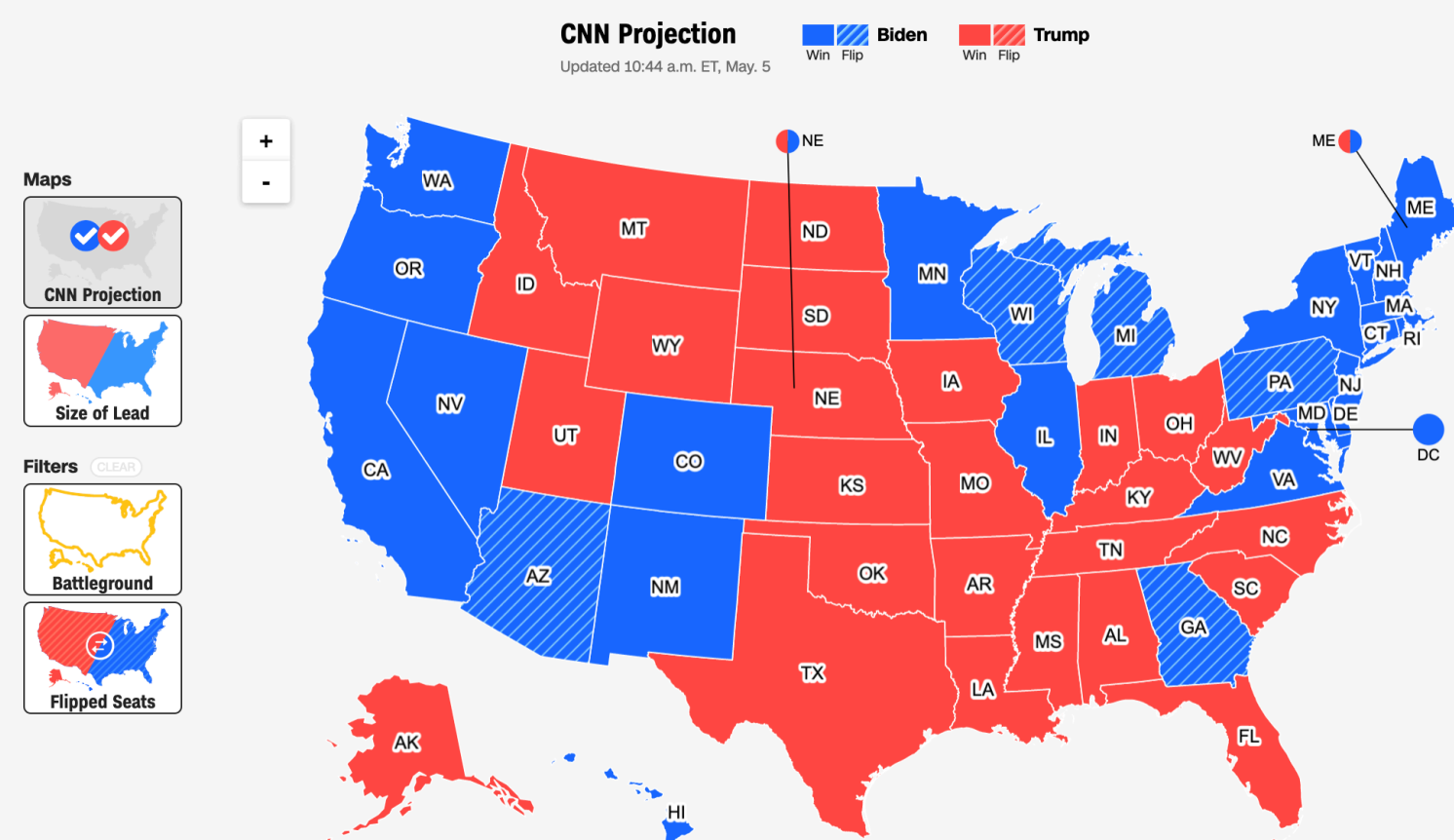
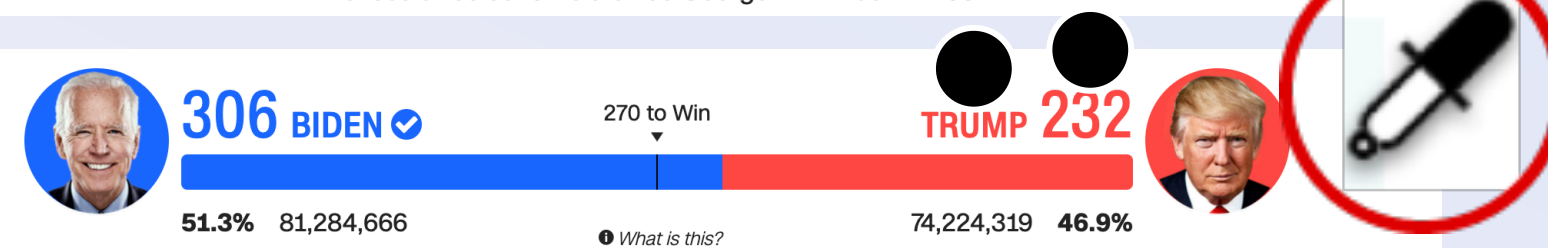
WCAG AA: **Fail**

Text Input

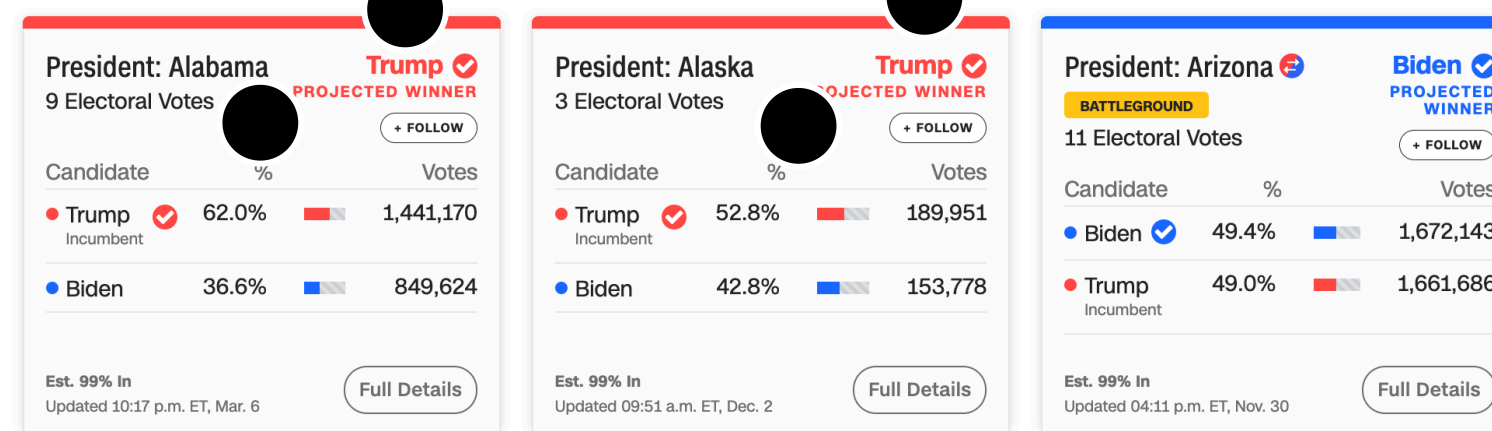
PRESIDENTIAL RESULTS

Joe Biden wins election to be the 46th US President

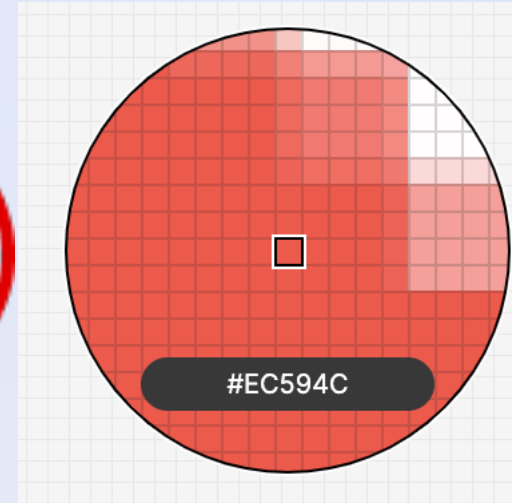
Pennsylvania's 20 electoral votes put native son Joe Biden above the 270 needed to become the 46th President of the United States. Born in Scranton, the former vice president and longtime Delaware senator defeated Donald Trump, the first President to lose a reelection bid since George H.W. Bush in 1992.



STATE RESULTS



Show More States



Contrast Checker

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

Foreground Color

#EC594C

Lightness



Background Color

#FFFFFF

Lightness



Contrast Ratio

3.44:1

permalink

Normal Text

WCAG AA: **Fail**

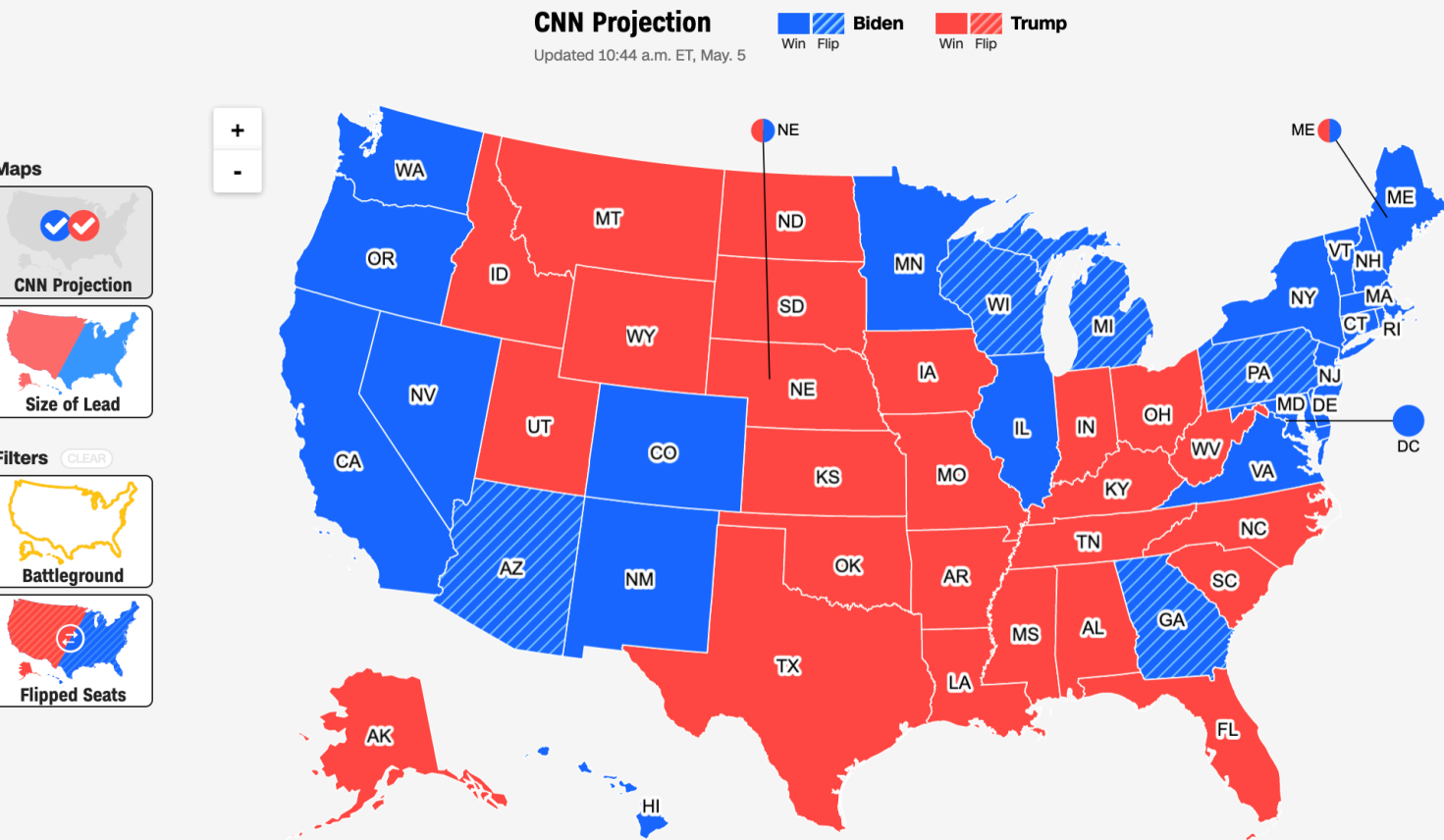
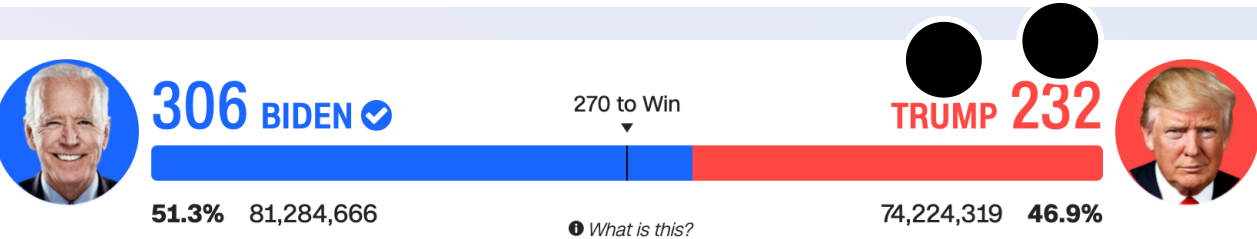
WCAG AAA: **Fail**

The five boxing wizards jump quickly.

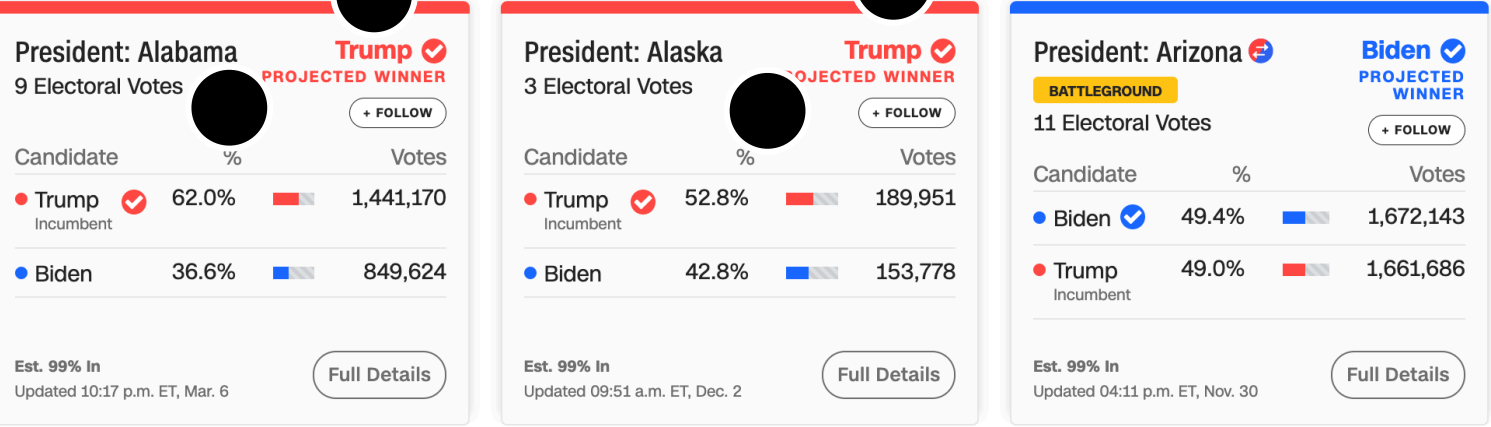
PRESIDENTIAL RESULTS

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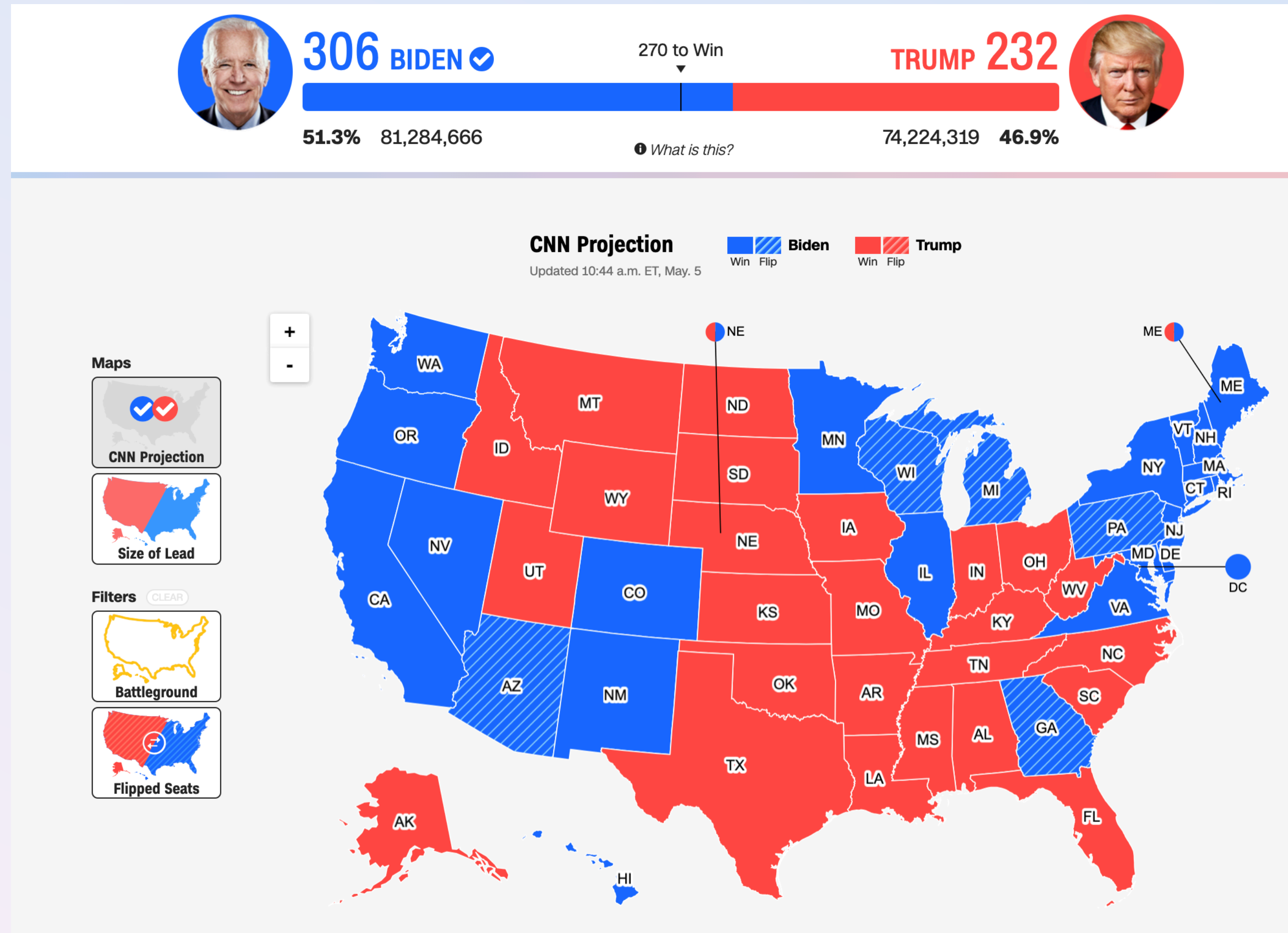
STATE RESULTS



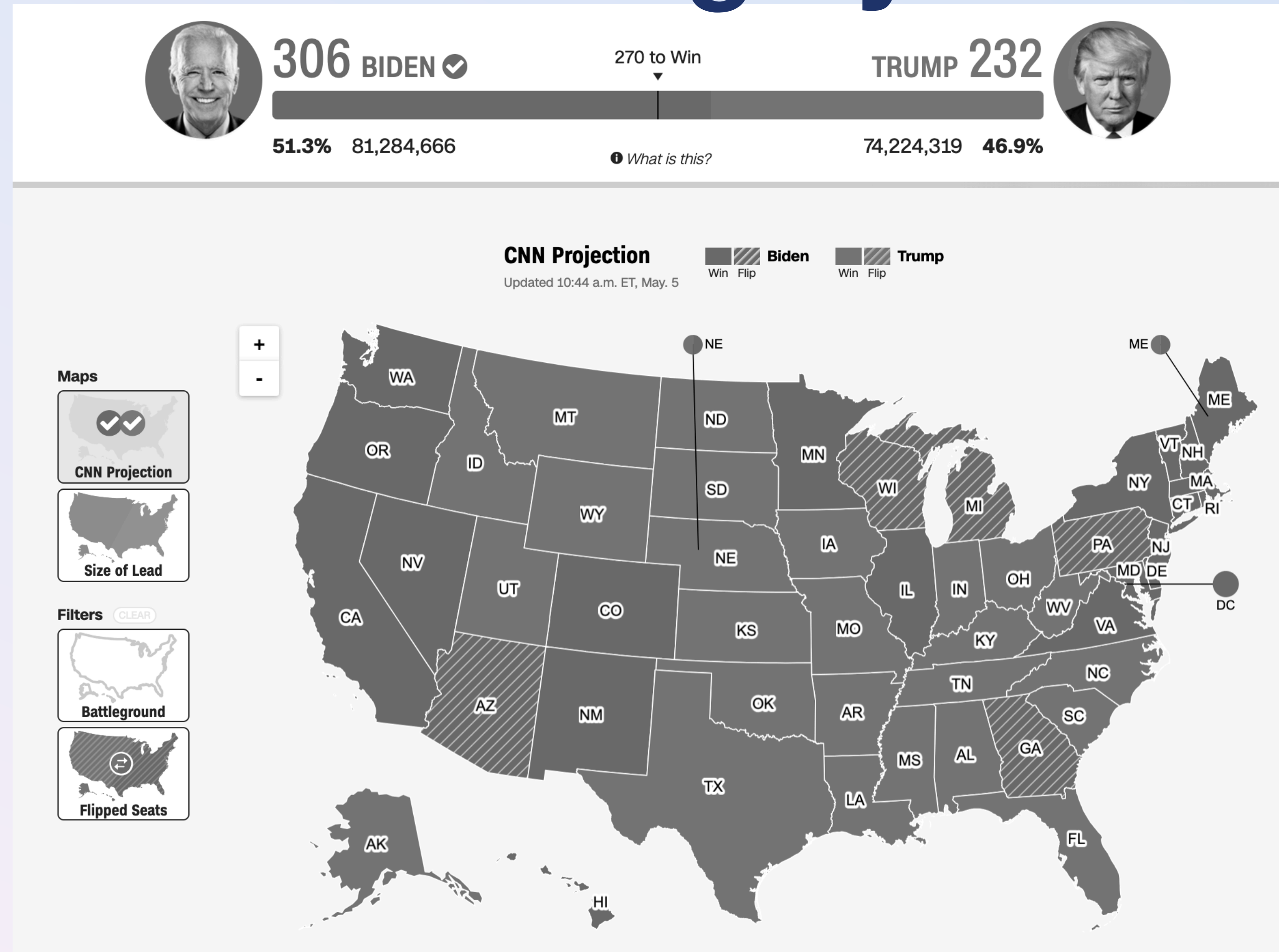
Show More States

6 instances of low contrast

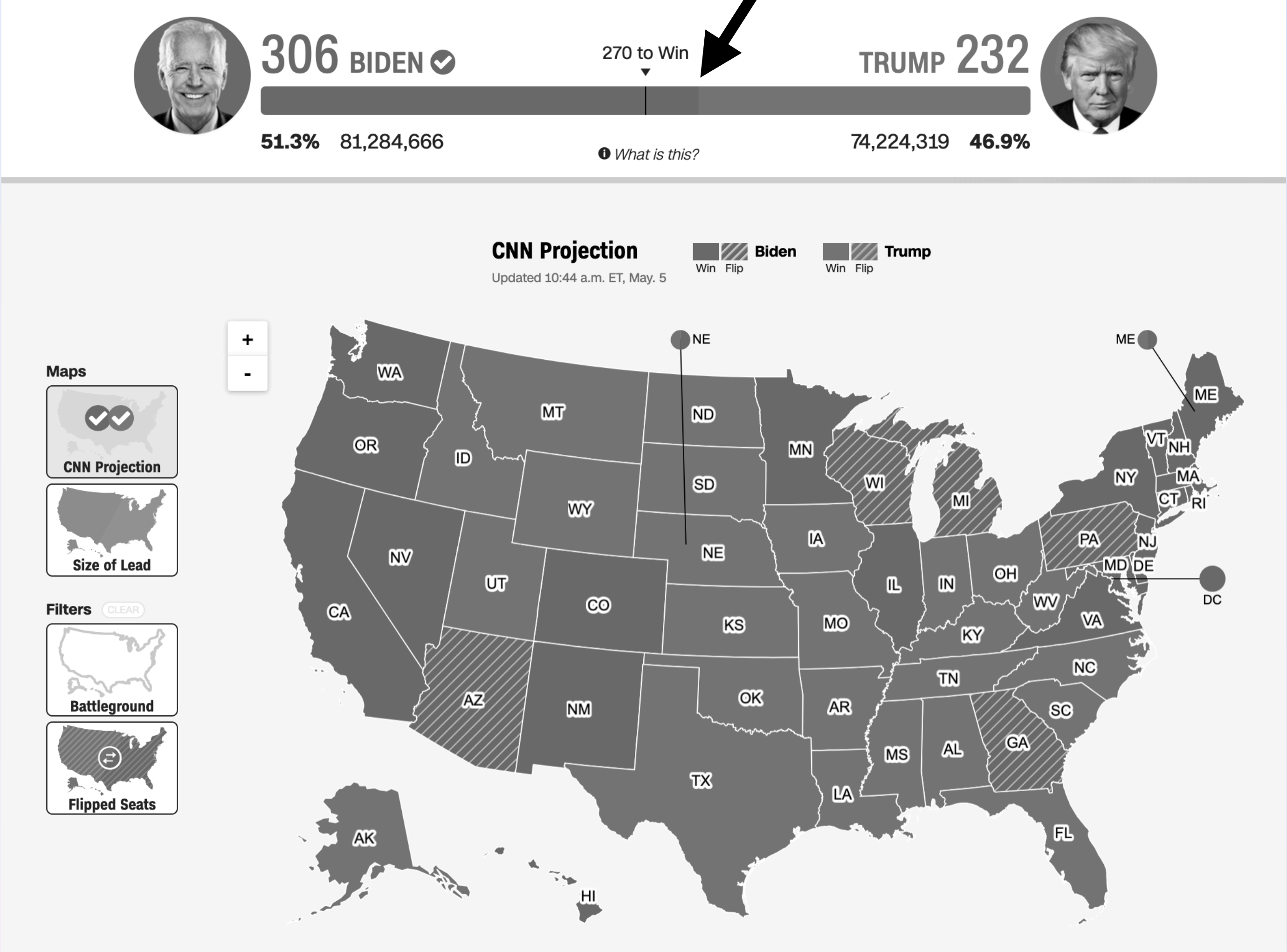
How can we fix this?



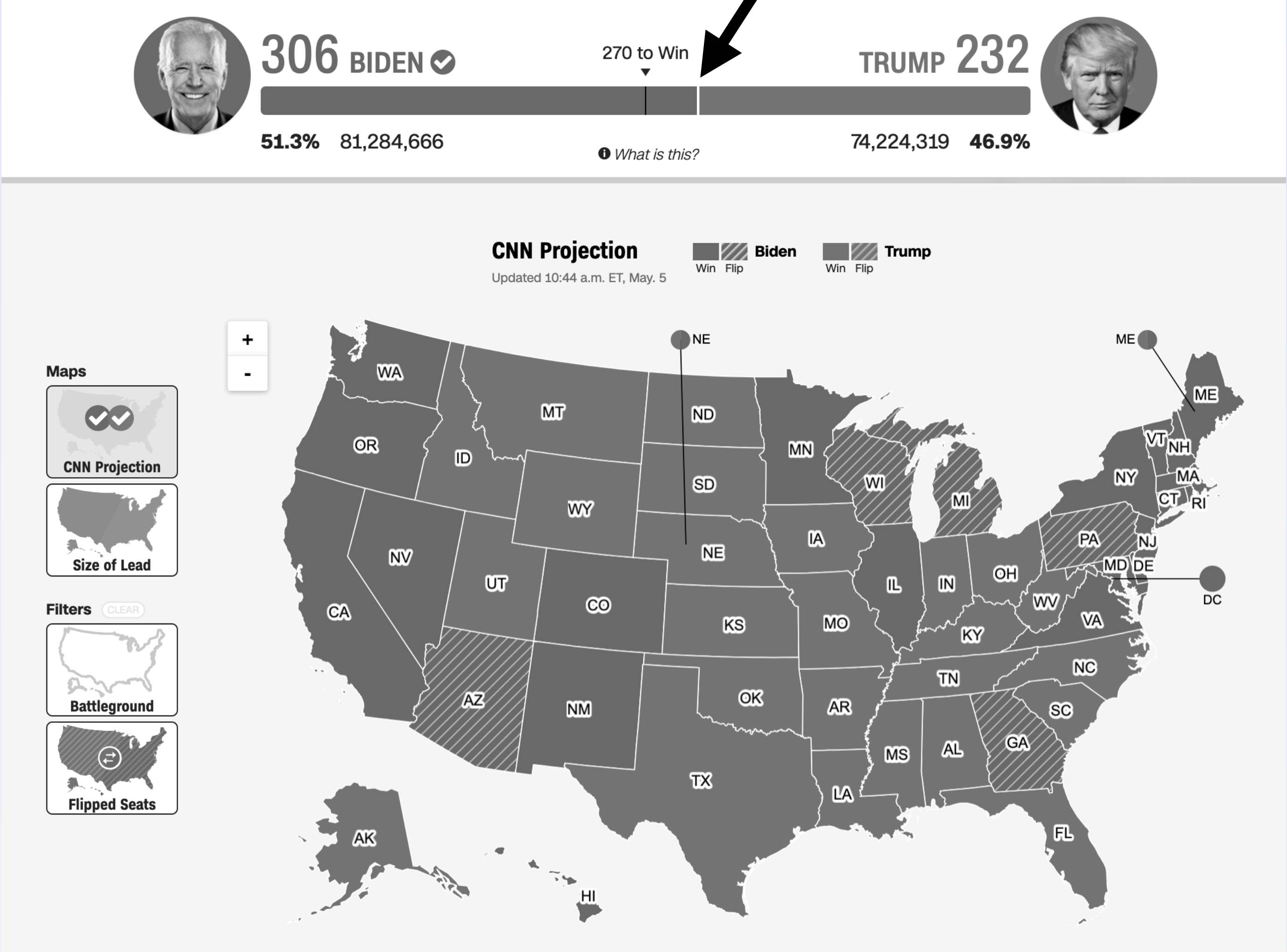
This map is trouble in greyscale



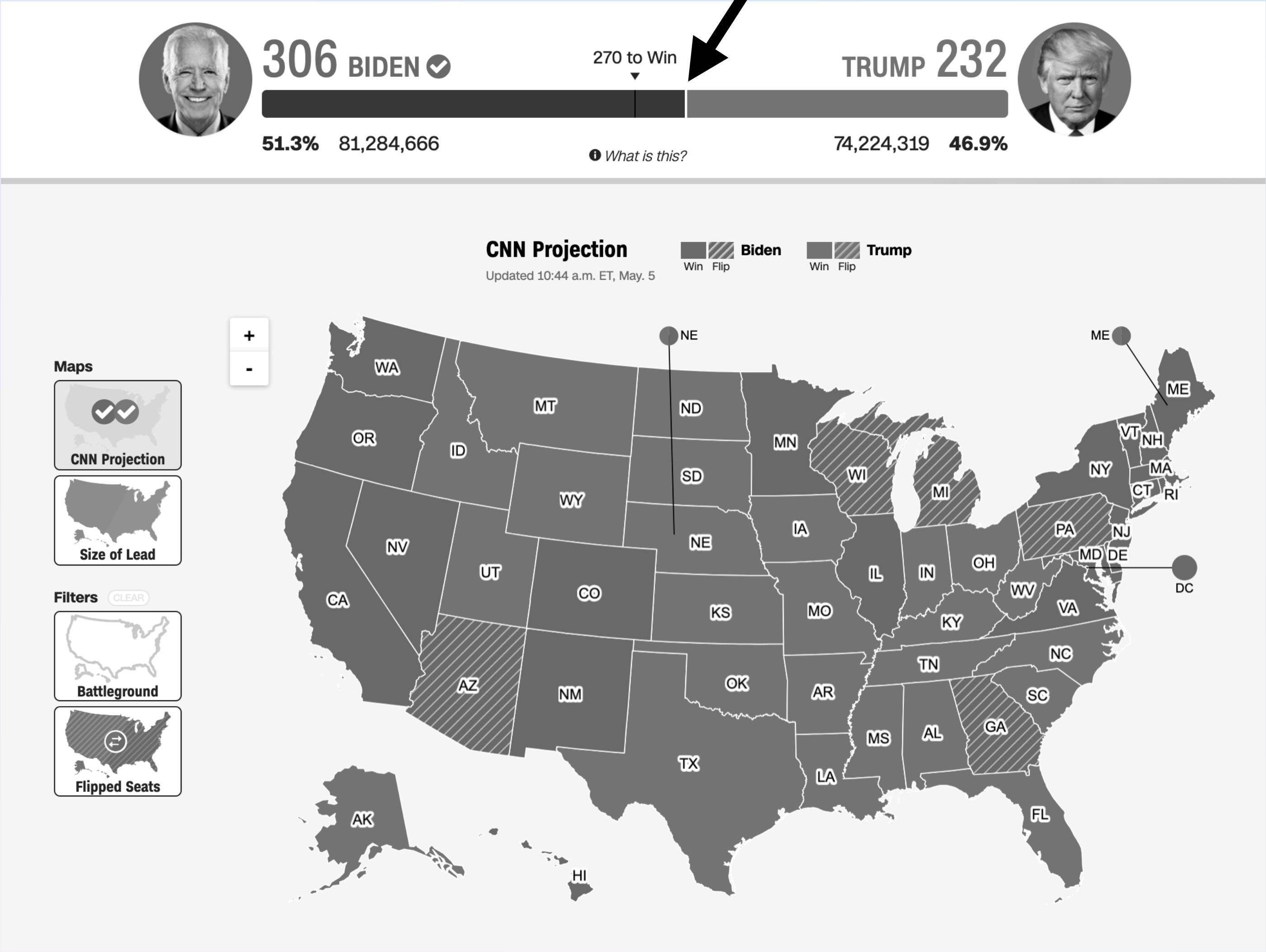
The division here matters!



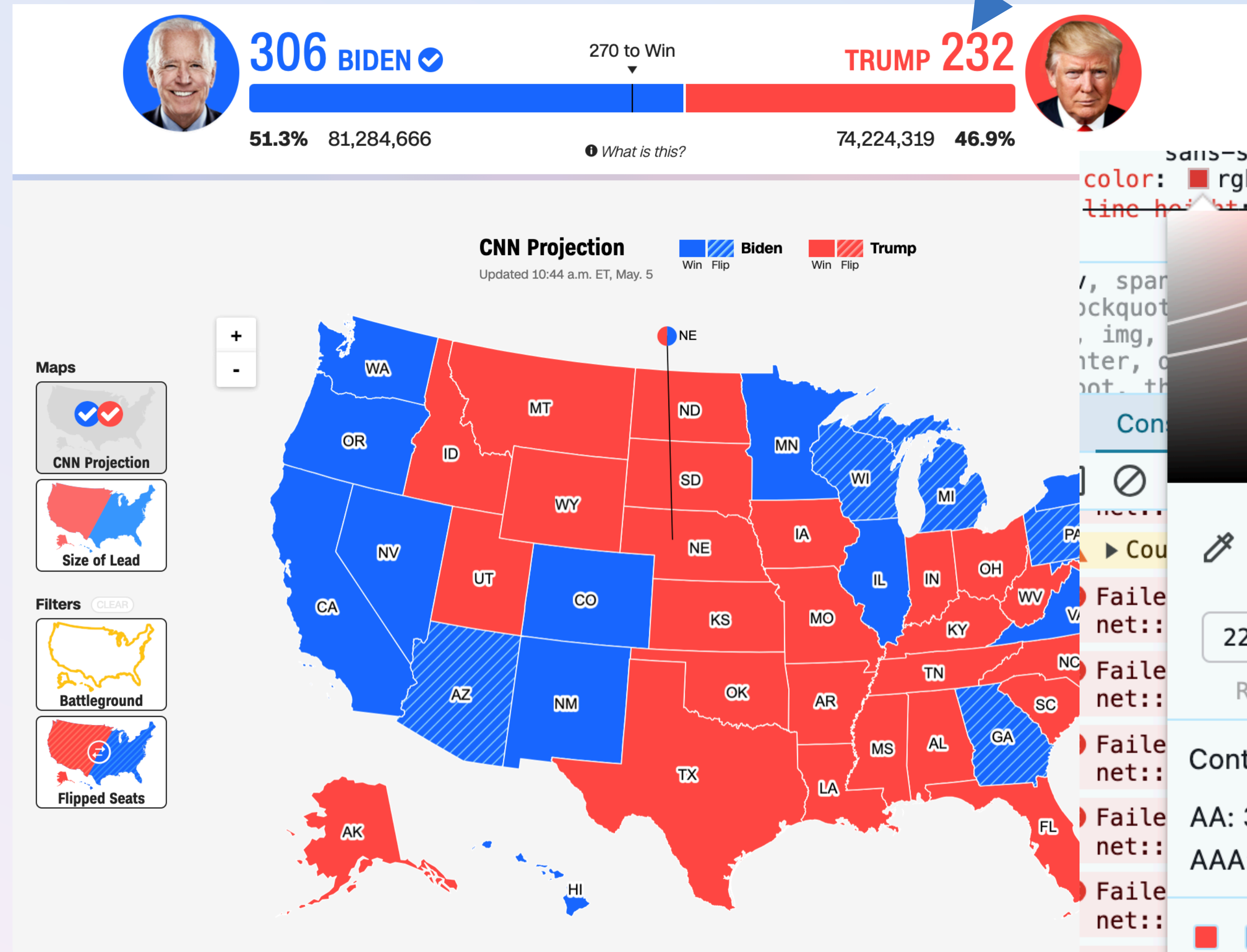
Maybe a small white divider, like the states?



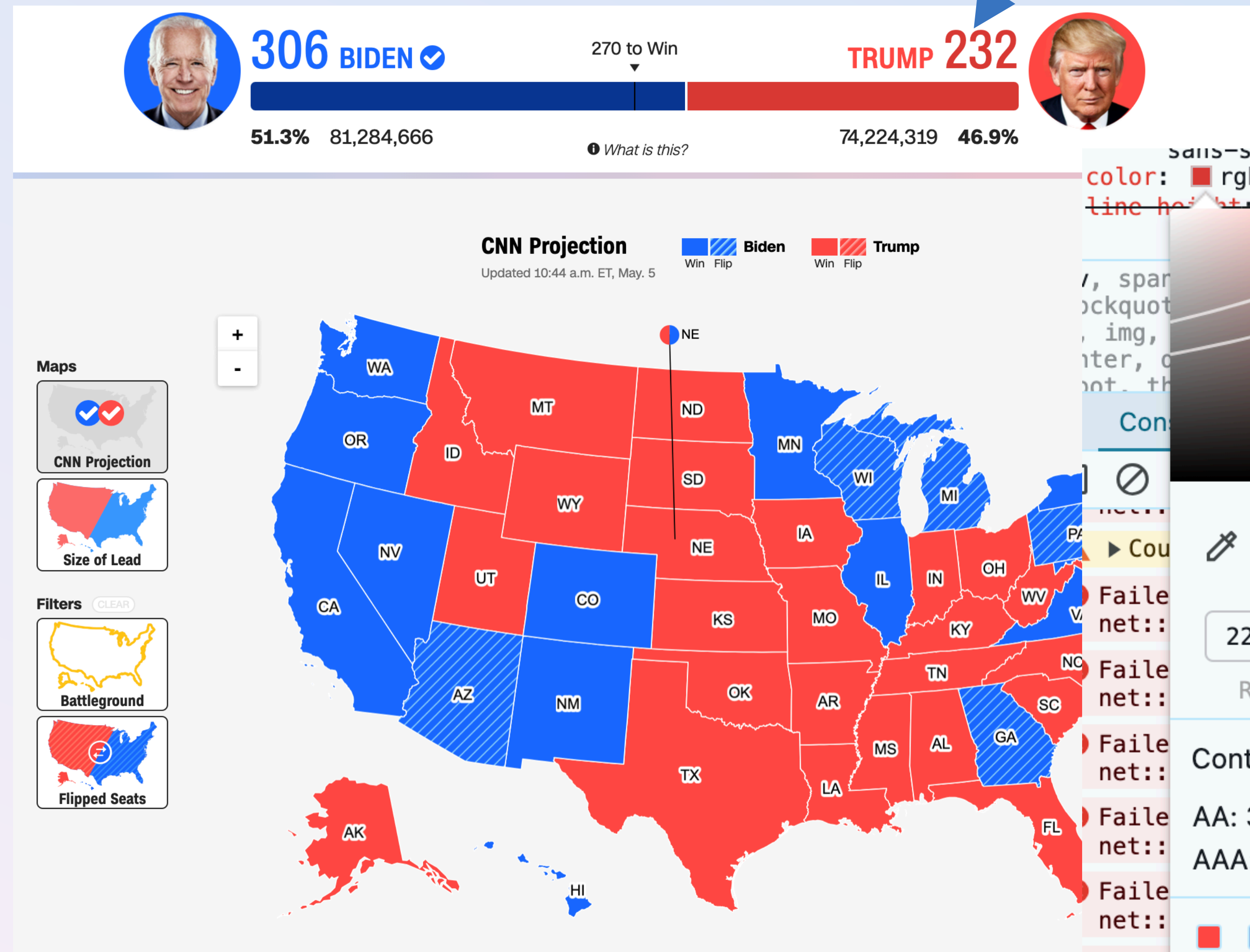
Perhaps test a darker blue too?



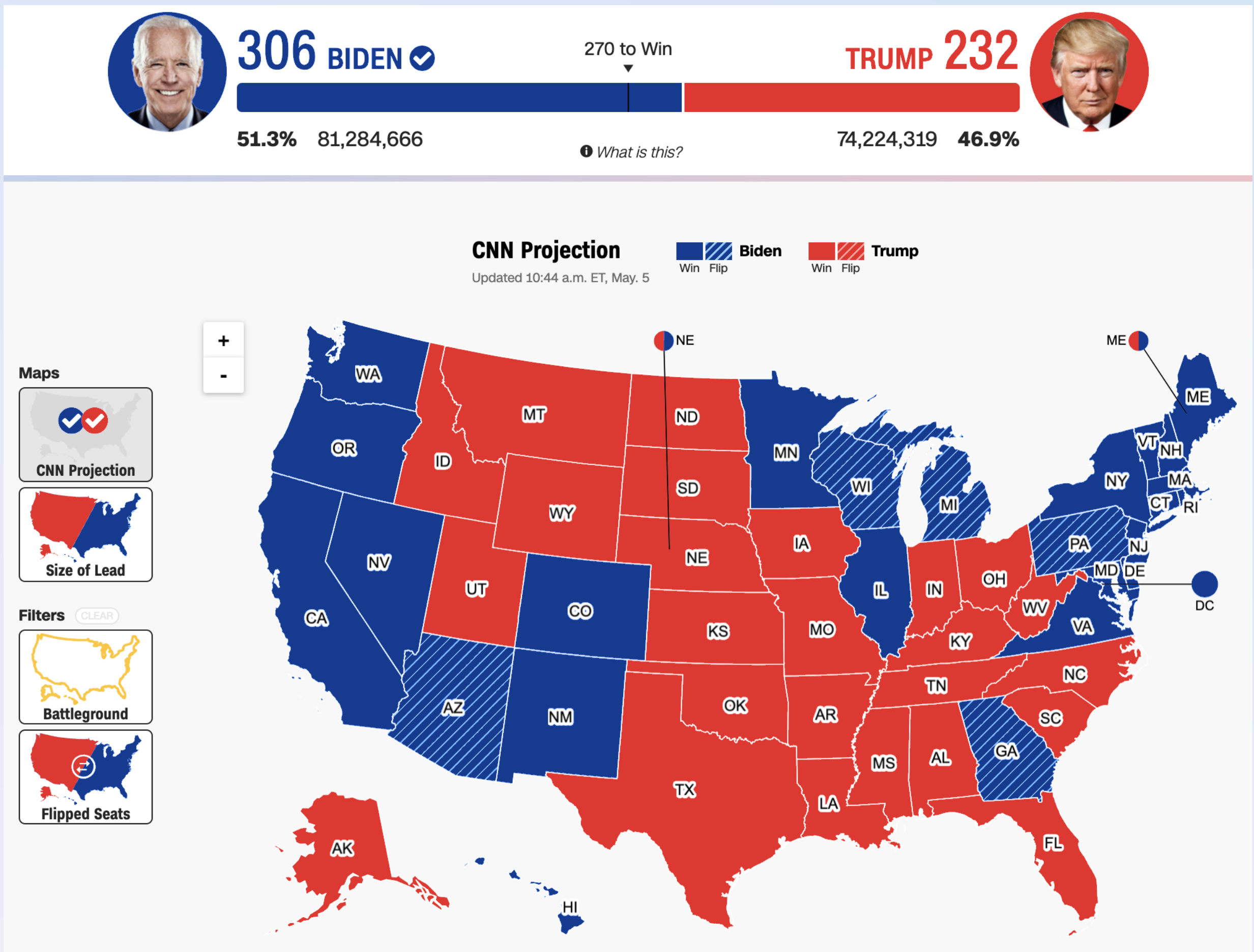
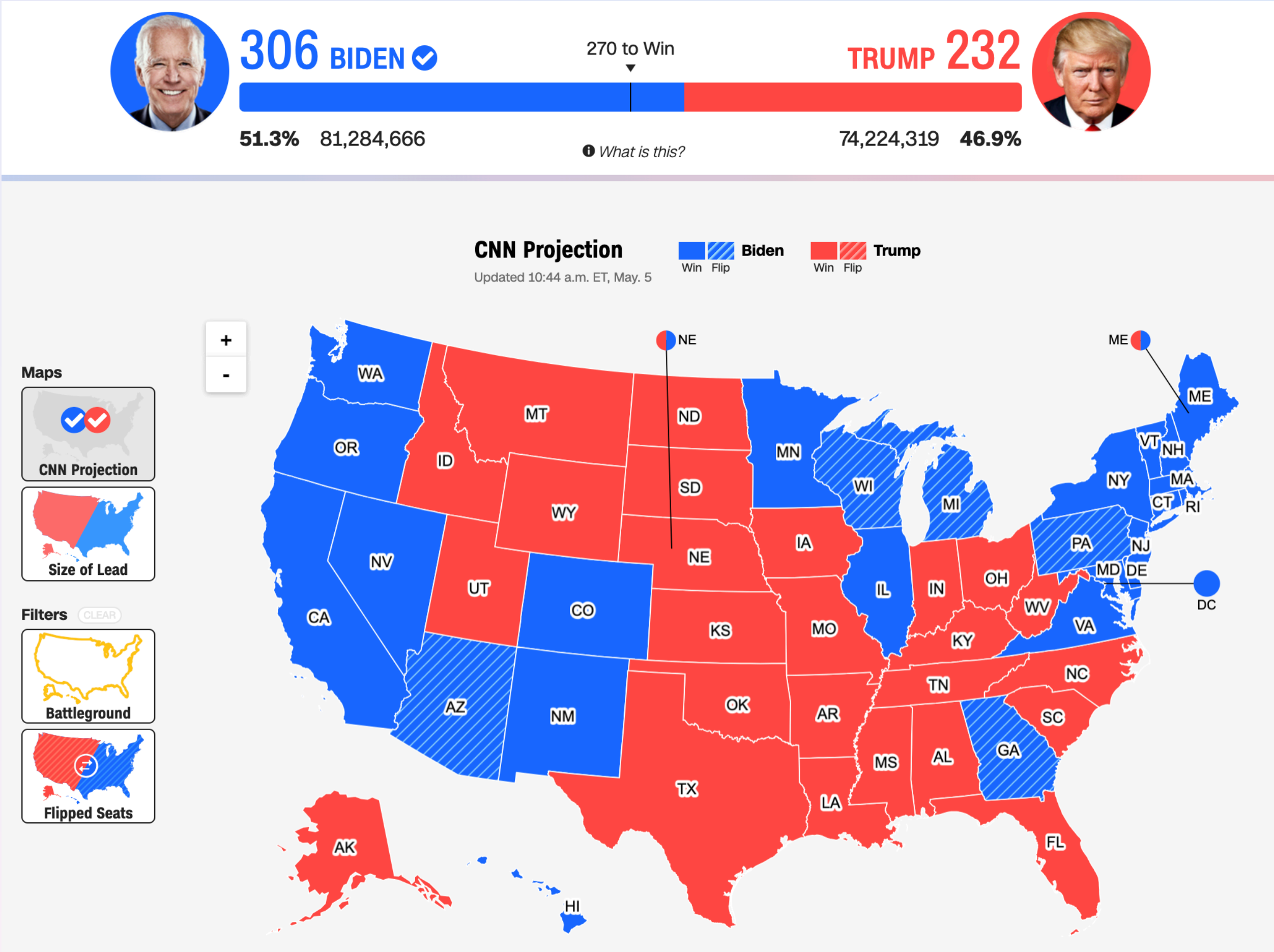
What if we fix the contrast failures at the same time?



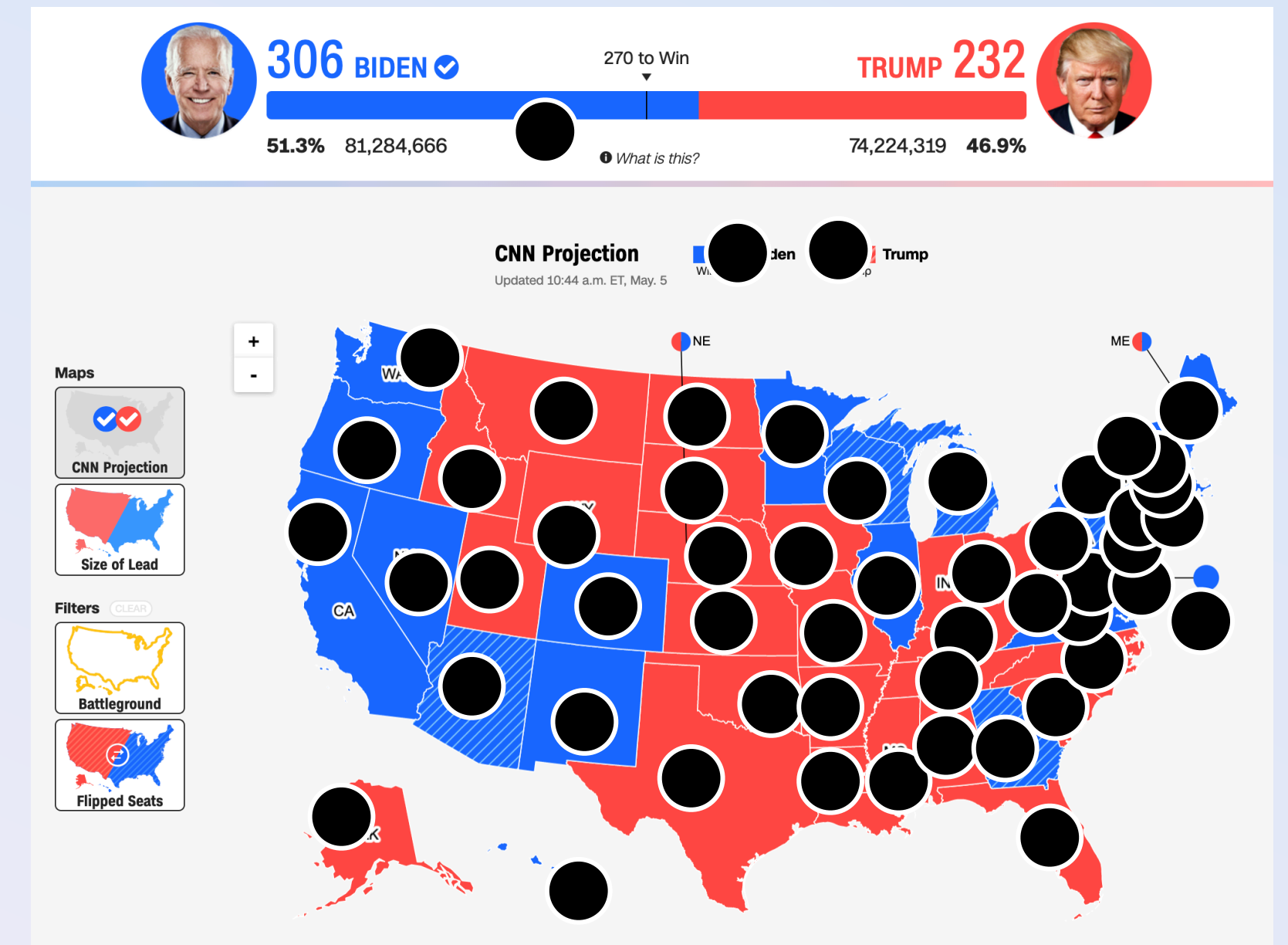
This text now passes!



Sufficient contrast can help folks differentiate



(repeat for 49
other heuristics)



Chartability is used in:

15+ Policy orgs and governments worldwide



110+ Tech, news, and non-profit companies/orgs



20+ Undergraduate and graduate courses

Carnegie Mellon University

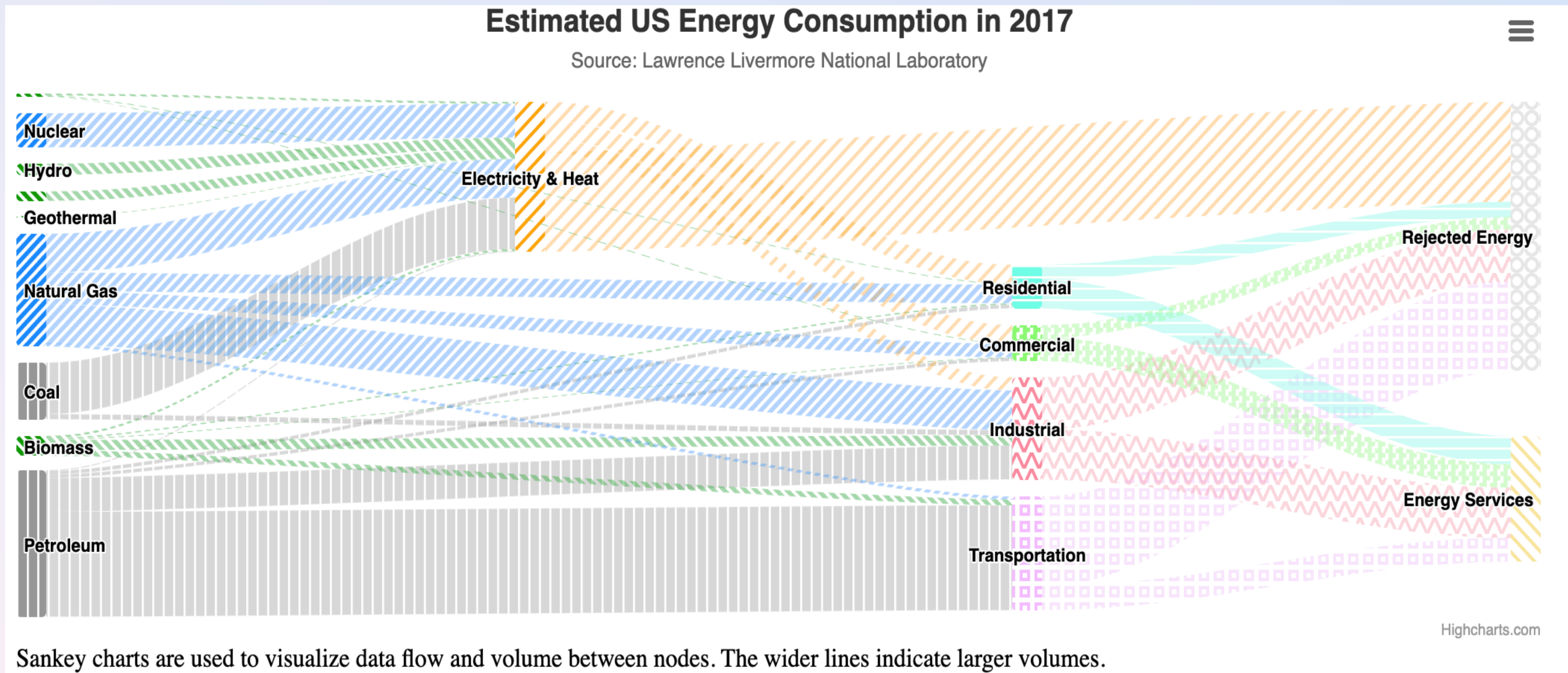


W

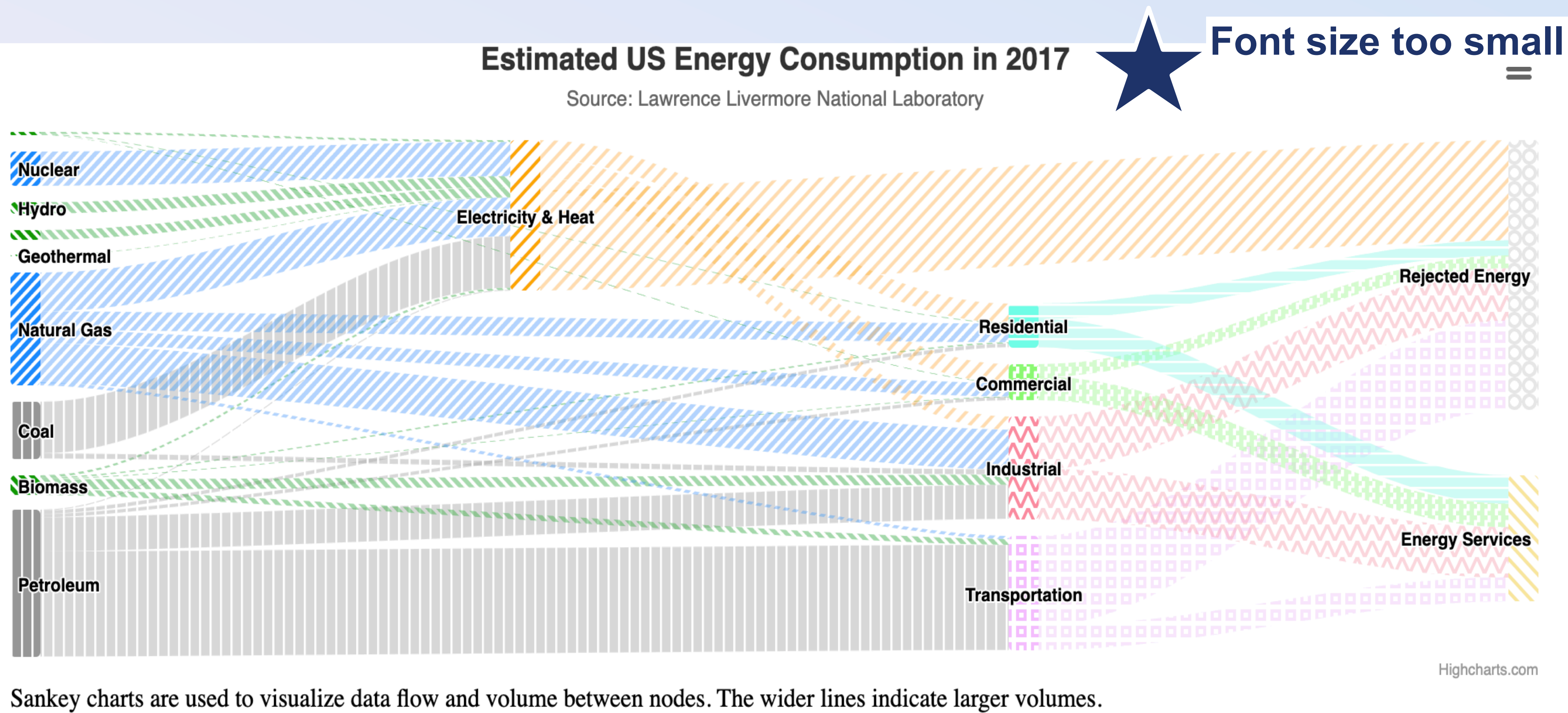
UNIVERSITY *of* WASHINGTON



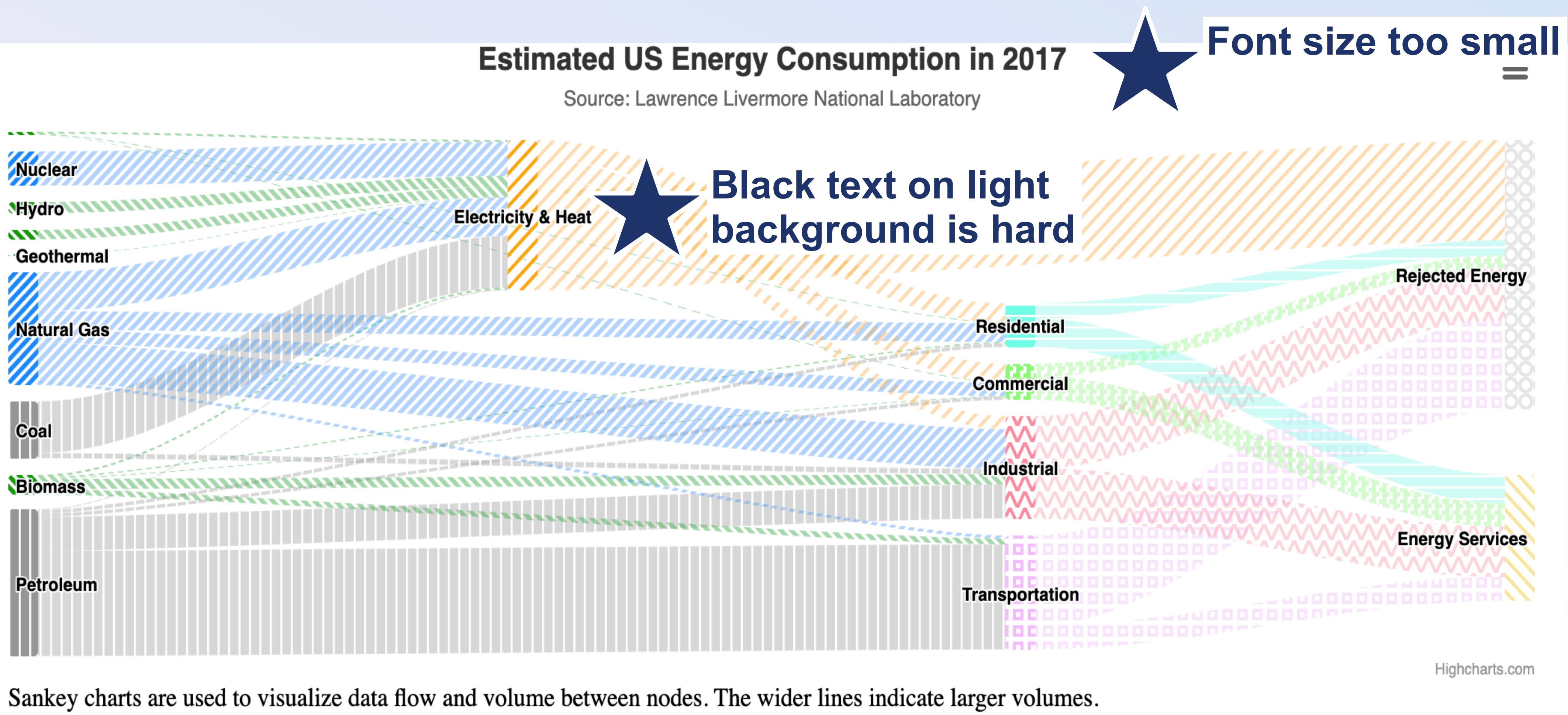
What about this visualization might be a barrier?



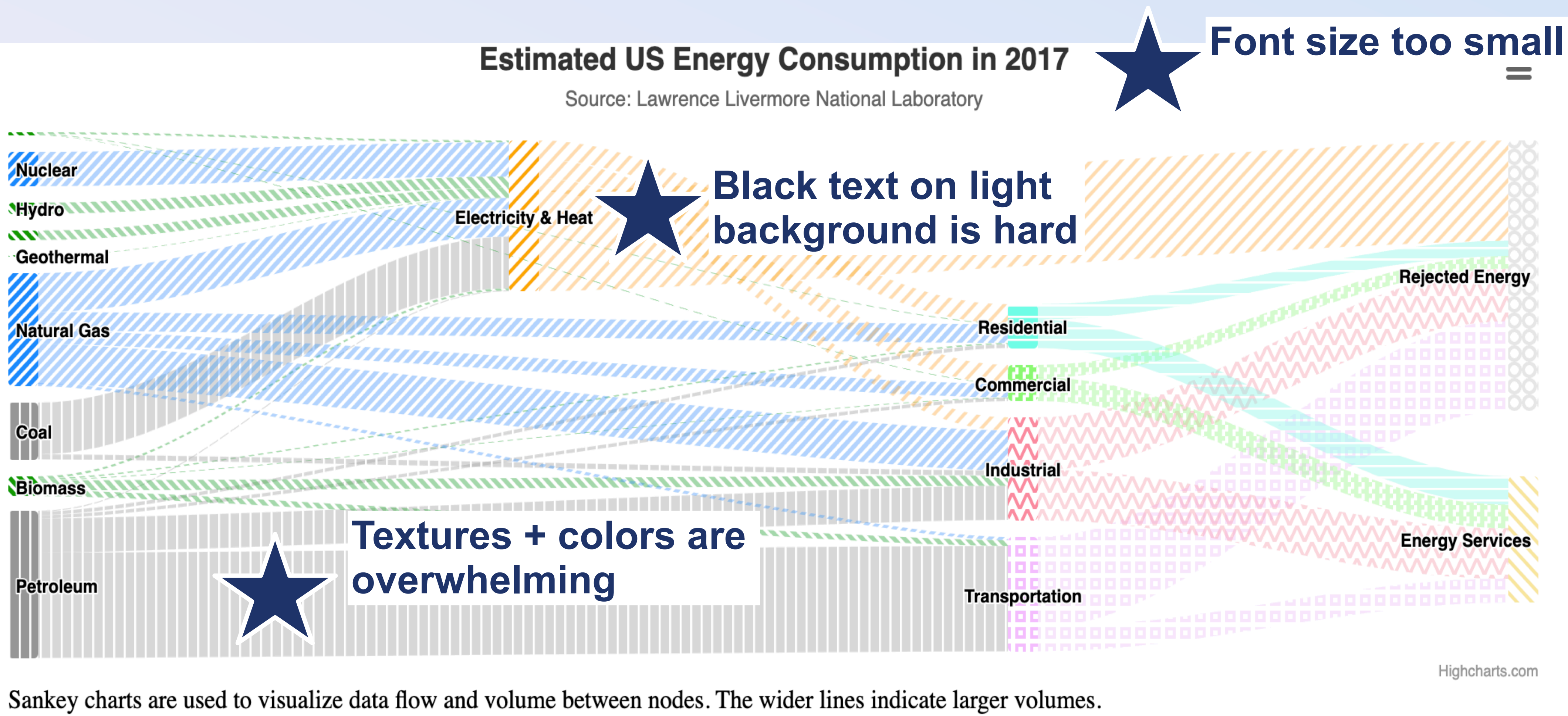
What about this visualization might be a barrier?



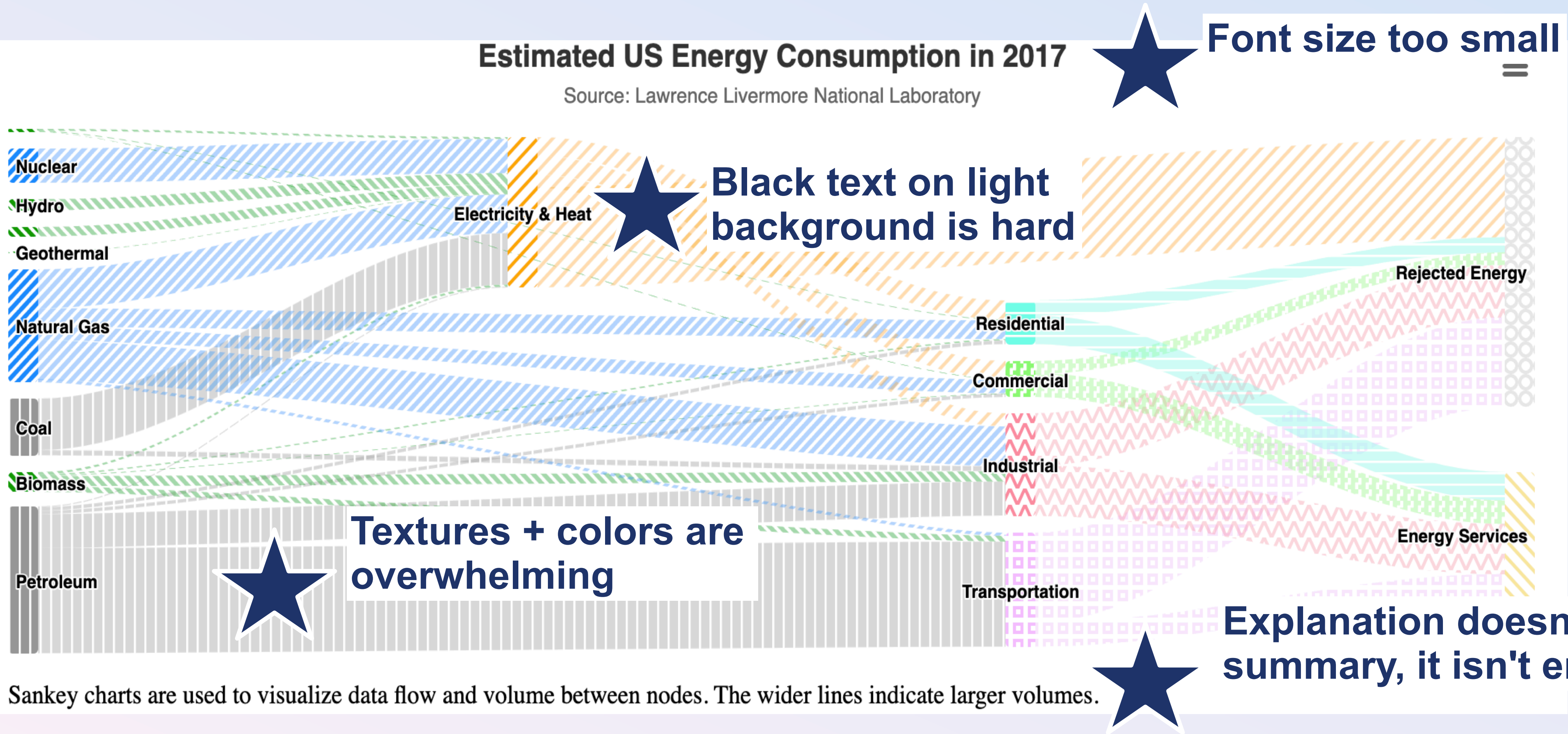
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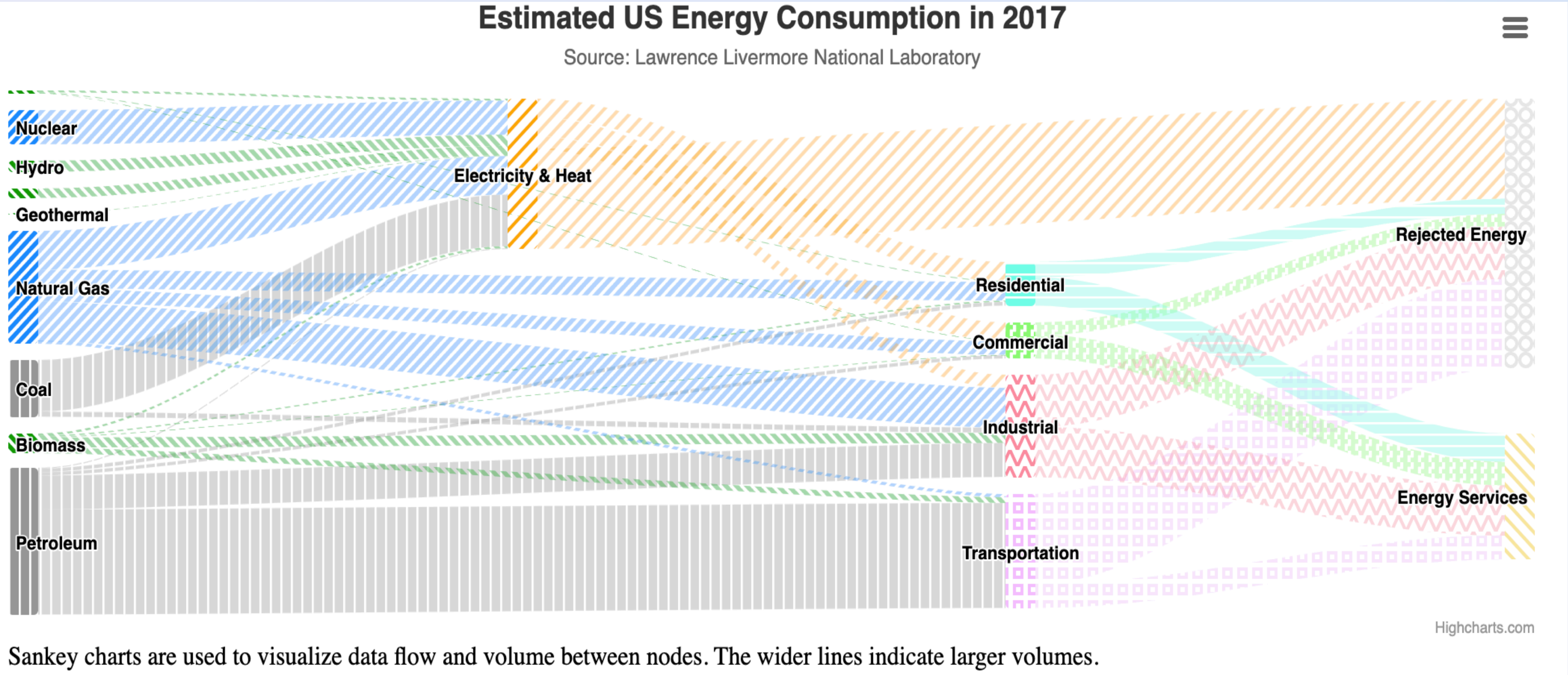
What about this visualization might be a barrier?



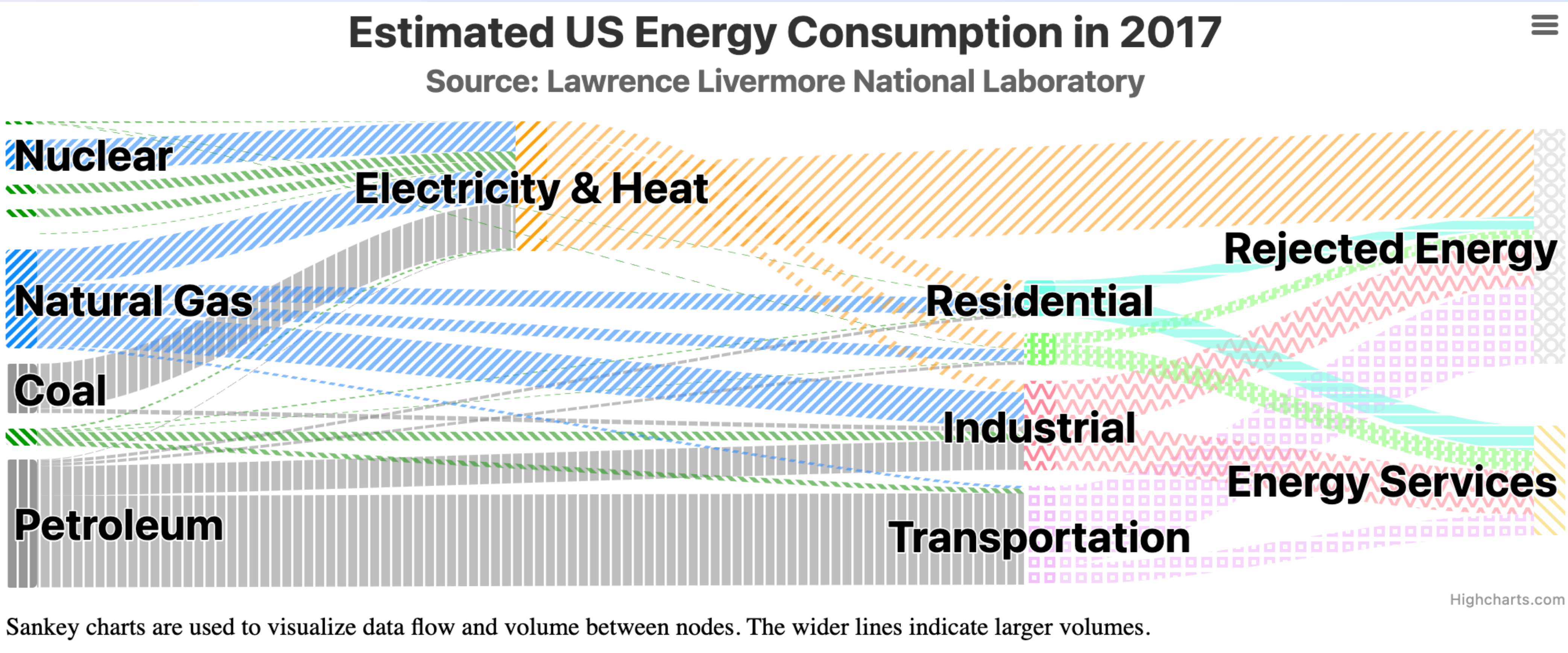
What about this visualization might be a barrier?



Can we fix this?



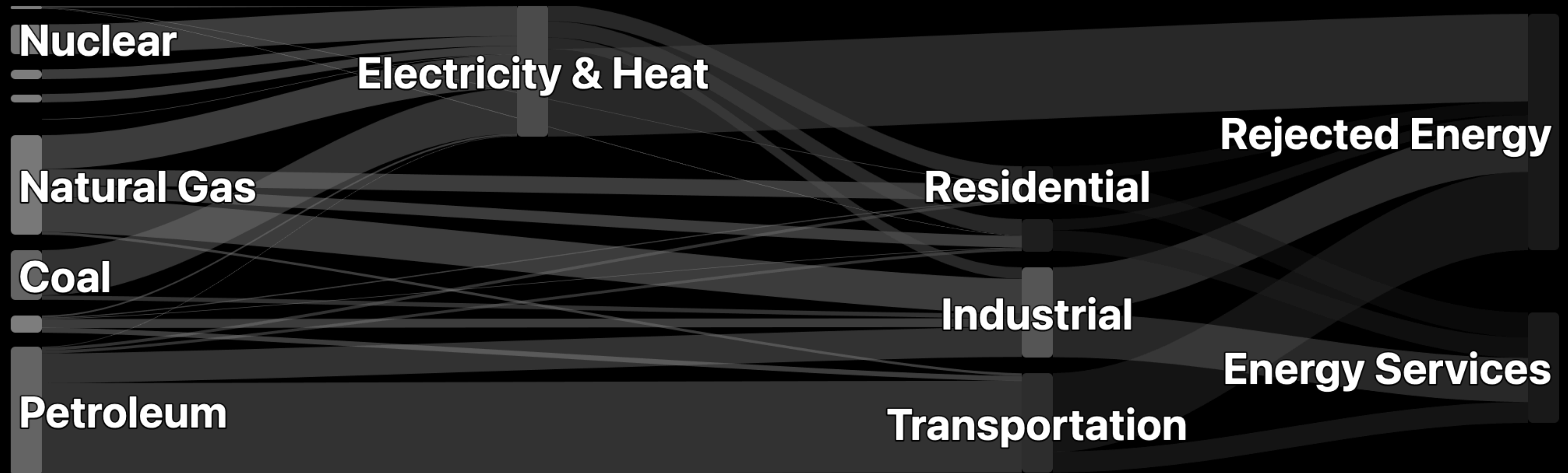
Maybe we can bump up the text size



We can reduce visual complexity too

Estimated US Energy Consumption in 2017

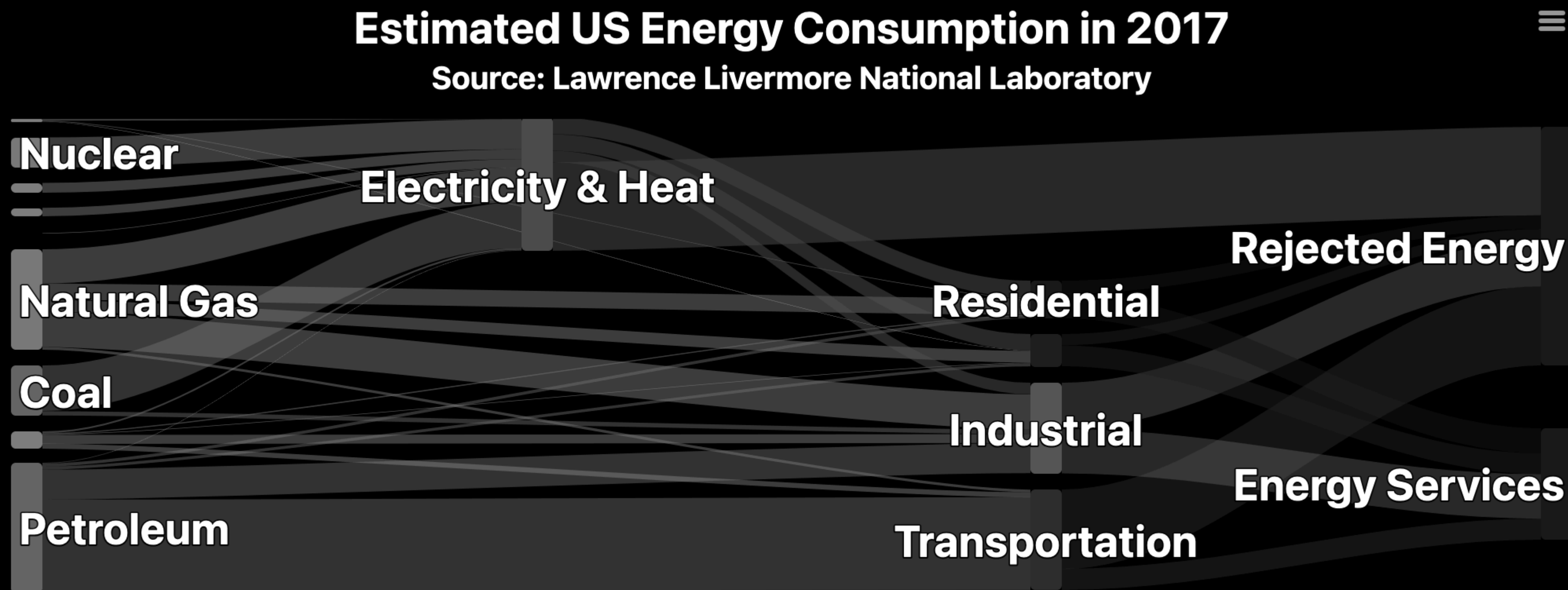
Source: Lawrence Livermore National Laboratory



Highcharts.com

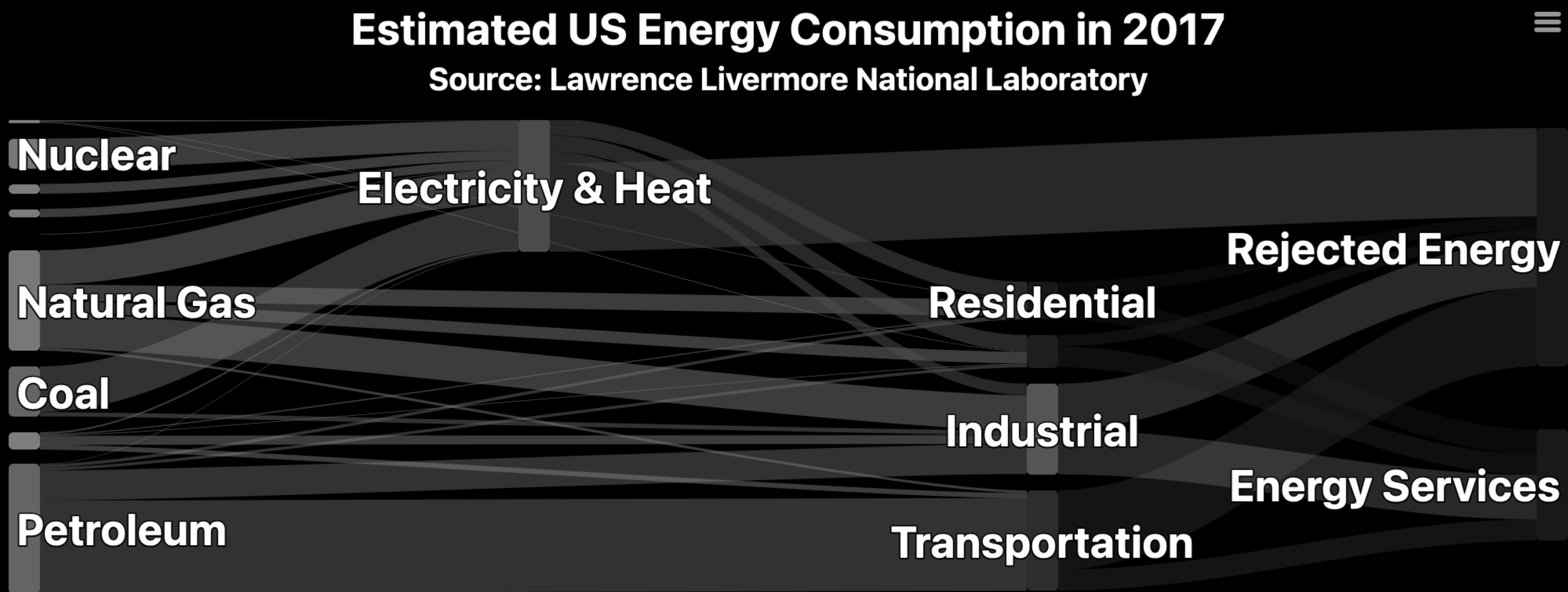
Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

We can add a more descriptive explanation



Sankey charts are used to visualize data flow and volume between nodes. Visually wider lines indicate larger volumes. This chart is showing energy consumption and types. Interacting with this chart by selecting a node or flow (such as with a click) will update the stacked bar chart below.

Is this the perfect, most accessible design?

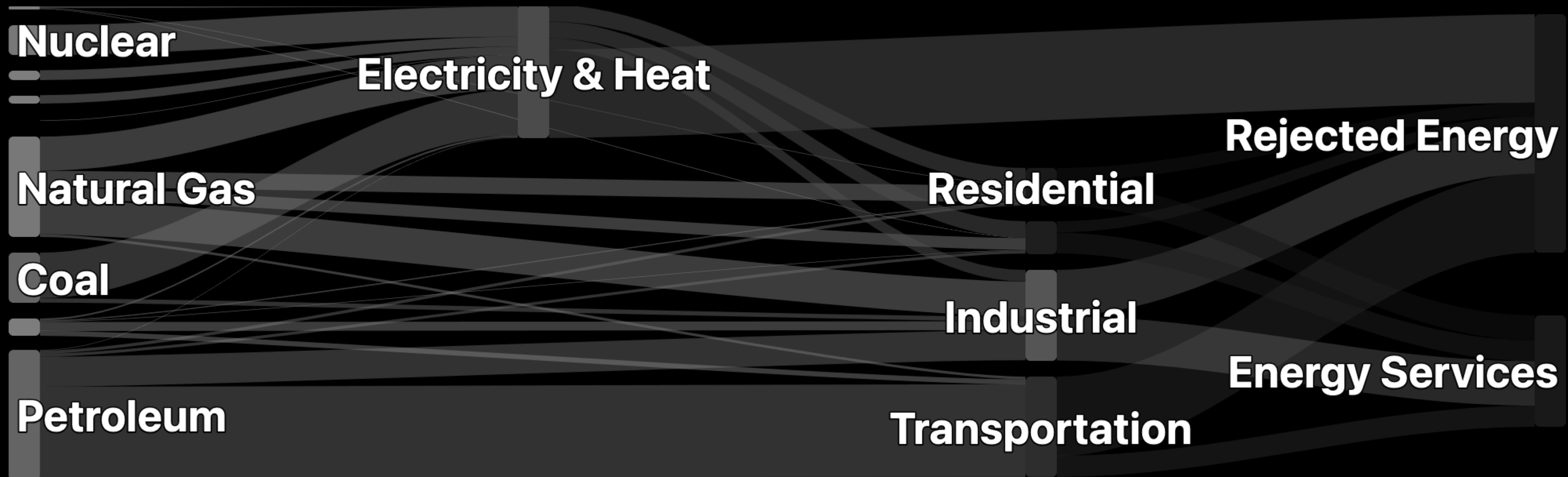


Sankey charts are used to visualize data flow and volume between nodes. Visually wider lines indicate larger volumes. This chart is showing energy consumption and types. Interacting with this chart by selecting a node or flow (such as with a click) will update the stacked bar chart below.

Bad news...

Estimated US Energy Consumption in 2017

Source: Lawrence Livermore National Laboratory



Highcharts.com

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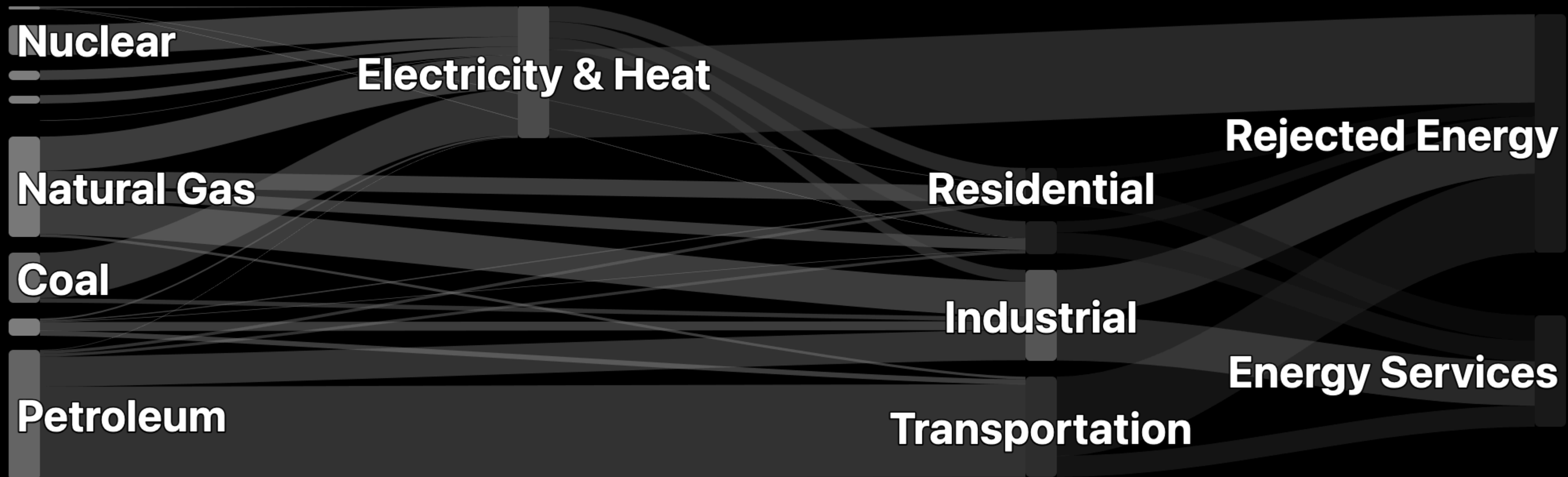
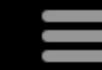
Bad news...



This design has
accessibility issues too

Estimated US Energy Consumption in 2017

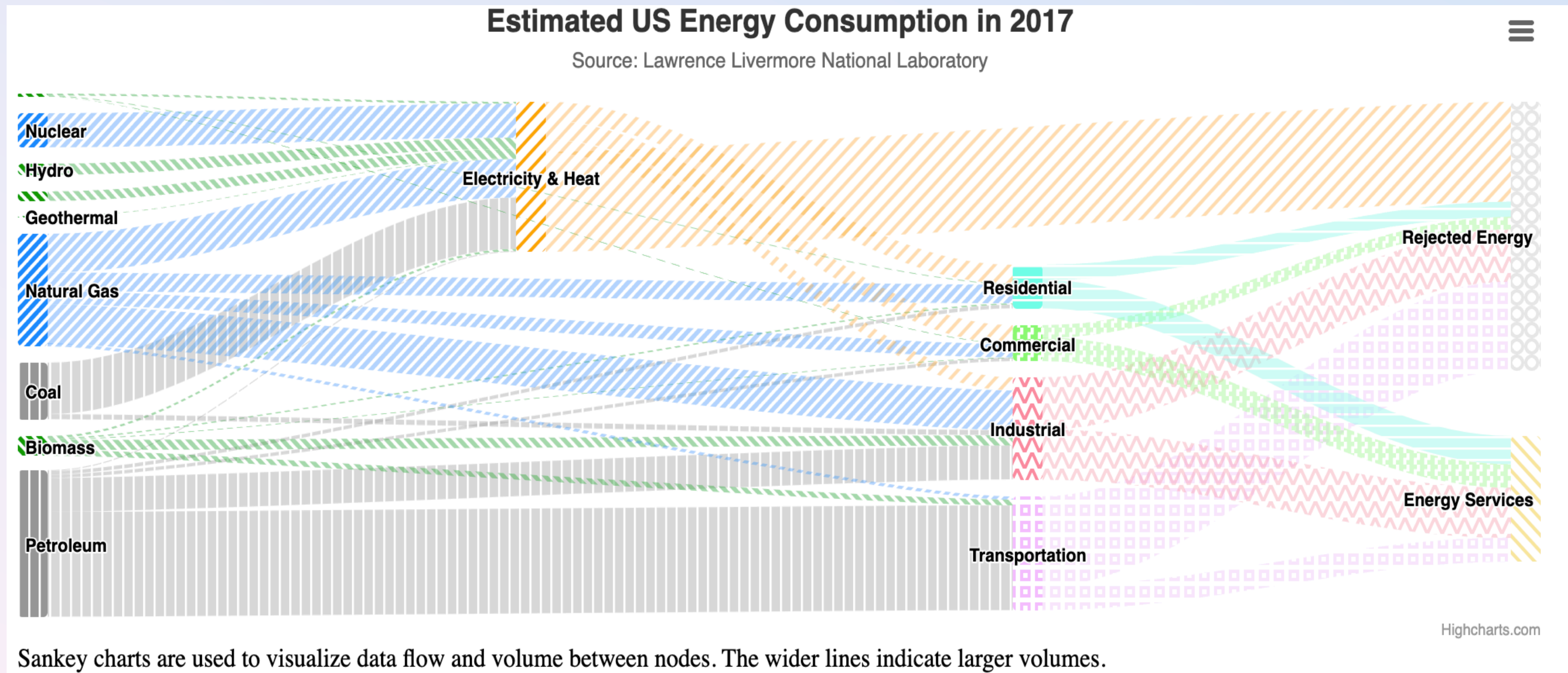
Source: Lawrence Livermore National Laboratory



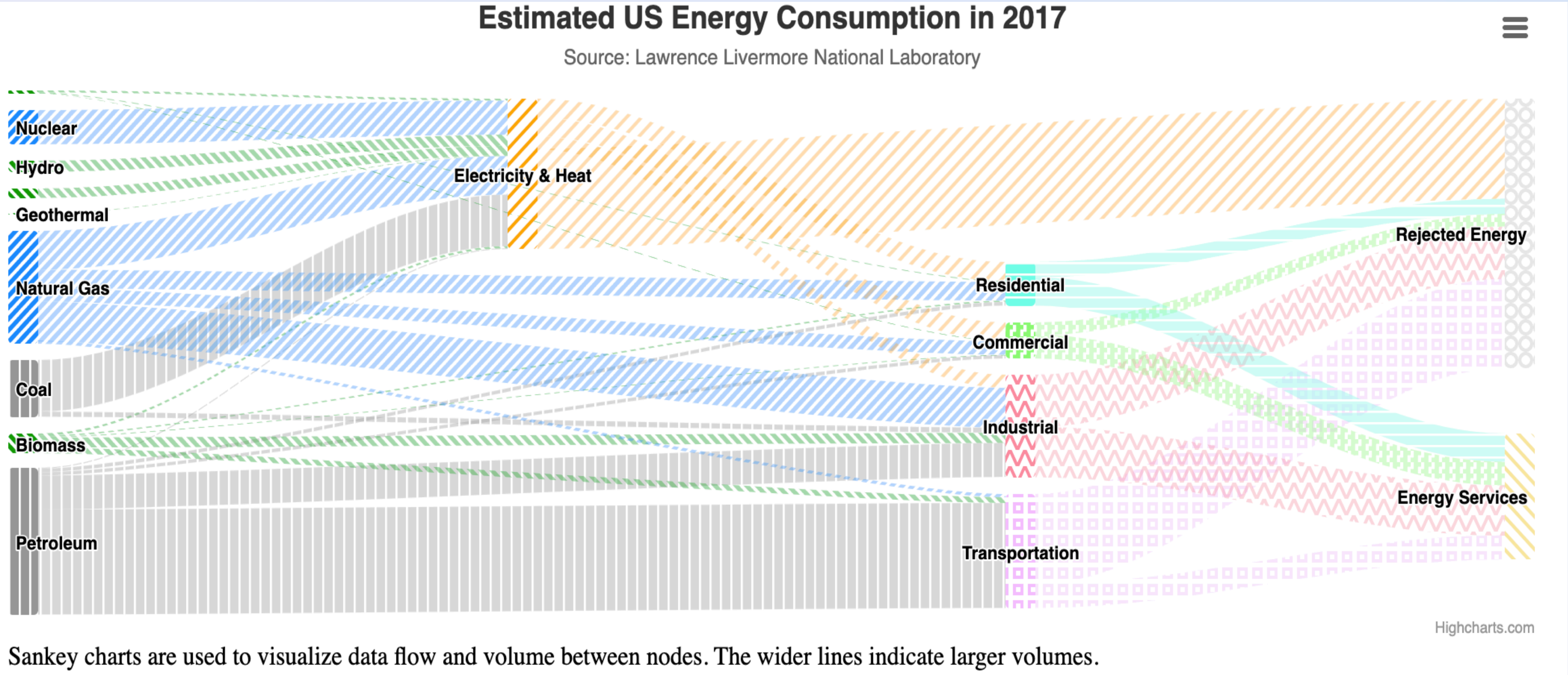
Highcharts.com

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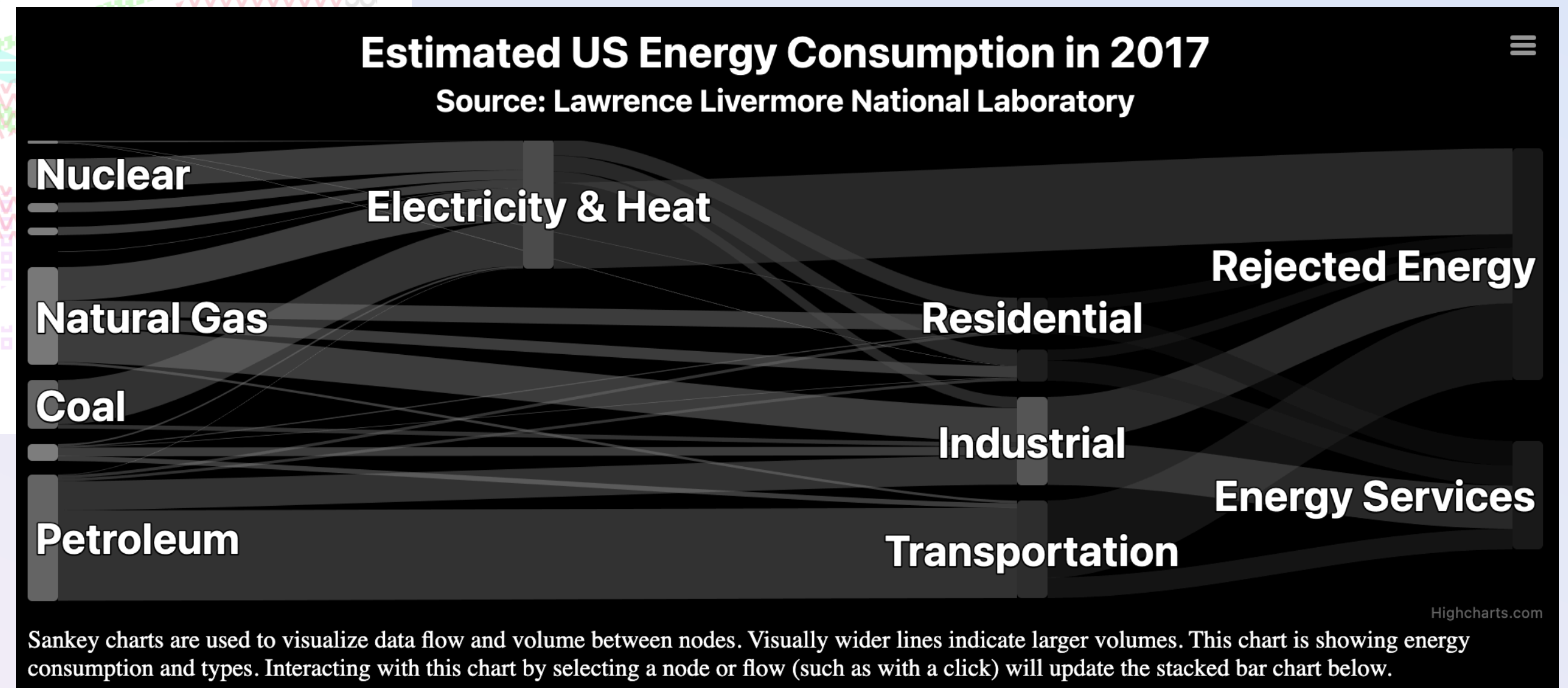
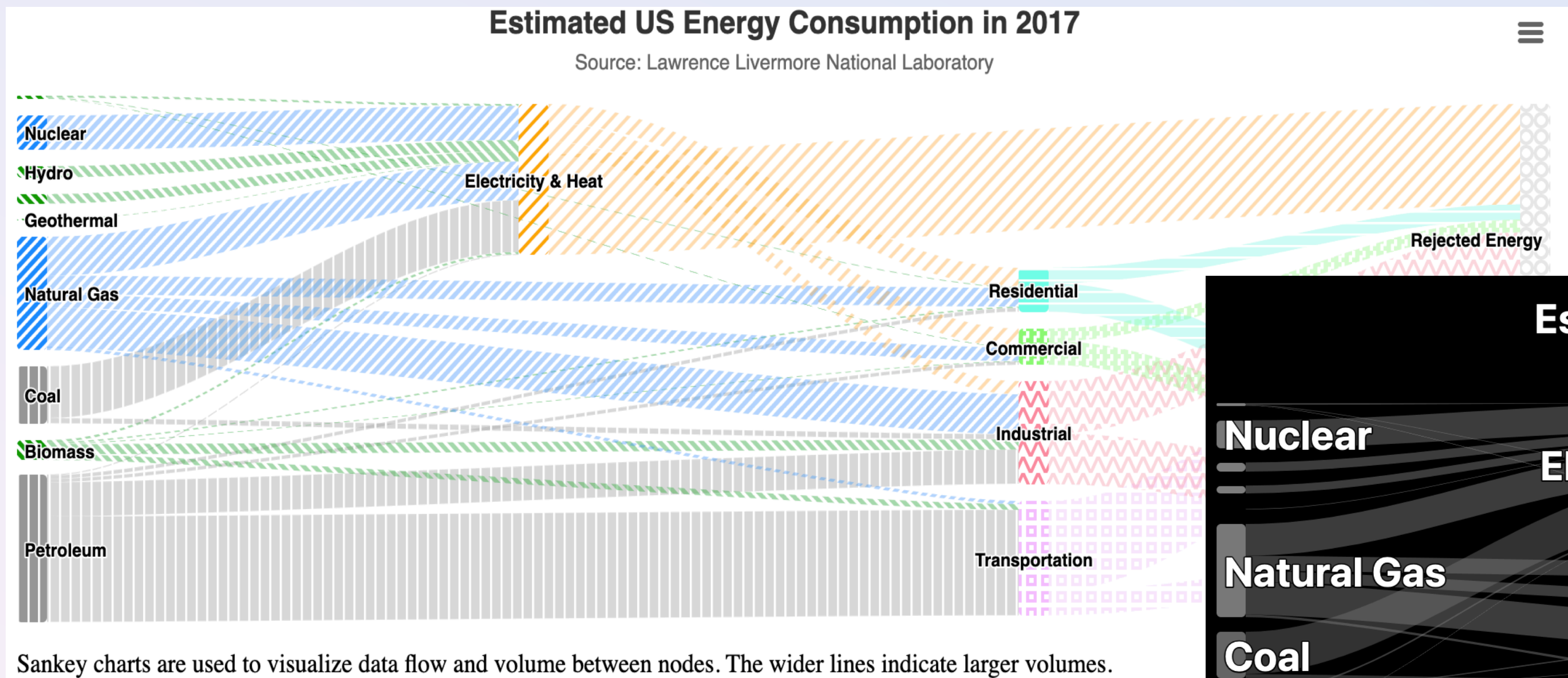
There is no such thing as a single, perfect design



One design *cannot* fit all



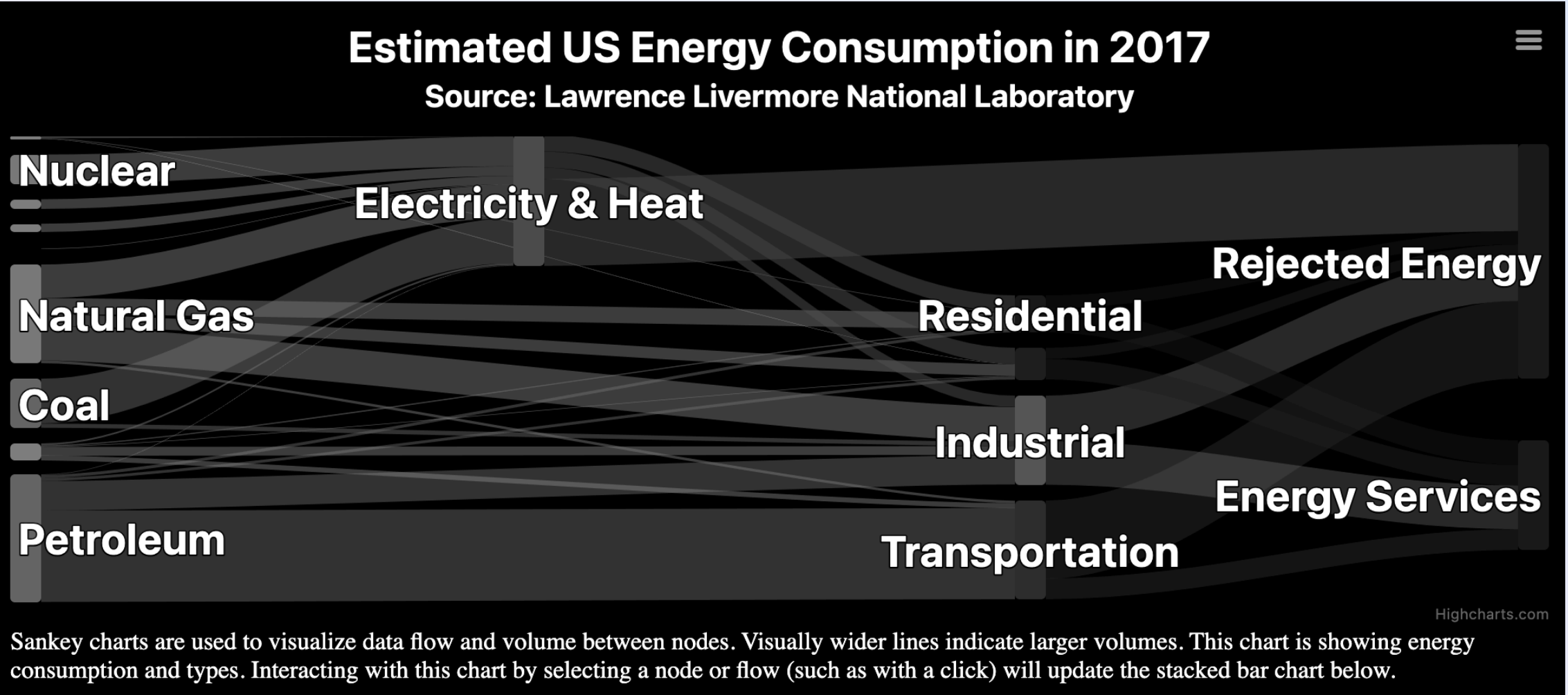
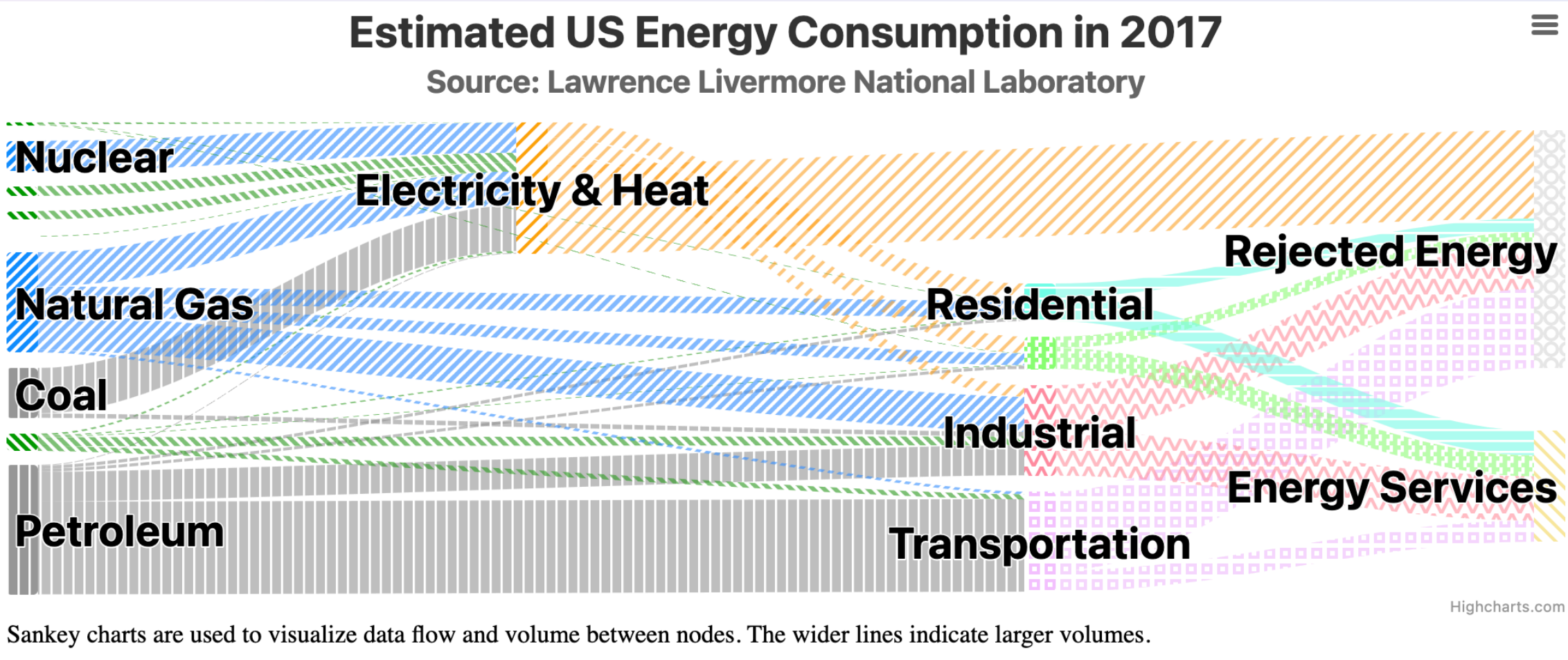
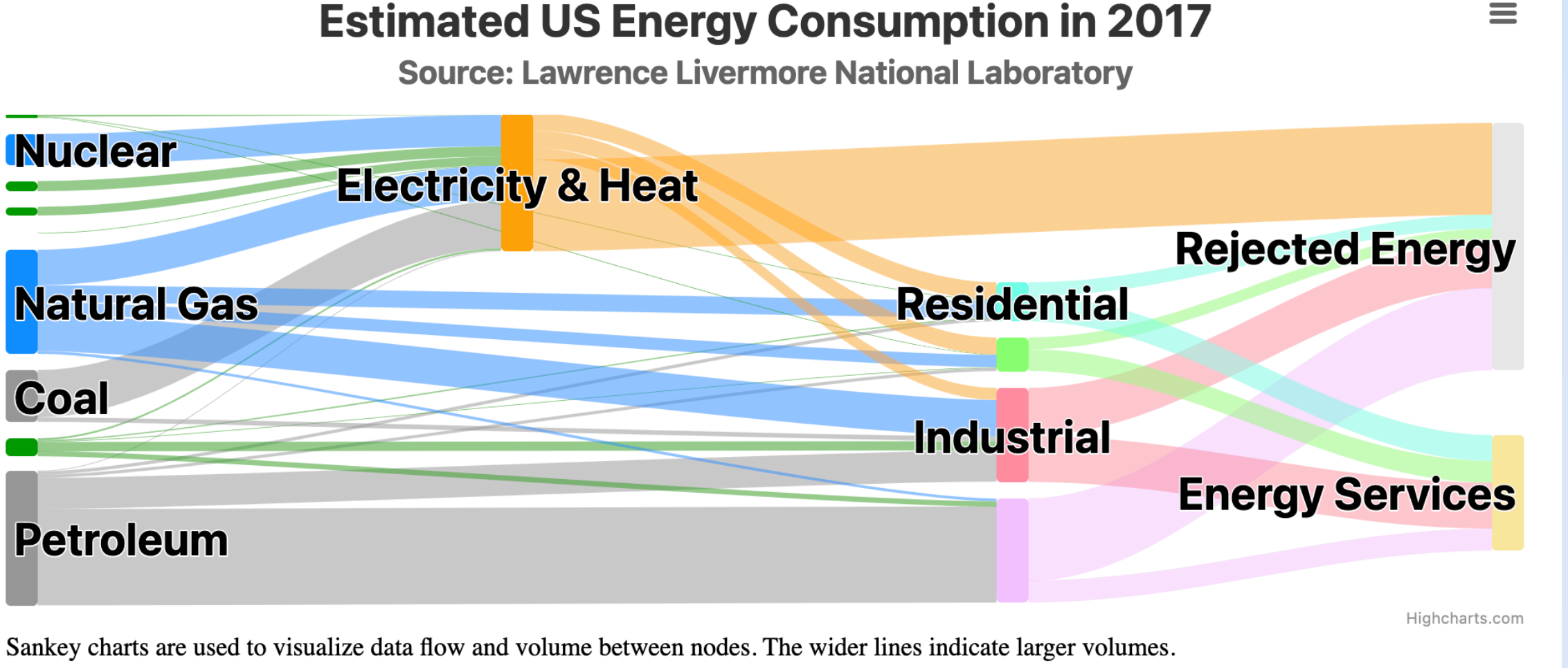
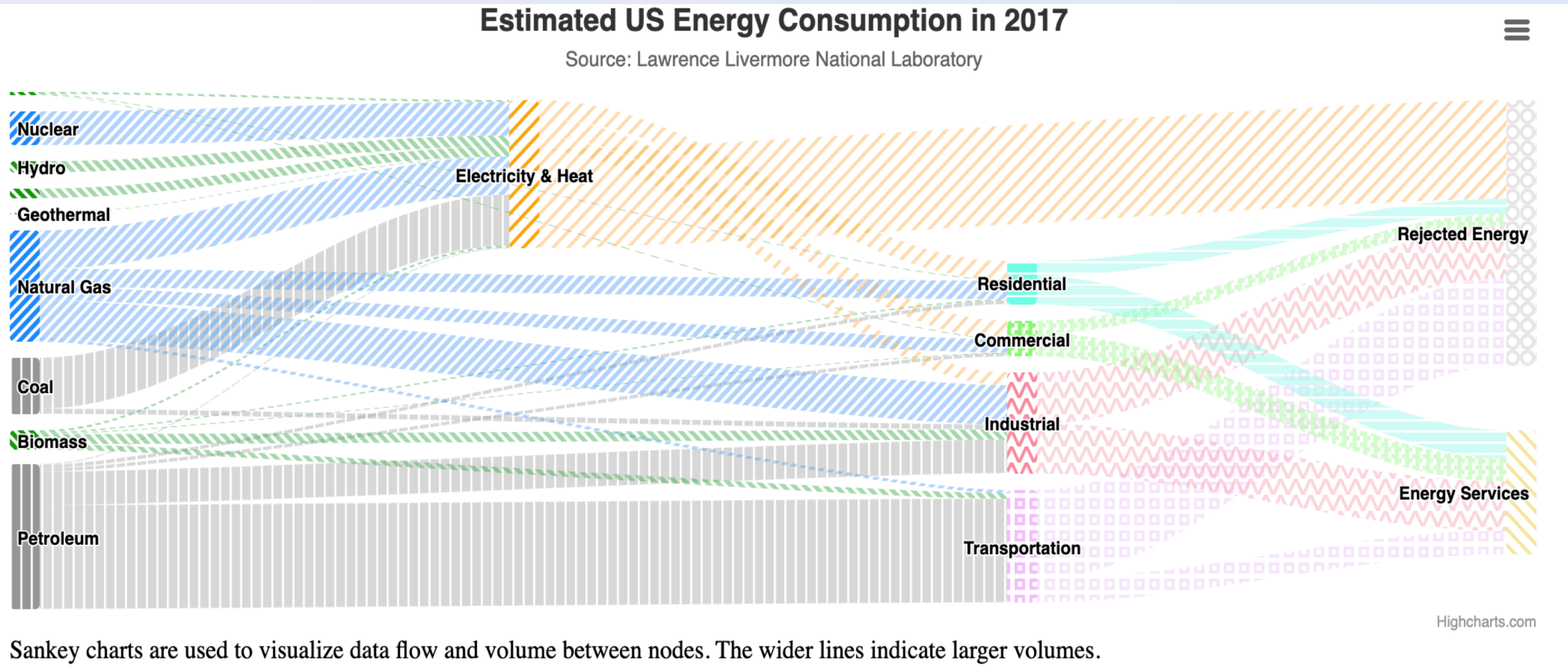
Research problem: How do we resolve this “access friction”?



Why should our designs be one-size-fits-all?



What if we let users personalize?



We have been enabling personalization for years

Video games



The Last of Us 2 has more than 60 settings

Devices and operating systems



"Make it yours" is the motto for Apple's accessibility personalization

We built a preferences menu!

Preferences

This menu provides a way to customize charts and graphs. The menu is organized into categories, and adjusting the settings at the category level will adjust all of the settings within that category. Some settings within categories also have sub-settings which will also inherit higher level settings that they belong to. If wording for a category's setting is hard to understand, try changing that setting and then navigating into the menu to see which children settings it affected.

Hide unavailable options ☒

Comprehension

default moderate robust

► Show more comprehension options...

Text visuals

default minimalist moderate maximalist

▼ Show more text visuals options...

Font Size

default small medium large

► Show more font size options...

Font Weight

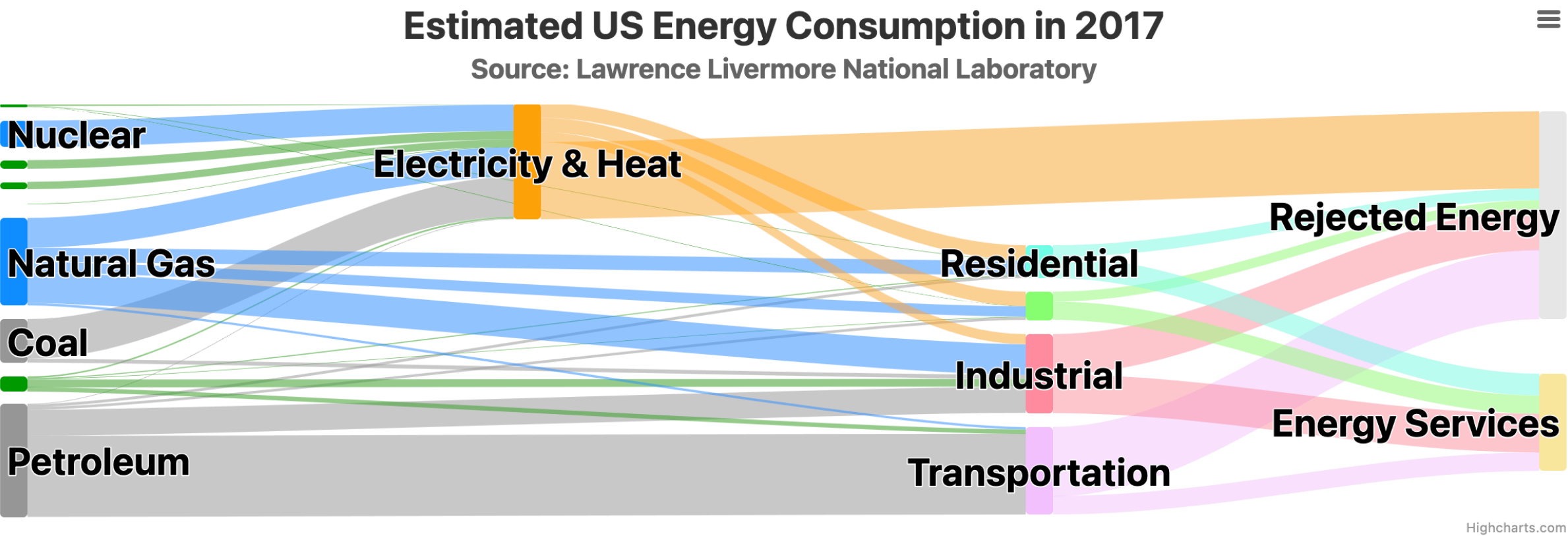
default 100 400 700

► Show more font weight options...

Color and contrast

default minimalist maximalist

▼ Show more color and contrast options...



Sankey charts are used to visualize data flow and volume between nodes. The wider lines indicate larger volumes.

Energy Sources

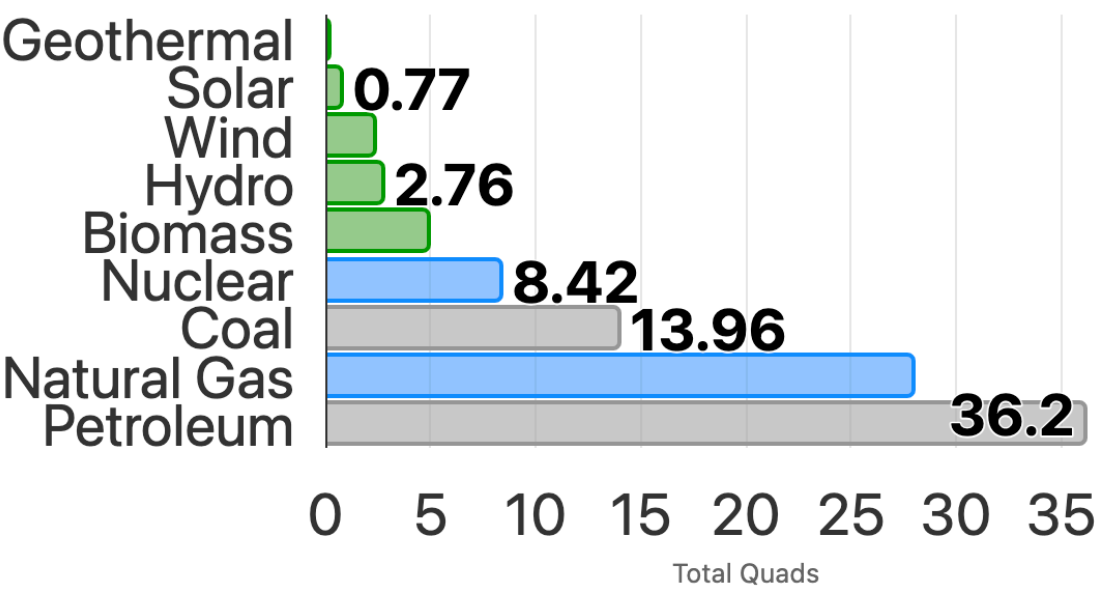
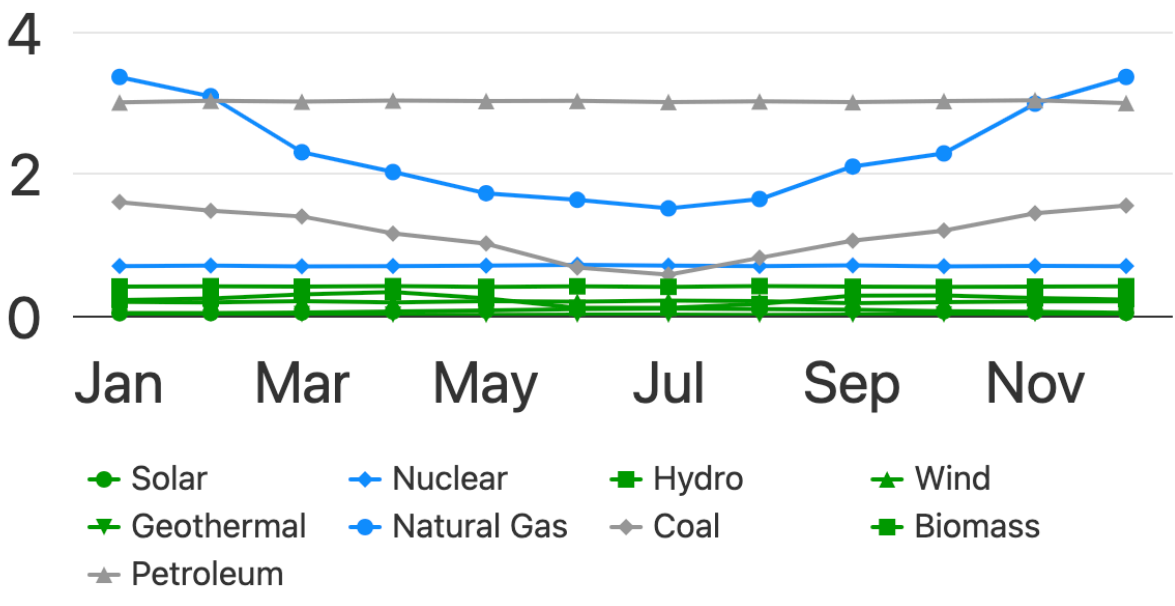


Chart showing stacked columns for comparing quantities. Stacked charts are often used to visualize data that accumulates to a sum.

Monthly Energy Consumption

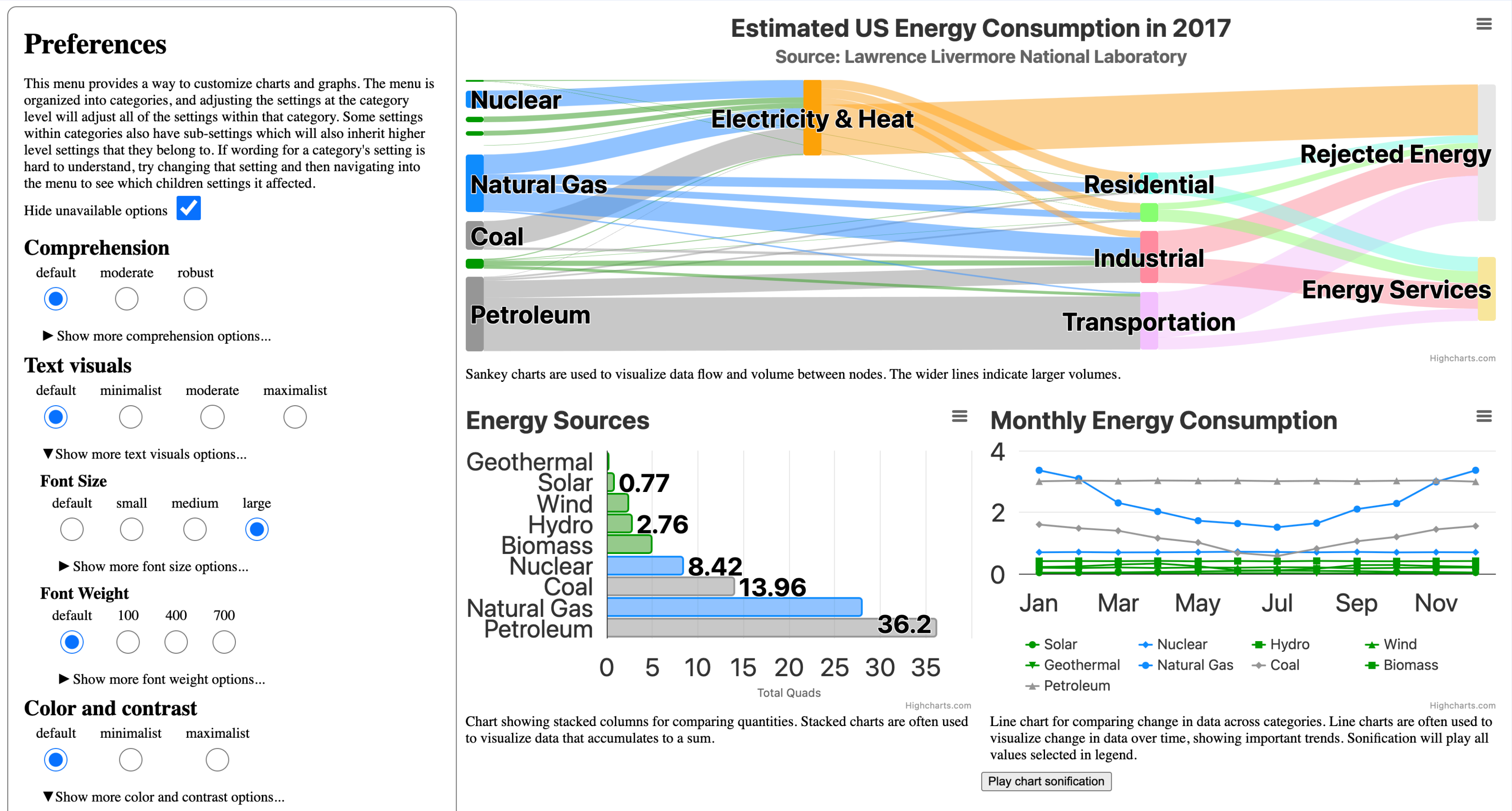


Line chart for comparing change in data across categories. Line charts are often used to visualize change in data over time, showing important trends. Sonification will play all values selected in legend.

Play chart sonification

What do people with disabilities want to personalize with visualizations?
And how does personalization change how we design visualization libraries, systems, and tools?

We gave 9 BLV users and 4 developers some levers to pull



(What is accessible for one...)

“If anything has dark mode? That’s great. I wish everything used dark mode.”

Participant #4

(...might be a barrier for another.)

“Oh, I can’t use dark mode at all. I hate when websites have [dark mode] because it can be virtually impossible to use.”

Participant #7



Malleable interfaces need guardrails

- It is possible to design harmful visualizations, so system designers should anticipate ways to help users personalize safely.

Results

F. Elavsky, M. Vindedal, T. Gies, P. Carrington, D. Moritz, and Ø. Mousing, “Towards *Software*: Enabling personalization of interactive data representations for users with disabilities,” *Computer Graphics and Applications*, 2025.

Results



Malleable interfaces need guardrails

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Our ethical responsibility: Accessible defaults first

- Some users won't want to personalize or manipulate interfaces at all, so they will still rely on smart, effective defaults.

F. Elavsky, M. Vindedal, T. Gies, P. Carrington, D. Moritz, and Ø. Mousing, “Towards *Software*: Enabling personalization of interactive data representations for users with disabilities,” *Computer Graphics and Applications*, 2025.

Results



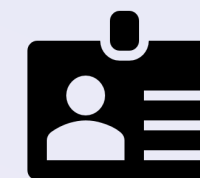
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Persistence, profiles, and "effort-to-usage" ratio

- Everything about malleable interfaces should save users time and energy. Let them save, reuse, and share their personalization.

F. Elavsky, M. Vindedal, T. Gies, P. Carrington, D. Moritz, and Ø. Mousing, “Towards *Software*: Enabling personalization of interactive data representations for users with disabilities,” *Computer Graphics and Applications*, 2025.

Results



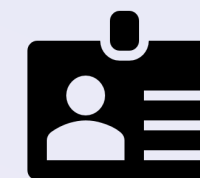
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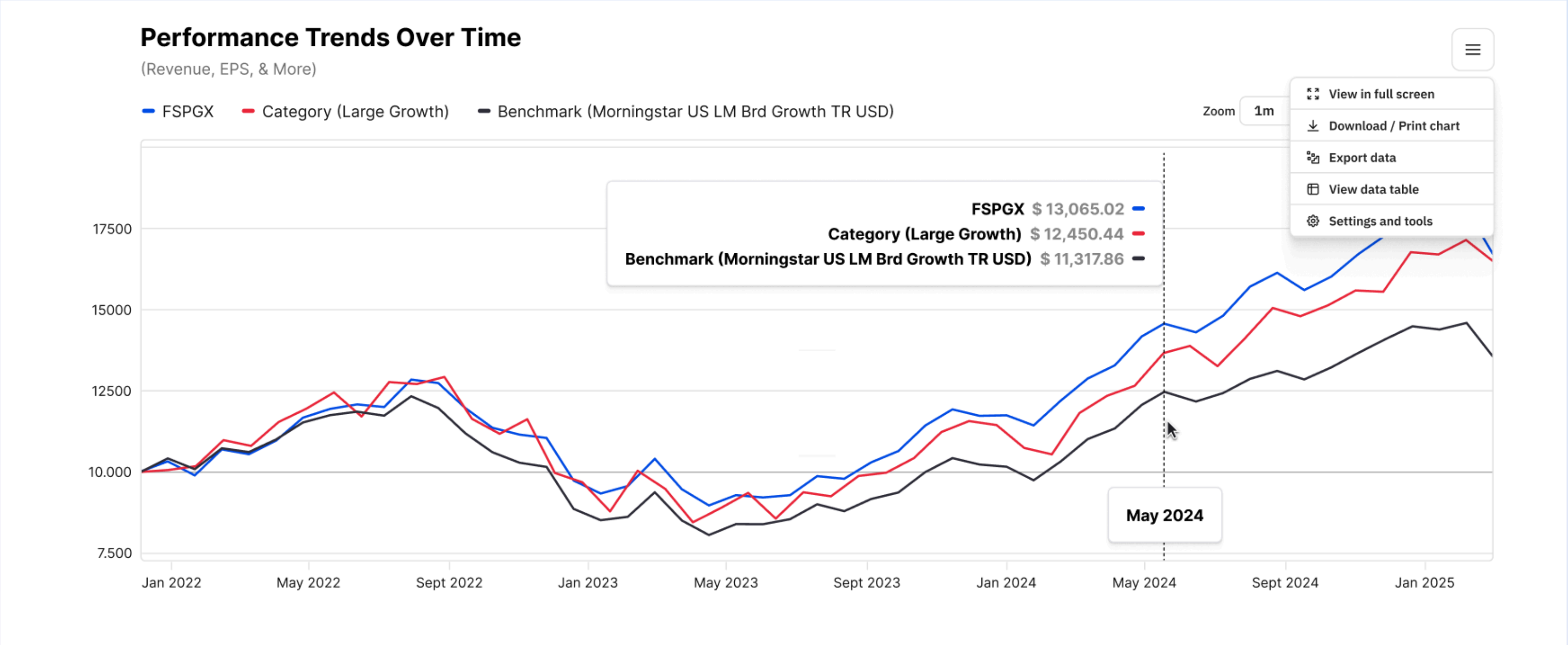
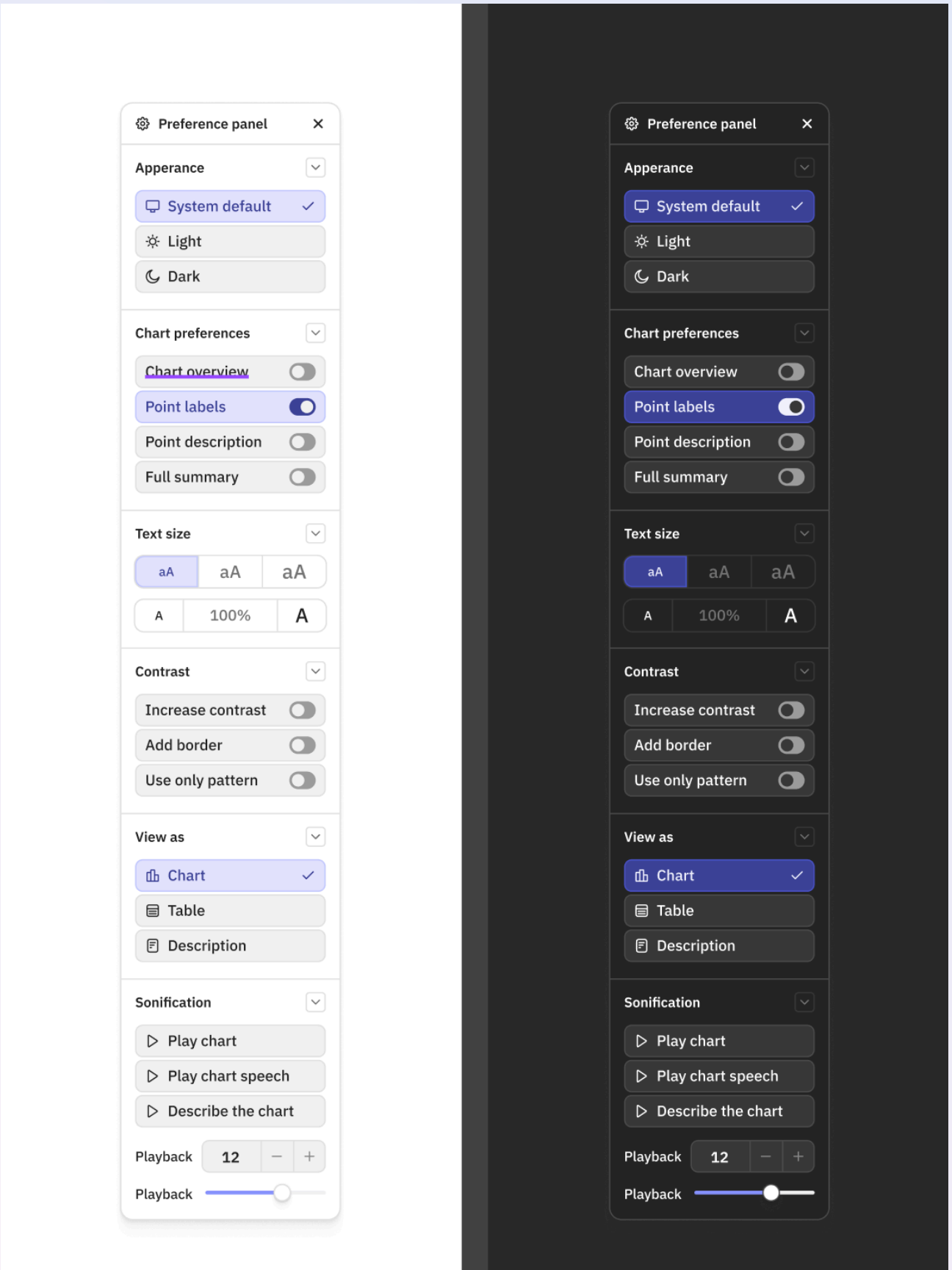


Interoperability: *everyone's* job

- One visualization library isn't enough: the way users personalize a chart in one place should carry over to other platforms and tools.

F. Elavsky, M. Vindedal, T. Gies, P. Carrington, D. Moritz, and Ø. Mousing, “Towards *Software*: Enabling personalization of interactive data representations for users with disabilities,” *Computer Graphics and Applications*, 2025.

Deployment in Highcharts, >6m downloads/month



F. Elavsky, M. Vindedal, T. Gies, P. Carrington, D. Moritz, and Ø. Mousing, “Towards *Software*: Enabling personalization of interactive data representations for users with disabilities,” *Computer Graphics and Applications*, 2025.

Section 2:

Low-level building blocks

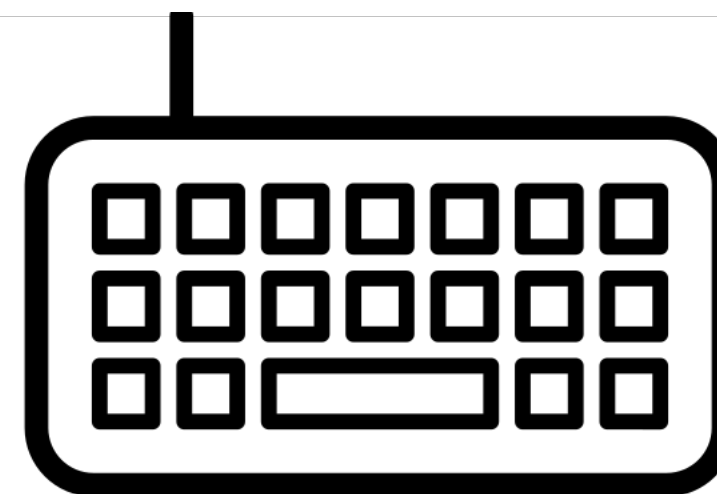
Research problem: How can we enable people to *build* accessible visualizations?

A default button

A default button

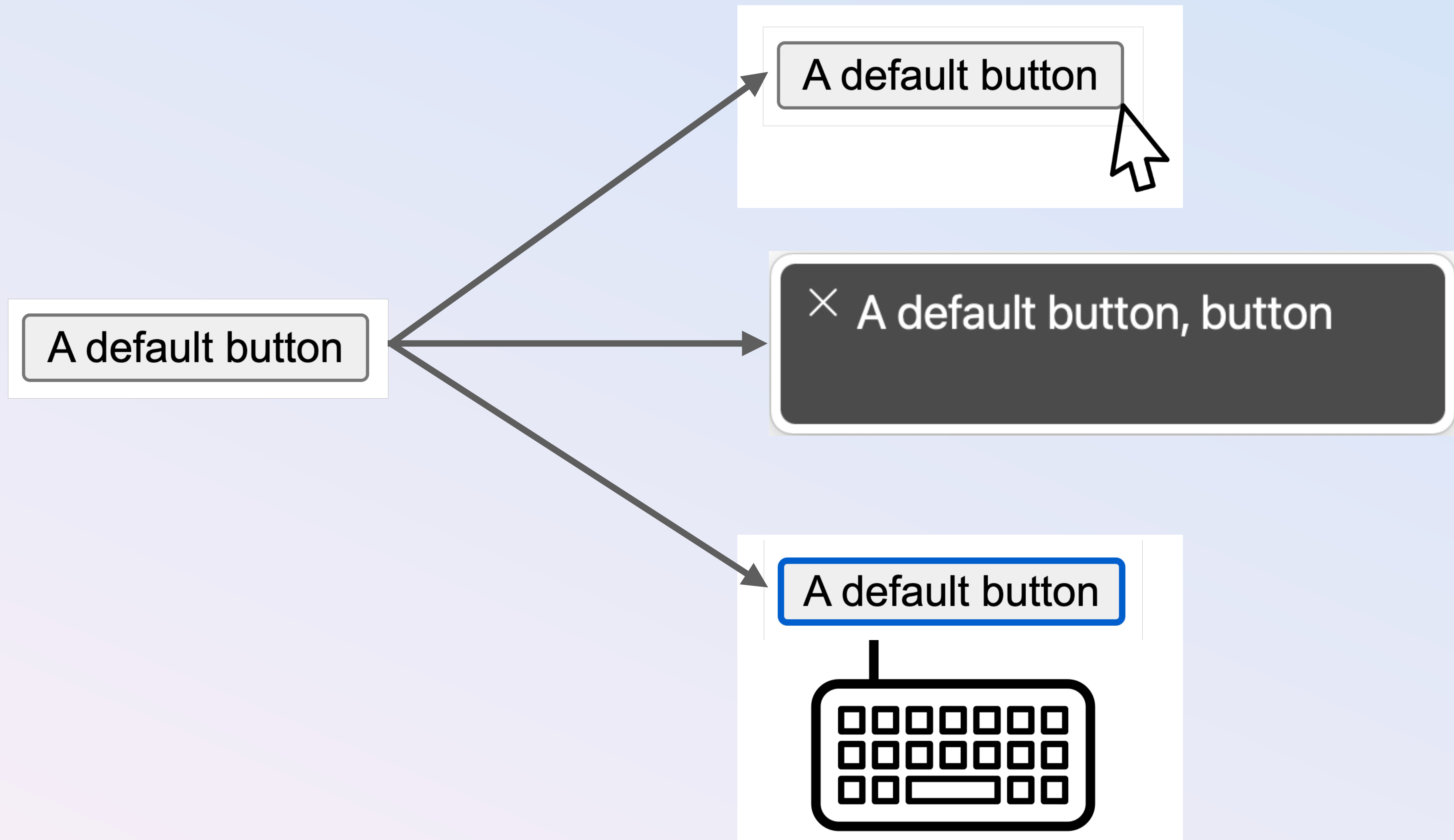


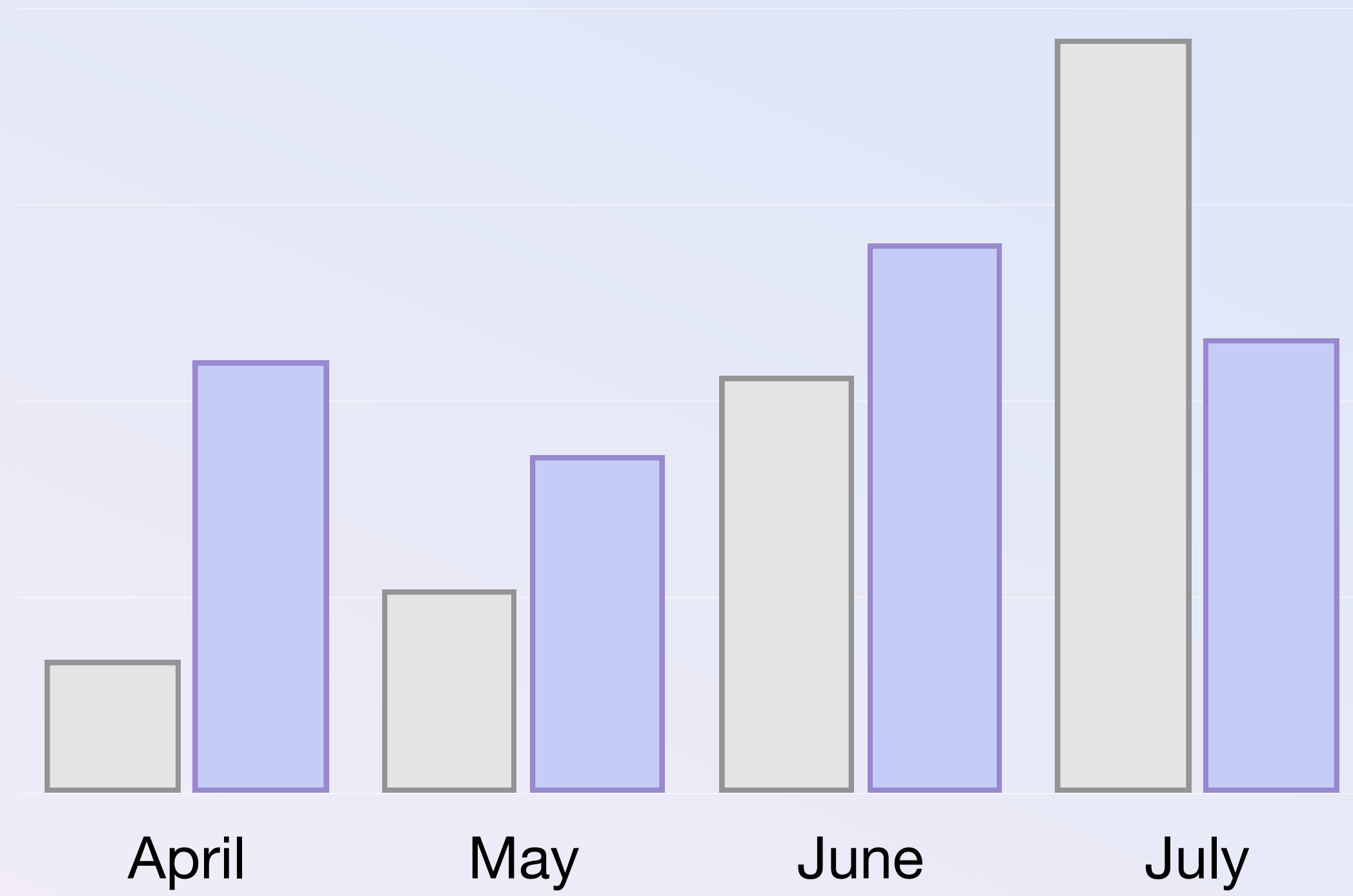
A default button



A default button

× A default button, button

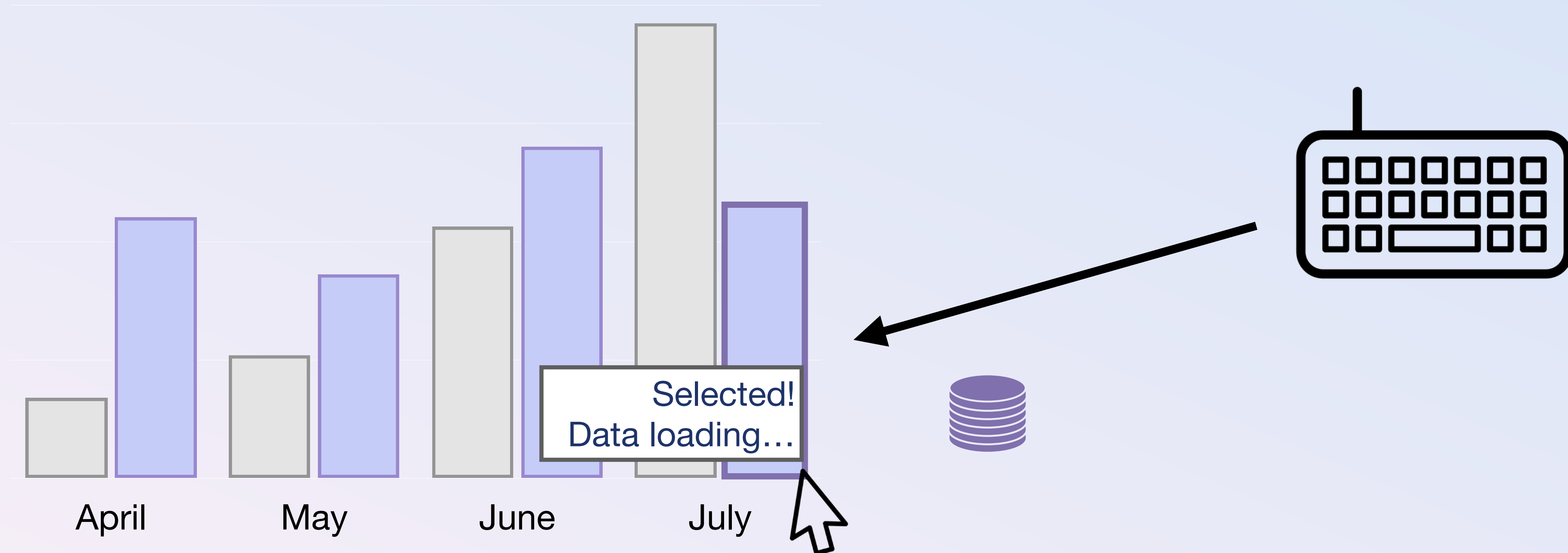




The mouse rules all



A keyboard should be able to do everything a mouse can



WAI. "Understanding success criterion 2.1.1: keyboard." *WCAG standard*, W3C, 2017.

Discrete and direct navigation face more barriers

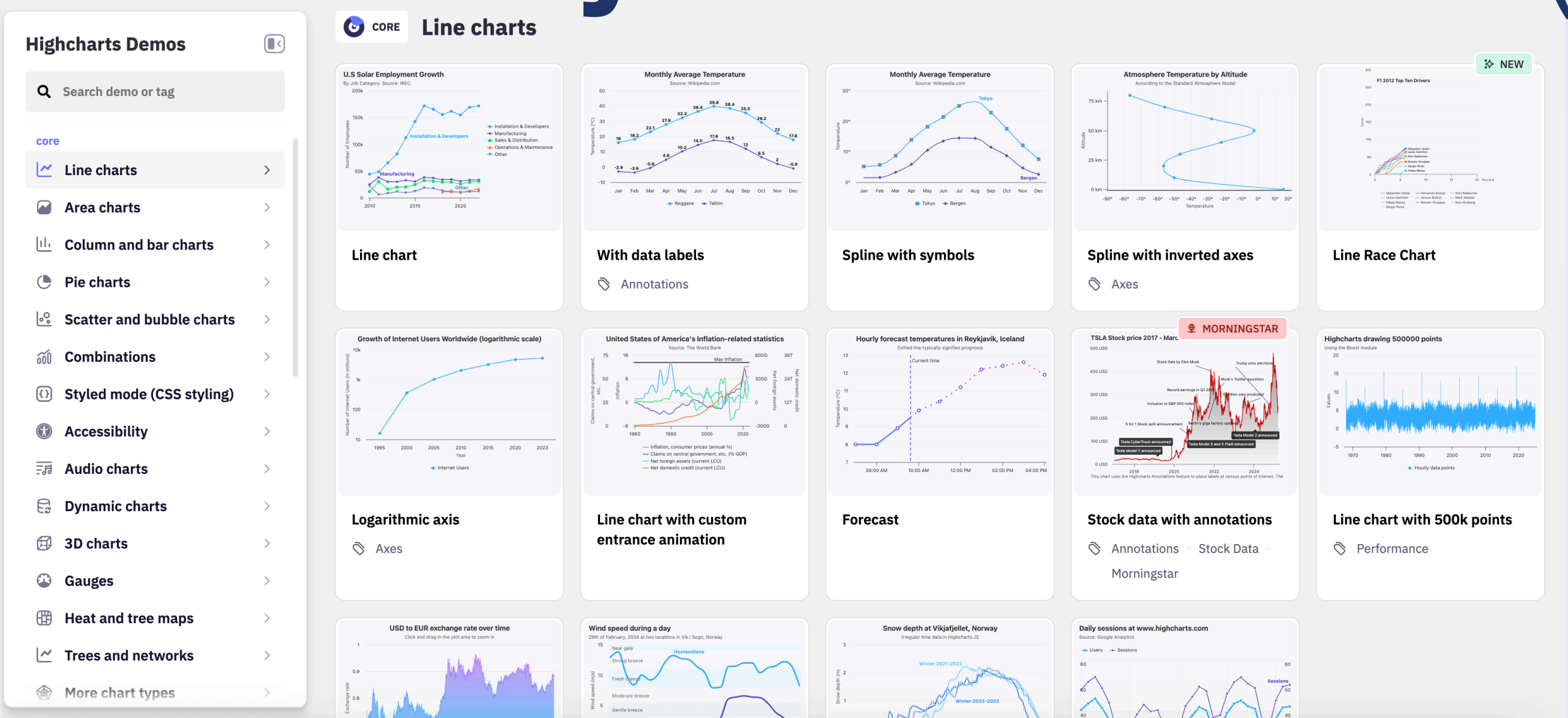


A person in a wheelchair operating an old computer using a desk-mounted sip and puff device called the POSSUM.

Image credit: [Wikipedia](#), Public Domain, 1960. Photographer: Possum Ltd.

Rich navigation (a short history)

2015: “beyond the table” (highcharts)



Rich navigation (a short history)

2015 (highcharts)

Highcharts Demos

Search demo or tag

core

Line charts

Area charts

Column and bar charts

Pie charts

Scatter and bubble charts

Combinations

Styled mode (CSS styling)

Accessibility

Audio charts

Dynamic charts

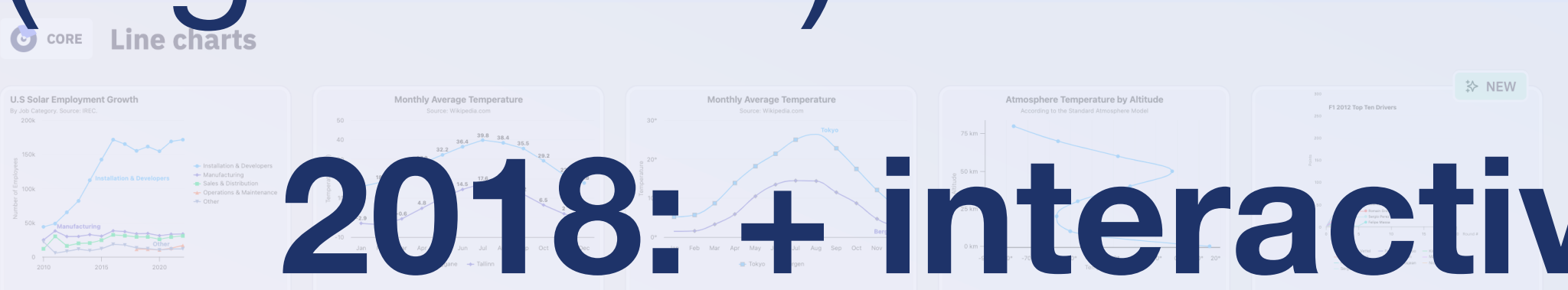
3D charts

Gauges

Heat and tree maps

Trees and networks

More chart types



2018: + interactivity (visa charts)

VISA

Product Design System

About VPDS

What's new

Designing

Developing

Contributing

Base elements

Components

Patterns

Content

Data visualization

Visa Chart Components

Development setup

Design visualization guidelines

Overview

Data visualization principles

Selecting a chart

Selecting a chart

Learn how to find the right chart for your audience's analysis needs.

Selecting the right chart requires determining the key purpose of the chart and tailoring it to your audience's needs.

Start by understanding the chart types available in our system. Once you're familiar, you can select a chart design from our collection of examples by defining the key insight your chart should provide, and determining the focus elements. Finally, optimize your chart's design to direct attention to the most important information.

Understand the chart types

Chart types refer to the broad categories of visual representations used to display data. Each chart type is best-suited for particular kinds of data analysis or insights. Charts help users understand and interpret data by leveraging simplified visual representations that highlight patterns and relationships.

BAR CHART

LINE CHART

HEAT MAP

SCATTER PLOT

ON THIS PAGE

Understand the chart types

Selecting a chart

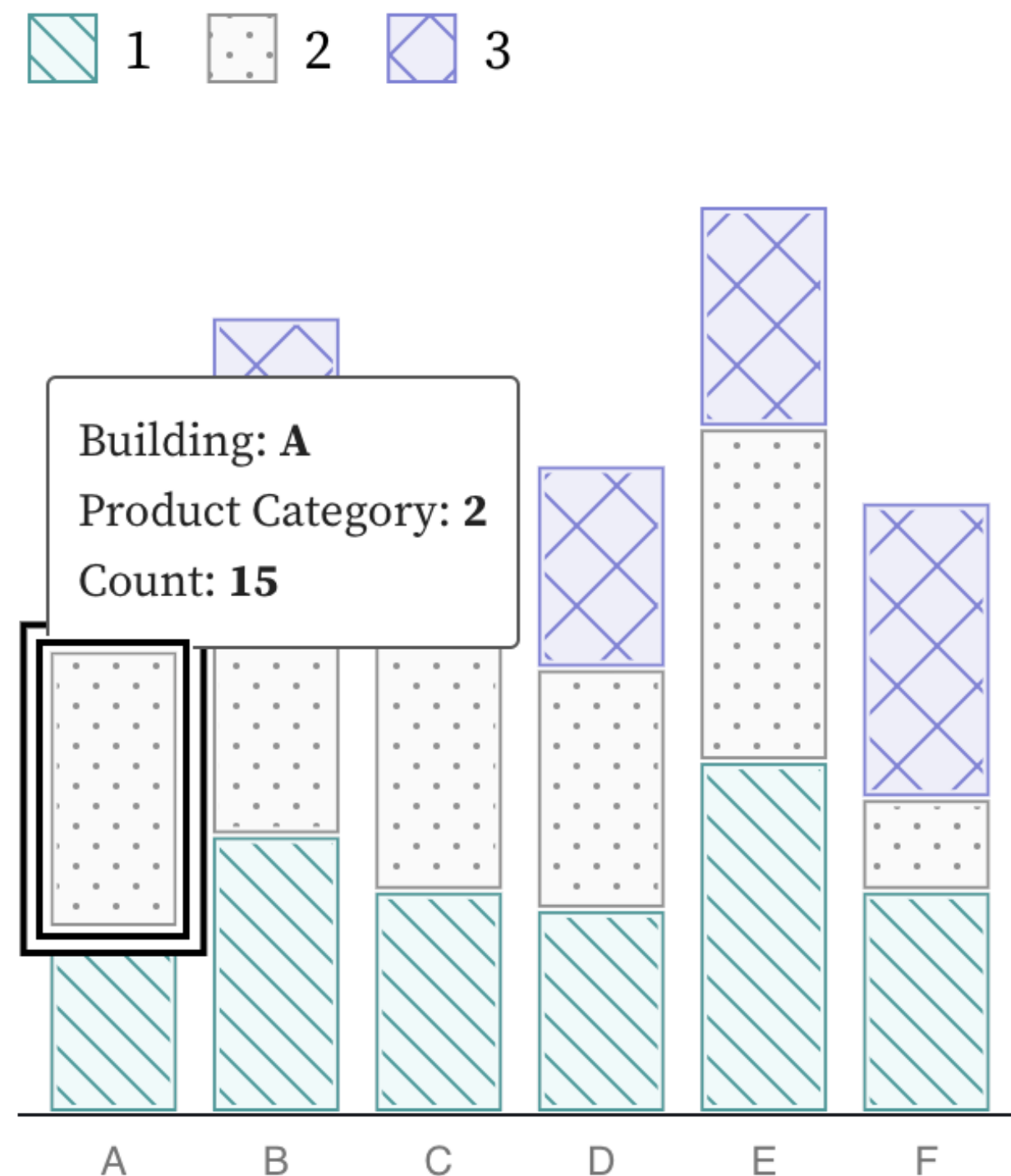
Step 1: Choose a key insight category

Step 2: Determine the focus

Step 3: Refine the chart

Alt text should communicate operability

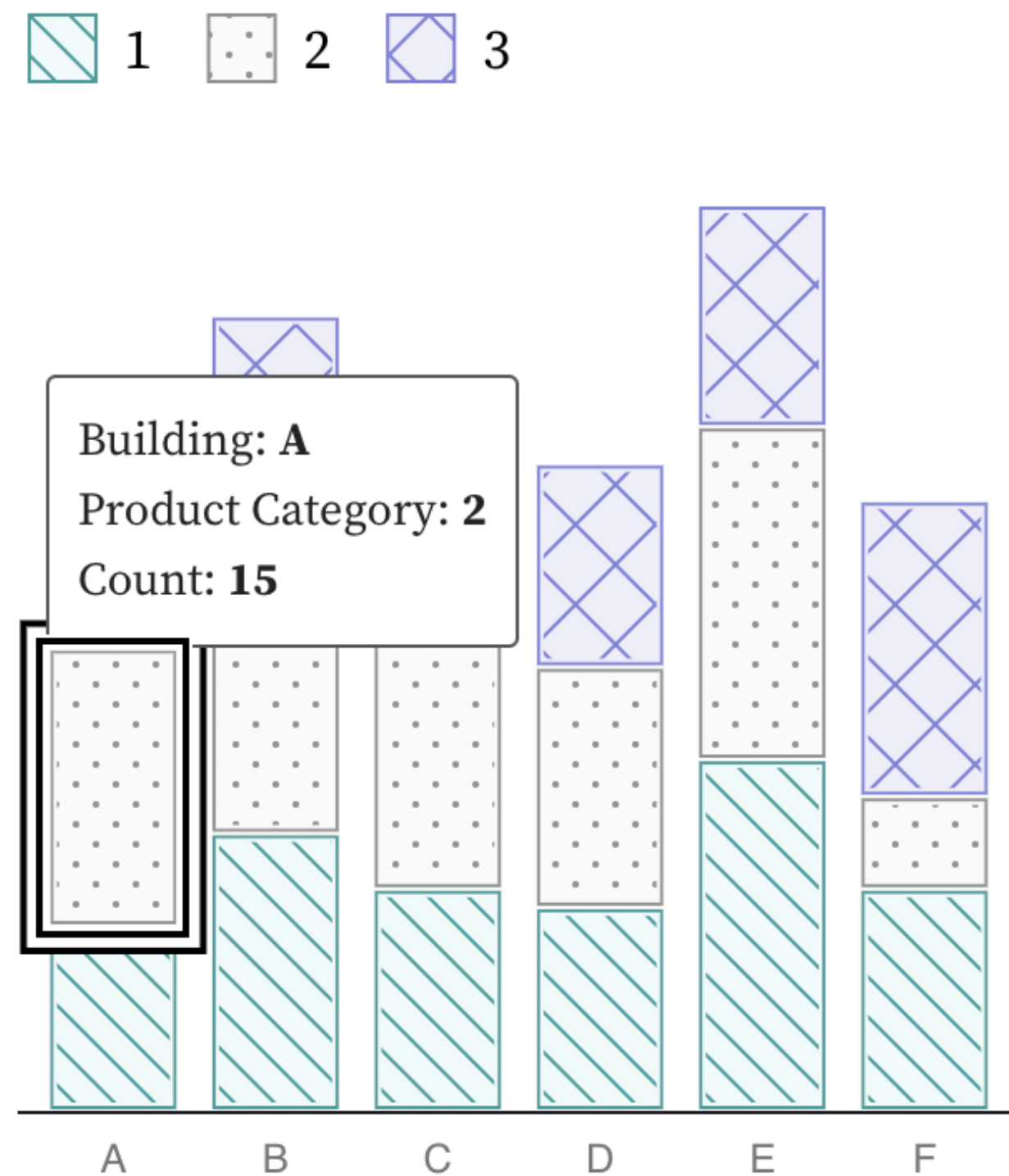
Source: Visa Chart Components, Frank Elavsky (2017-2019)



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

Semantics matter

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



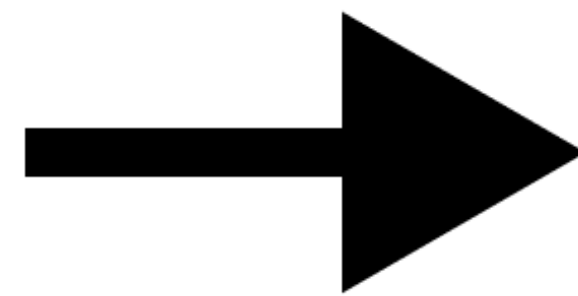
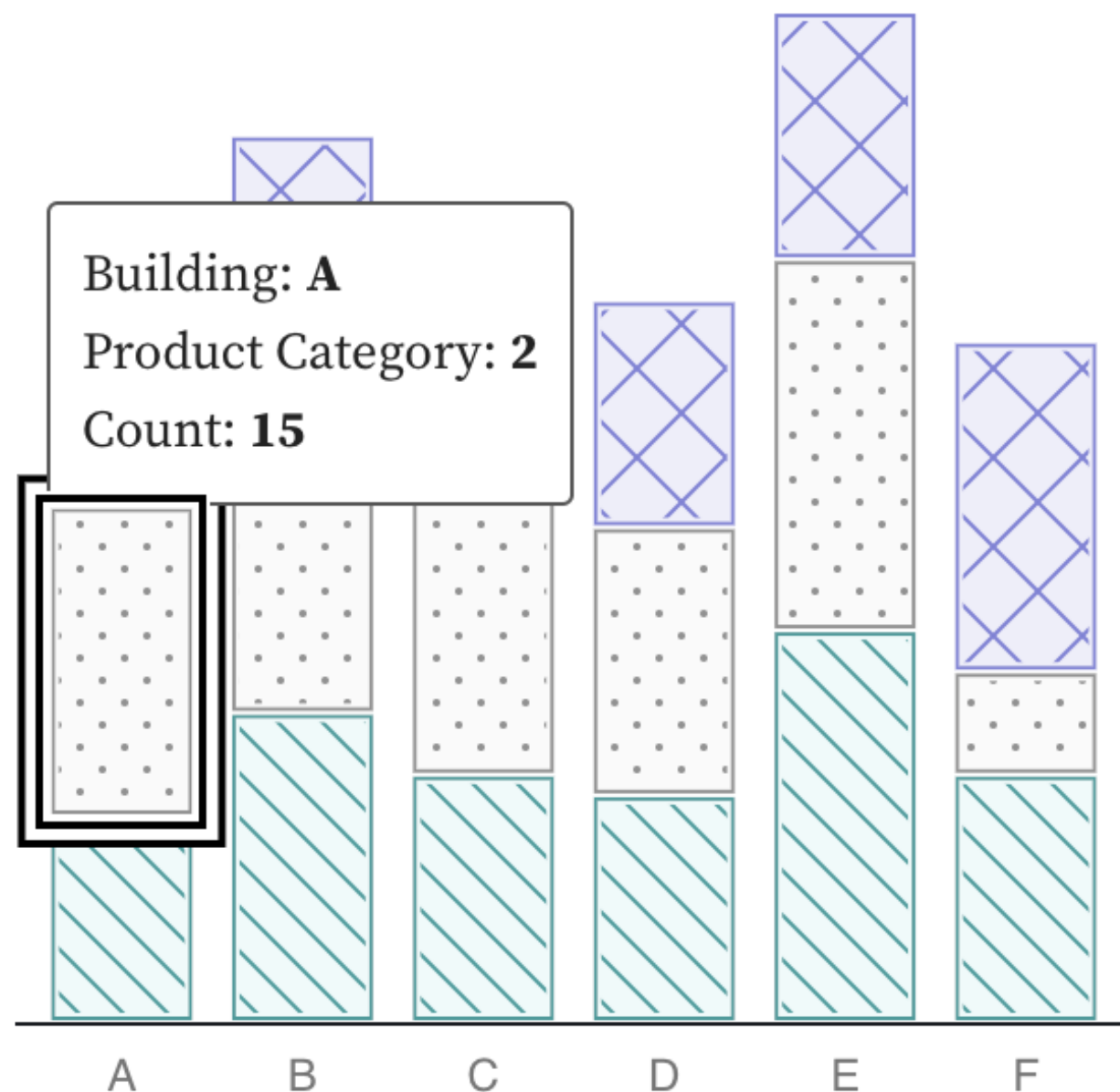
× Building A. Product Category 2.
Count 15. Bar 2 of 3. Image.

“Image” doesn’t signal
interactivity!

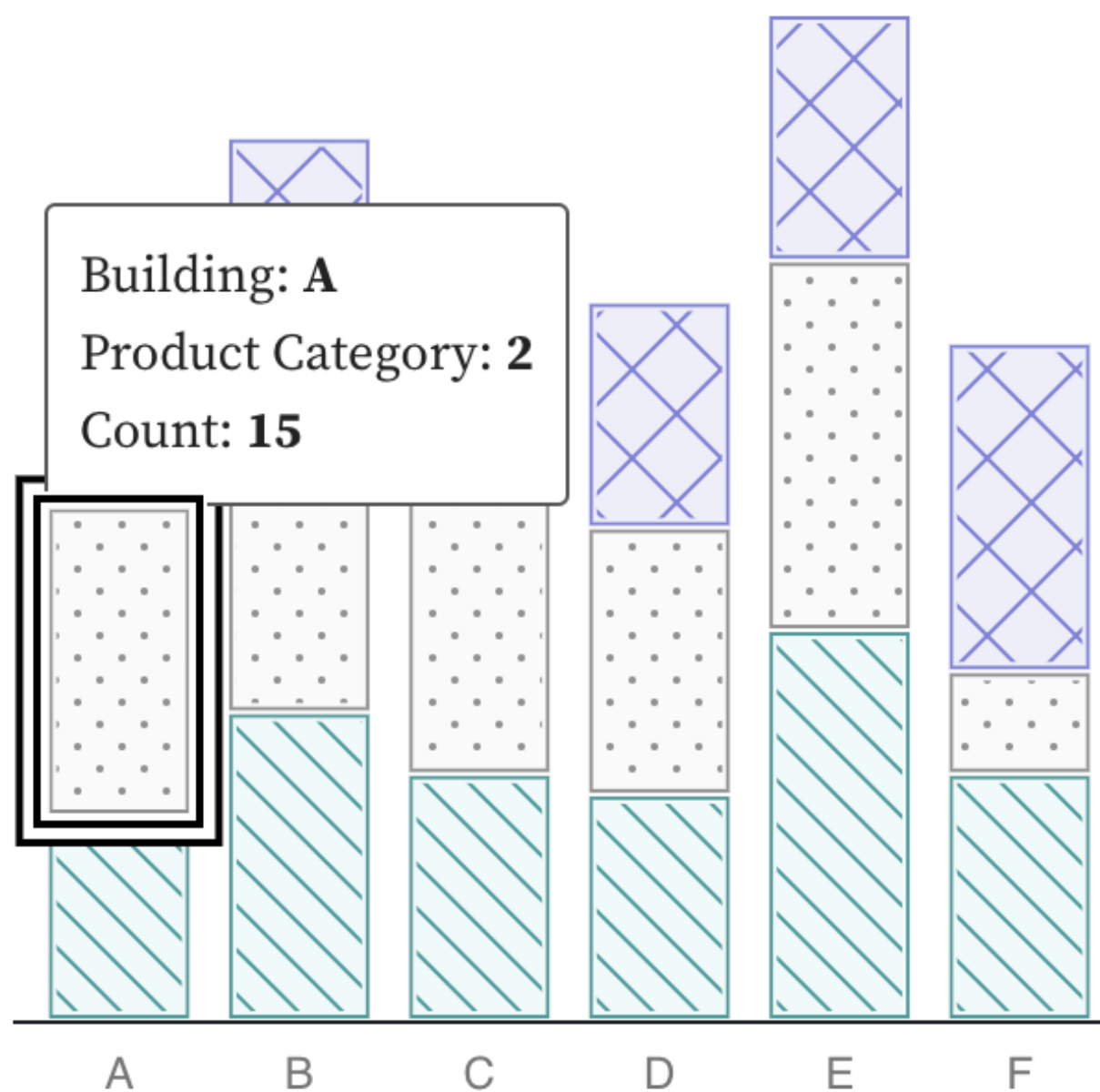
ARIA semantics are standardized

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

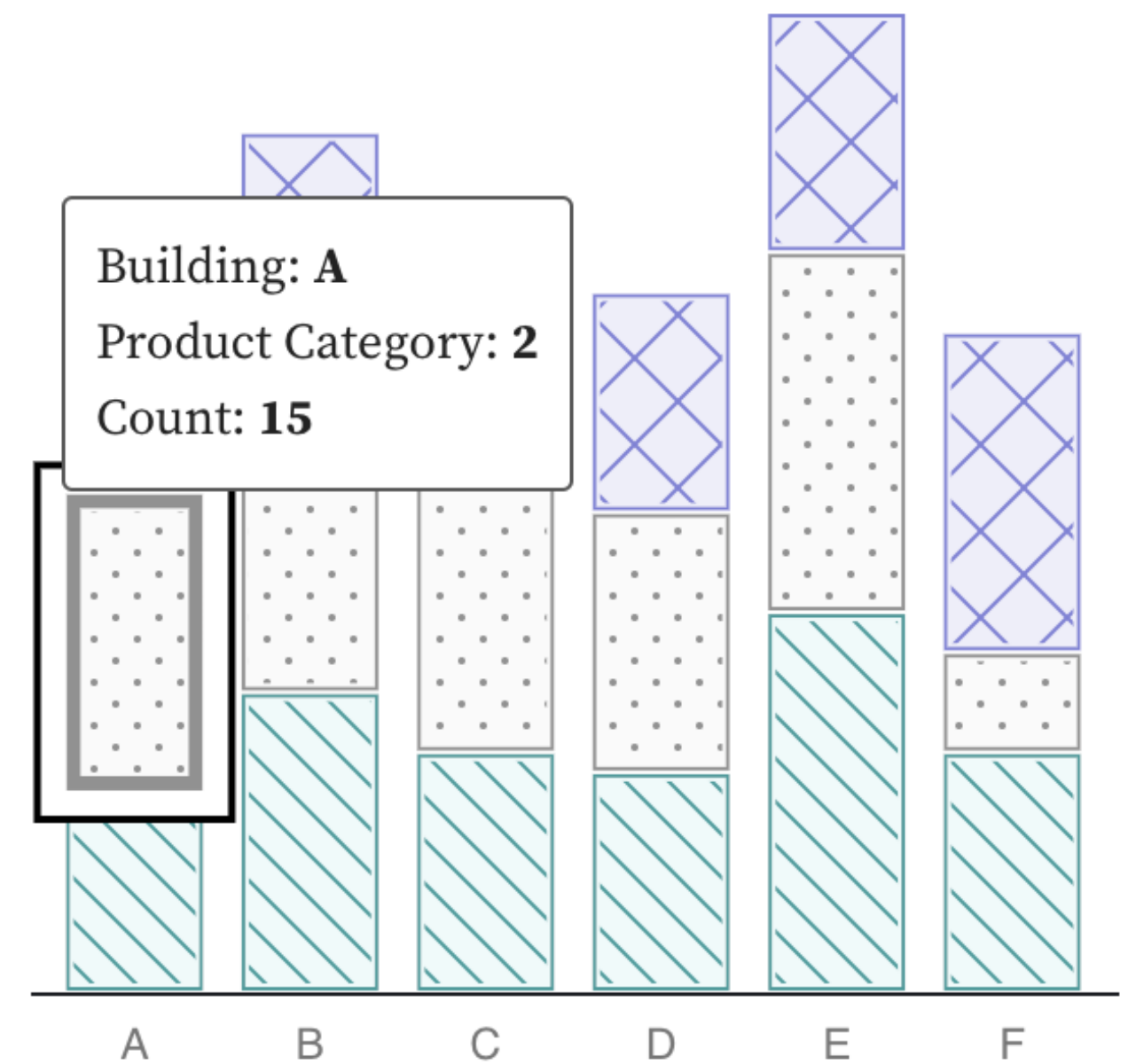
1 2 3



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)

Highcharts Demos

Search demo or tag

core

Line charts

Area charts

Column and bar charts

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3D charts

Gauges

Heat and tree maps

Trees and networks

More chart types

CORE Line charts

U.S. Solar Employment Growth

Monthly Average Temperature

Monthly Average Temperature

Atmosphere Temperature by Altitude

F1 2012 Top Ten Drivers

Line chart

Annotations

Spline with symbols

Spline with inverted axes

Line Race Chart

2018 (visa charts)

Growth of Internet Users Worldwide (logarithmic scale)

United States of America's Inflation-related statistics

Hourly forecast temperatures in Reykjavik, Iceland

TSLA Stock price 2017 - Mar

Highcharts drawing 500000 points

Logarithmic axis

Line chart with custom entrance animation

USD to EUR exchange rate over time

Content

Visa Chart Components

Development setup

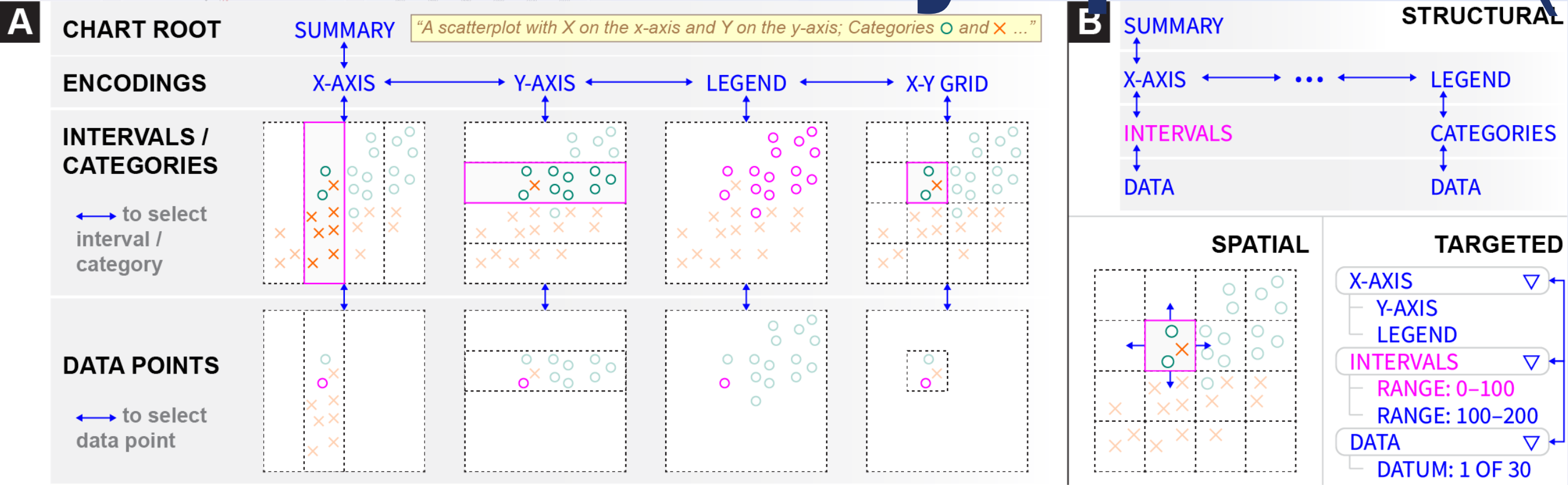
Design visualization guidelines

Overview

Data visualization principles

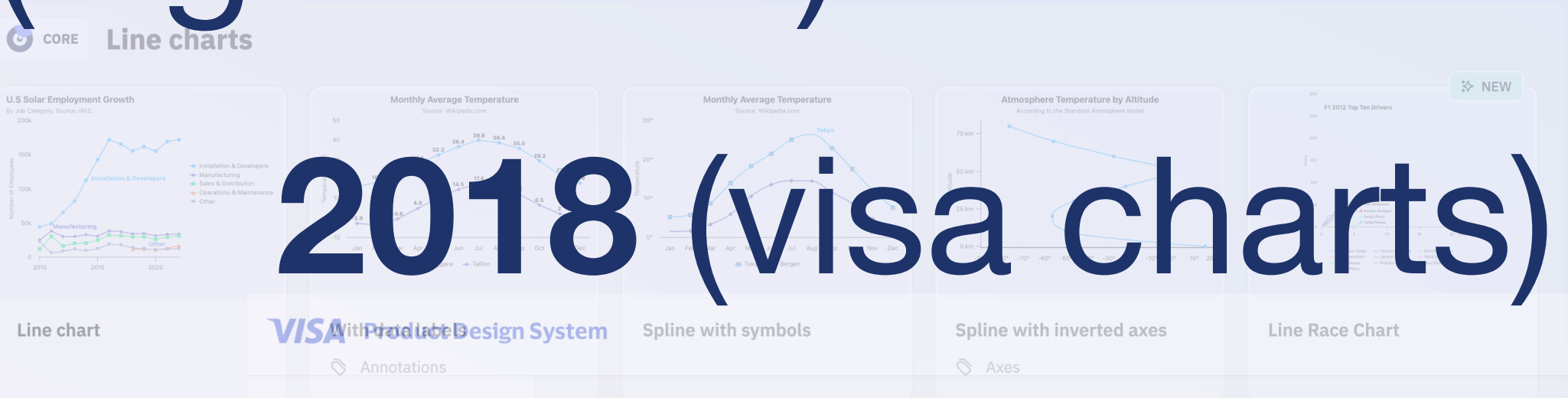
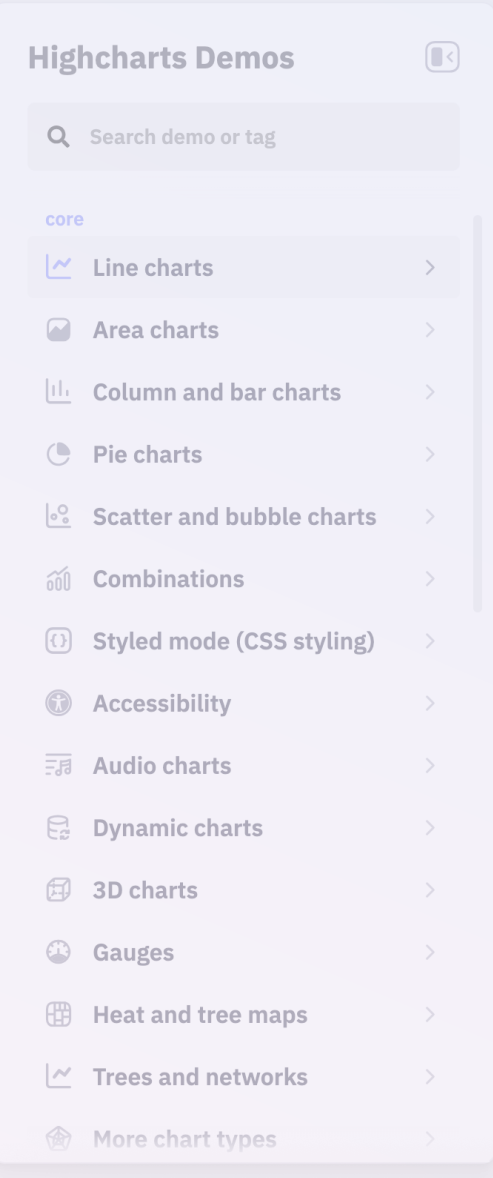
Selecting a chart

2022: not library specific (olli)



Rich navigation (a short history)

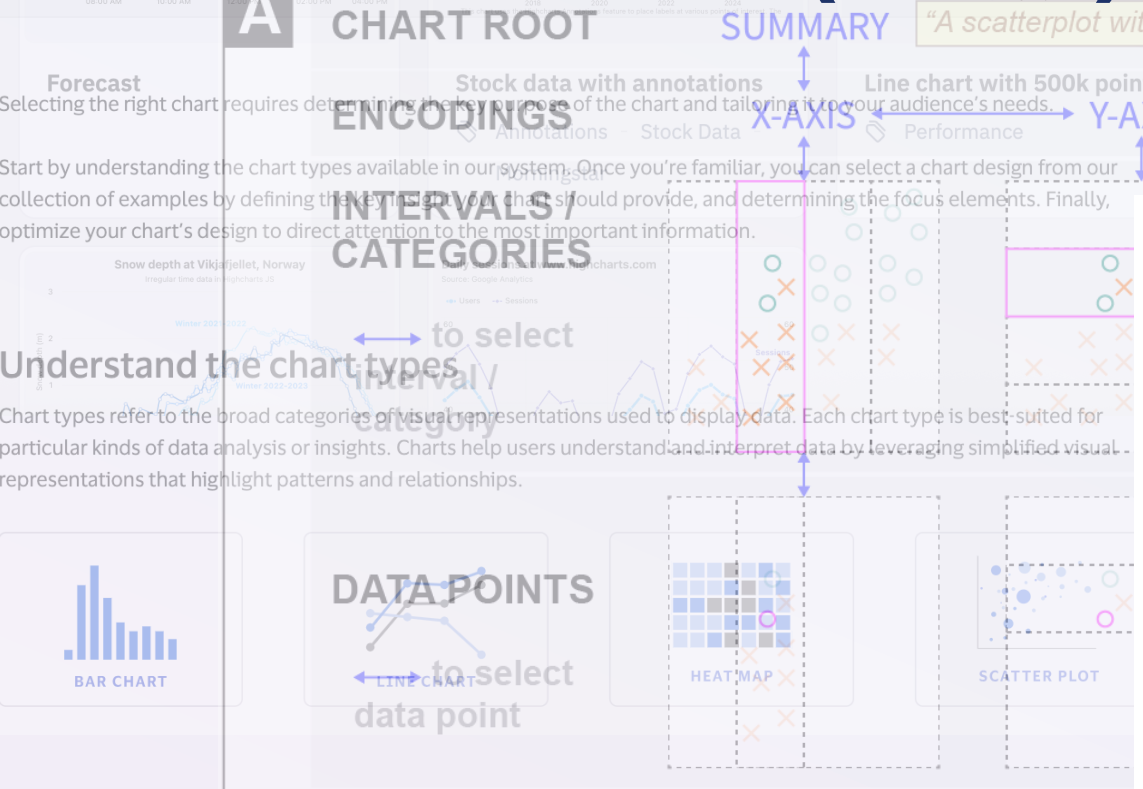
2015 (highcharts)



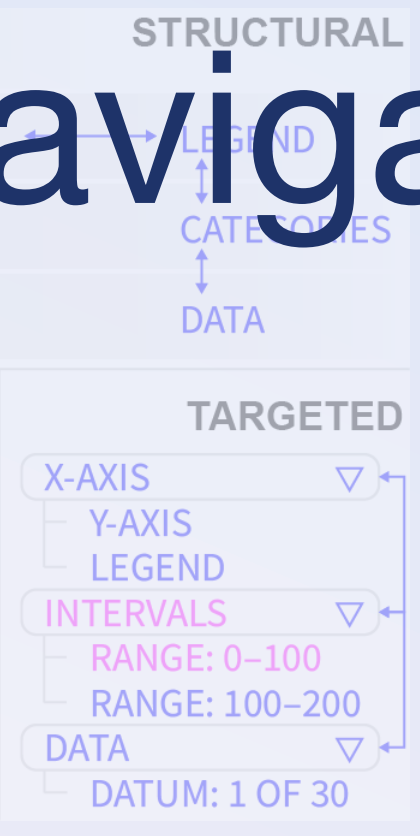
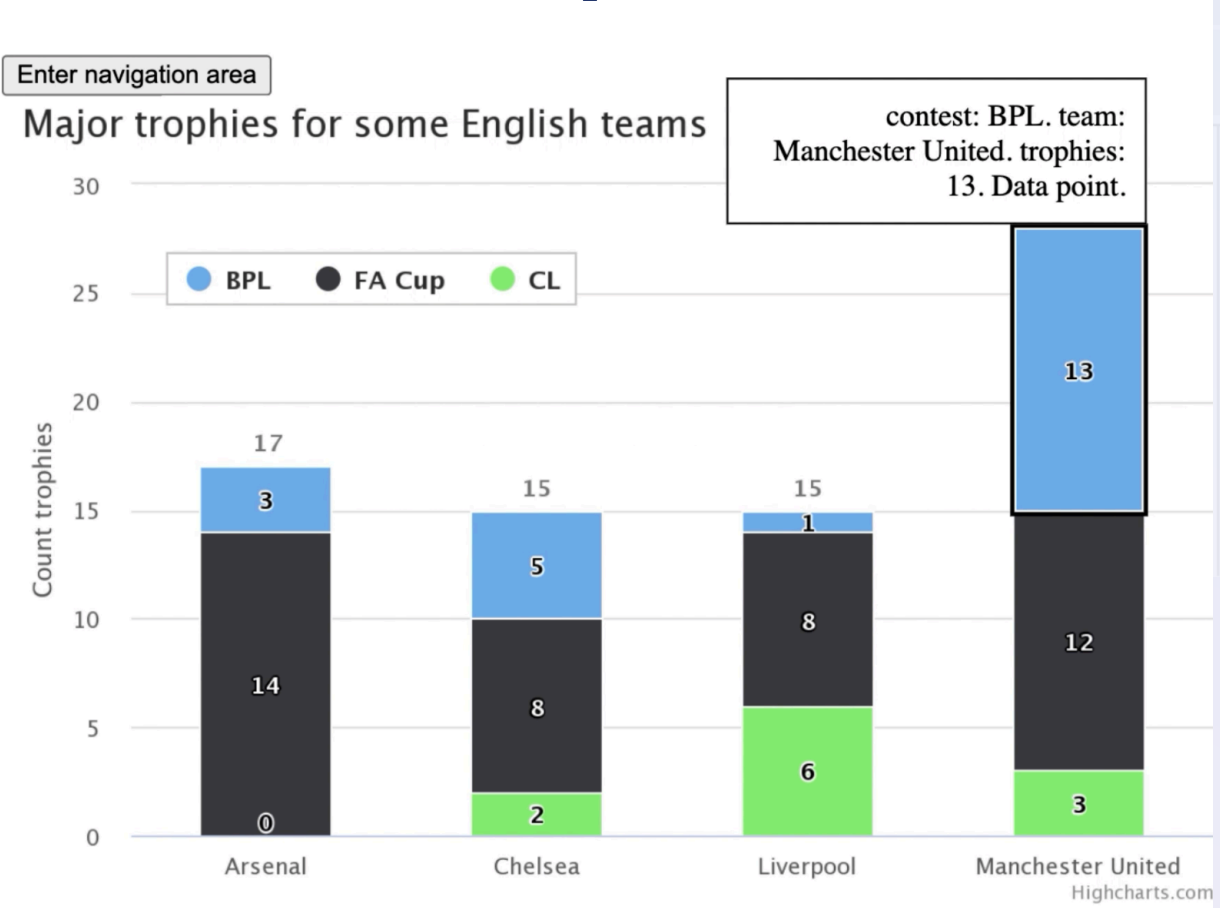
2018 (visa charts)



2022 (olli)



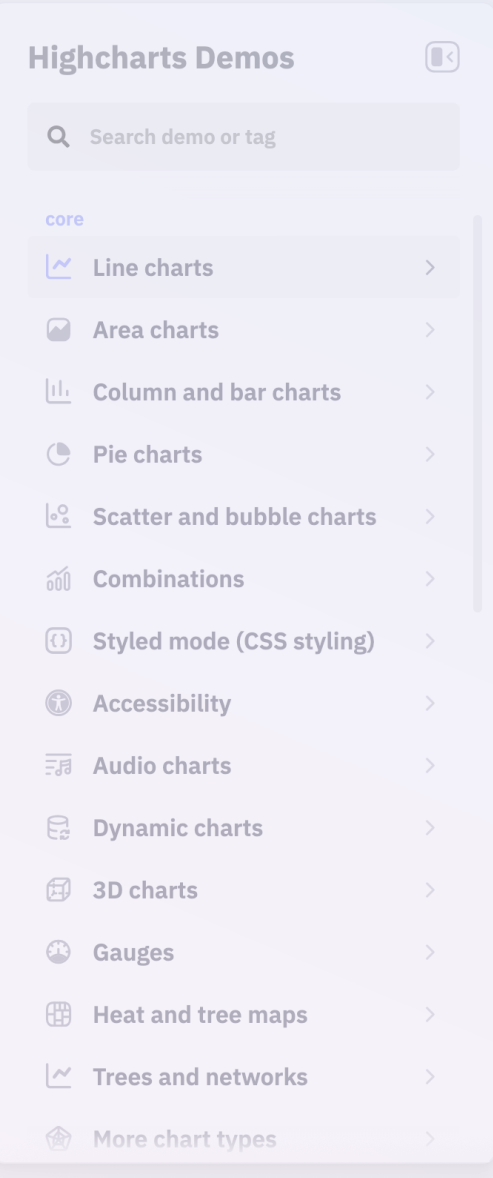
2023 (data navigator)



F. Elavsky, L. Nadolskis, and D. Moritz, “Data Navigator: An Accessibility-Centered Data Navigation Toolkit,” *IEEE Transactions on Visualization and Computer Graphics*, 2023.

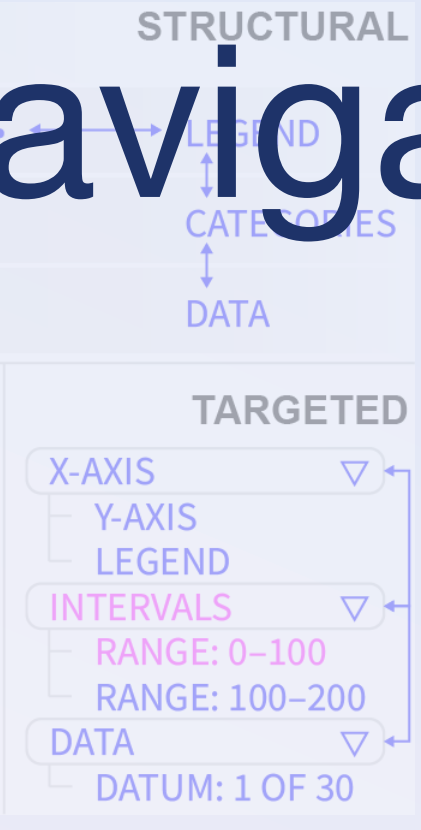
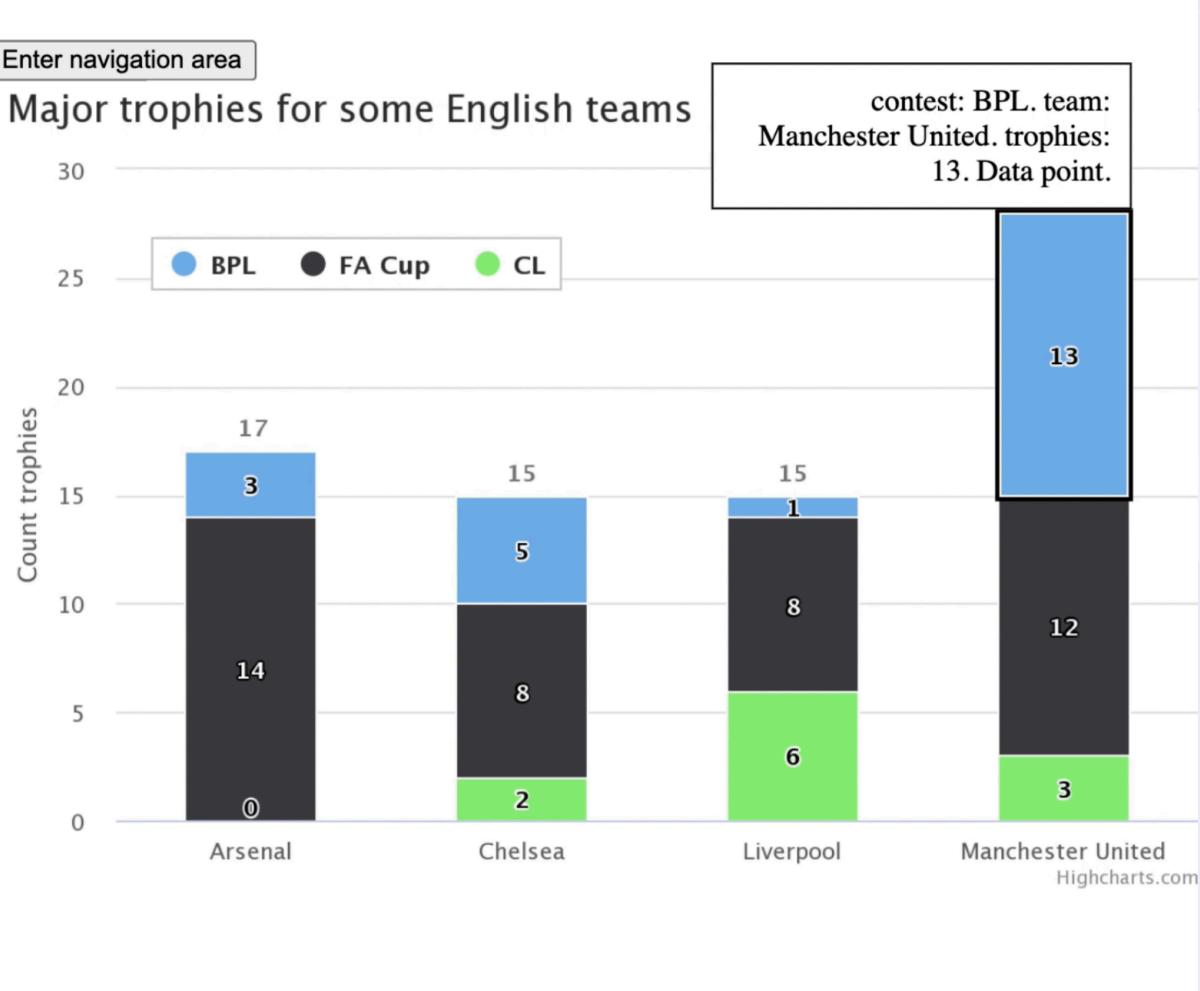
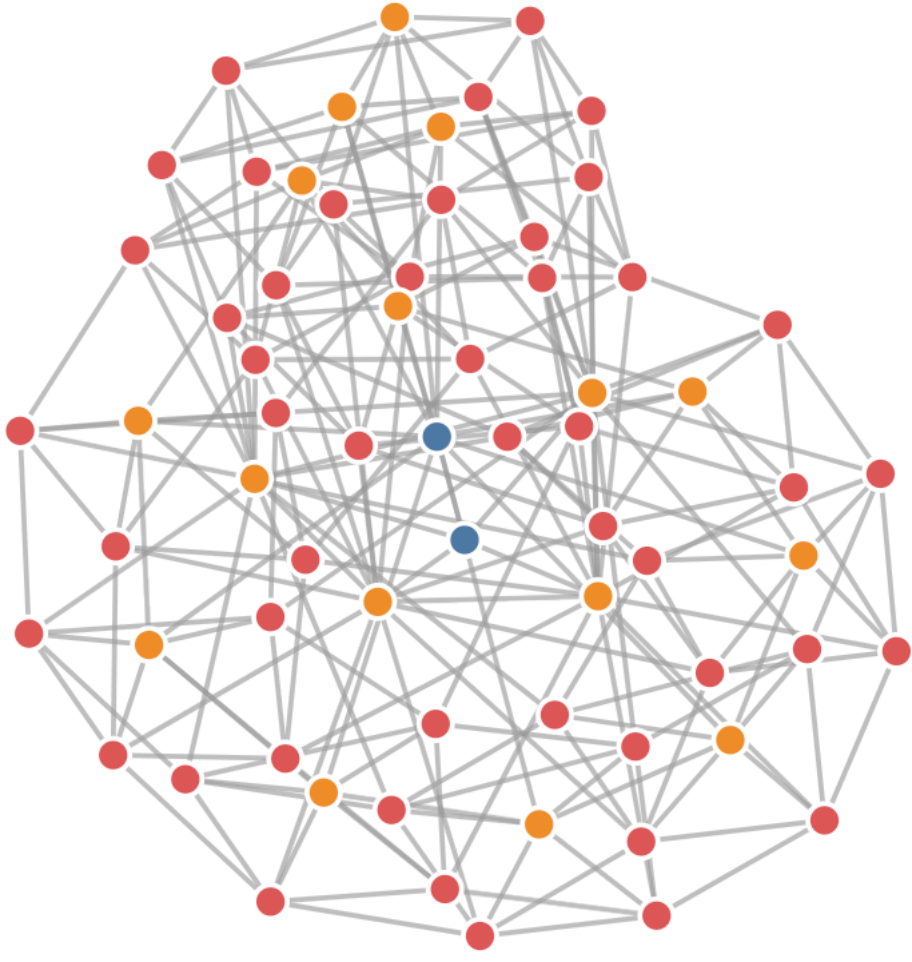
Rich navigation (a short history)

2015 (highcharts)



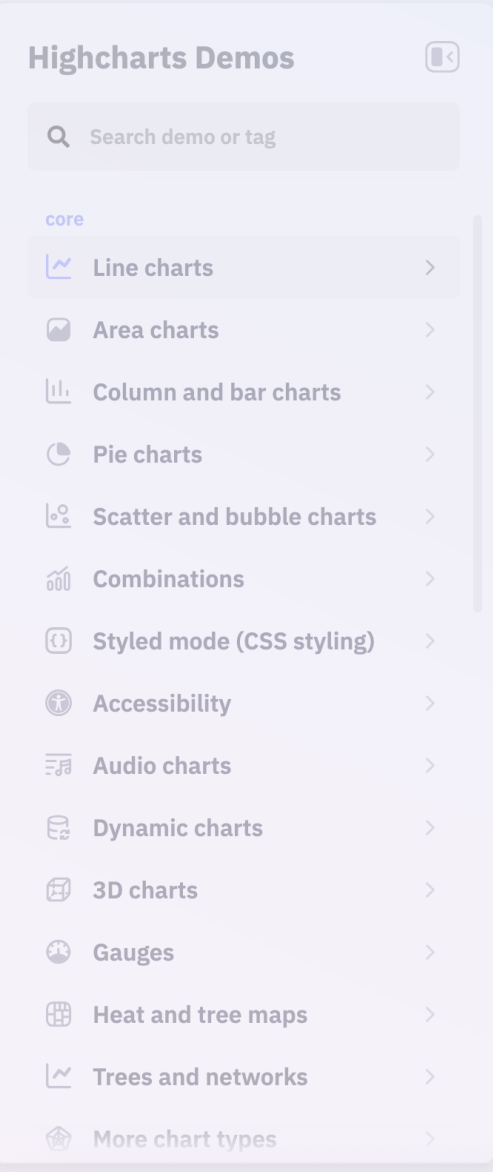
2023 (data navigator)

F. Elavsky, L. Nadolskis, and D. Moritz, “Data Navigator: An Accessibility-Centered Data Navigation Toolkit,” *IEEE Transactions on Visualization and Computer Graphics*, 2023.



Rich navigation (a short history)

2015 (highcharts)



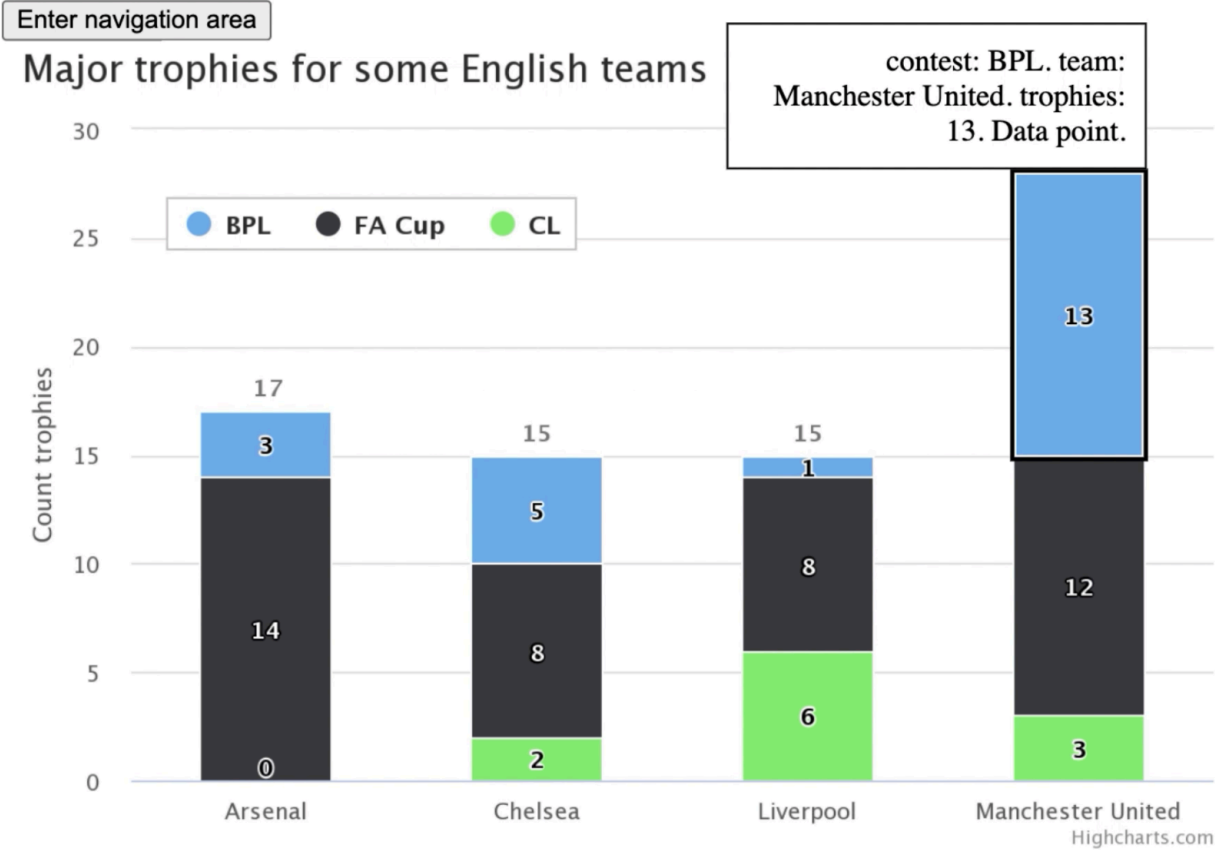
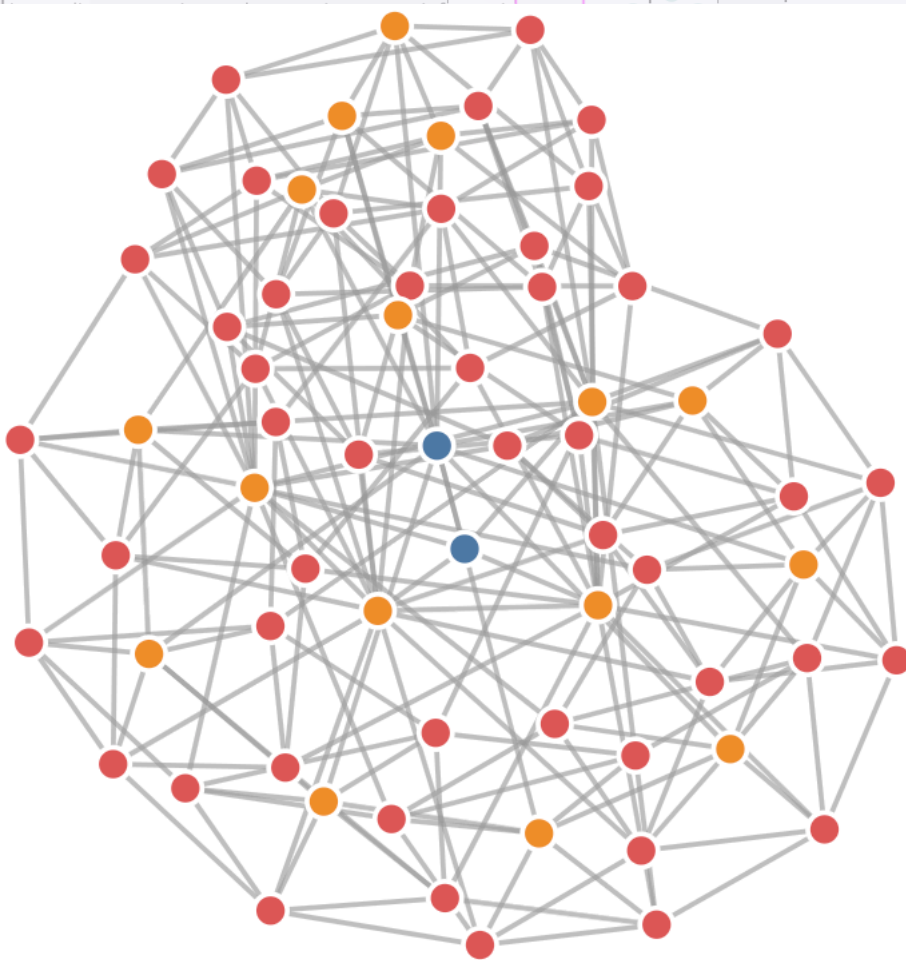
2018 (visa charts)



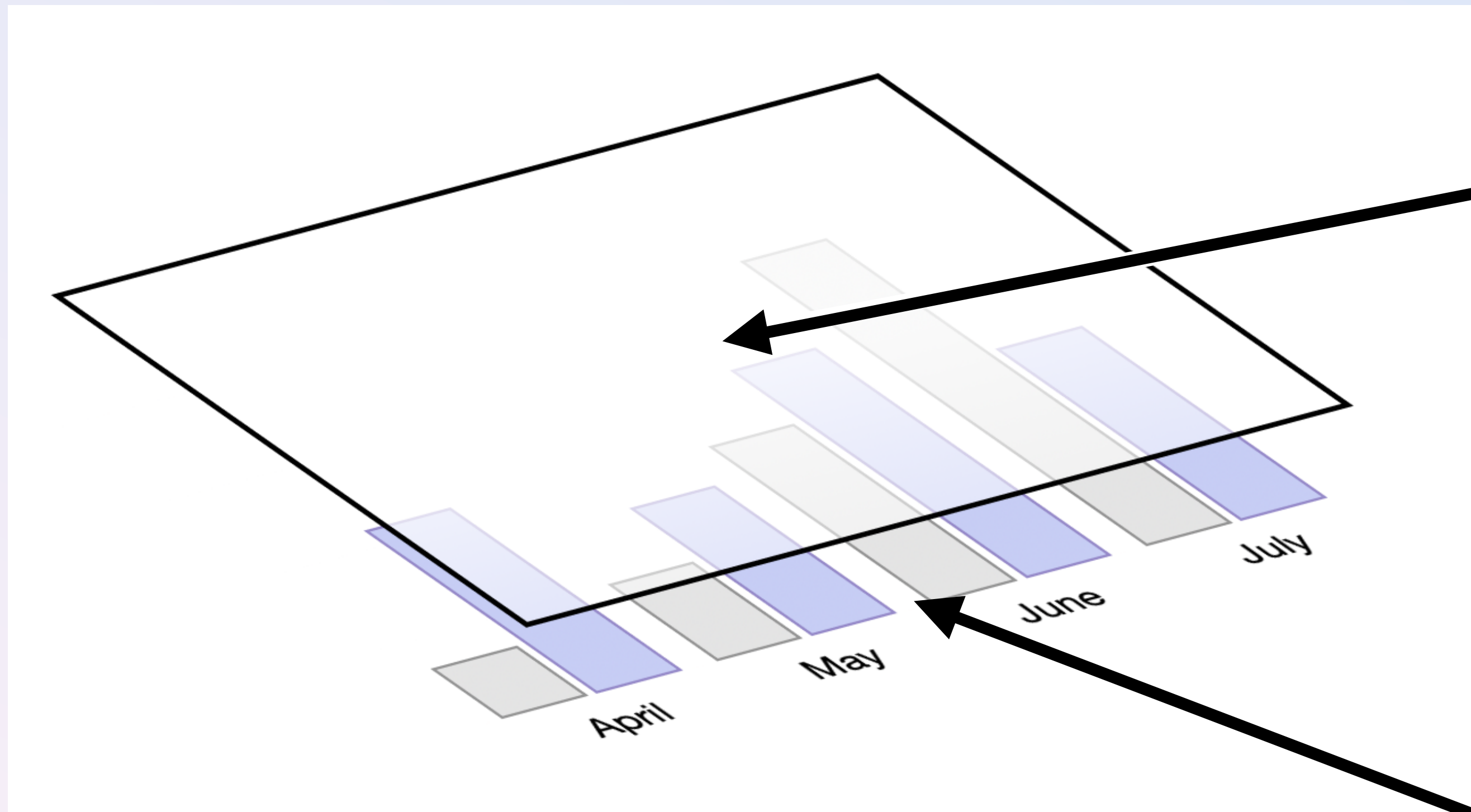
2022 (olli)

2023 (data navigator)

F. Elavsky, L. Nadolskis, and D. Moritz, “Data Navigator: An Accessibility-Centered Data Navigation Toolkit,” *IEEE Transactions on Visualization and Computer Graphics*, 2023.



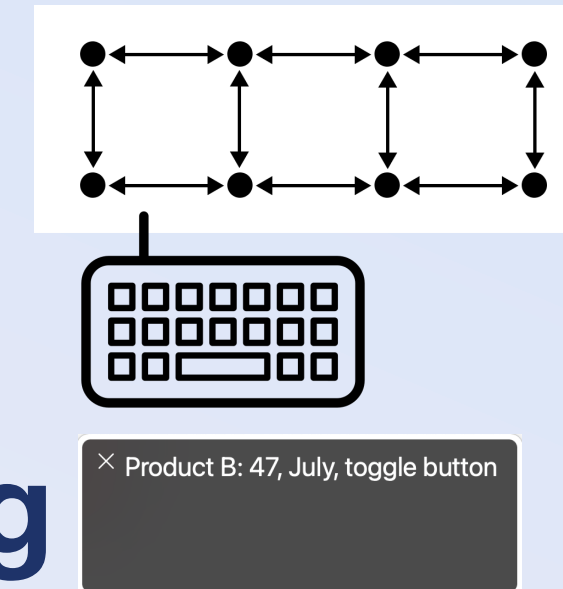
How does data navigator work?



Structure

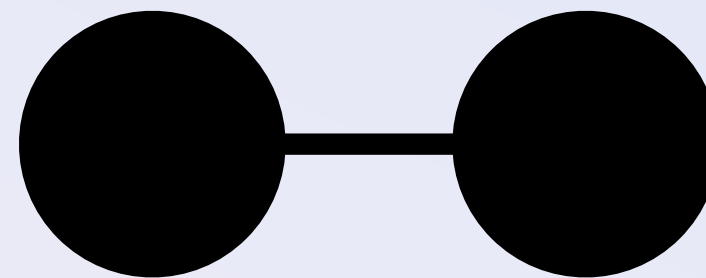
Input

Rendering



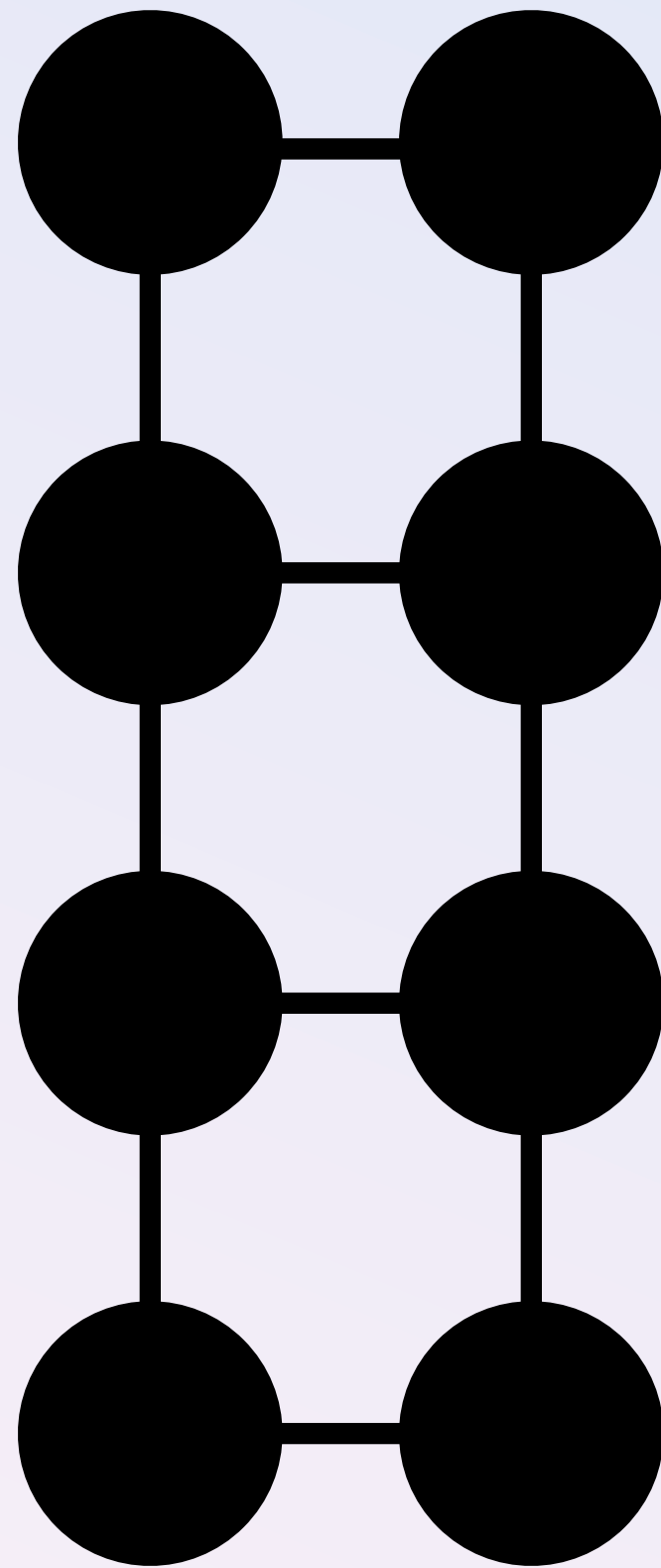
To visualization toolkits

Structure is a *graph*: nodes and edges

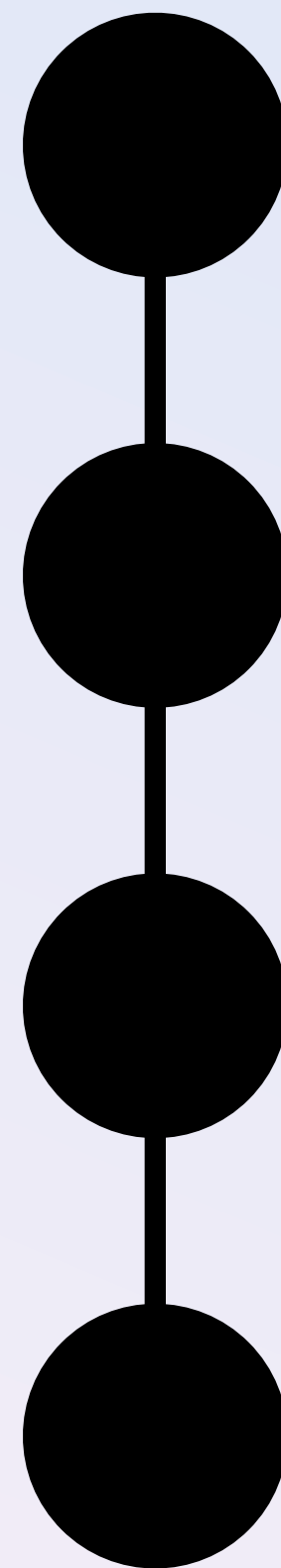


Graphs can create nearly all *other* structures

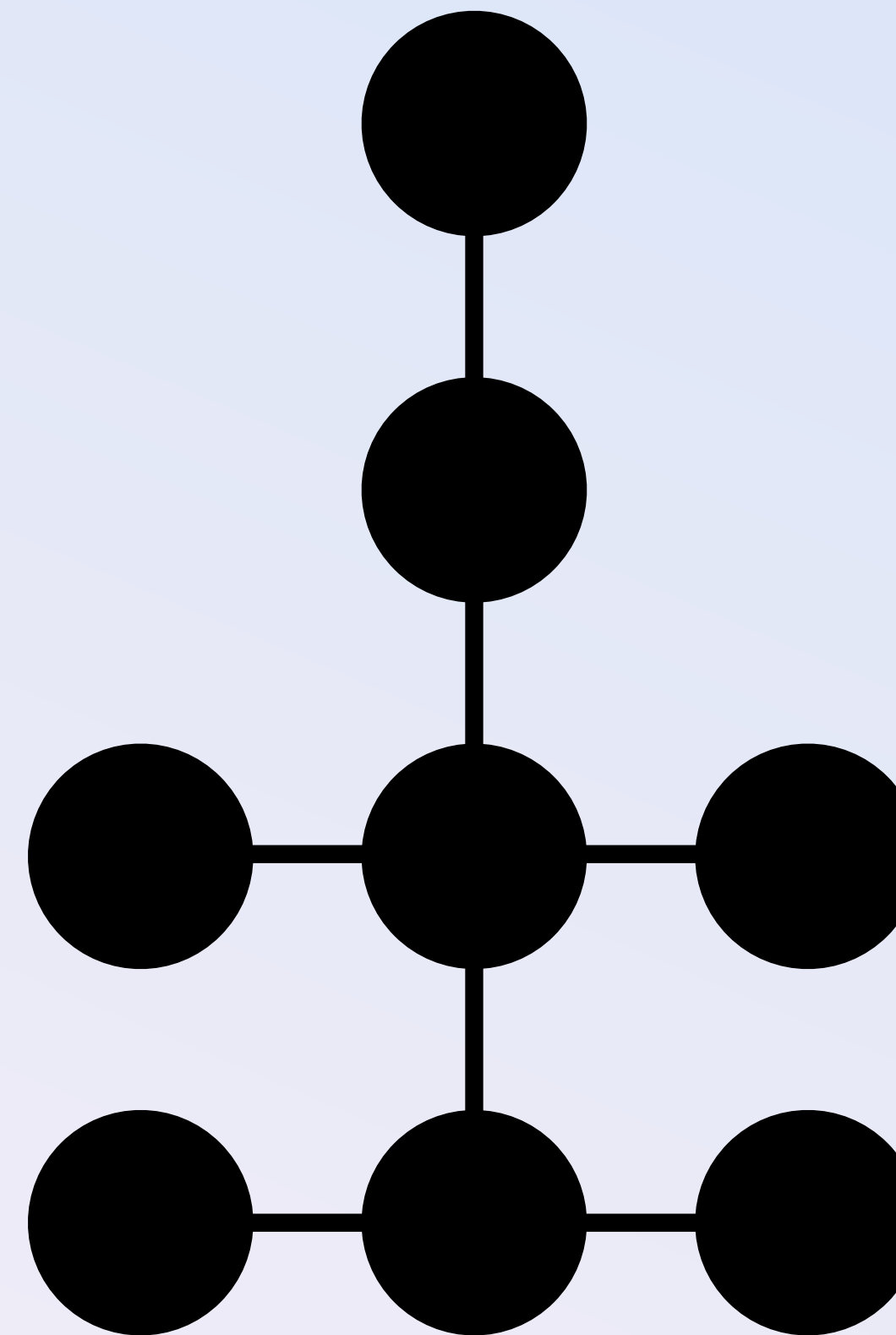
Tables



Lists

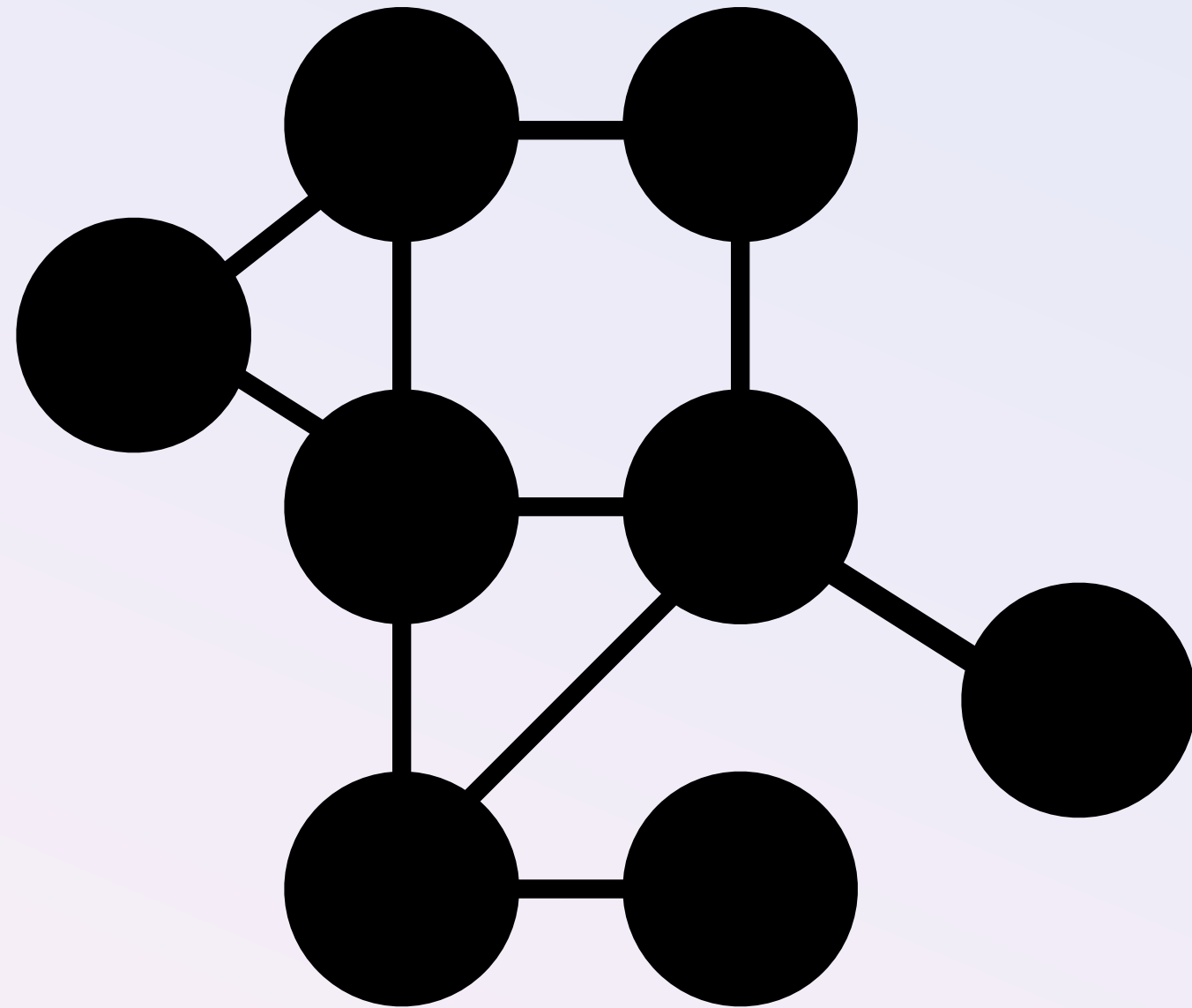


Hierarchies

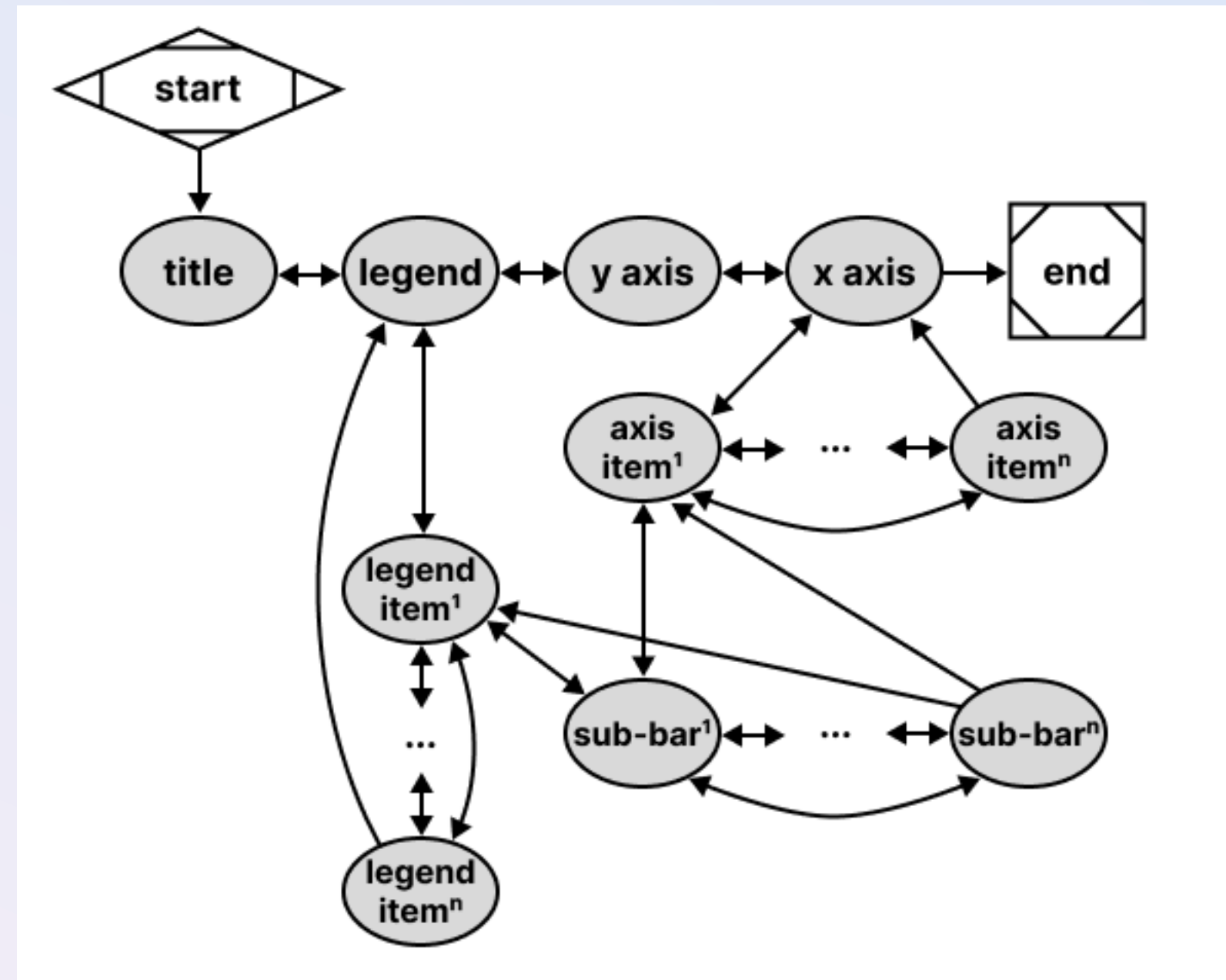


Nodes can become virtually anything

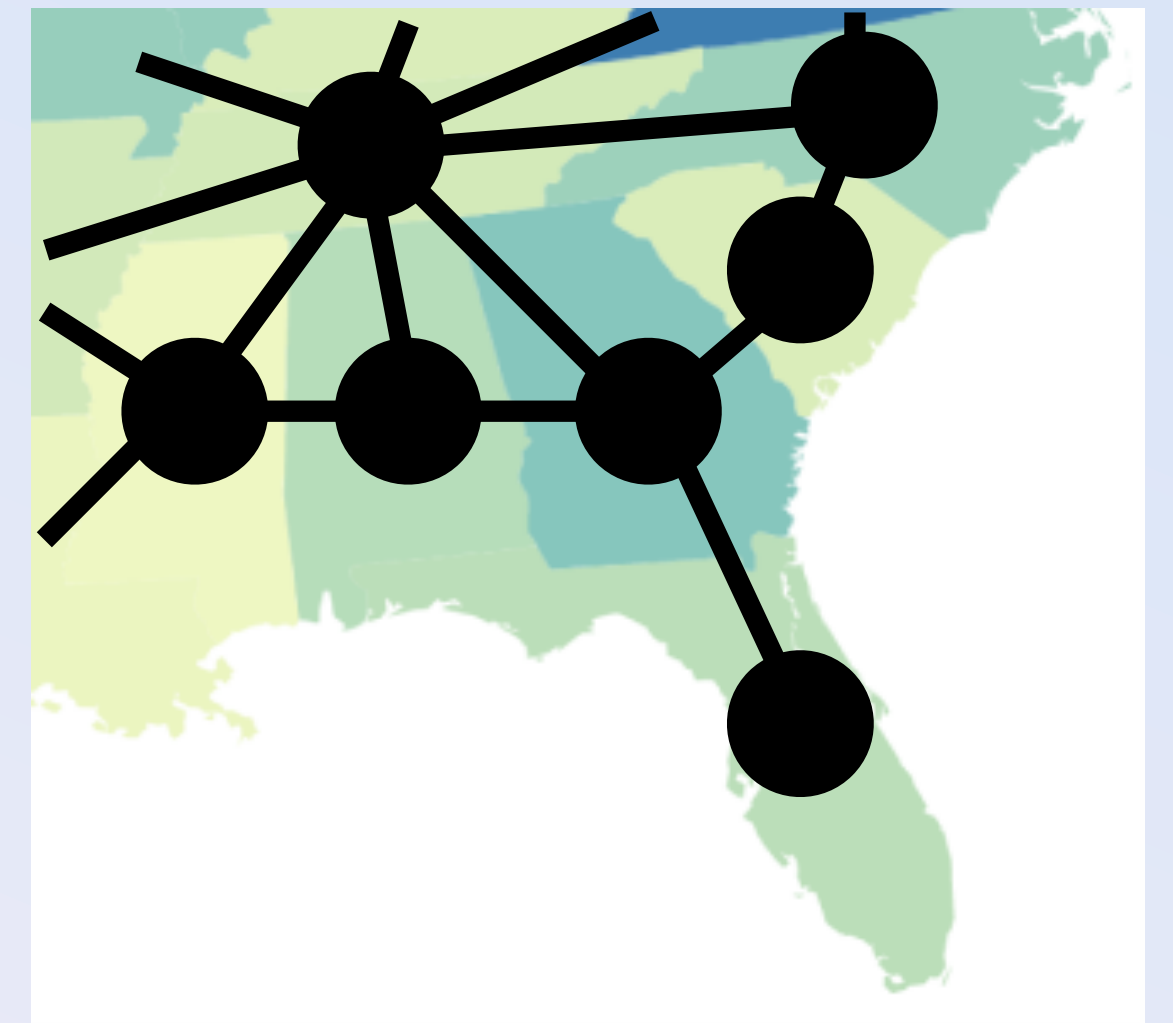
Network graphs



Diagrams



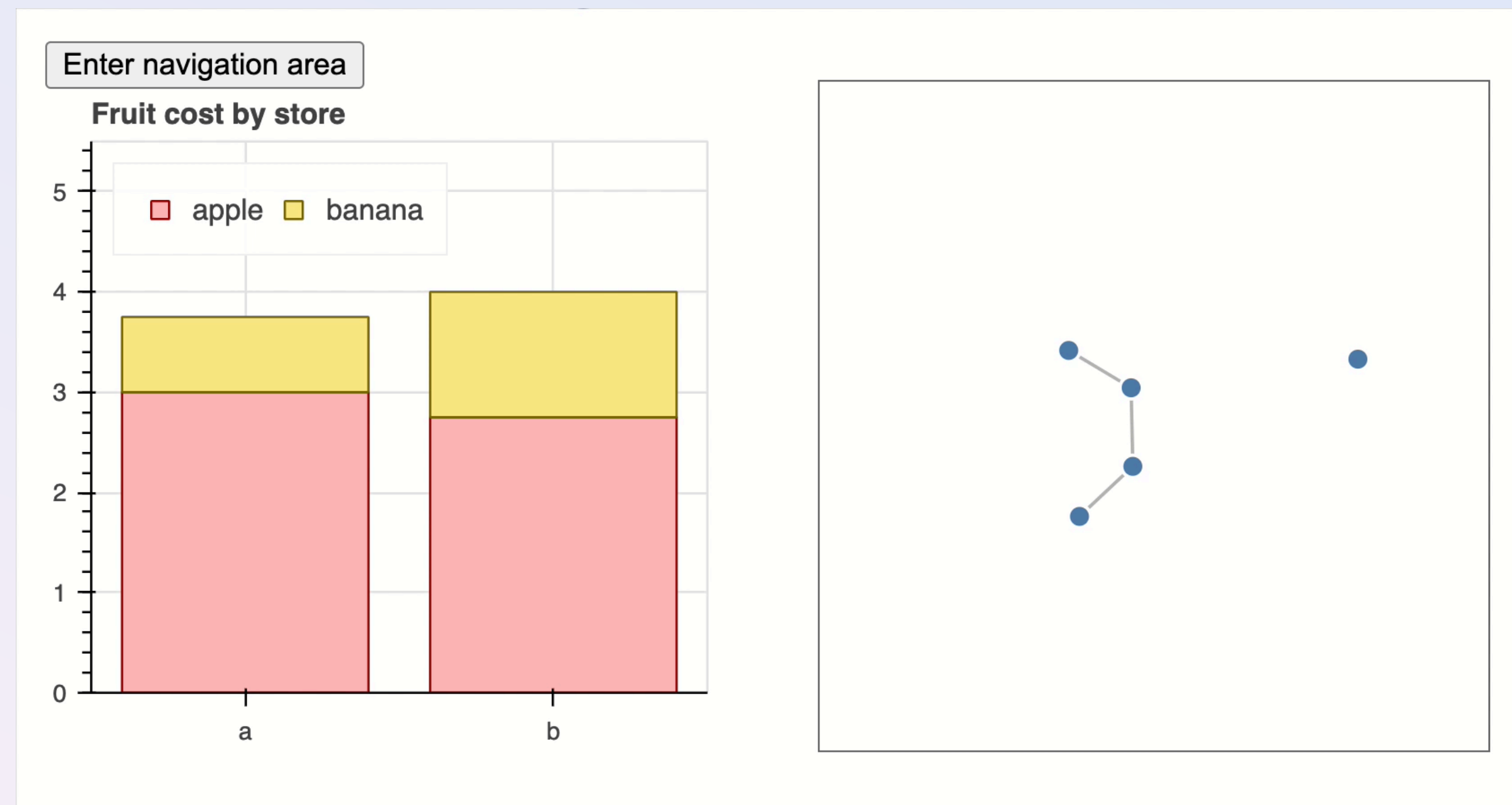
Maps



Data Navigator: Empowering practitioners

Bokeh, a python visualization library,

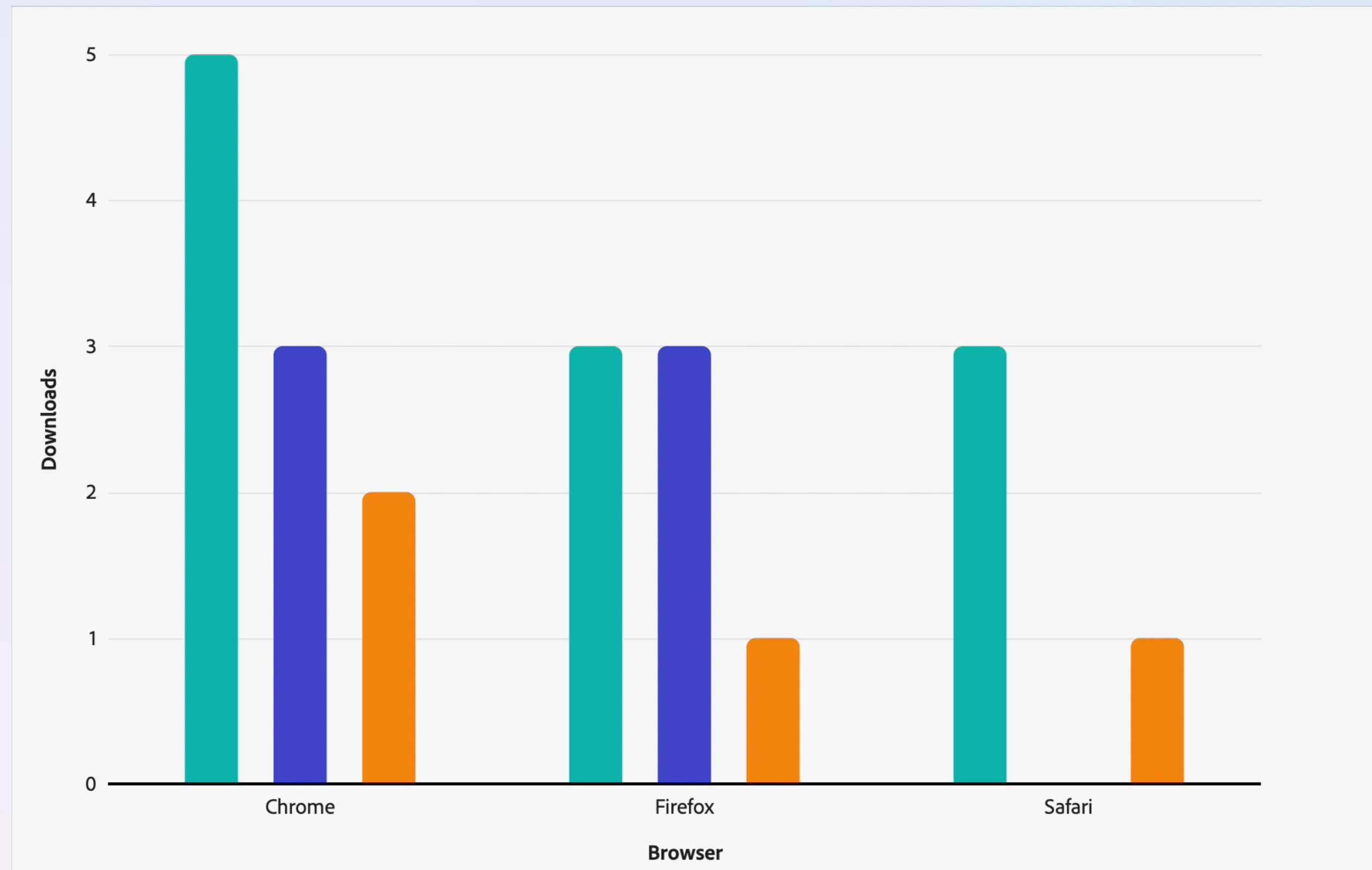
Work enabled thanks to a CZI EOSS Cycle 6 Grant



Data Navigator: Empowering practitioners

React Spectrum Charts, Adobe's visualization design system

Work enabled thanks to 2x funding from Adobe



Navigation + Animation

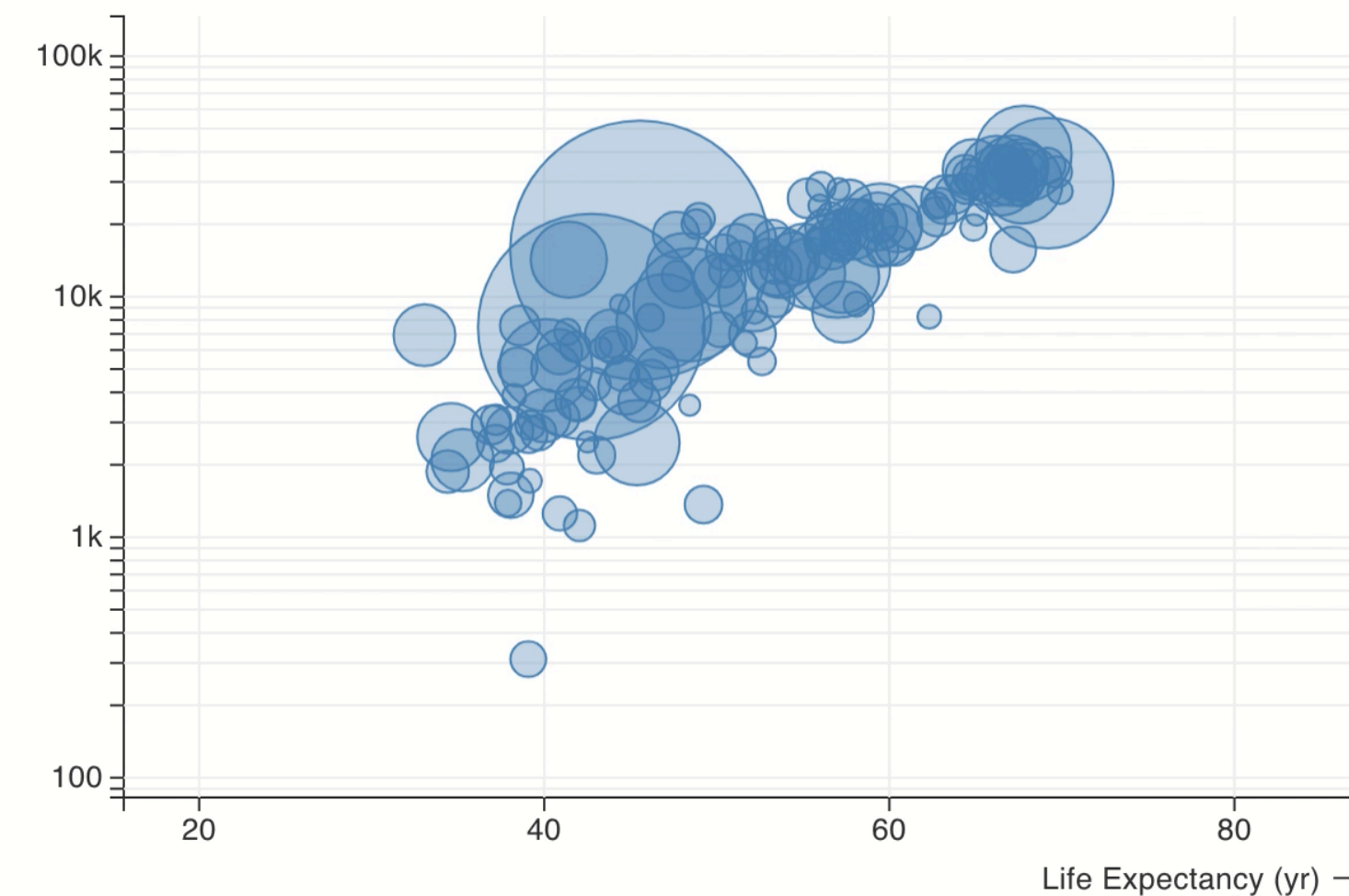


Example: Accessible Gapminder Chart

Below is a responsive, screen-reader-navigable version of the chart shown on the [homepage](#). Press Navigate to enter keyboard navigation. Or, change your “prefers reduced motion” system setting to see fade animations instead of motion.

Navigate

↑ GDP Per Capita



Year: 1992



Play/Pause

X axis:

Life Expectancy ▾

Y axis:

GDP Per Capita ▾

Radius:

Population ▾

Reset Zoom

Source: Free Data from
World Bank via
gapminder.org, CC-BY
license

V. Sivaraman, **F. Elavsky**, D. Moritz, and A. Perer. “Counterpoint: Orchestrating large- scale custom animated visualizations.” *IEEE Visualization and Visual Analytics*, 2024.

Section 3:

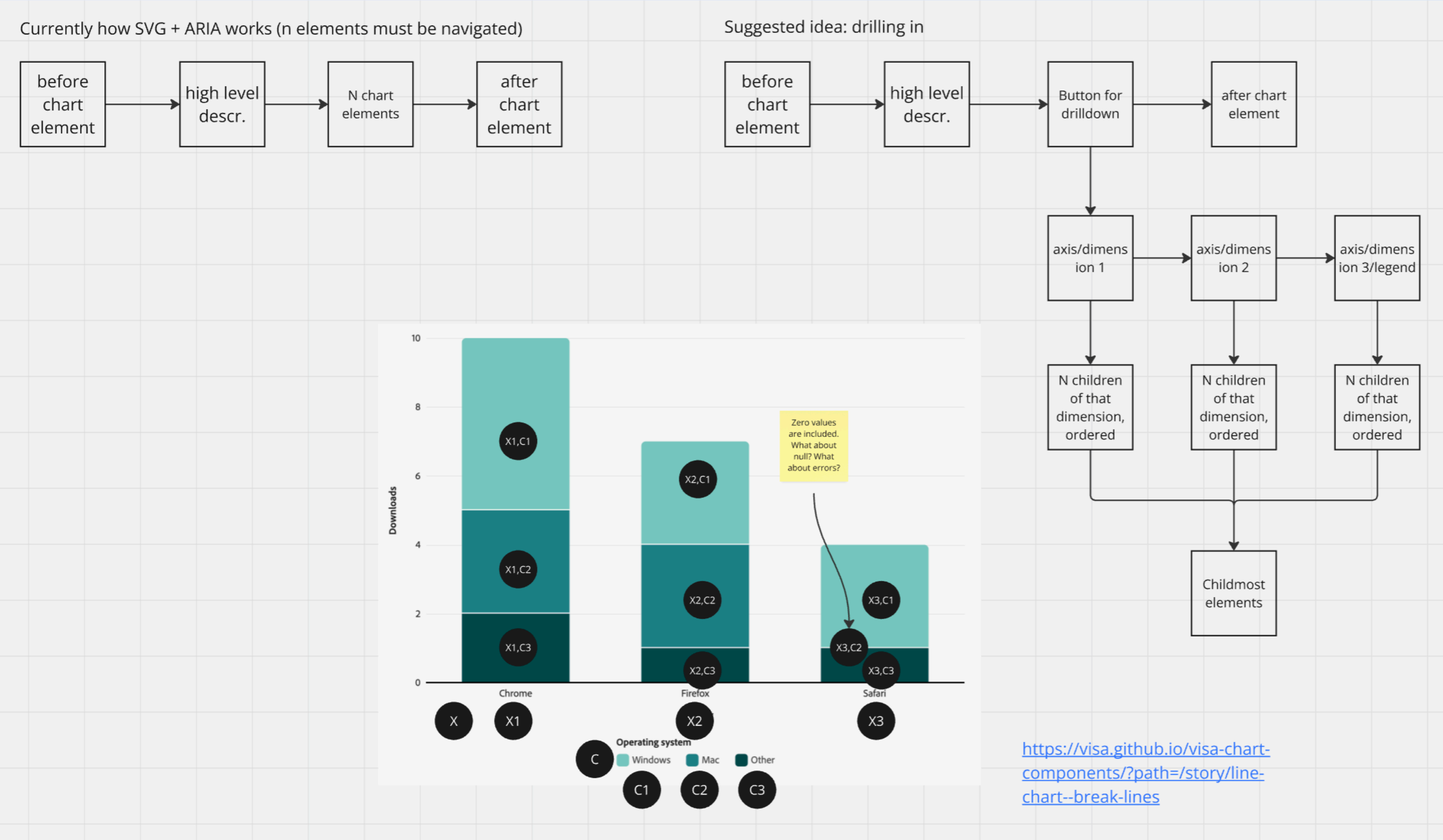
Current work

Skeleton: a graphical user interface that visualizes non-visual data experiences

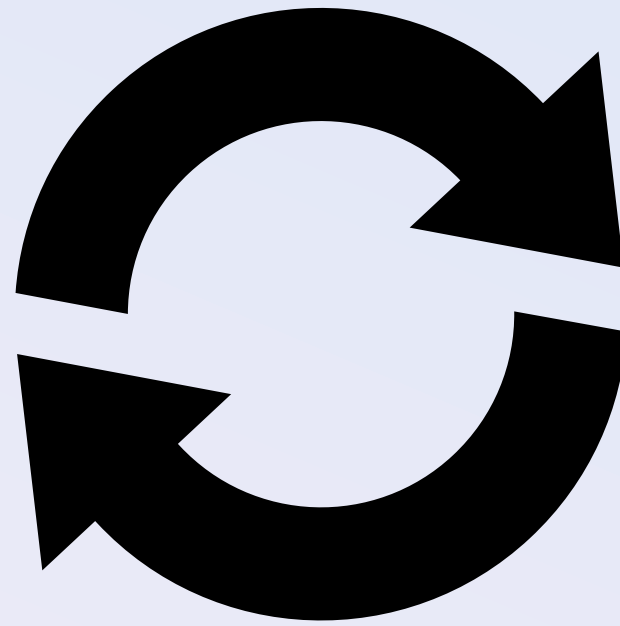
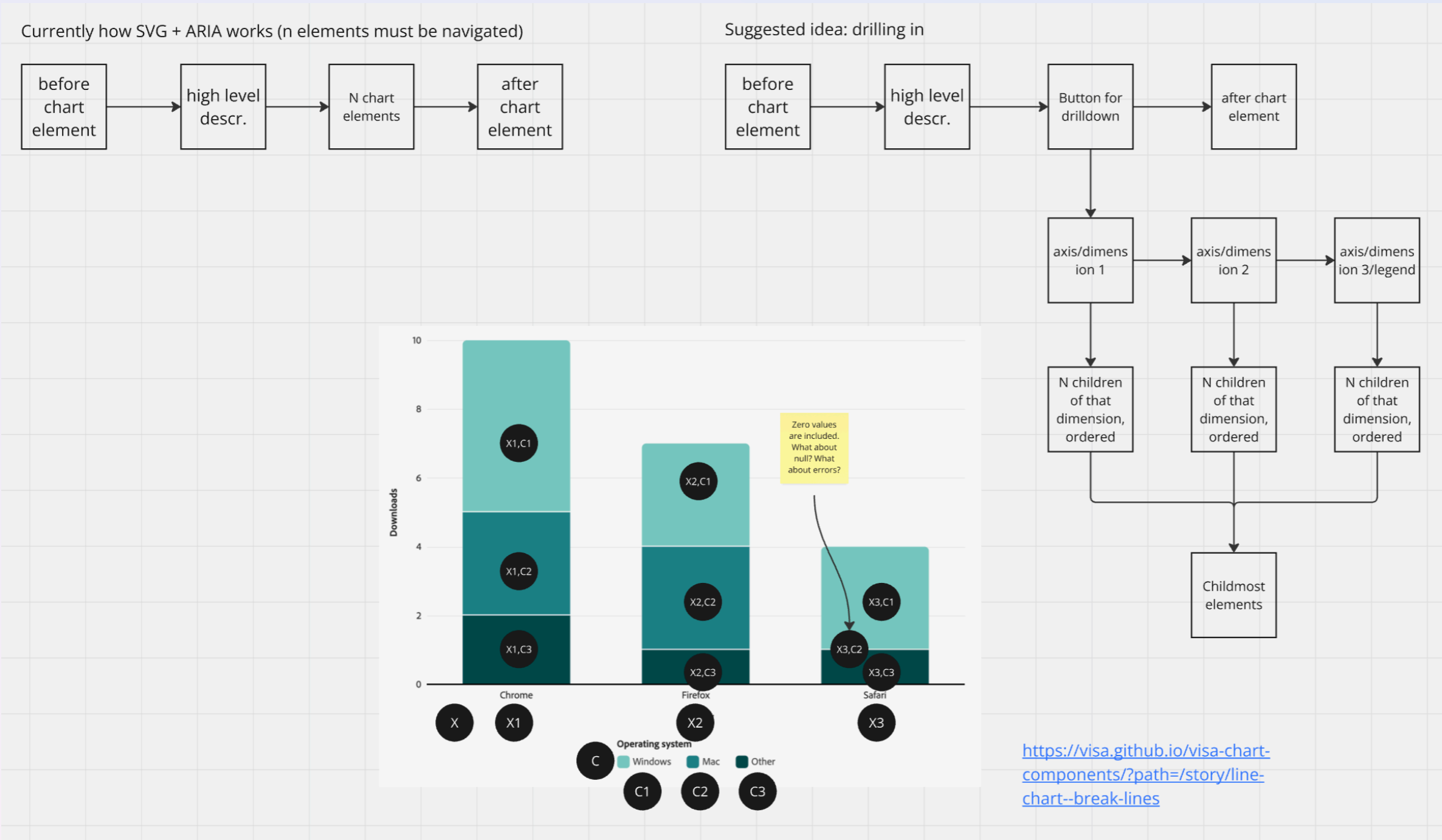
Skeleton

Conjecture: non-visual experiences are an accessibility barrier for *sighted* people

Designing navigation schema is hard

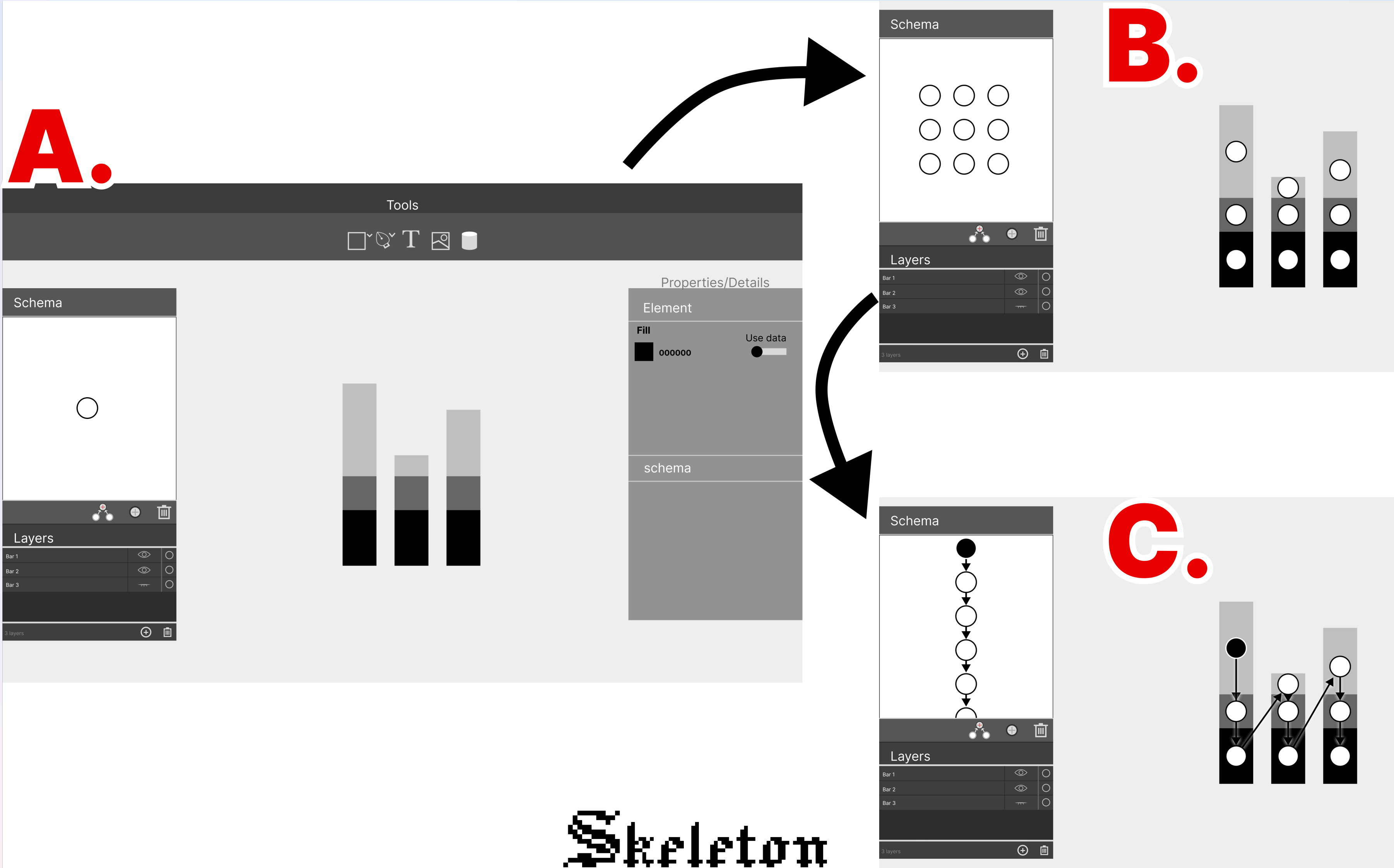


Design and dev iteration becomes error-prone and slow

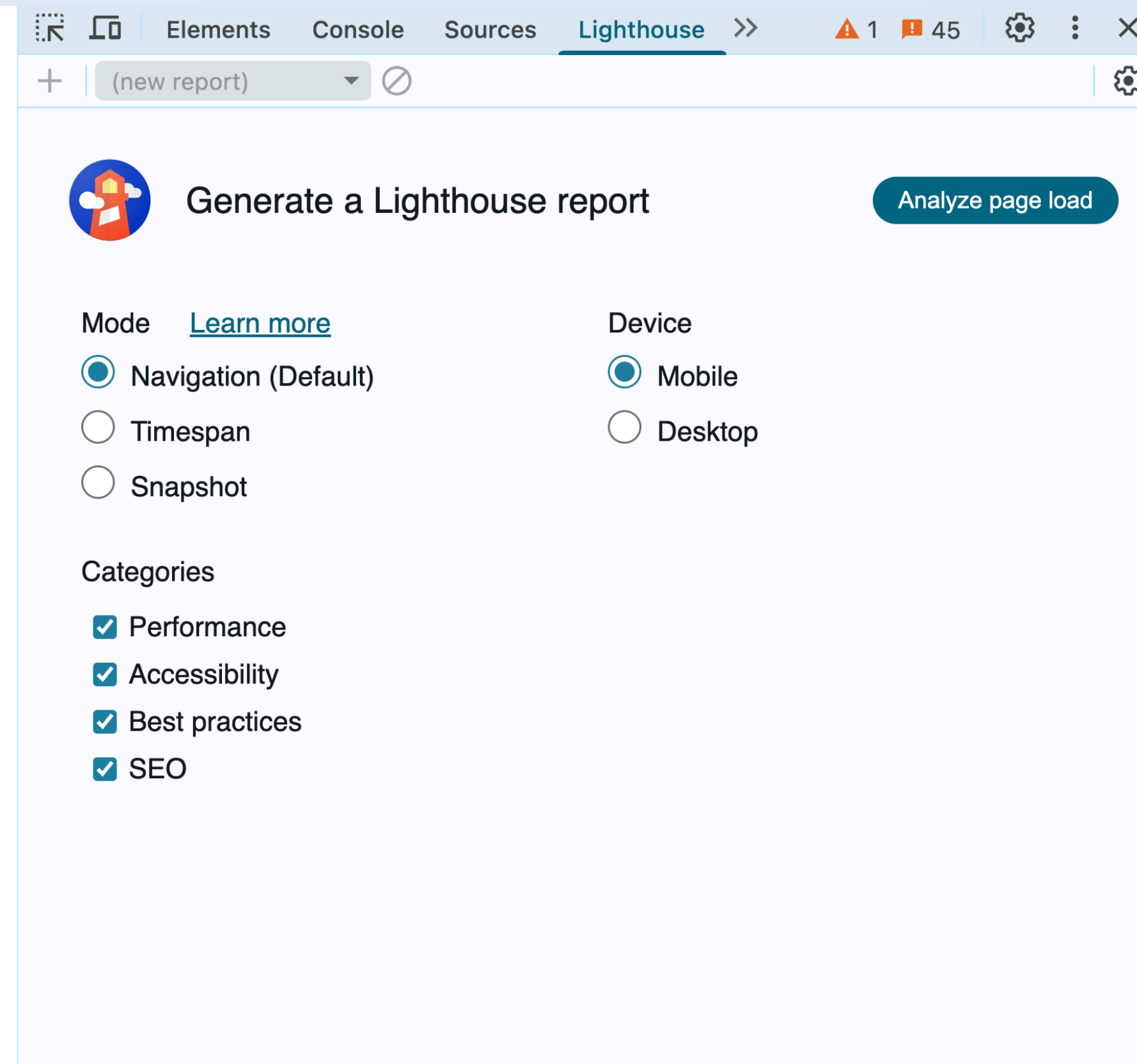
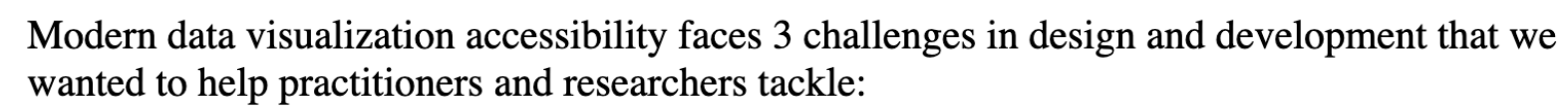


```
274 let simpleStructure = dataNavigator.structure({
275   data: simpleDataTest,
276   idKey: 'id',
277   dimensions: {
278     values: [
279       {
280         dimensionKey: 'cat',
281         type: 'categorical',
282         behavior: {
283           extents: 'circular'
284         }
285       },
286       {
287         dimensionKey: 'num',
288         type: 'numerical',
289         behavior: {
290           extents: 'terminal'
291         }
292       }
293     ],
294   },
295   genericEdges: [
296     {
297       edgeId: 'any-exit',
298       edge: {
299         source: (_d, c) => c,
300         target: () => {
301           exit['simple']();
302           return '';
303         },
304         navigationRules: ['exit']
305       }
306     ]
307   ]
308 });
```


We plan to make an interface for authoring and debugging

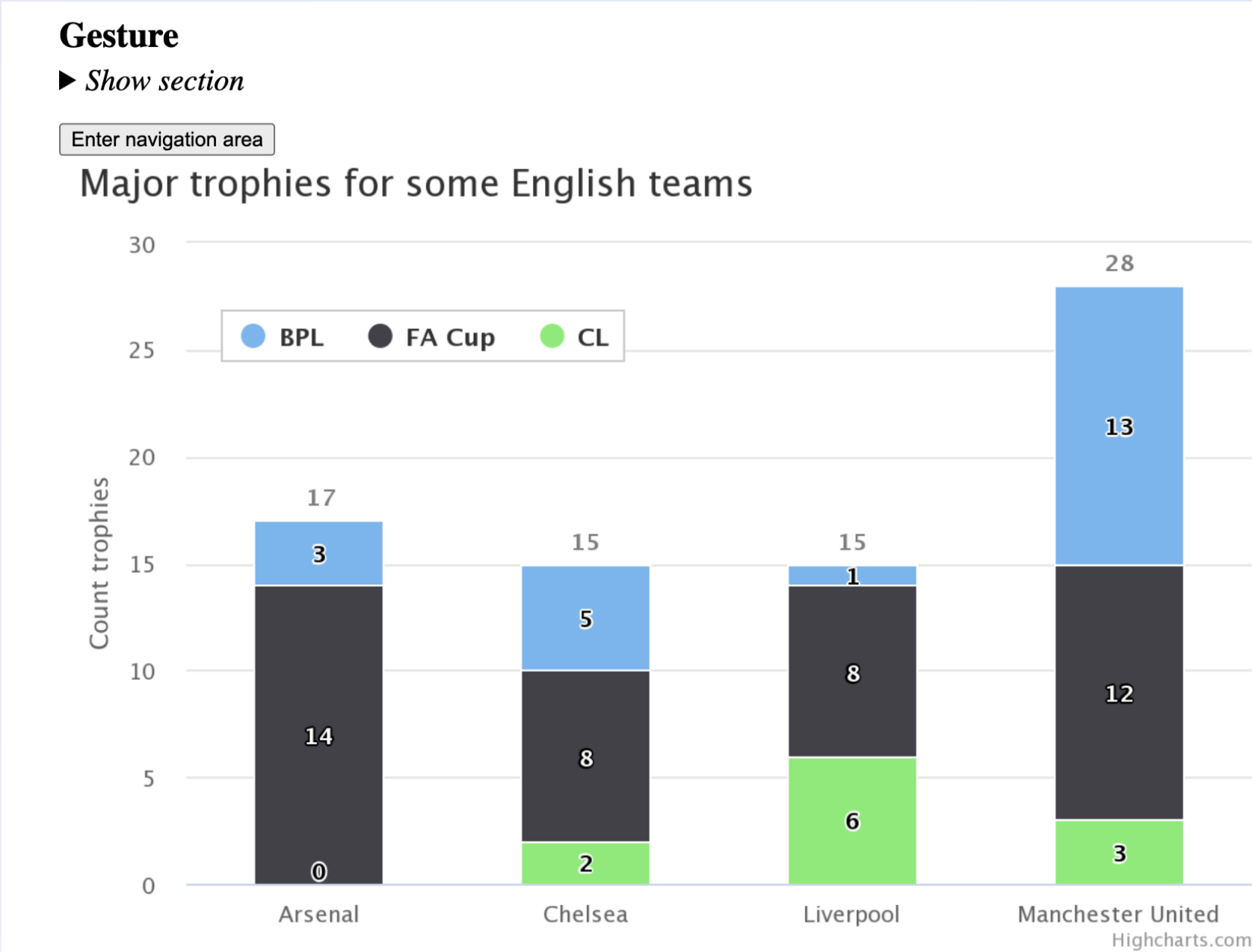


Web development accessibility tooling



Skeleton

Web development accessibility tooling



Why make Data Navigator?

Modern data visualization accessibility faces 3 challenges in design and development that we wanted to help practitioners and researchers tackle:

1. Navigable structure is hard to build for data visualizations. Structure is important for understanding and usability but is often ignored.

Elements Console Sources **Lighthouse** >> 1 40

11:50:31 AM - dig.cmu.edu

http://dig.cmu.edu/data-navigator/

75

Performance

100

Accessibility

59

Best Practices

100

SEO

There were issues affecting this run of Lighthouse:

- Clearing the browser cache timed out. Try auditing this page again and file a bug if the issue persists.

75

[skip to main content](#)

Data Navigator demo

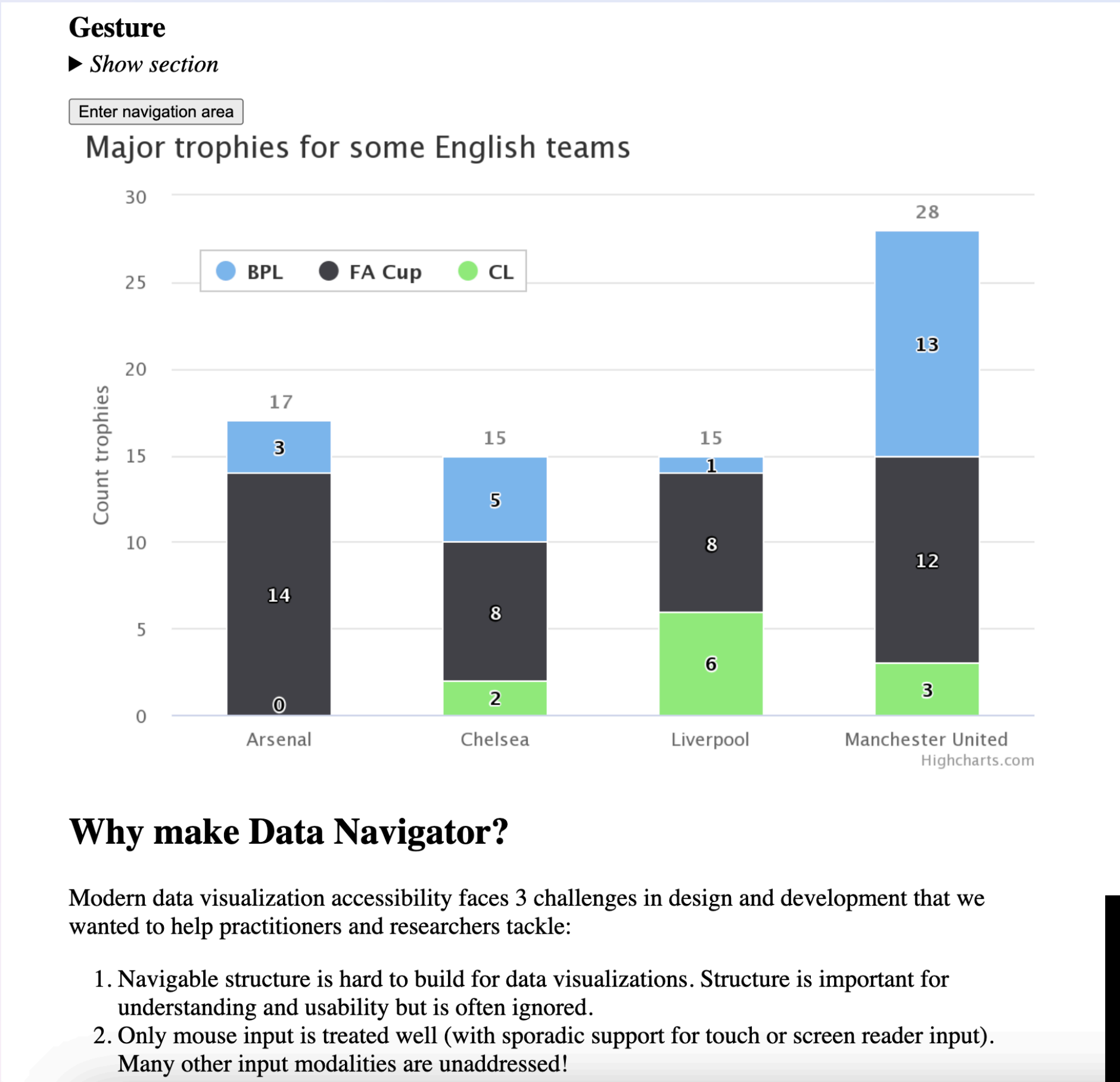
This page is a live, interactive application that demos some of the coolest capabilities of our system, Data Navigator.

What is Data

Skeleton

What if you could see AT navigation?

Currently navigation is still manually verified!



Elements Console Sources Lighthouse >> 1 40

11:50:31 AM - dig.cmu.edu

http://dig.cmu.edu/data-navigator/

75 100 59 100

100

Accessibility

These checks highlight opportunities to [improve the accessibility of your web app](#). Automatic detection can only detect a subset of issues and does not guarantee the accessibility of your web app, so [manual testing](#) is also encouraged.

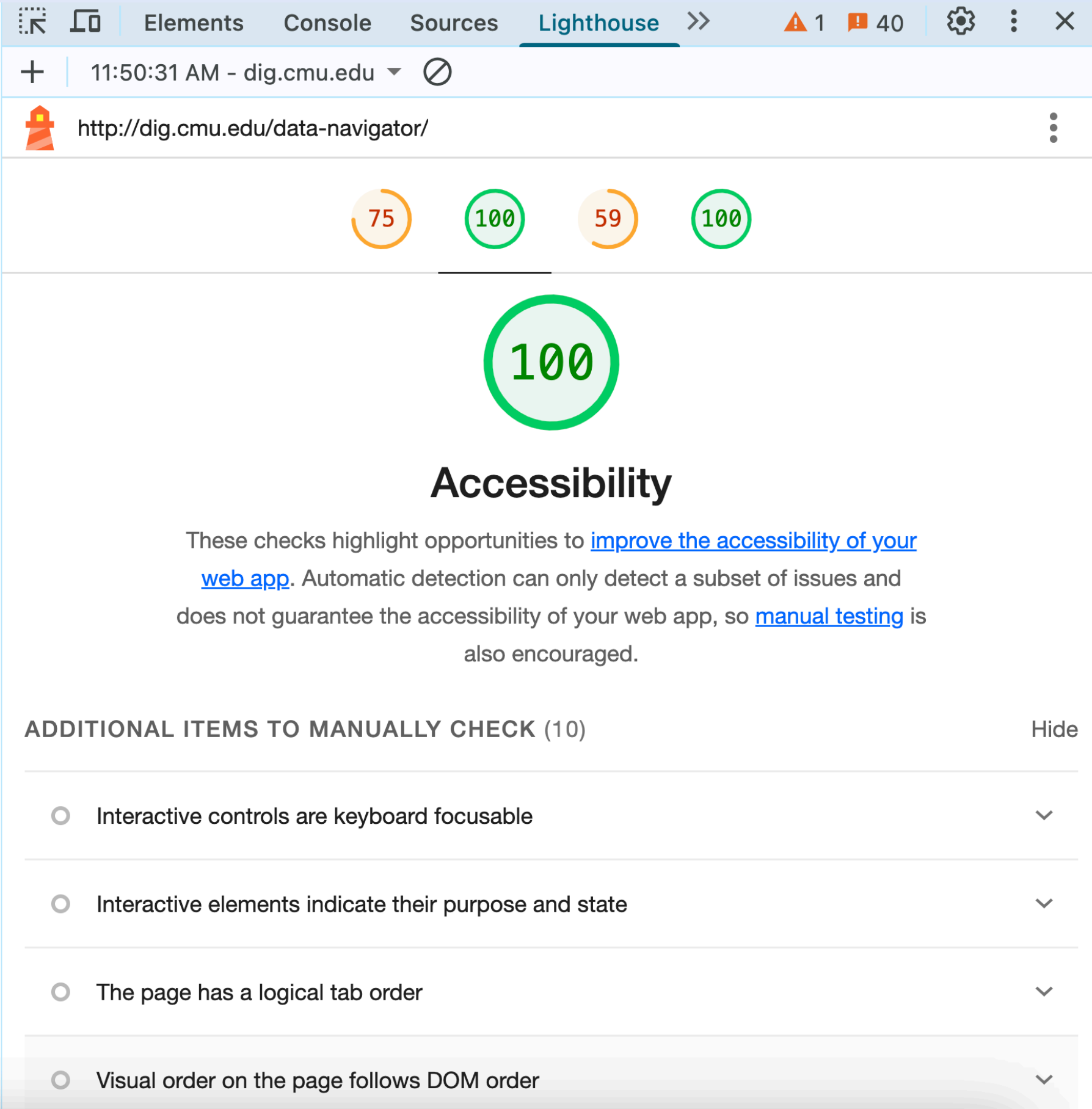
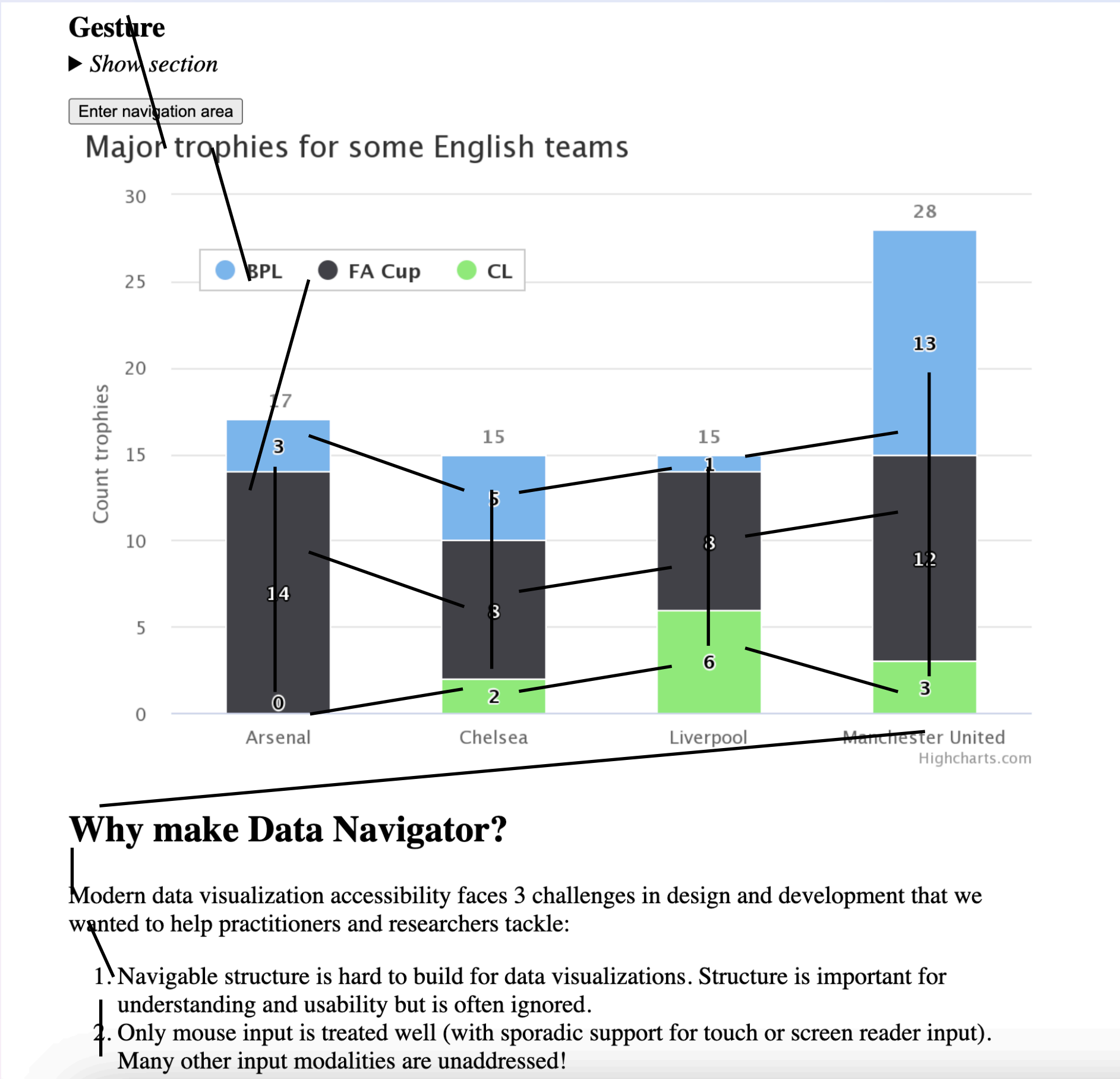
ADDITIONAL ITEMS TO MANUALLY CHECK (10) Hide

- ☐ Interactive controls are keyboard focusable
- ☐ Interactive elements indicate their purpose and state
- ☐ The page has a logical tab order
- ☐ Visual order on the page follows DOM order

Skeleton

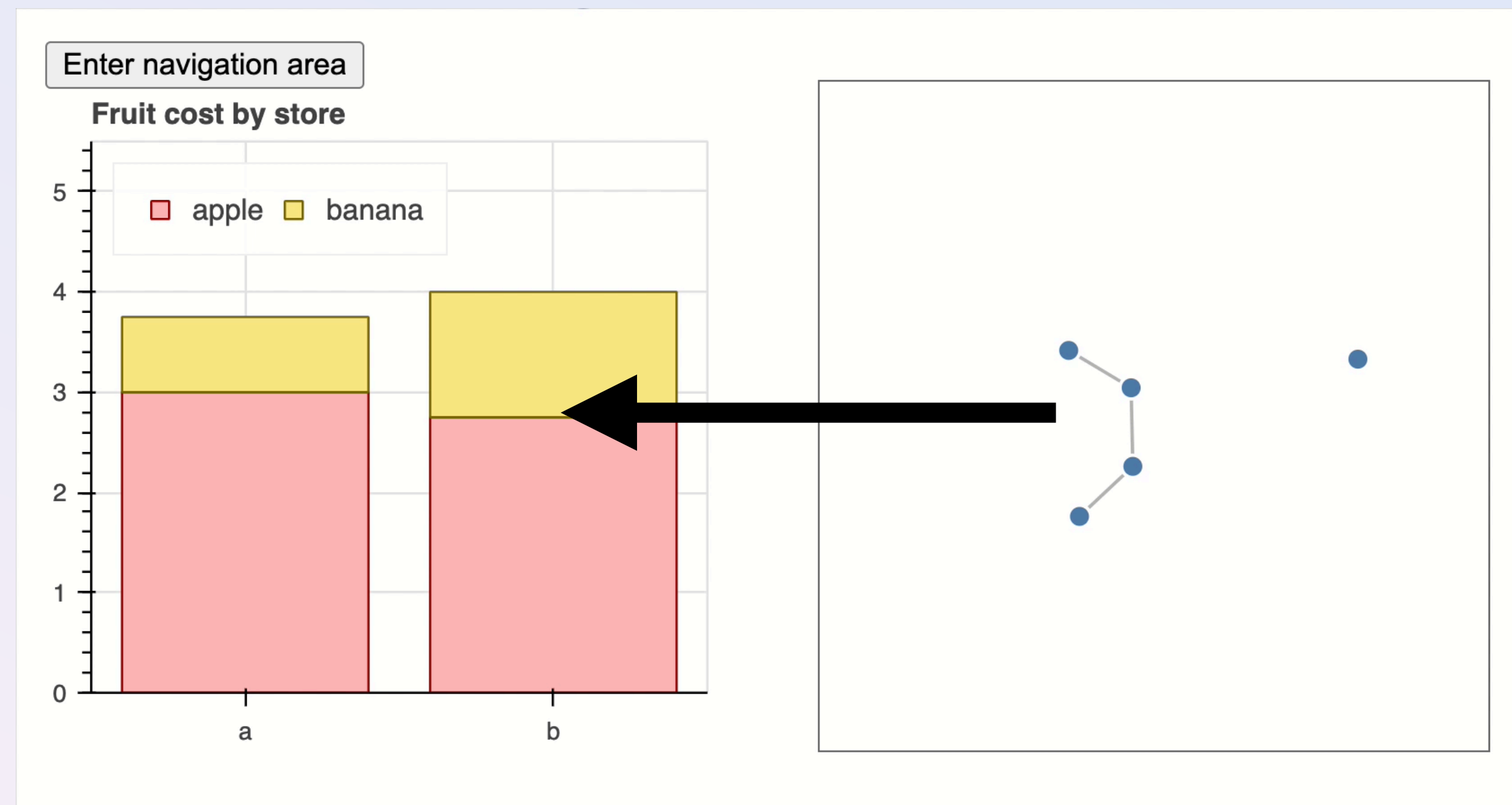
What if you could see AT navigation?

Currently navigation is still manually verified!

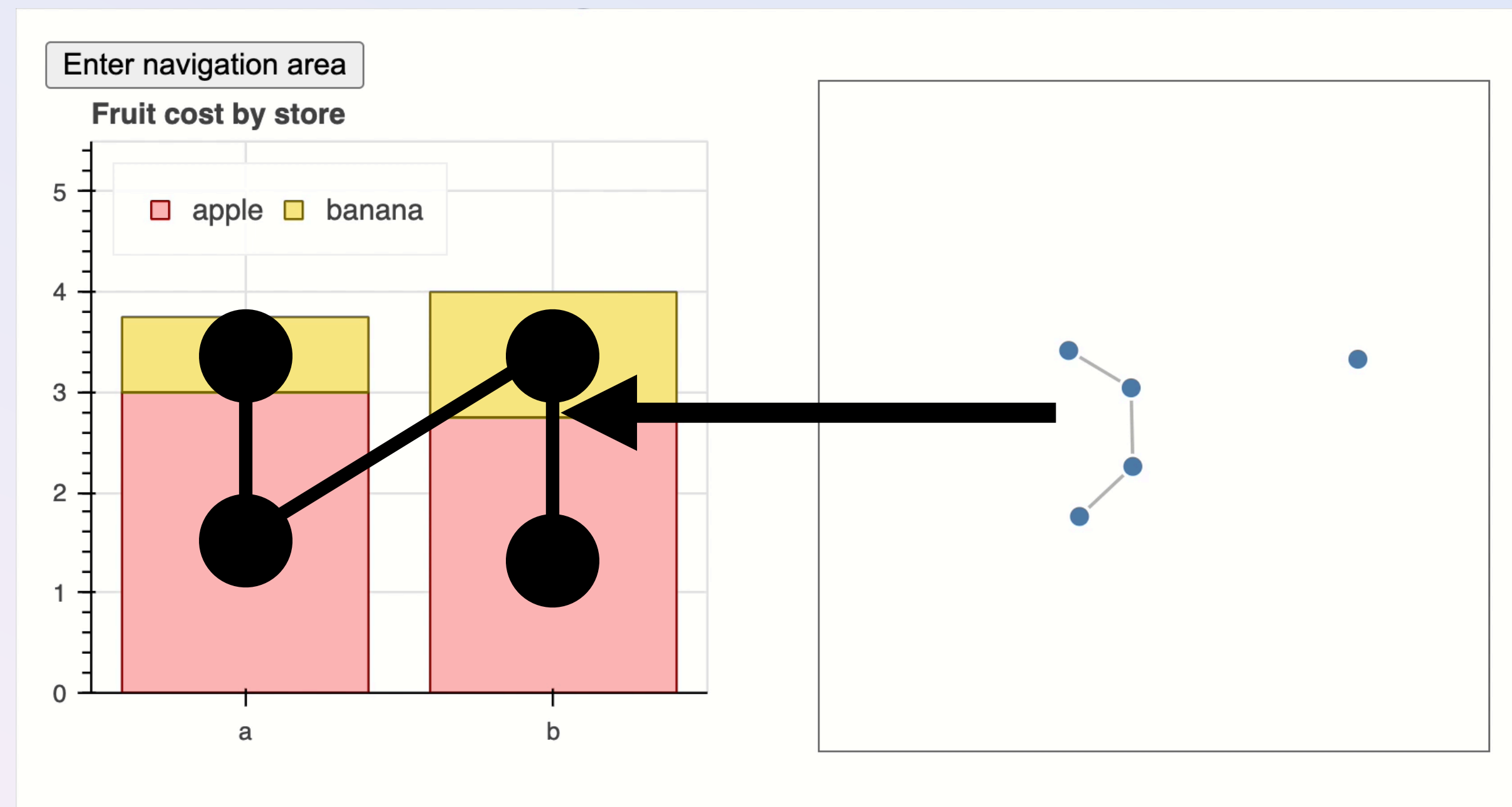


Skeleton

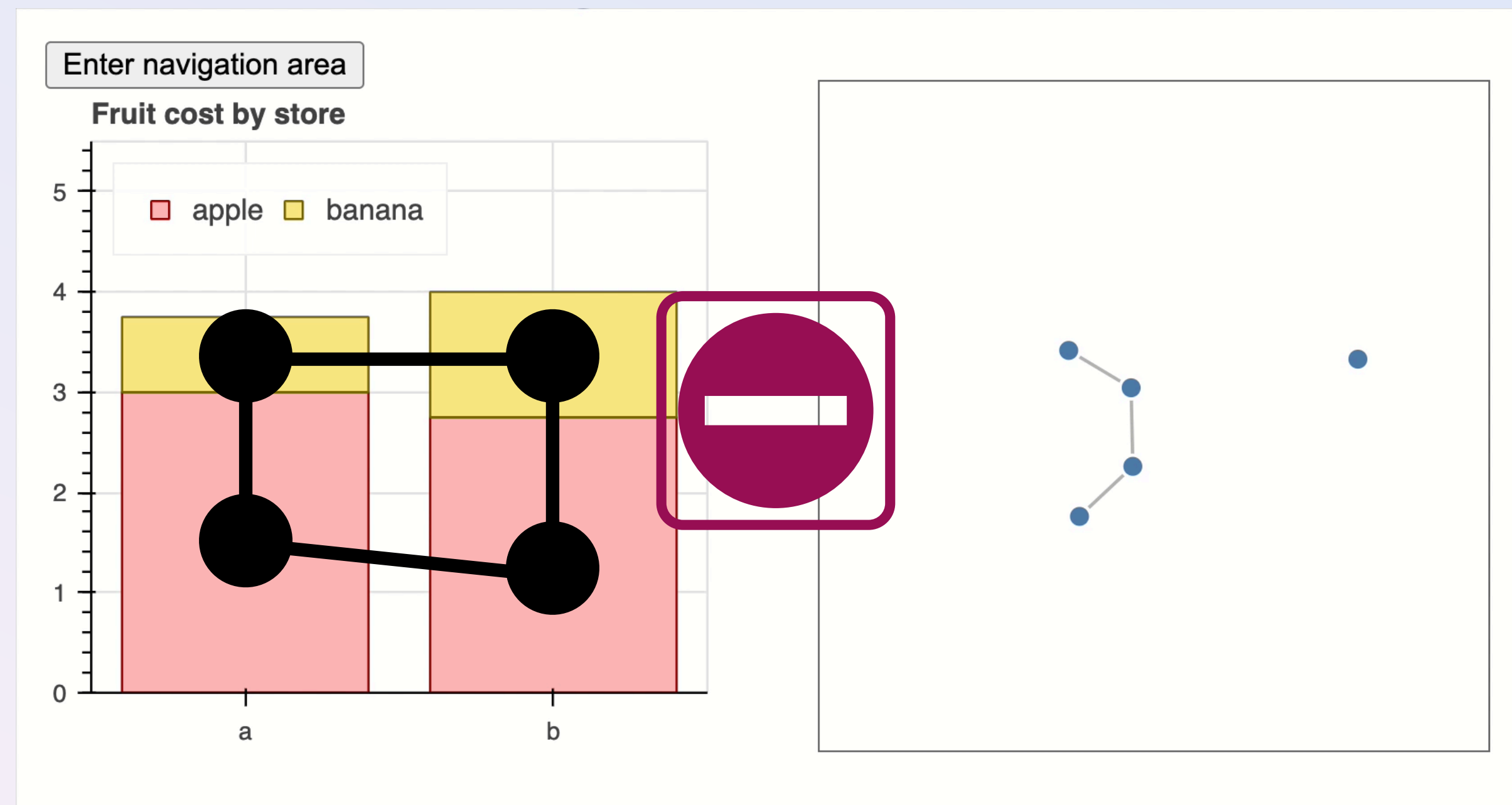
What if you could see the navigation structure?



What if you could see the navigation structure?



What if you could see the navigation structure?



My latest community and critical work

Blind-led innovation and using community response to build a *how-not-to* guide



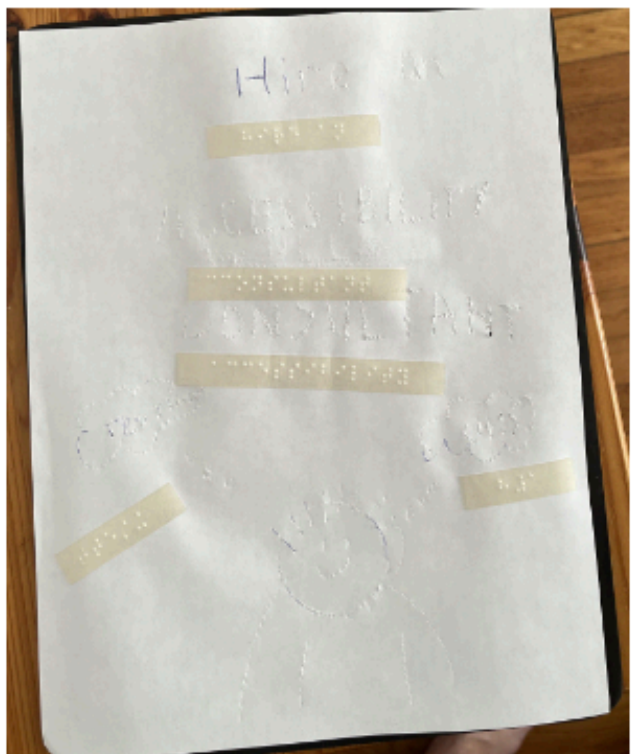
(a) Tactile maps of grocery store with standardized symbols, by P2



(b) Smart glasses with AI capabilities, by P9



(c) A photo of craft supplies in a shopping app, by P10



(d) Example of semantically correct HTML headings structure, by P4



(e) Phone interface with navigation consistency, by P6



(f) A device to aid with touch screen interaction, by P11

Fig. 2. Participant's prototypes in response to the Grocery shopping prompt.

How Not To Make Bad Assistive Tech: A Guide

Created by [Iman Ouzzani](#), Advised by [Frank Elavsky](#)

Some technologies that are created with "good" intentions can end up effectively useless, sometimes even harmful. This can especially be true when technology is made for people with disabilities. So how do you avoid making bad assistive technologies? We created this guide and framework to help you ask questions about your own work and suggest directions for how you can rethink, reframe, and adjust your approach.

Motivation: Avoiding Disability Dongles

Consider the following examples of bad assistive technology:

Sign-Language Glove



SignAloud - The Index Project

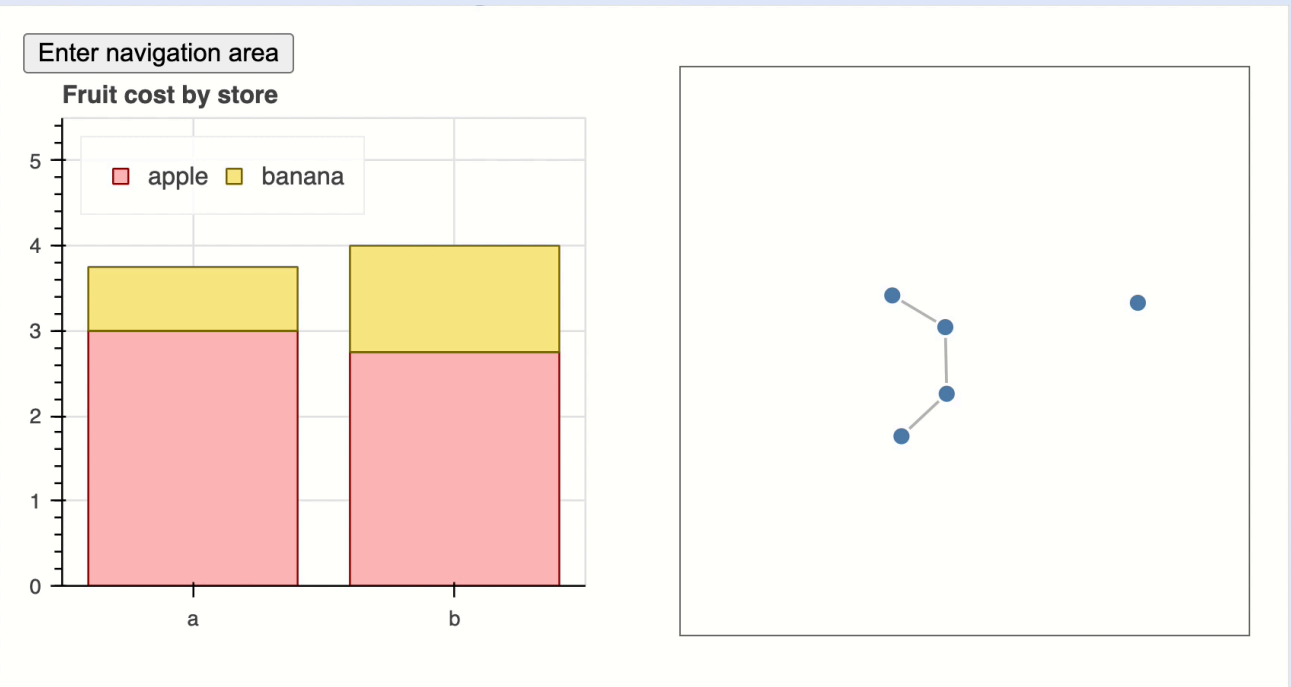
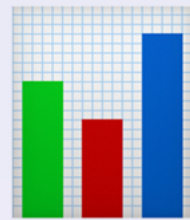
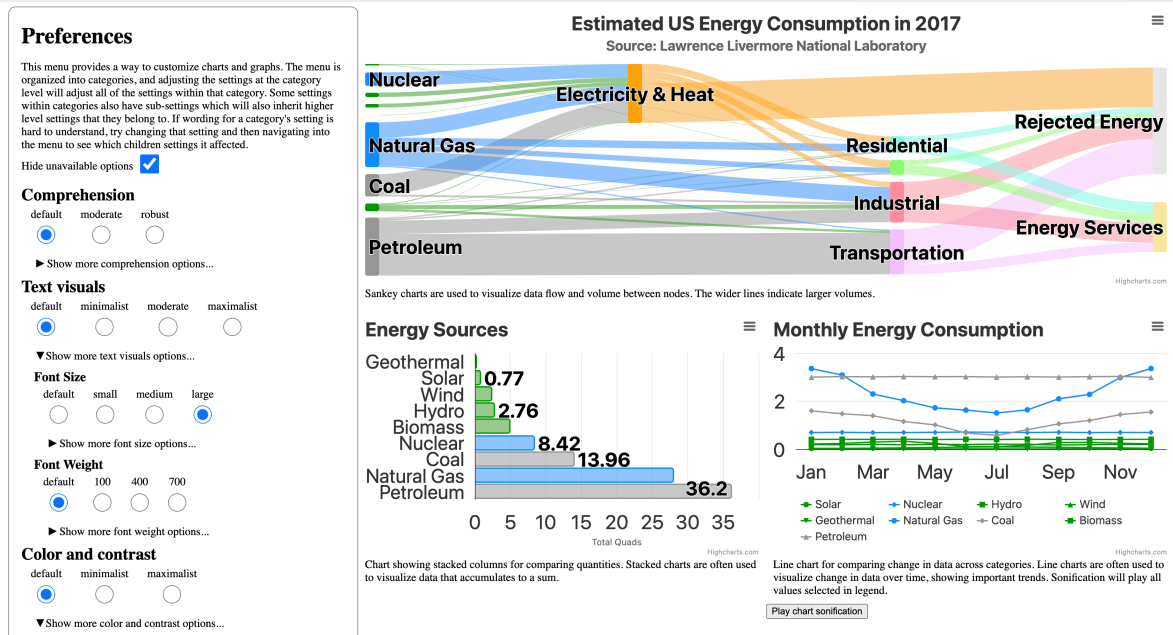
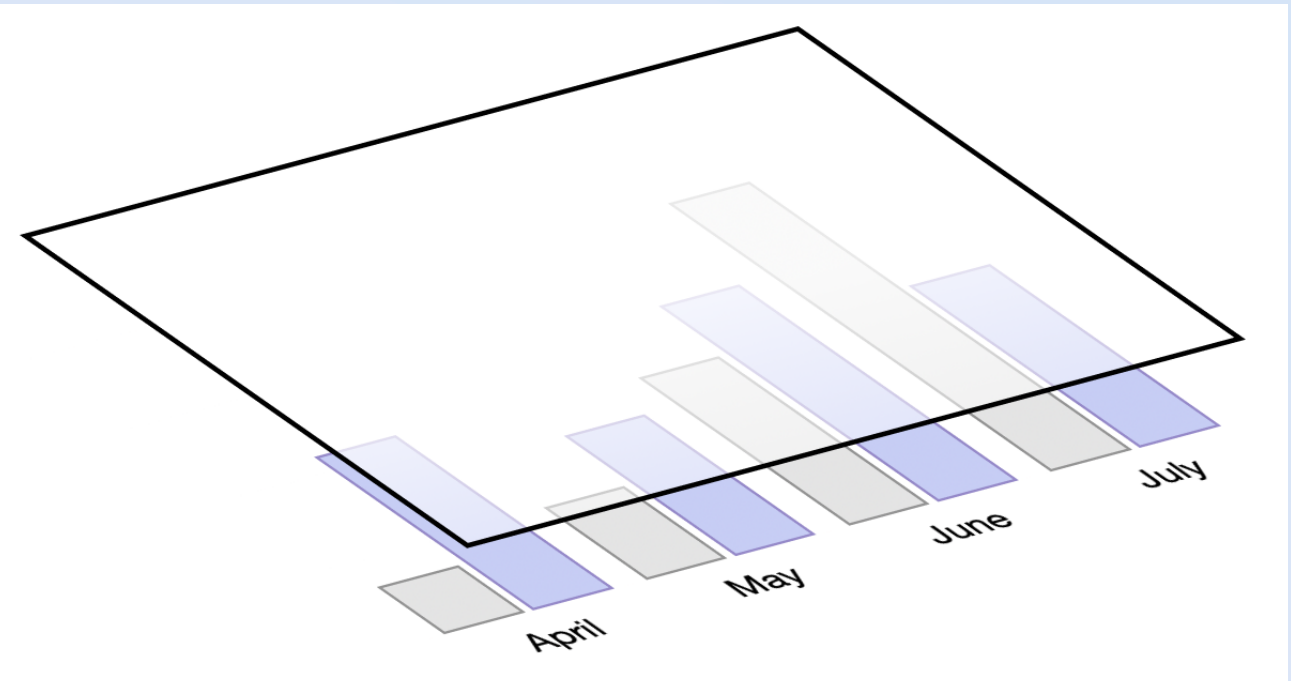
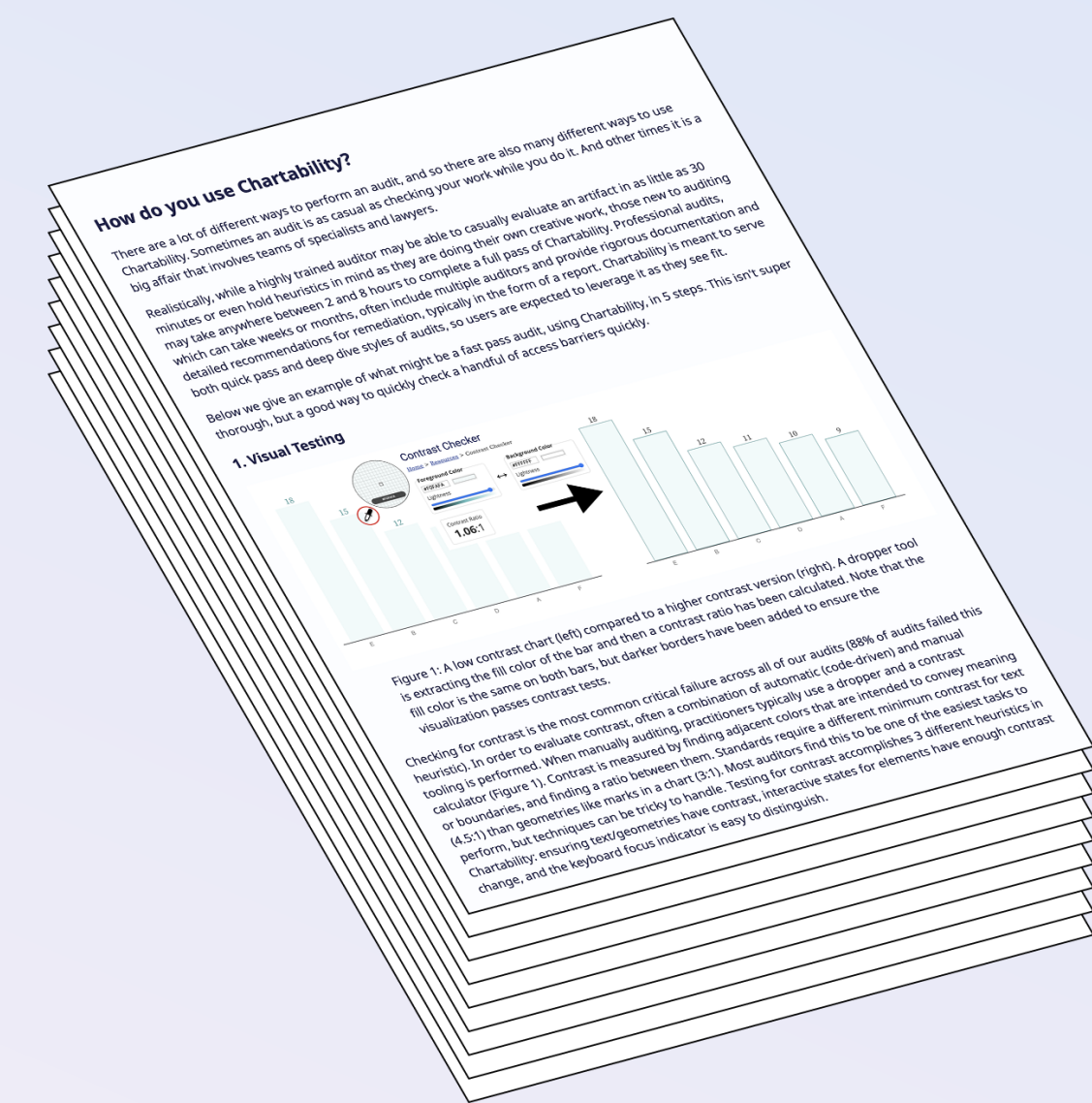
Why is it bad? The people who make these projects rarely consult with deaf people when they create it, which results in gloves that make an assumption that sign language only occurs in the movement of the hands, rather than with facial expressions and body language as well.

Stair-Climbing Wheelchair

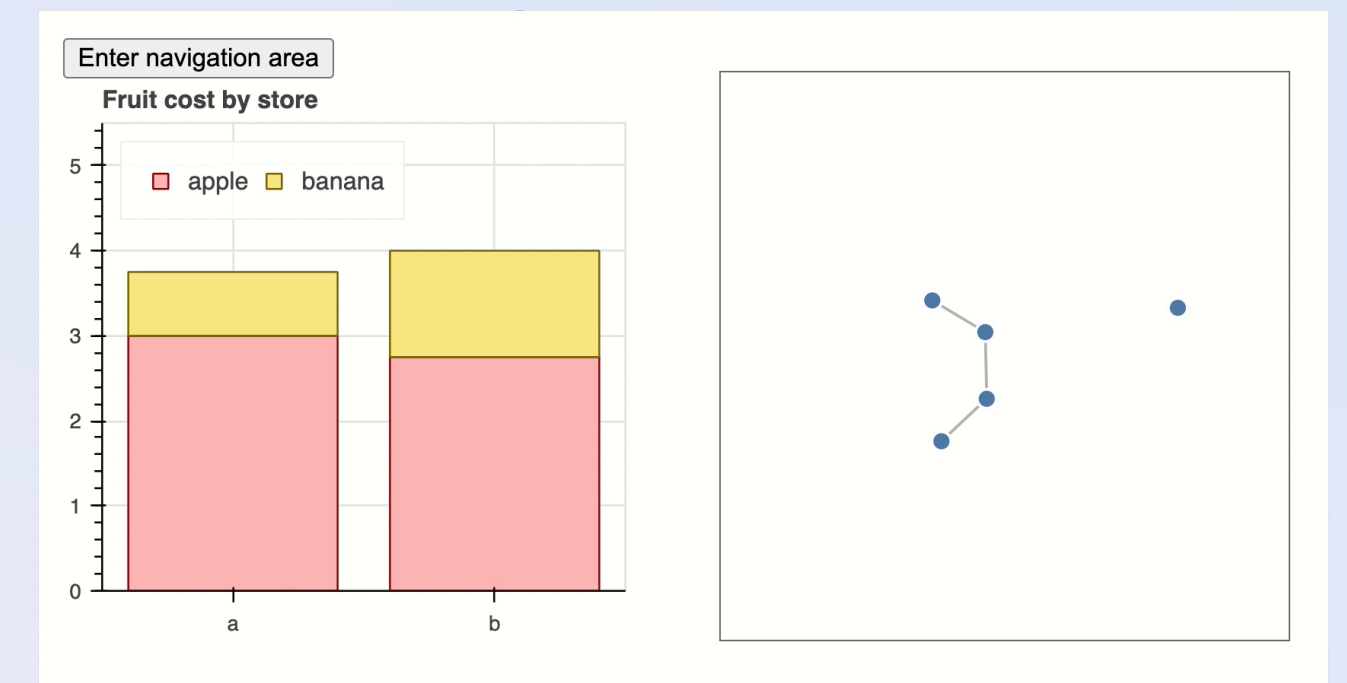
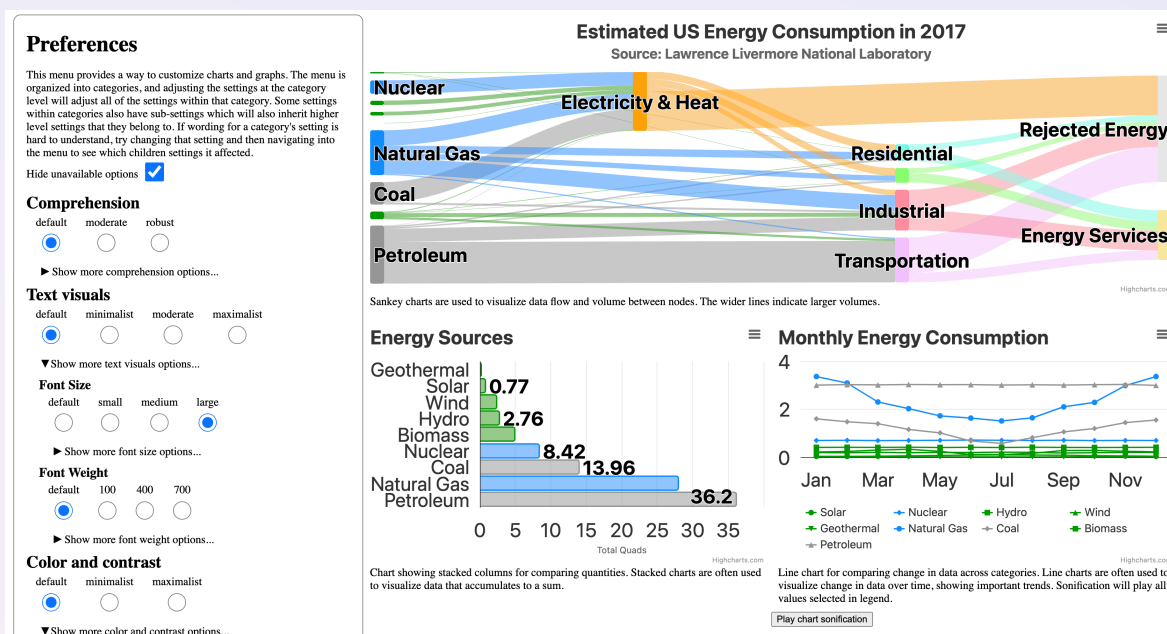
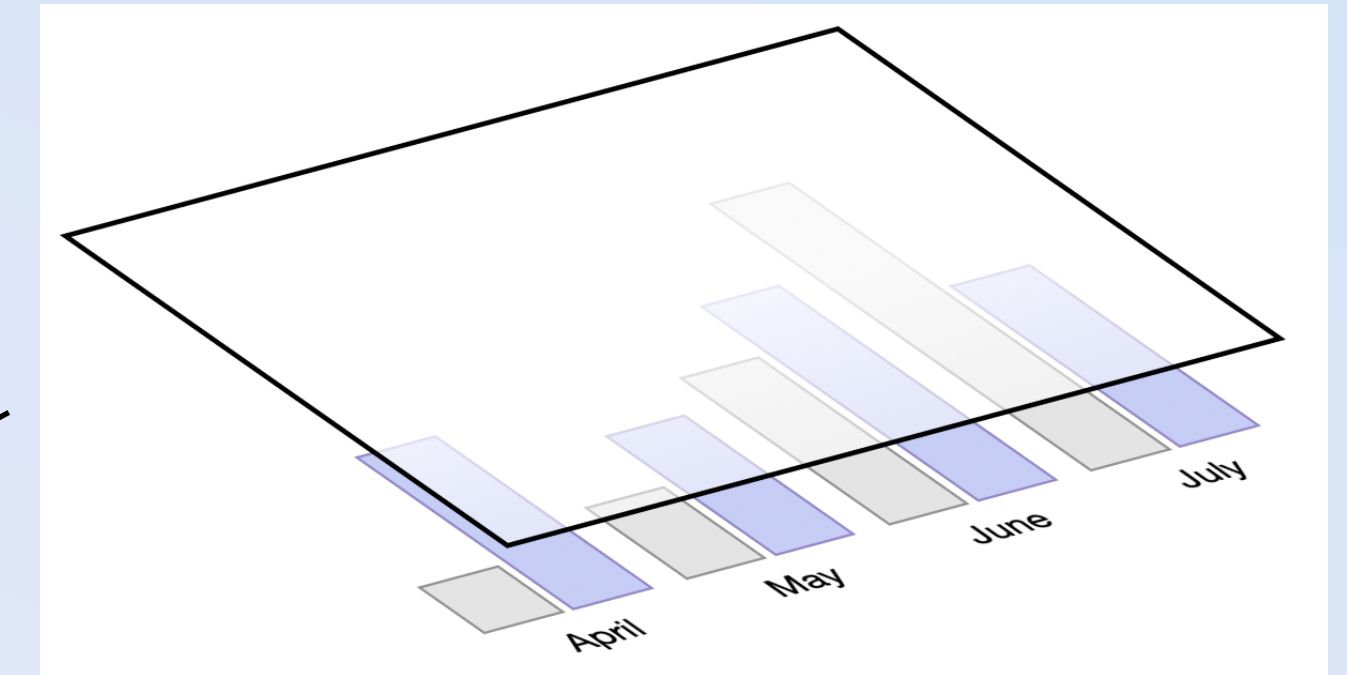


Section 4: **Summary**

"Strictly speaking,
nothing is a tool unless
during actual use."
Samuel Butler



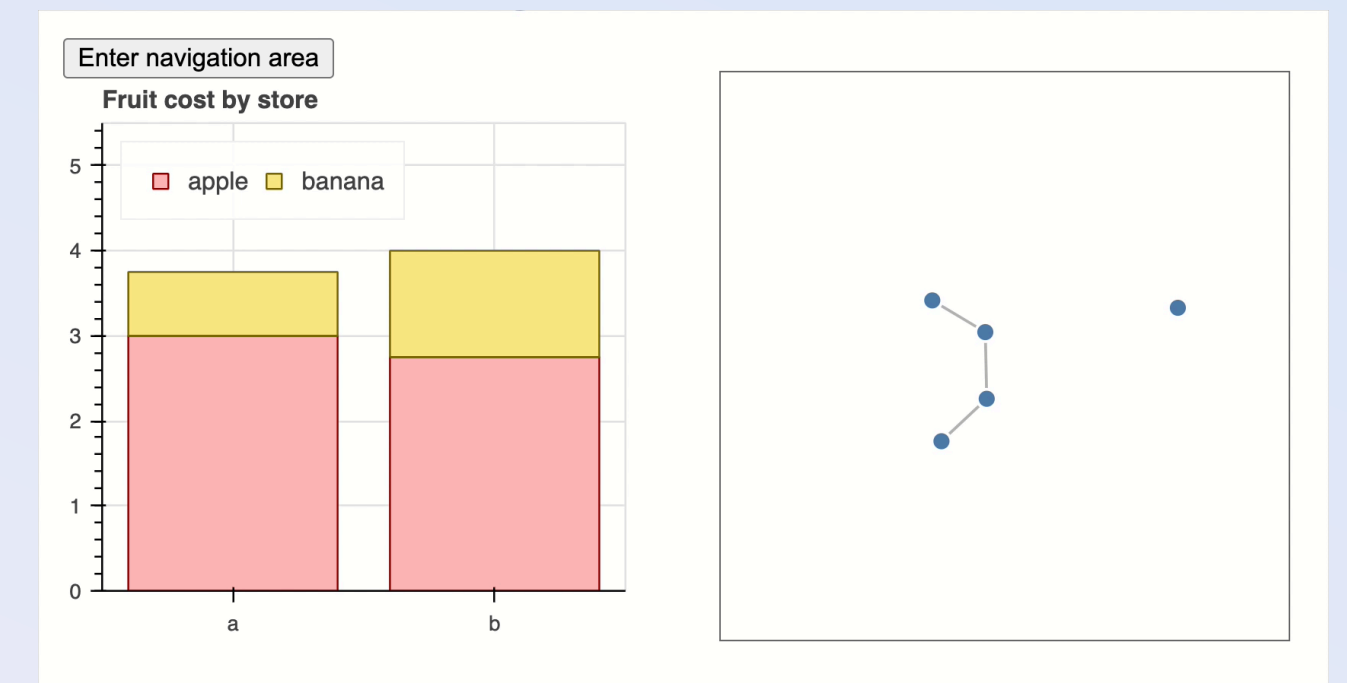
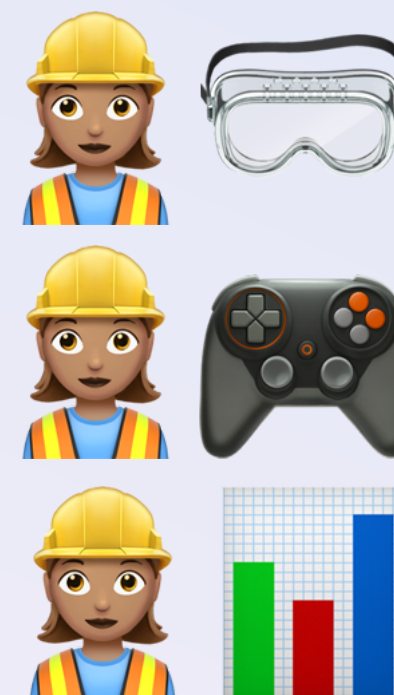
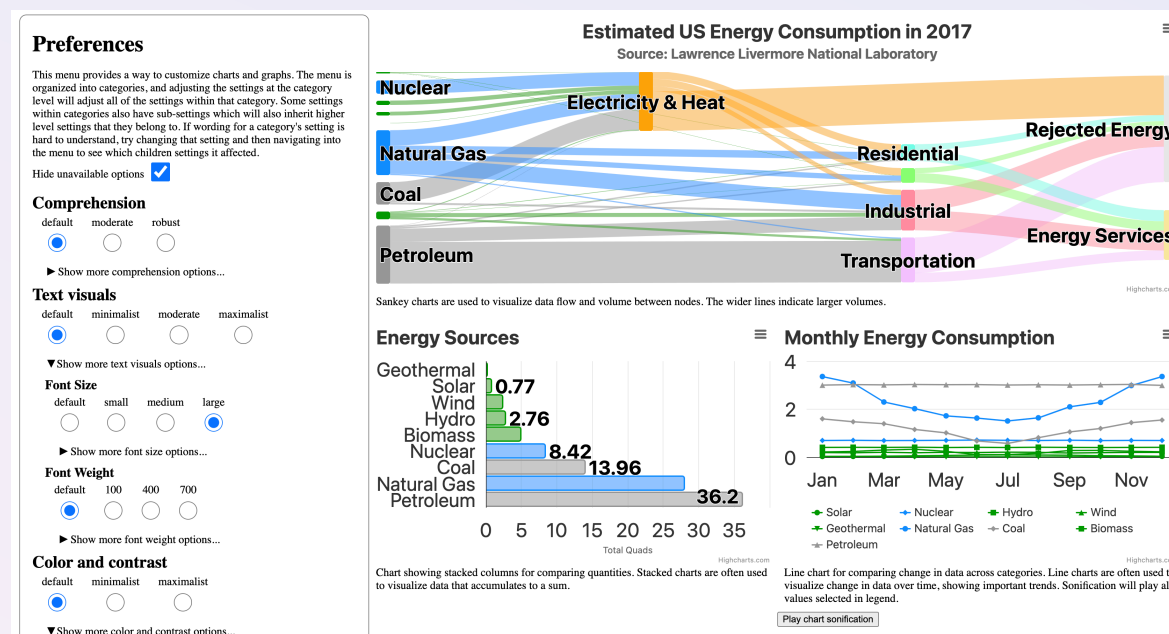
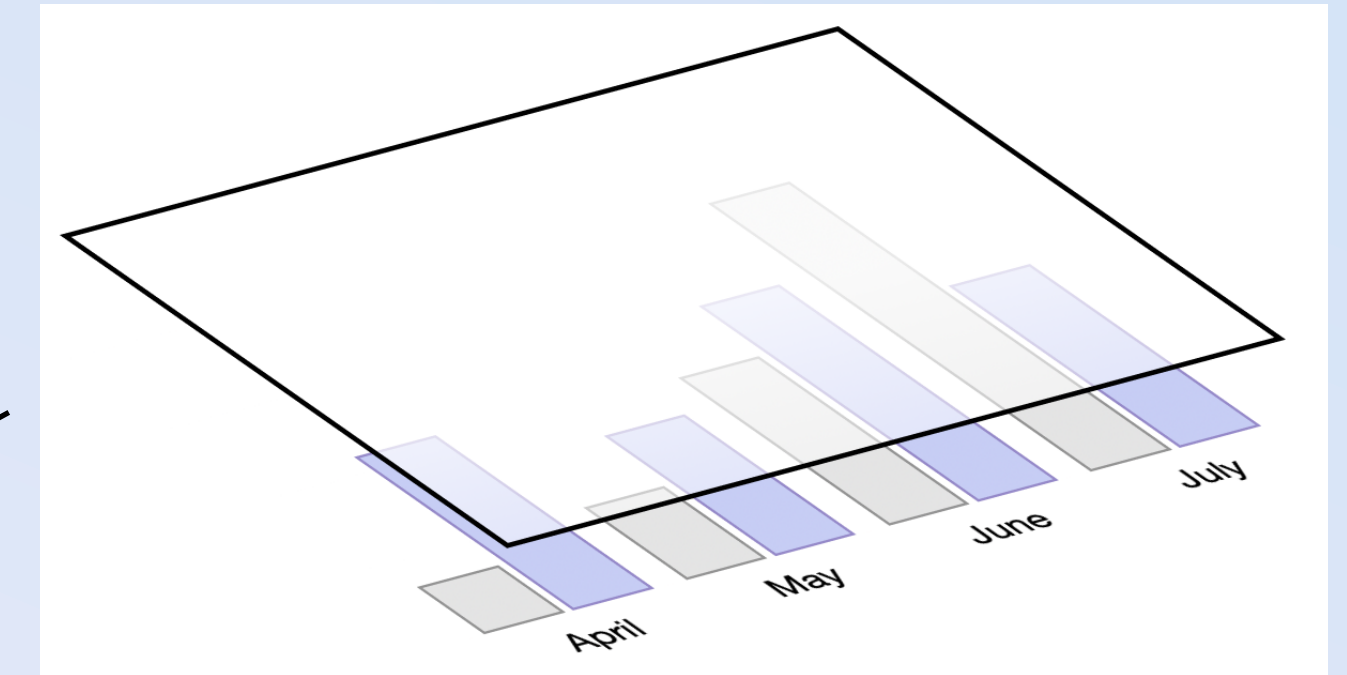
"Strictly speaking,
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Samuel Butler



Working with people as they work with data is how you build effective tools.

Section 5: **Future Work**

"Strictly speaking,
nothing is a tool unless
during actual use."
Samuel Butler



Working with people as they work with [3D graphics, games, data]
is how you build effective tools.

2025

frank.computer

Tools for Accessible Data Interaction



Frank Elavsky



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