

***Cross-feelting*: Exploring a coordinated, cross-interaction prototype for blind data interaction**



Frank Elavsky, PhD Student

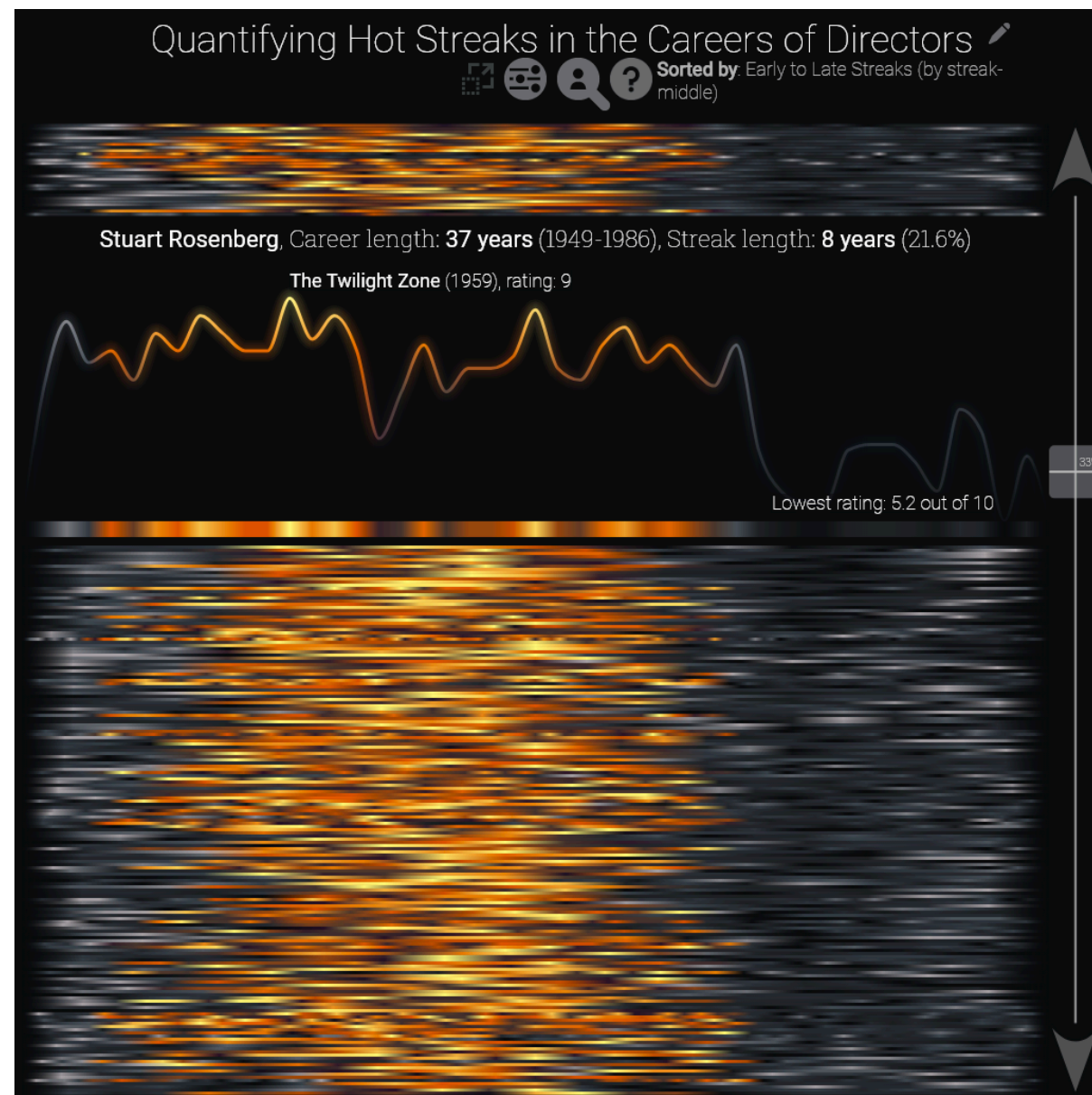


hcii.cmu.edu, axle-lab.com, dig.cmu.edu

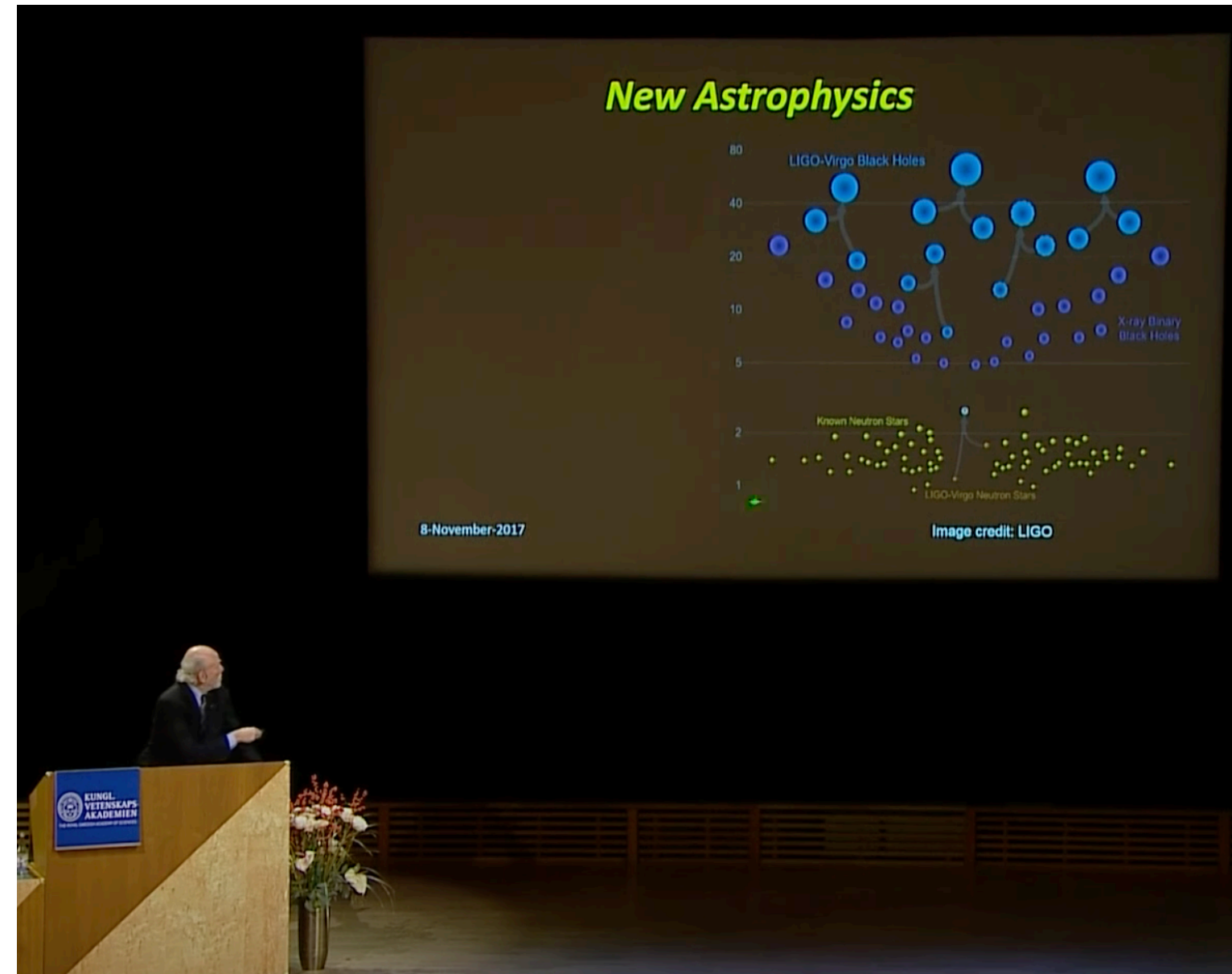
My pre-phd work in visualization

Industry and research engineering

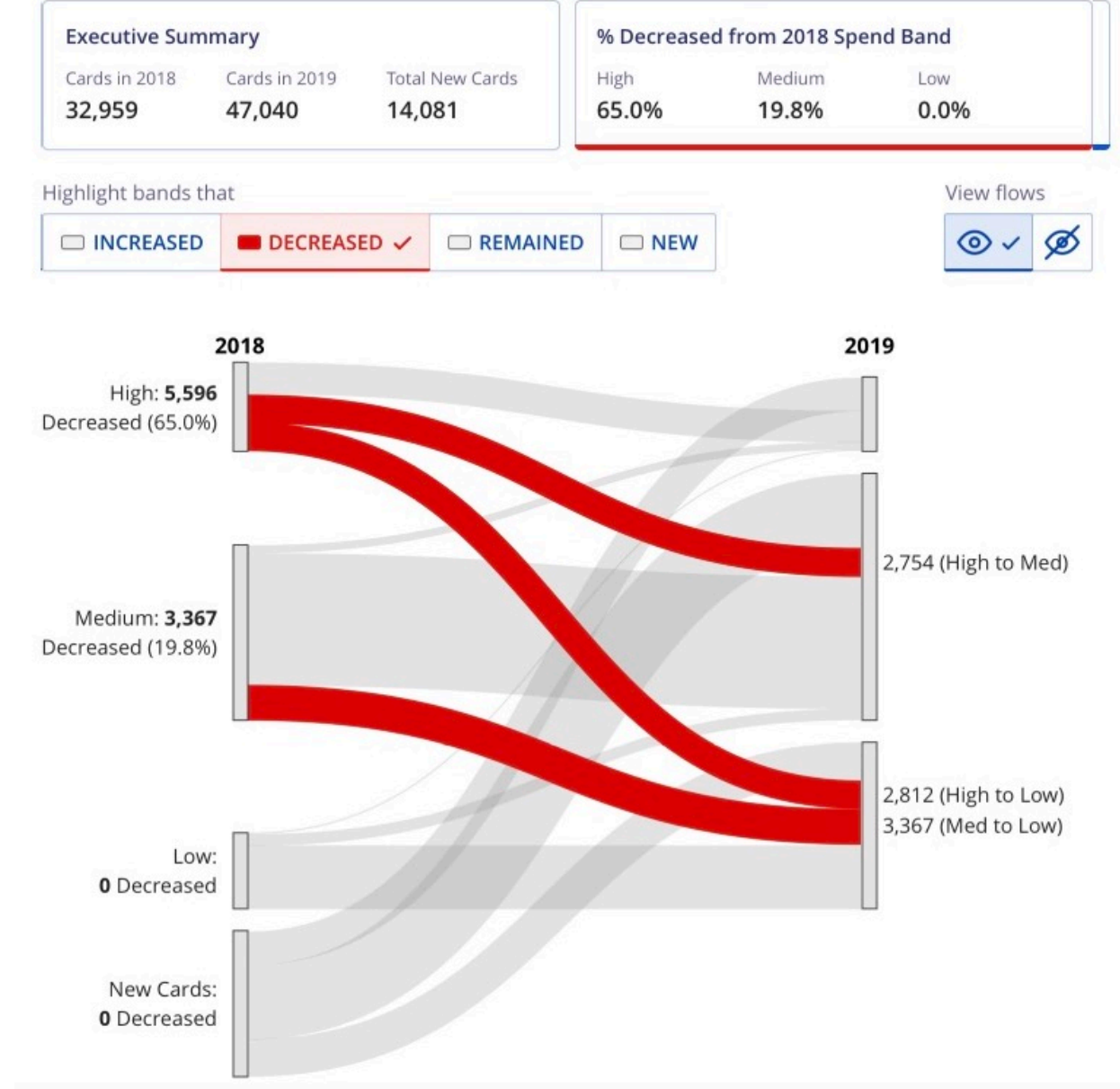
Dense model visualizations



Domain-specific visualizations



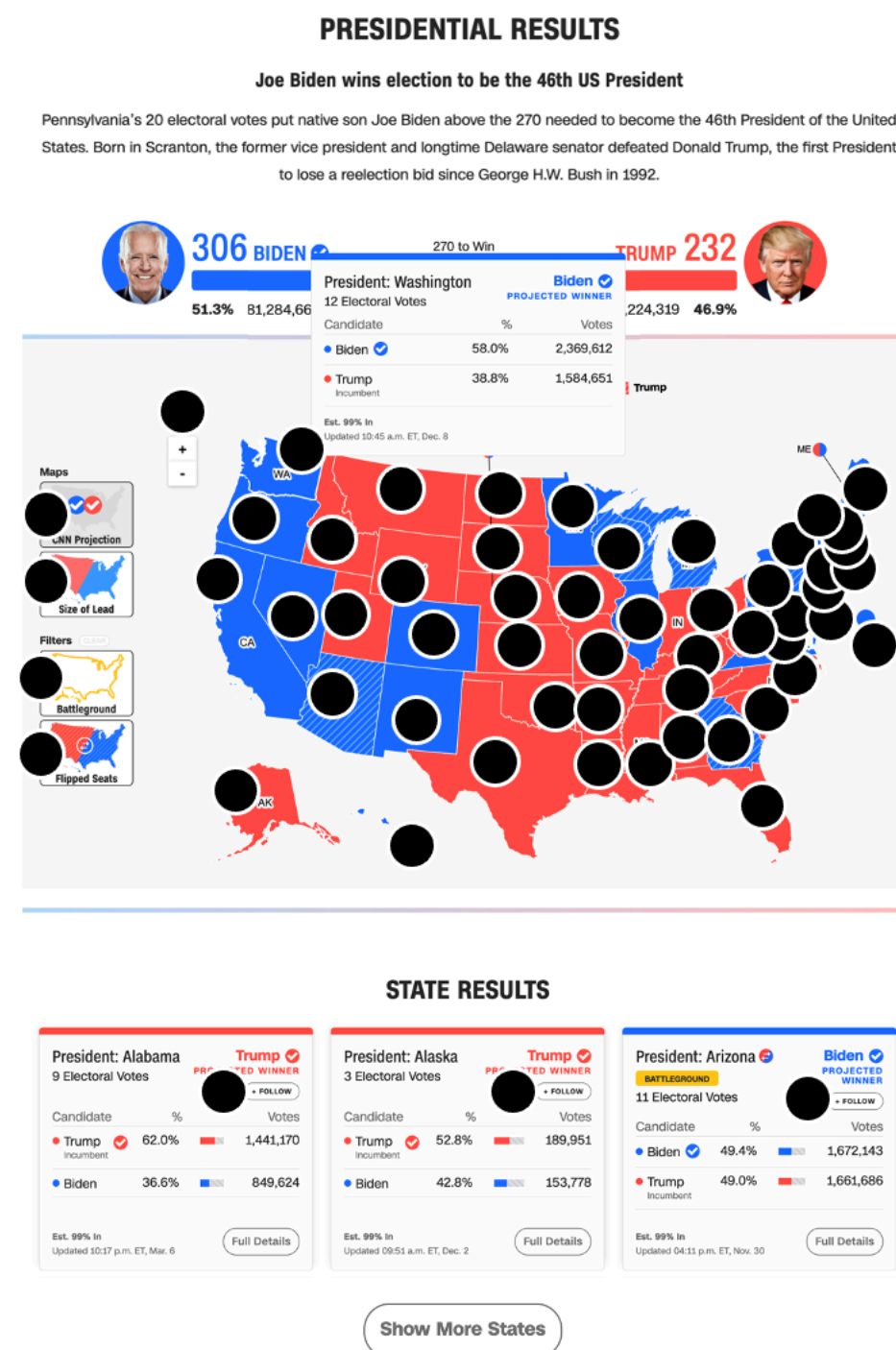
Data visualization library



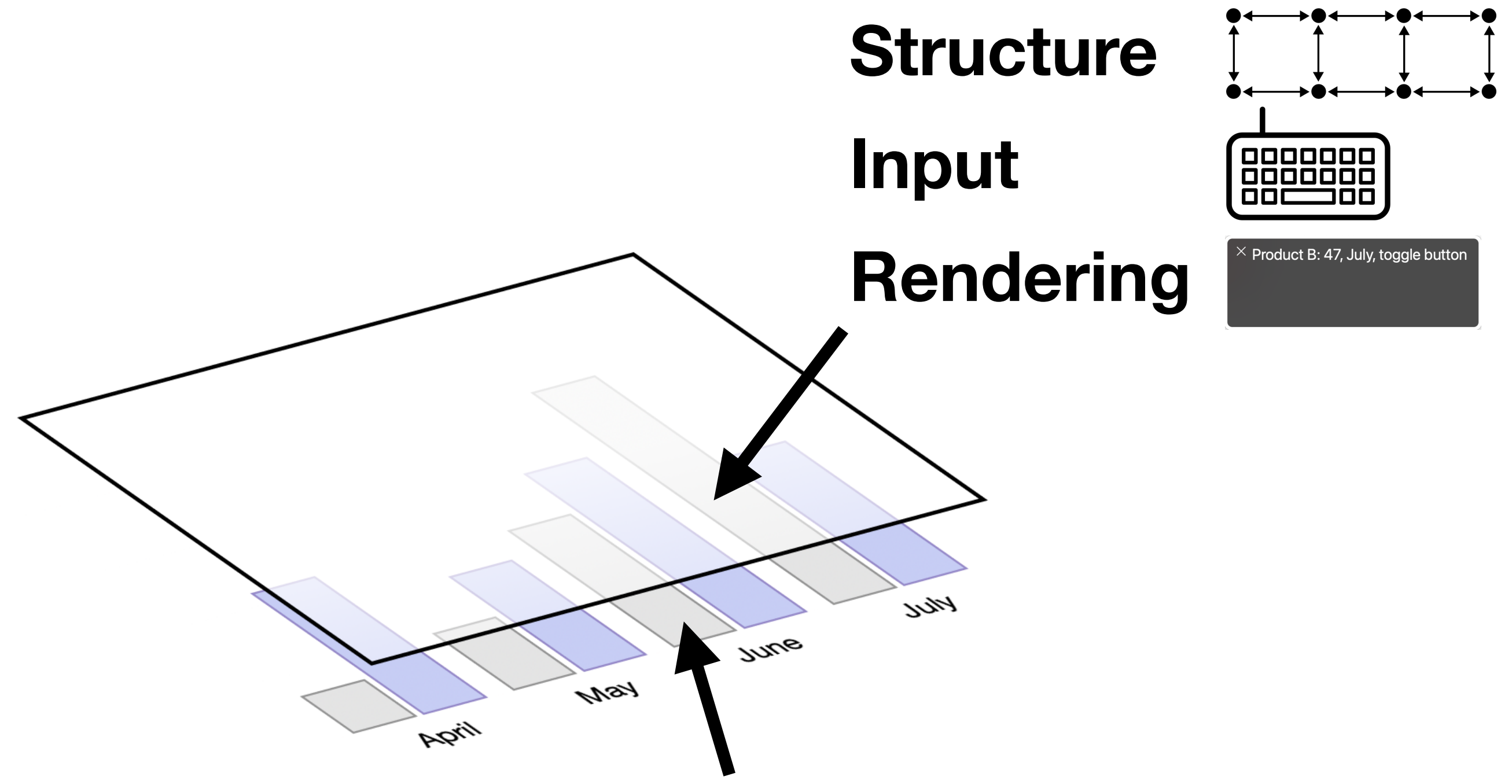
What and how of visualization accessibility

(My recent research)

Chartability:
What are accessibility barriers?



Data Navigator:
How do we build accessible visualizations?



To any visualization toolkit

What if we let users hack chart designs?

Preferences

Hide unavailable options

▼ **Comprehension**
 default moderate robust

Alt text appearance
 default show high level show all

► **Description verbosity**
 default disable minimal verbose

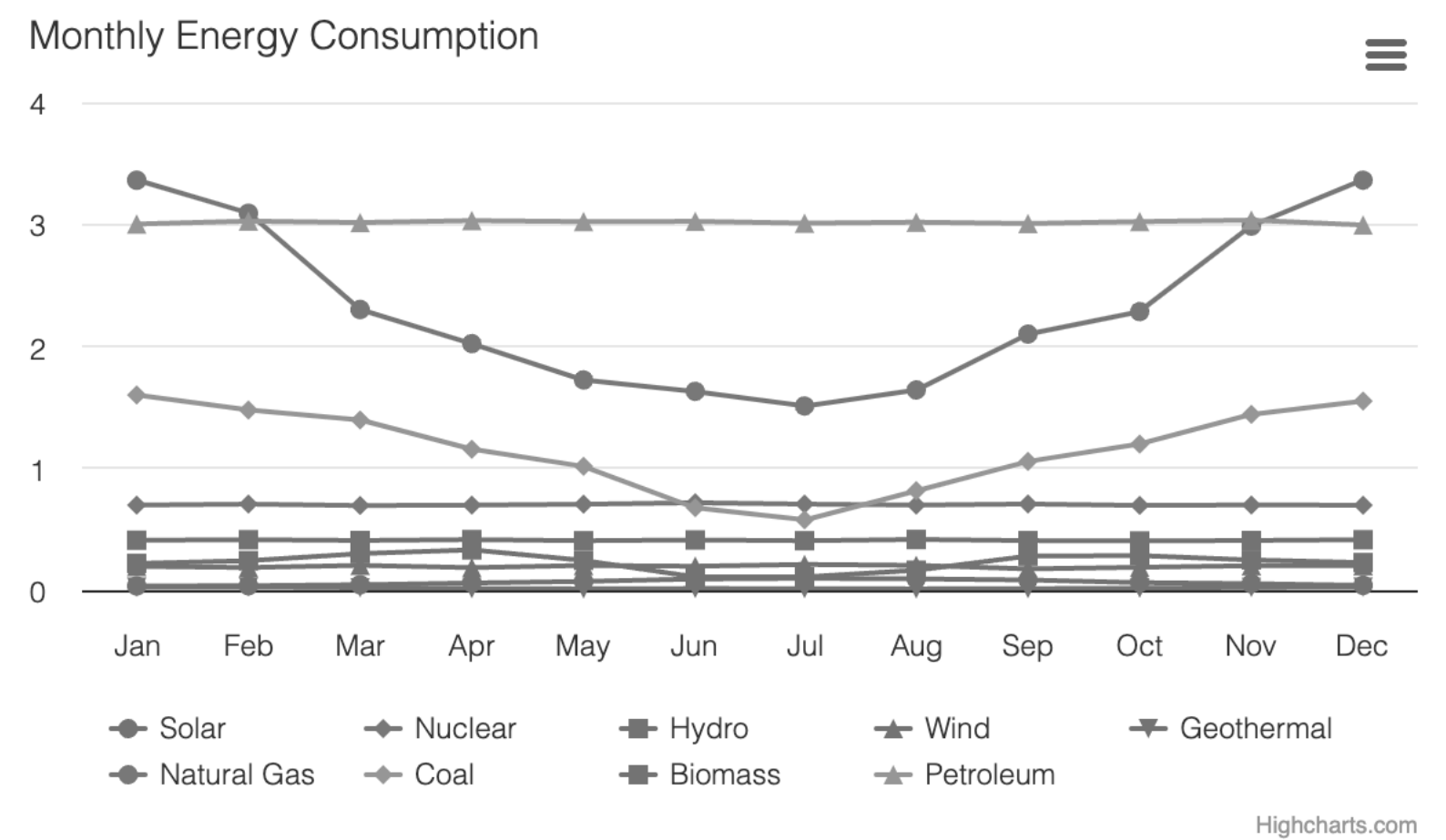
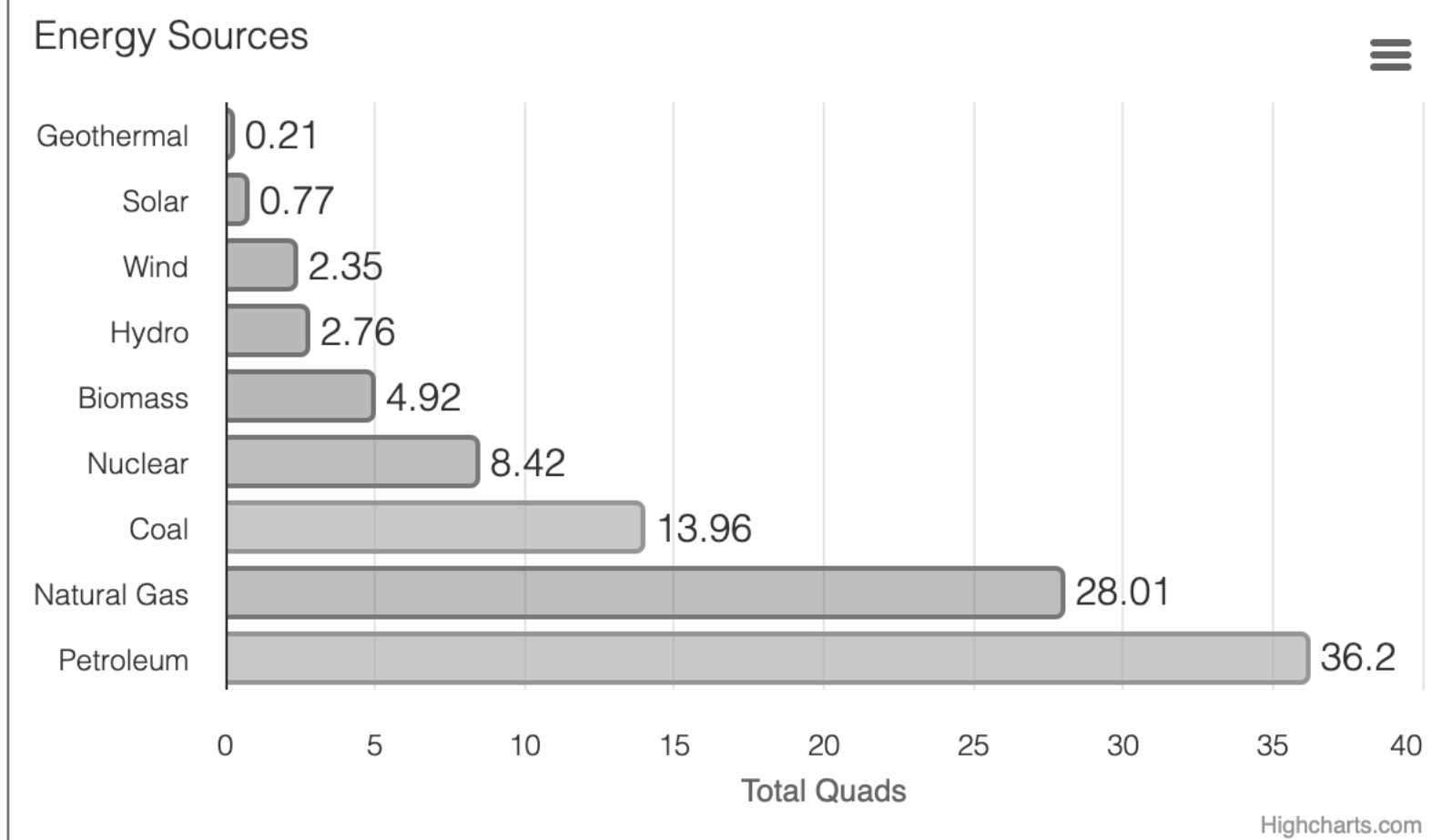
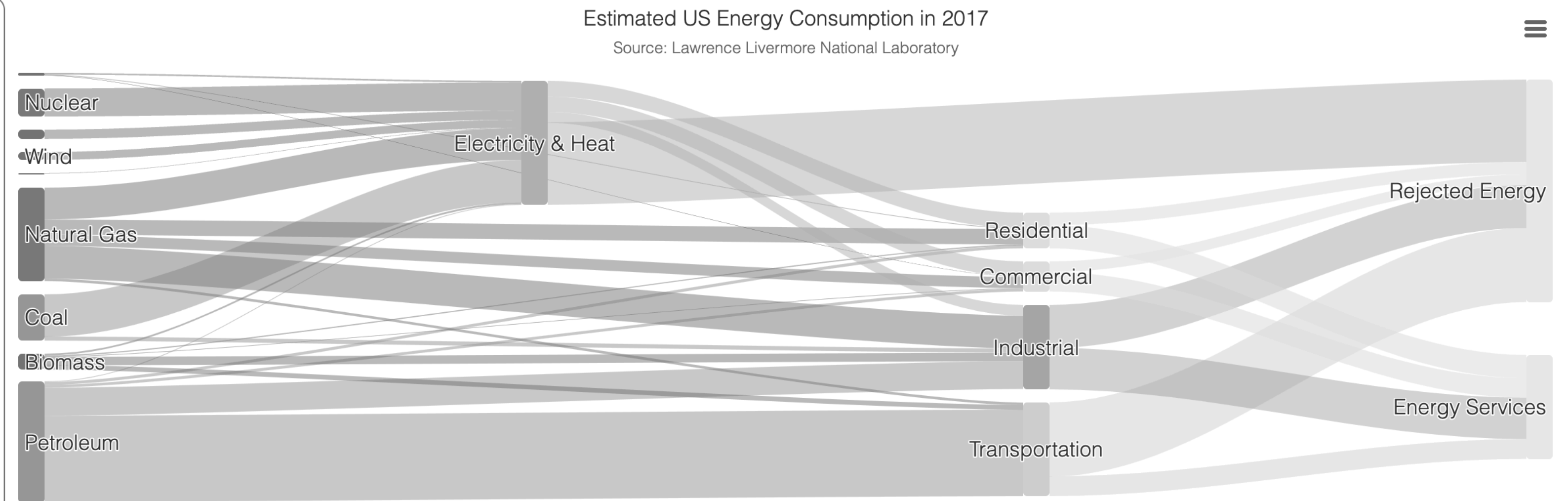
▼ **Text**
 default minimalist moderate maximalist

▼ **Font Size**
 default small medium large

Title
 default small small+ medium medium+ large

Subtitle
 default small small+ medium medium+ large

Series Labels
 default small small+ medium medium+ large



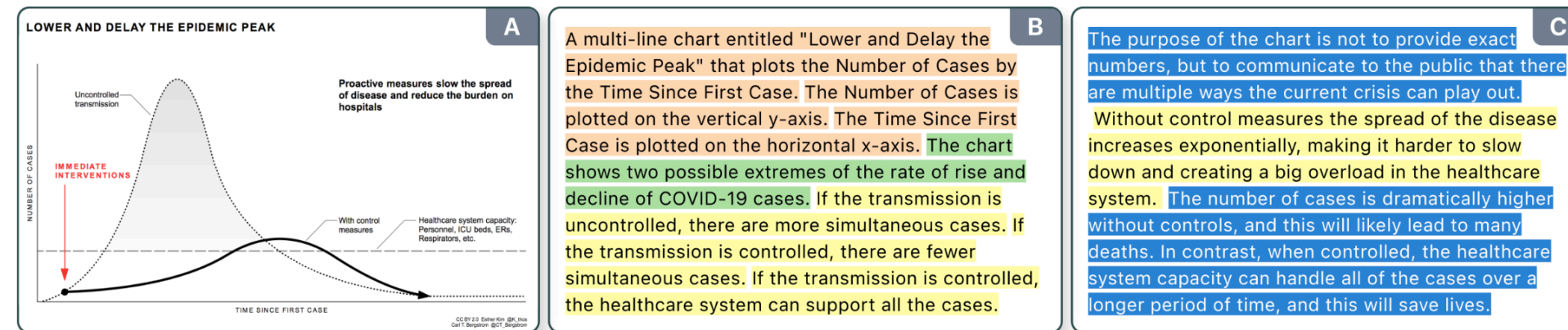
[Interactive demo link](#)



Accessible data *representation*

Accessible data *representation*

Descriptions



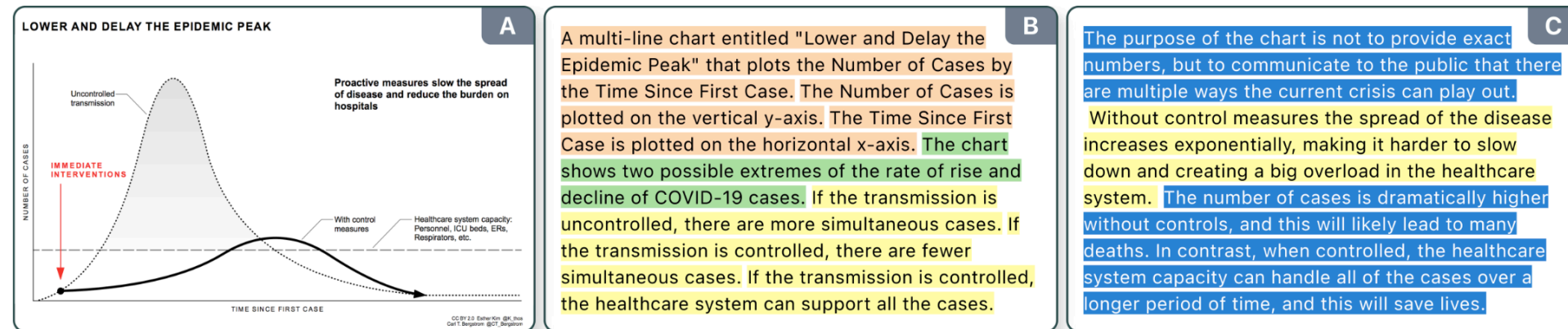
Long Description

Visualizations like "Flatten the Curve" (A) efficiently communicate critical public health information, while simultaneously excluding people with disabilities [11, 28]. To promote accessible visualization via natural language descriptions (B, C), we introduce a four-level model of semantic content. Our model categorizes and color codes sentences according to the semantic content they convey.

Image source

Accessible data *representation*

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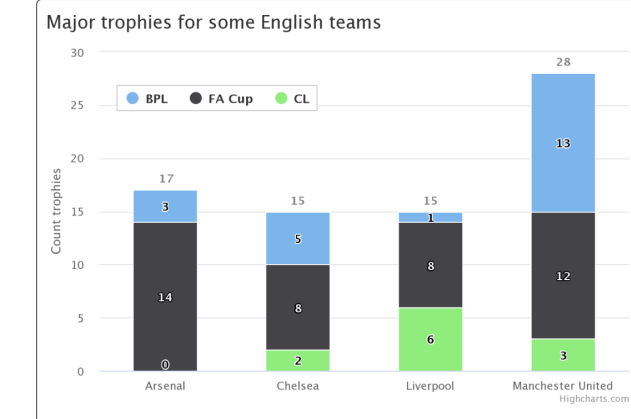
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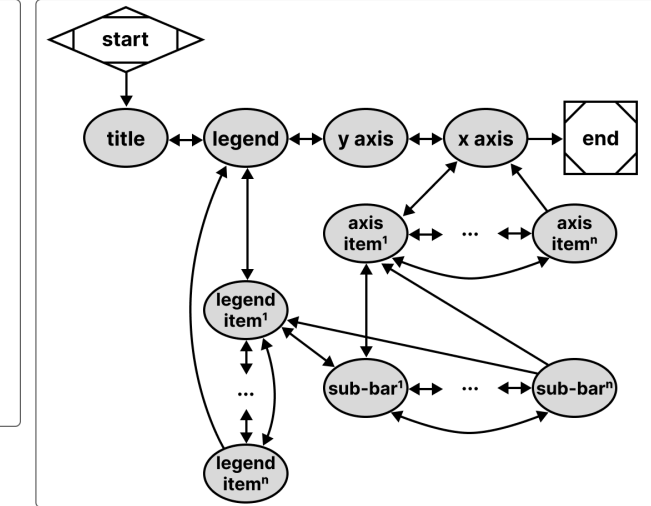
[Image source](#)

Structure

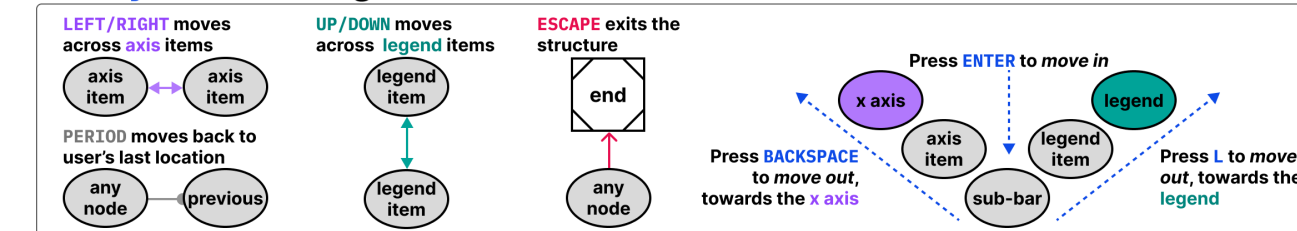
A. Raster (png) visualization



B. Dual tree schema design

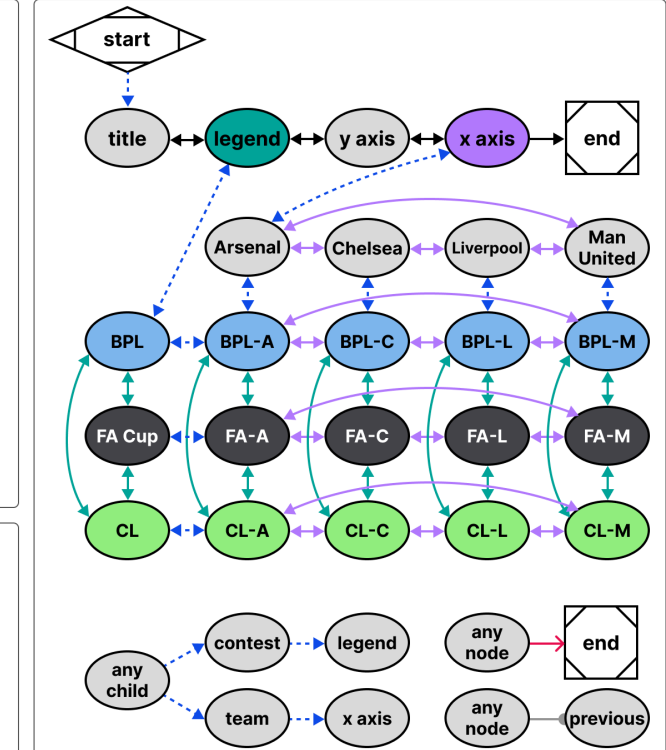


C. Keyboard navigation rules



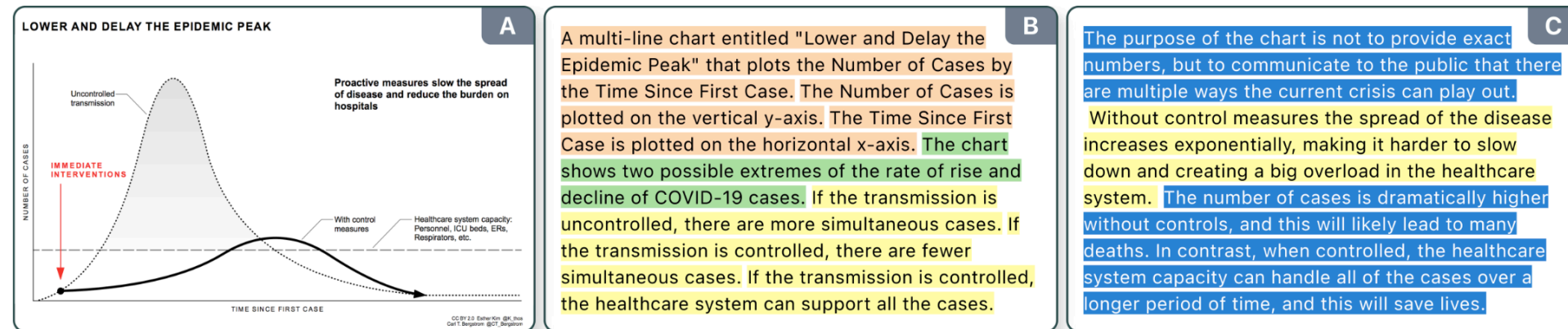
[Image source](#)

D. Schema instantiated



Accessible data representation

Descriptions

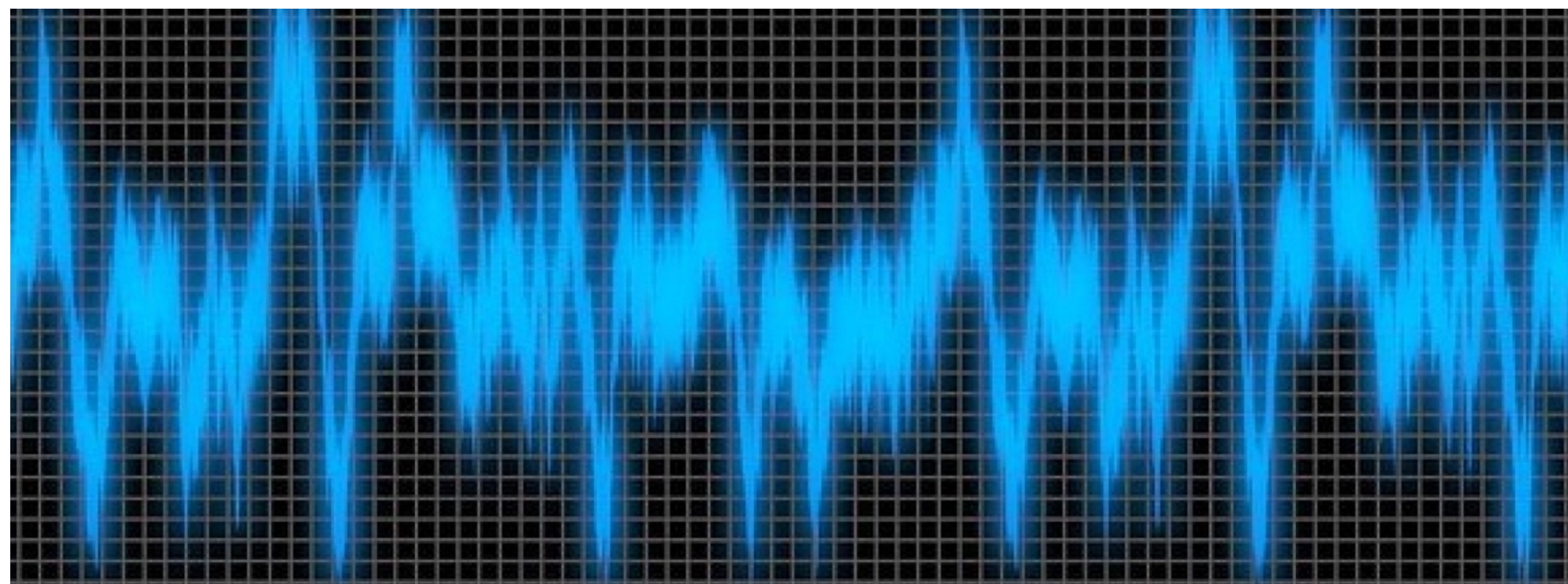


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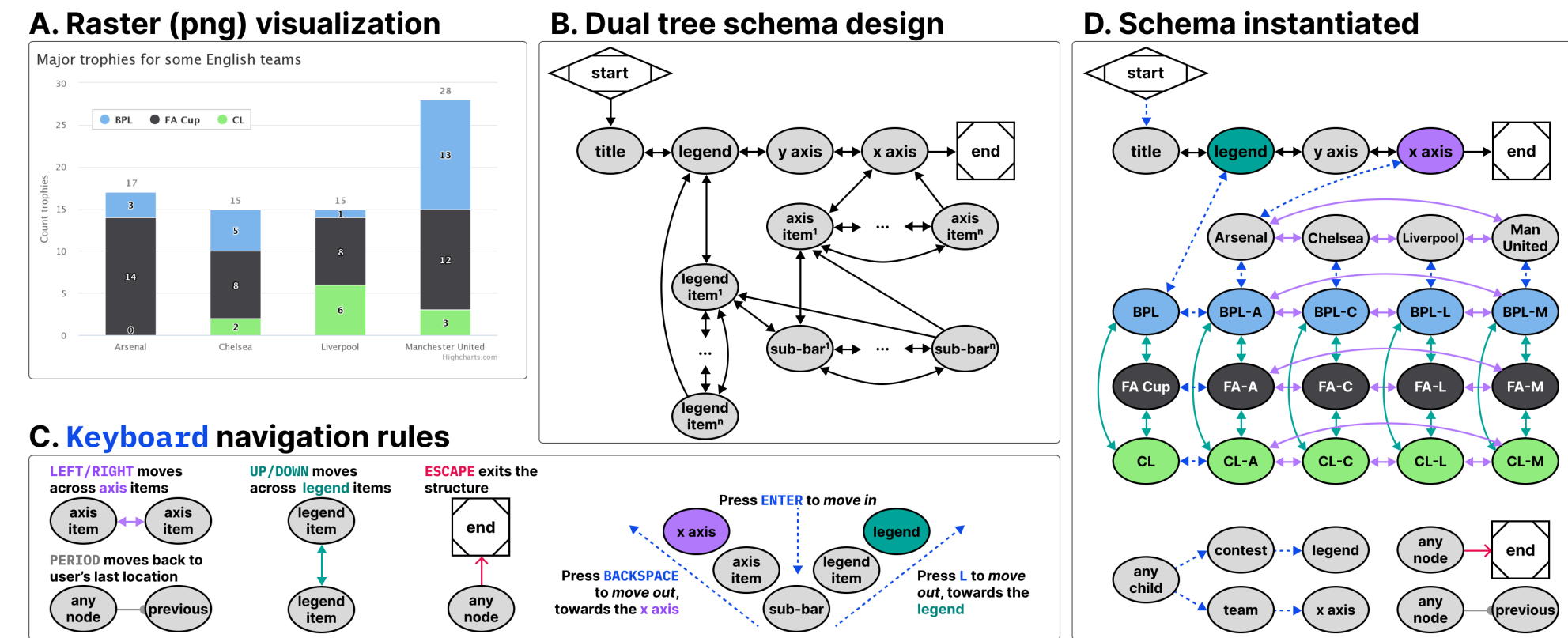
[Image source](#)

Sonifications



[Image source](#)

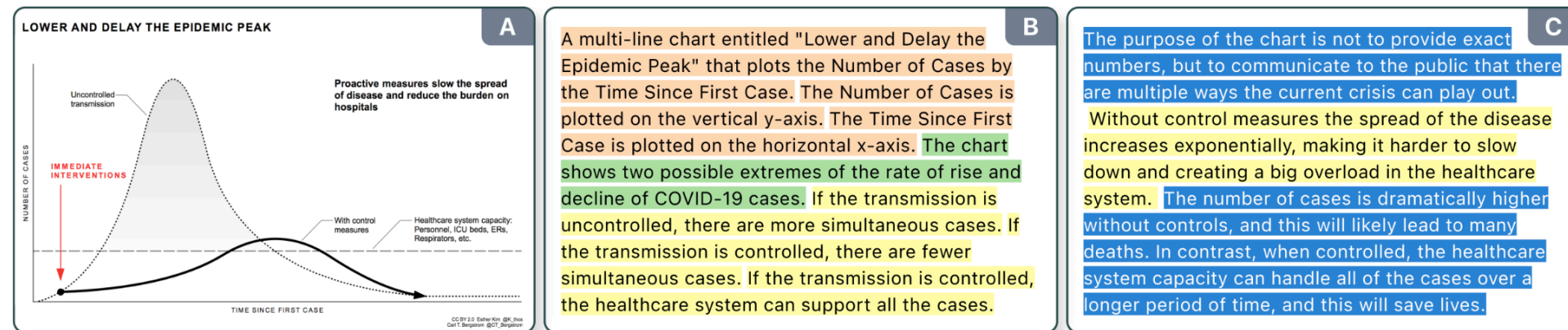
Structure



[Image source](#)

Accessible data representation

Descriptions

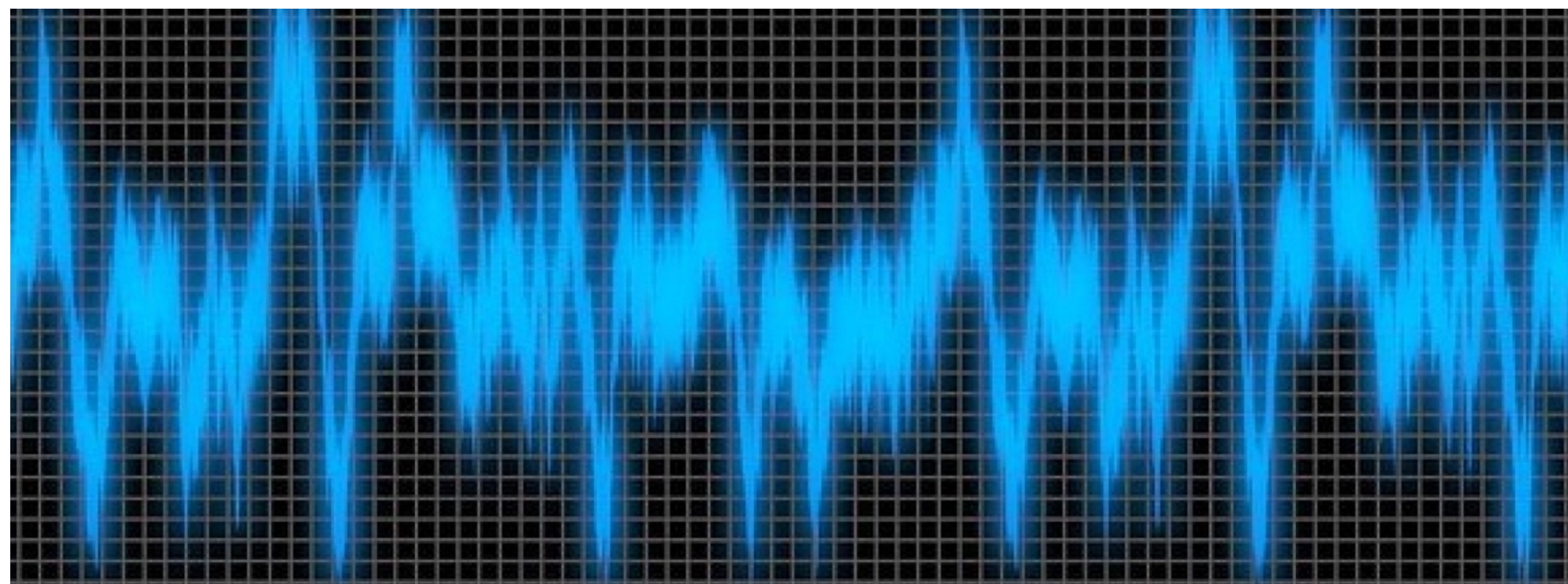


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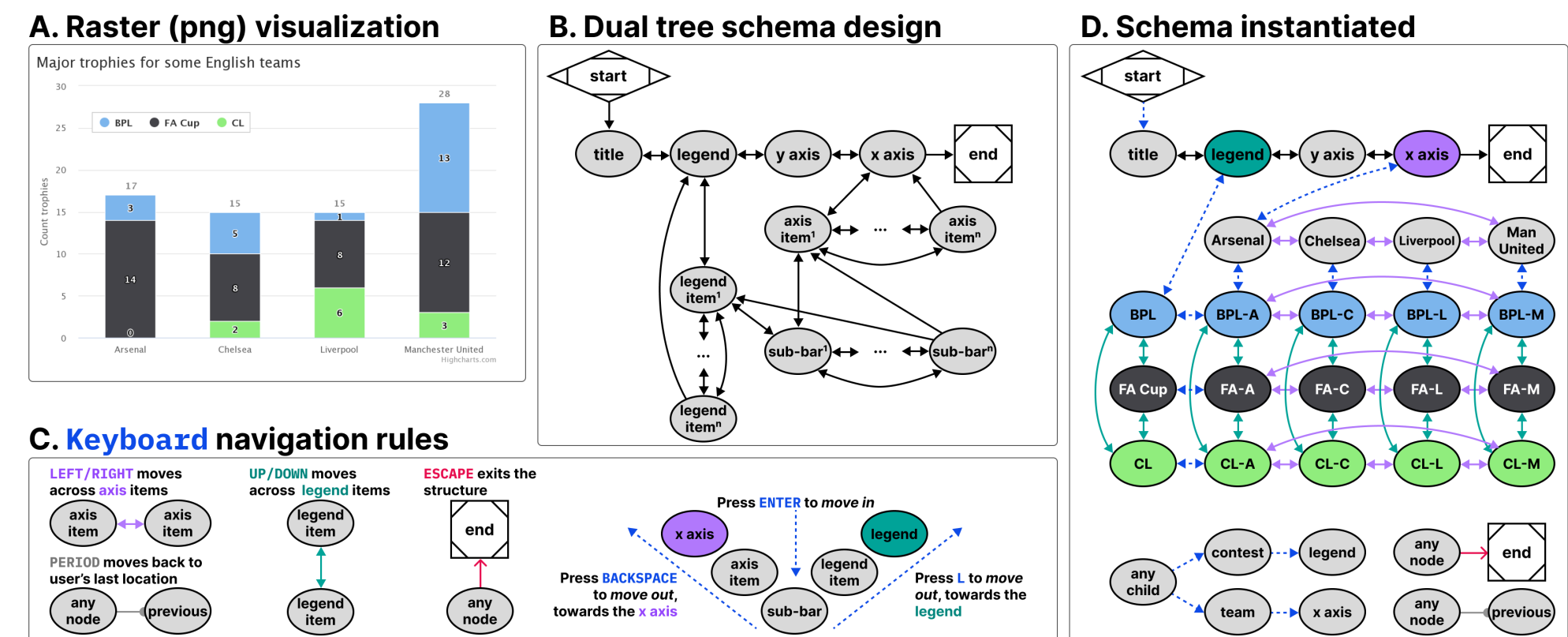
[Image source](#)

Sonifications



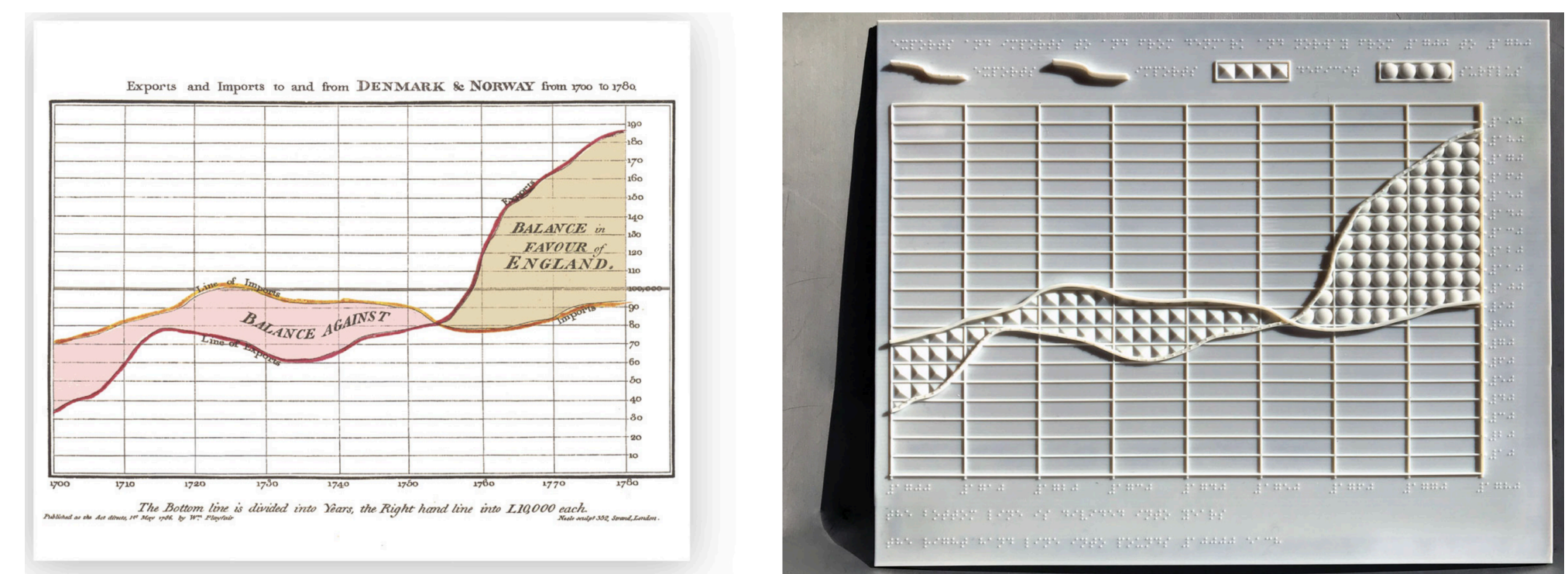
[Image source](#)

Structure



[Image source](#)

Tactiles



[Image source](#)

But what about *interactivity*?

Output has been our focus, primarily. But what about *input*?

But screen readers processes 1 input at a time

The image shows a screenshot of the Wikipedia article for "Cat". Red annotations highlight several key elements for a screen reader user:

- The search bar at the top, containing the text "Search Wikipedia".
- The article title "Cat" and the language selection menu "262 languages".
- The "Contents" sidebar on the left, which lists various sections of the article. A red bracket groups these sections, indicating they are a single input for a screen reader.
- The main article text, where the word "Felidae" is circled in red, indicating it is a key term or link.
- The "Cat" infobox on the right, which contains a title, a temporal range, and four images of cats.

67 Nav points, ~32s

Movement between tasks becomes cognitively expensive

The image shows a screenshot of the Wikipedia article for 'Cat'. Red lines and circles highlight various navigation elements: the search bar, the article title, the '262 languages' link, the 'From Wikipedia, the free encyclopedia' line, the disambiguation text, the word 'Cat' in the first paragraph, the word 'cat' in the second paragraph, and the 'Cat' infobox. A large red arrow points from the search bar to the article title. Another red arrow points from the '262 languages' link to the article title. A third red arrow points from the 'From Wikipedia, the free encyclopedia' line to the article title. A fourth red arrow points from the disambiguation text to the article title. A fifth red arrow points from the word 'Cat' in the first paragraph to the article title. A sixth red arrow points from the word 'cat' in the second paragraph to the article title. A seventh red arrow points from the 'Cat' infobox to the article title. A large red arrow points from the search bar to the 'Cat' infobox. A large red arrow points from the search bar to the 'Cat' infobox. A large red arrow points from the search bar to the 'Cat' infobox. A large red arrow points from the search bar to the 'Cat' infobox. A large red arrow points from the search bar to the 'Cat' infobox.

**67 Nav points,
~32s**

The cat (*Felis* species in the f domestication c and farm cat, b companionship prey like mice c

cat, is the only domesticated have shown that the only kept as a house pet is valued by humans for it is adapted to killing small eth, and its night vision and

Temporal range: 9,500 years ago – present

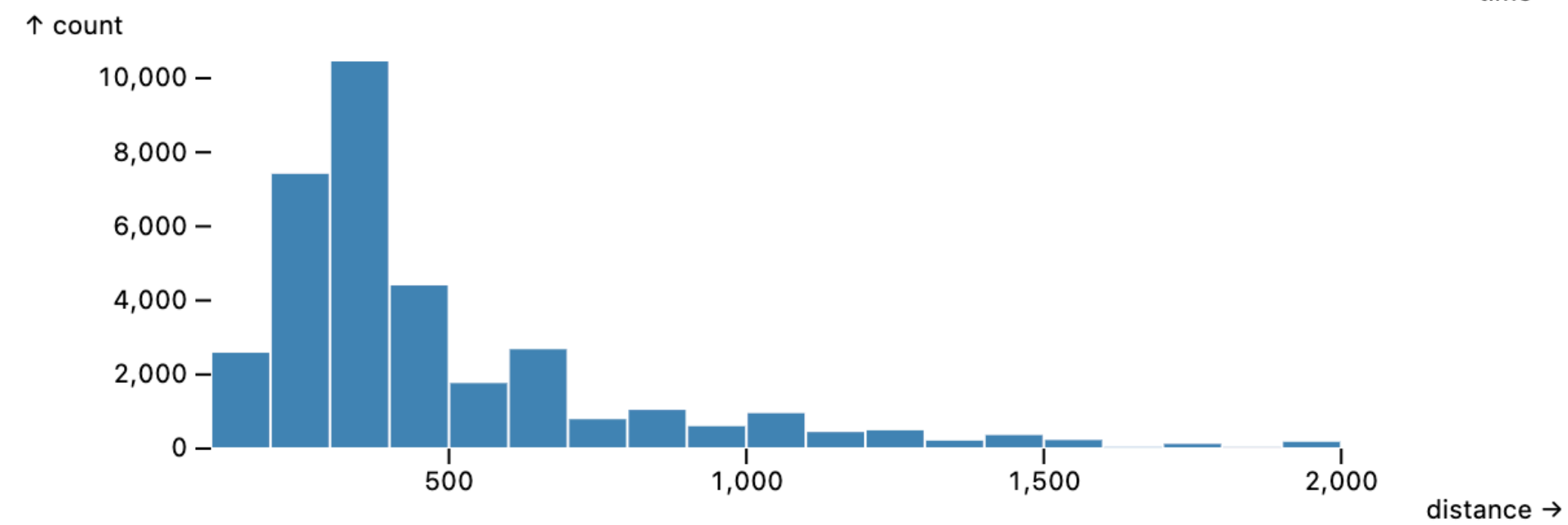
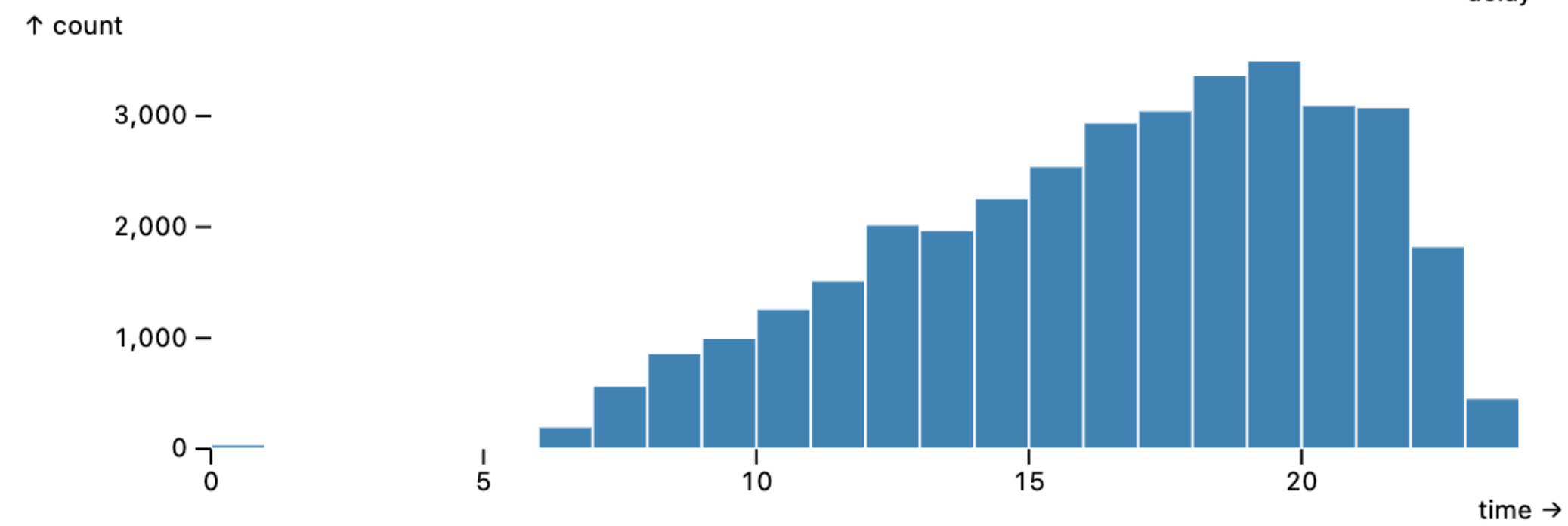
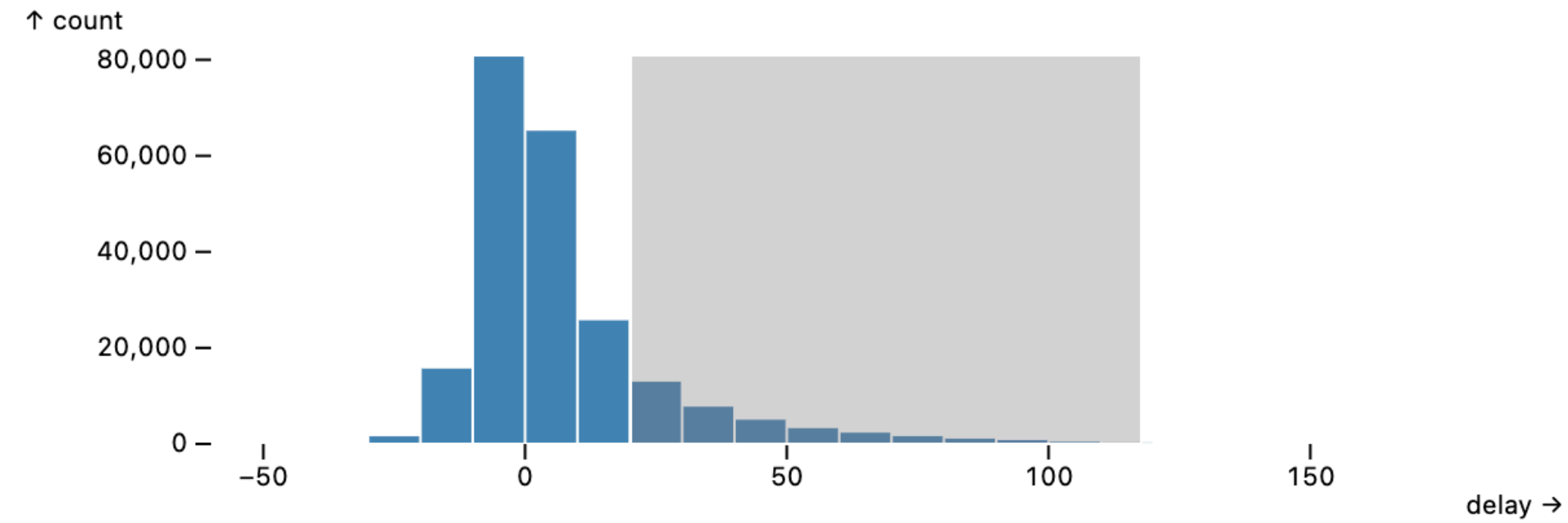
Auditory processing struggles with *dual-task* paradigms*

*Citation

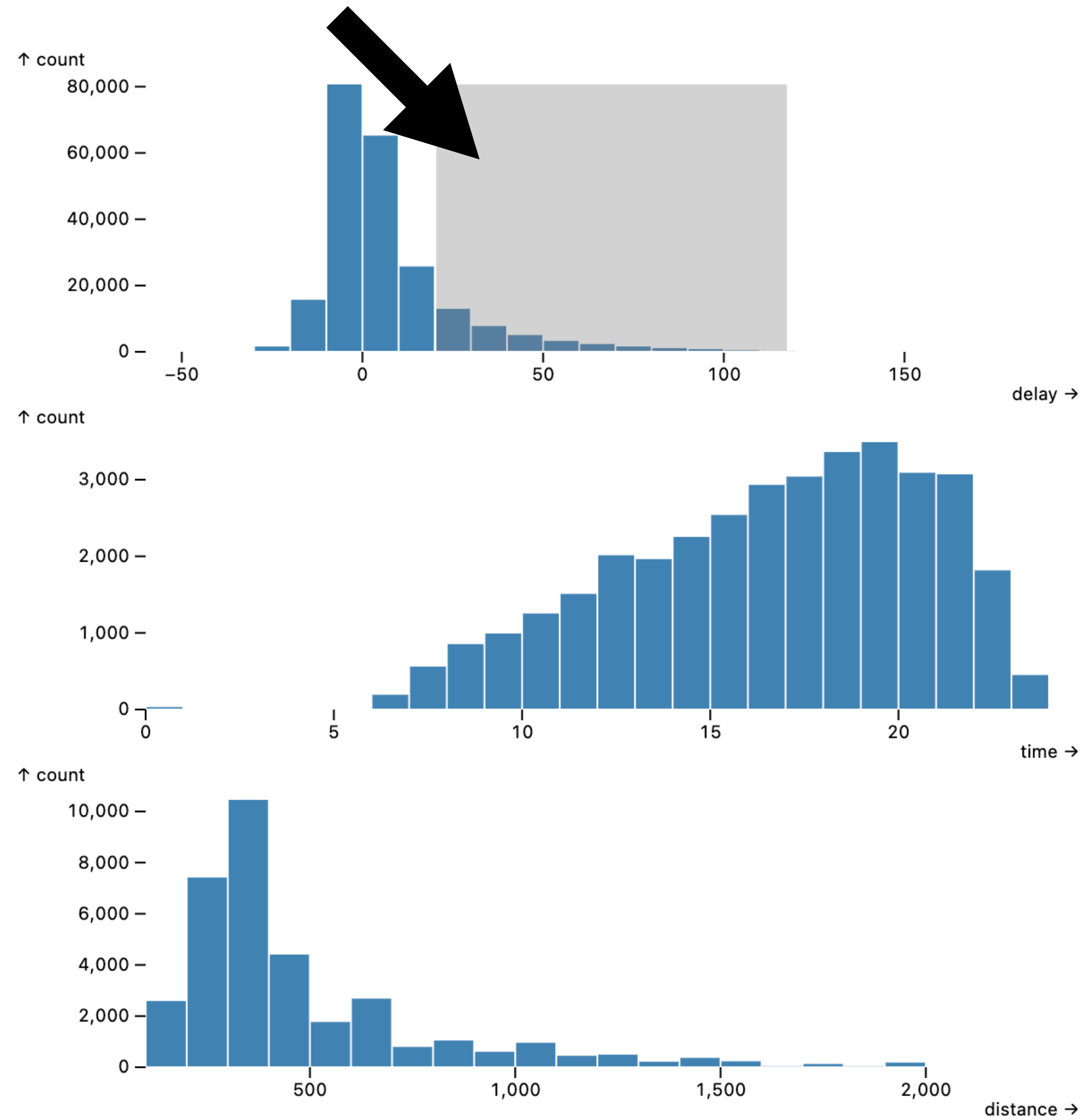
So what about cross-filtering?

[Interactive link](#)

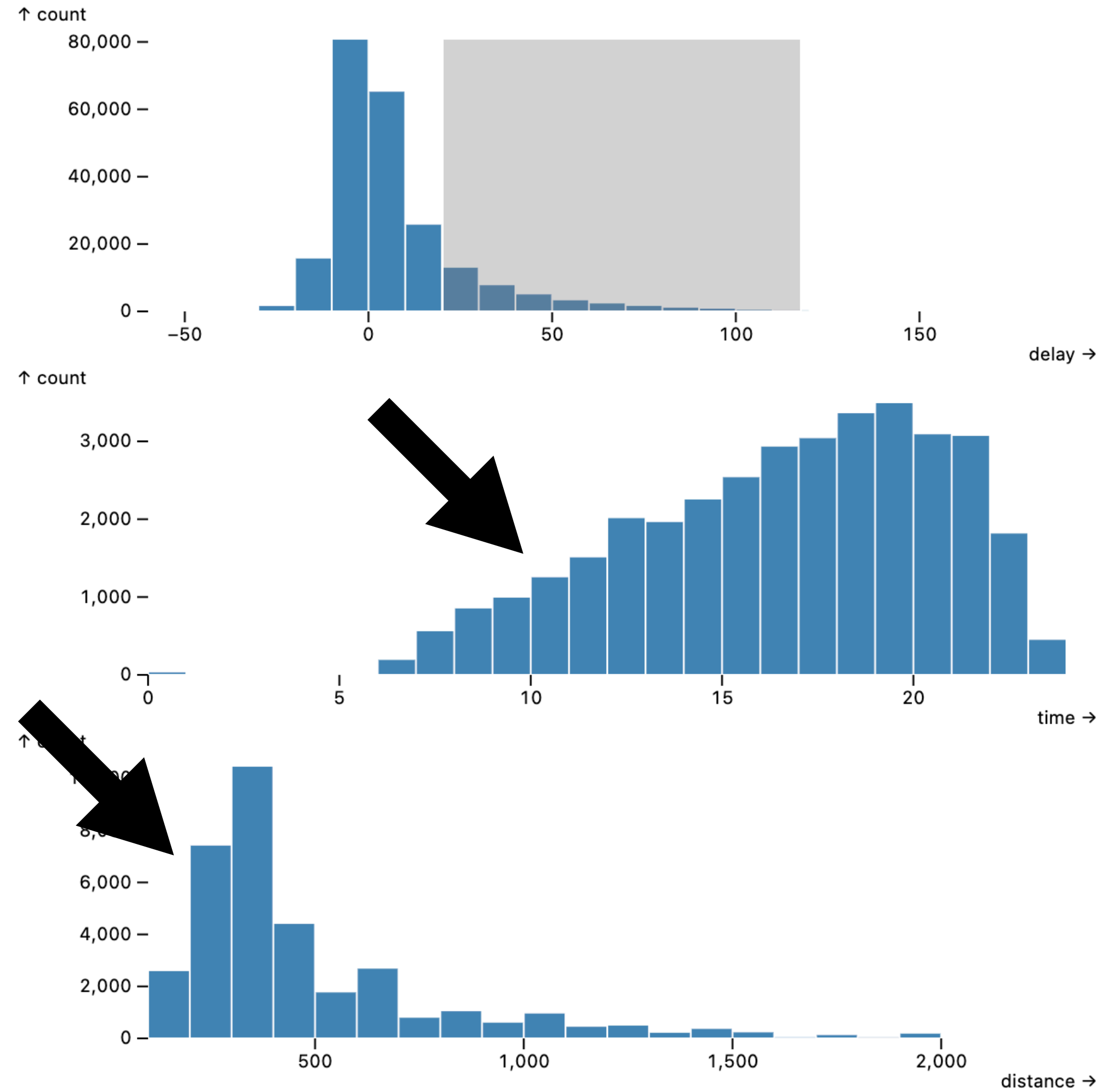
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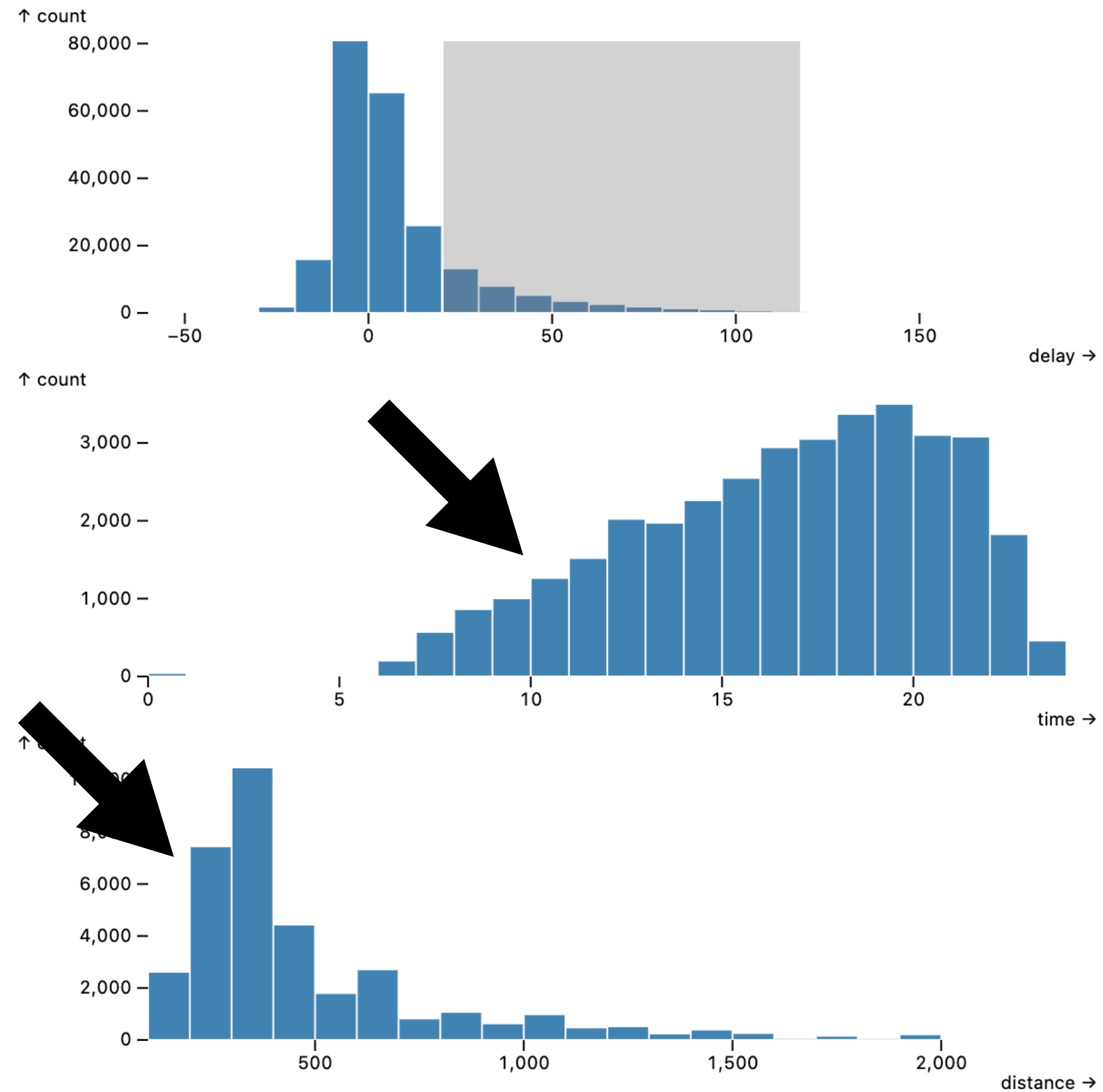
Interaction in one space...



Produces simultaneous, coordinated change in another.



How can we enable coordinated cross-interaction?



For blind users, descriptions, structural navigation, and sonifications will likely *not* solve this challenge.

Preliminary research question:

How do blind people interact with *multiple* tactile media simultaneously?

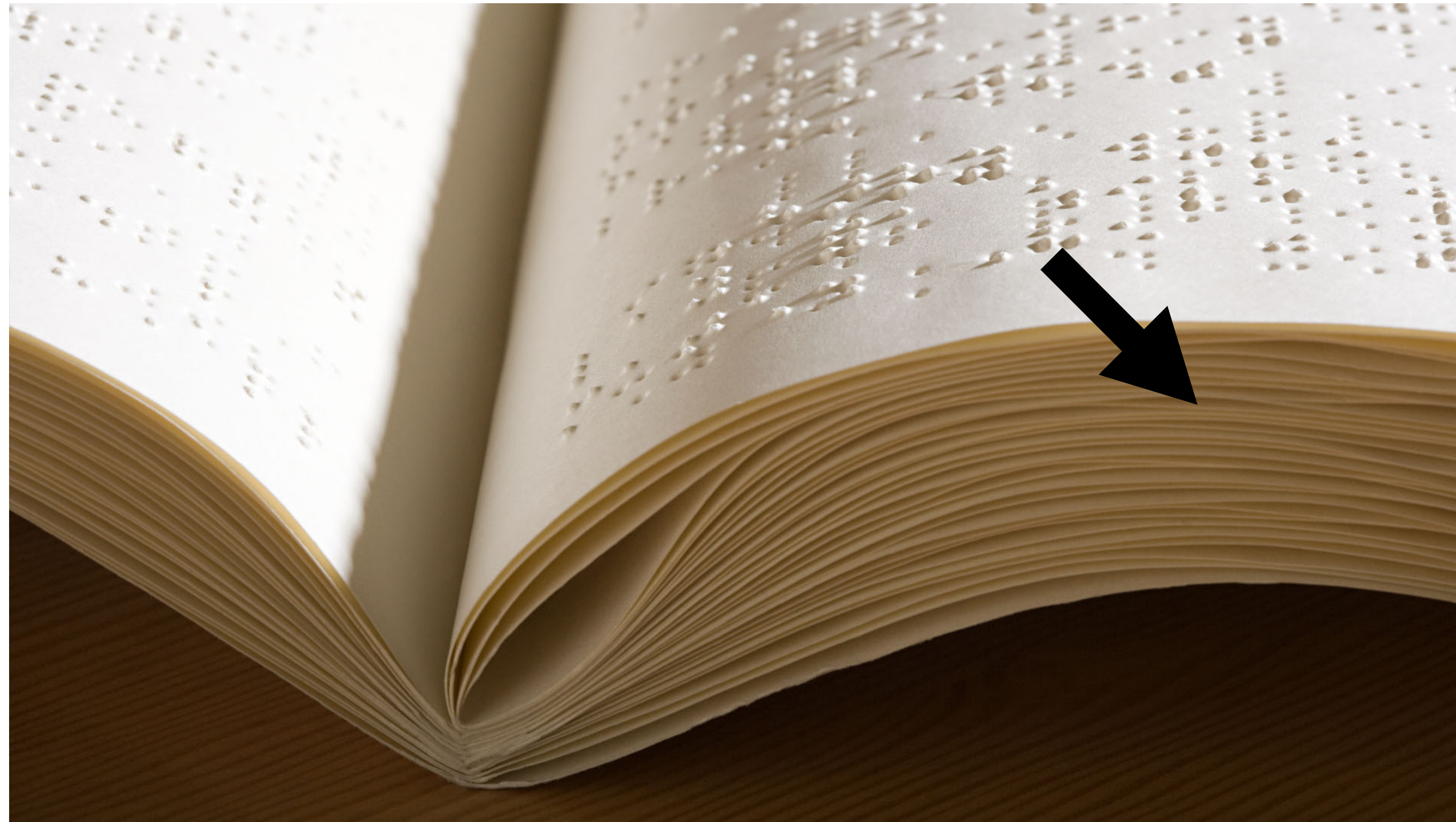
Observing: Embossed braille in a research context



[Image source](#)

Observation 1: Spatial memory storage

My friend didn't remember the details of a math equation exactly, but he knew *where* that equation was located in his stack of braille pages and *where* on the page the equation was.



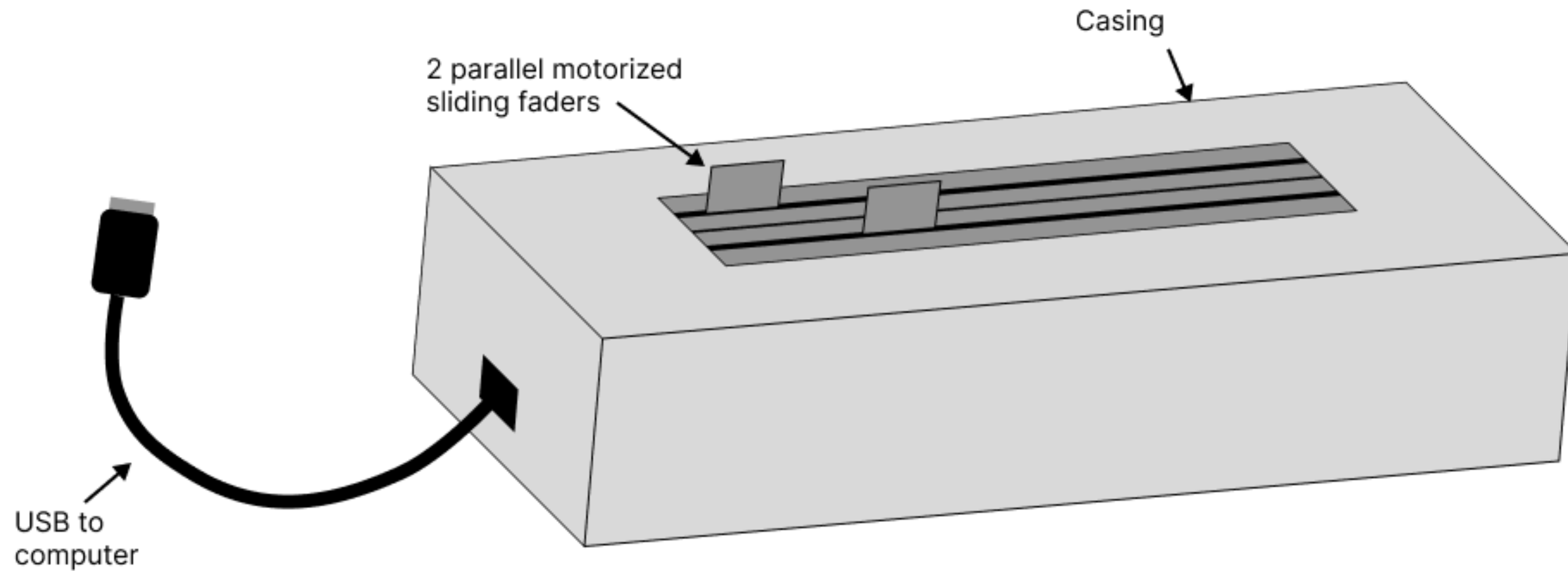
[Image source](#)

Observation 2: Coordinating perception and comparison

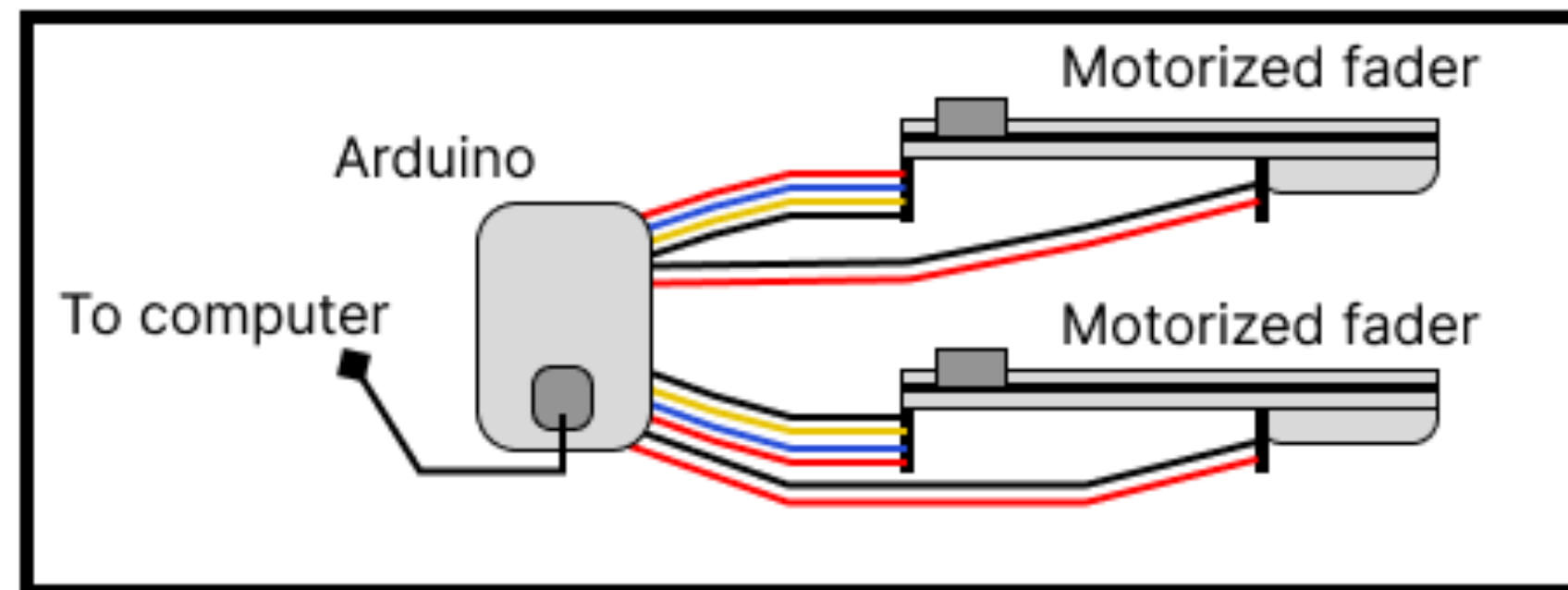
He then compared 2 equations at once. The details of each weren't important. He was *feeling* for differences simultaneously.



Prototype 2: the *cross-feelter*, 2 motorized faders



Schematic

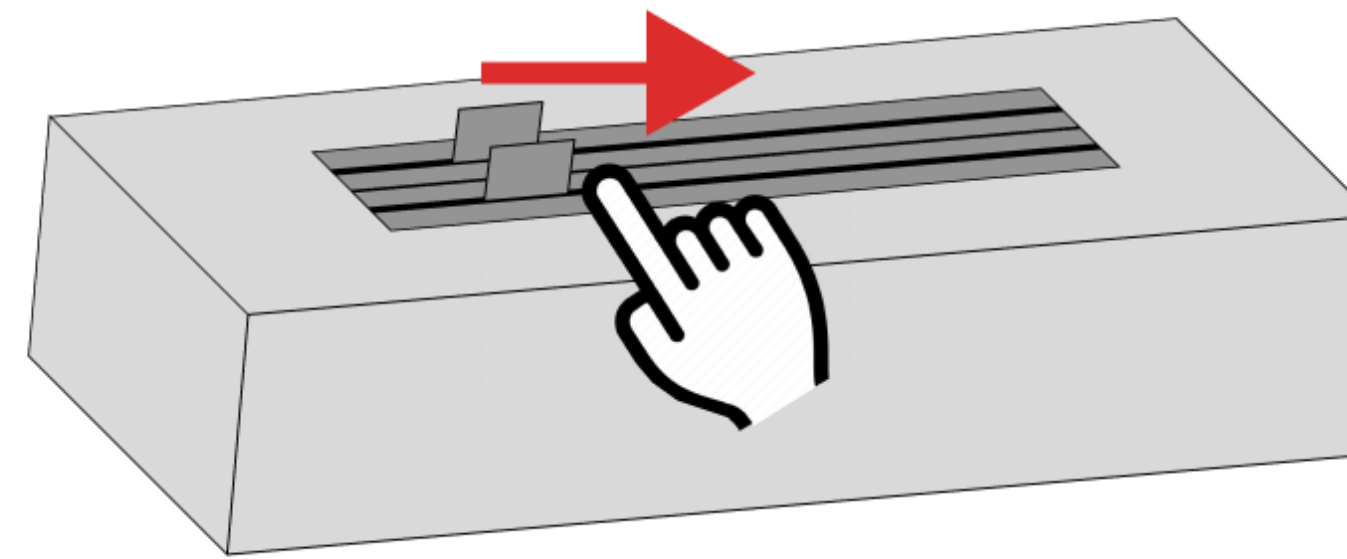


One slider can work with video

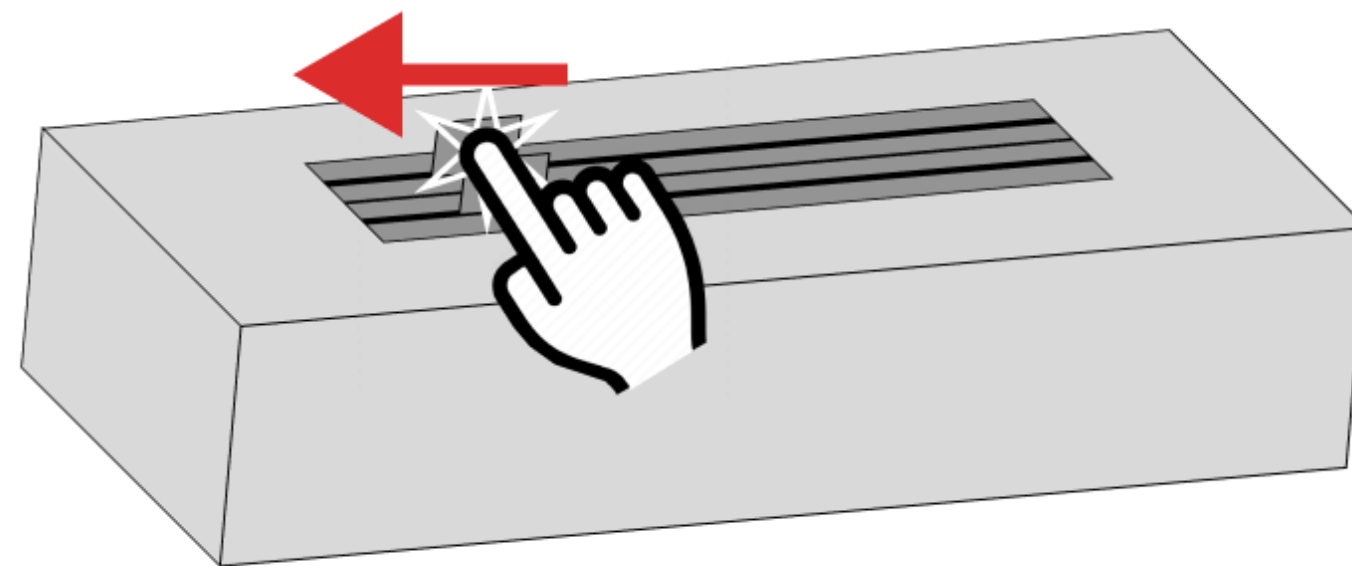
1. Video plays with progress slider moving



2. Slider follows, can be felt



3. User can move slider

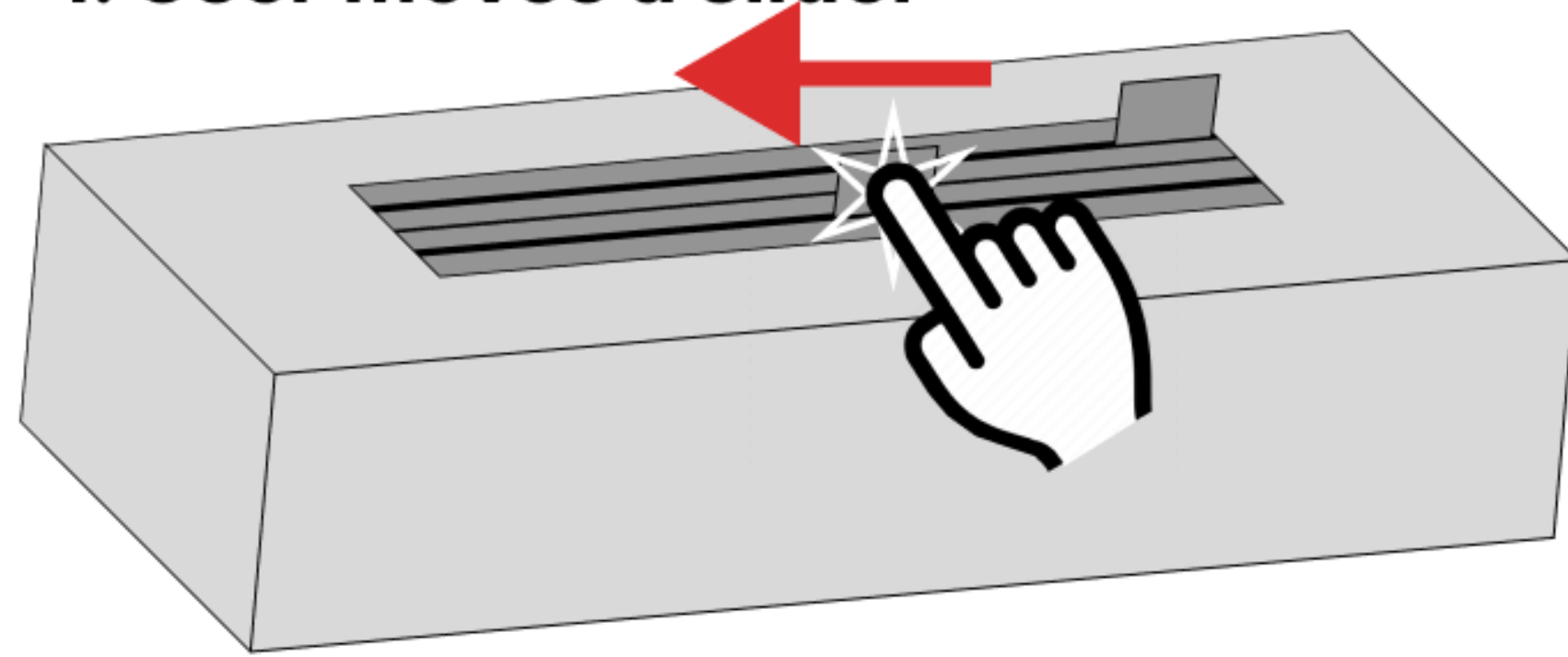


4. Video slider will move with slider change

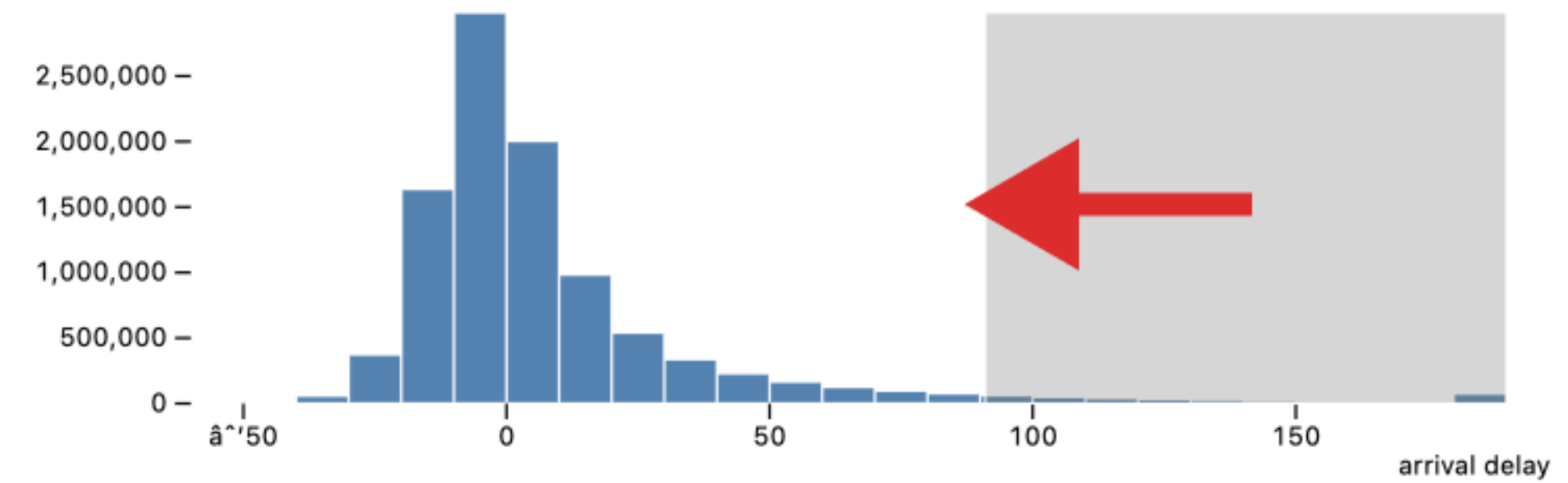


While 2 sliders works for cross-filtering

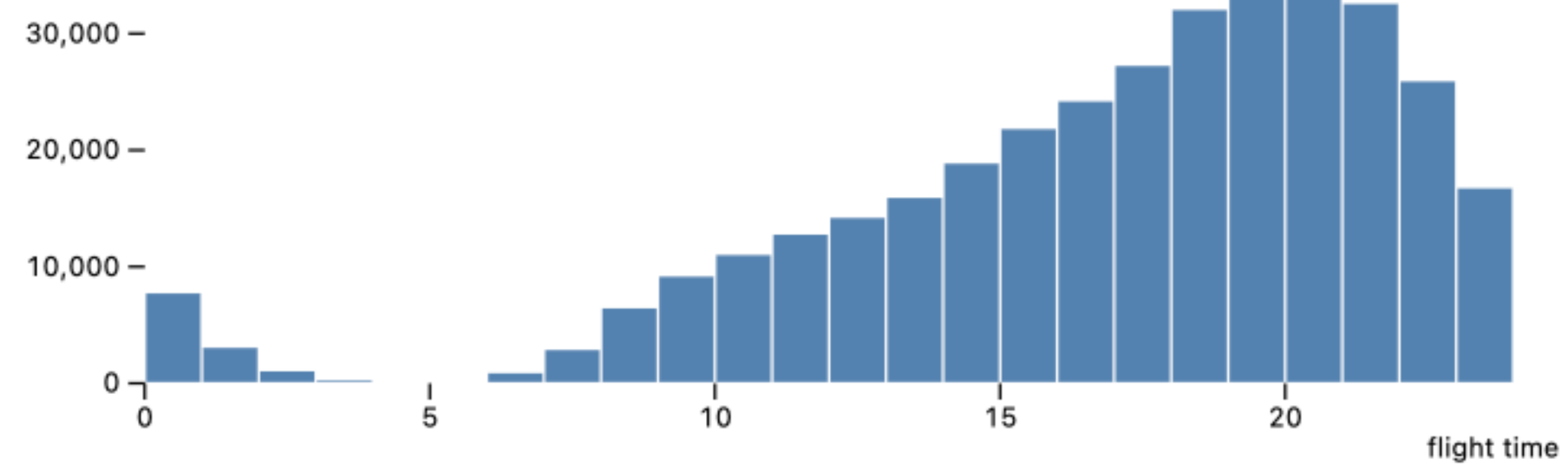
1. User moves a slider



2. Corresponding filter edge moves with

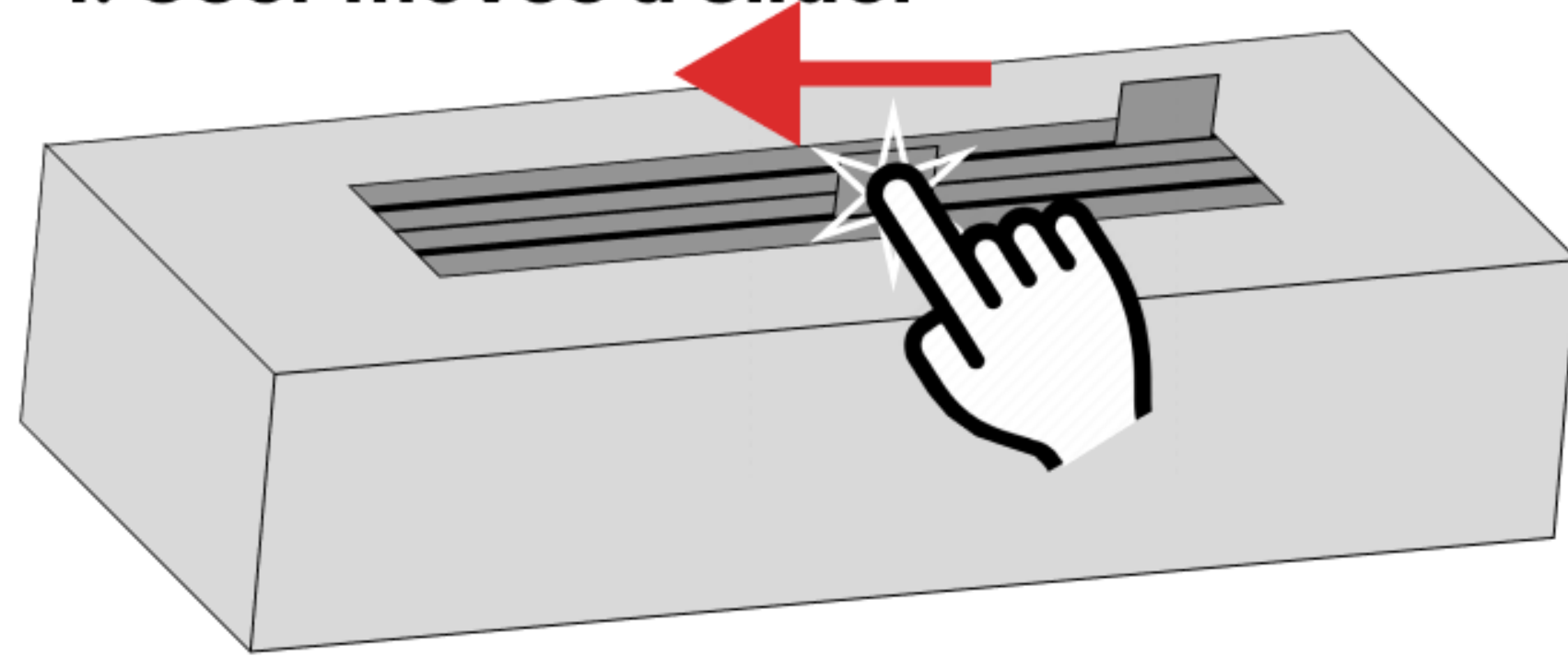


3. Secondary visualization updates

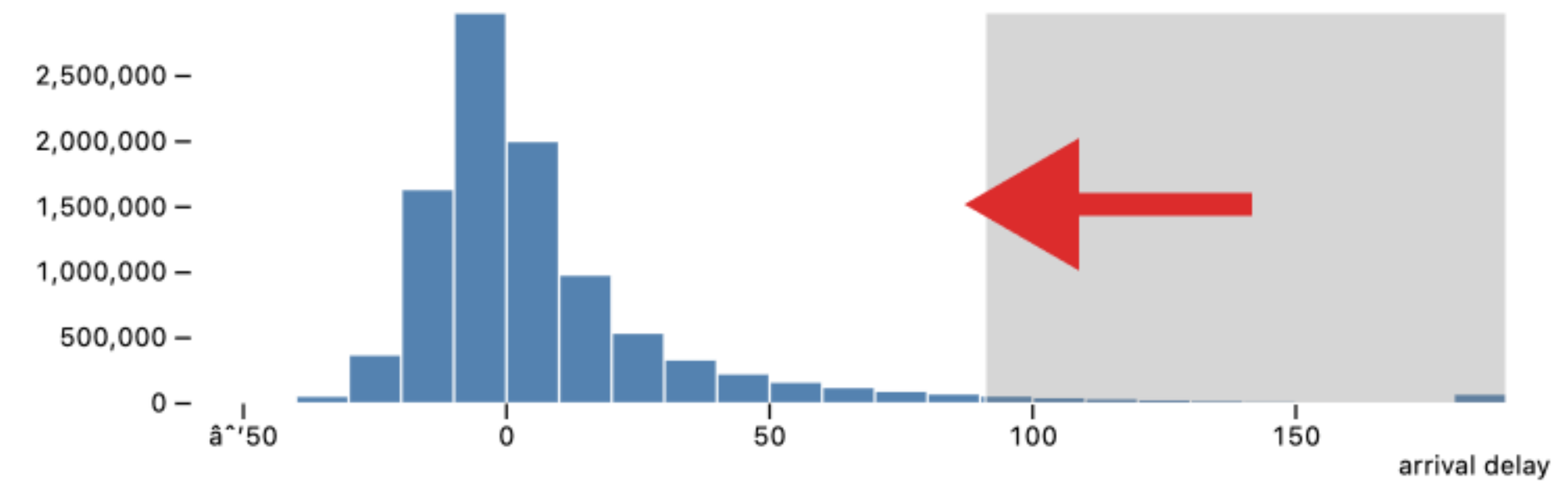


A tactile display can render the input or output chart

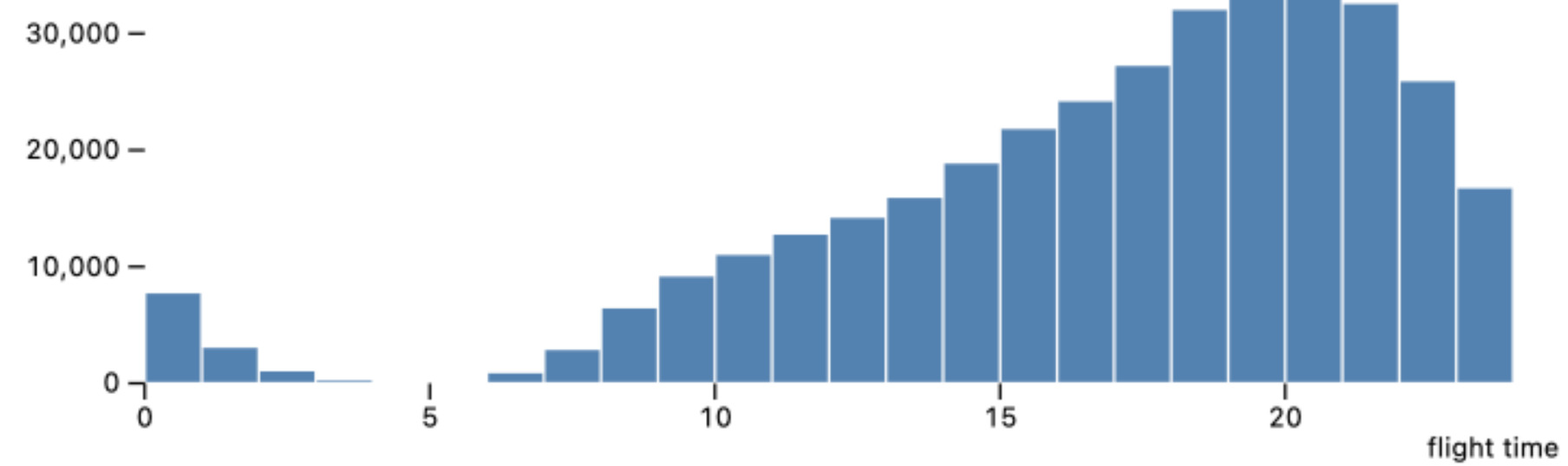
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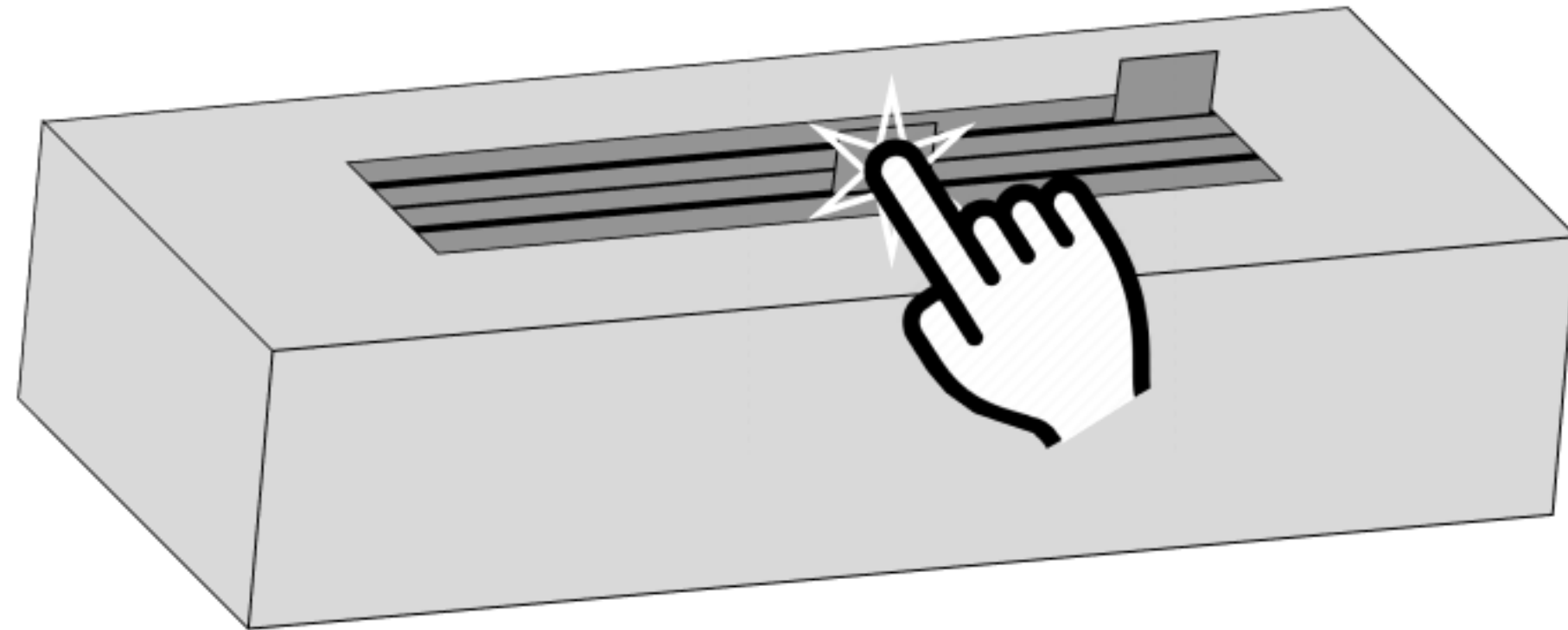


4. Tactile display renders



Cross-coordination! A tactile, dual-task paradigm.

User can interact with a space separate from their current focus!



2025

★ Slides here → frank.computer

Cross-feelting: Exploring a coordinated, cross-interaction prototype for blind data interaction



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