

Accessibility and Visualization

An introductory lecture: Concepts, history, and practice.



Frank Elavsky

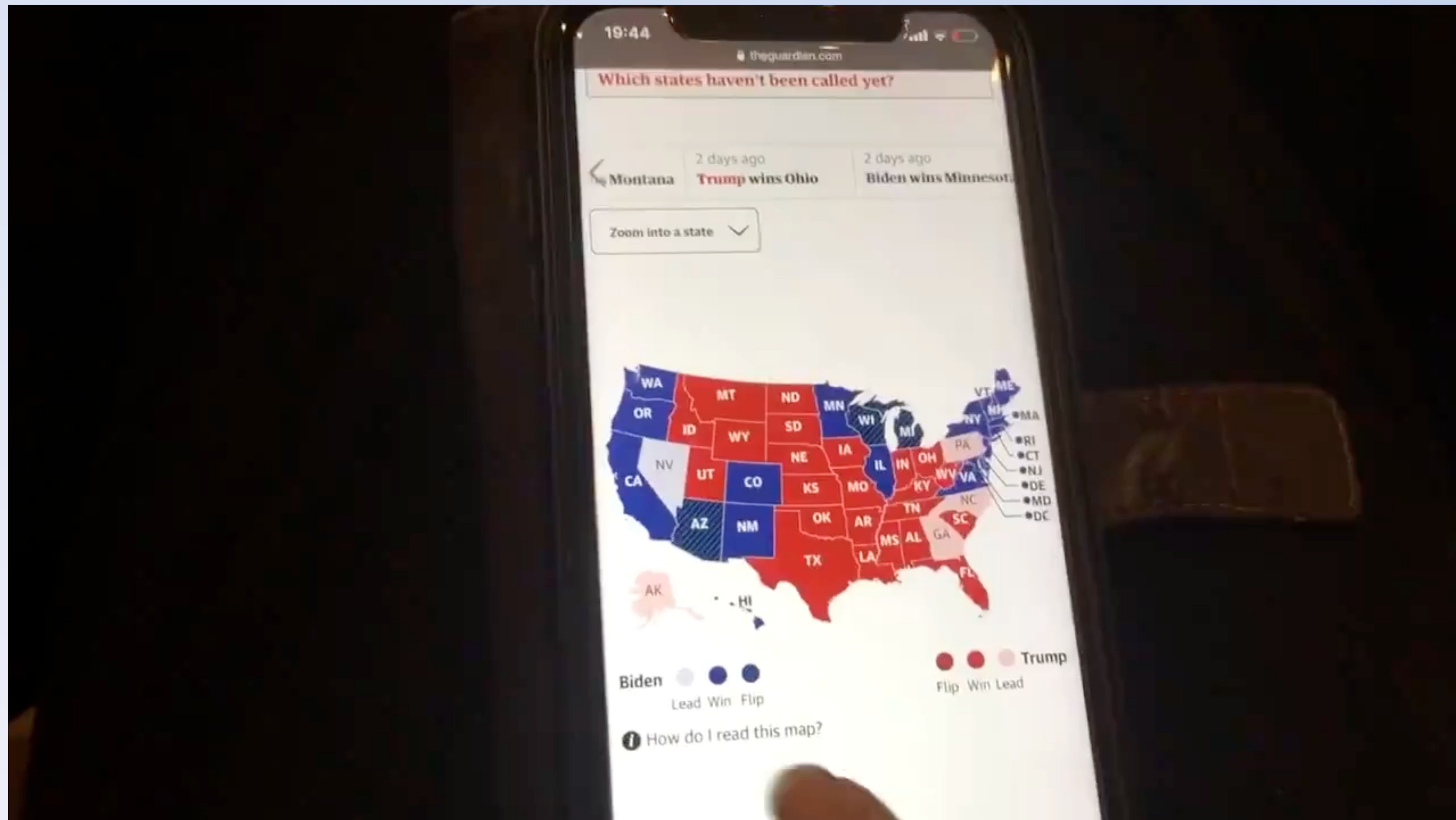


hcii.cmu.edu, axle-lab.com, dig.cmu.edu



What is an inaccessible experience like?

Credit: Sarah Fossheim [on twitter](#)



So “accessibility:” What is it?

Accessibility:

1. The qualities that make an experience open or usable to all.

Accessibility:

1. The qualities that make an experience open or usable to all.
- 2. The qualities that make an experience open or usable specifically for people with disabilities.**

Discuss: Why do people do this work?

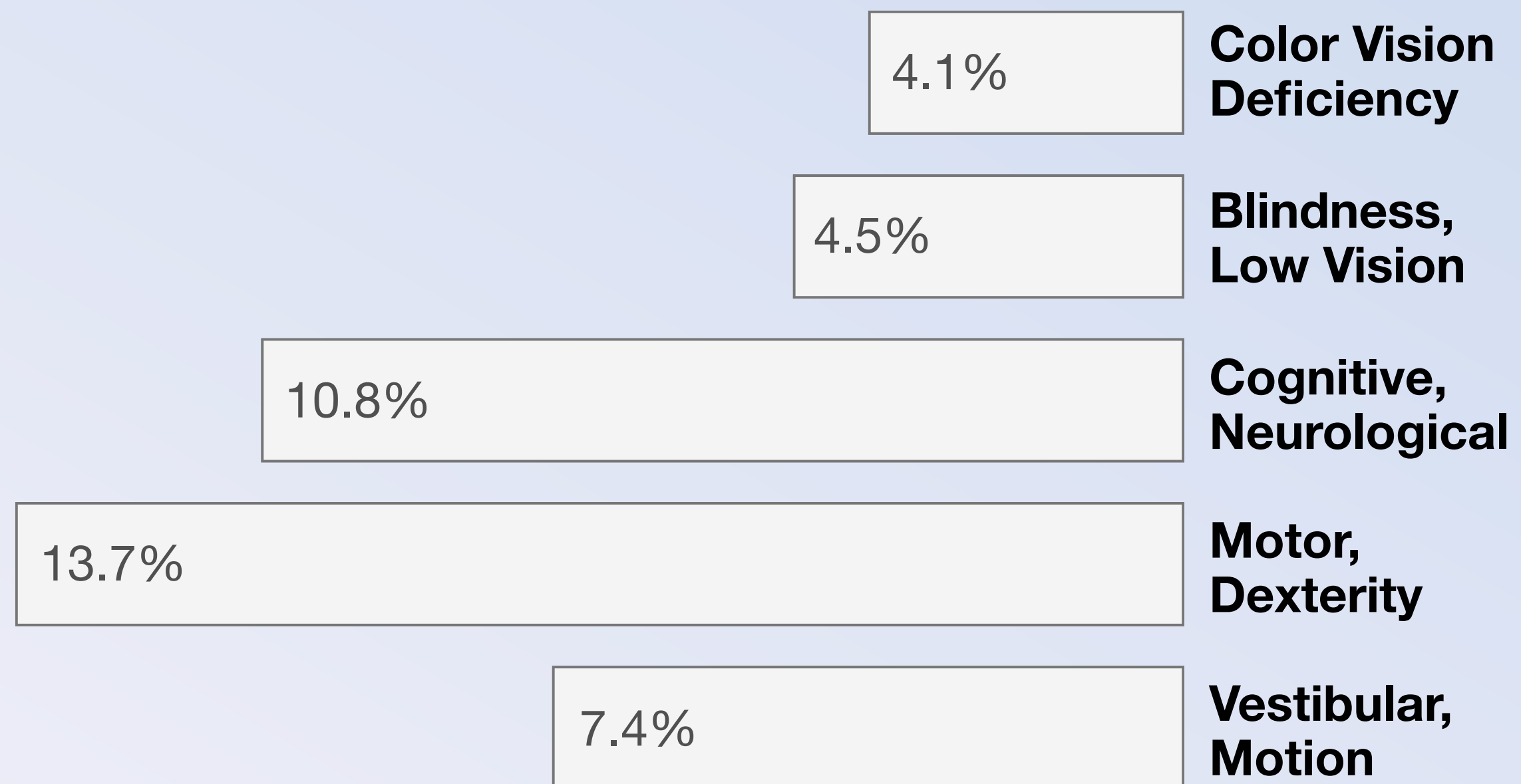
Access is a human right

Accessibility is an internationally recognized human right.

It is the morally and ethically correct thing to do.



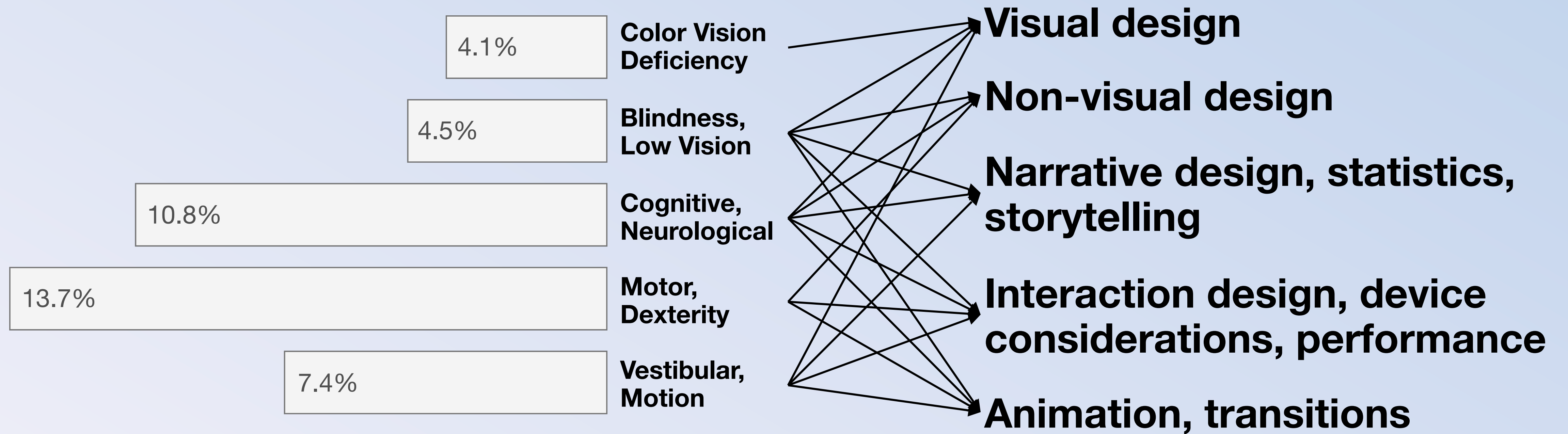
UN CRPD Article 9: Accessibility, UN CRPD Article 10: Right to Life

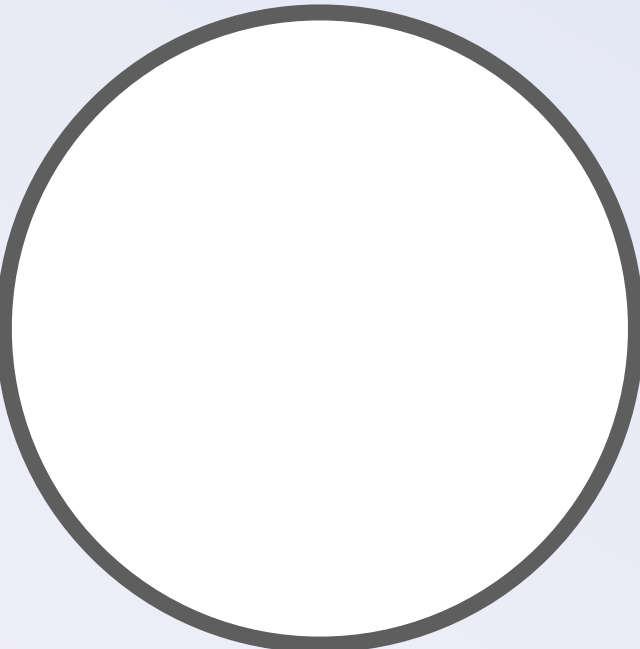


Source: Okoro et al. "Prevalence of Disabilities and Health Care Access by Disability Status and Type Among Adults"

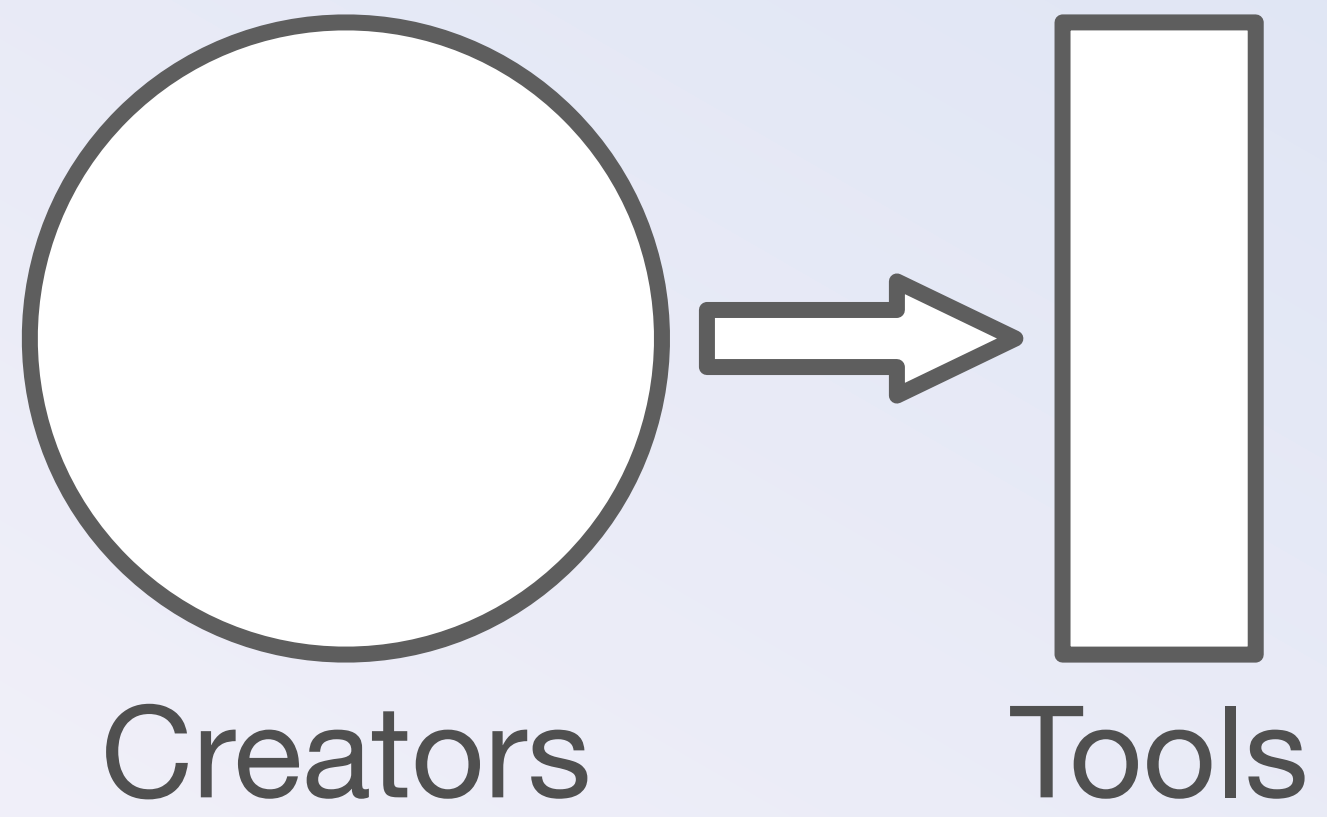
~27% of people living in the United States self-report living with a disability that affects their daily life.

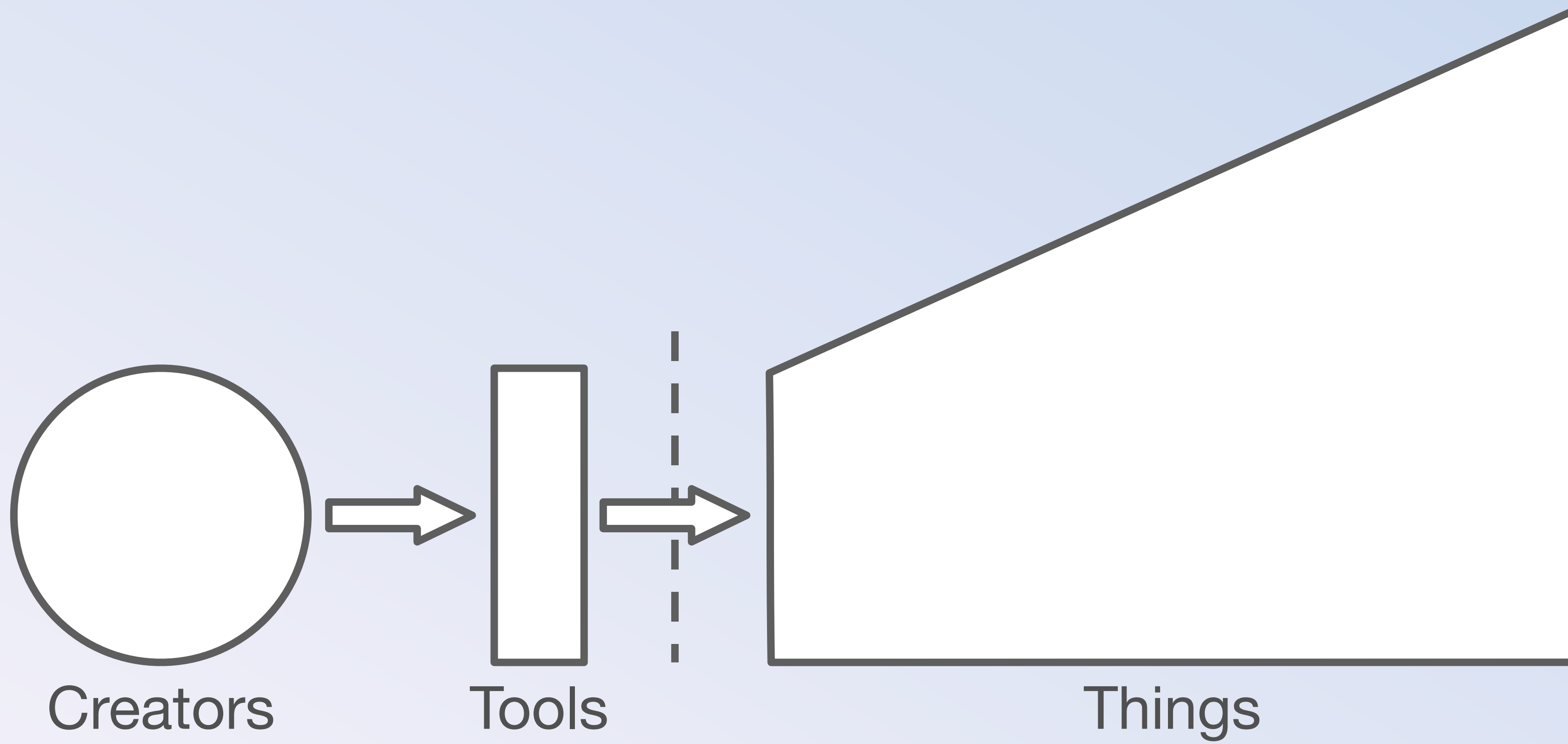
Accessibility affects every aspect of visualization work

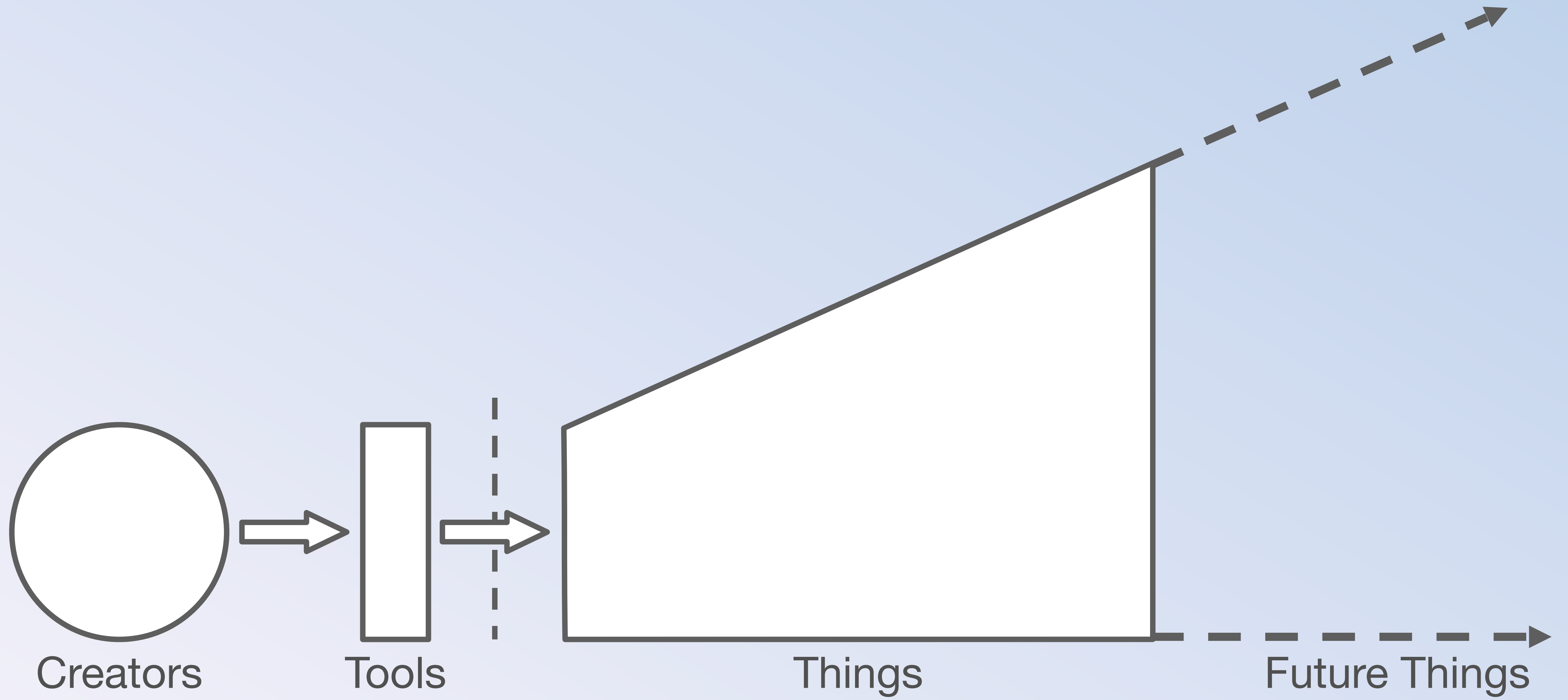




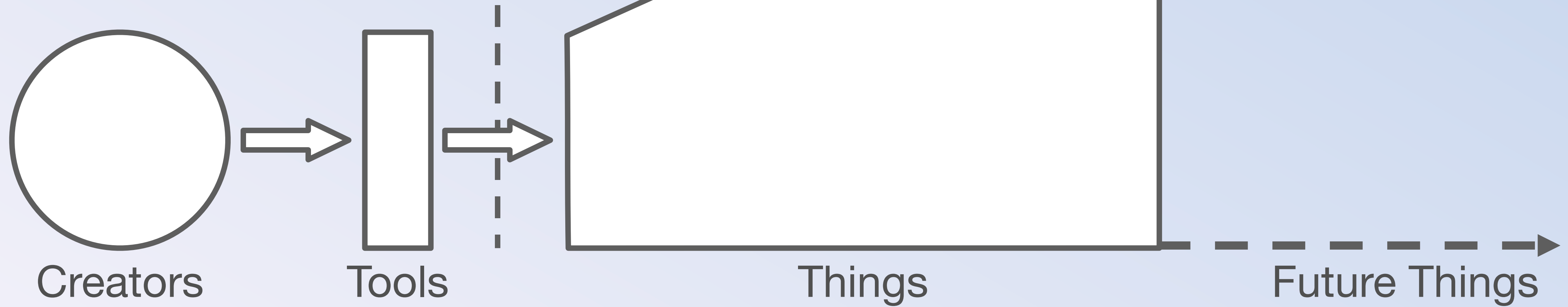
Creators





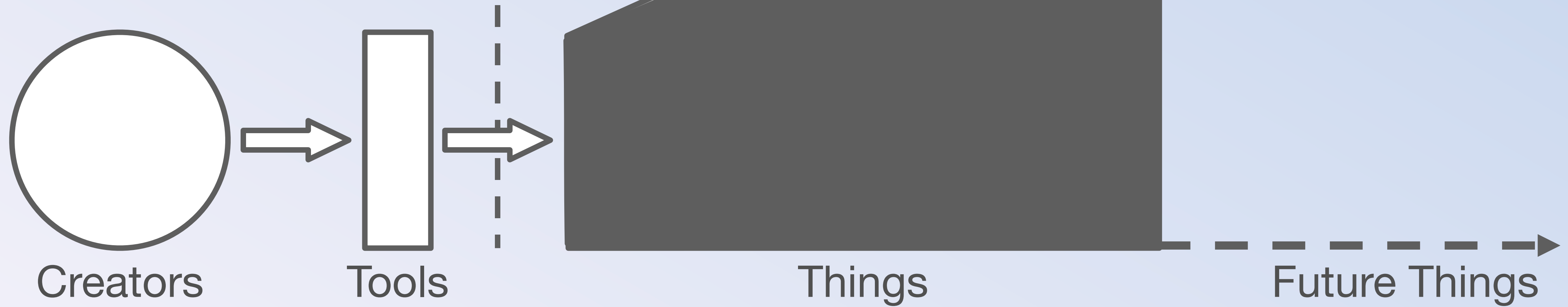


**But how much of this is
inaccessible?**



97-99%

Source: World Wide Web Consortium. "The WebAIM Million Report." 2019-2022



Concept(s): **social** vs **medical** models of disability

a “curb”



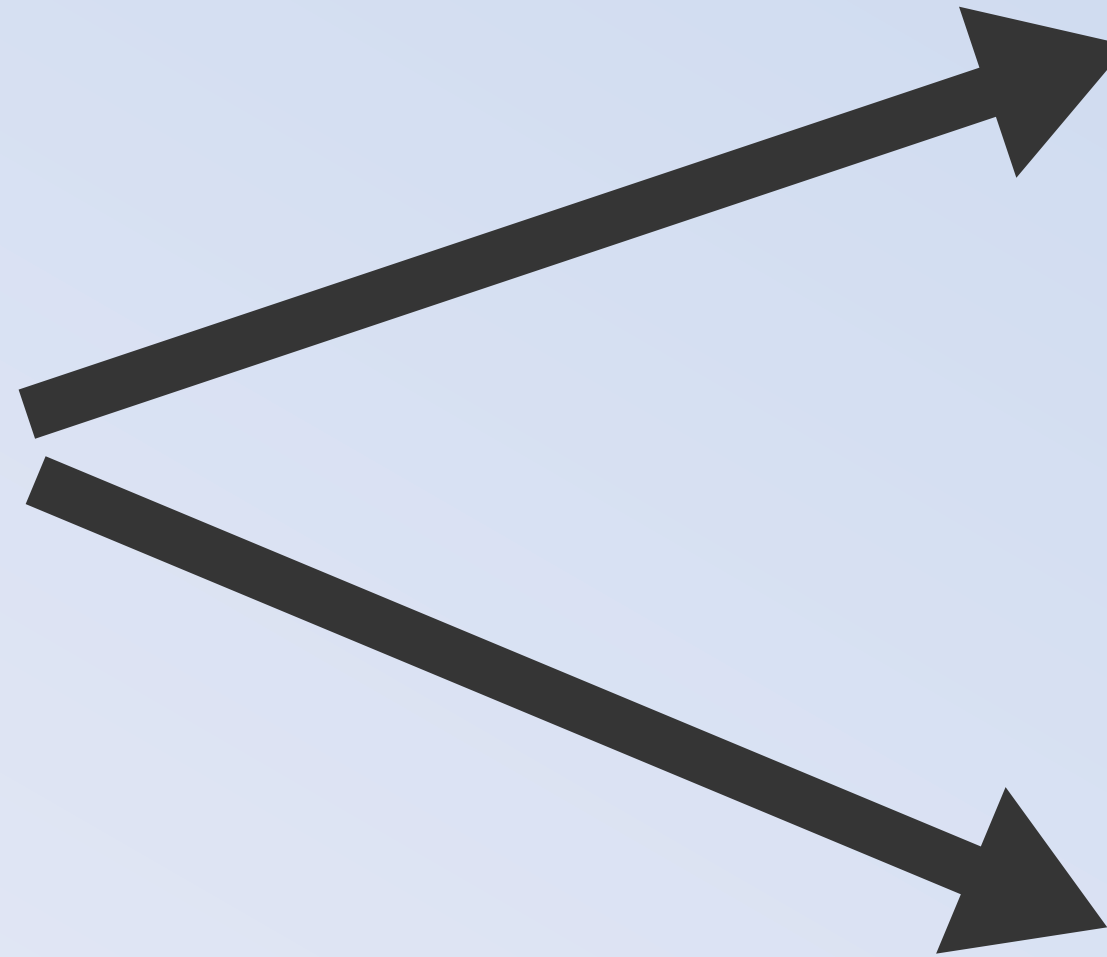
What do we do about curbs in our cities?



Medical model: the body is the cause of disability (according to normative standards).



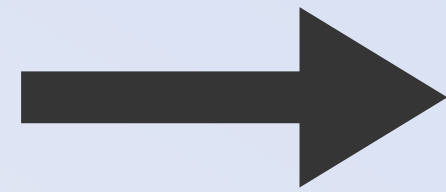
Medical model: augment or “cure” the body.



Social model: The *curb* is the source of disability (a “barrier” to access).



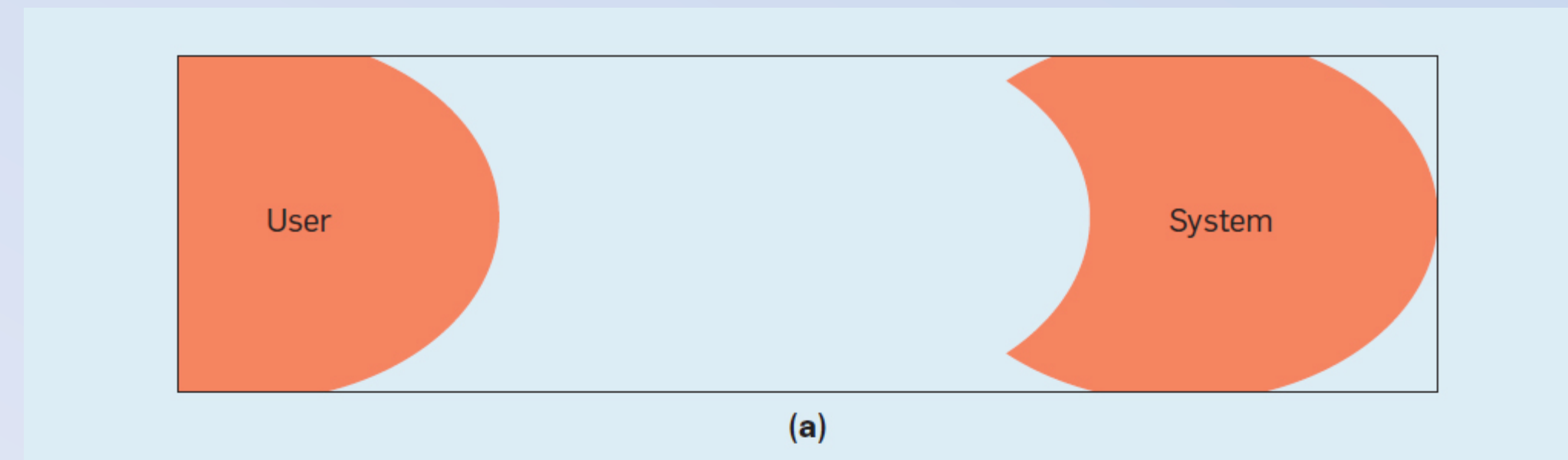
Social model: Cut the curb and standardize.



Concept: **Ability Assumptions**

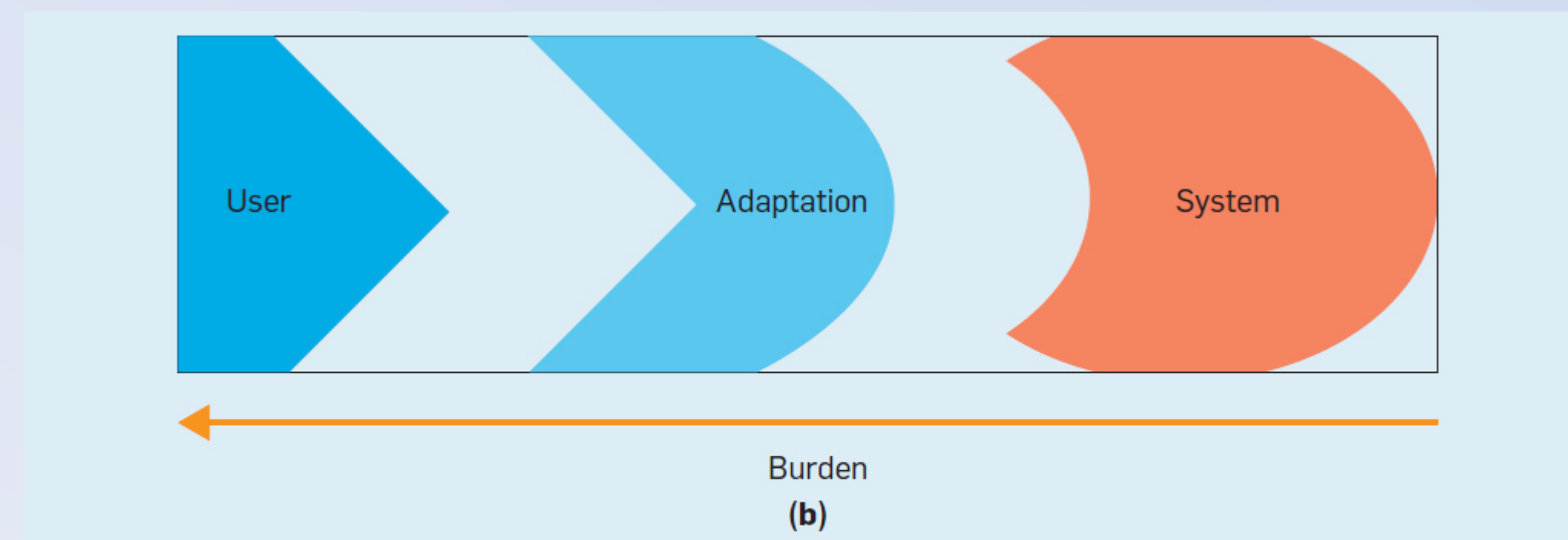
Ability Assumptions

(Wobbrock et al) <https://cacm.acm.org/magazines/2018/6/228034-ability-based-design/fulltext>



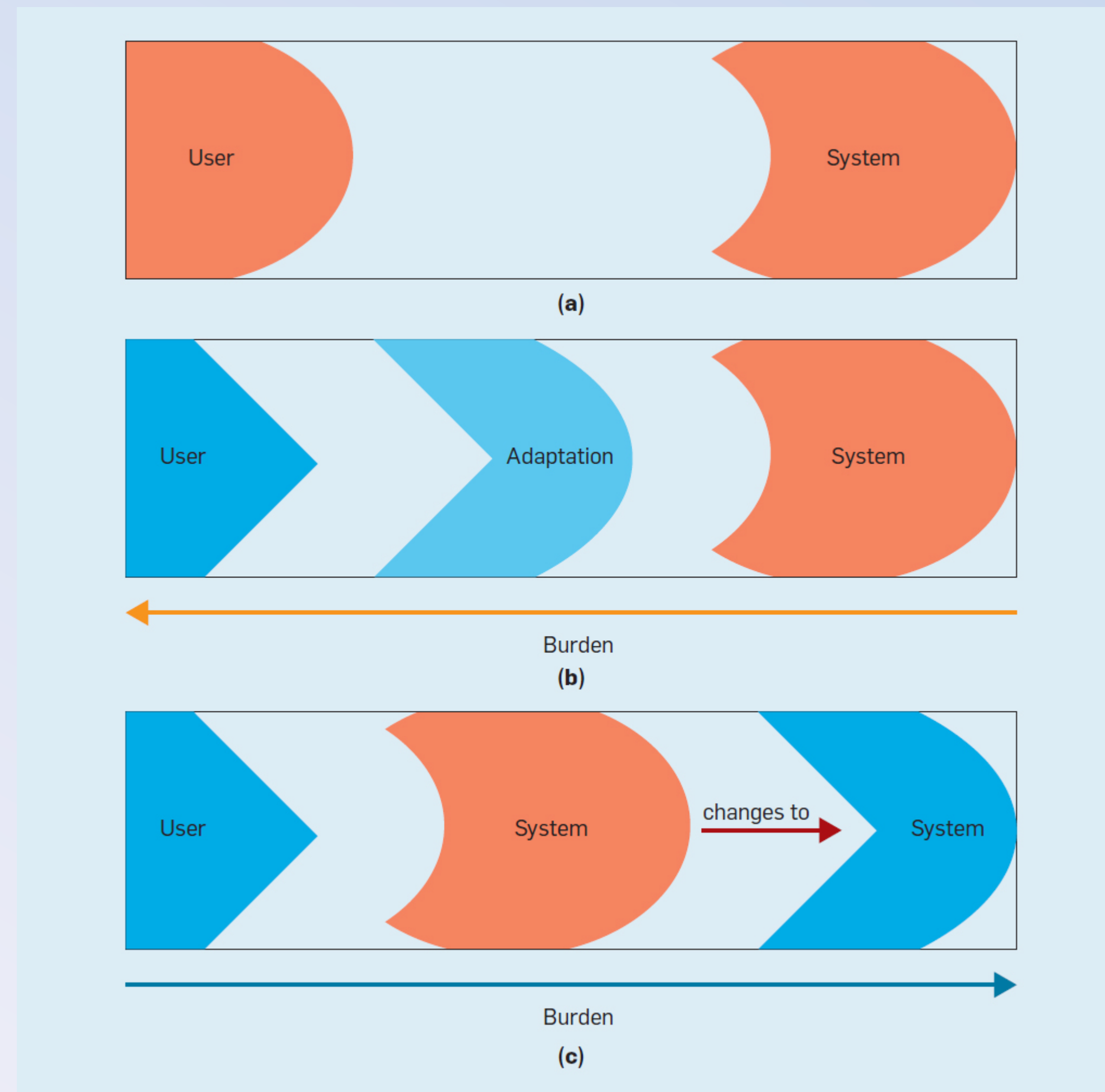
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A curb exclusively assumes the ability to step up



A cut curb has fewer *exclusive* ability assumptions



Concept: **Situational Impairment**

Permanent

Touch



One arm

Permanent

Temporary

Touch



One arm



Arm injury

Permanent

Temporary

Situational

Touch



One arm

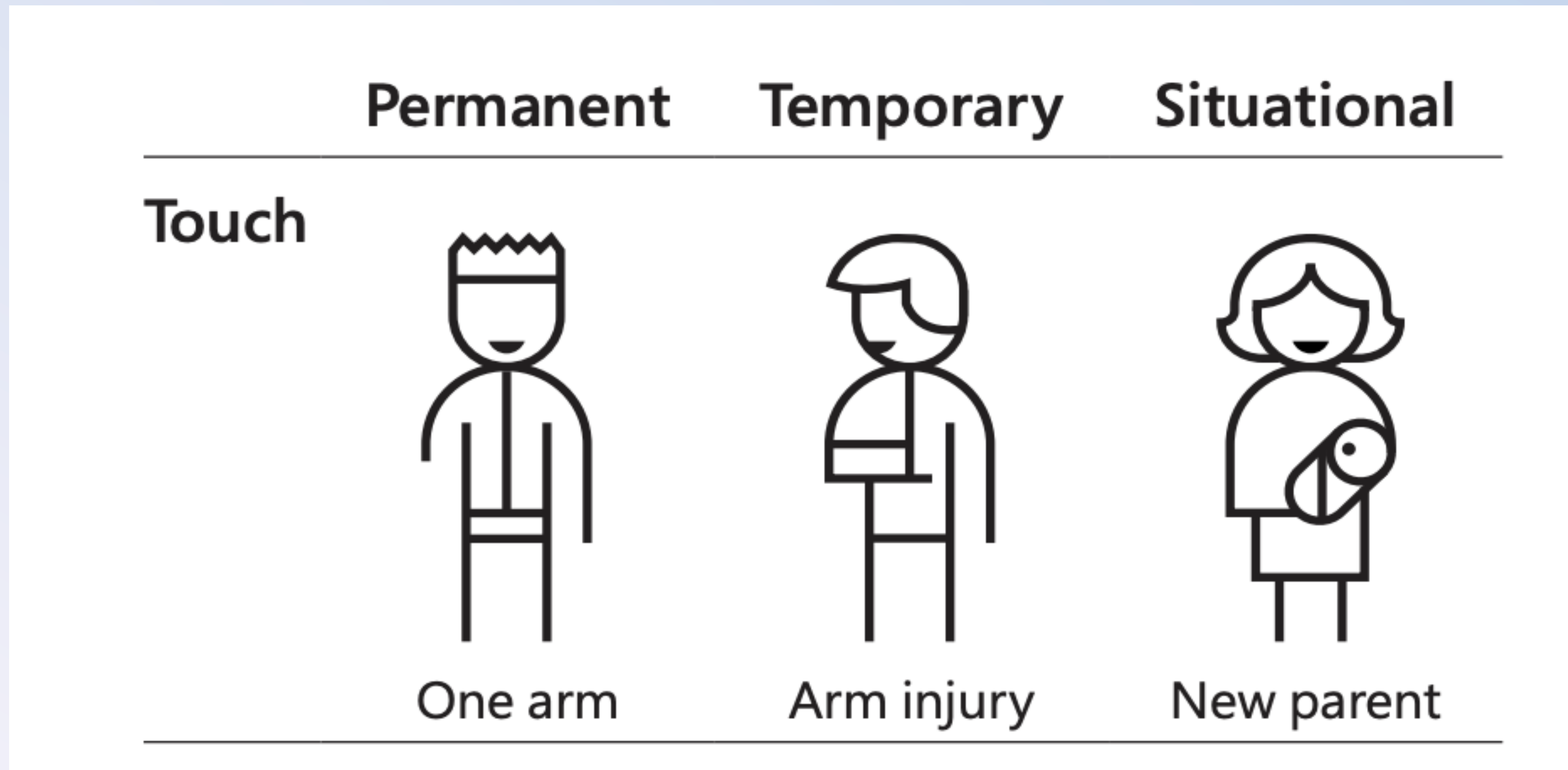


Arm injury



New parent

We all experience situational impairment in our daily lives. **Accessibility benefits everyone!**



“Design for One, Extend to All”

Microsoft’s Inclusive Design 101 Toolkit: https://download.microsoft.com/download/b/0/d/b0d4bf87-09ce-4417-8f28-d60703d672ed/inclusive_toolkit_manual_final.pdf

	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

Discuss: Share an example where you might be impaired in some way and how accessible technology or infrastructure helps you.

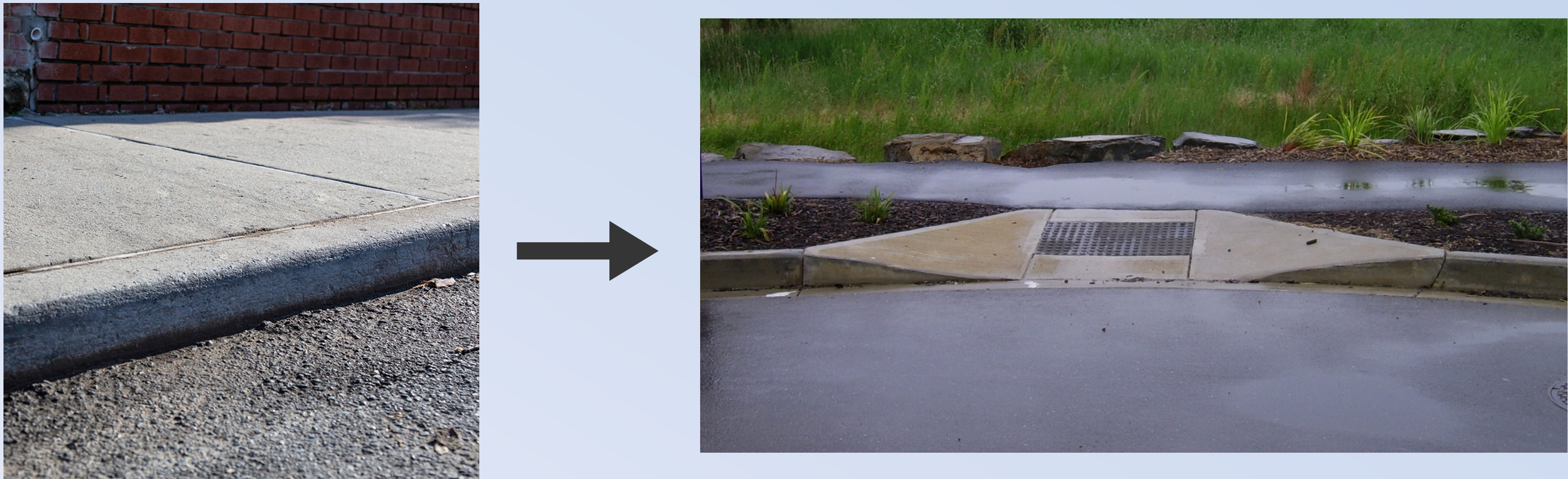
**Does “design for one, extend to all”
have limits? Problems?**

Final Concept: **Disability-Centered Design**

**“Nothing about us
without us”**
And the 1977 504 sit-in.

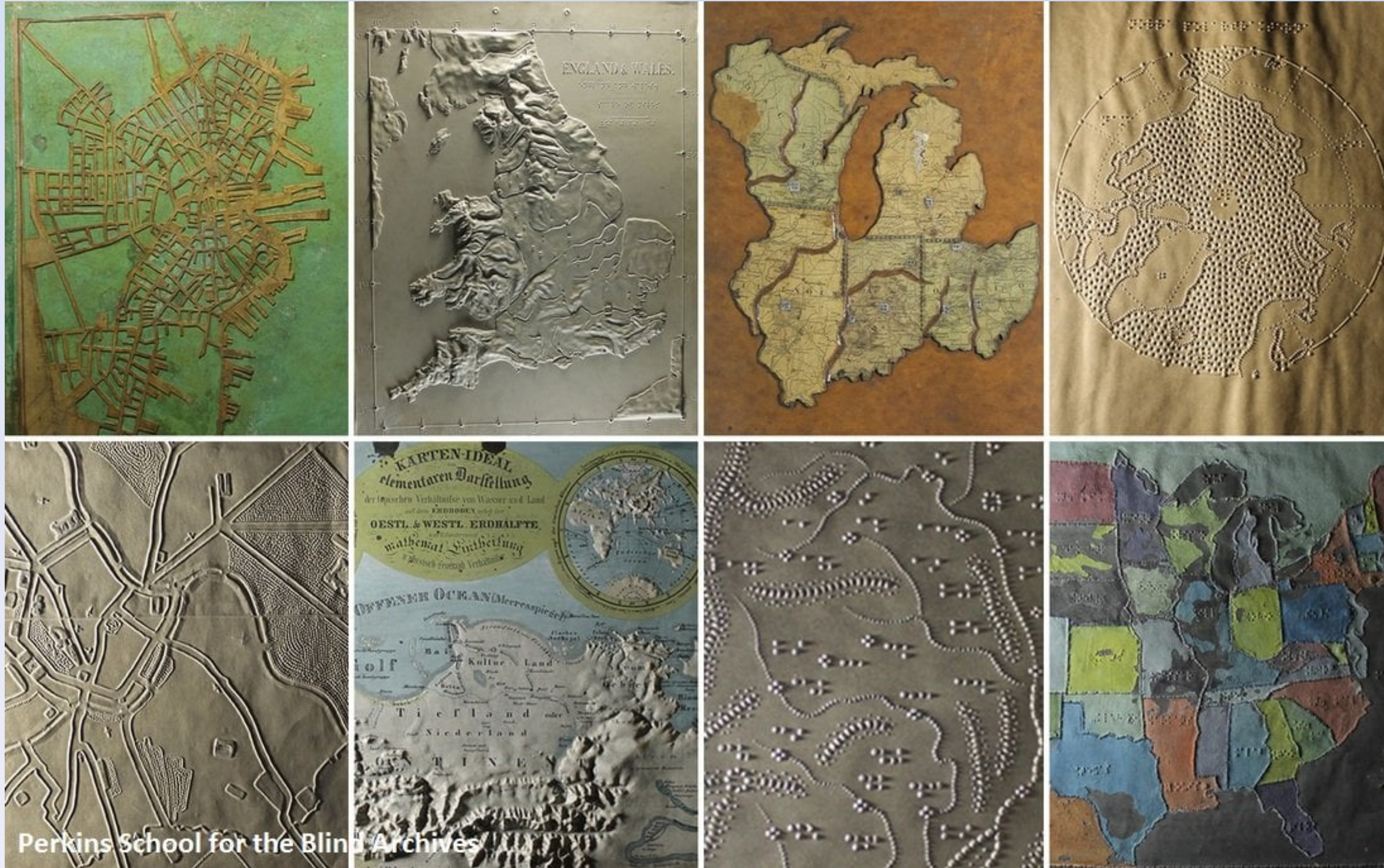


In practice, “curb cut” work has been *prioritized*



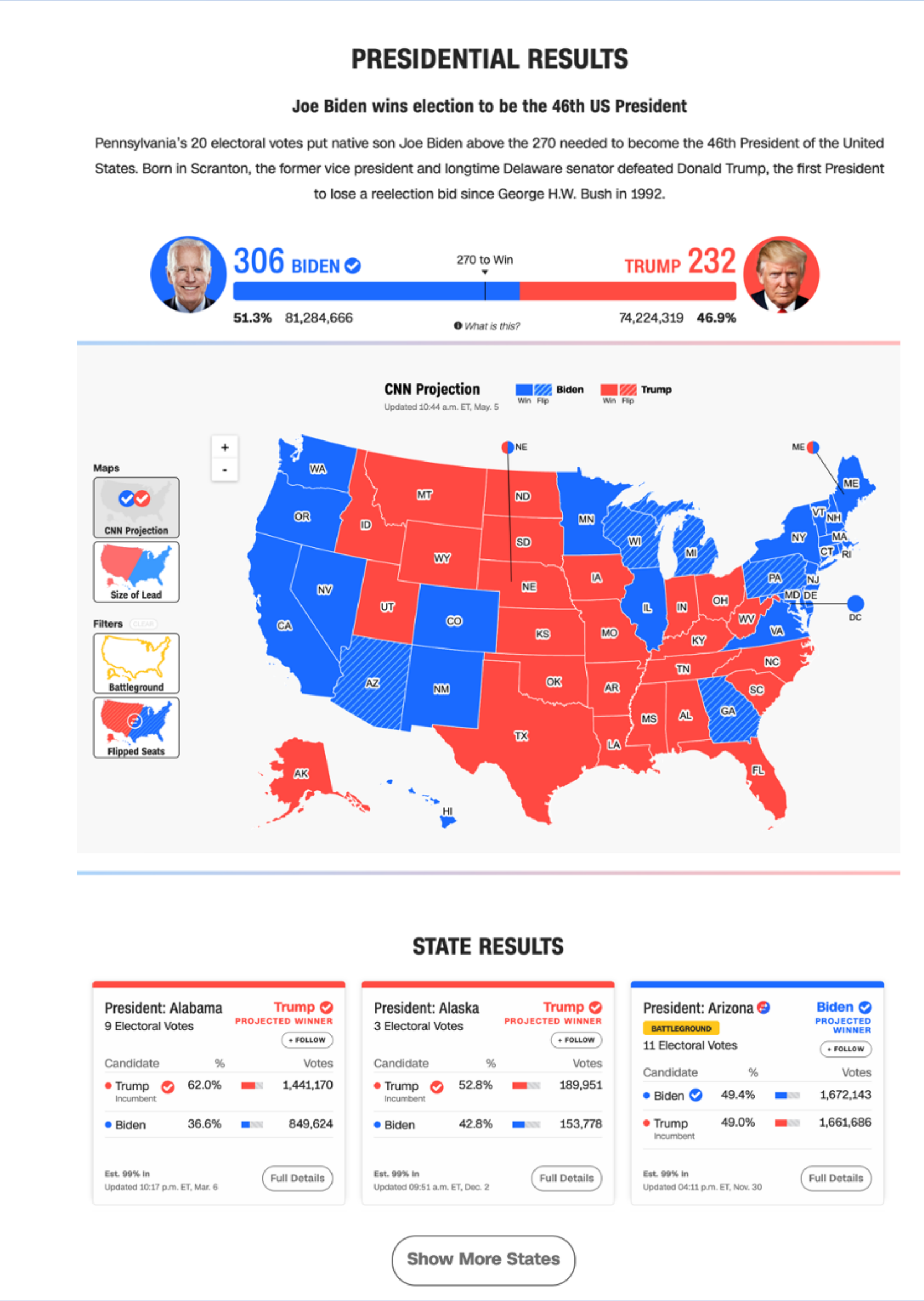
	Permanent	Temporary	Situational
Touch			
	One arm	Arm injury	New parent

The best work centers on people with disabilities

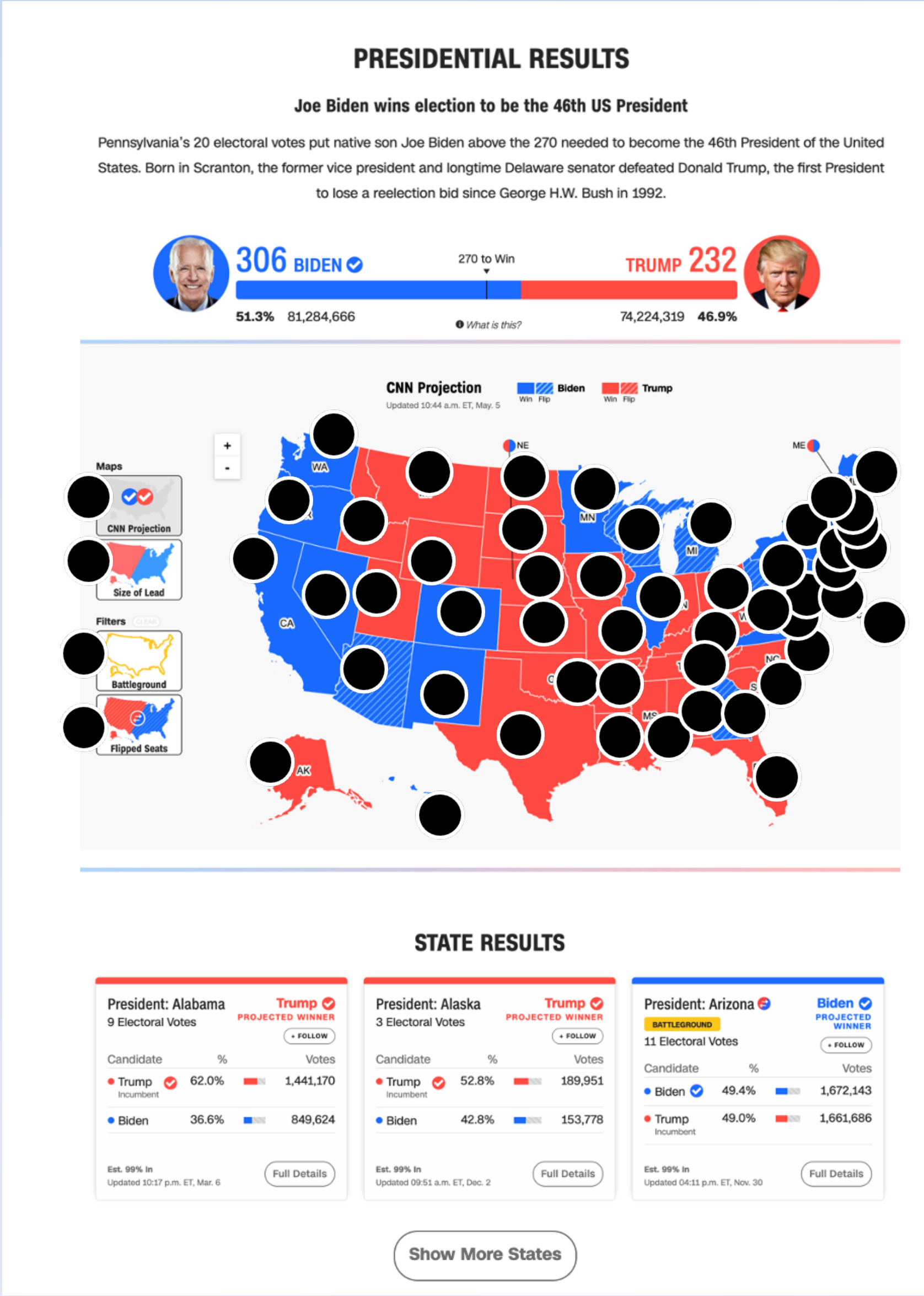


Perkins School for the Blind Archives, with tactile maps dating back to the early 1800s

Evaluating accessibility



978 access barriers
Found in about an hour.



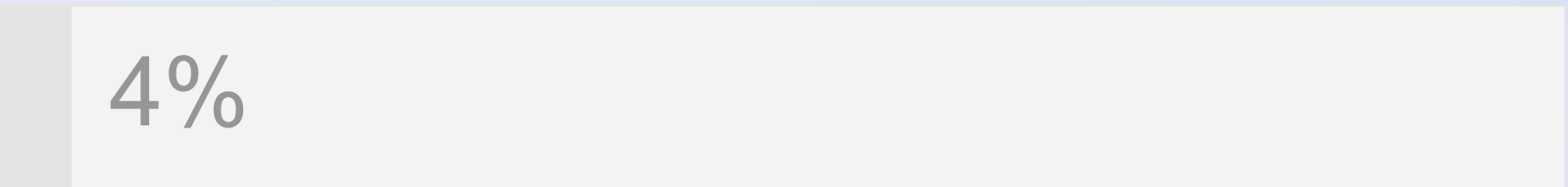
Perceivable

Can someone perceive this in multiple ways? Is each way easy?

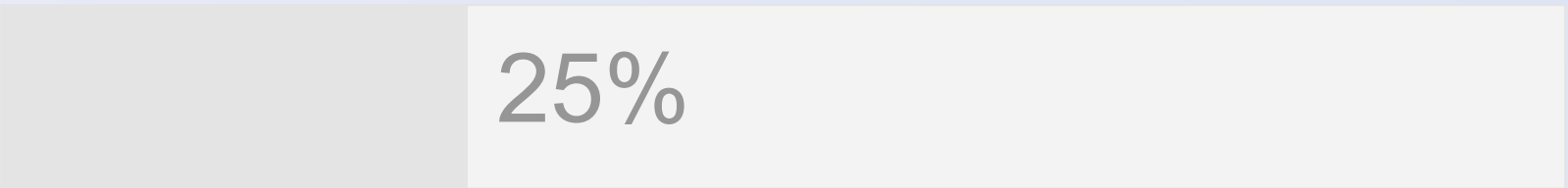
Design with high contrast

Colorblindness Disproportionately Overrepresented in A11y Resources

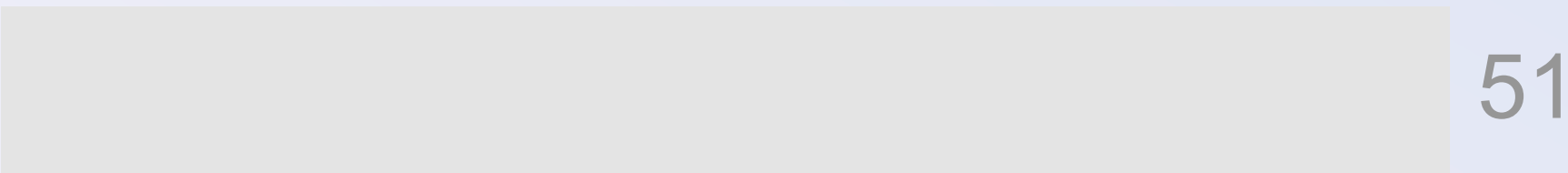
Colorblindness: % of People



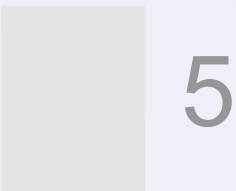
Low Vision: % of People



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



Check your contrasts

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

Large text and **geometries** must 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.

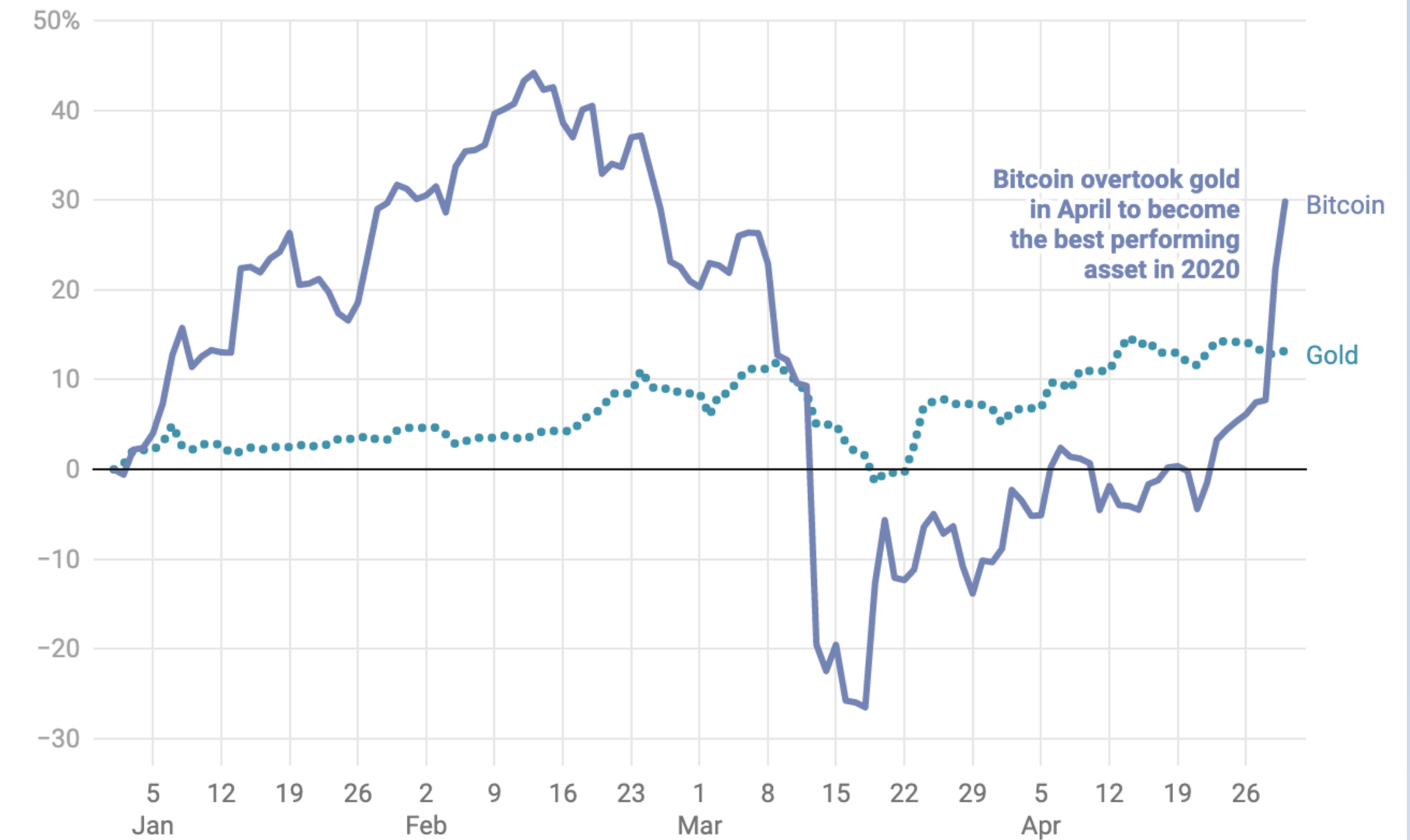
Don't rely on color alone!



WHAT PEOPLE WITH NORMAL VISION SEE



WHAT GREEN-BLIND PEOPLE SEE
1% OF MEN



Bitcoin and gold price change (%) between January and May 2020

Chart: Based on [Anthony Cuthbertson](#) • Source: [CoinMarketCap](#), [Nasdaq](#), [Gold Price](#) • [Get the data](#)

[Data Wrapper's color guide](#)

Add alt text

There is great research on alt text, but the most important thing to know is that you should add it to every image you post online (including twitter), in a document, or presentation.

Guidance: <https://medium.com/nightingale/writing-alt-text-for-data-visualization-2a218ef43f81>

alt= "**Chart type** of **type of data**
where **reason for including chart**"

Include a **link to data source**
somewhere in the text

Operable

Can someone operate this in multiple ways? Is each way easy?

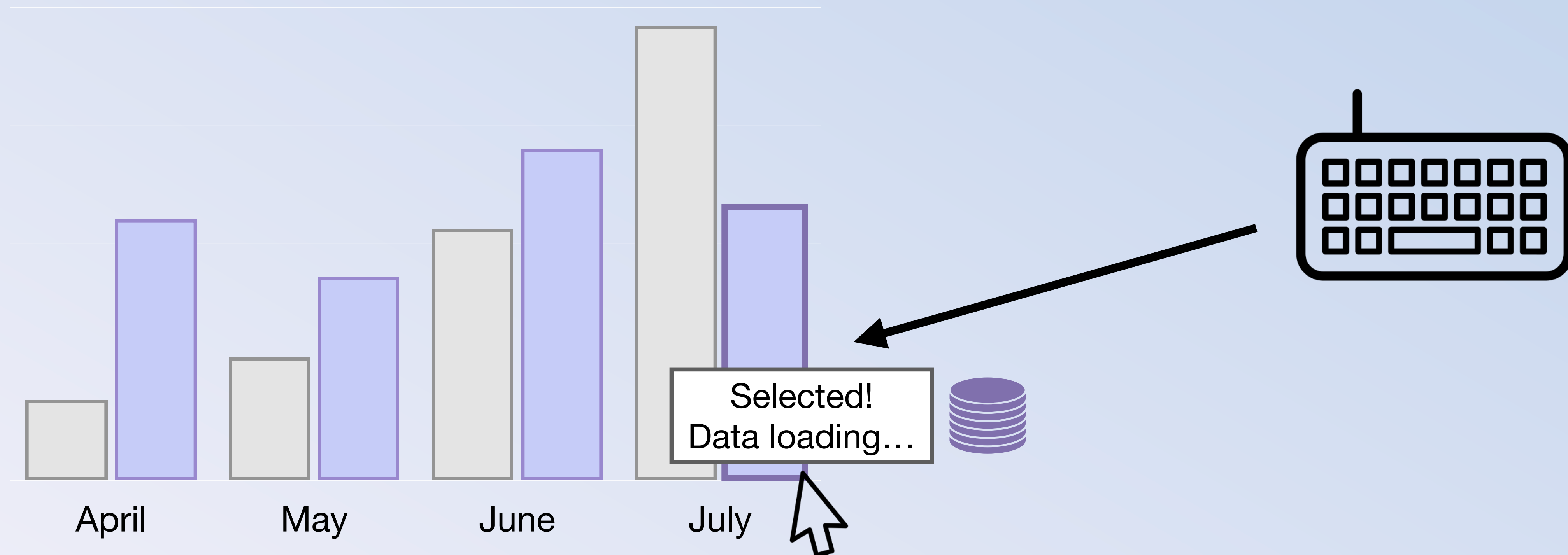
Many assistive input technologies “navigate”



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.

A keyboard should be able to do everything a mouse can



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

Understandable

Can someone understand this in multiple ways? Is each way easy?

Keep summaries as non-technical as possible

Measured in EF units (non-normalized). EF units are valuable for catching egregious over-simulation in models that use randomized data decimation techniques. This particular evaluation findings demonstrate that the randomization models are significantly over-producing entropy in our latest force simulations.

Hemingway

Readability

Post-graduate

Poor. Aim for 14.

Words: 39

Show More ▼

1 adverb. Aim for 0 or fewer.

0 uses of passive voice. Nice work.

1 phrase has a simpler alternative.

0 of 3 sentences are hard to read.

2 of 3 sentences are very hard to read.

Measured in EF units (non-normalized). These units are helpful for catching bad data loss when we remove our data at random. We are producing too much entropic force in our latest models.

Hemingway

Readability

Grade 6

Good

Words: 32

Show More ▼

0 adverbs. Well done.

0 uses of passive voice. Nice work.

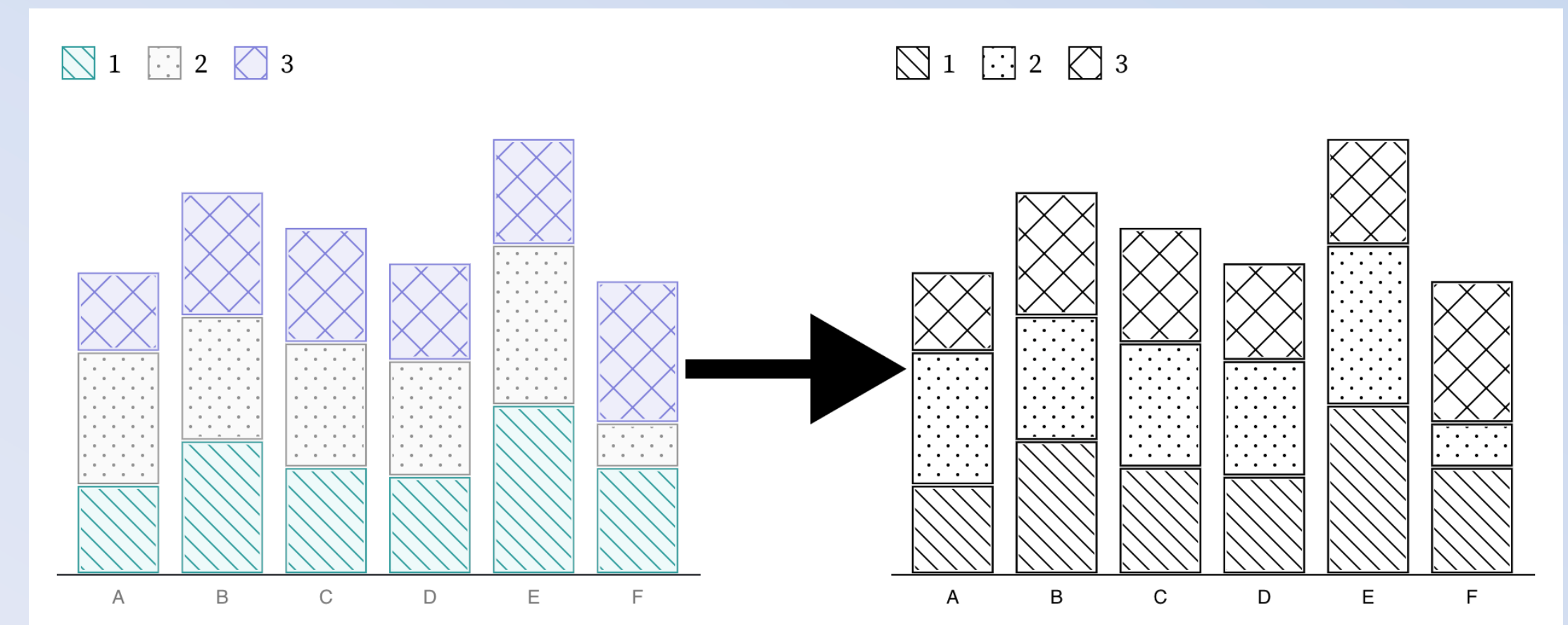
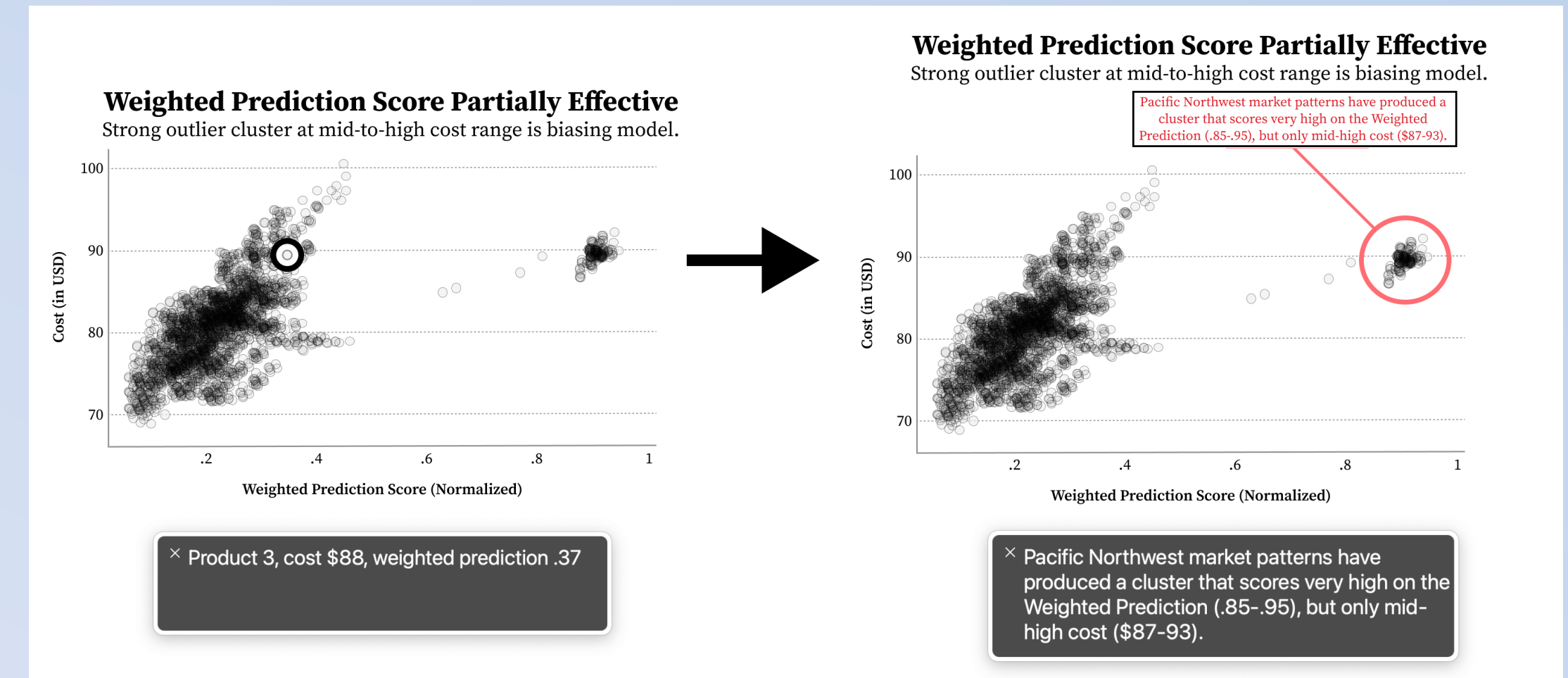
0 phrases have simpler alternatives.

0 of 3 sentences are hard to read.

0 of 3 sentences are very hard to read.

Check out Chartability for more

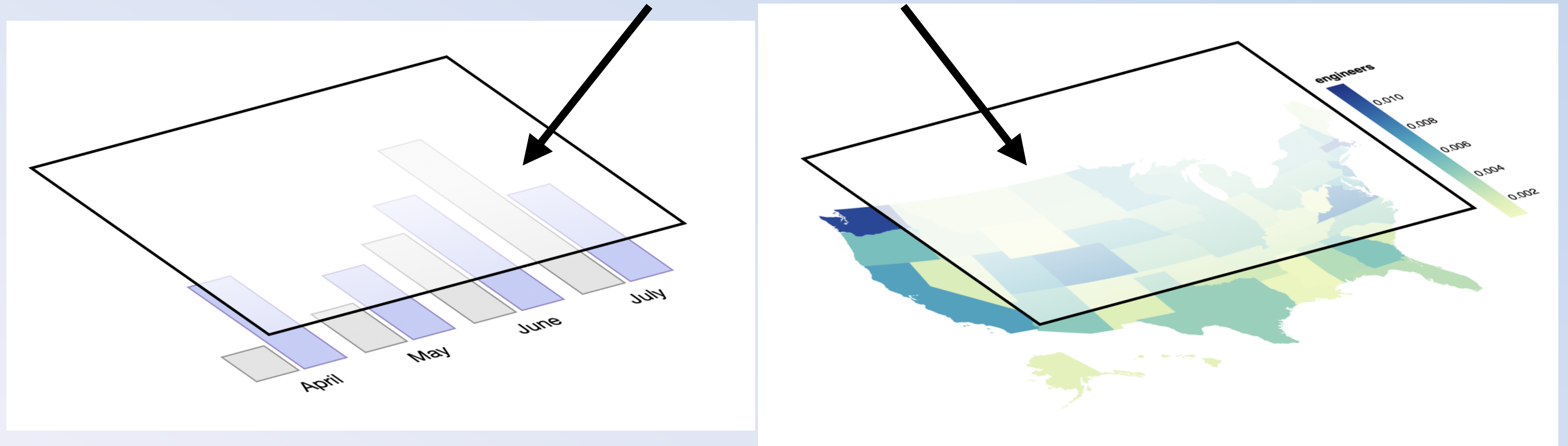
- Perceivable
- Operable
- Understandable
- Robust
- Compromising
- Assistive
- Flexible



Chartability

Also try Data Navigator

An interactive layer that interfaces between data structures and assistive technologies



Data Navigator

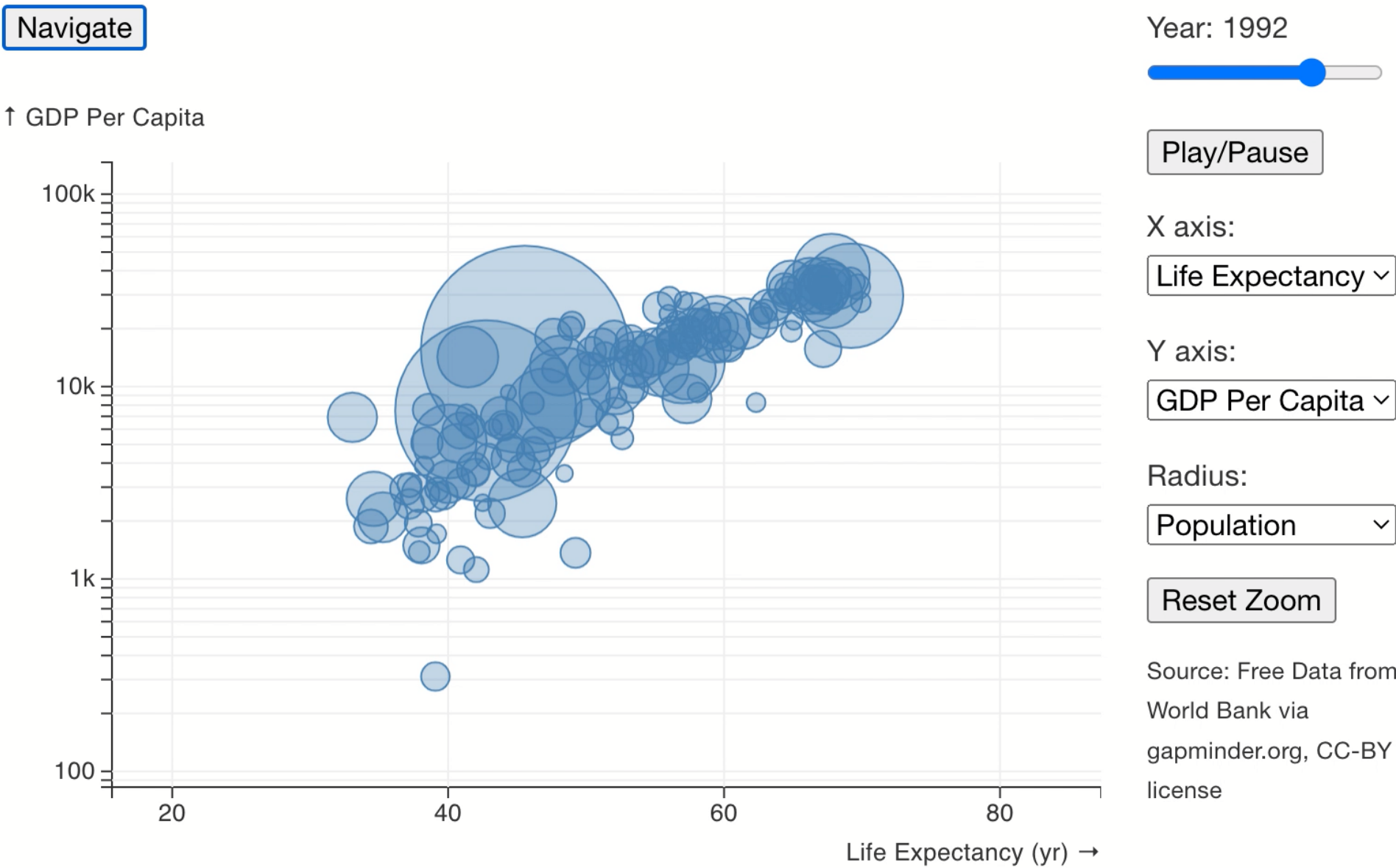
Counterpoint: navigating animations

Sivaraman's *Counterpoint* (2024)



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.



Exercise! <https://tinyurl.com/1302-access-critique>

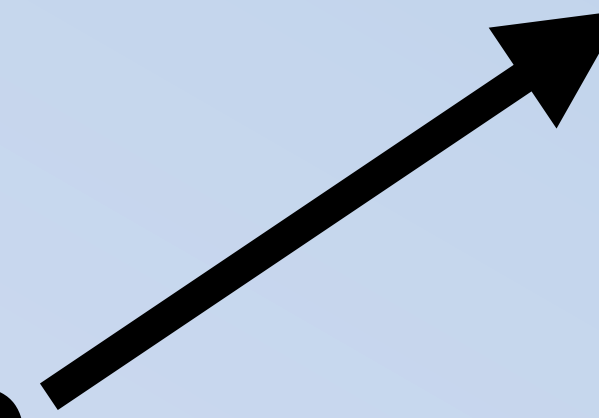
Get into groups (up to 4 groups)



Brown 2025

frank.computer

★ Slides here



Accessibility and Visualization

An introductory lecture: Concepts, history, and practice.



Frank Elavsky



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

