

Chapter 2, Episode 2: Perceivable barriers

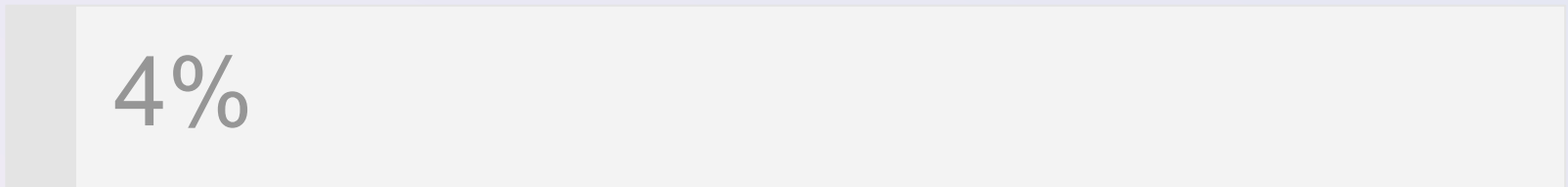
Perceivable

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

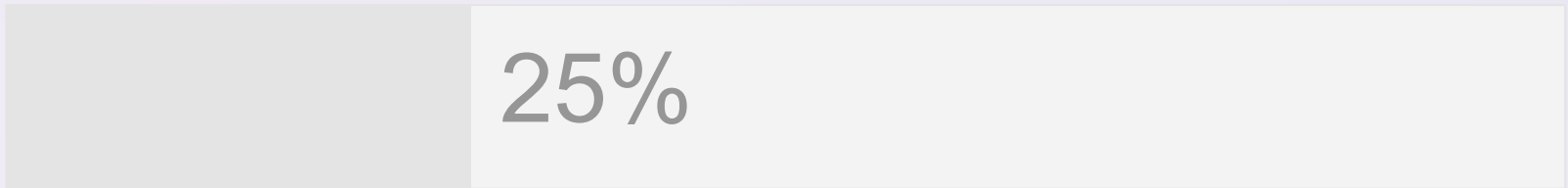
Design with high contrast

Colorblindness Disproportionately Overrepresented in A11y Resources

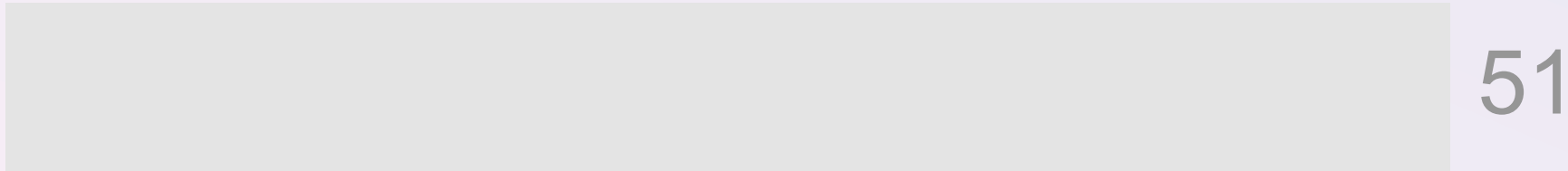
Colorblindness: % of People



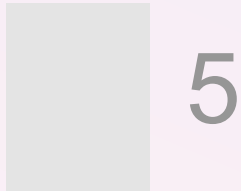
Low Vision: % of People



Colorblindness: # of Resources



Low Vision: # of Resources

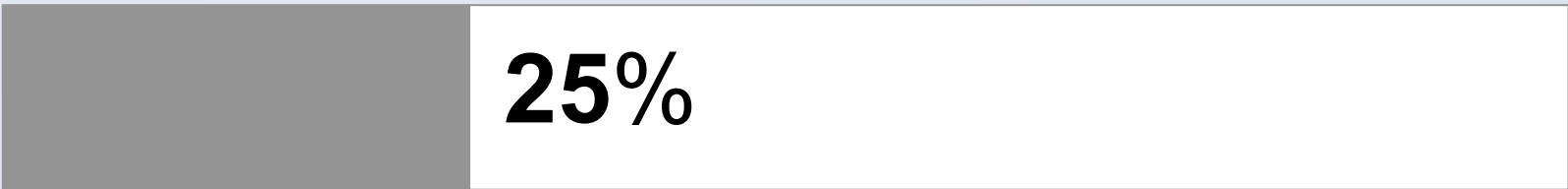


Colorblindness Disproportionately Overrepresented in A11y Resources

Colorblindness: % of People



Low Vision: % of People



Colorblindness: # of Resources



Low Vision: # of Resources



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

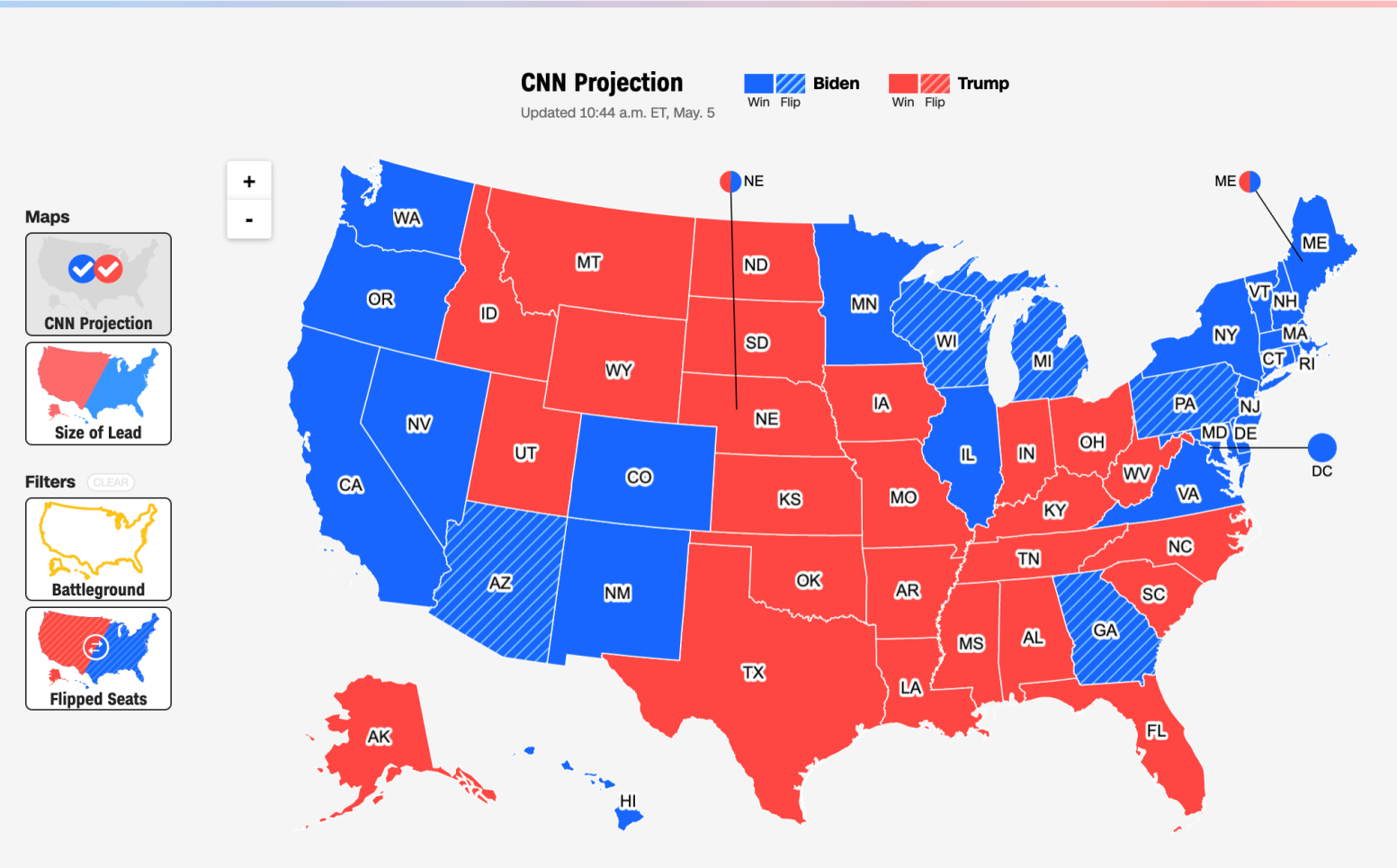
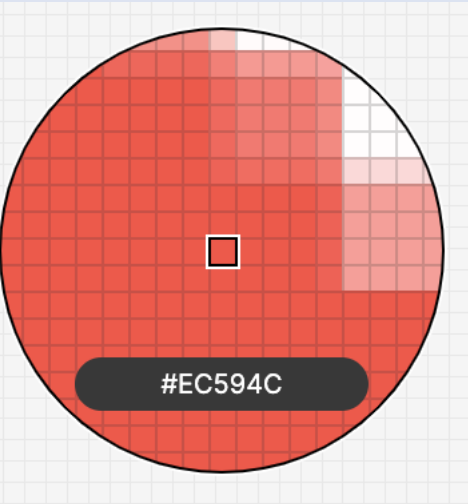
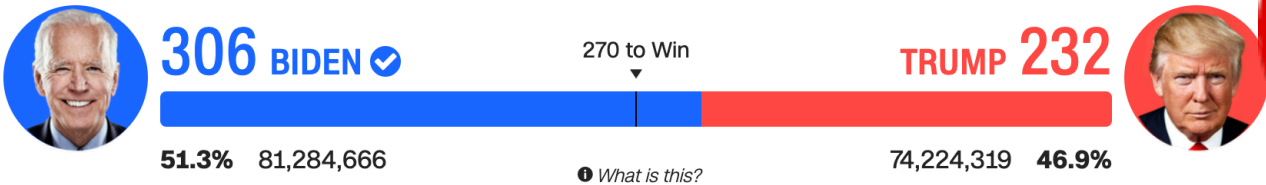
WCAG AA: **Fail**

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

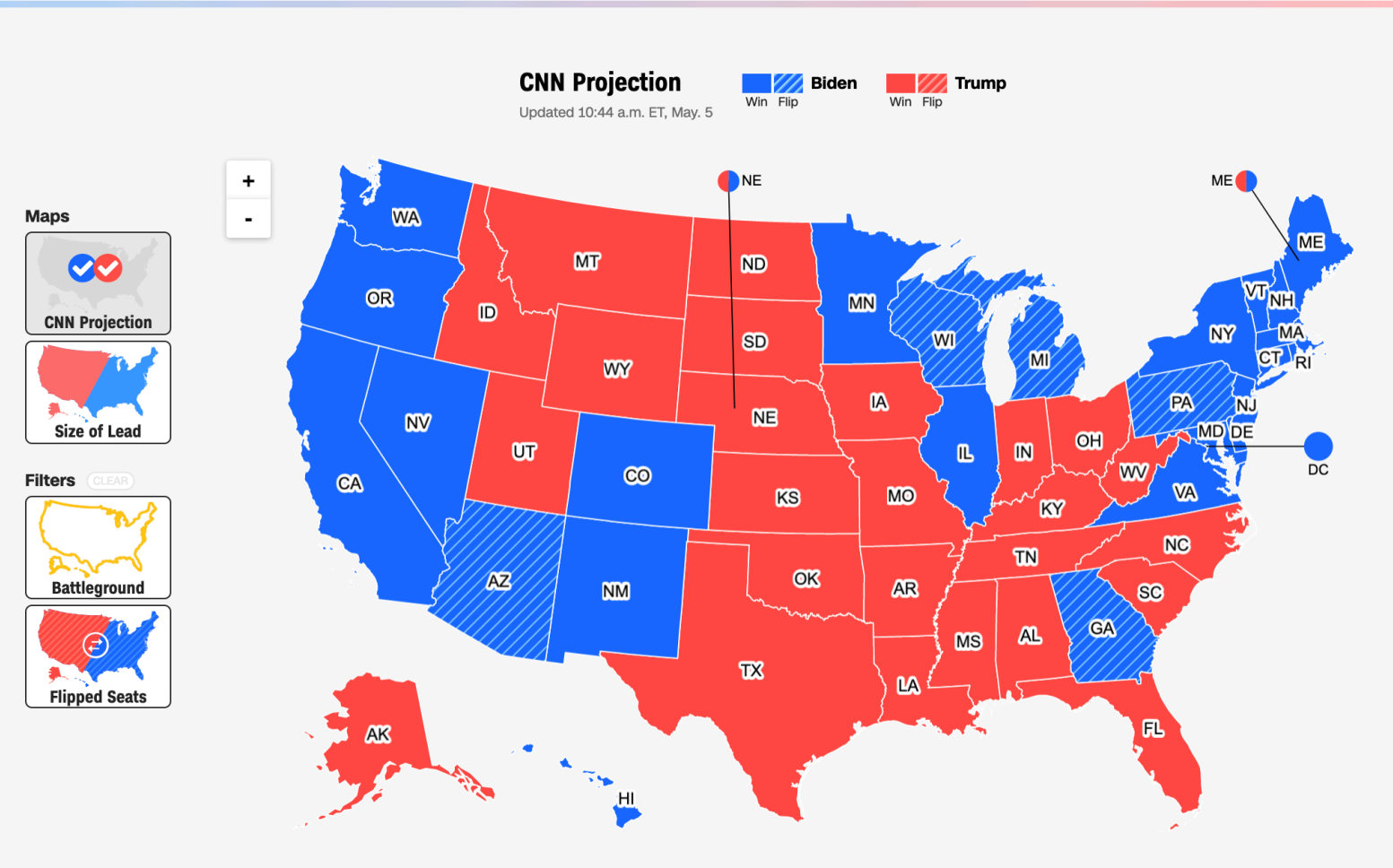
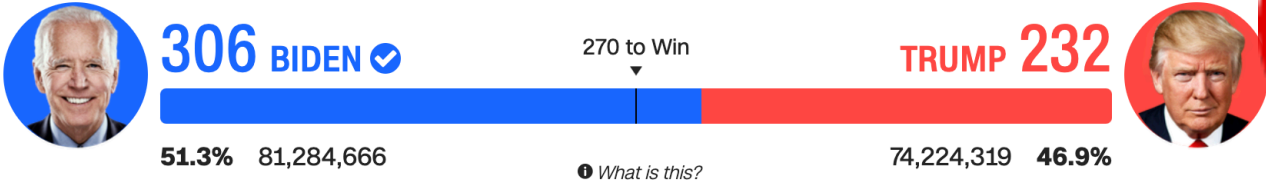
President: Alabama 9 Electoral Votes Trump PROJECTED WINNER + FOLLOW <table><tr><th>Candidate</th><th>%</th><th>Votes</th></tr><tr><td>Trump</td><td>62.0%</td><td>1,441,170</td></tr><tr><td>Biden</td><td>36.6%</td><td>849,624</td></tr></table> Est. 99% In Updated 10:17 p.m. ET, Mar. 6 Full Details	Candidate	%	Votes	Trump	62.0%	1,441,170	Biden	36.6%	849,624	President: Alaska 3 Electoral Votes Trump PROJECTED WINNER + FOLLOW <table><tr><th>Candidate</th><th>%</th><th>Votes</th></tr><tr><td>Trump</td><td>52.8%</td><td>189,951</td></tr><tr><td>Biden</td><td>42.8%</td><td>153,778</td></tr></table> Est. 99% In Updated 09:51 a.m. ET, Dec. 2 Full Details	Candidate	%	Votes	Trump	52.8%	189,951	Biden	42.8%	153,778	President: Arizona 11 Electoral Votes Biden PROJECTED WINNER + FOLLOW BATTLEGROUNDS <table><tr><th>Candidate</th><th>%</th><th>Votes</th></tr><tr><td>Biden</td><td>49.4%</td><td>1,672,143</td></tr><tr><td>Trump</td><td>49.0%</td><td>1,661,686</td></tr></table> Est. 99% In Updated 04:11 p.m. ET, Nov. 30 Full Details	Candidate	%	Votes	Biden	49.4%	1,672,143	Trump	49.0%	1,661,686
Candidate	%	Votes																											
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Show More States

PRESIDENTIAL RESULTS

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STATE RESULTS

President: Alabama

9 Electoral Votes

Trump **PROJECTED WINNER**

Candidate

%

Votes

Trump	62.0%	1,441,170
Biden	36.6%	849,624
Est. 99% In		
Updated 10:17 p.m. ET, Mar. 6		

President: Alaska

3 Electoral Votes

Trump **PROJECTED WINNER**

Candidate

%

Votes

Trump	52.8%	189,951
Biden	42.8%	153,778
Est. 99% In		
Updated 09:51 a.m. ET, Dec. 2		

President: Arizona

11 Electoral Votes

Biden **PROJECTED WINNER**

Candidate

%

Votes

Biden	49.4%	1,672,143
Trump	49.0%	1,661,686
Est. 99% In		
Updated 04:11 p.m. ET, Nov. 30		

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**

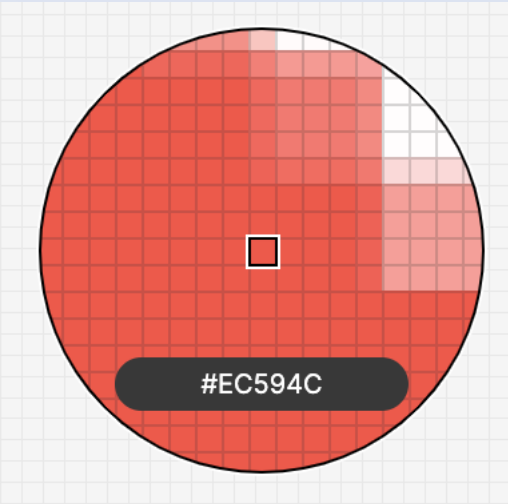
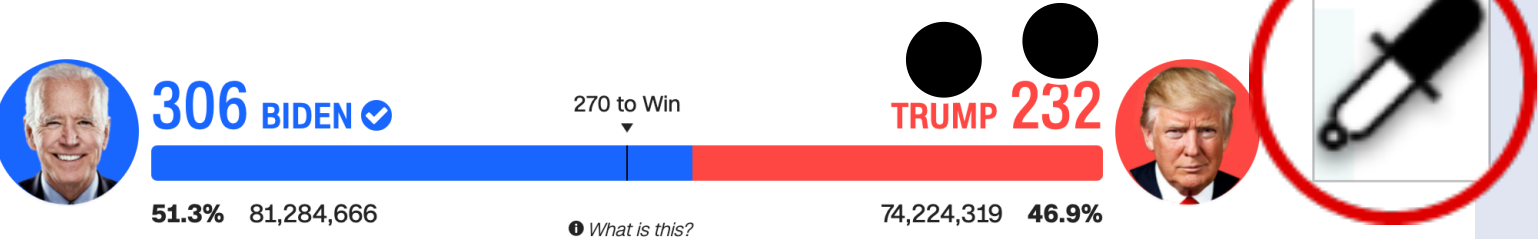
WCAG AAA: **Fail**

The five boxing wizards jump quickly.

PRESIDENTIAL RESULTS

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Contrast Checker

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

Foreground Color

#EC594C

Lightness



Background Color

#FFFFFF

Lightness



Contrast Ratio

3.44:1

[permalink](#)

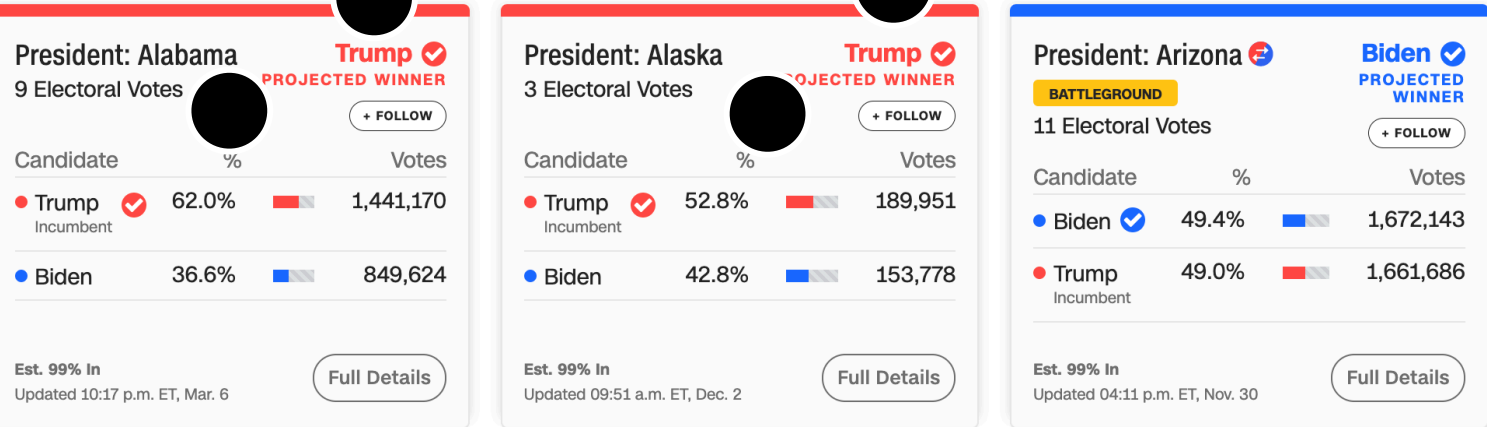
Normal Text

WCAG AA: **Fail**

WCAG AAA: **Fail**

The five boxing wizards jump quickly.

STATE RESULTS



Show More States

Don't rely on color alone!

(Muth) <https://blog.datawrapper.de/colorblindness-part2/>



WHAT PEOPLE WITH NORMAL
VISION SEE



WHAT GREEN-BLIND PEOPLE SEE
1% OF MEN

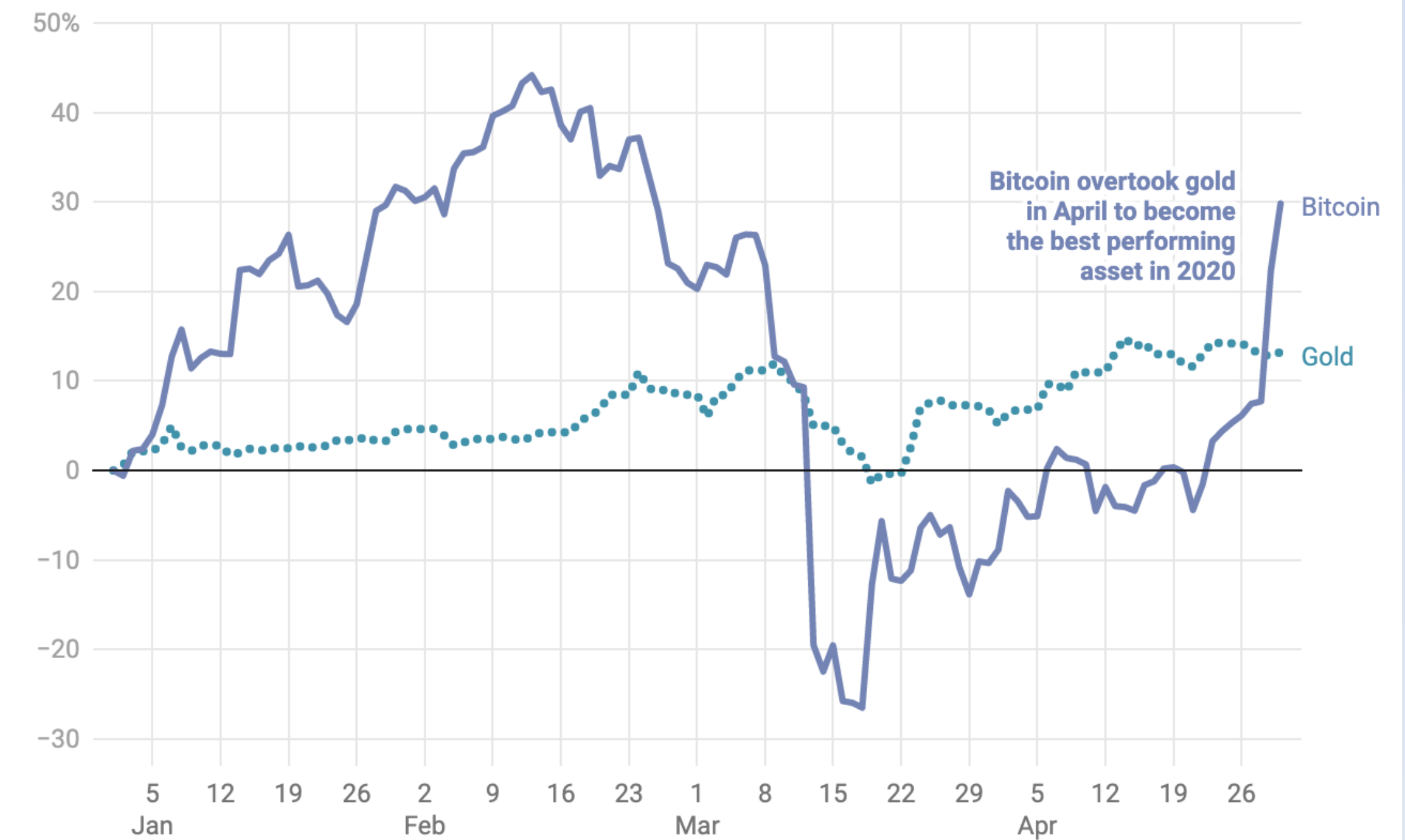
“Redundant encoding” is one strategy



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](#)

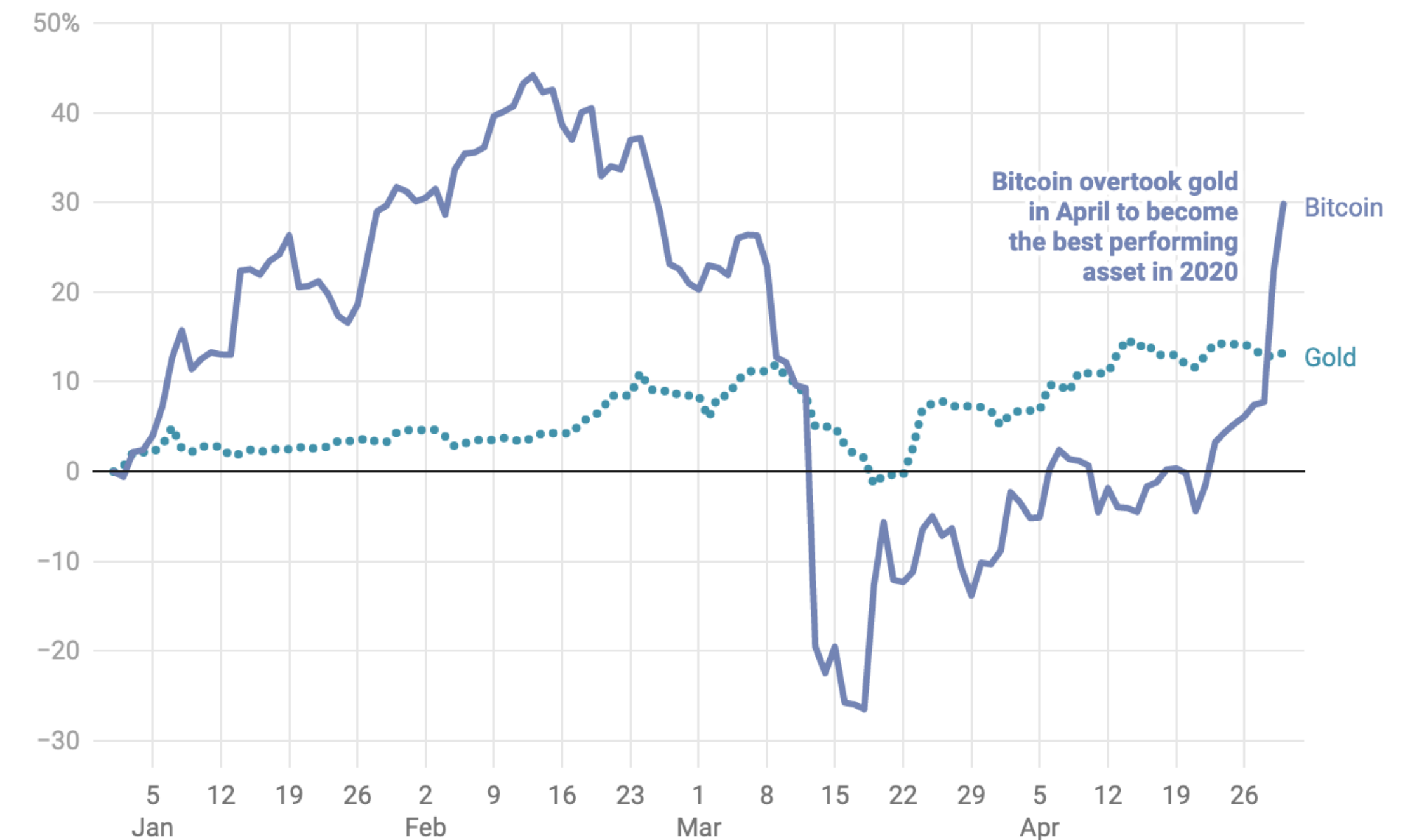
A note: “**Color-vision deficiency**” and “**colorblindness**” refer to the same thing, both terms are fine to use.



WHAT PEOPLE WITH NORMAL VISION SEE



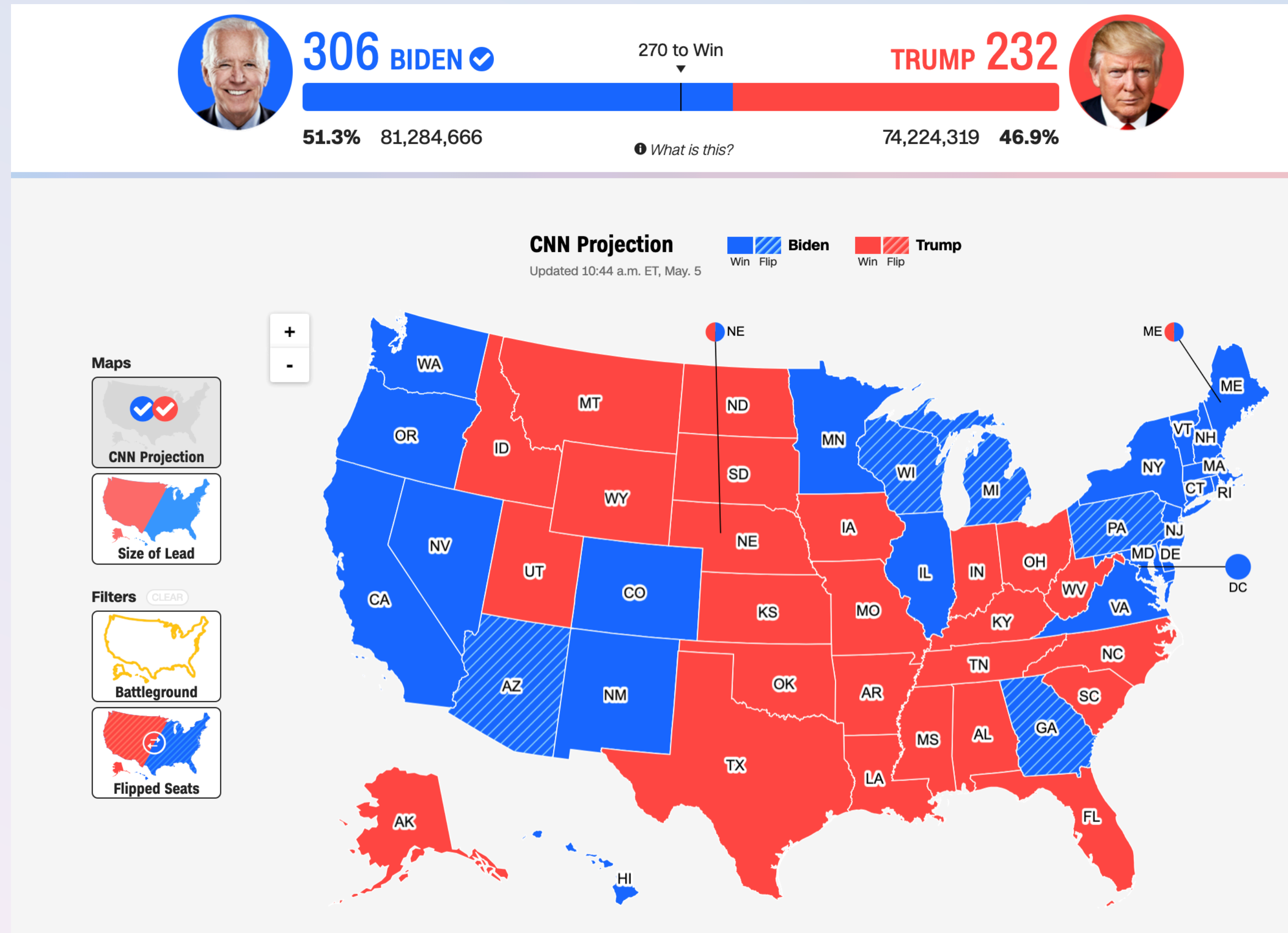
WHAT GREEN-BLIND PEOPLE SEE
1% OF MEN



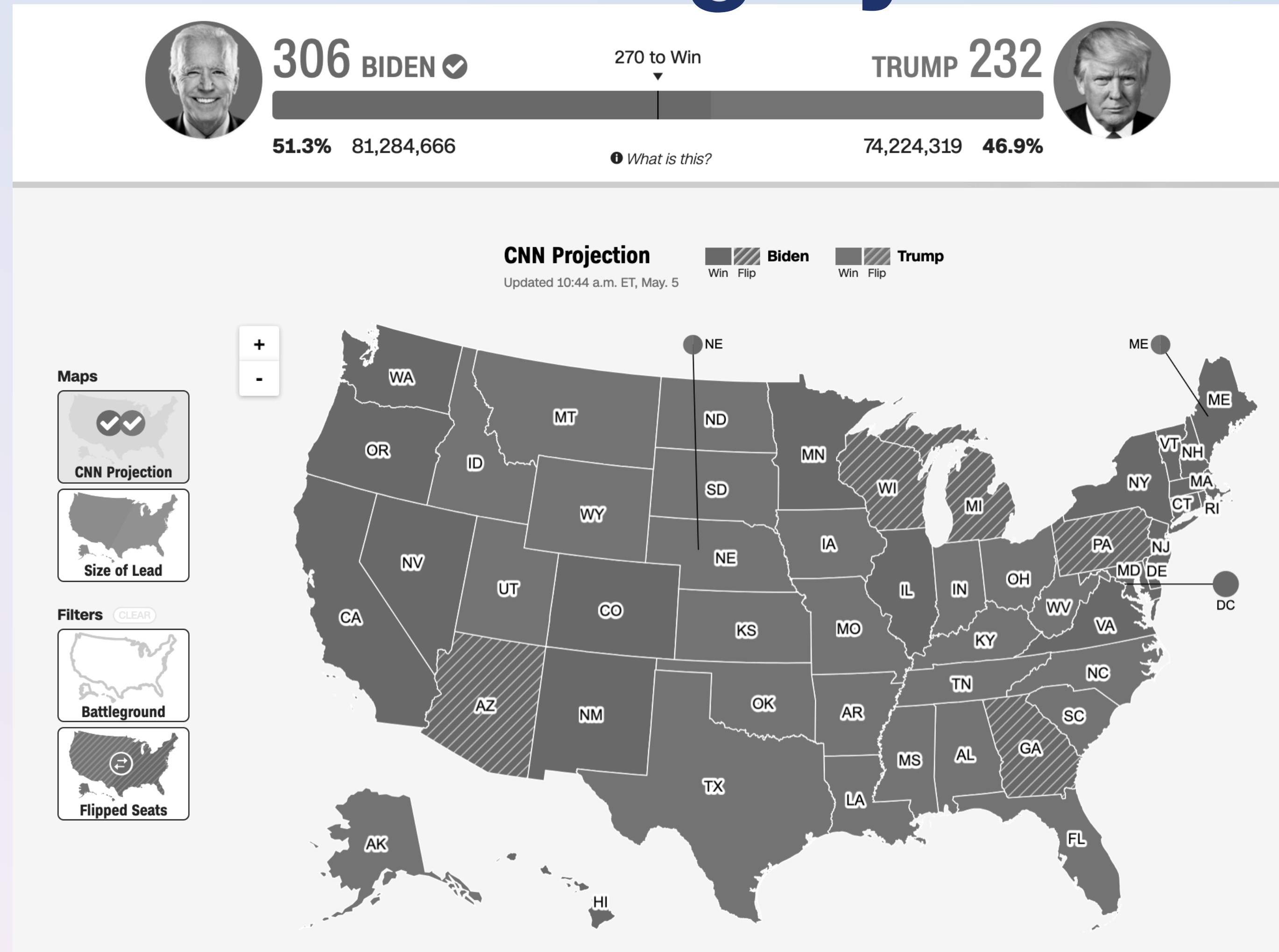
Bitcoin and gold price change (%) between January and May 2020

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

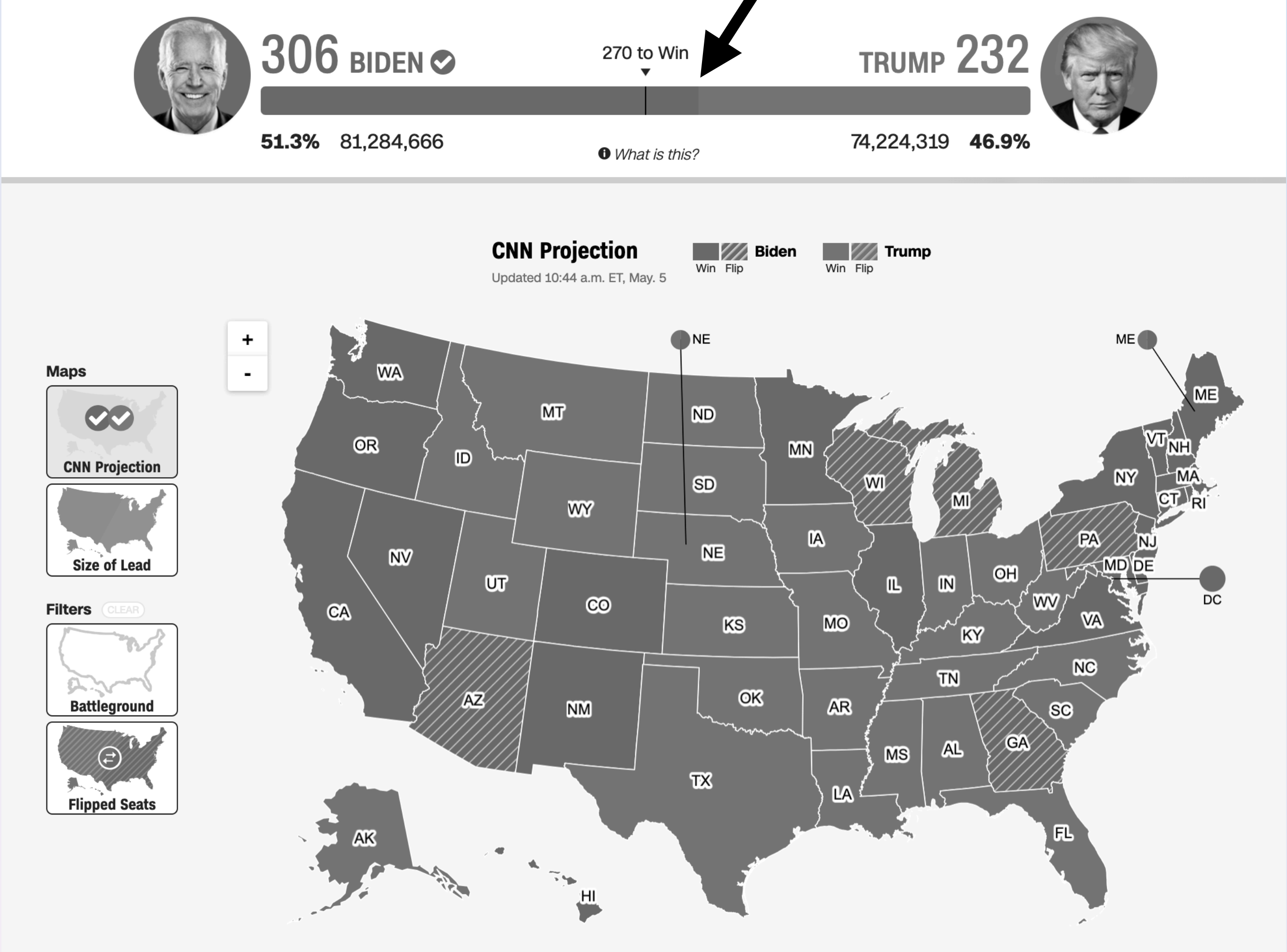
But sometimes you *can't* redundantly encode!



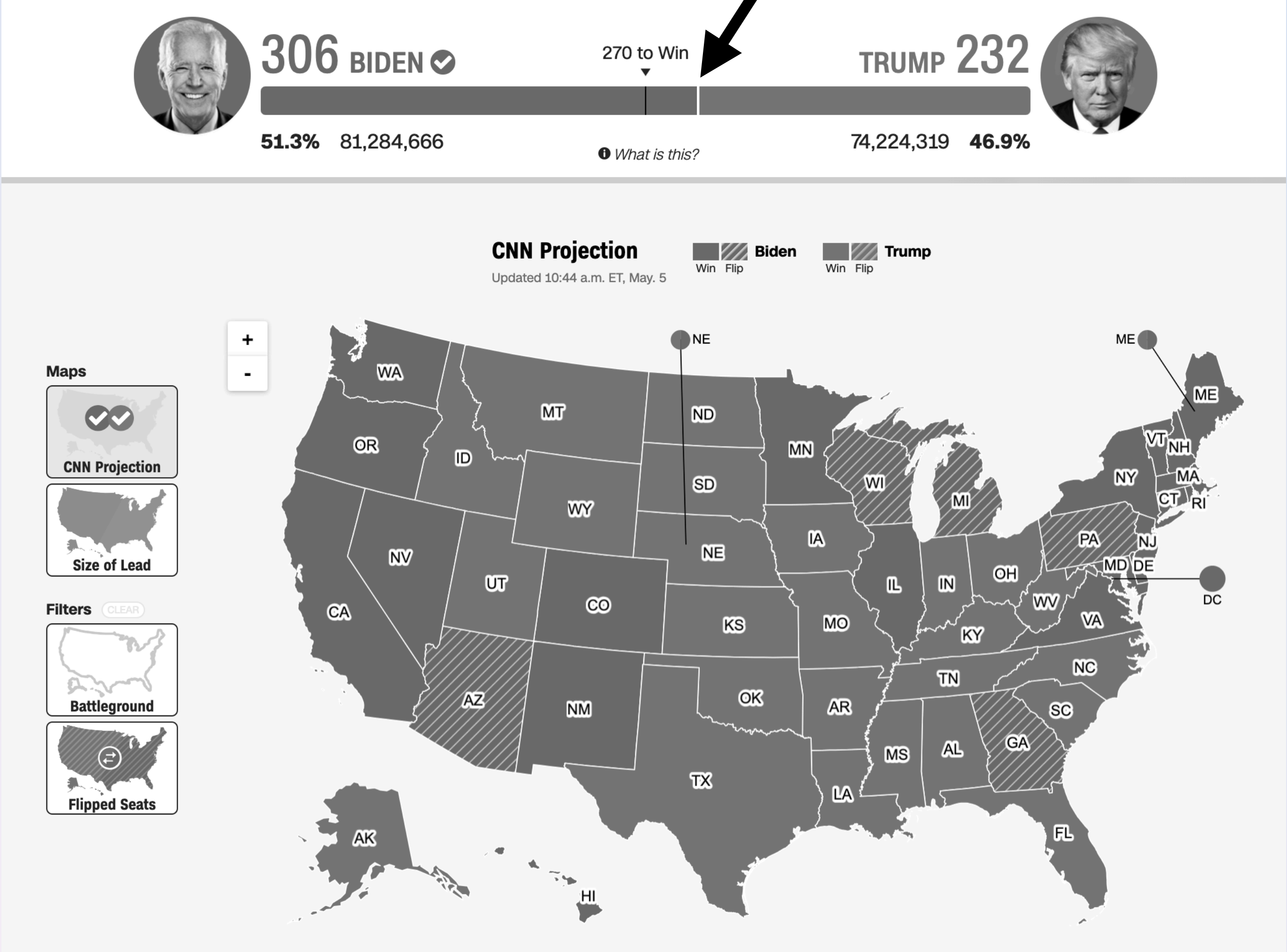
This map is trouble in greyscale



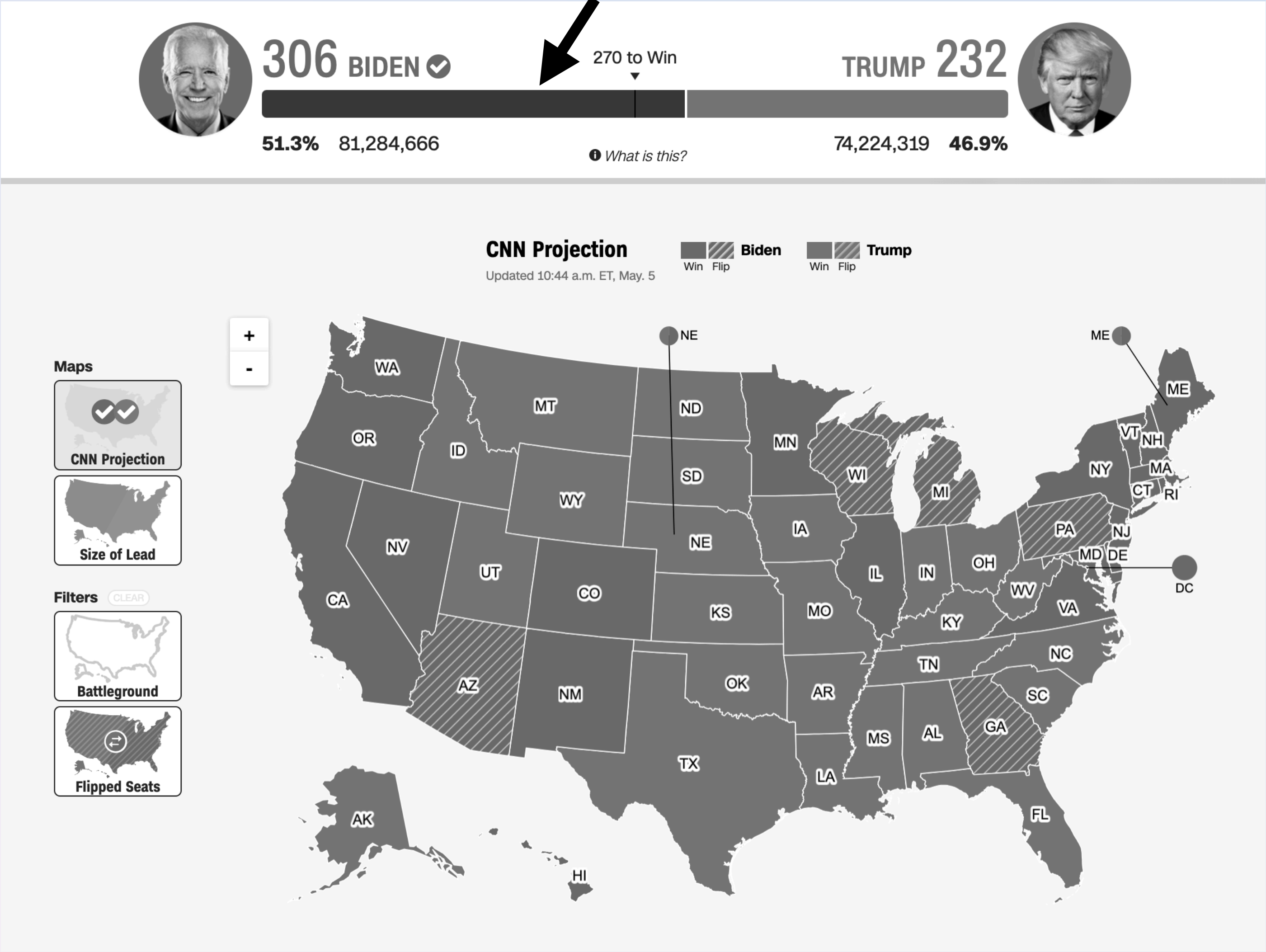
The division here matters!



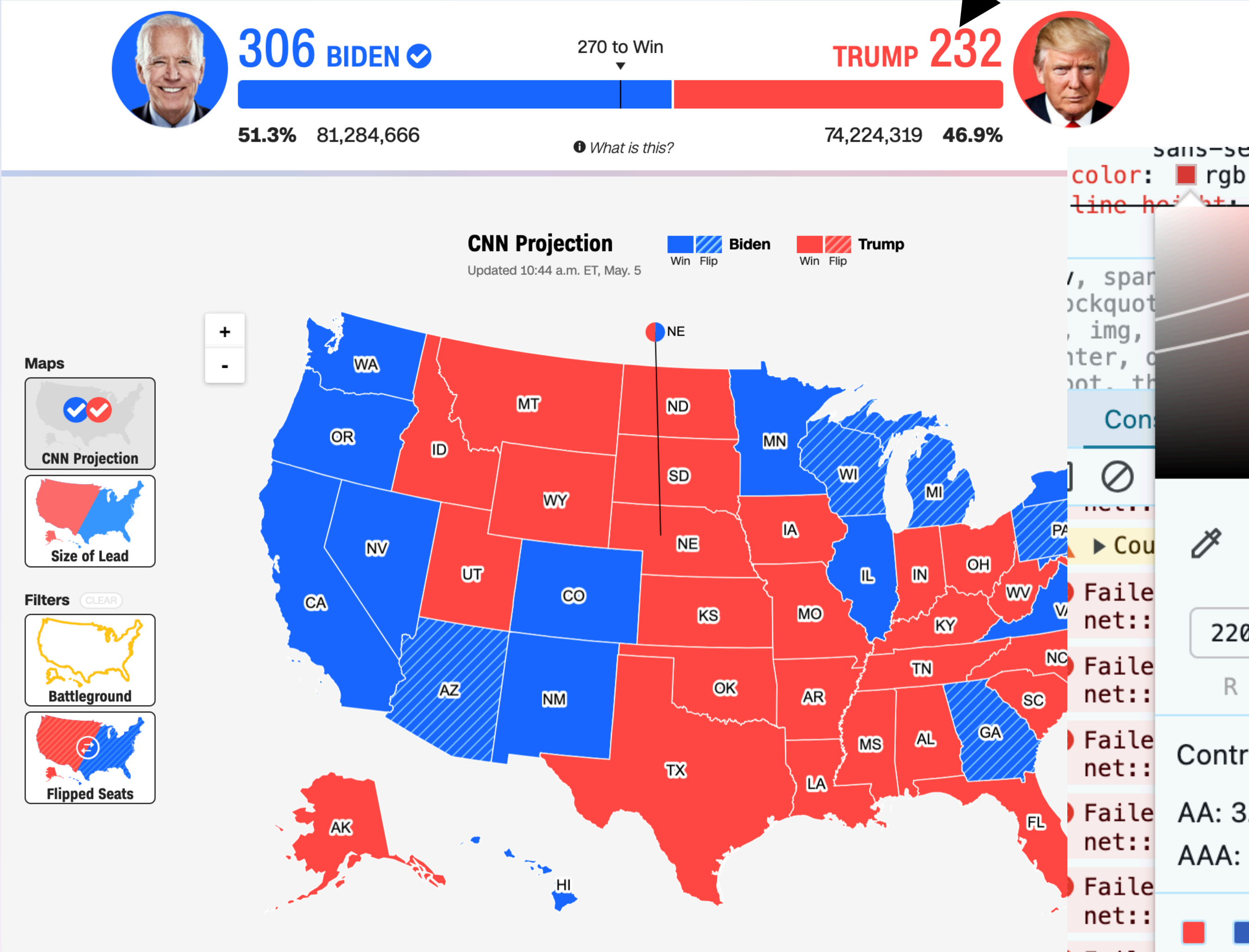
Maybe a small white divider, like the states?



Perhaps test a darker blue too?



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



color: ■ rgb(220 57 50);

line height: 0.8;

Contrast ratio 4.5

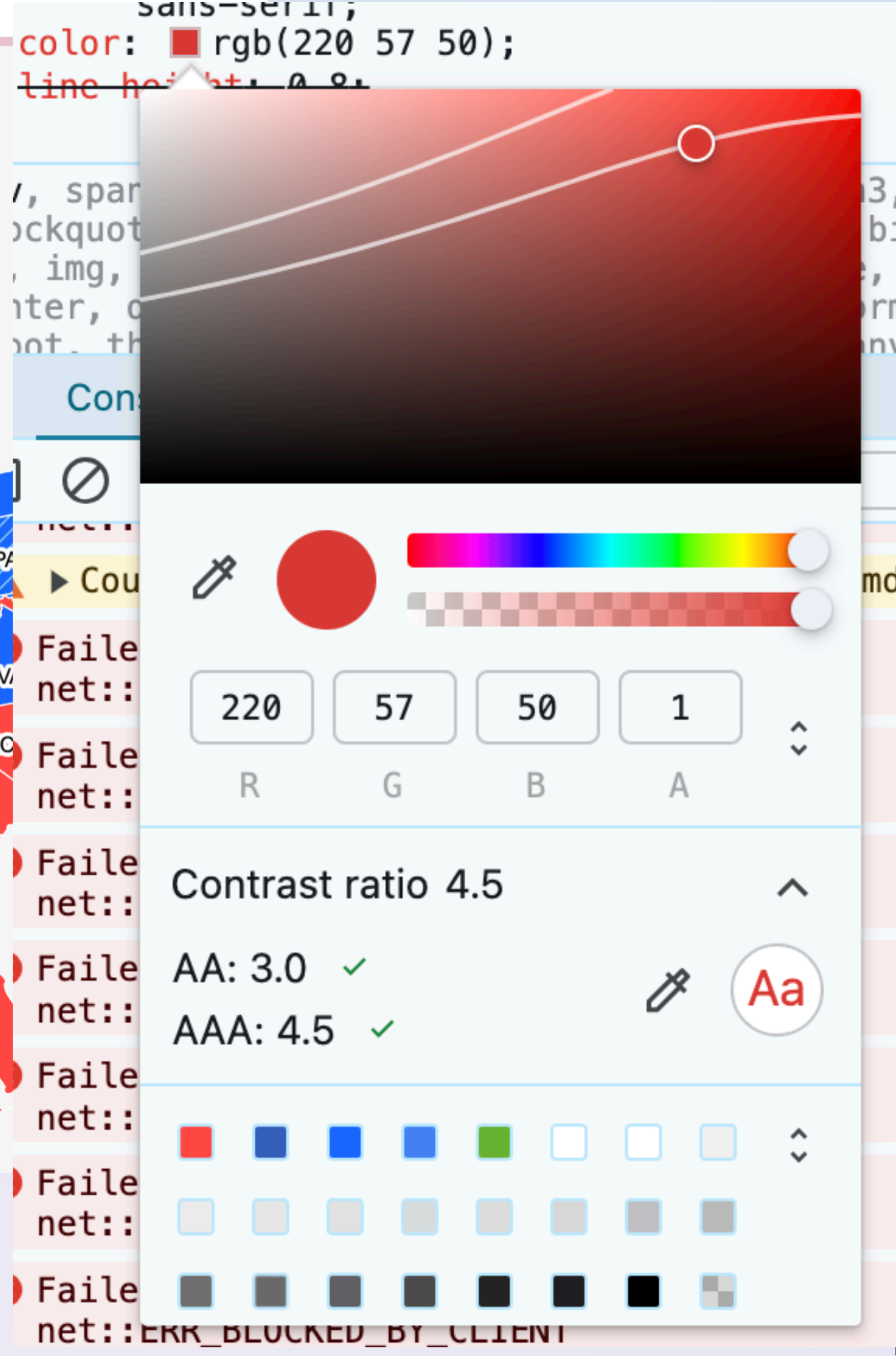
AA: 3.0 ✓

AAA: 4.5 ✓

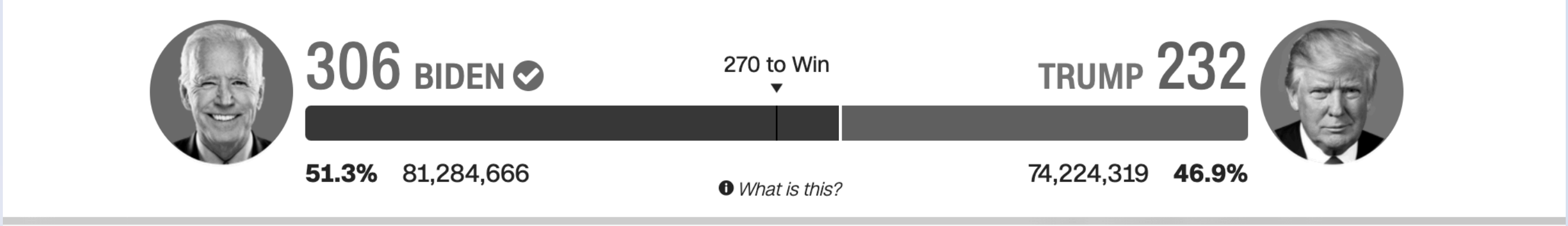
Contrast ratio 4.5

AA: 3.0 ✓

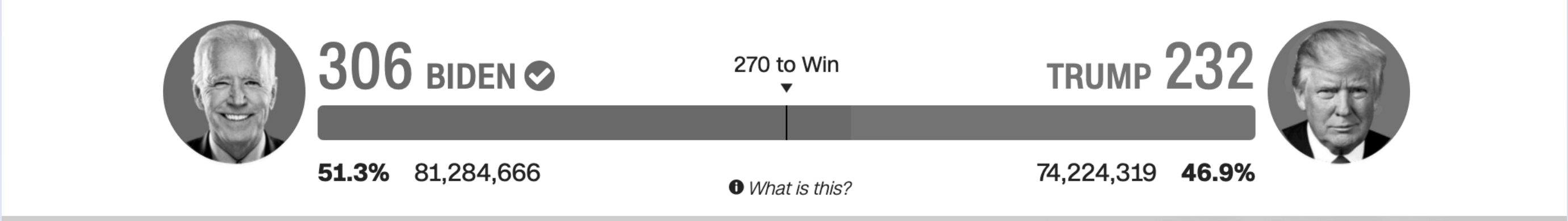
AAA: 4.5 ✓

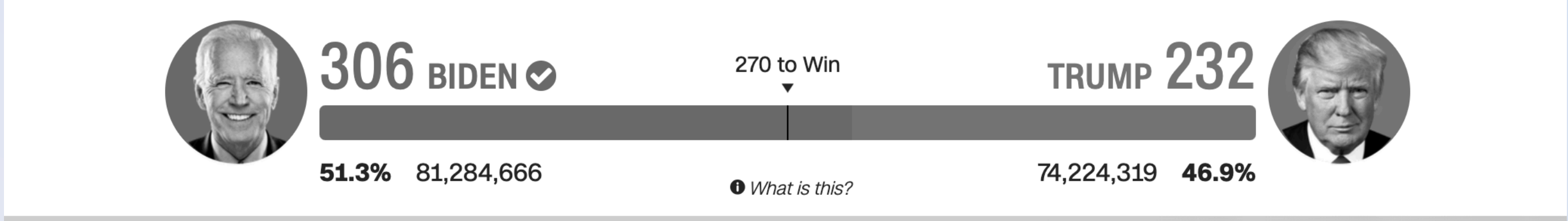


Let's check that greyscale again...

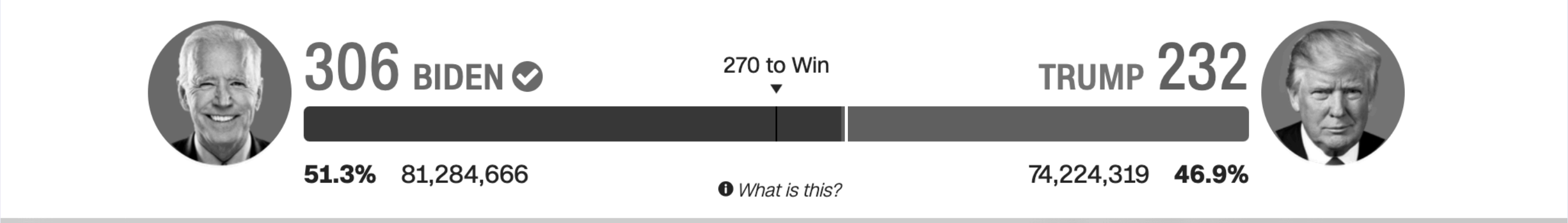


Before

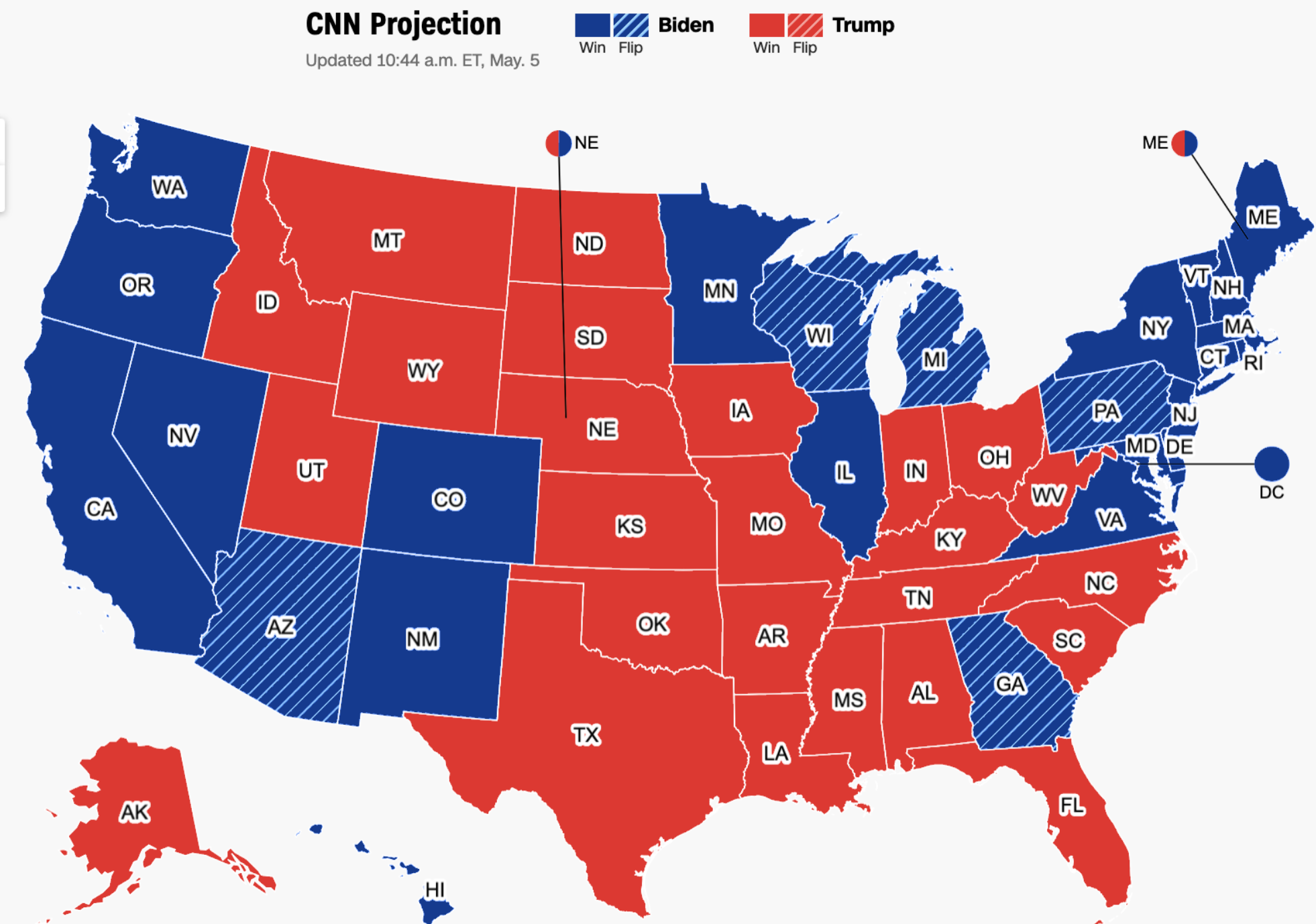
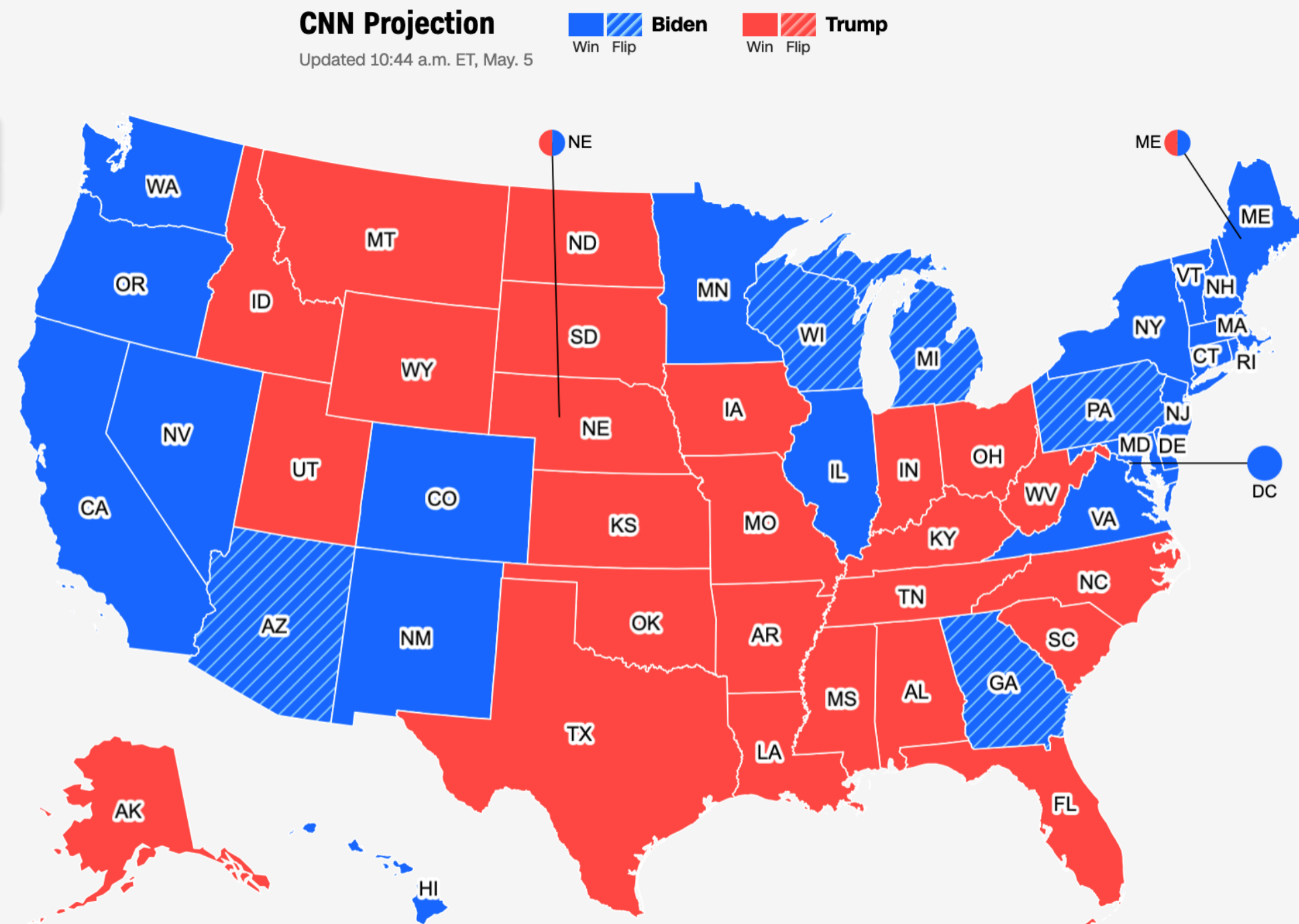
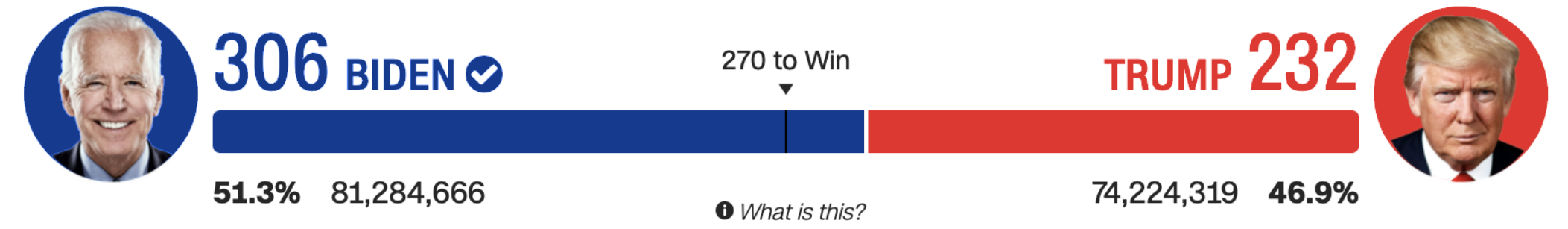
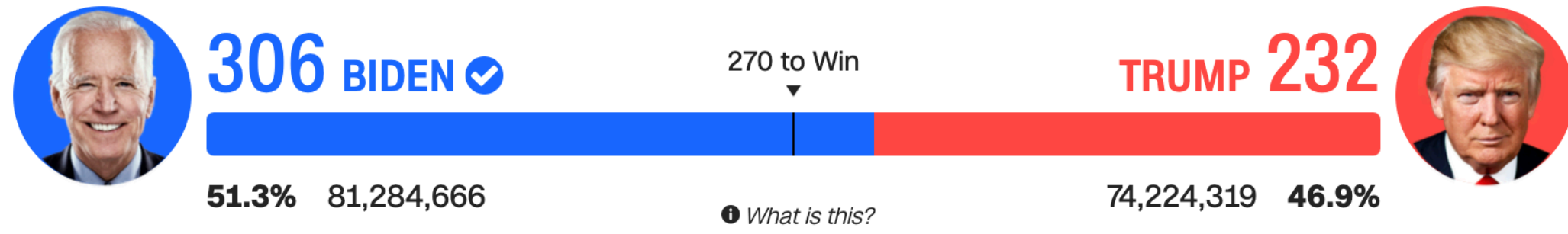




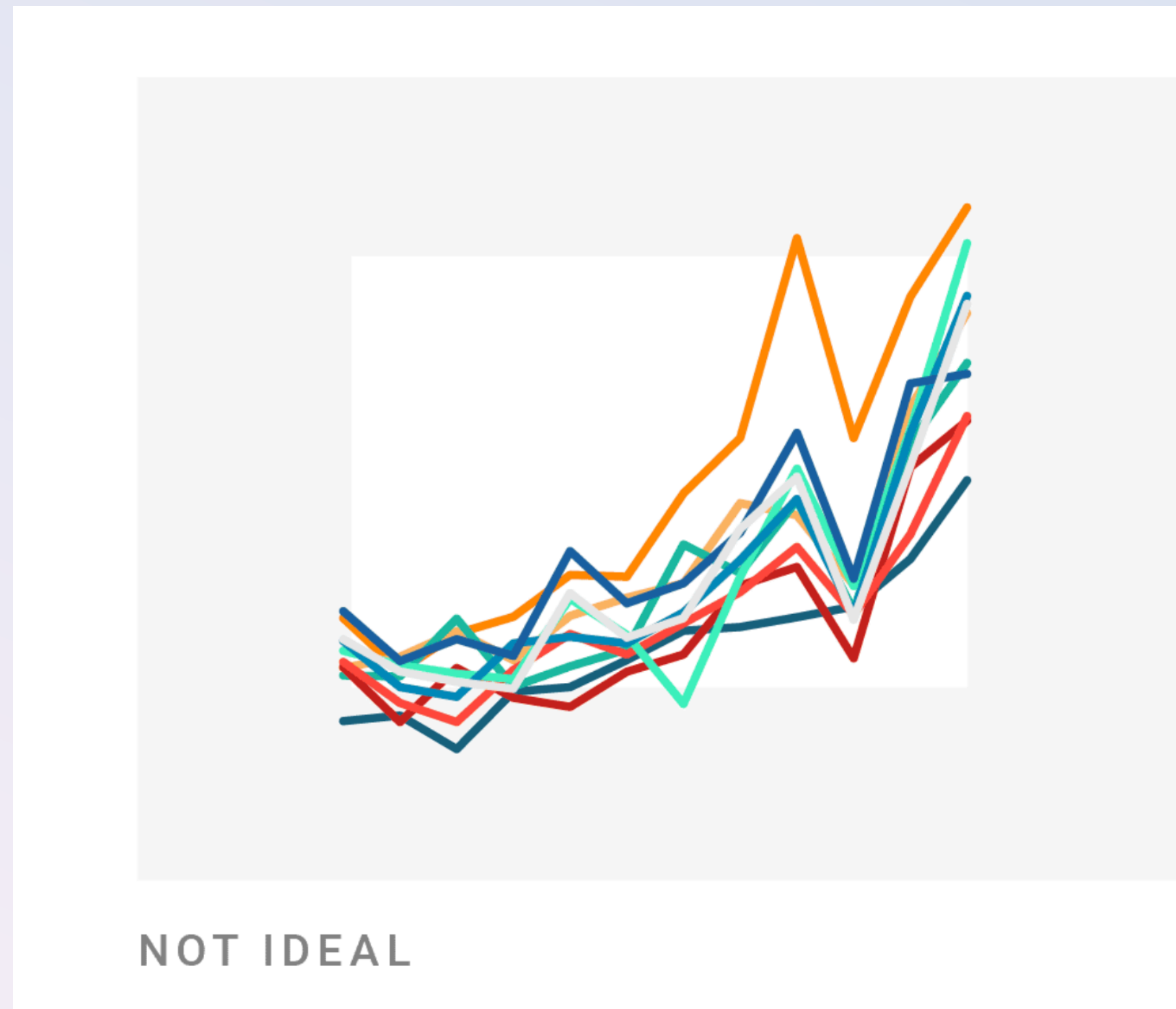
And after!



Sufficient contrast can help folks differentiate

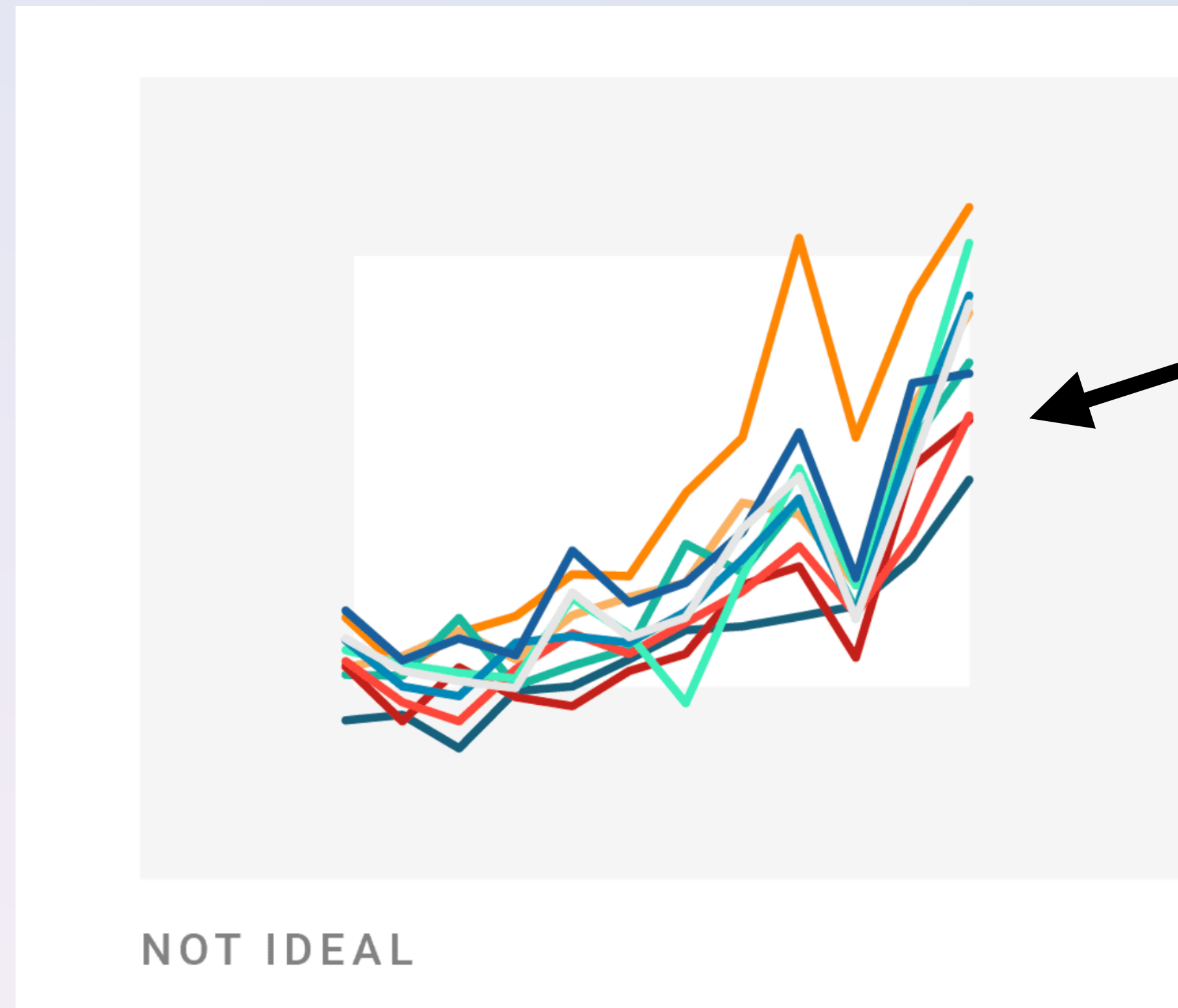


But what about more than 2 colors?



Source: [Datawrapper](#)

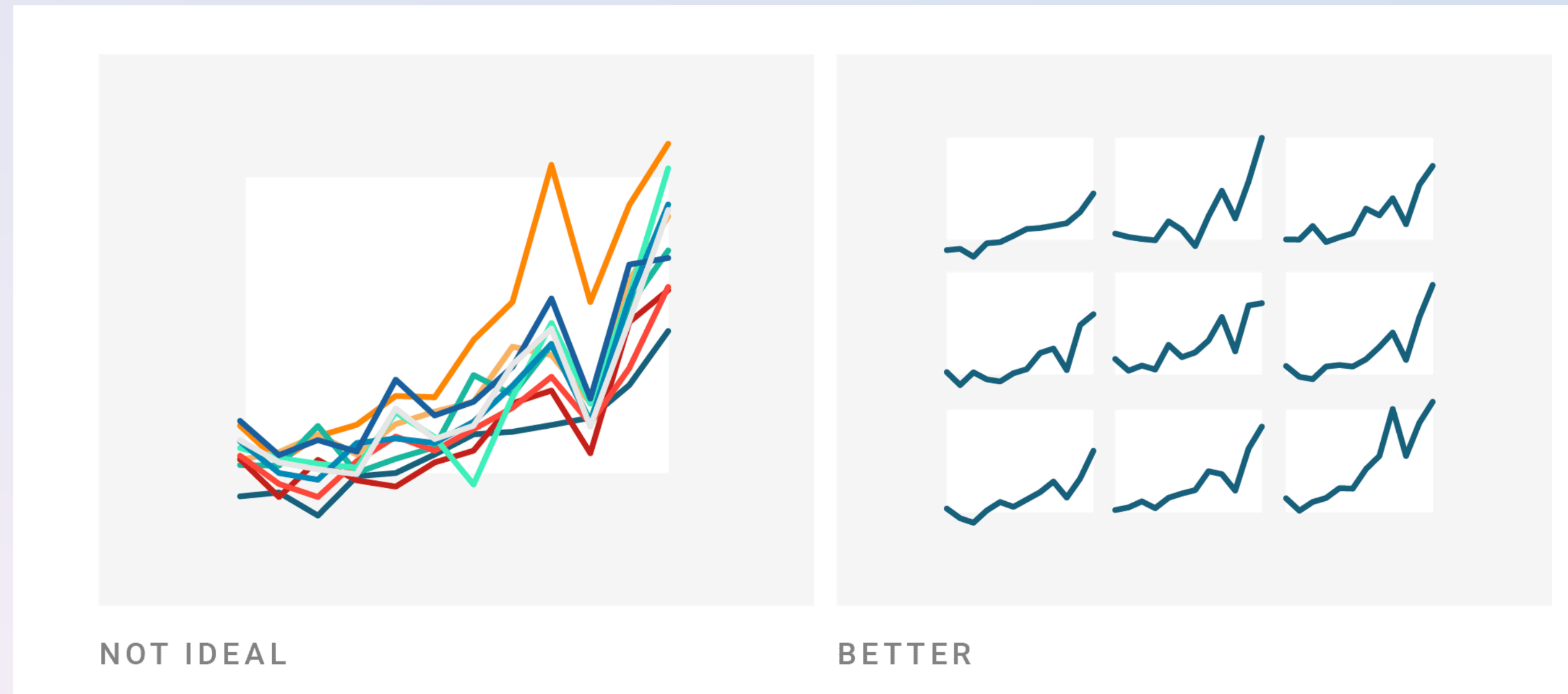
But what about more than 2 colors?



Finding “pair” contrast gets really hard after 3+ colors...

Source: [Datawrapper](#)

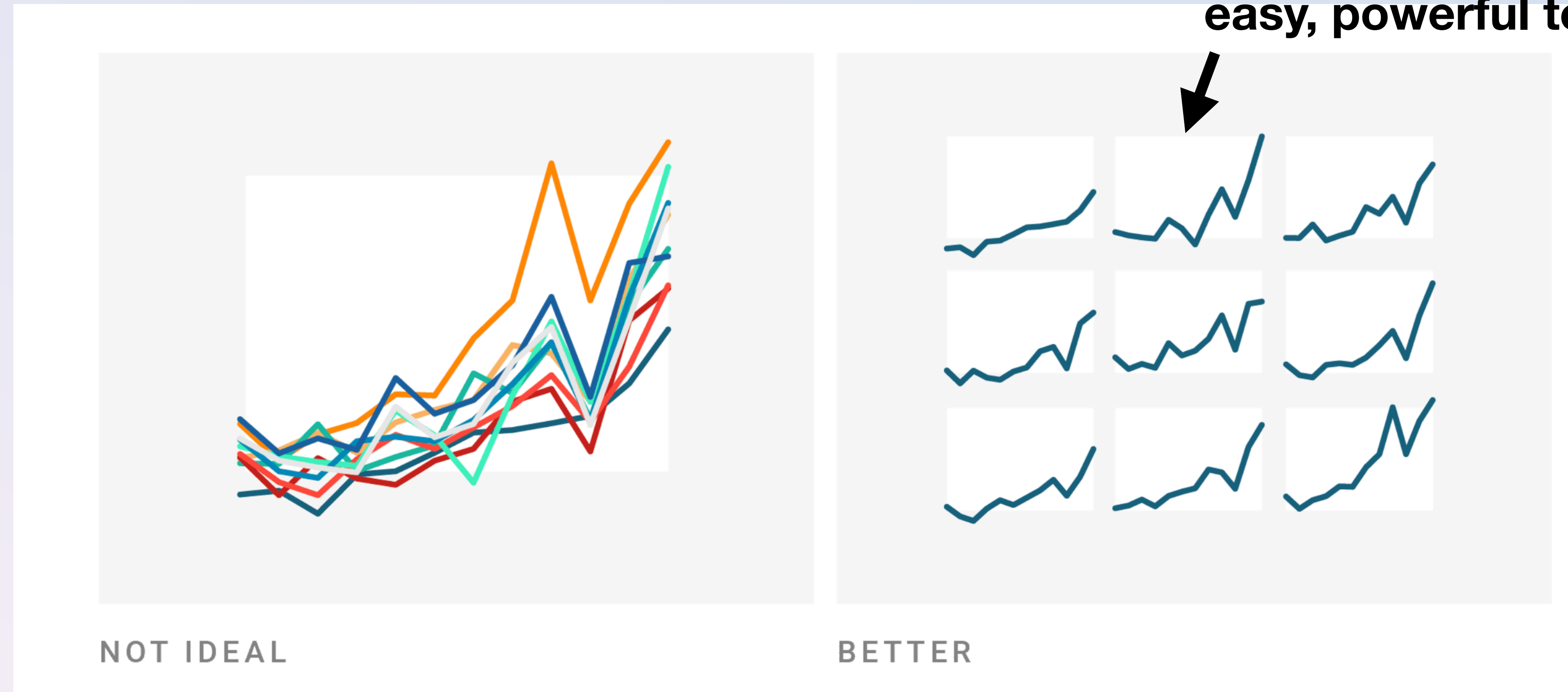
Reduce your colors and redesign!



Source: [Datawrapper](#)

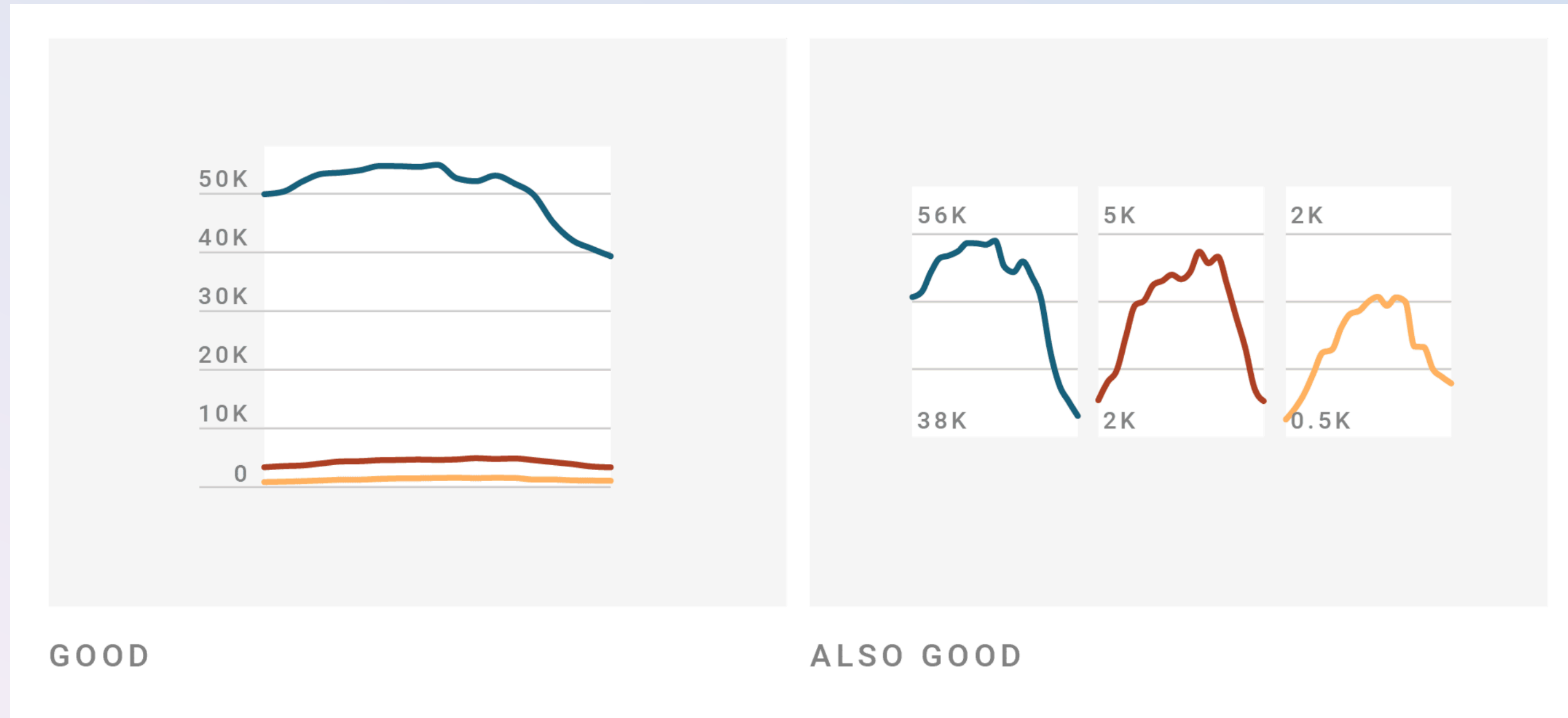
Reduce your colors and redesign!

Using “small multiples” is an easy, powerful technique



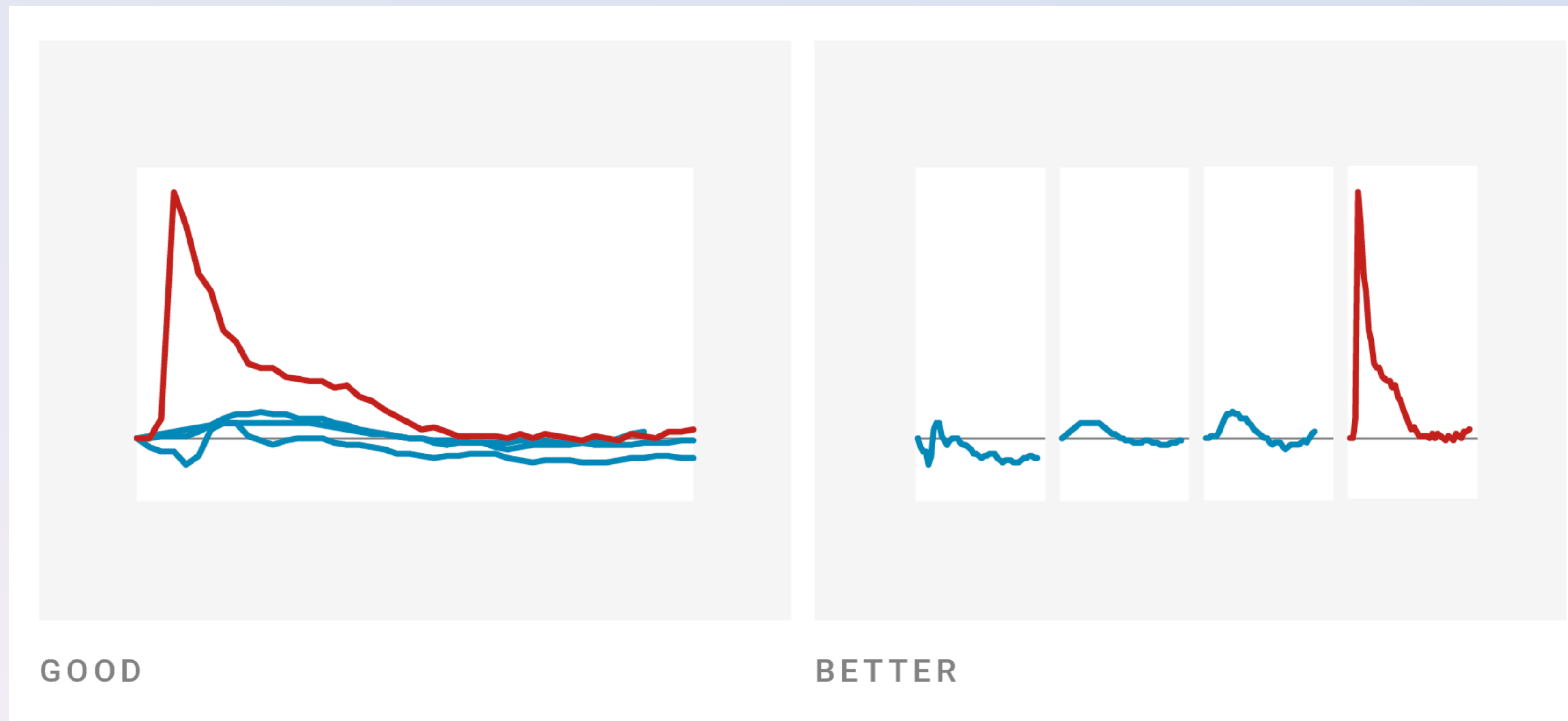
Source: [Datawrapper](#)

Or simply separate your colors, if they matter



Source: [Datawrapper](#)

My favorite color strategy is to pick just one for *emphasis*

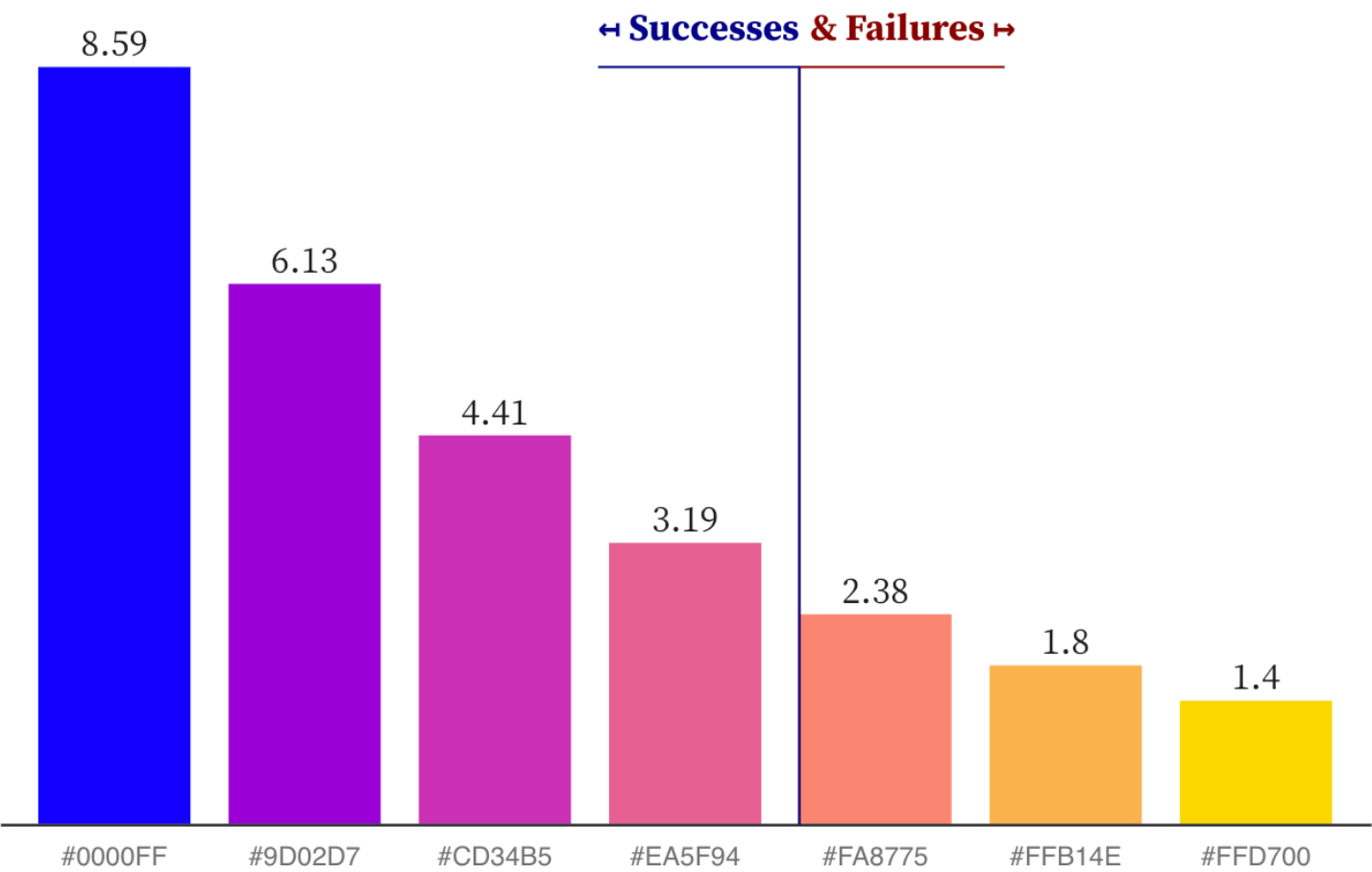


Source: [Datawrapper](#)

I have multiple guides on color on Observable

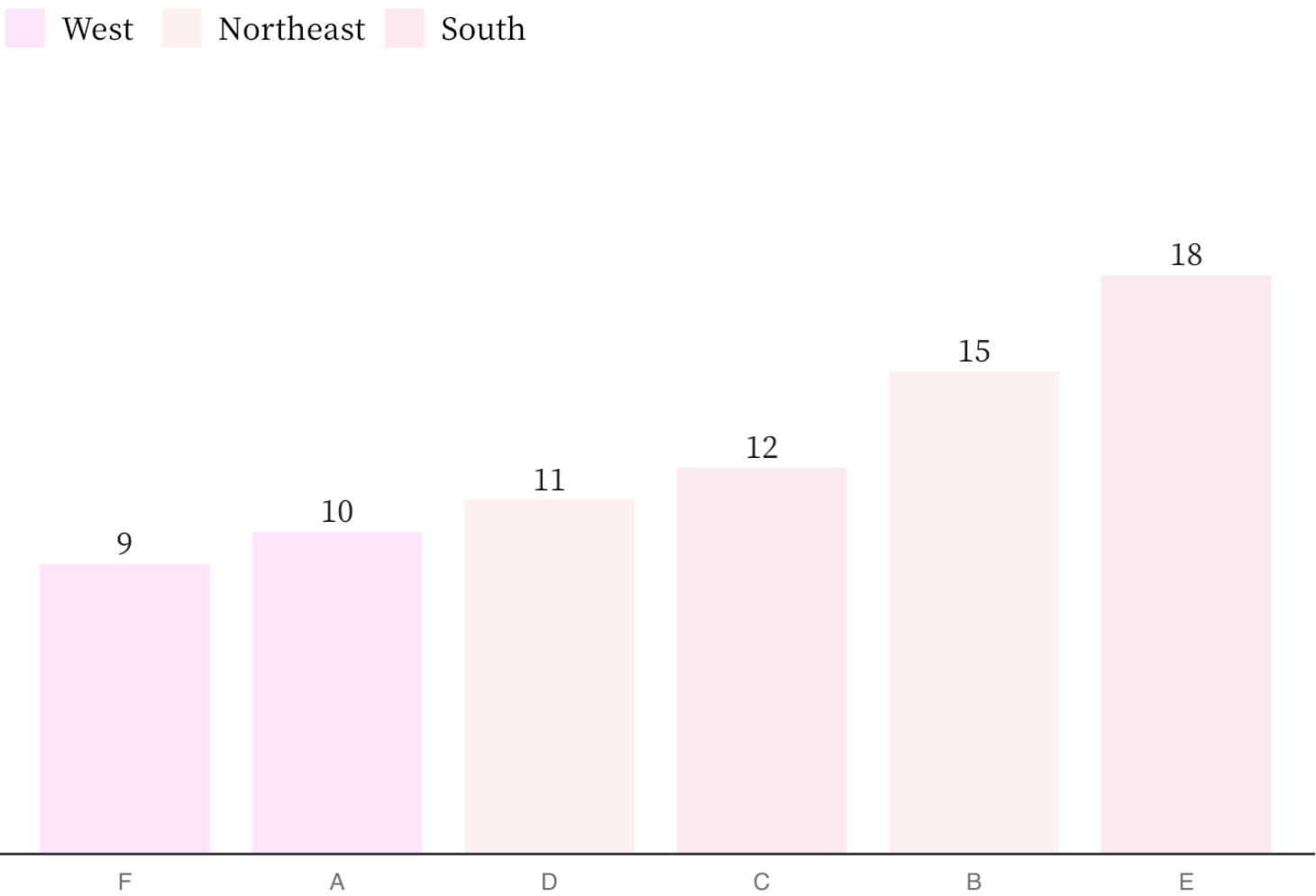
Demonstrating the contrast ratios of various fill colors

The number above each bar in the chart below represents the first half of a contrast ratio. So for "#EA5F94" you would read it as "3.19:1." Note that anything below 3:1 fails contrast requirements for chart elements.



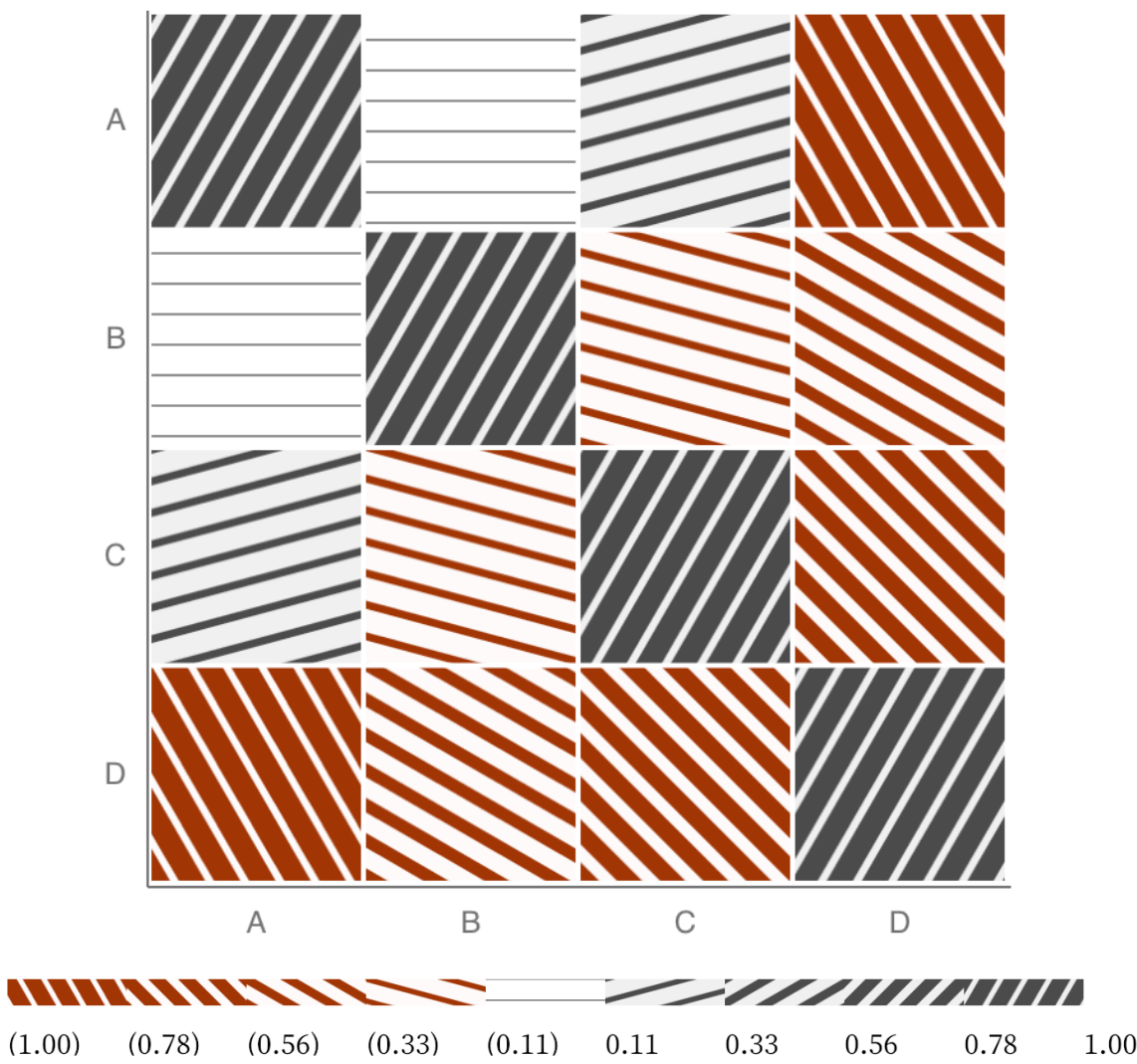
[Introduction to Contrast](#)

This is what someone with red-green colorblindness would see. Not great!



[Introduction to “No use of color alone”](#)

A heatmap that uses a diverging color scale with textures that also match



[Experimenting with textures](#)

Add alt text

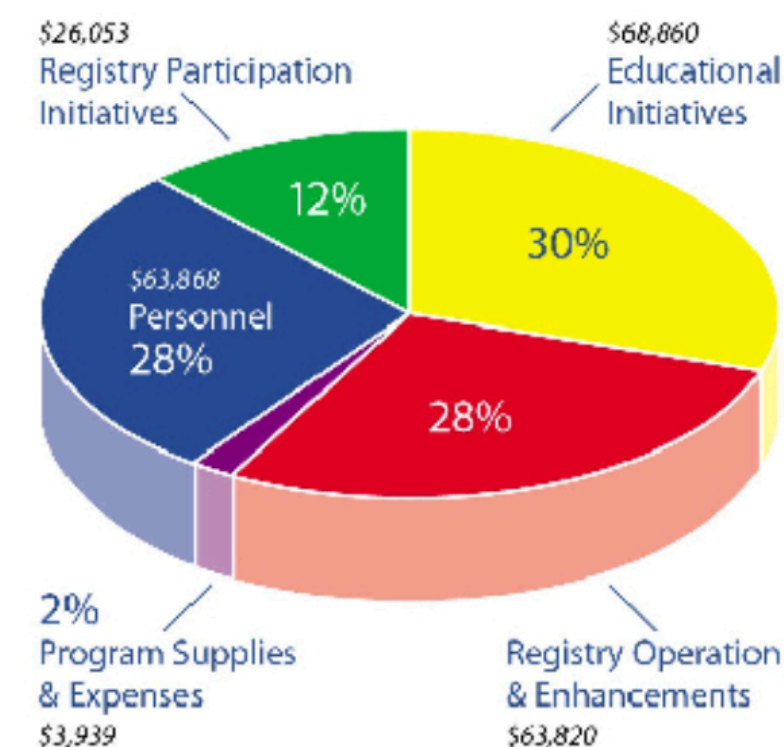
There is great research on alt text, but the most important thing to know is that you should add it to every image you post online (including twitter), in a document, or presentation.

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

NCAM: Descriptions, short and long



© NCAM 2009

Guidelines:

- Pie graphs should be converted into accessible tables.
- It is not necessary to describe the visual attributes of the charts, e.g., red wedge, blue lines, etc., unless there is an explicit need such as an exam question referring to these attributes.
- It is helpful to list the numbers from smallest to largest, regardless of how they are presented in the image.

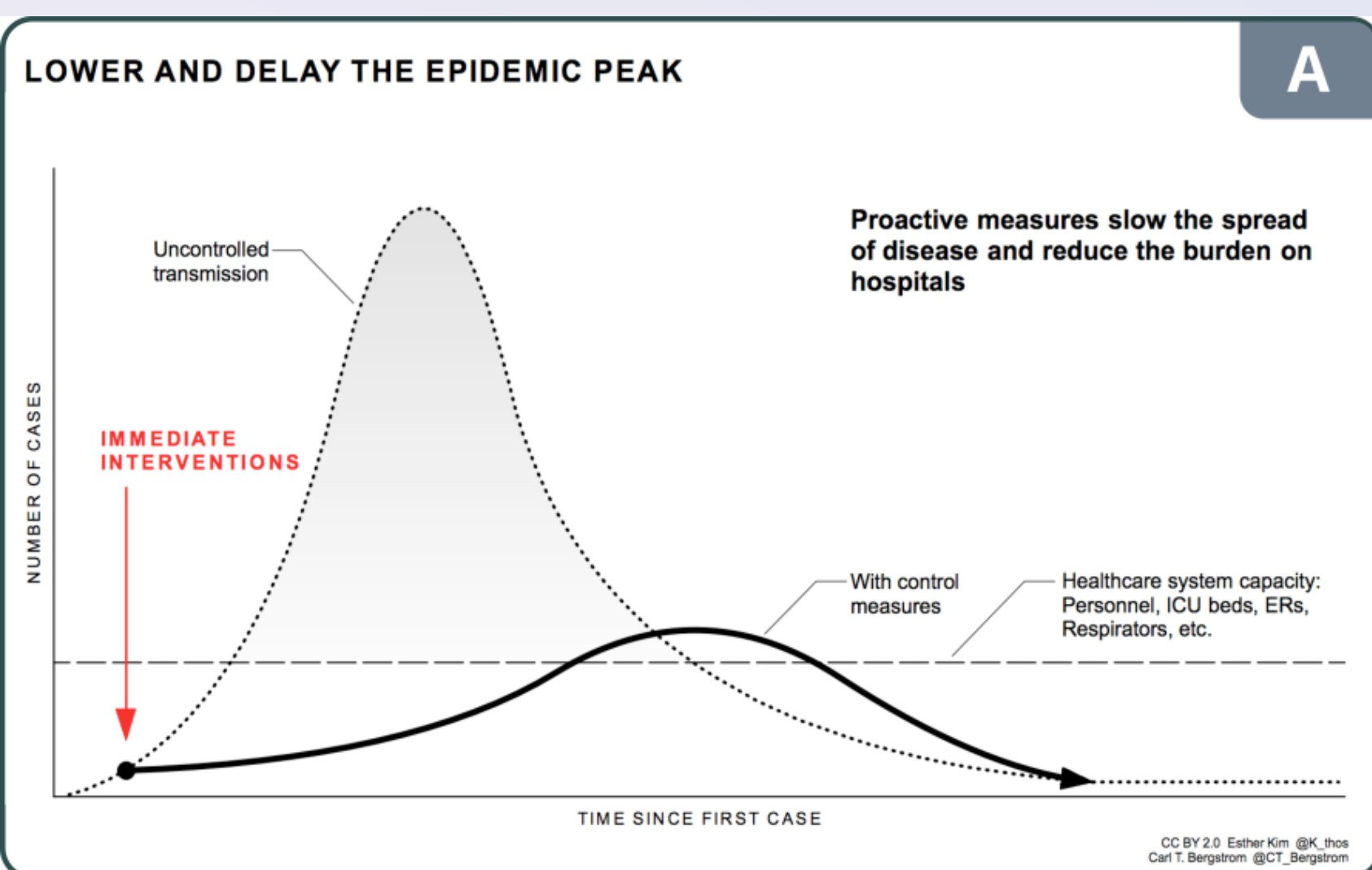
Description:

This figure is a pie graph that can be shown in the following table.

Program Expenses		
Expense	Percent of Total	Dollar Amount
Program Supplies and Expenses	2%	\$3,939
Registry Participation Initiatives	12%	\$26,052
Registry Operation and Enhancements	28%	\$63,820
Personnel	28%	\$63,868
Educational Initiatives	30%	\$68,860

Source: [NCAM's Diagram Center Guidelines](#)

Describing charts, in parts



B

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.

C

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.

Source: "Accessible Visualization via Natural Language Descriptions," by Lundgard and Satyanarayan

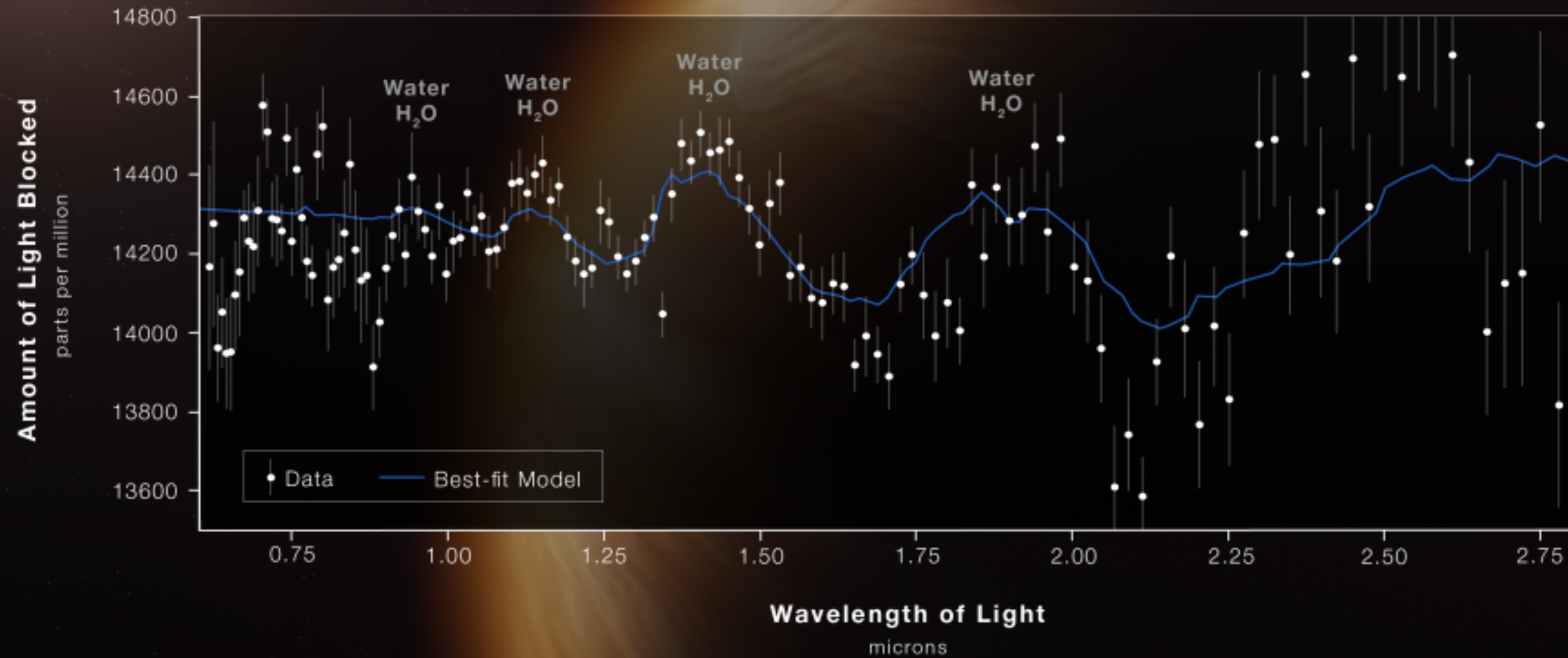


Source: [NASA's James Webb Space Telescope](#)

HOT GAS GIANT EXOPLANET WASP-96 b

ATMOSPHERE COMPOSITION

NIRISS | Single-Object Slitless Spectroscopy



Source: [NASA](#)

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.

Source: [NASA](#)

Perceivable Evaluation Toolkit:

1. [Contrast Checker](#)
2. Color design (see [my series on Observable](#))
 1. [CVD Checker](#)
 2. [Redundant encoding design ideas](#)
 3. [Small multiples design ideas](#)
3. Add descriptions:
 1. [Alt text](#), [Semantic levels](#), and [Alt documents](#)