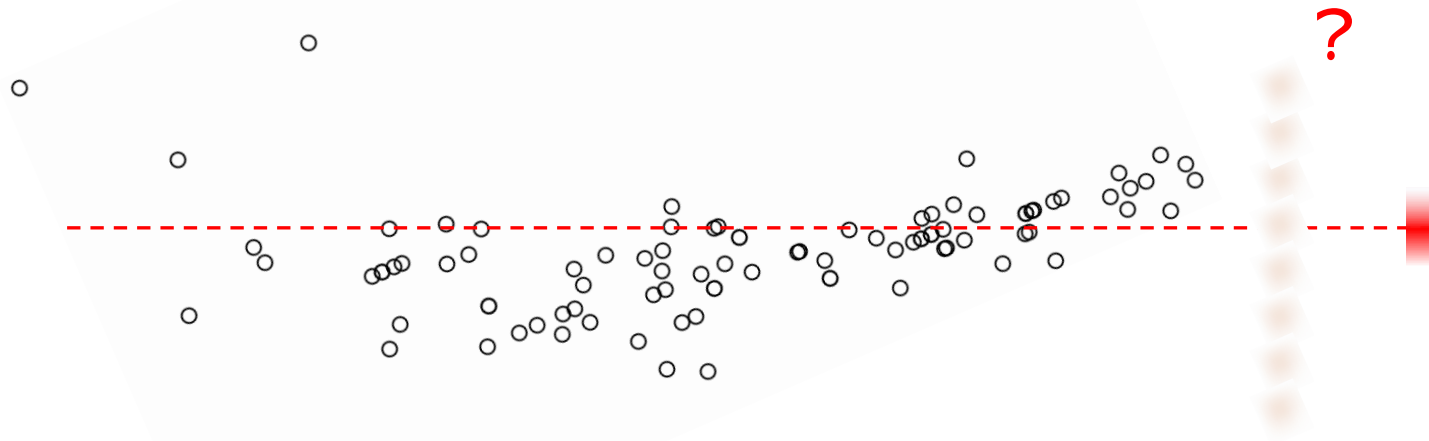


# **UNCERTAINTY AND VARIABILITY**

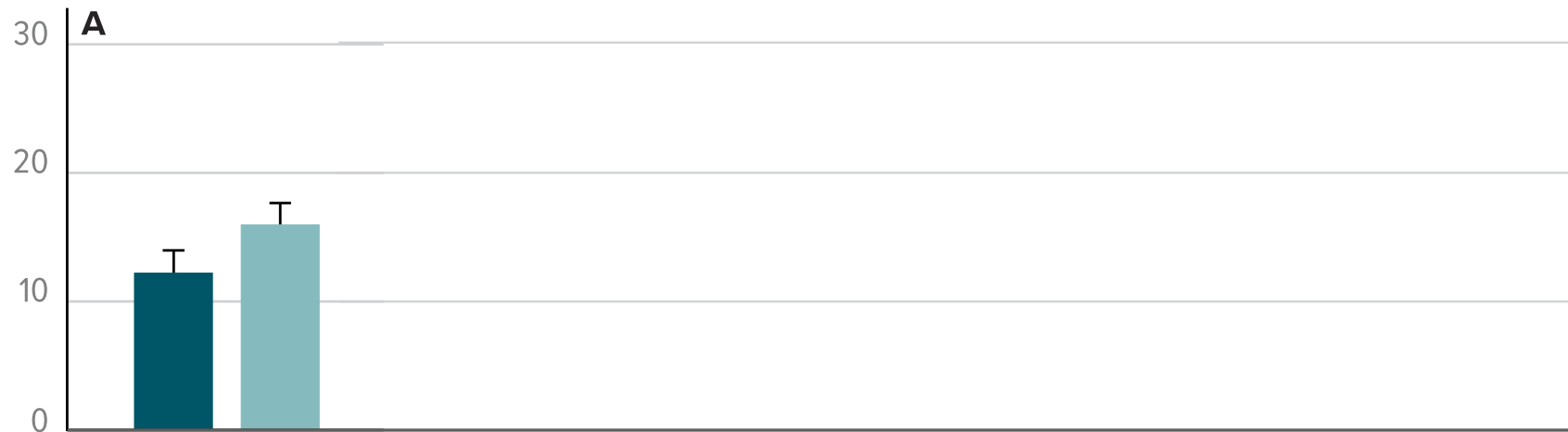
# UNCERTAINTY AND VARIABILITY

In some way related: given some past events or objects extracted from a population, I do not know what will be the next one due to both! (cf. epistemic uncertainty and statistical/stochastic uncertainty)



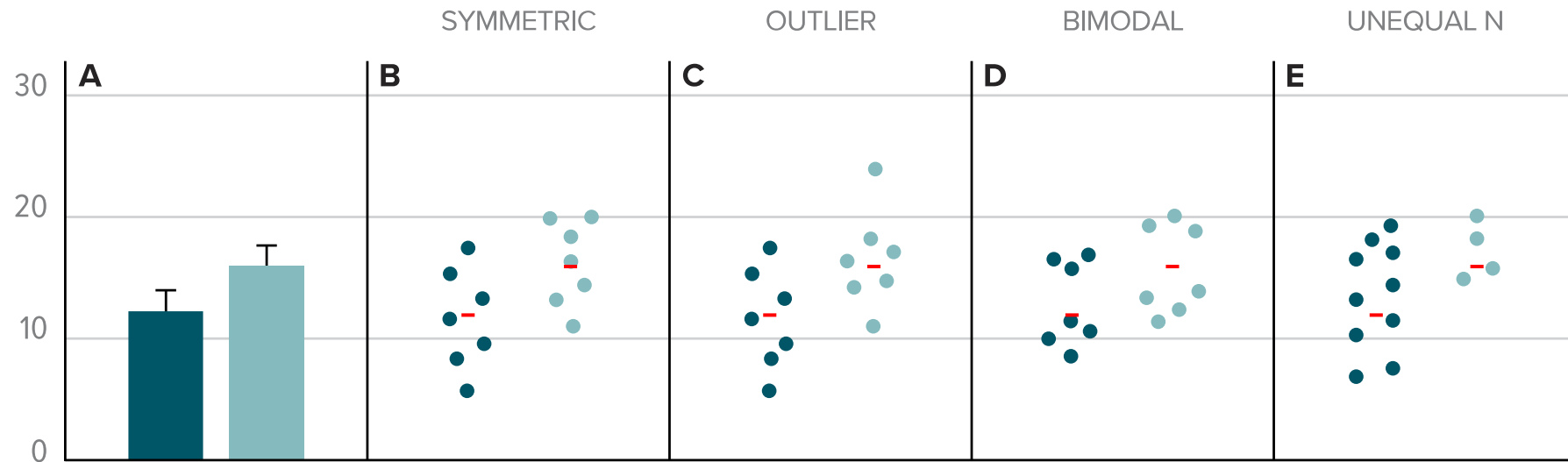
**WHY SHOULD WE CARE ABOUT HOW TO VISUALIZE  
UNCERTAINTY AND VARIABILITY?**

# WHY SHOULD WE CARE ABOUT HOW TO VISUALIZE UNCERTAINTY AND VARIABILITY?



Average is all we need!

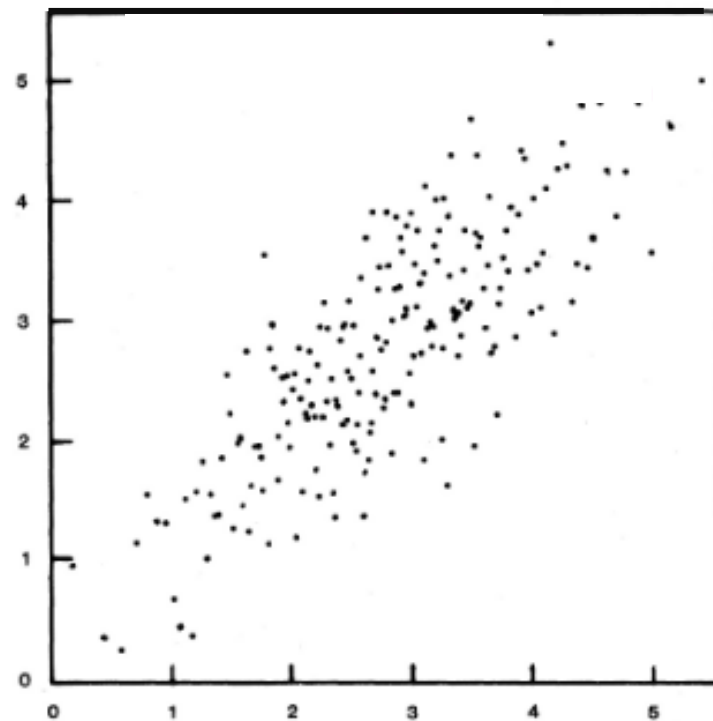
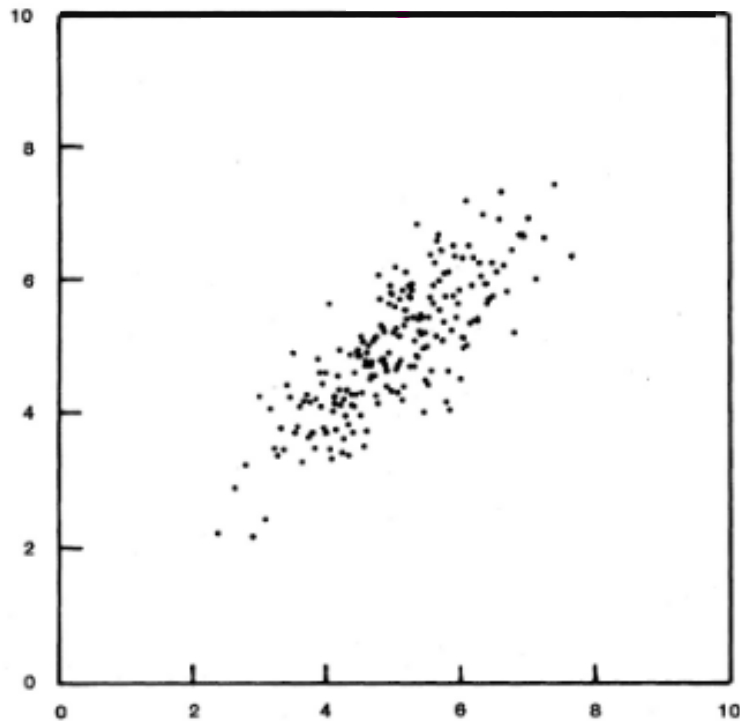
# WHY SHOULD WE CARE ABOUT HOW TO VISUALIZE UNCERTAINTY AND VARIABILITY?



Try jittered strip plots (or jitter plot)

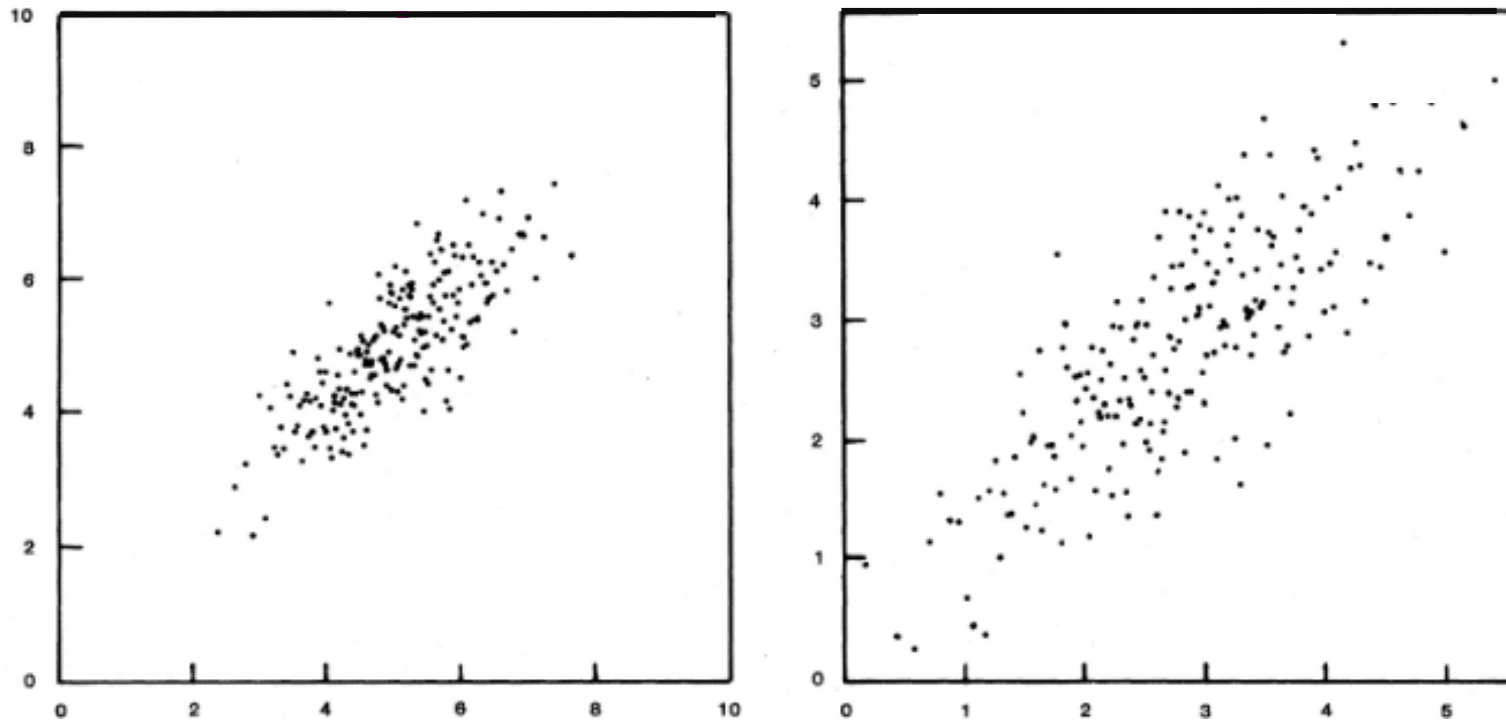
Average is all we need! Really?!

# WHY SHOULD WE CARE ABOUT HOW TO VISUALIZE UNCERTAINTY AND VARIABILITY?



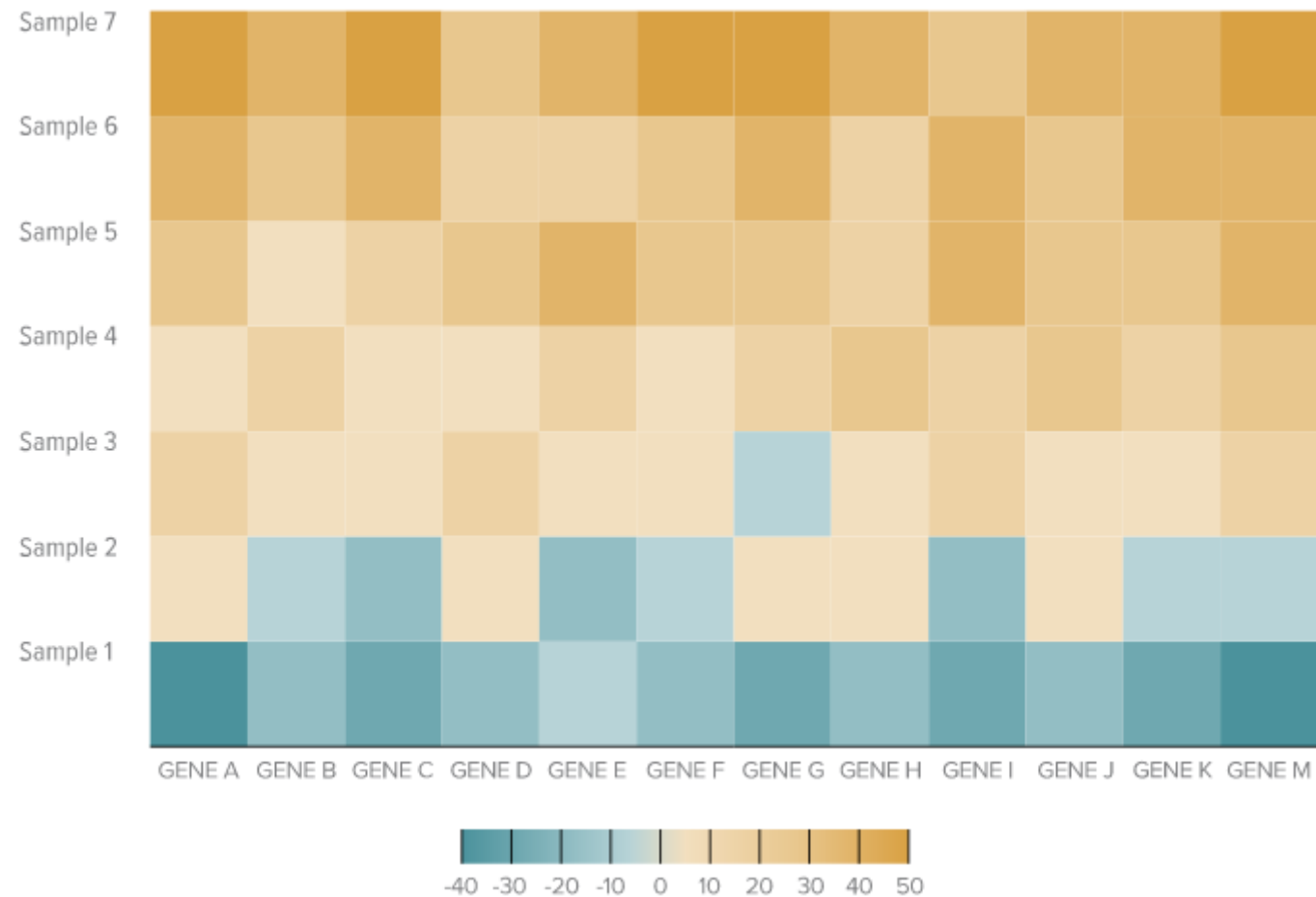
What's dataset is more correlated?

# WHY SHOULD WE CARE ABOUT HOW TO VISUALIZE UNCERTAINTY AND VARIABILITY?



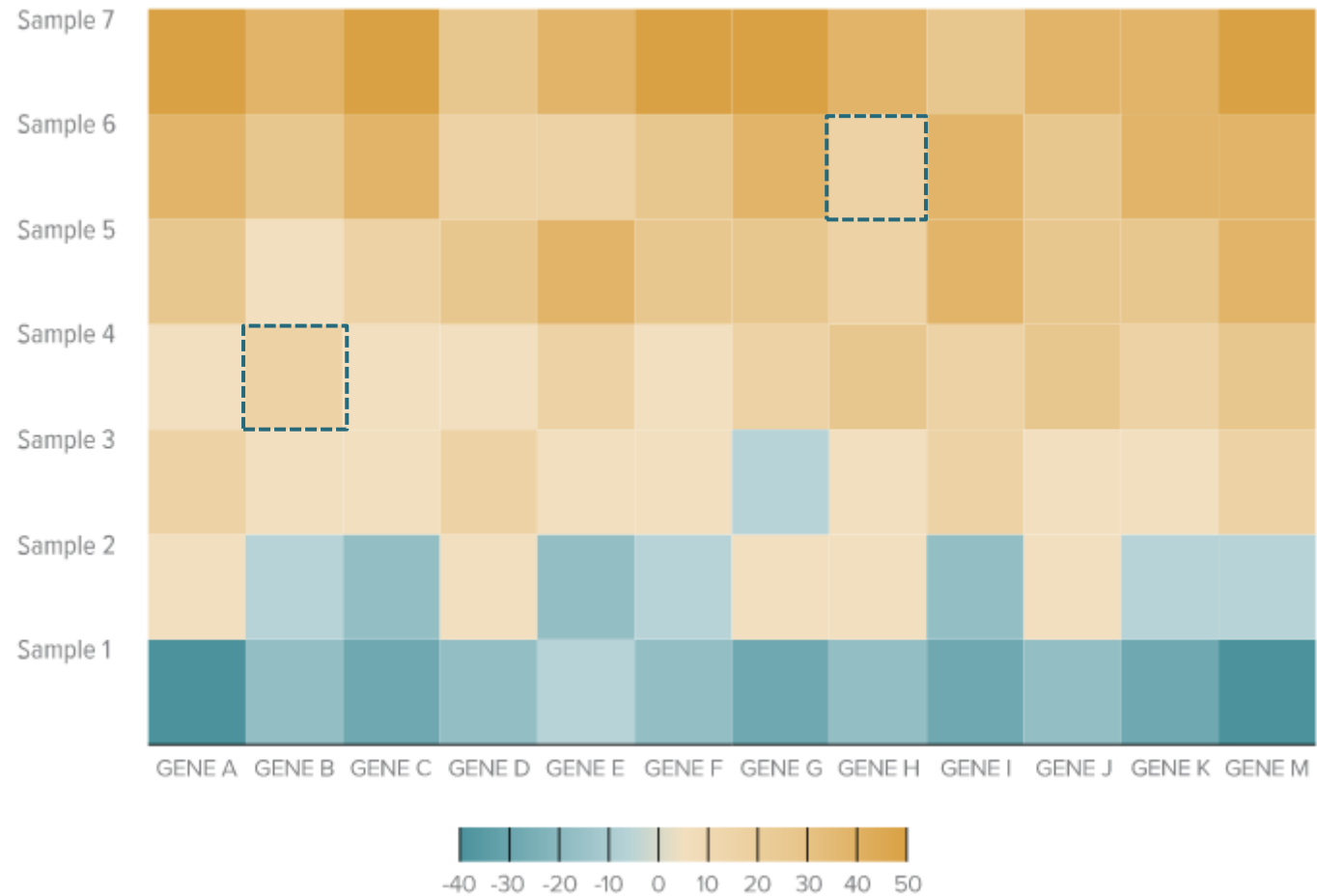
What's dataset is more correlated? Equally correlated ( $r=.8$ ) but point cloud size different.

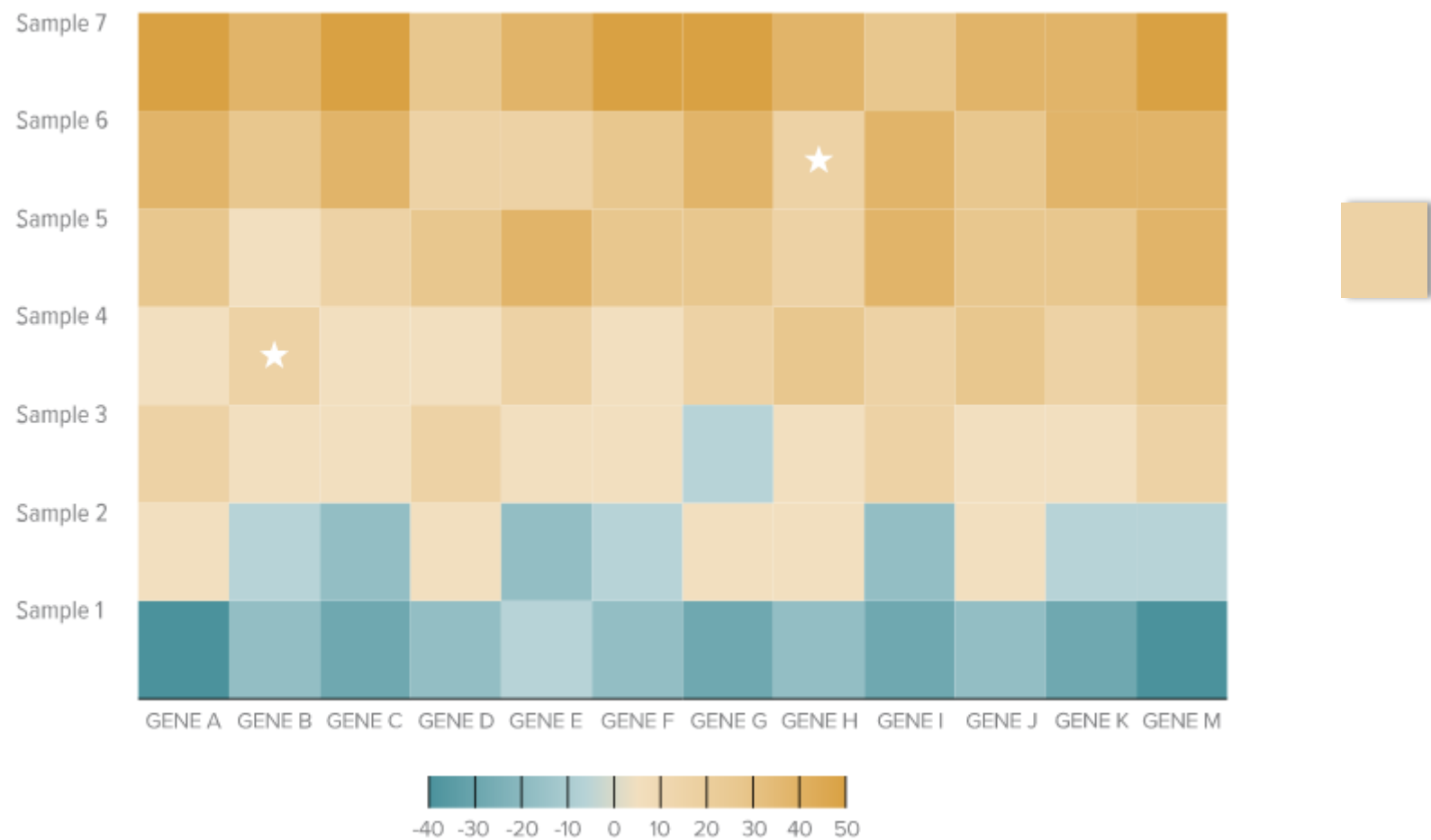
# WHY SHOULD WE CARE ABOUT HOW TO VISUALIZE UNCERTAINTY AND VARIABILITY?





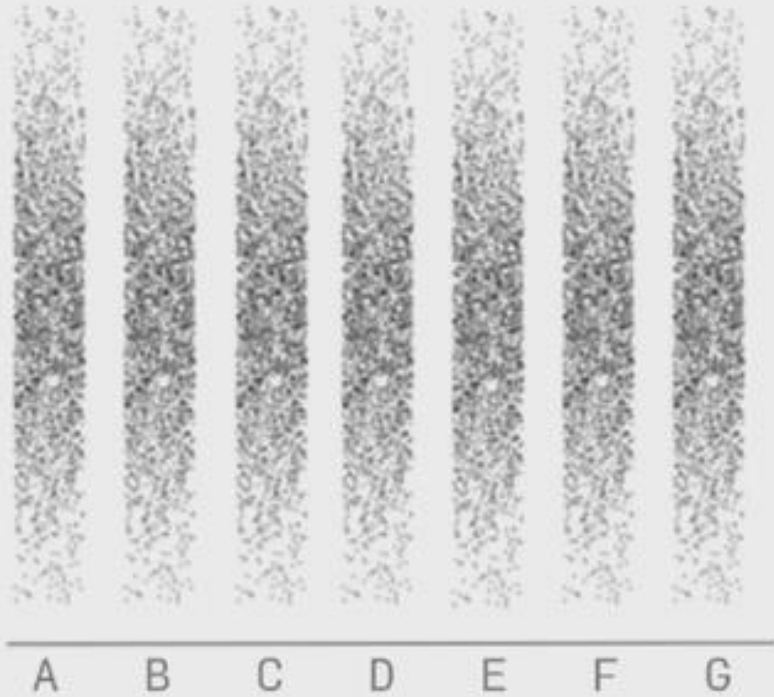
Gene B in sample 4 and Gene H in sample 6 look different, uh?



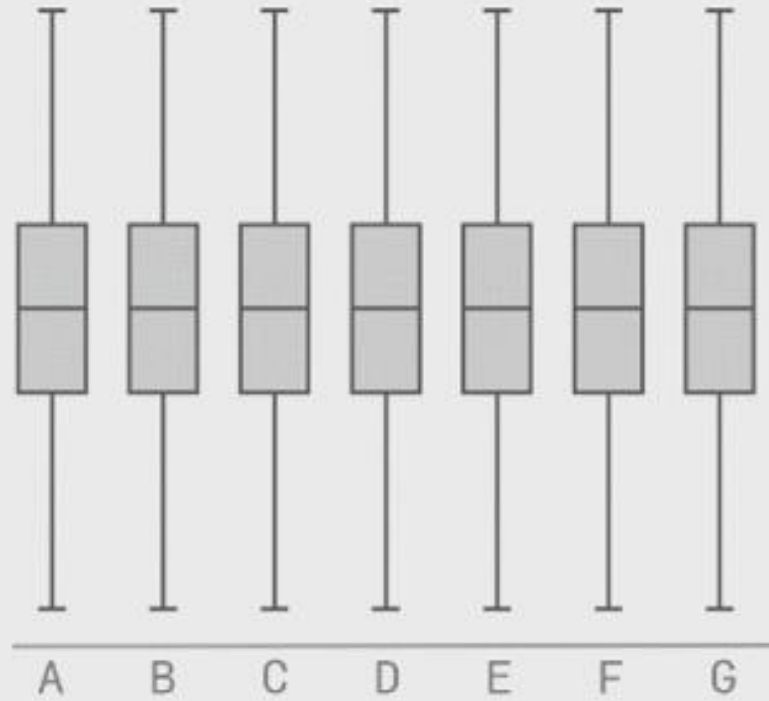


# Let people see the data!

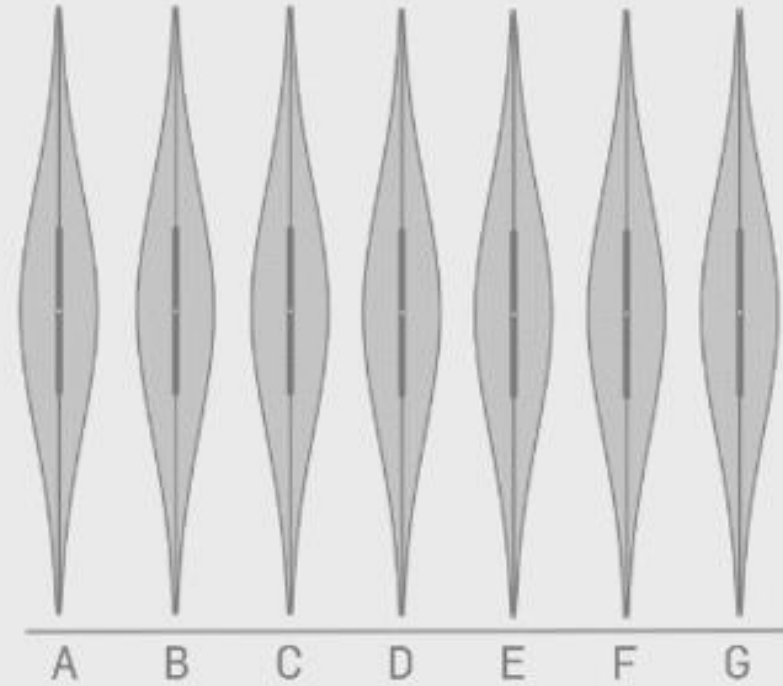
**Raw Data**



**Box-plot of the Data**

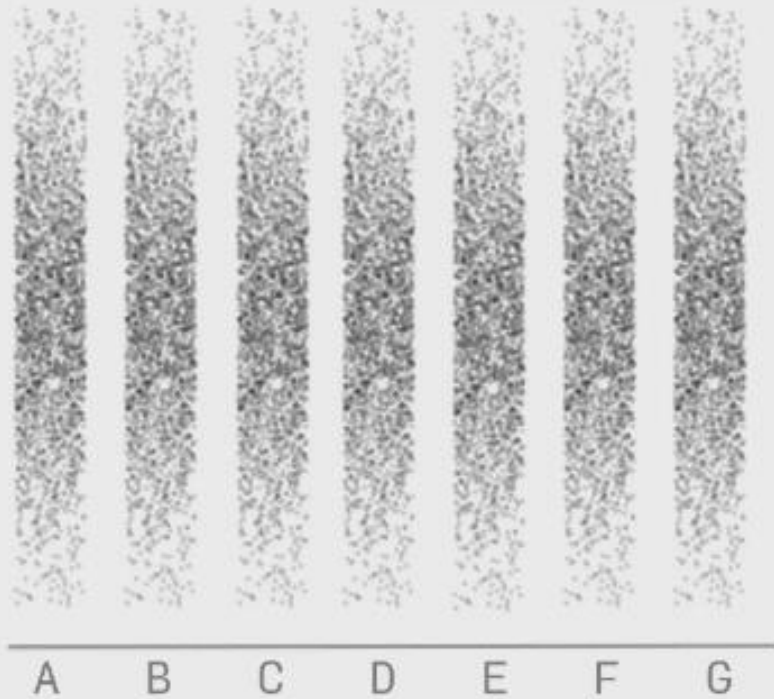


**Violin-plot of the Data**

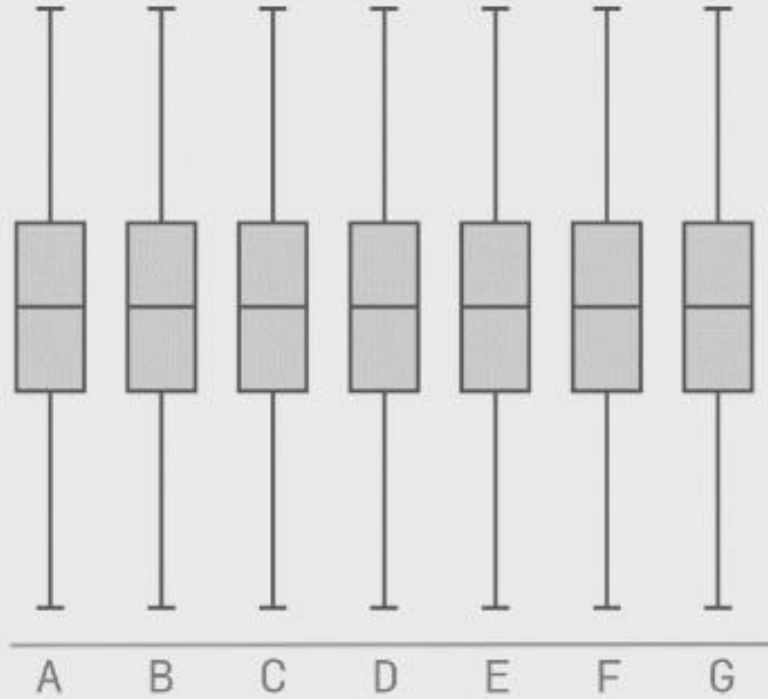


# Let people see the data!

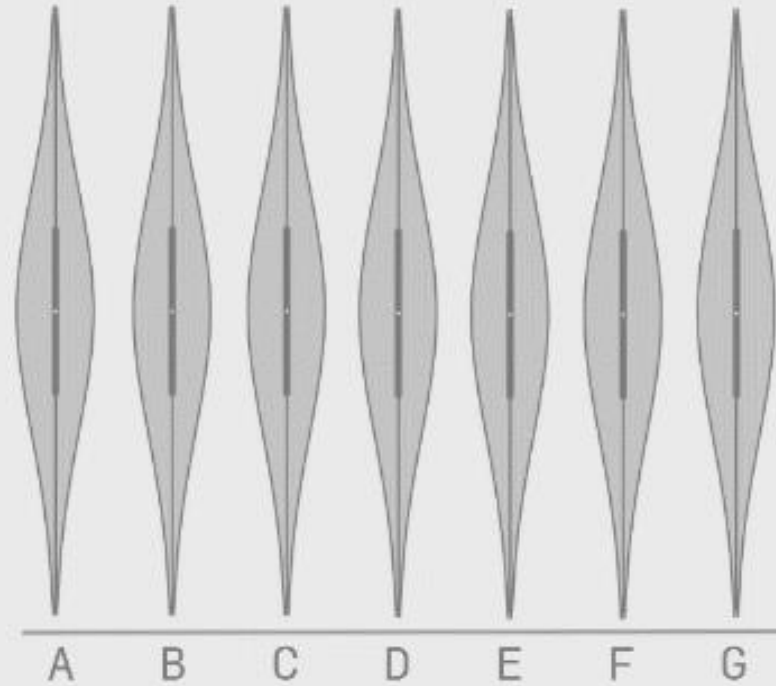
**Raw Data**



**Box-plot of the Data**

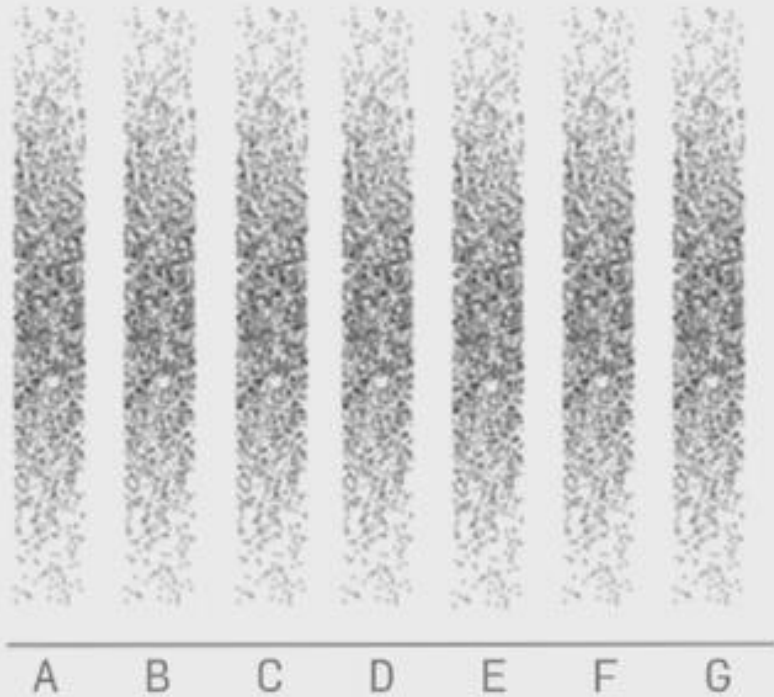


**Violin-plot of the Data**

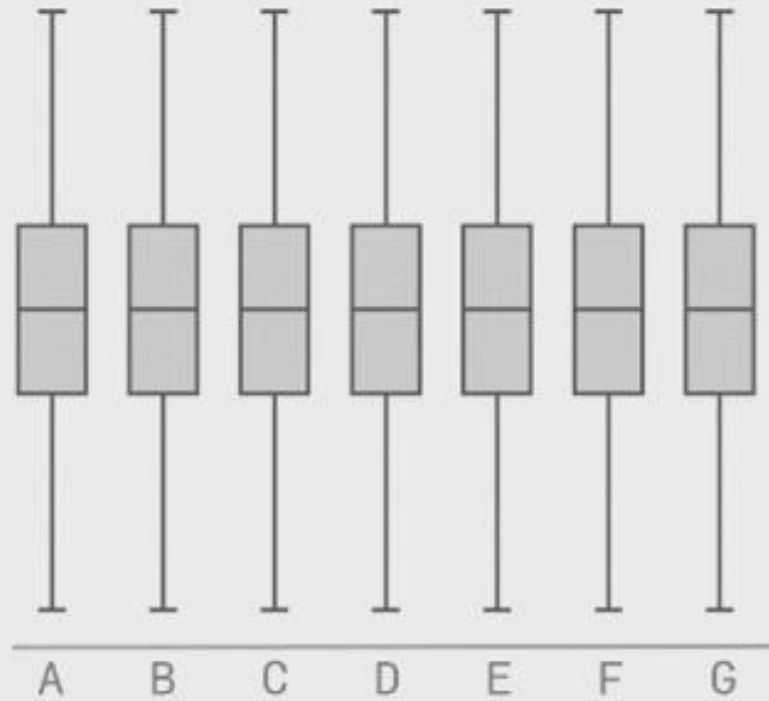


# Let people see the data!

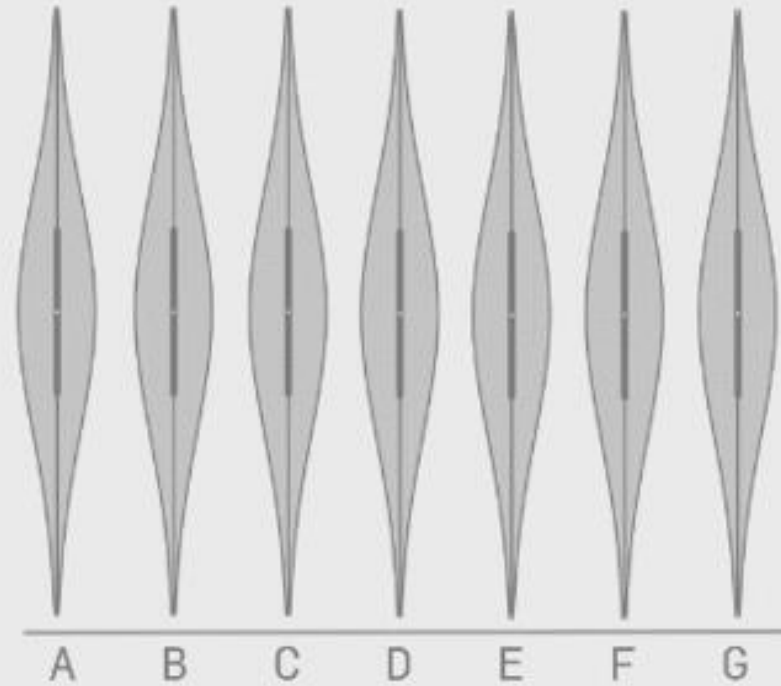
**Raw Data**



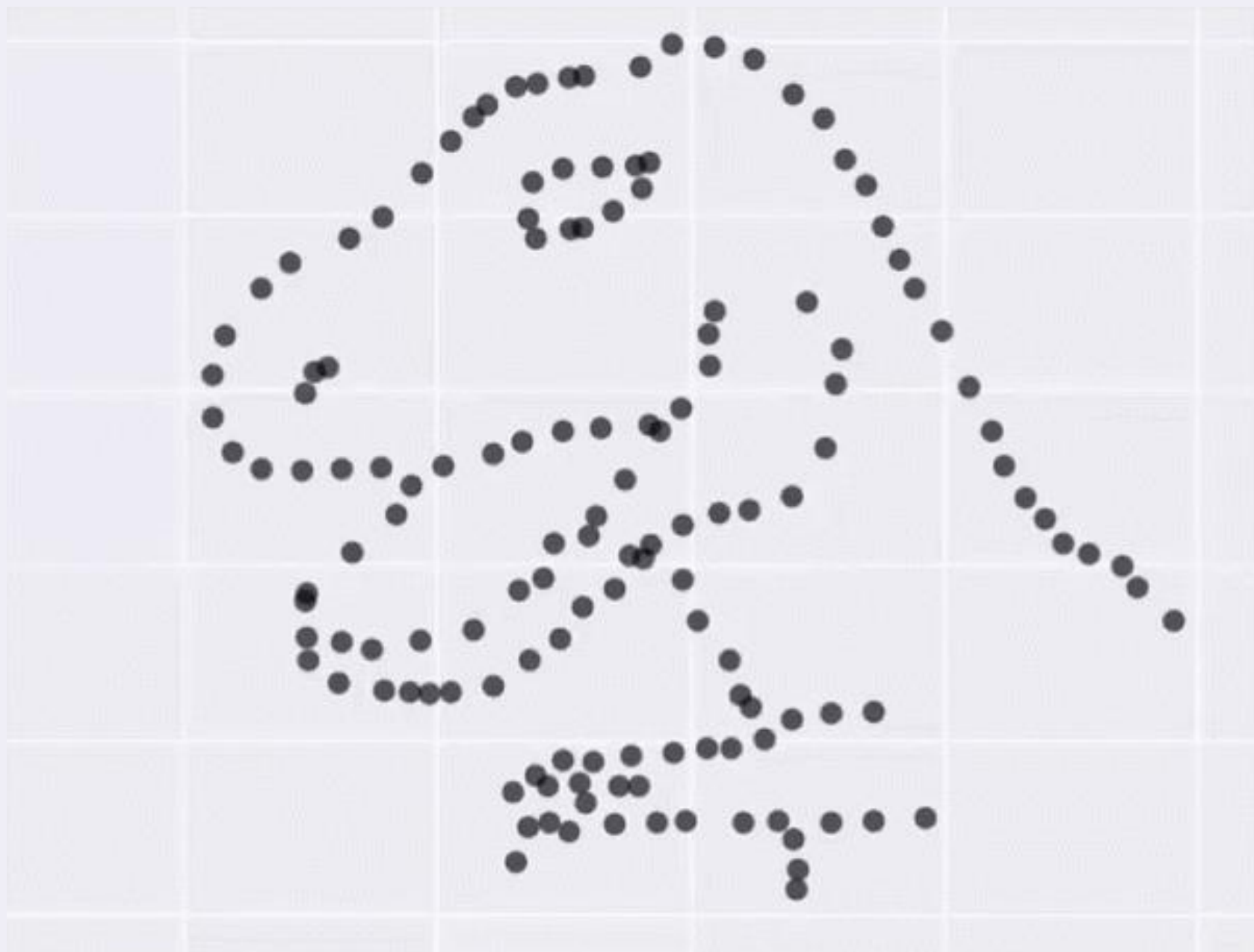
**Box-plot of the Data**

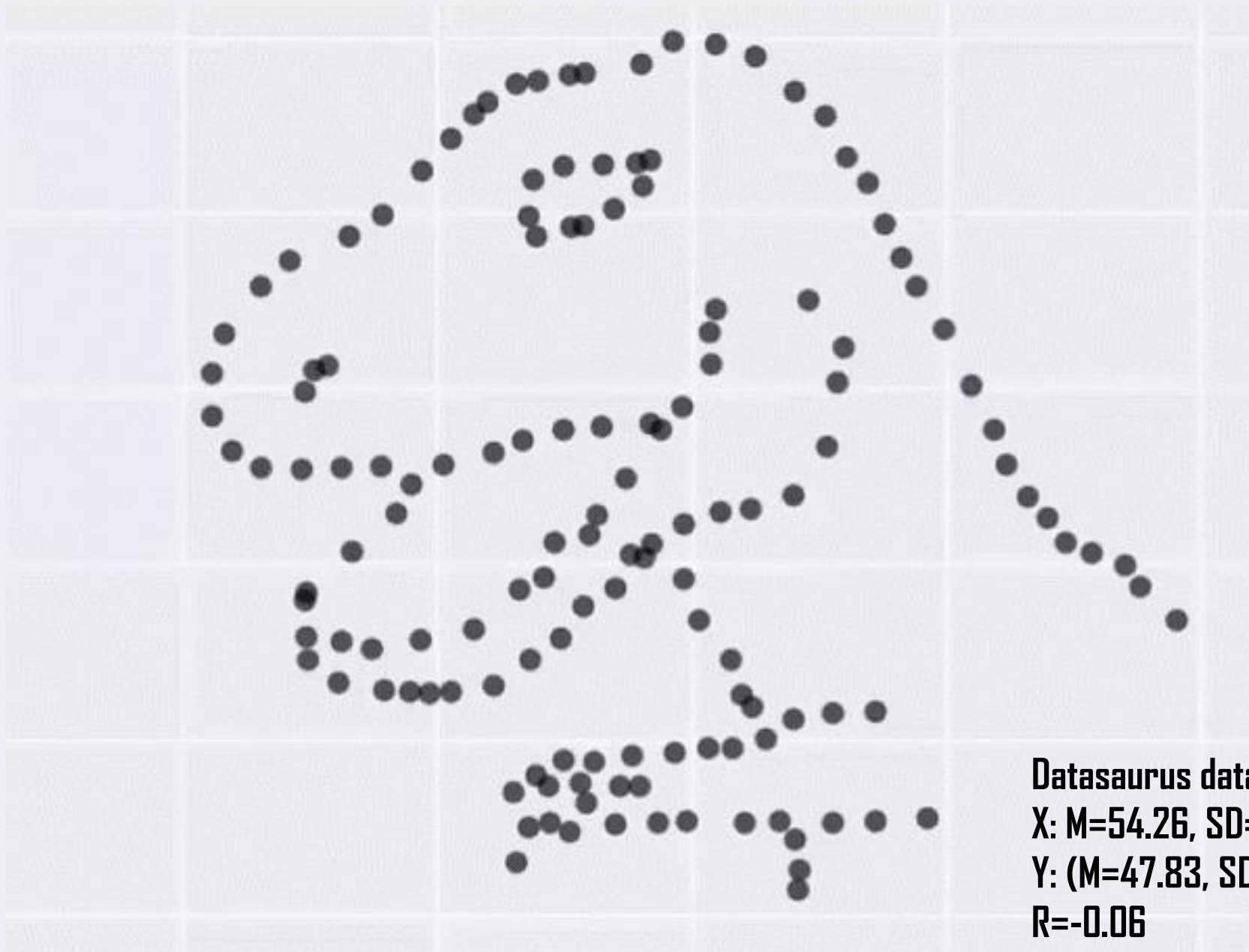


**Violin-plot of the Data**



It depends on your data, on the point (of your data story), and on your readership!





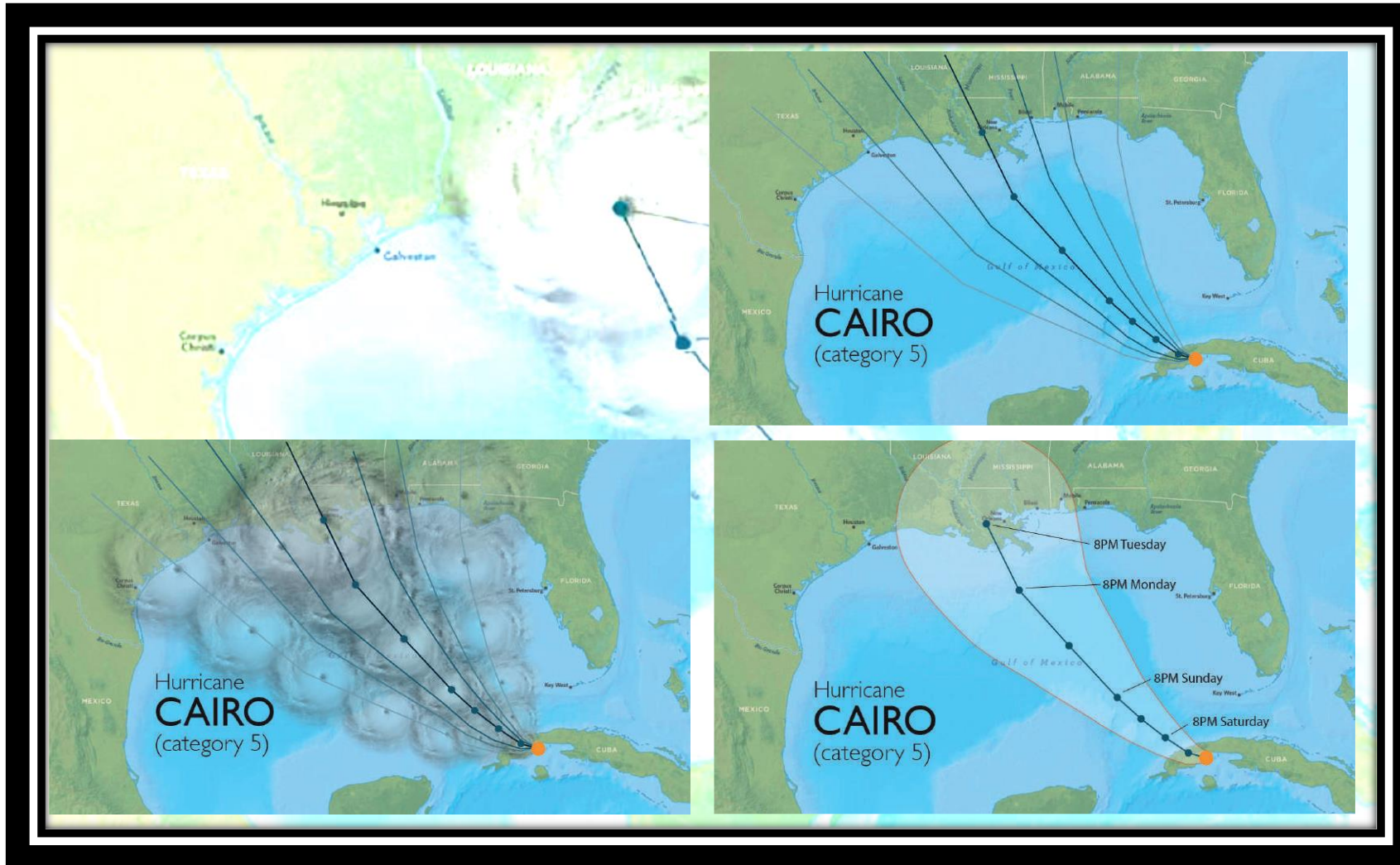


# Messing up with (or concealing) uncertainty!

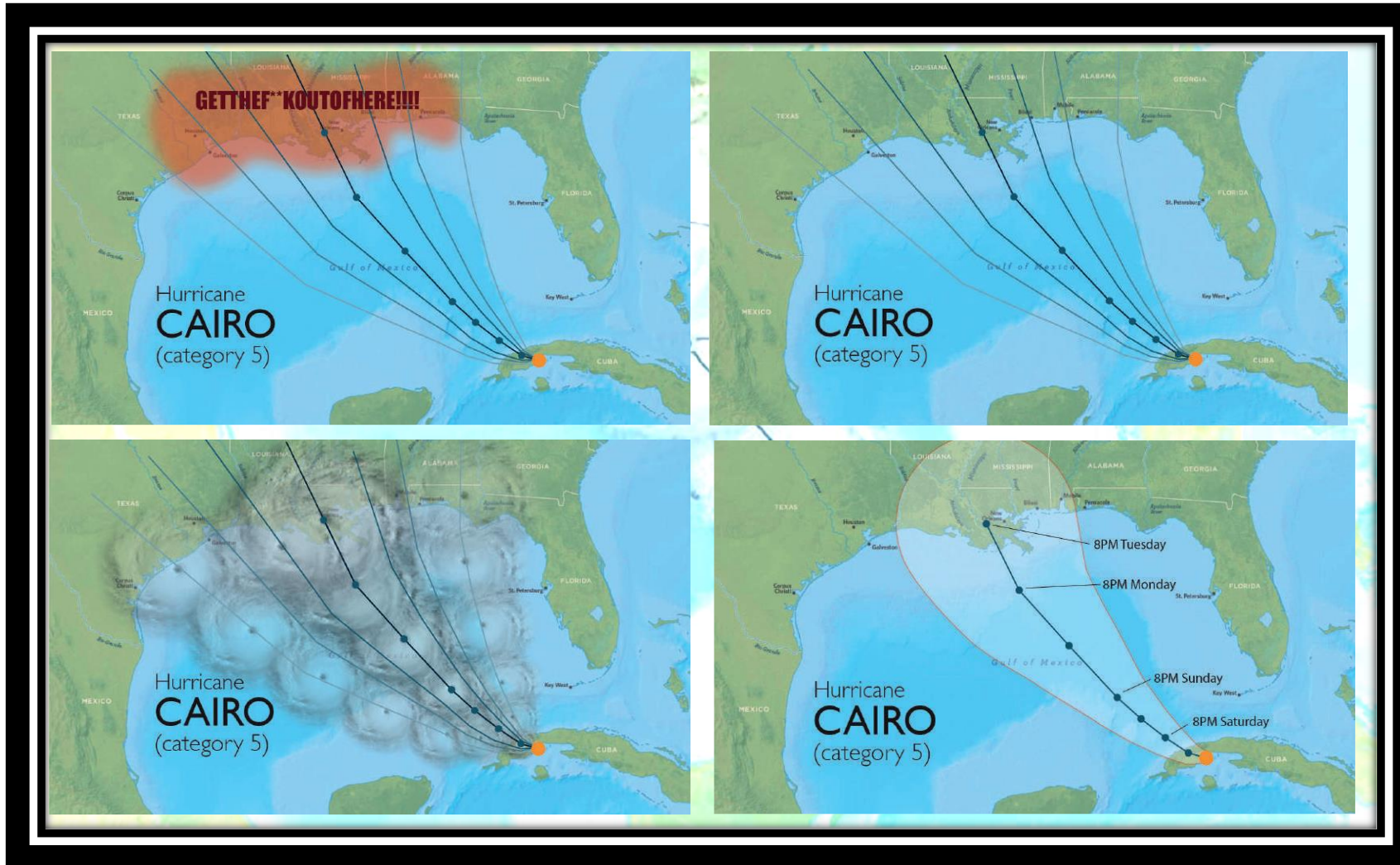




# Messing up with (or concealing) uncertainty!



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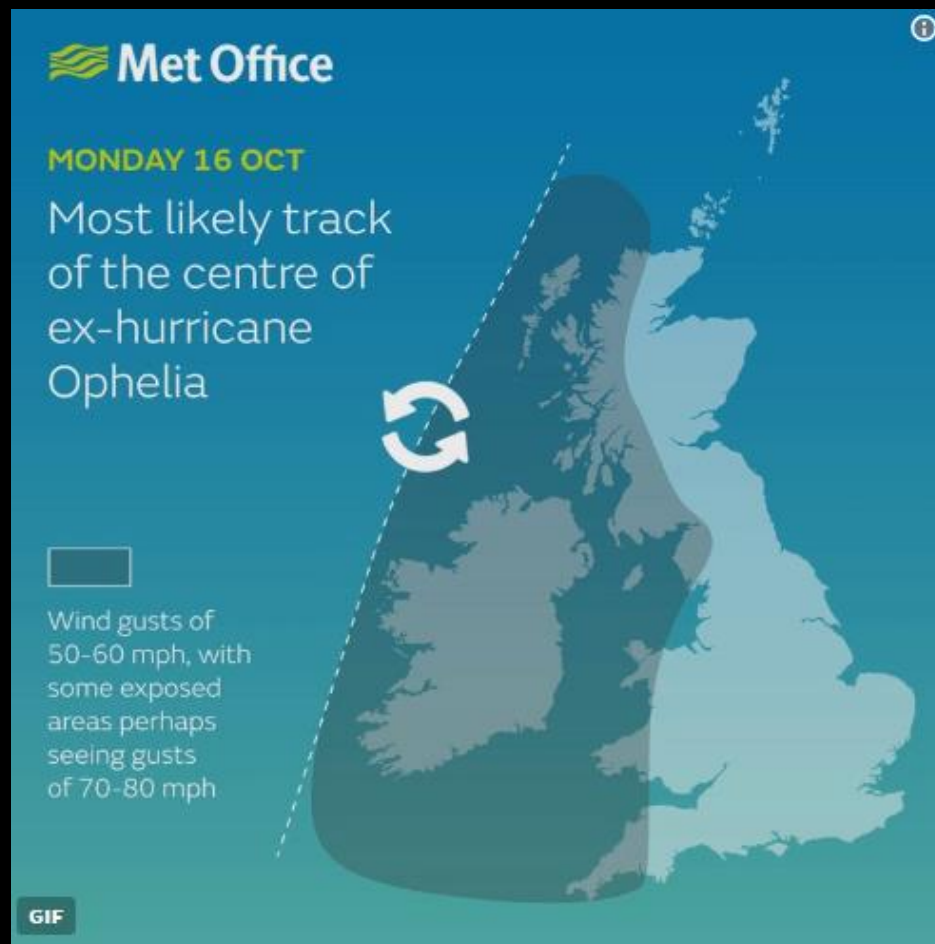


# Messing up with (or concealing) uncertainty!

This is a good “compromise”:

The “most likely” track is shown and then a shaded area that is meaningful for the common reader (layperson)

(in this specific case about wind gusts above a specific speed threshold)



# How not to conceal but rather acknowledge uncertainty!

**Intervals**

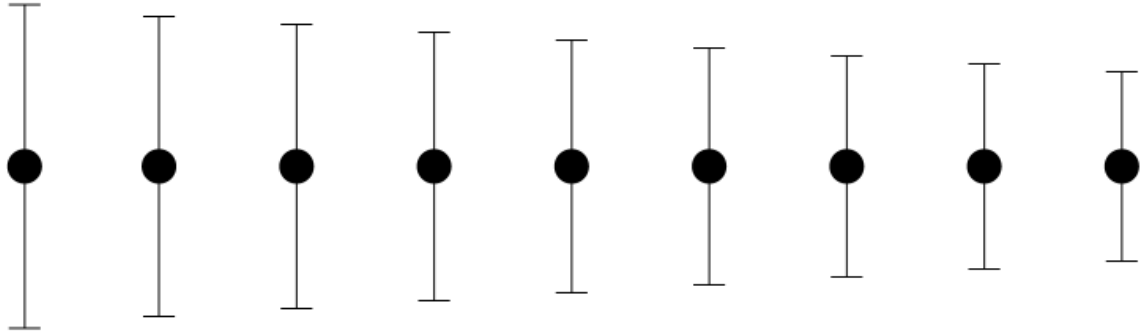
**Dispersion**

**Blurriness**

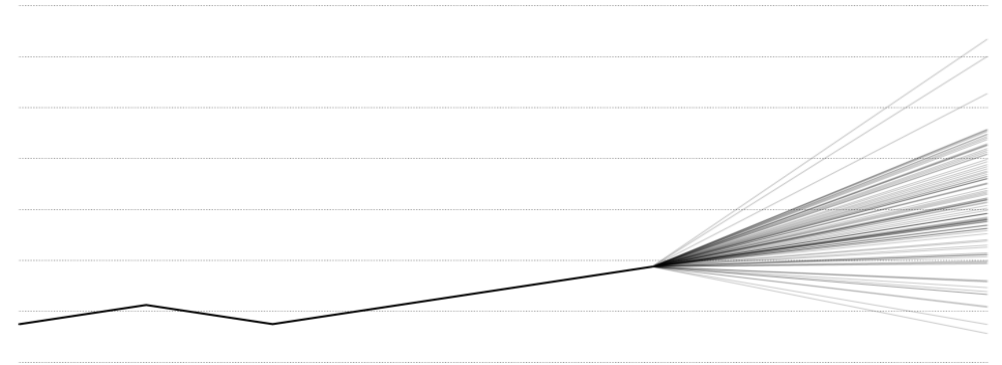
**Saturation, brightenes...**

# How not to conceal but rather acknowledge uncertainty!

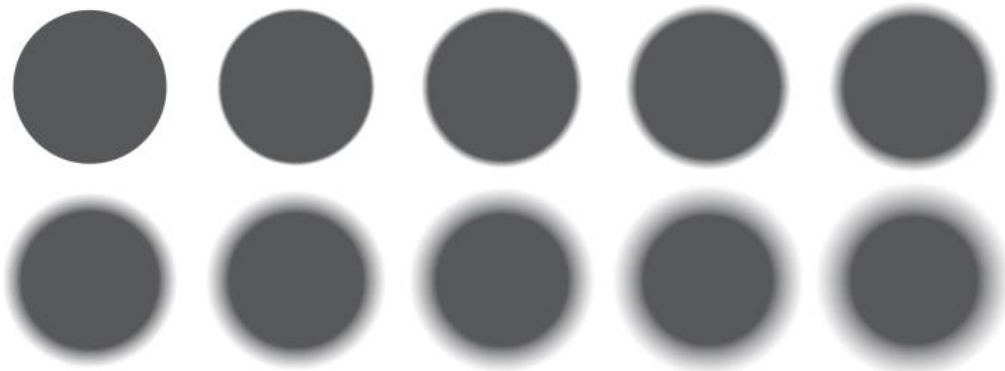
## Intervals



## Dispersion



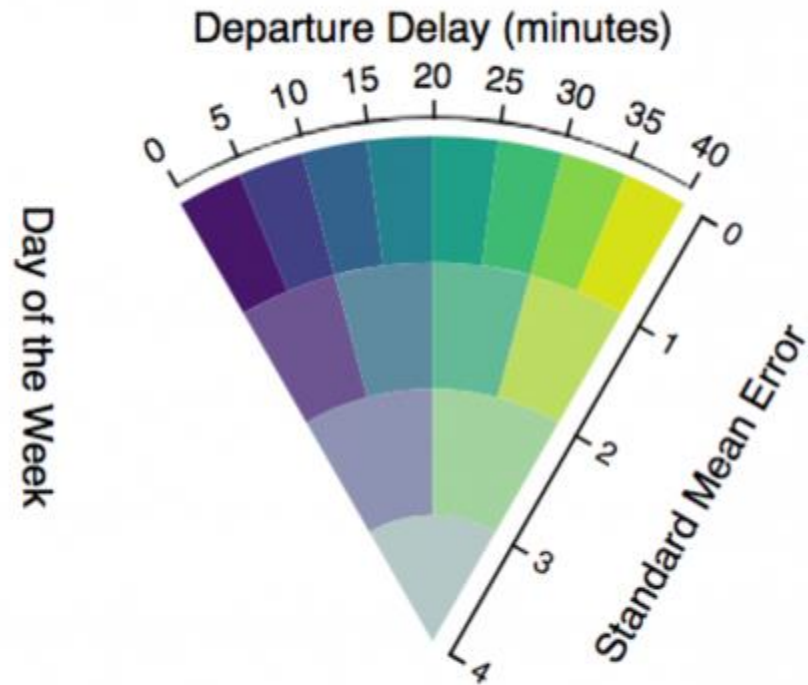
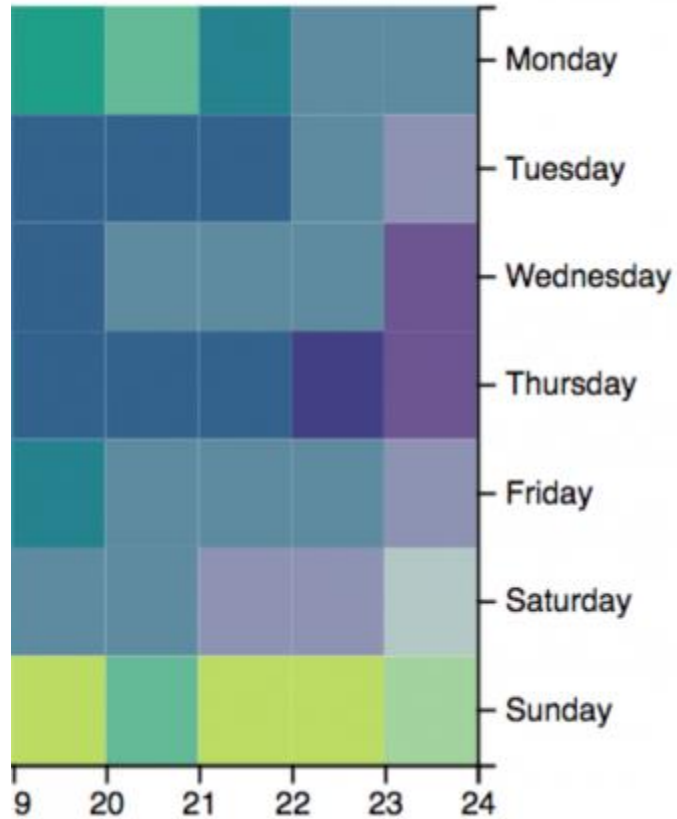
## Blurriness



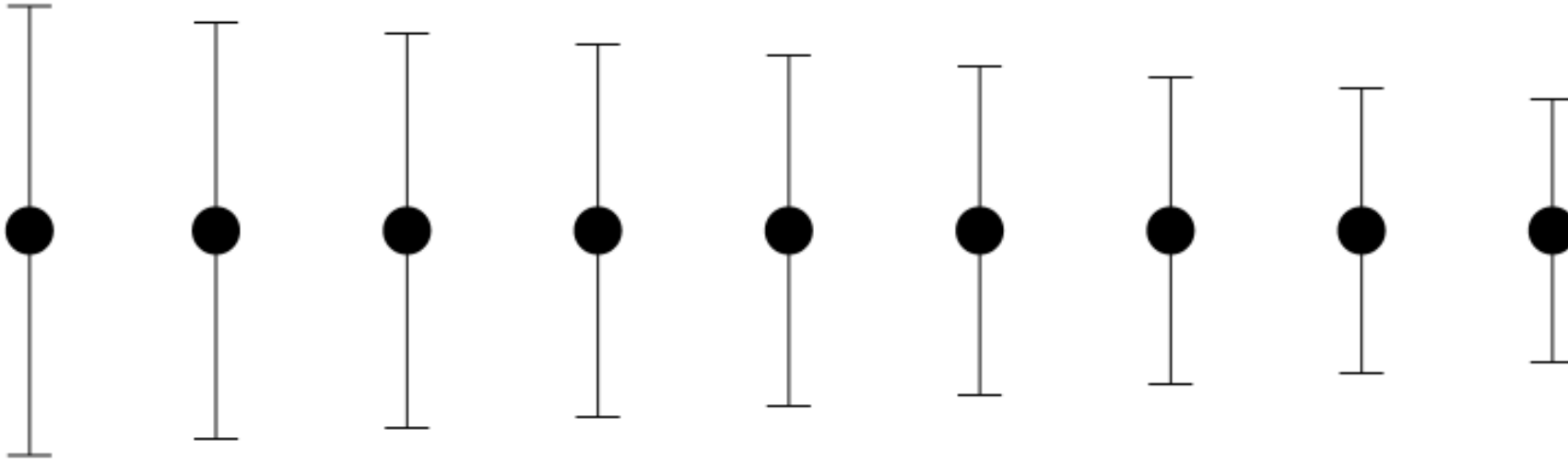
## Saturation, brightenes...



# Value-Suppressing Uncertainty Palettes



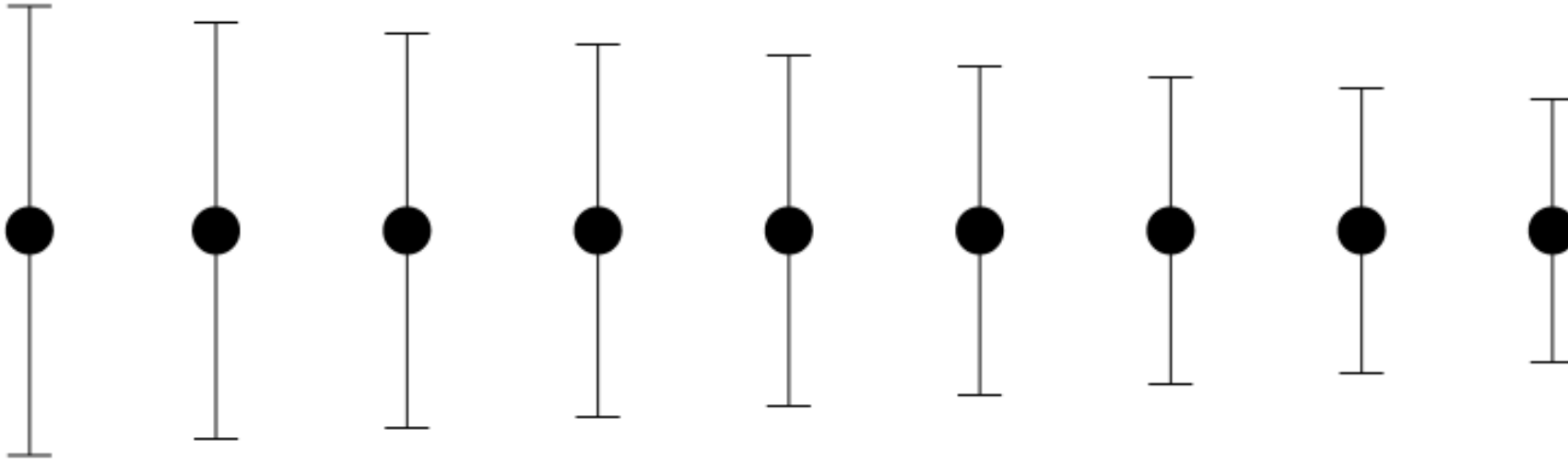




Be careful that "error bars" can indicate different things: confidence intervals (CI), standard errors (SE), standard deviations (SD),...





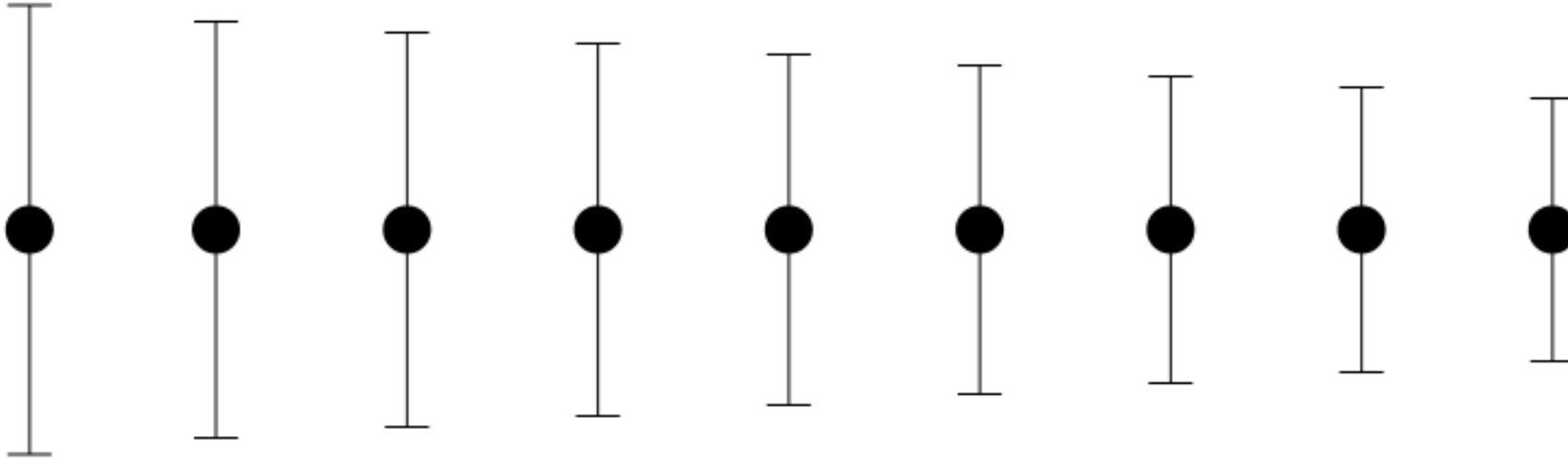


SO: always be explicit re  
what your "error bars"  
represent.

(Dispersion? Uncertainty?)



A

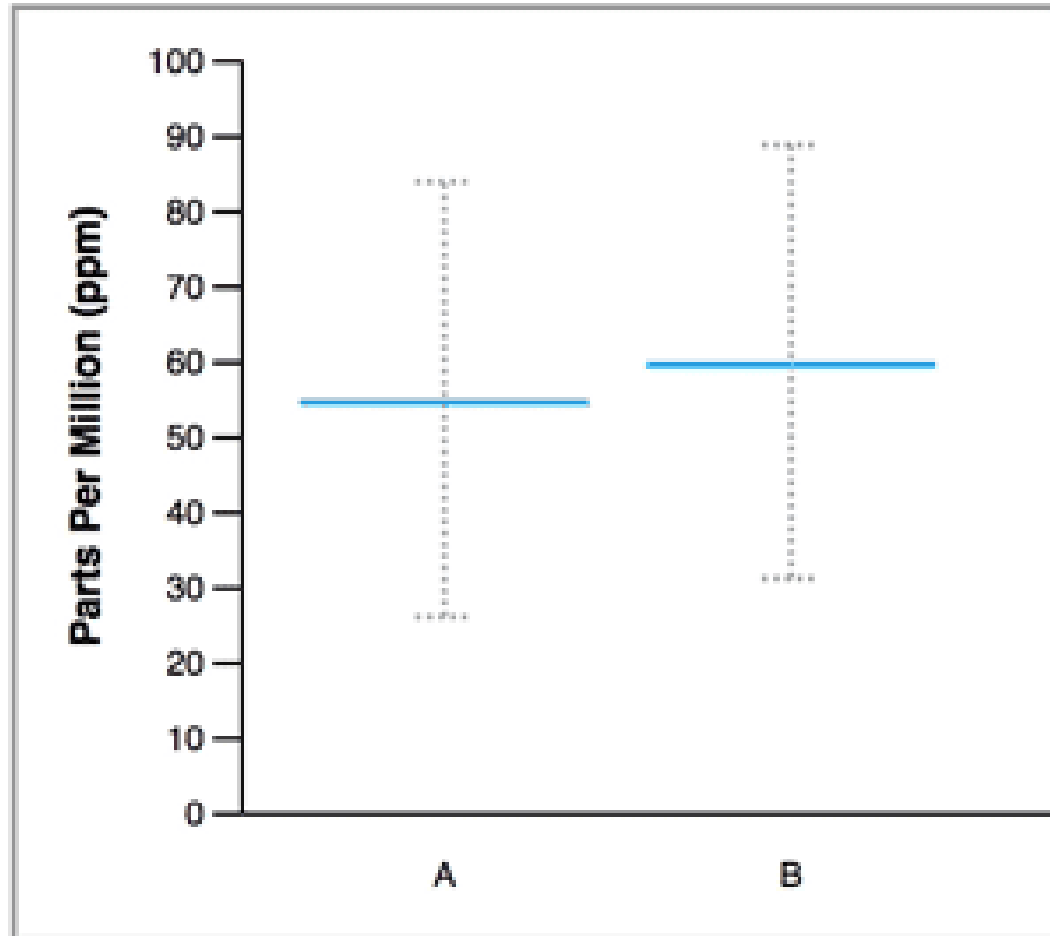


B

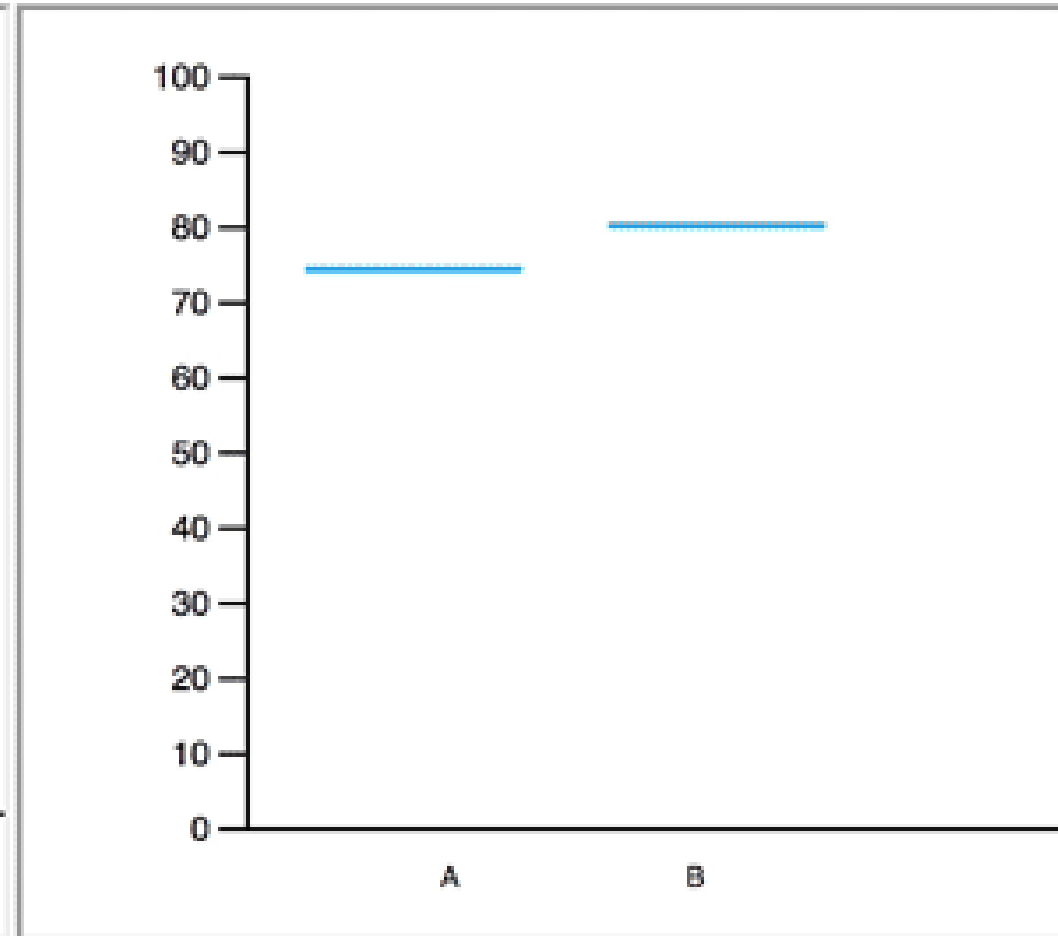
BTW: what's the representation of the estimate about which you want to be more confident of? A or B?



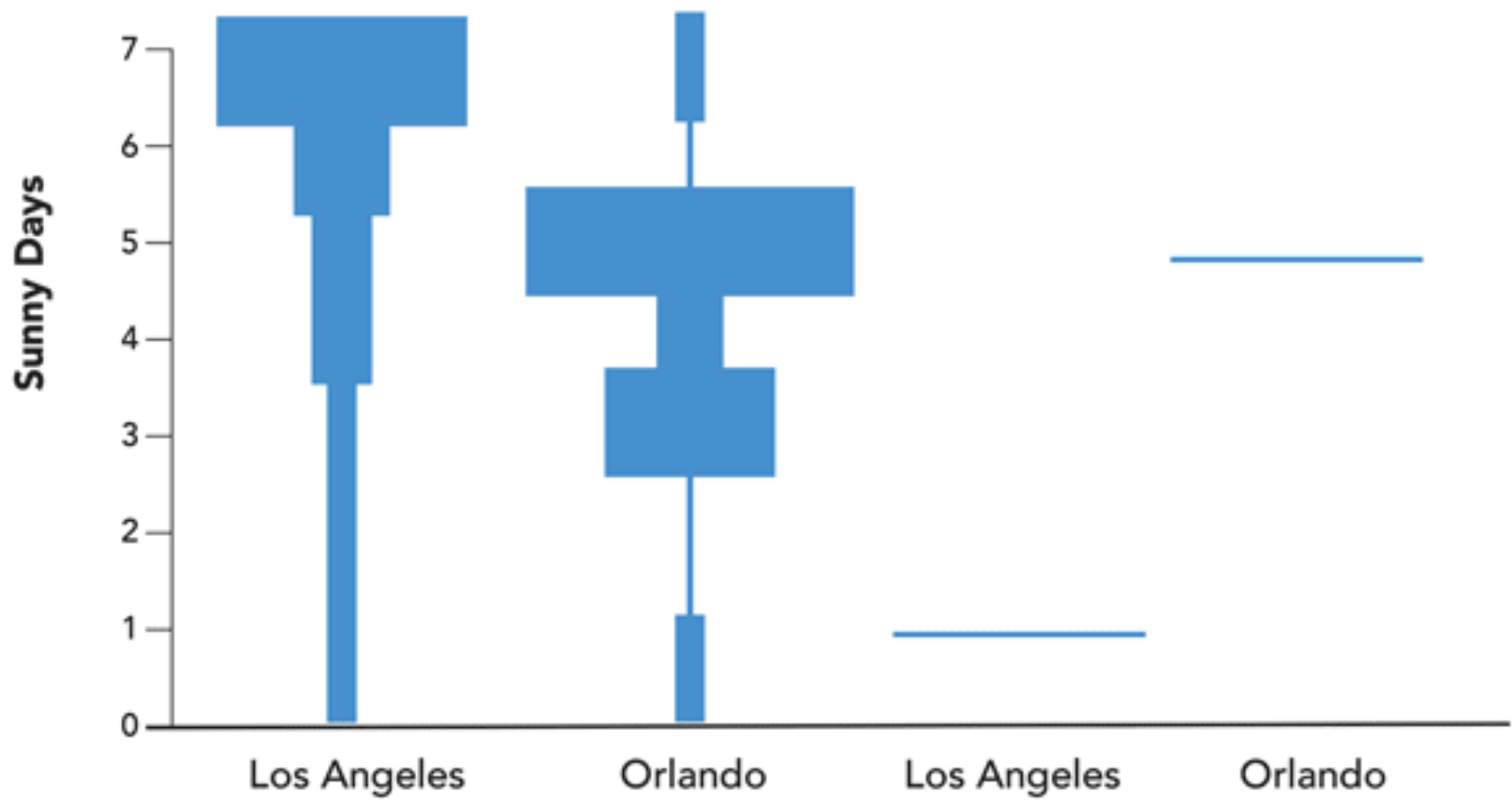
# An alternative to error bars...



Errors bars

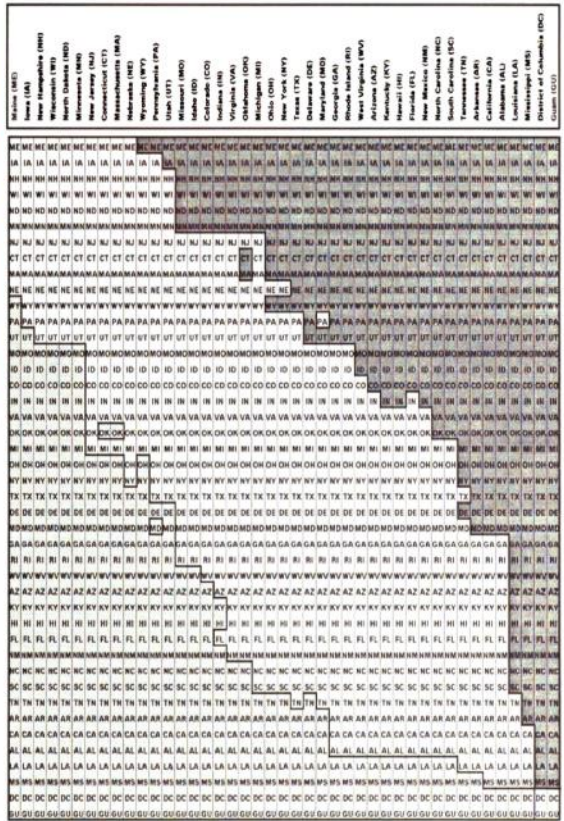
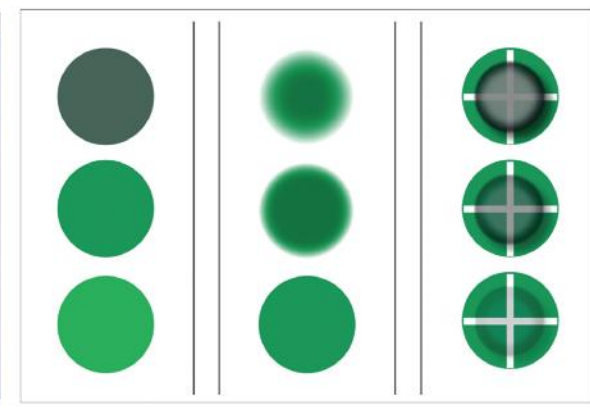
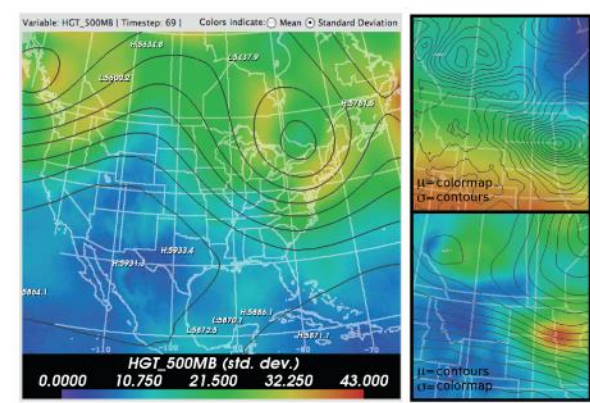
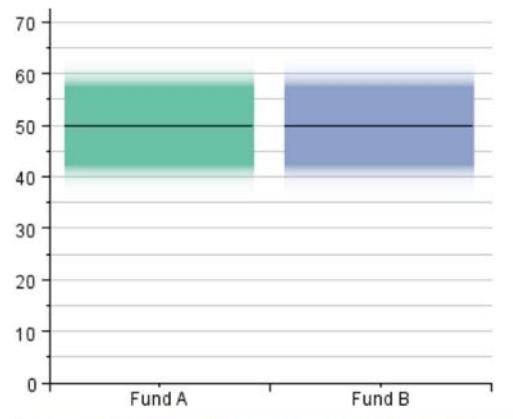
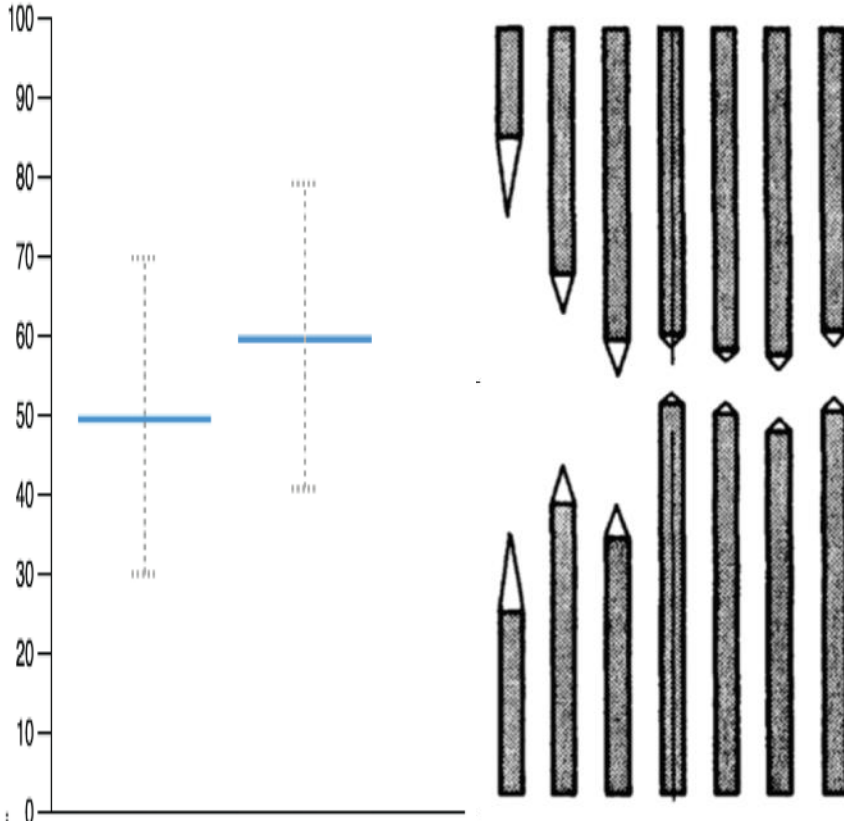


Hypothetical Outcome Plots (HOPs)



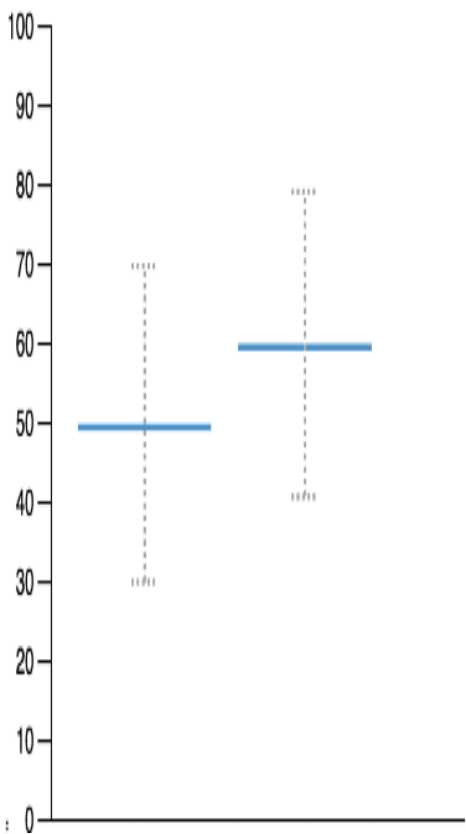
Hypothetical Outcome Plots (HOPs)

# Many alternatives to error bars...

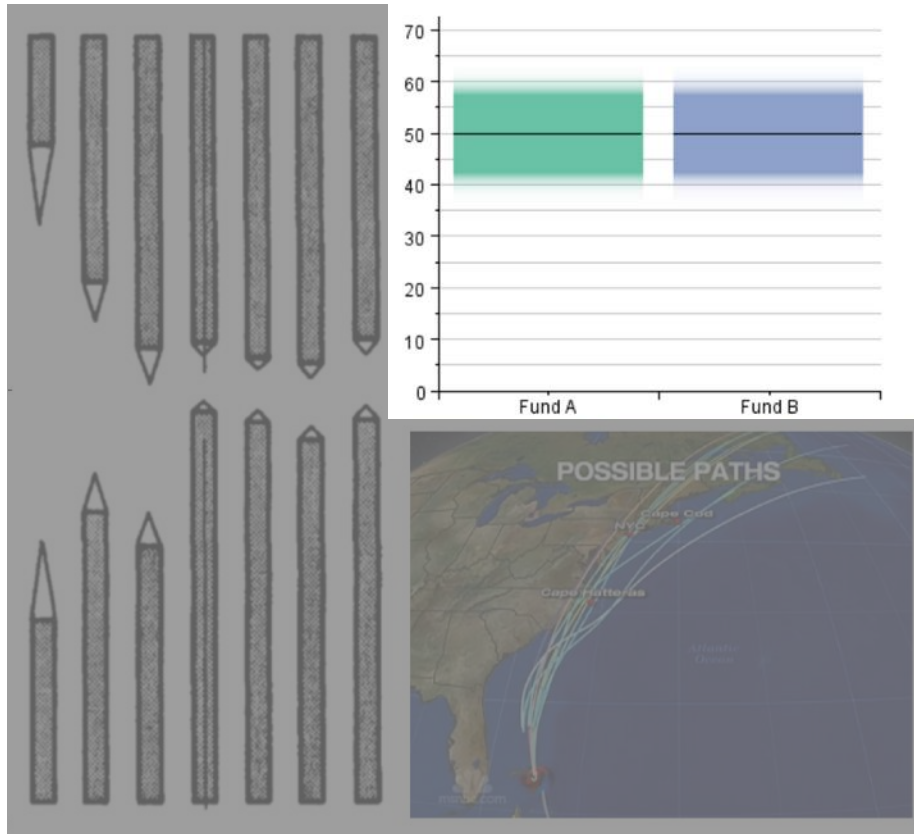




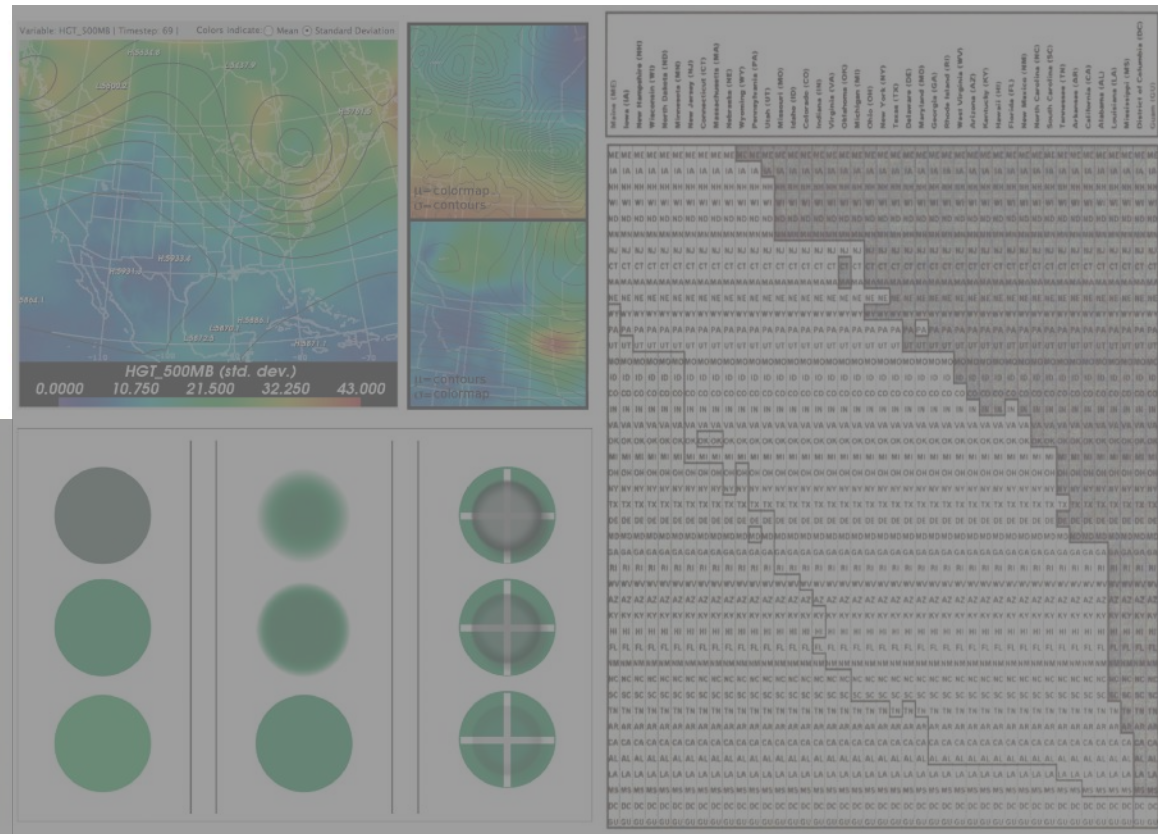
# Many alternatives to error bars...



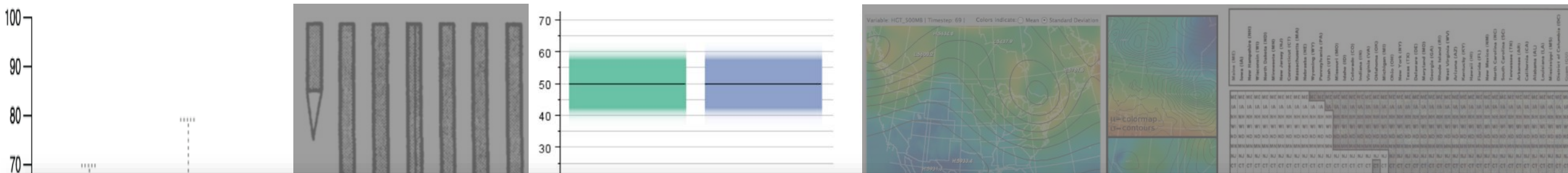
Errors bars



Gradient plots

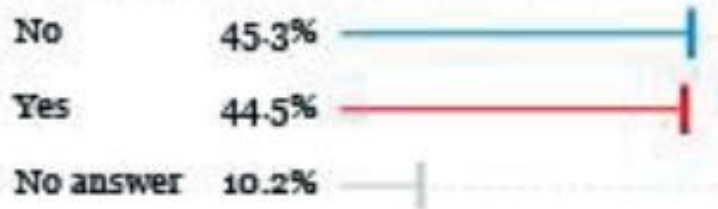


# Many alternatives to error bars...



## DON'T DO THIS

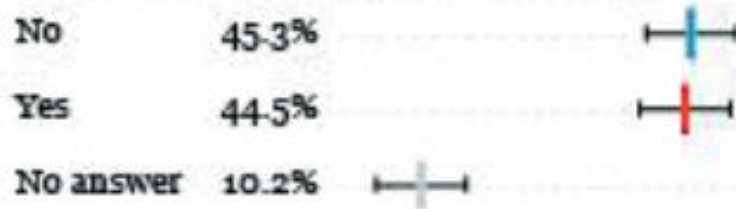
*Do you want Catalonia to become an independent state?*



Margin of error: +/-2.95 at 95% confidence level

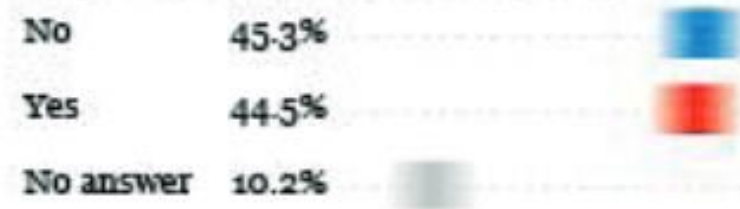
## DO SOMETHING LIKE THESE INSTEAD

*Do you want Catalonia to become an independent state?*



The probability of the tiny difference between the "No" and the "Yes" being just due to random chance is very high

*Do you want Catalonia to become an independent state?*

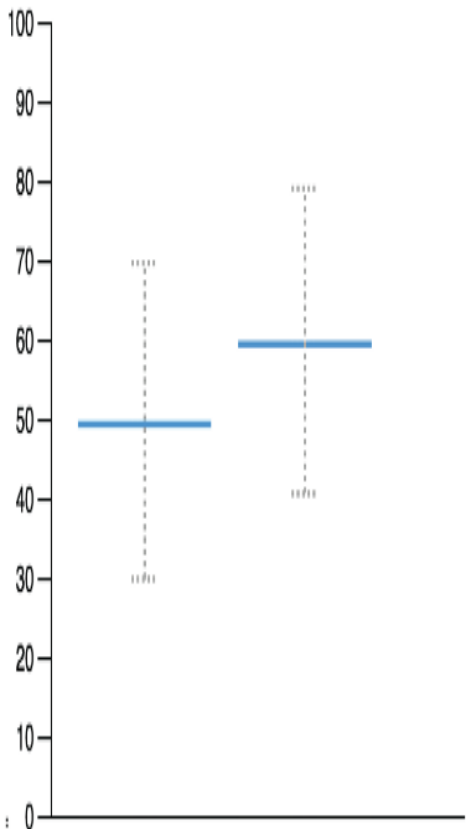


The probability of the tiny difference between the "No" and the "Yes" being just due to random chance is very high

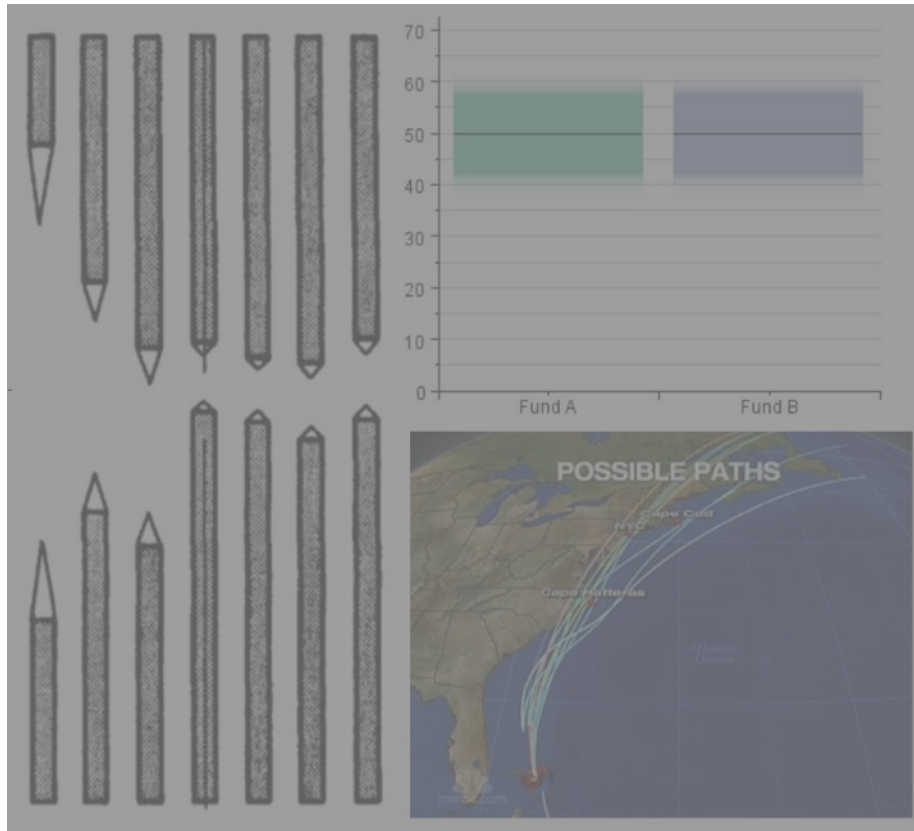
Errors bars

Gradient plots

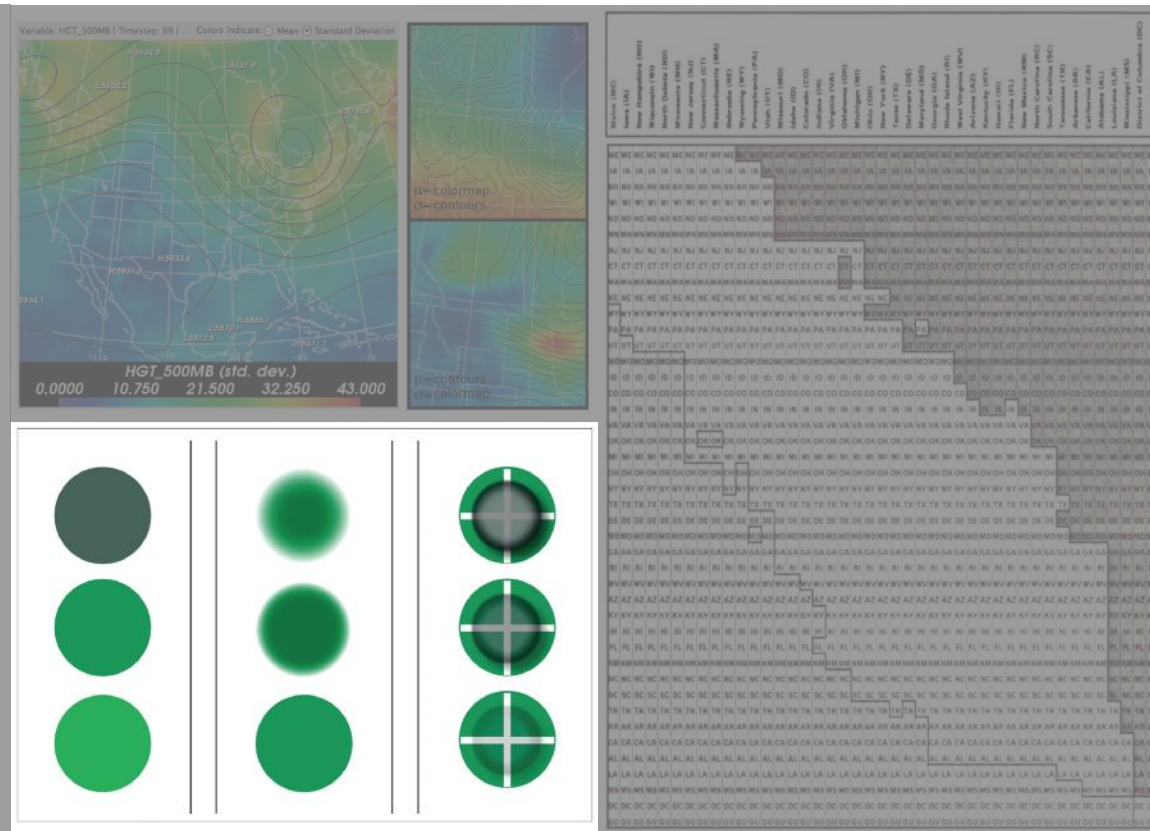
# Many alternatives to error bars...



Errors bars



Gradient plots



Saturation, Fuzziness, transparency



# How not to conceal but rather acknowledge uncertainty!



*grain*



*arrangement*



*fuzziness*



*transparency*



*color value*

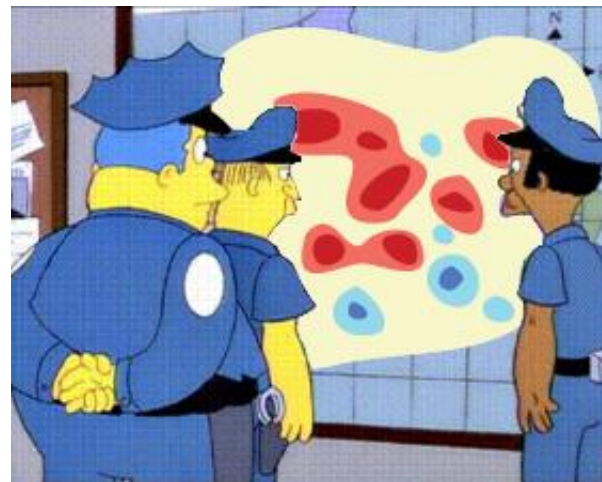


*color saturation*

# How to Spot Visualization Lies

Keep your eyes open.

## Oh, heatmaps!

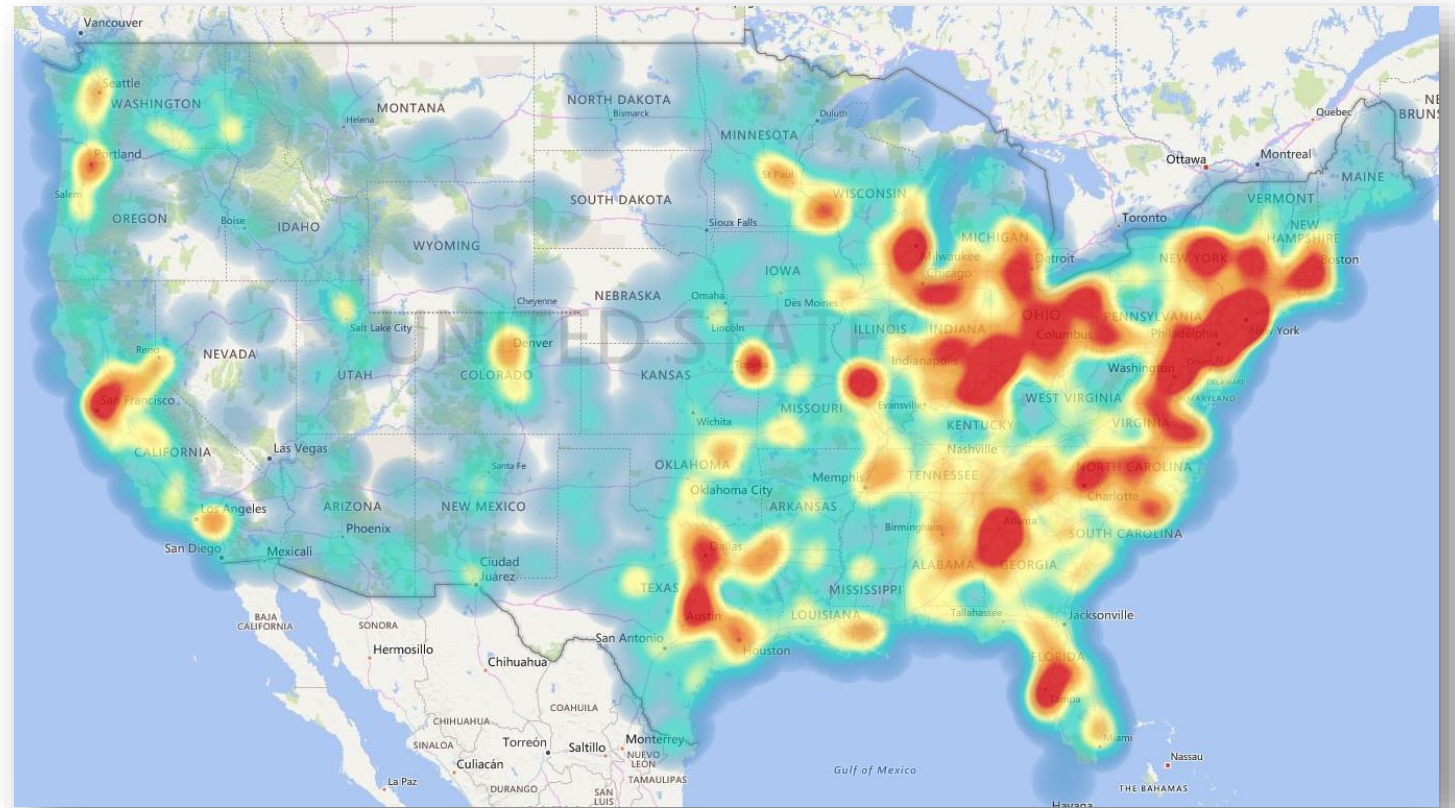


# How to Spot Visualization Lies

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## Oh, heatmaps!

a heatmap is a data visualization where a range of colors represent the density of points in a particular area.





# How to Spot Visualization Lies

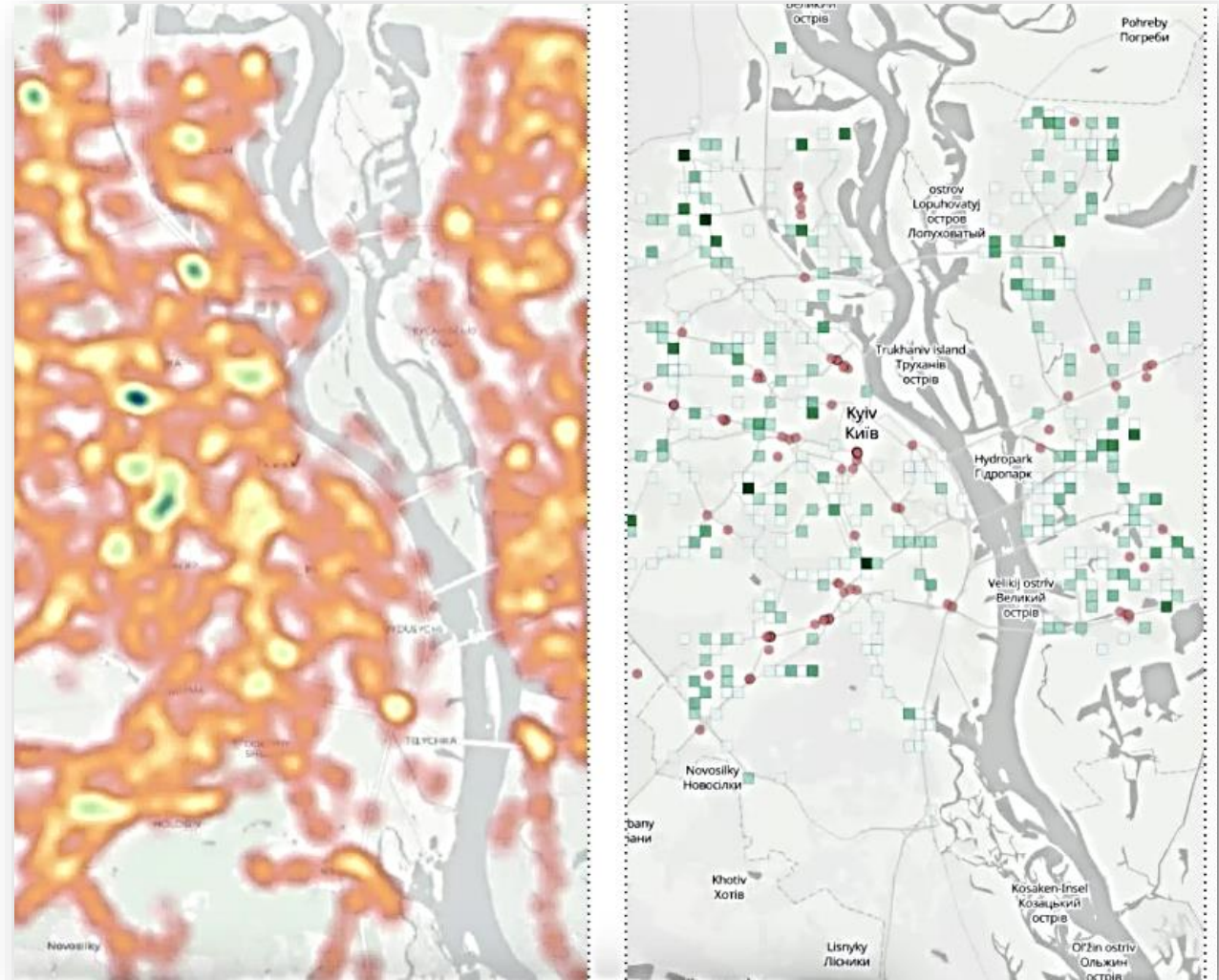
Keep your eyes open.

## Oh, heatmaps!

a heatmap is a data visualization where a range of colors represent the density of points in a particular area.

The problem are:

- ✓ interpolation across points where data are missing:



# How to Spot Visualization Lies

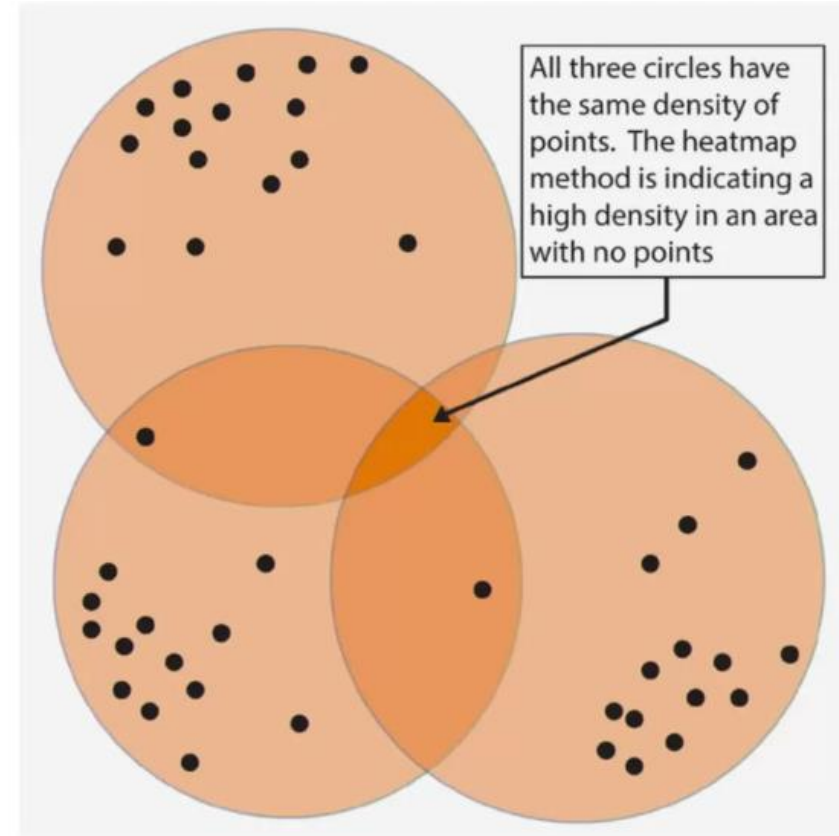
Keep your eyes open.

## Oh, heatmaps!

a heatmap is a data visualization where a range of colors represent the density of points in a particular area.

The problem are:

- ✓ interpolation across points where data are missing.
- ✓ Misleading overlaps!



The heat map method can create a **high density** for an area that has **very few, if any, points**  
[DeBoer, Mike. (2015). *Understanding the Heat Map*. *Cartographic Perspectives*. 39-43. 10.14714/CP80.1314.]

# How to Spot Visualization Lies

Keep your eyes open.

## Oh, heatmaps!

Arbitrary, rainbow-like, spectrum. Avoid.

### Heatmap color



Default Color Ramp for the Heatmap Visualization in 'Mapbox Studio'

## Color suggestions.



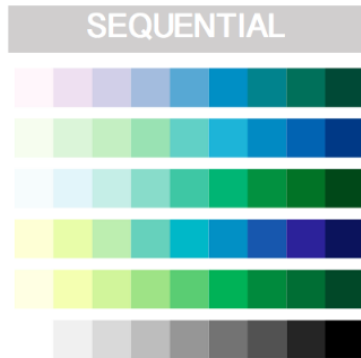
Don't place more than **two hues** with the same lightness in your gradient, but design it **from a bright color** (e.g. white) **to a dark color** (e.g. dark blue) in a consistent way.

[[Lisa Charlotte Rost](#)]

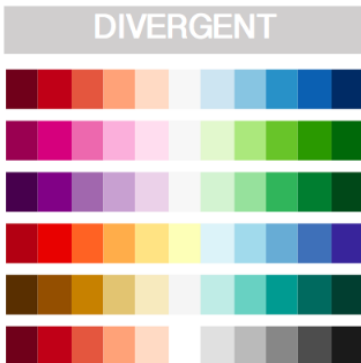
# How to Spot Visualization Lies

Keep your eyes open.

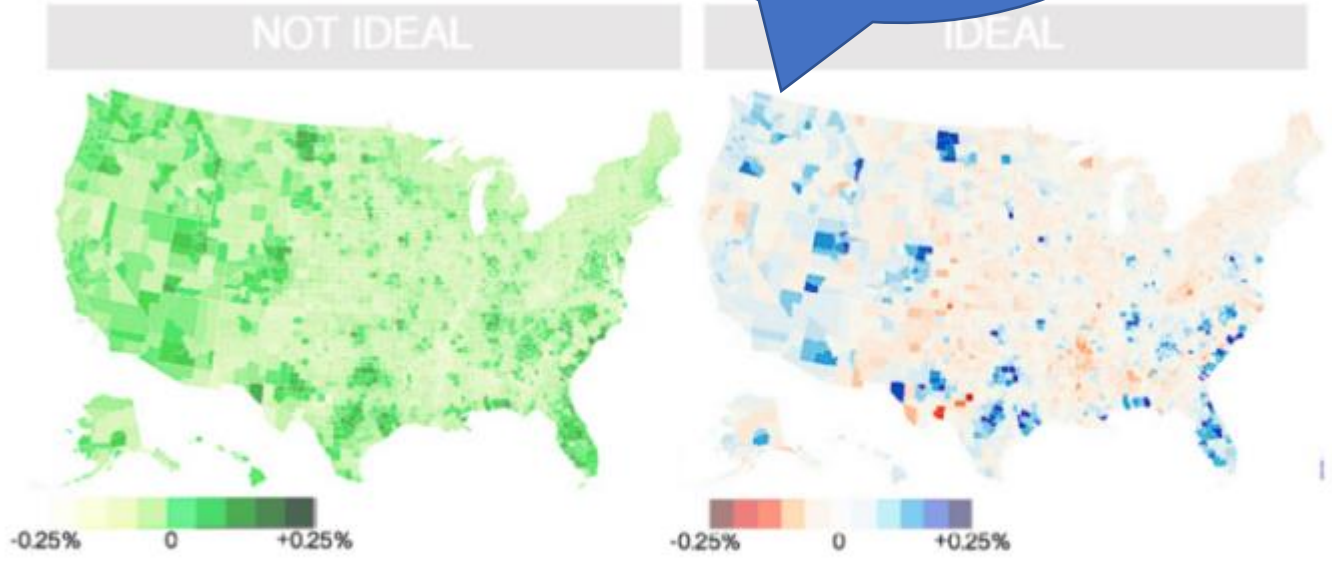
## Oh, heatmaps!



## Color suggestions.



If scale is symmetrical prefer a divergent 2-hues gradient (e.g., red vs blue)



Percentage change in population in the USA from 2010–2019. The divergent color scheme made of two hues (red and blue) with an inflection point at zero is more suitable than a sequential color scheme. [made by author]. Source of data.



# How to Spot Visualization Lies

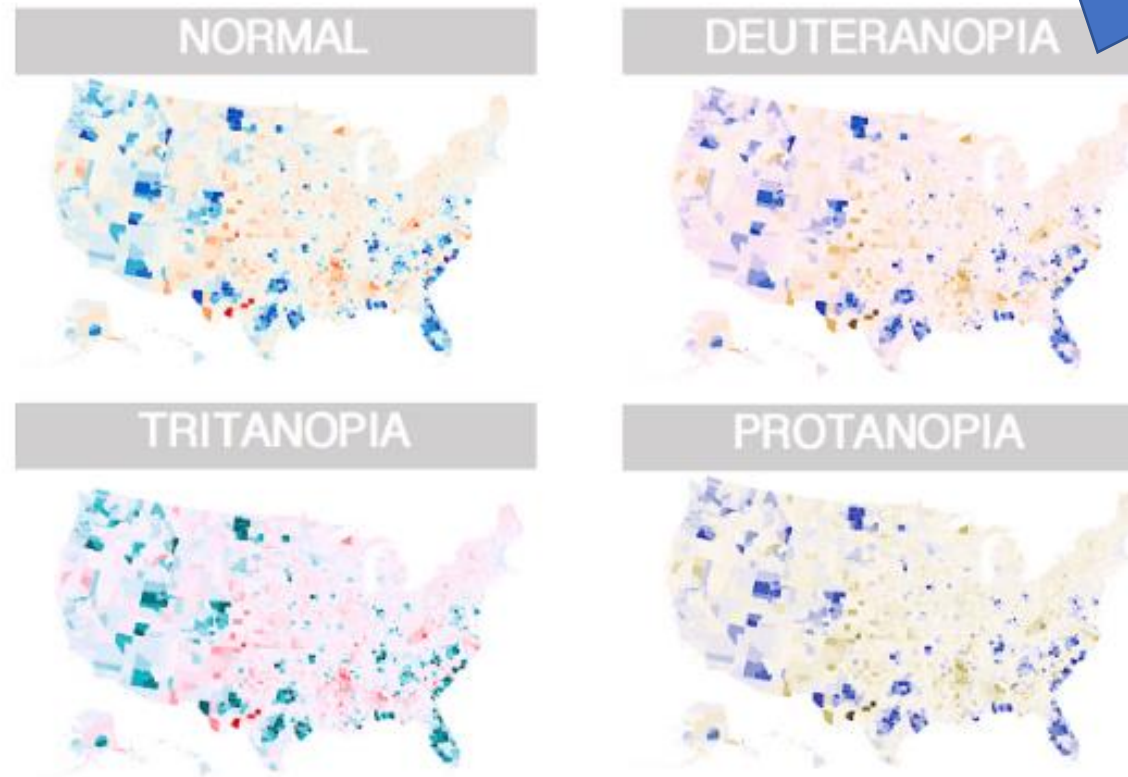
Keep your eyes open.

## Oh, heatmaps!

Tools for selecting colour combinations.

1. Colour brewer [Link](#)
2. d3-interpolate [Link](#)
3. Colourco [Link](#)
4. Color Palette Helper [Link](#)
5. I want hue [Link](#)

Stil again, mind color blindness as a thing you have to care about!



How colour blindness affects perception of colours. [made by author]

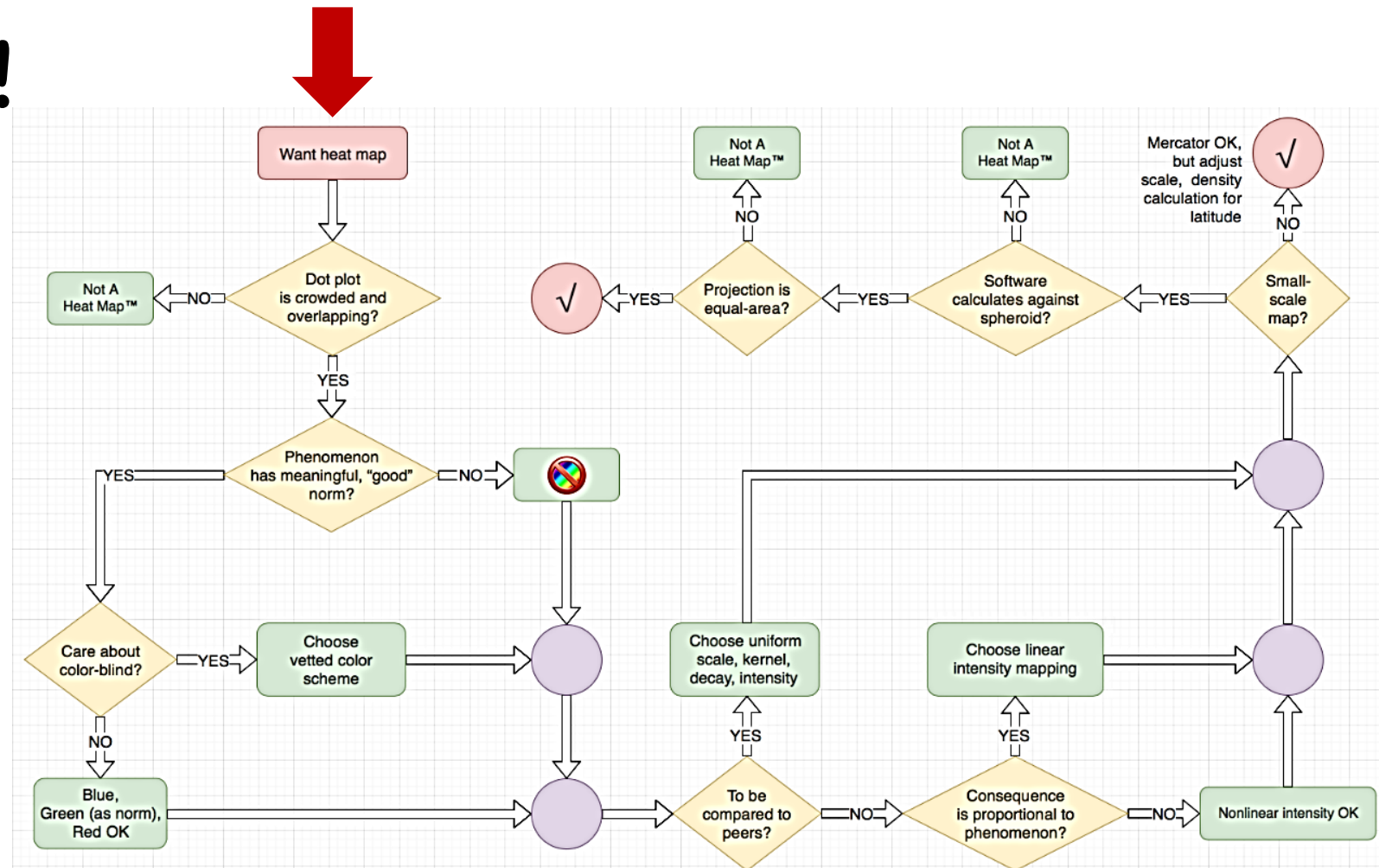


# How to Spot Visualization Lies

Keep your eyes open.

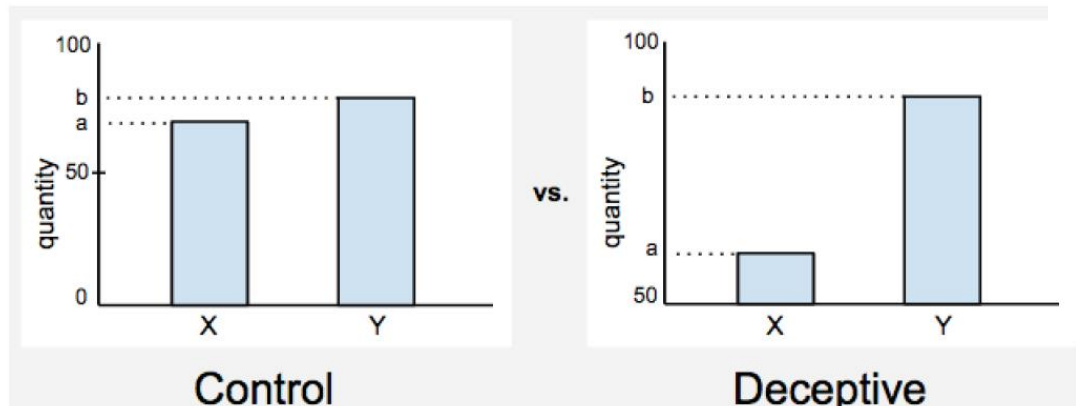
## Oh, heatmaps!

### You still want to use a heat map?



# How to Spot Visualization Lies

Keep your eyes open.

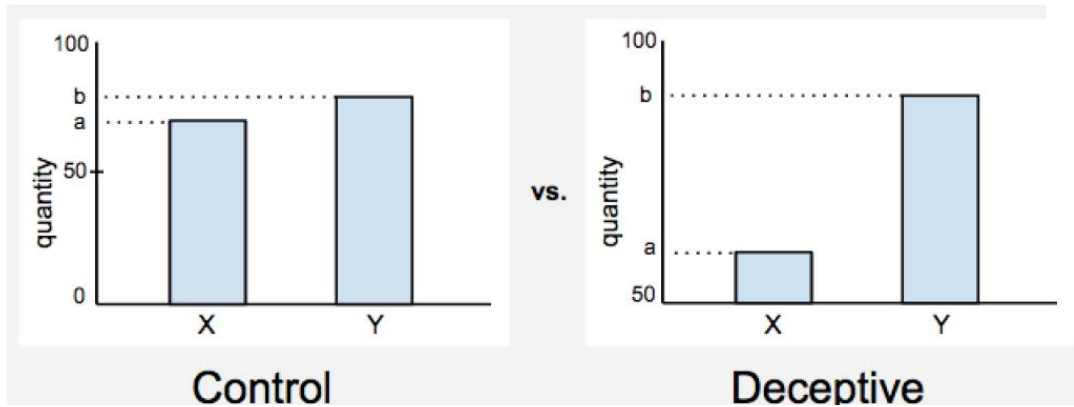


**TRUNCATED AXIS DISTORTION**

MESSAGE EXAGGERATION/UNDERSTATEMENT

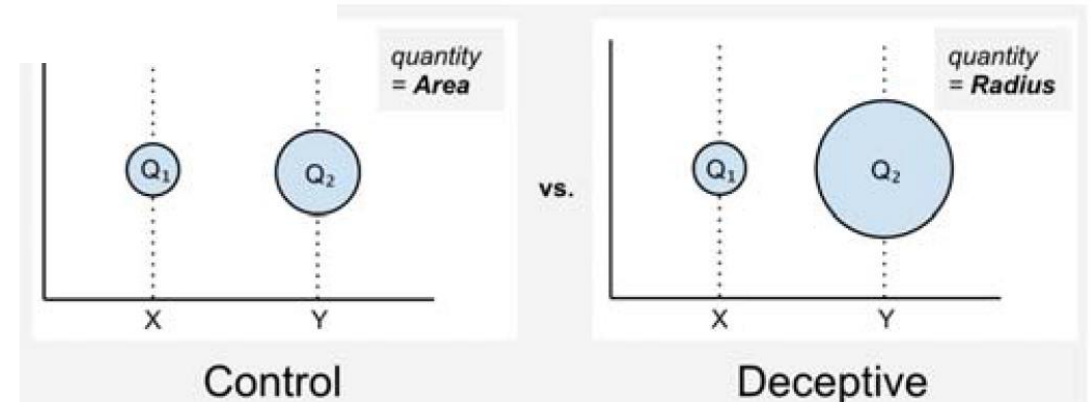
# How to Spot Visualization Lies

Keep your eyes open.



## TRUNCATED AXIS DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT

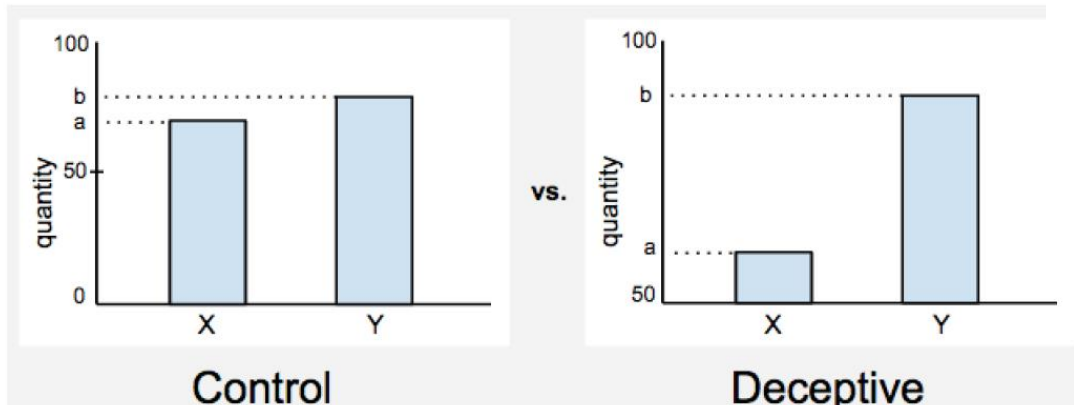


## AREA AS QUANTITY DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT

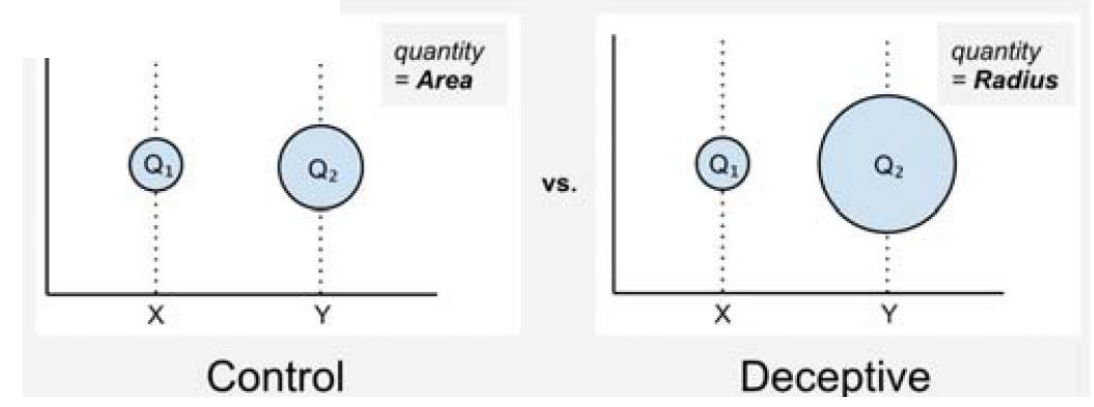
# How to Spot Visualization Lies

Keep your eyes open.



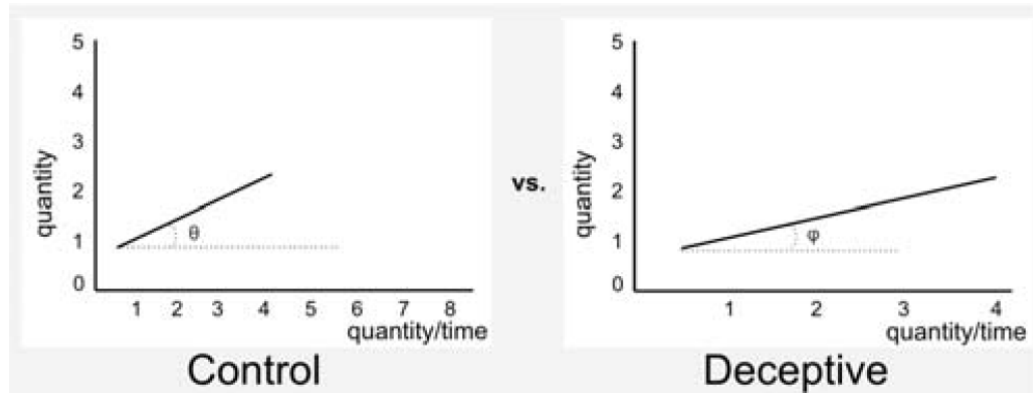
## TRUNCATED AXIS DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT



## AREA AS QUANTITY DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT

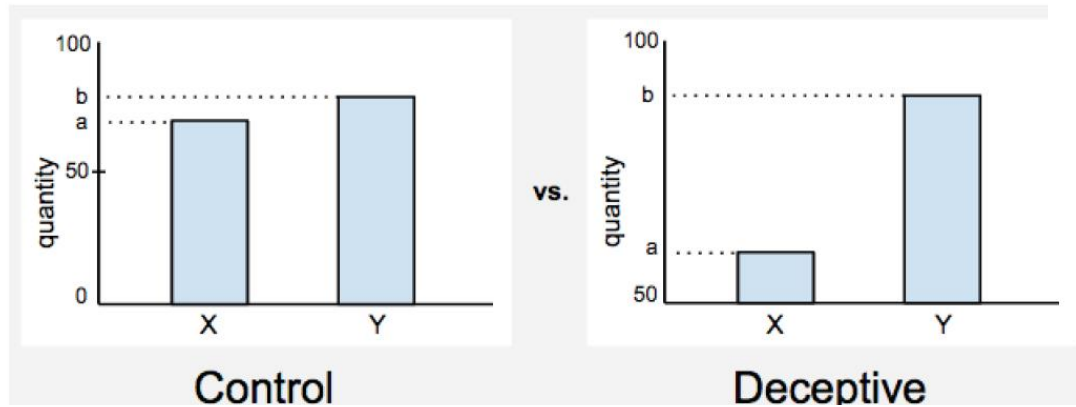


## ASPECT RATIO DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT

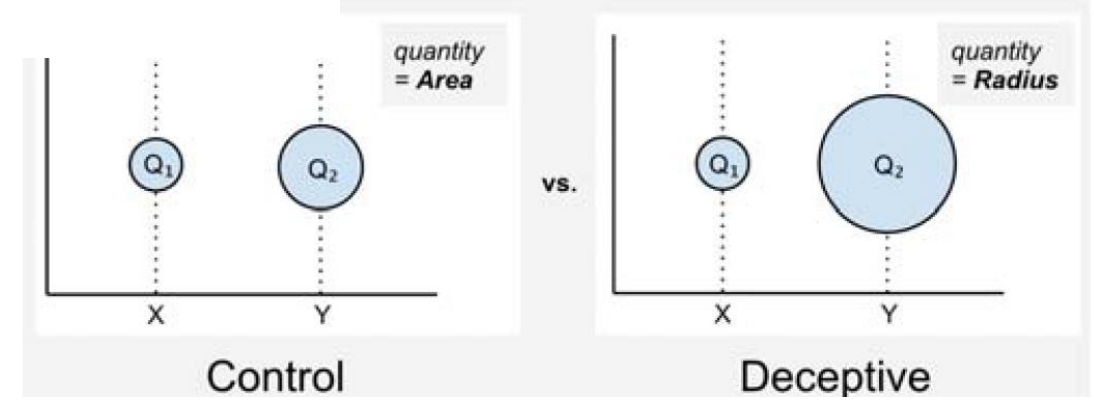
# How to Spot Visualization Lies

Keep your eyes open.



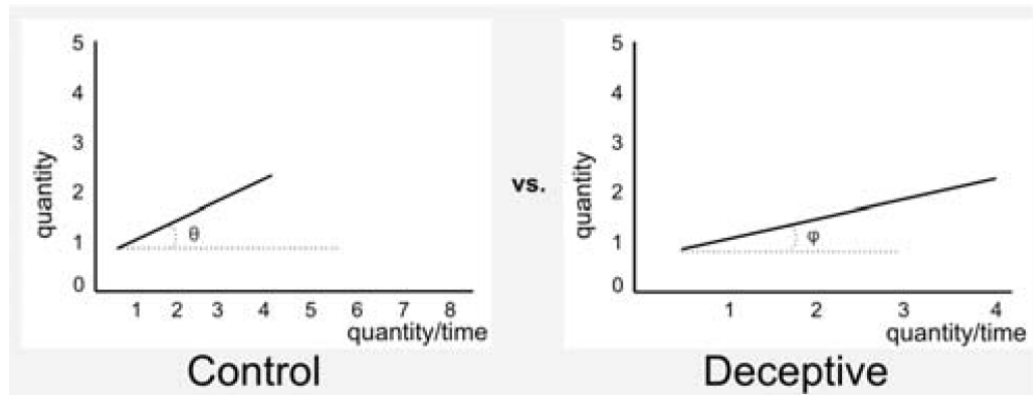
## TRUNCATED AXIS DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT



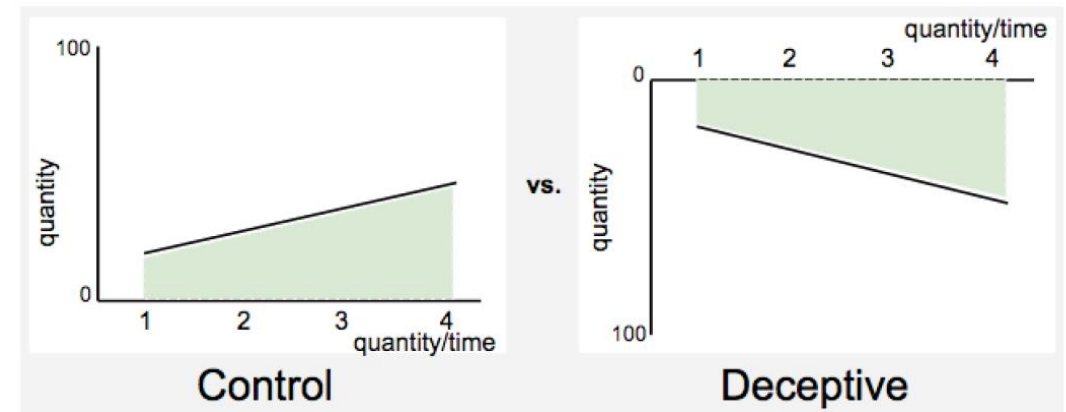
## AREA AS QUANTITY DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT



## ASPECT RATIO DISTORTION

MESSAGE EXAGGERATION/UNDERSTATEMENT



## INVERTED AXIS DISTORTION

MESSAGE REVERSAL

# How to Spot Visualization Lies

Keep your eyes open.

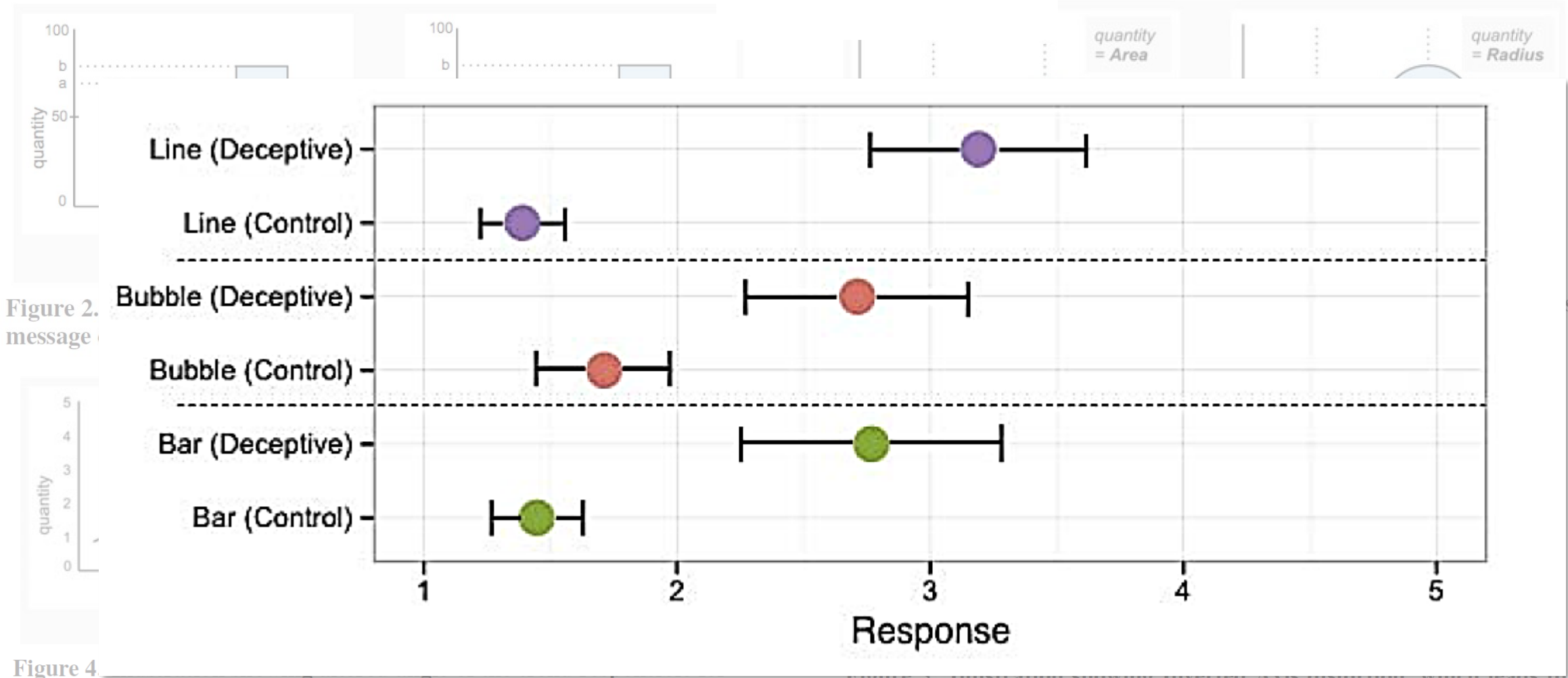


Figure 4. "rate of increase/decrease" due to Aspect Ratio distortion, which leads to message exaggeration/understatement type of deception.

Figure 5. Illustration showing inverted axis distortion, which leads to message reversal type of deception.

# How to Spot Visualization Lies

Keep your eyes open.

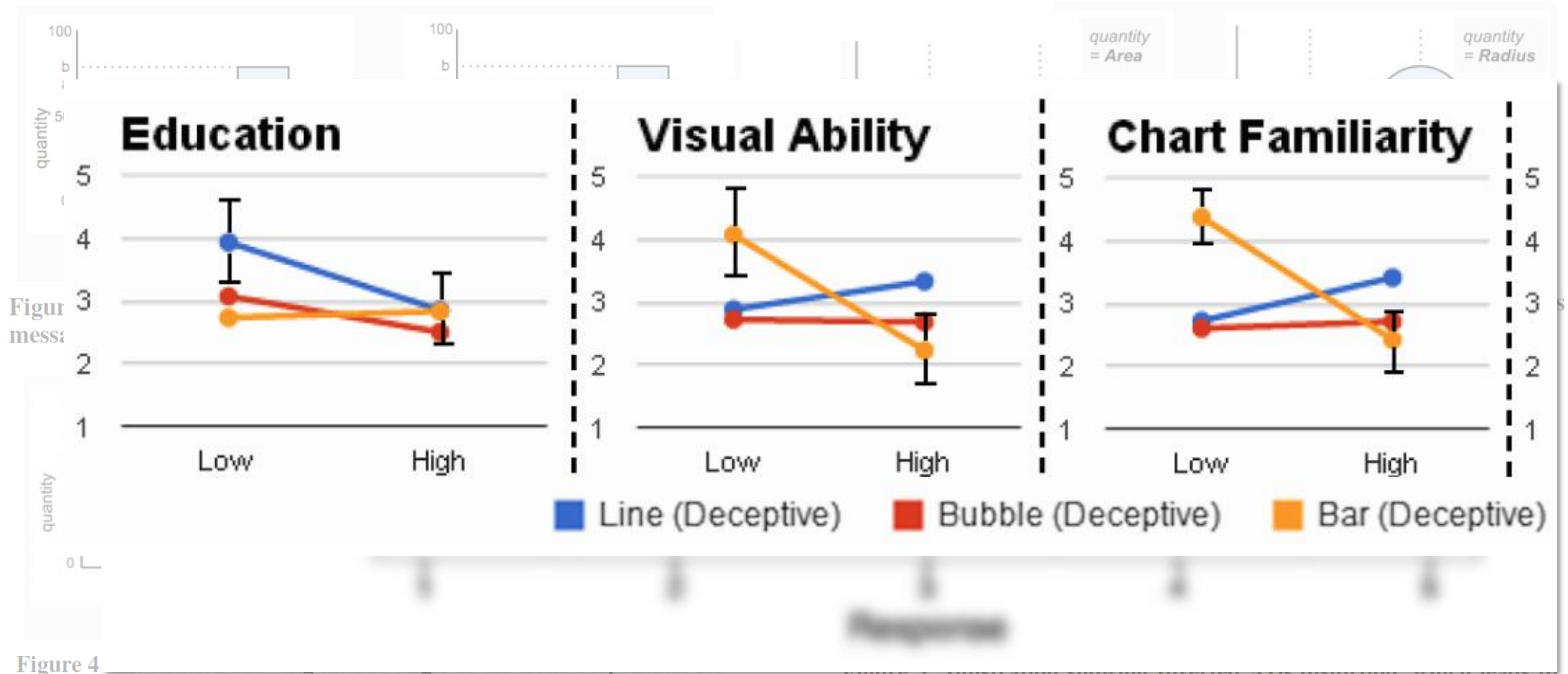


Figure 4. "rate of increase/decrease" due to Aspect Ratio distortion, which leads to message exaggeration/understatement type of deception.

Figure 5. Illustration showing inverted axis distortion, which leads to message reversal type of deception.