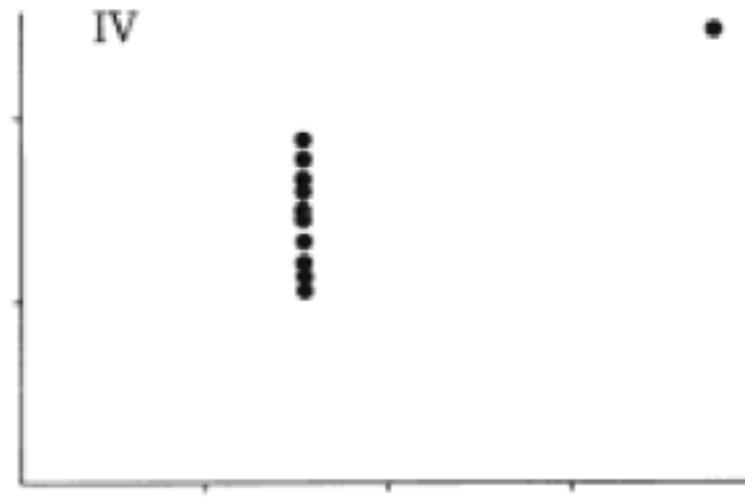
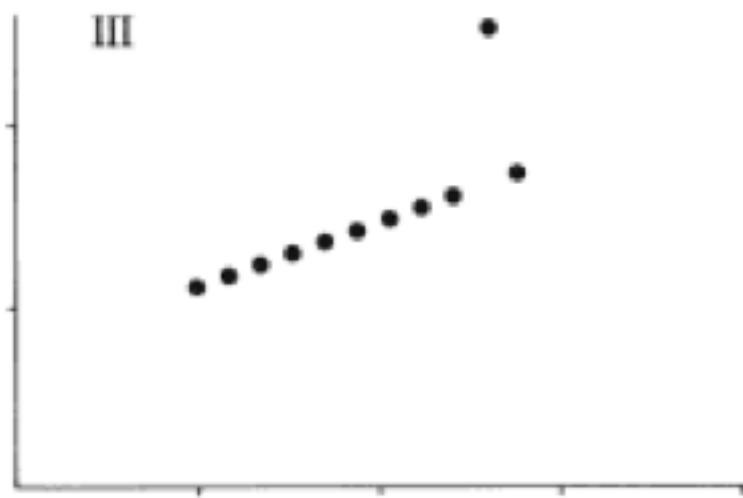
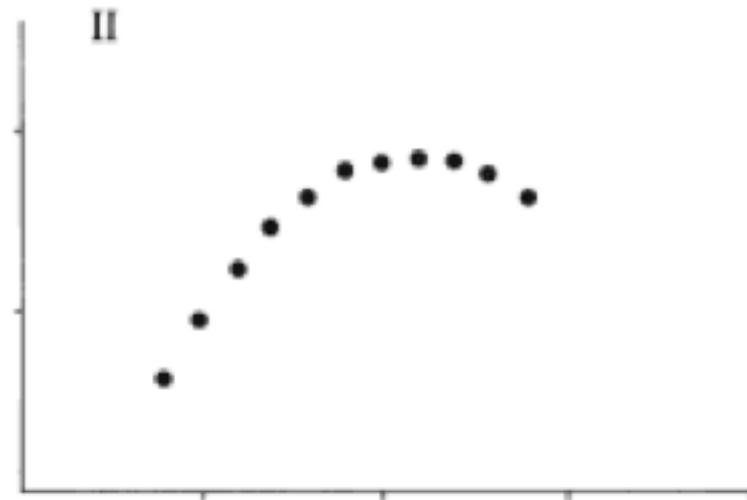
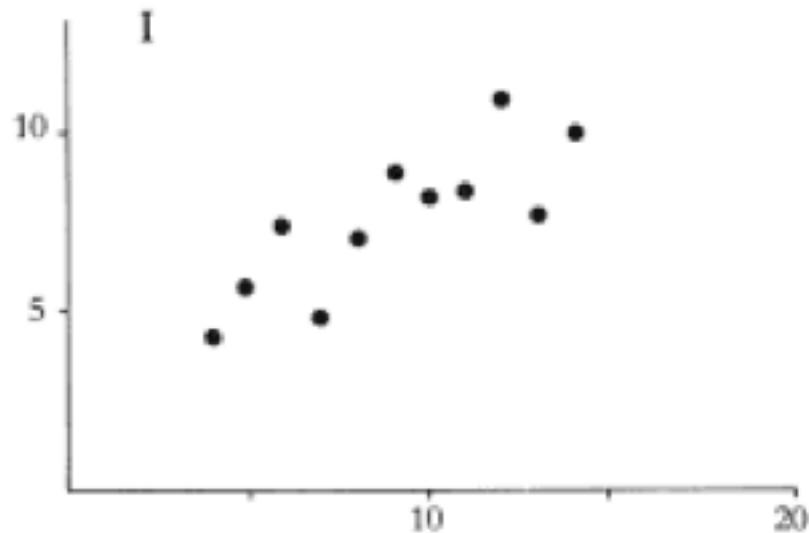


# Introduction to Visual Encodings

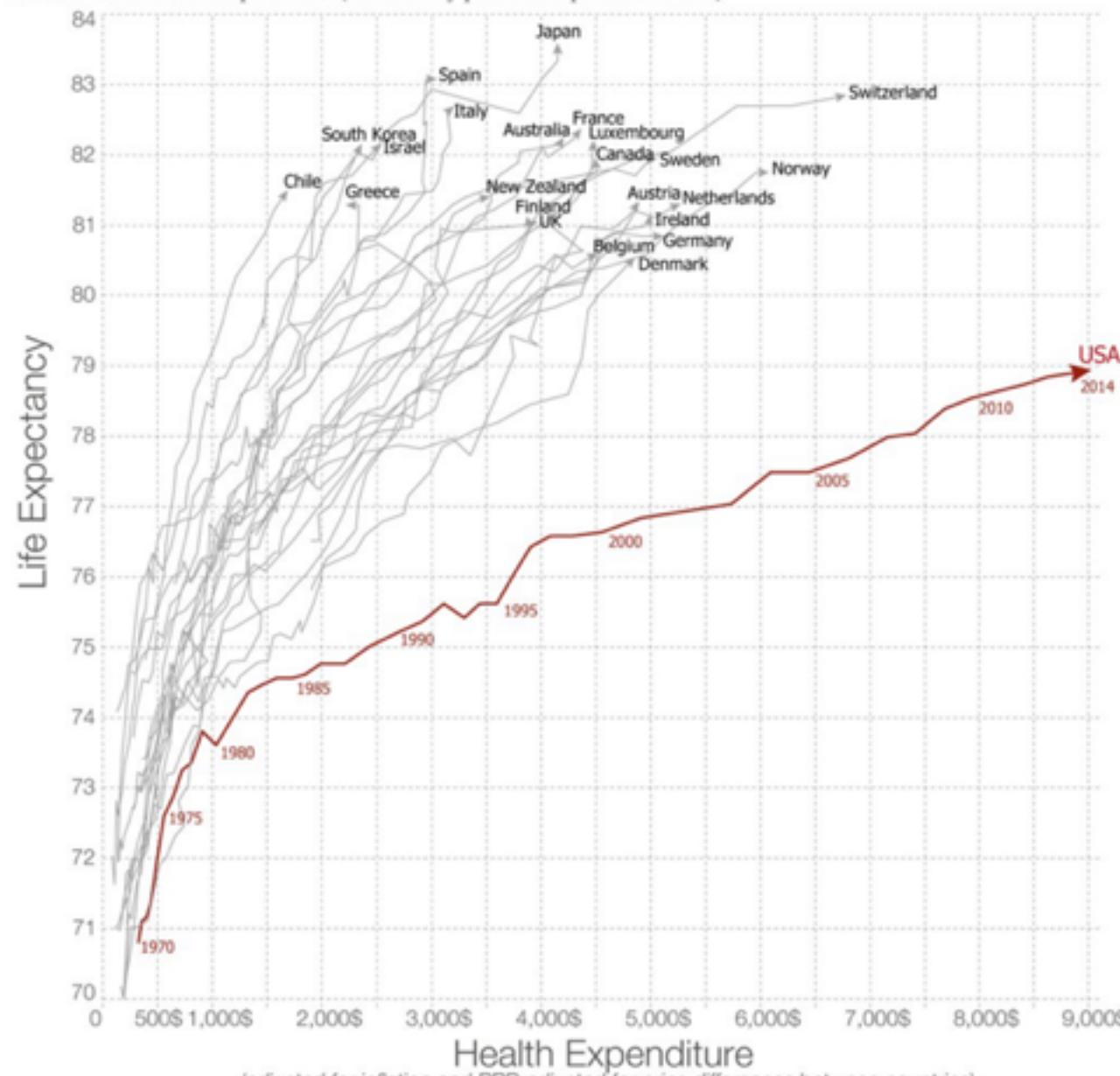
# Anscombe's Quartet



# Life expectancy vs. health expenditure over time (1970-2014)

Our World  
in Data

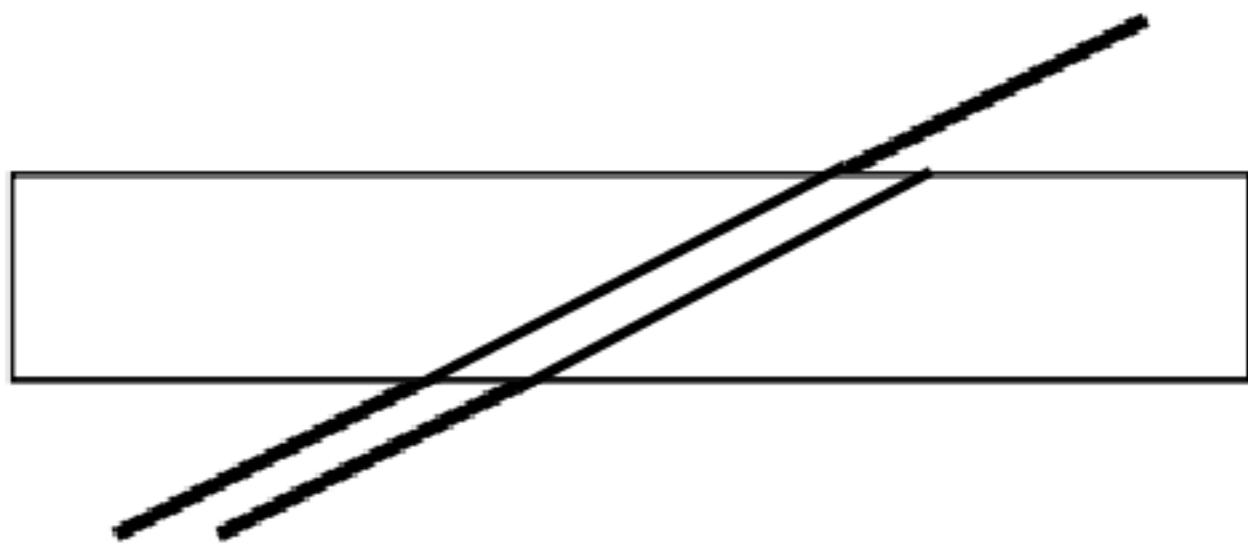
Health spending measures the consumption of health care goods and services, including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments. Shown is total health expenditure (financed by public and private sources).



## Muller-Lyer Illusion



# Poggendorf Illusion



# Horizontal-Vertical Illusion

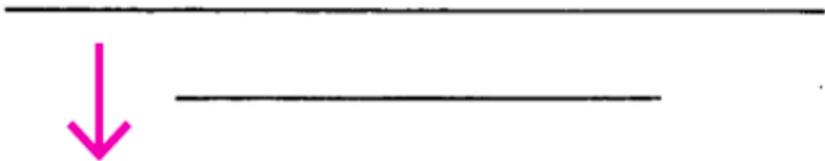
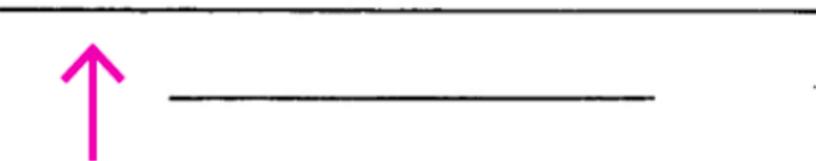




**look similar**



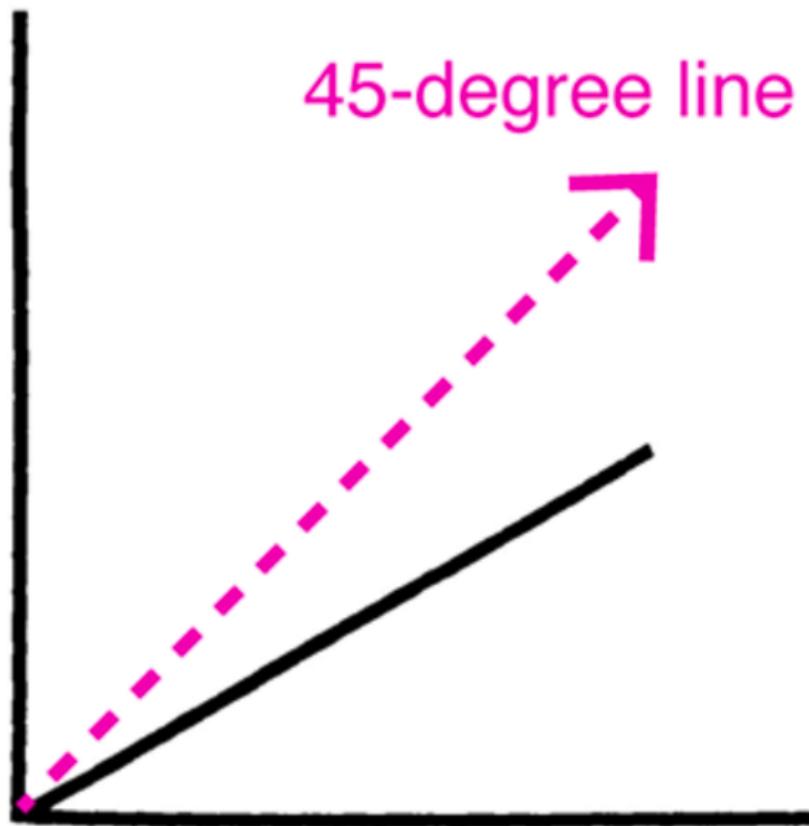
**look different**



**Figure 1. Example of the parallel-lines illusion configuration. Relative to a no-context control line, the test line is overestimated when presented with the longer contextual line.**

Jordan and Schiano found that when lines of varying sizes were presented close together, participants recalled them being more similar in length. When they were presented farther apart, participants saw larger contrasts between the lines.

Why is this a problem?



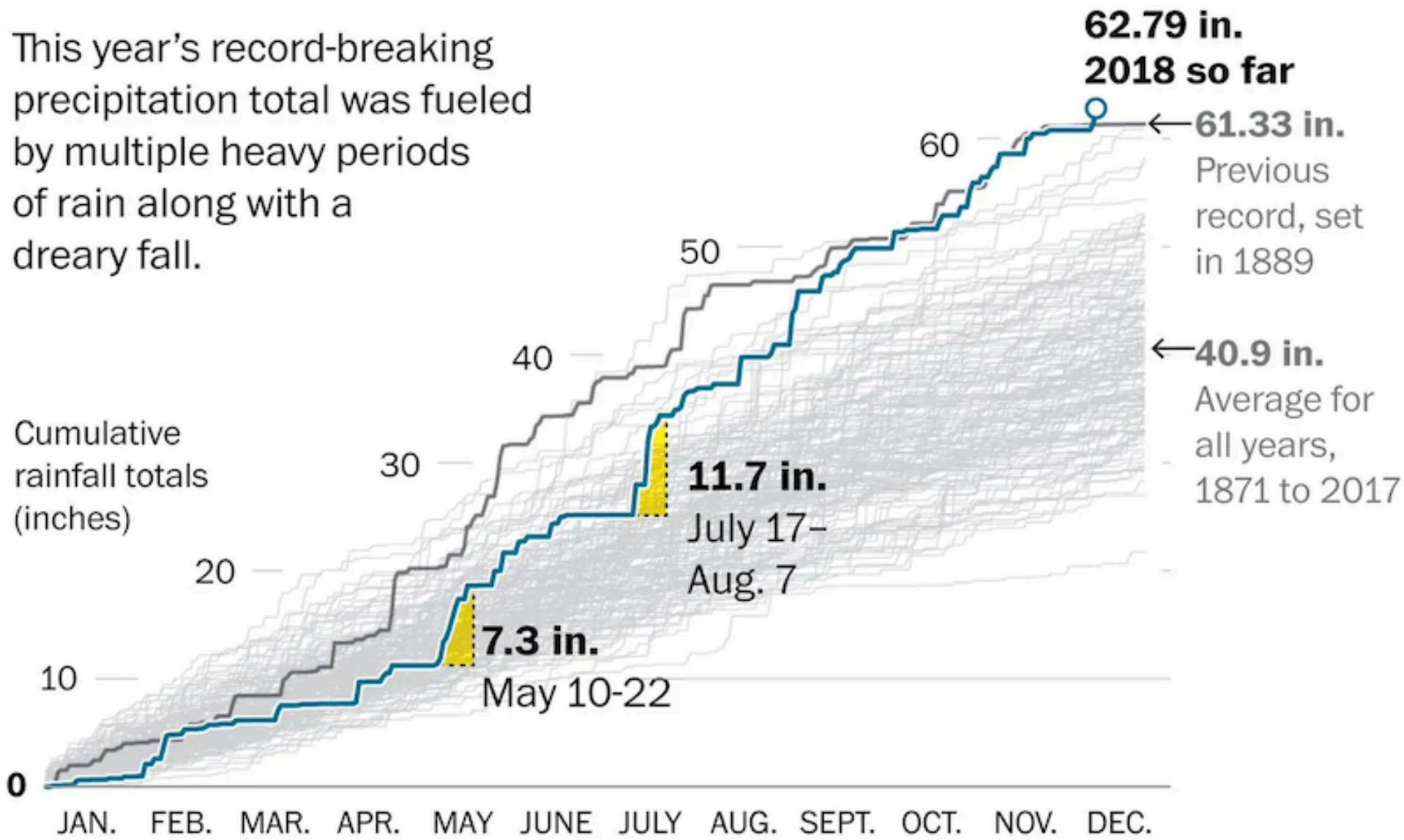
**Figure 1. A sample stimulus configuration.**

In two separate studies, Schiano and Tversky found that the 45-degree line is an imaginary reference point in line graphs, but not in other types of charts.

Serial processing and the parallel-lines illusion -  
Jordan & Schiano, 1986.

This year's record-breaking precipitation total was fueled by multiple heavy periods of rain along with a dreary fall.

Cumulative rainfall totals (inches)

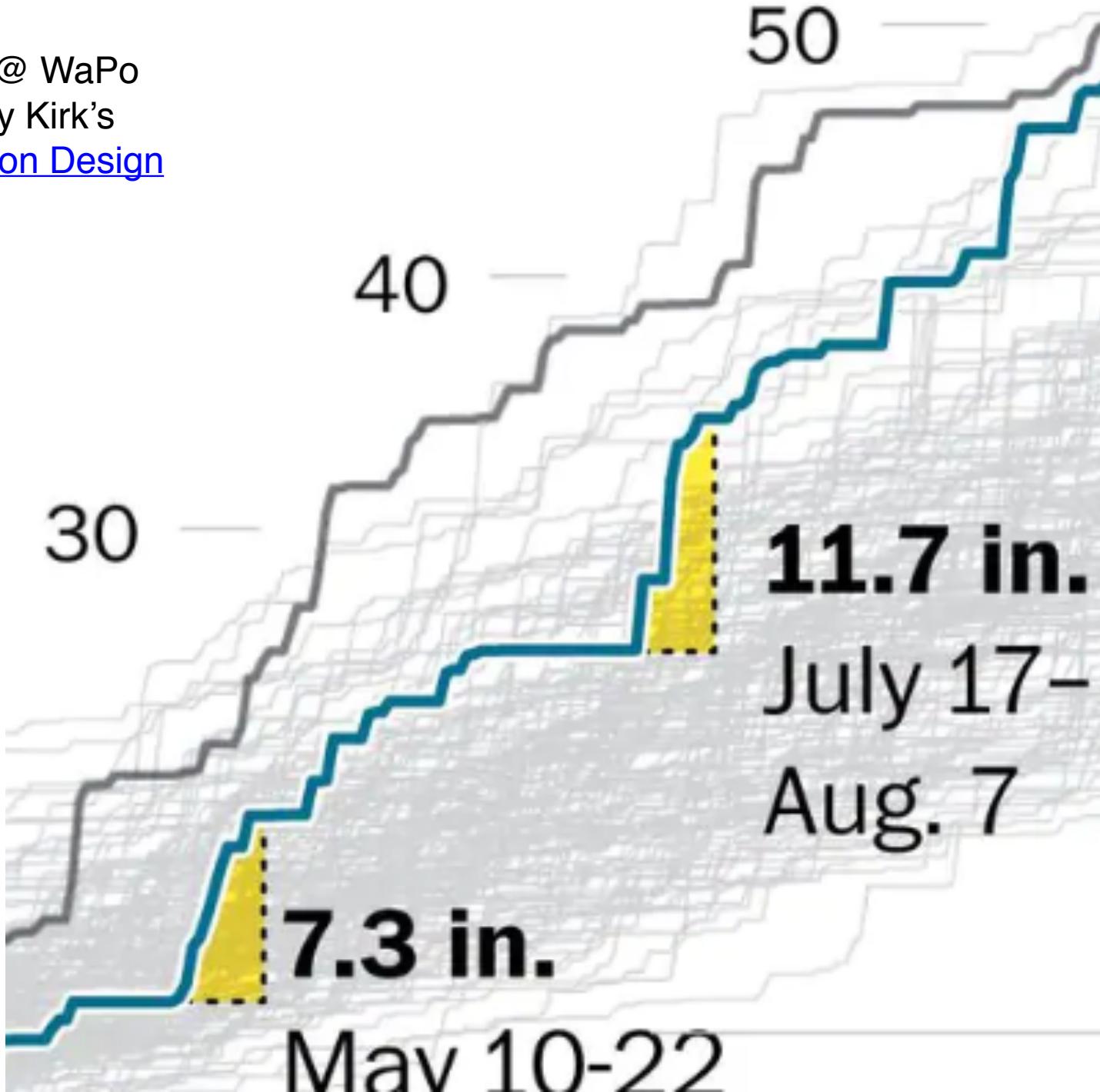


2018 total is through 7 p.m. Saturday

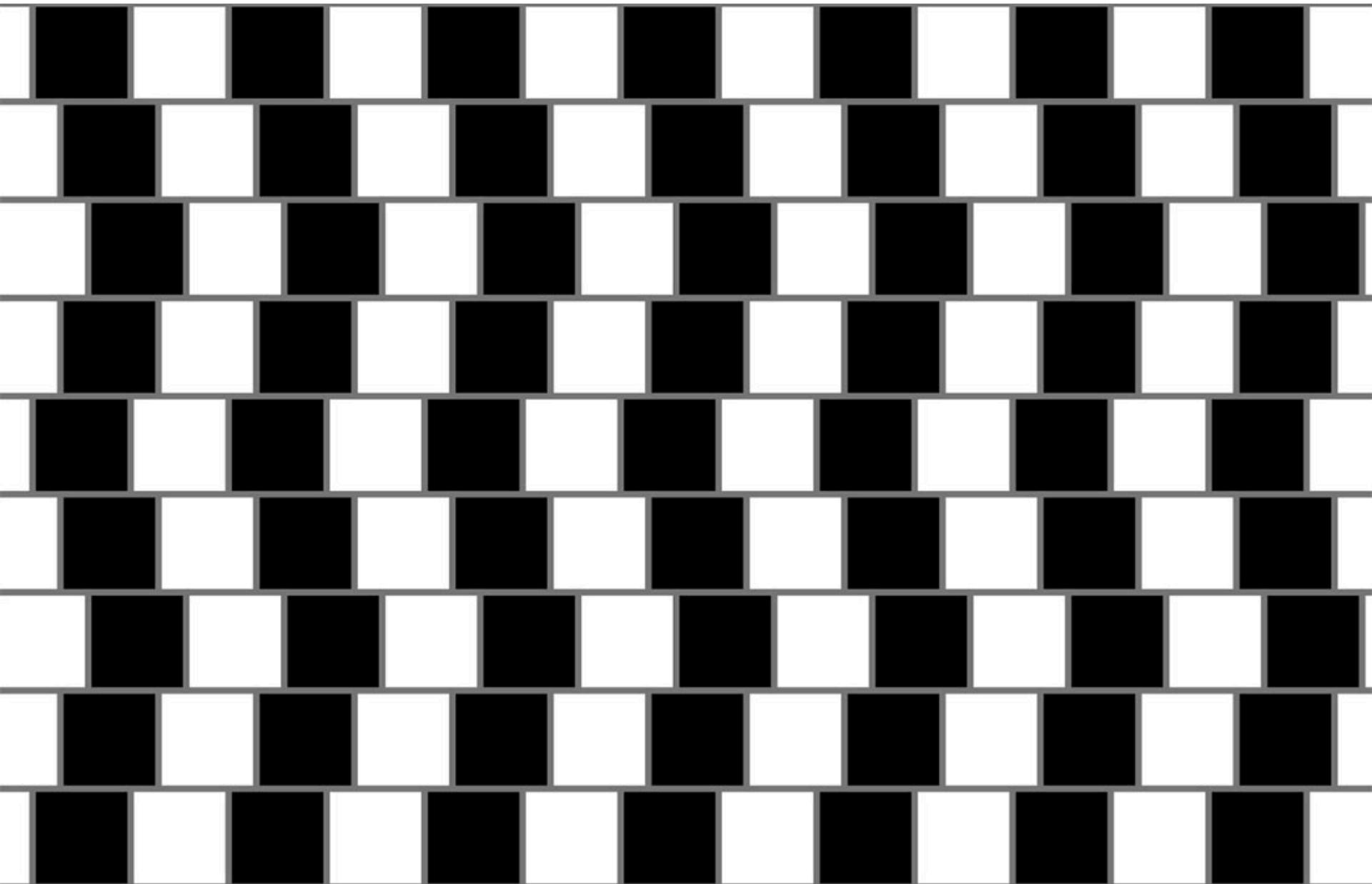
Source: National Weather Service

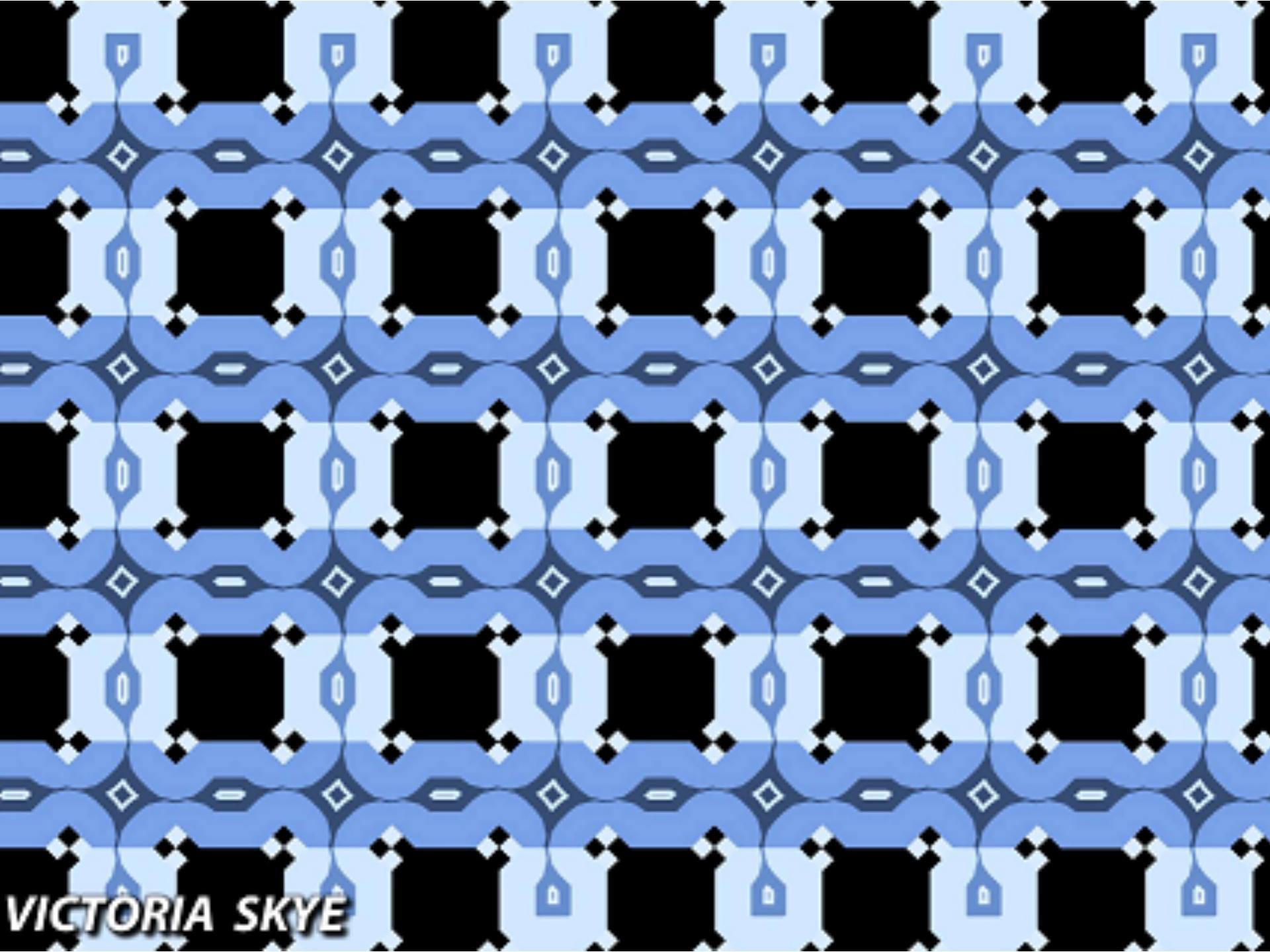
TIM MEKO/THE WASHINGTON POST

Credit: Tim Meko @ WaPo  
Graphics and Andy Kirk's  
[Little of Visualization Design](#)



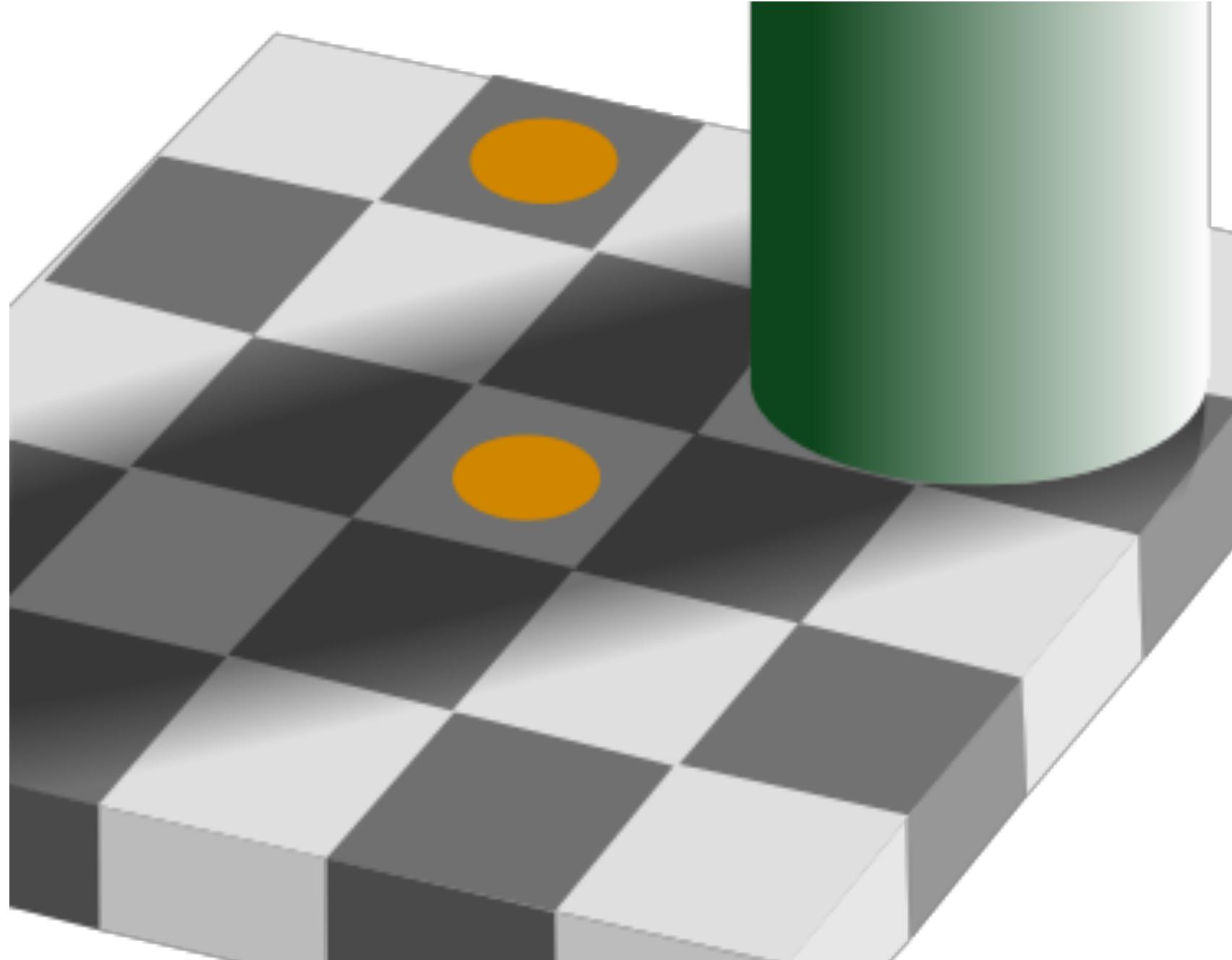
## Cafe Wall Illusion





VICTORIA SKYE

# Checker-Shadow



It only gets worse...



# What is visual perception?

- Light bounces off of stuff, then that light hits our eyes;
- Different neurons fire in reaction to individual components of an object; ([Cortical V1 Neuron](#))
- This is done by the Visual Cortex, in the rear of the brain;
- Perception is incredibly fast & efficient.

- Brain rebuilds object out of individual components, the final product of which is what you perceive;
- Brain can still distinguish individual components
- Cognition is much slower than perception;

## **Cognition Comes Next**

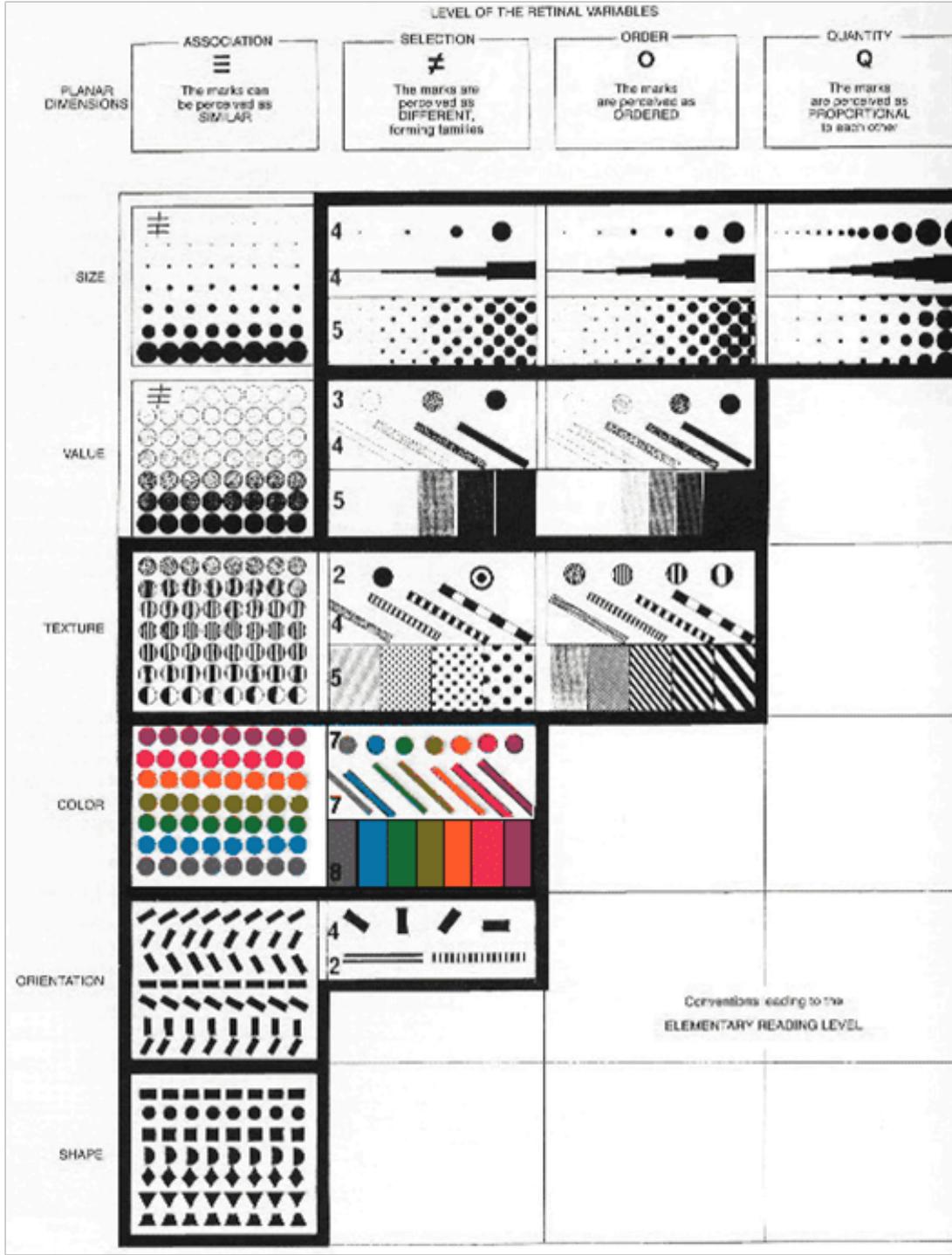
**Data Visualization**, done well, allows us to push workload from cognition to perception.

“The eye and the visual cortex form  
a massively parallel processor  
that provides the highest  
bandwidth channel into human  
cognitive centers.”

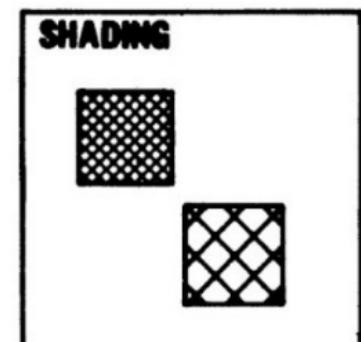
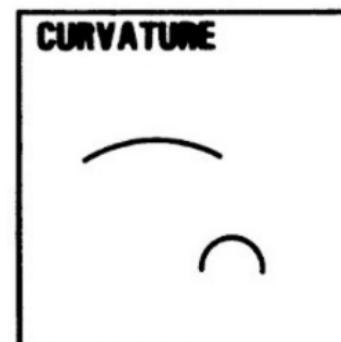
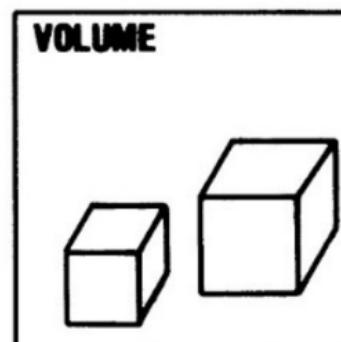
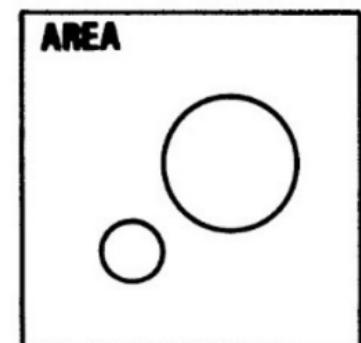
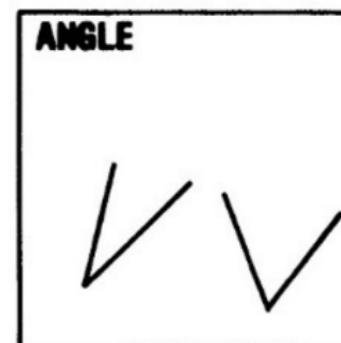
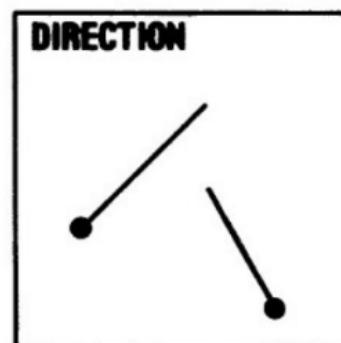
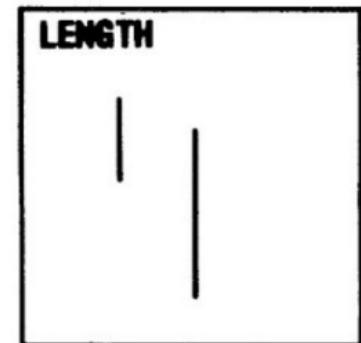
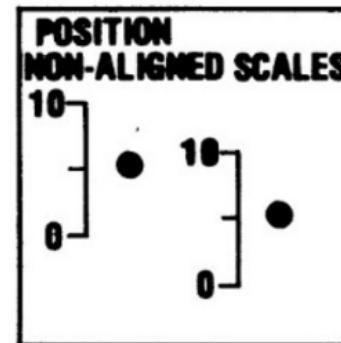
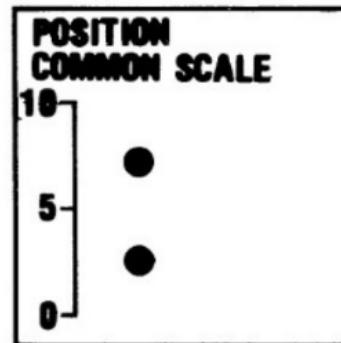
— Colin Ware

# **Components of Visual Perception in Graphics**

- 2-dimensional location
- Length
- Width
- Area
- Shape
- Color (Hue, Saturation, Brightness)
- Orientation

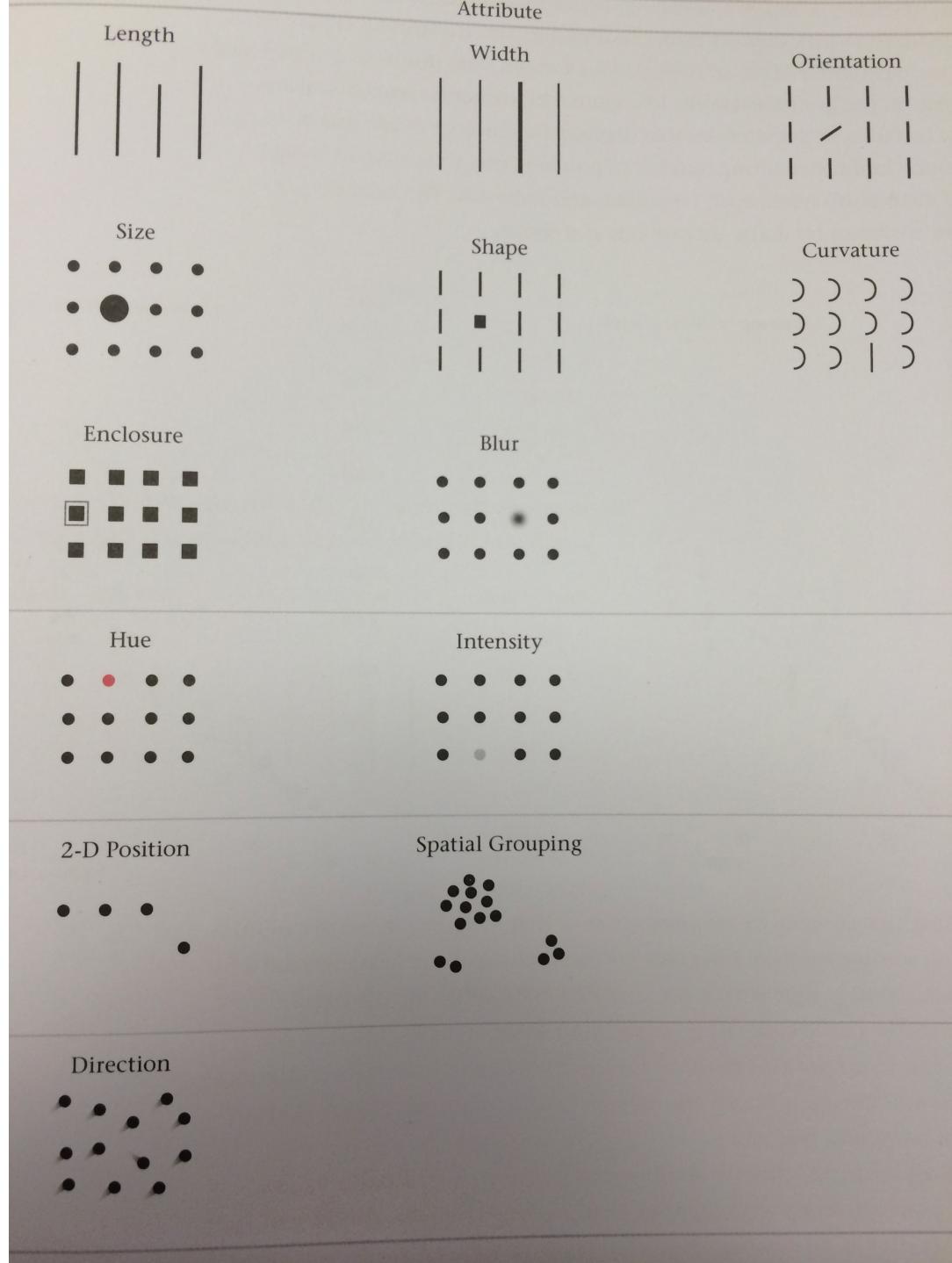


# Visual Encodings



**COLOR SATURATION**

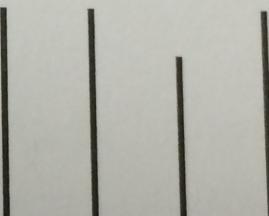
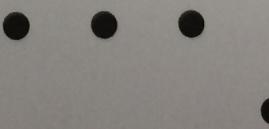
# Visual Encodings



- Direction of motion

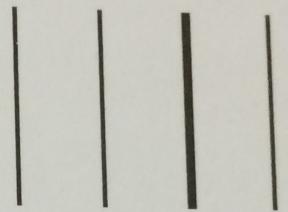
• • • • •

Here's the list of the pre-attentive attributes that are quantitatively perceived in and of themselves, without having values arbitrarily assigned to them:

Precision of Quantitative Perception	Attribute	Example	Description
Very precise	Length		Longer = greater
	2-D Position		Higher or farther to the right = greater
Not very precise	Width		Wider = greater

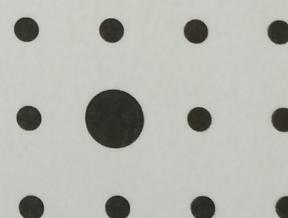
Not very precise

Width



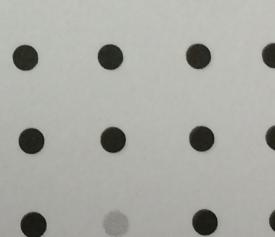
Wider = greater

Size



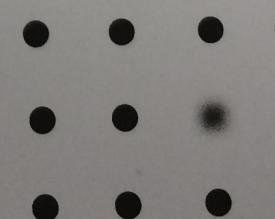
Bigger = greater

Intensity



Darker = greater

Blur



Clearer = greater

Heer &  
Bostock,  
2010

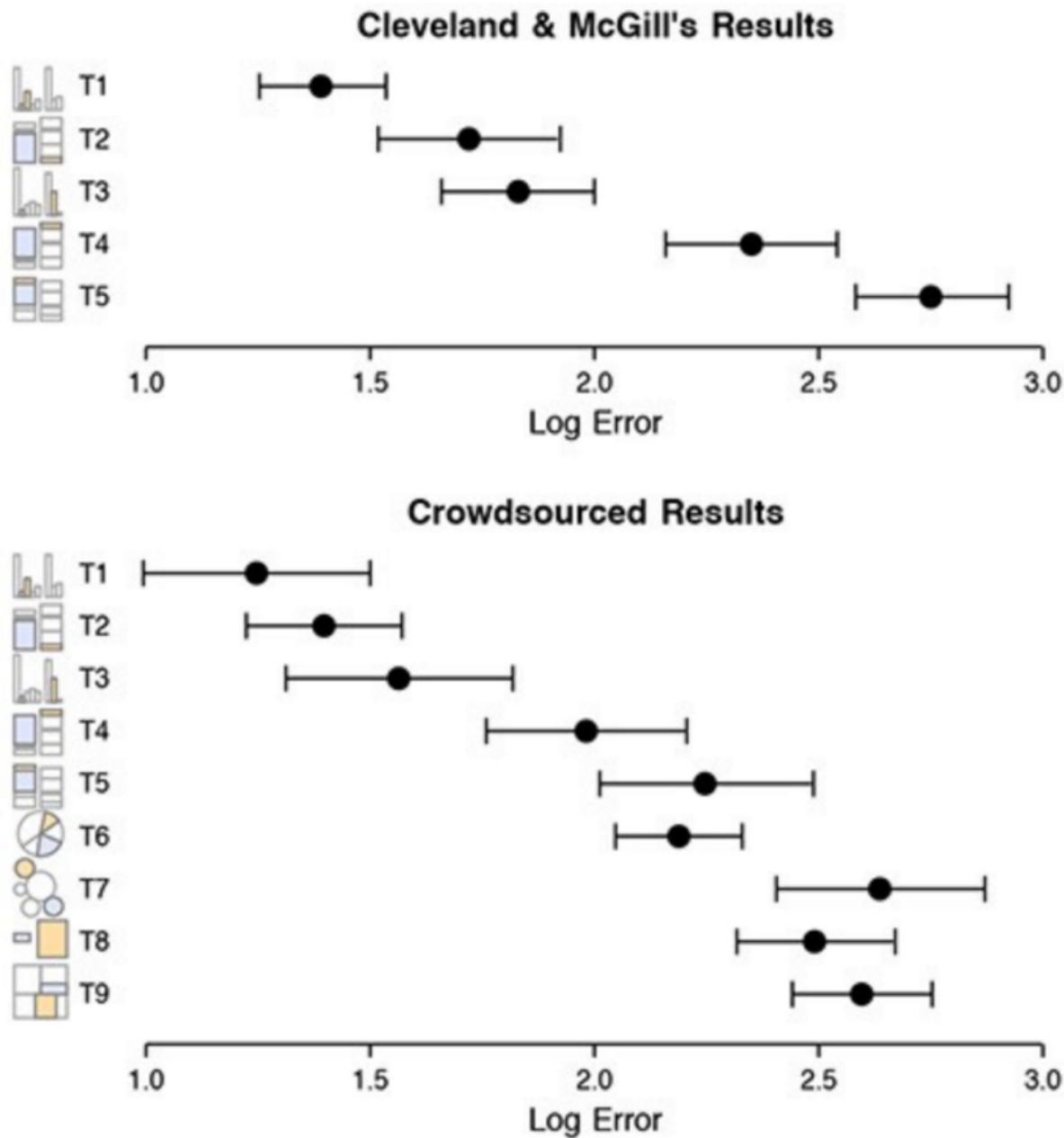


Figure 4: Proportional judgment results (Exp. 1A & B).  
Top: Cleveland & McGill's [7] lab study. Bottom: MTurk  
institutions. Error bars indicate  $\pm 25\%$  of the mean.

Heer &  
Bostock,  
2010

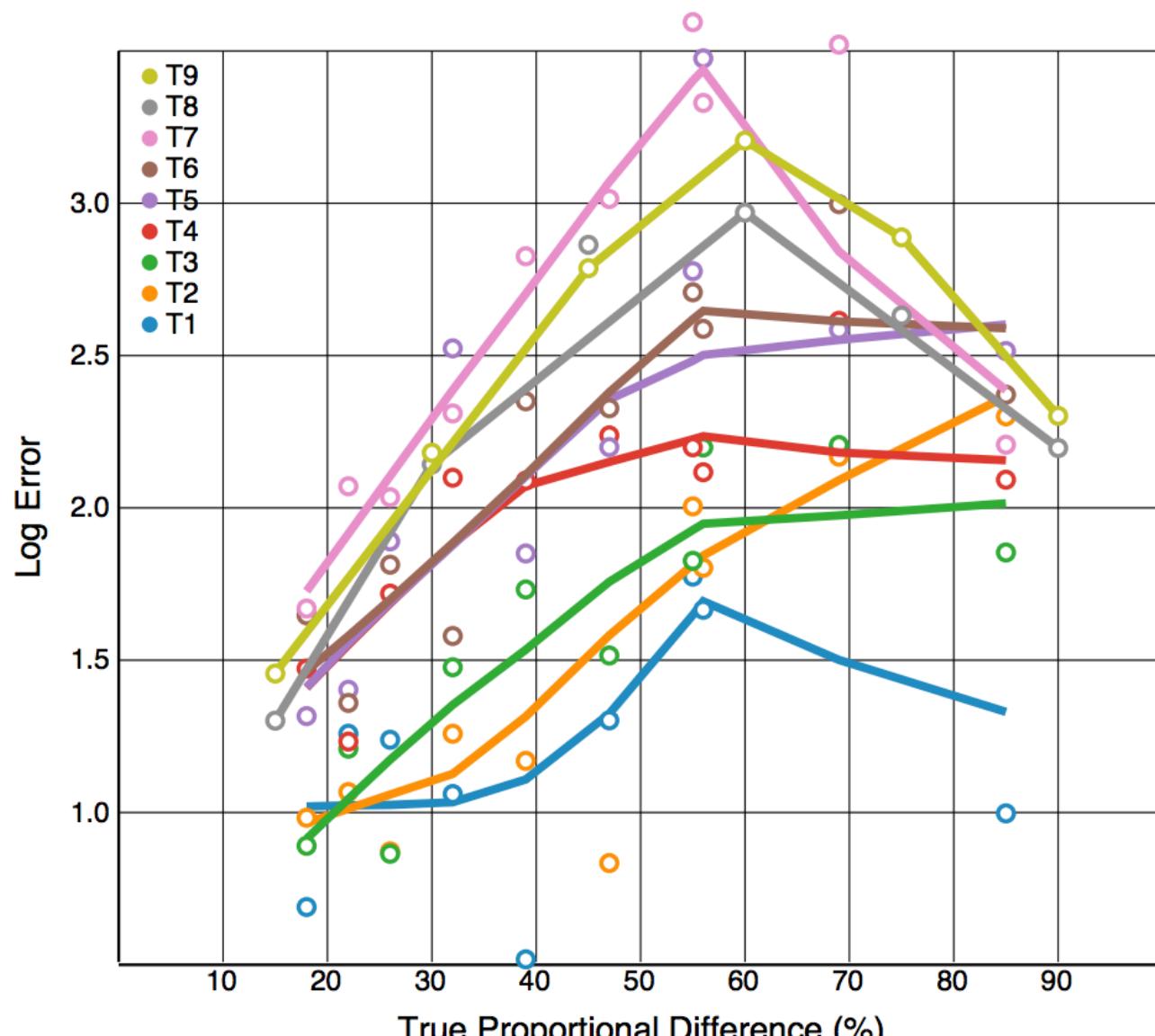
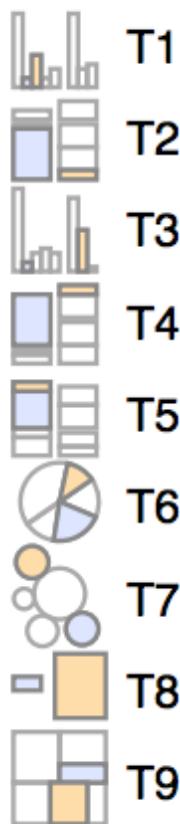
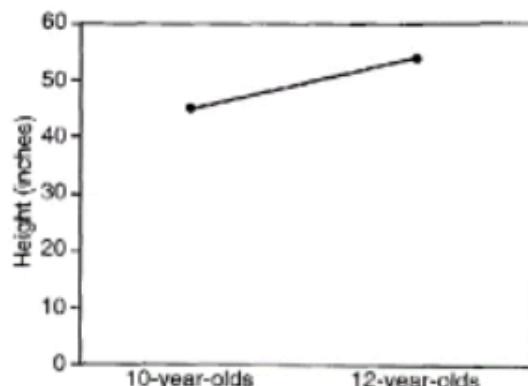
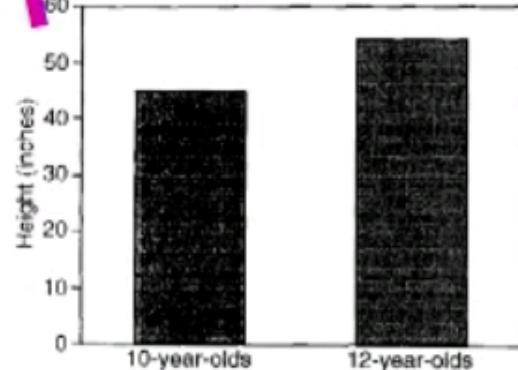
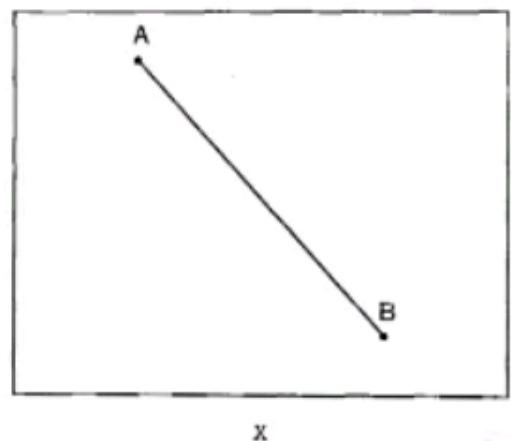
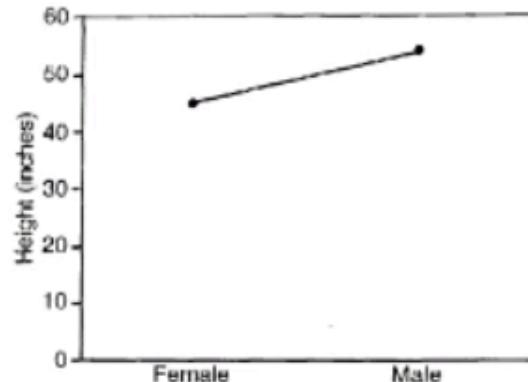
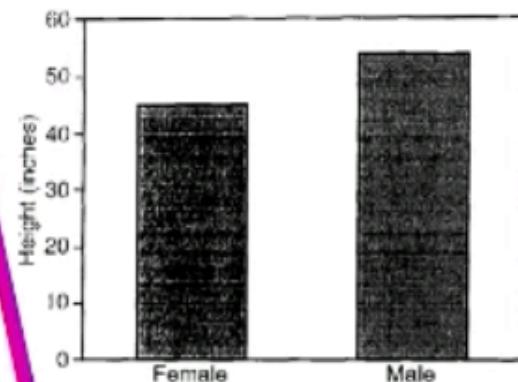
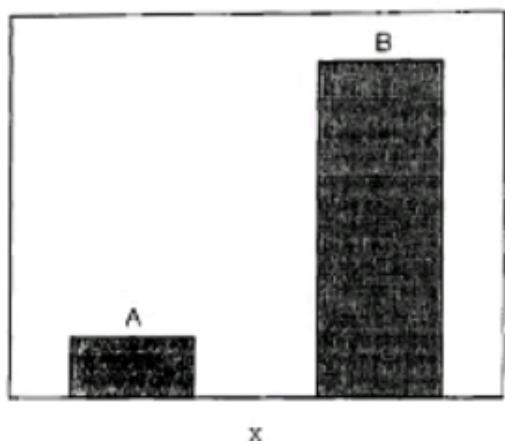


Figure 3: Midmeans of log absolute errors against true percentages for each proportional judgment type; superimposed are curves computed with *lowess*.

# discrete values

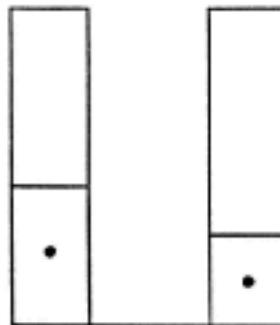


trends

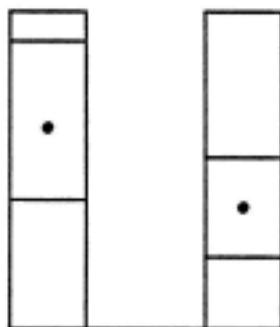
segment-to-  
segment



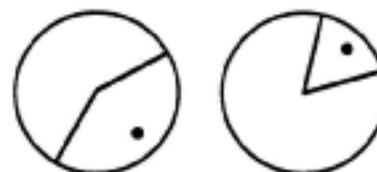
Simple bar chart



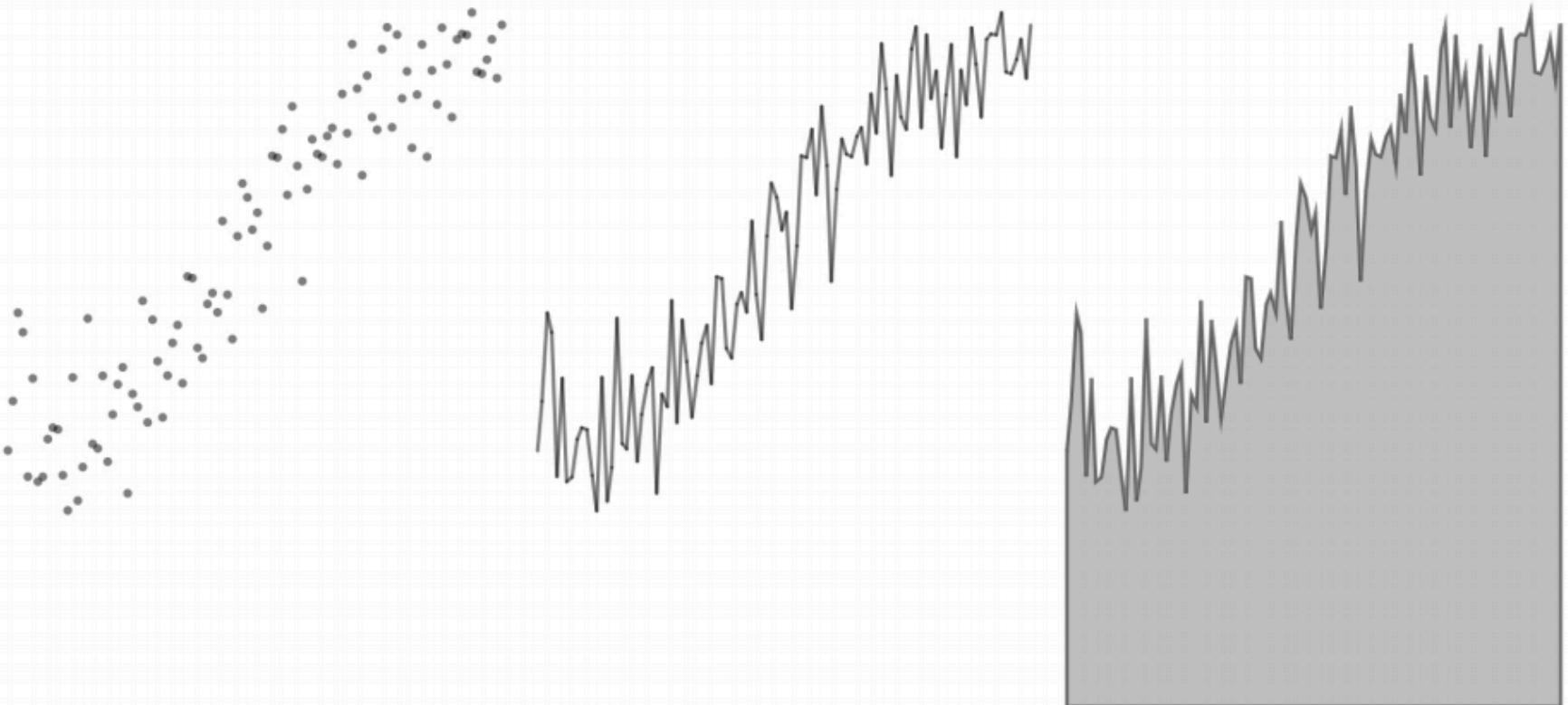
Divided bar chart



Pie Chart

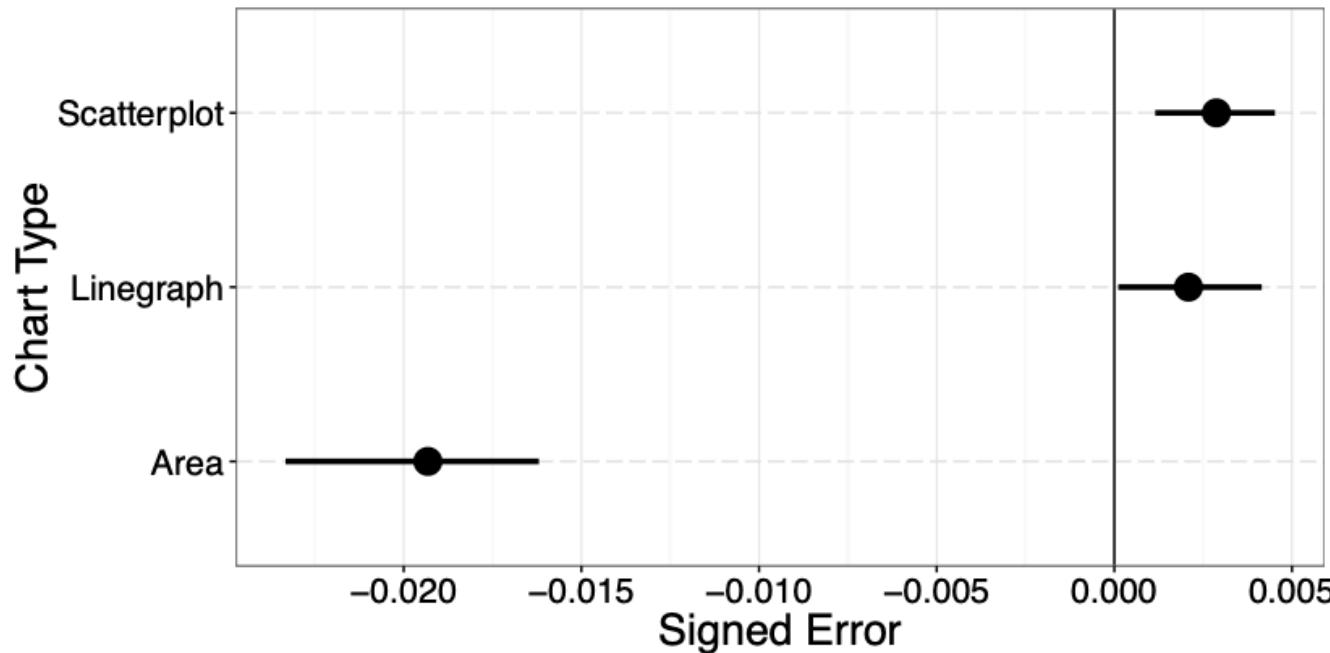


proportional



**Figure 3. The three types of bivariate visualizations explored in this work: scatter plots, line graphs, and area charts. The density of points made bar charts and area charts visually similar, and so we excluded bar charts from our experiments. Likewise, the error in estimating trends from heatmaps [13] made them unsuitable for the experimental task.**

# Within-the-bar bias



**Figure 8. The effect of chart type on signed error in Experiment 2. See Fig. 4 for example stimuli at each factor level. Area charts are visually asymmetric, with the area below the line filled in with a color. This visual asymmetry results in a form of within-the-bar bias [27], where values in the filled region are perceived as likelier than values outside of it. This bias manifests as a consistent under-estimation in the intercept of trend lines. Other chart types we examined do not have this bias. Confidence intervals represent bootstrapped 95% CIs of interquartile means.**

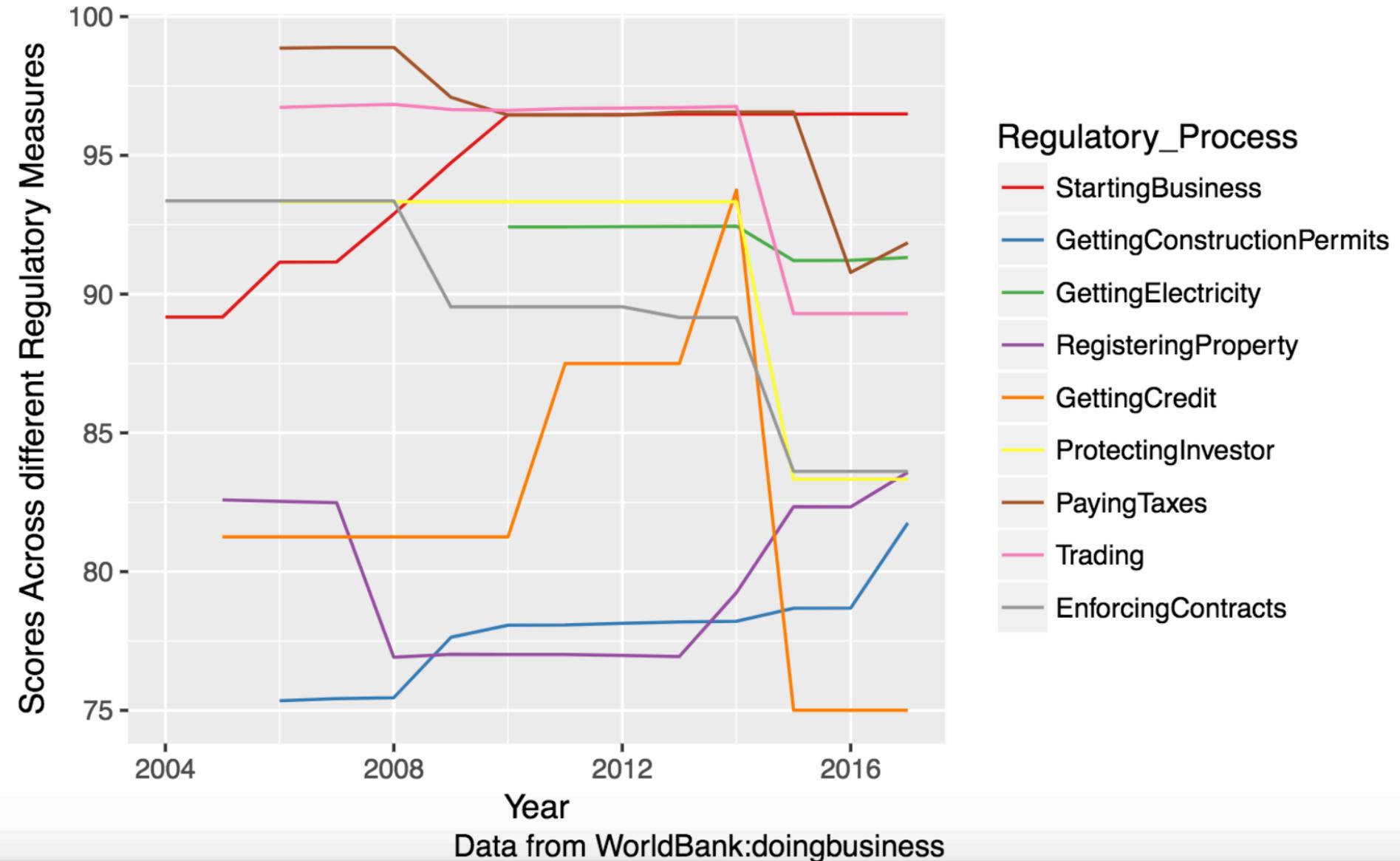
Example	Encoding	Ordered	Useful values	Quantitative	Ordinal	Categorical	Relational
	position, placement	yes	infinite	Good	Good	Good	Good
1, 2, 3; A, B, C	text labels	optional alpha or num	infinite	Good	Good	Good	Good
	length	yes	many	Good	Good		
	size, area	yes	many	Good	Good		
	angle	yes	medium	Good	Good		
	pattern density	yes	few	Good	Good		
	weight, boldness	yes	few		Good		
	saturation, brightness	yes	few		Good		
	color	no	few (<20)			Good	
	shape, icon	no	medium			Good	
	pattern texture	no	medium			Good	
	enclosure, connection	no	infinite			Good	Good
	line pattern	no	few				Good
	line endings	no	few				Good
	line weight	yes	few		Good		

## “N-O-I-R” Examples

- Nominal - press, radio, television
- Ordinal - freshman, sophomore, junior
- Interval - age (years):    0-4    5-9    10-14
- Ratio - age in years

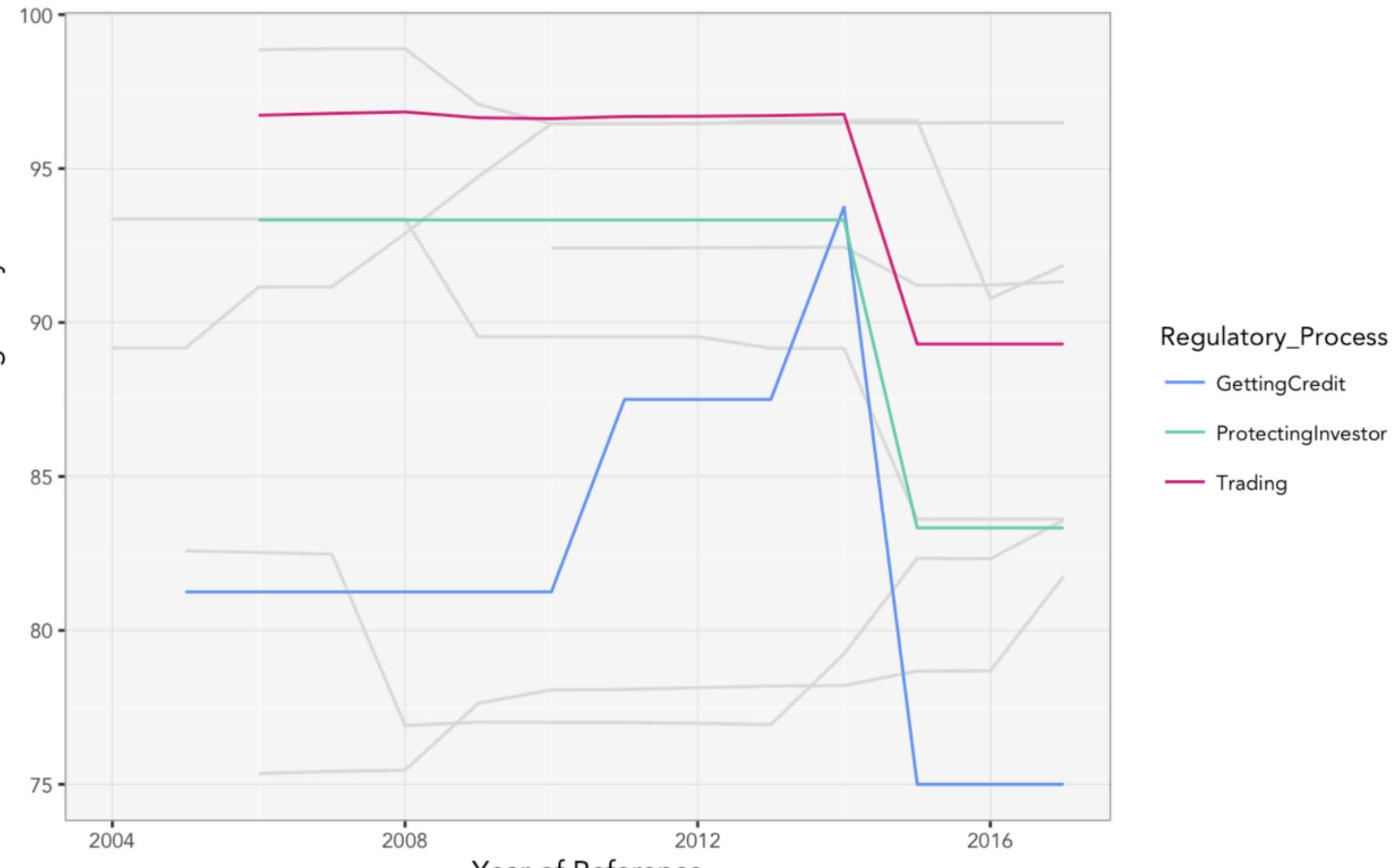
# Performance drop by Singapore 2004–17

There has been a steep drop in Sgp's performance. However, it is still ranked 7 overall



# Performance drop by Singapore 2004-17

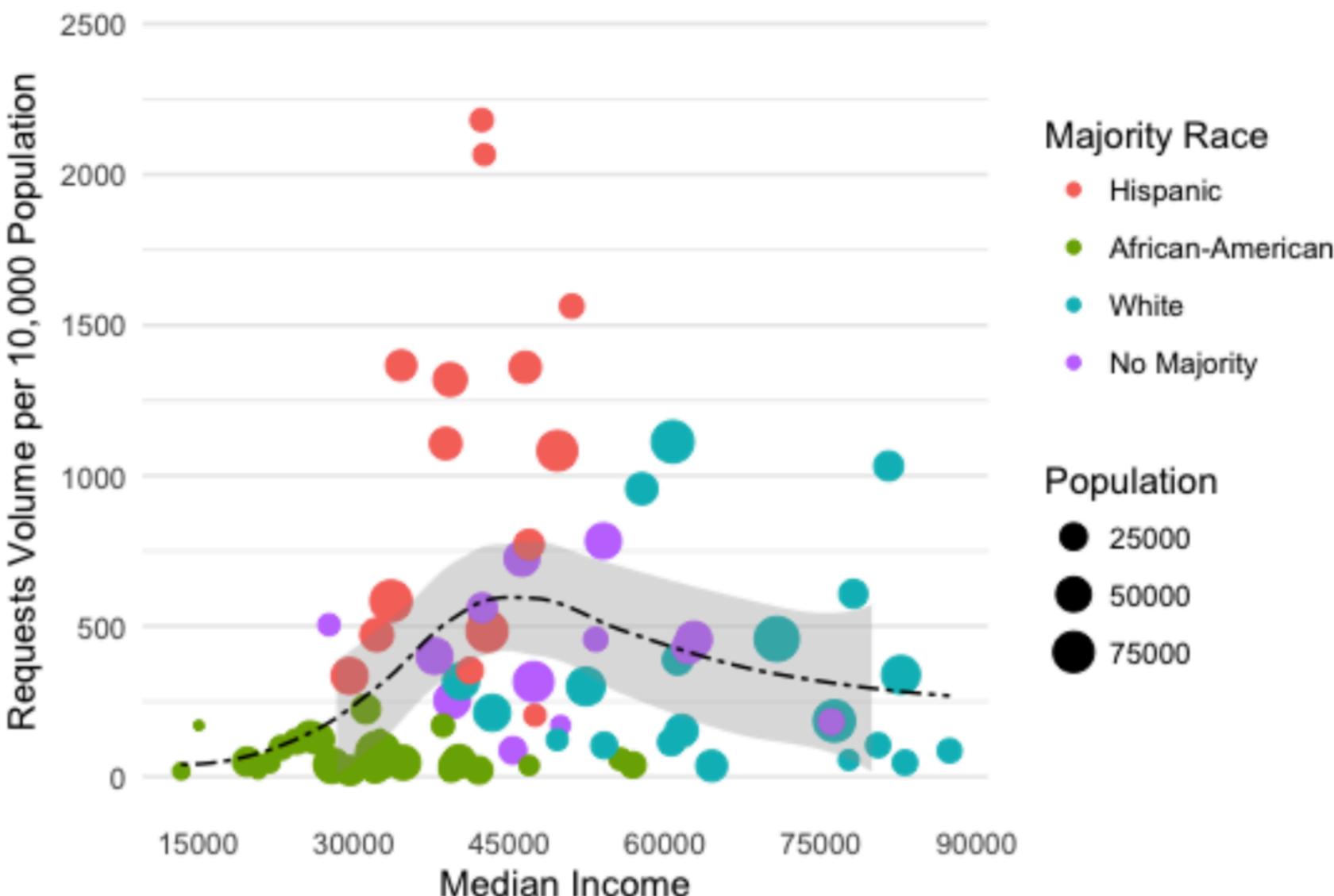
There has been a steep drop in Sgp's performance in the financial aspects. However, it is still ranked 7 overall.



Data from WorldBank:doingbusiness

# Graffiti Removal Requests Volume by Community in 2016

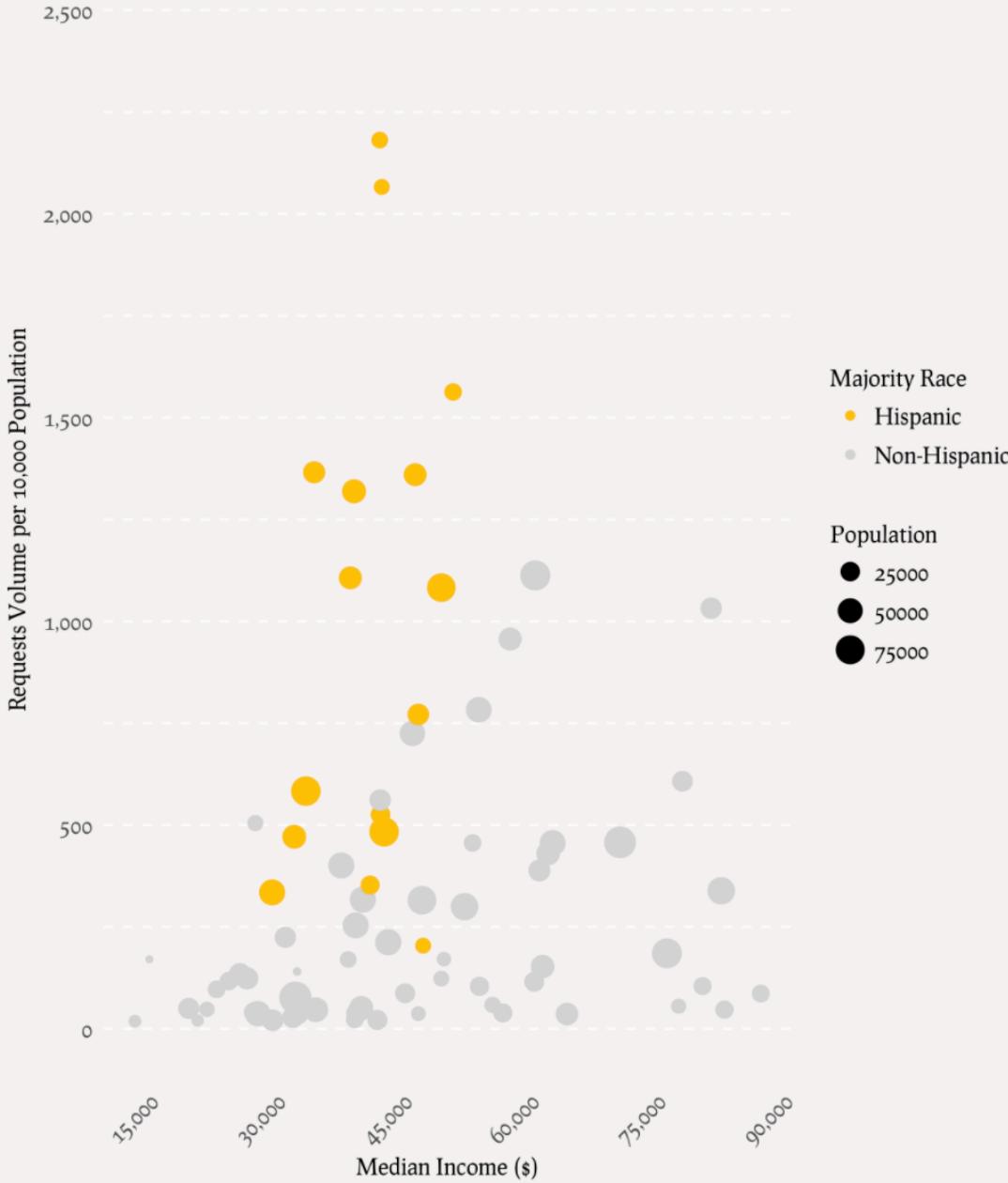
Hispanic neighborhoods present a remarkably higher volume of graffiti removal requests



Data from Chicago Data Portal and American Community Survey

# Graffiti Removal Requests by Community, 2016

Hispanic neighborhoods present a remarkably higher volume



# How many 5's?

385720939823728196837293827  
382912358383492730122894839  
909020102032893759273091428  
938309762965817431869241024

# How many 5's?

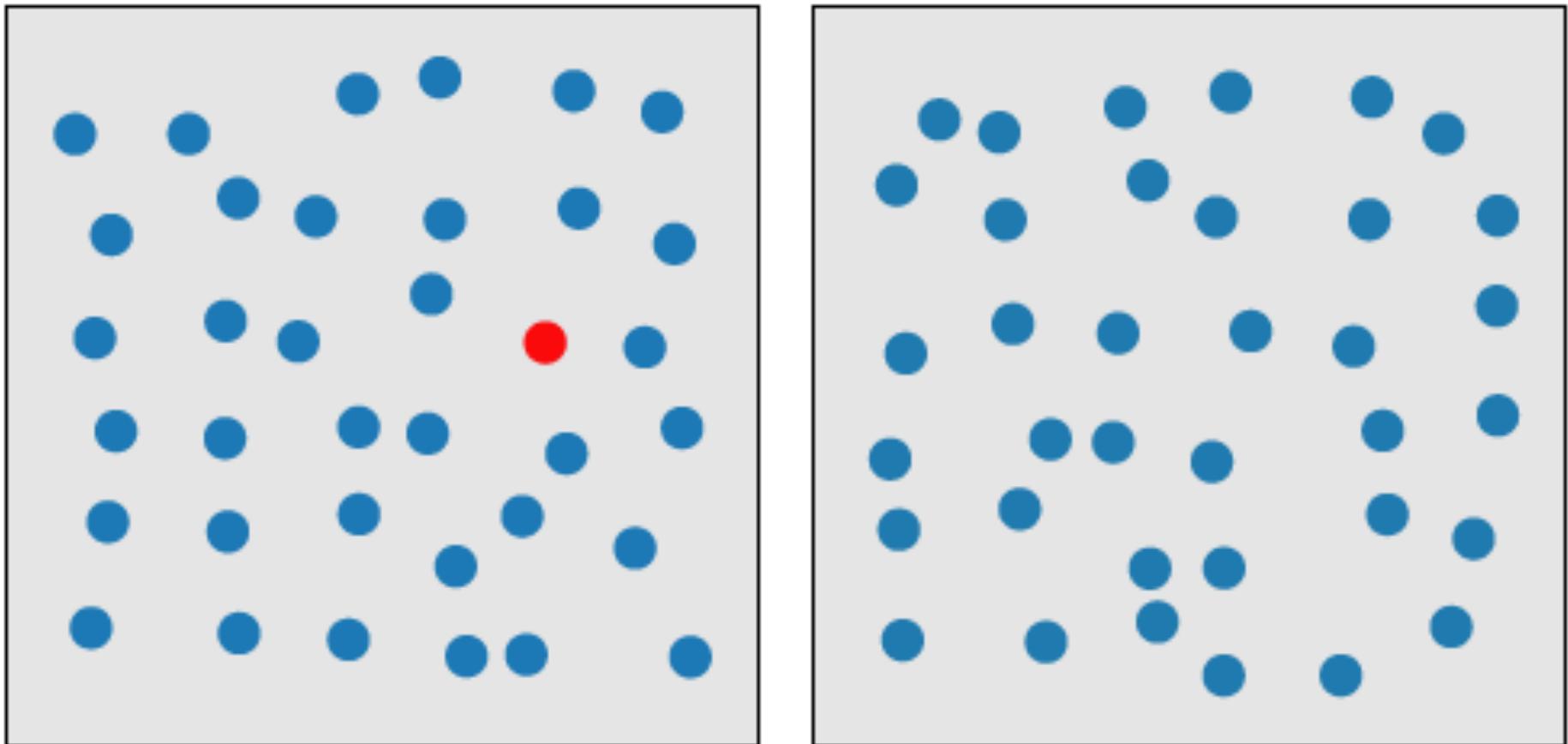
385720939823728196837293827

382912358383492730122894839

909020102032893759273091428

938309762965817431869241024

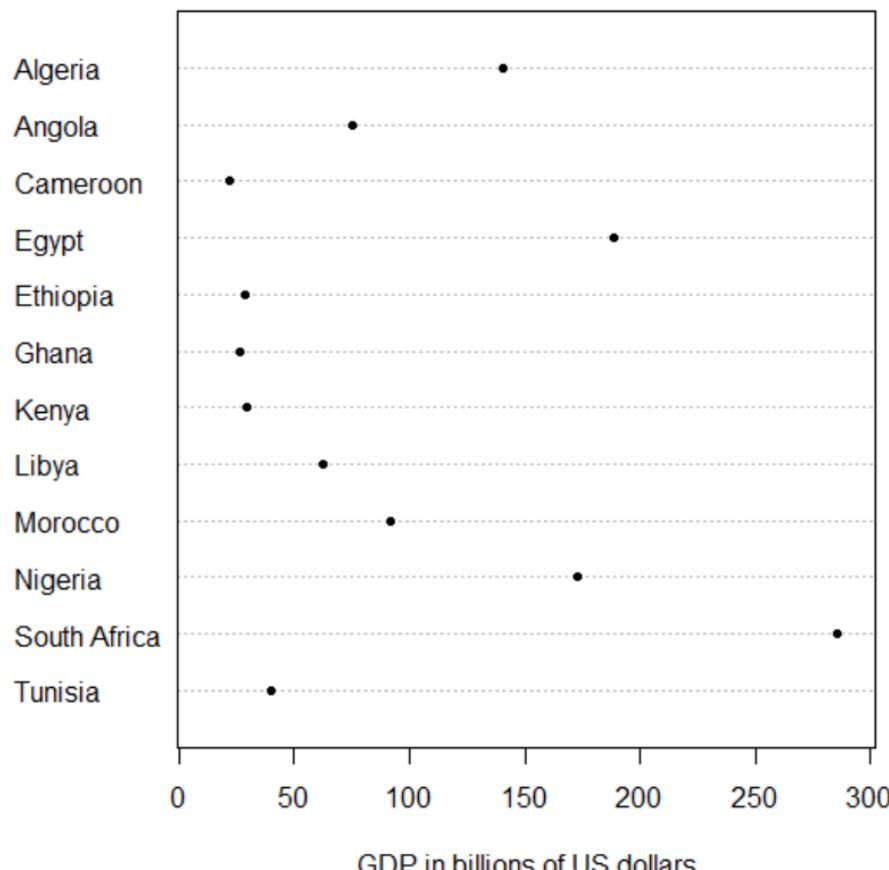
# Color Hue is Pre-Attentive



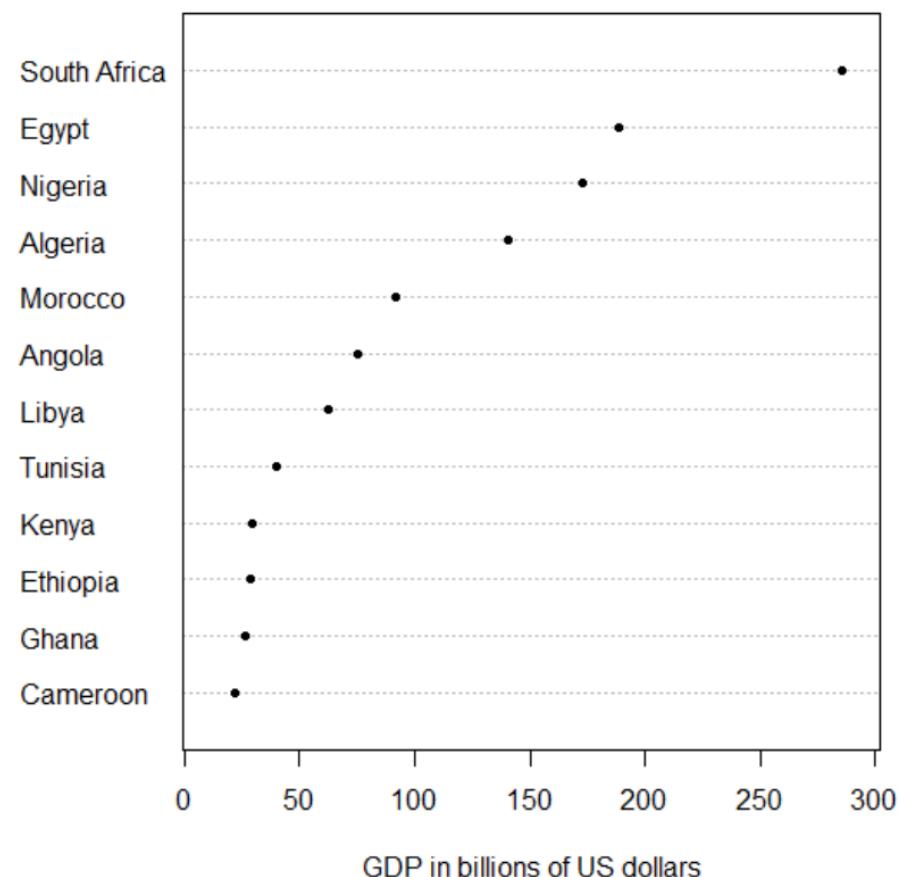
[Pre-attentive Processing Tool](#)

# Redundant Encodings

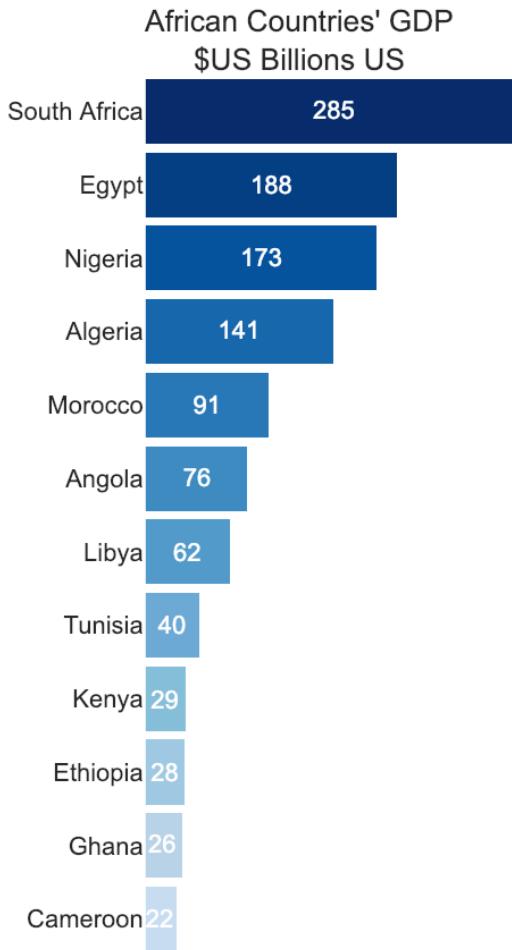
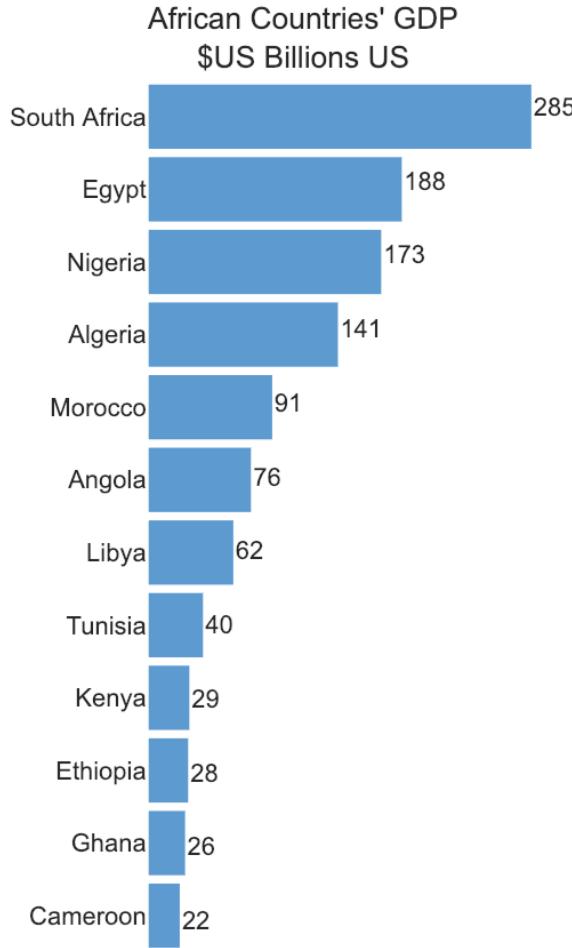
African Countries by GDP

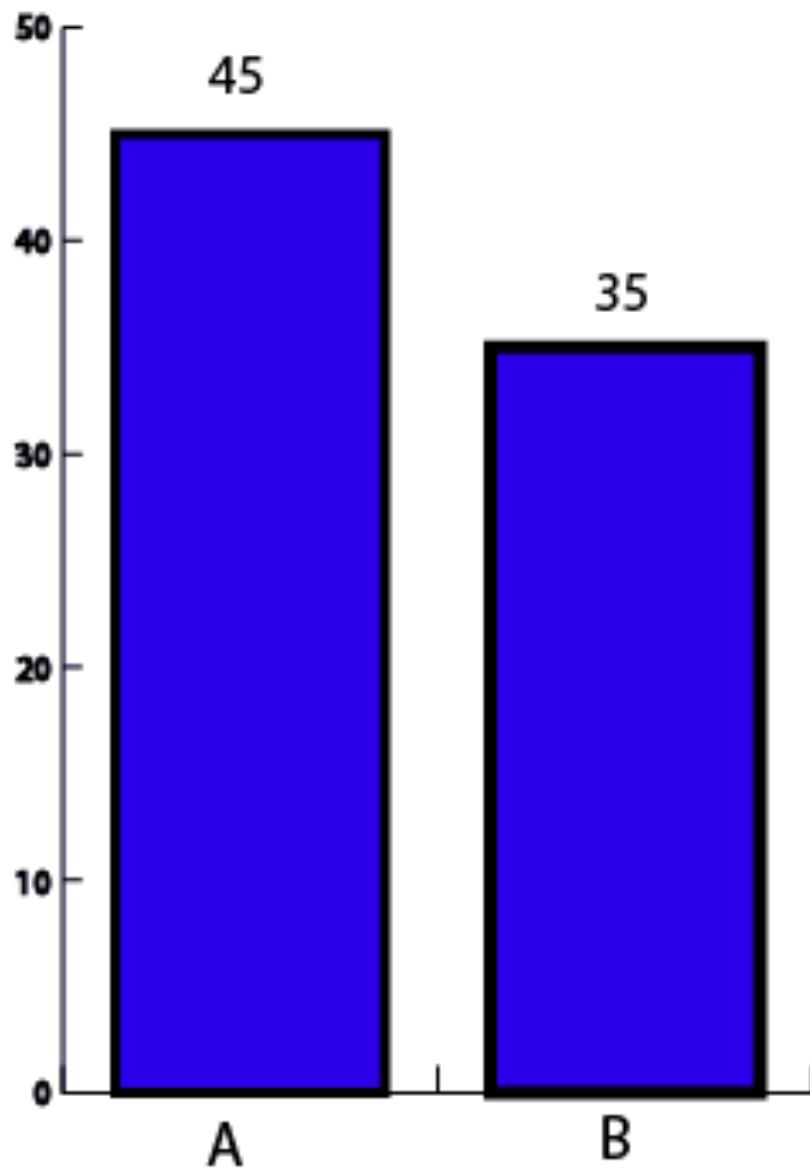


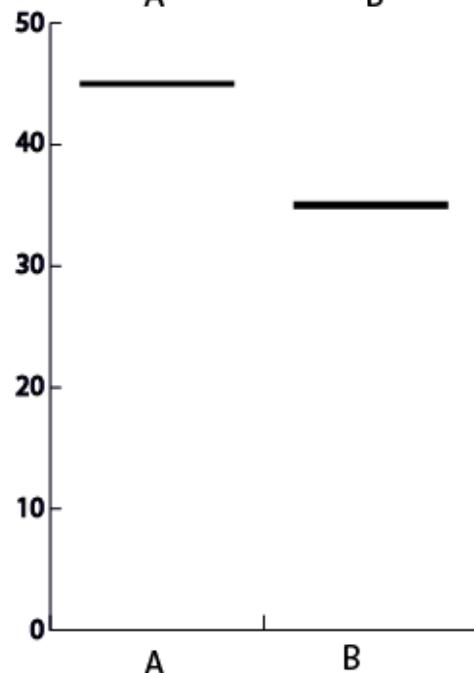
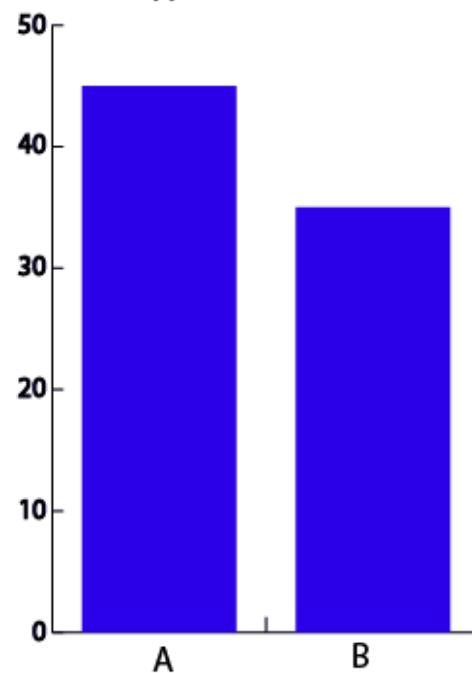
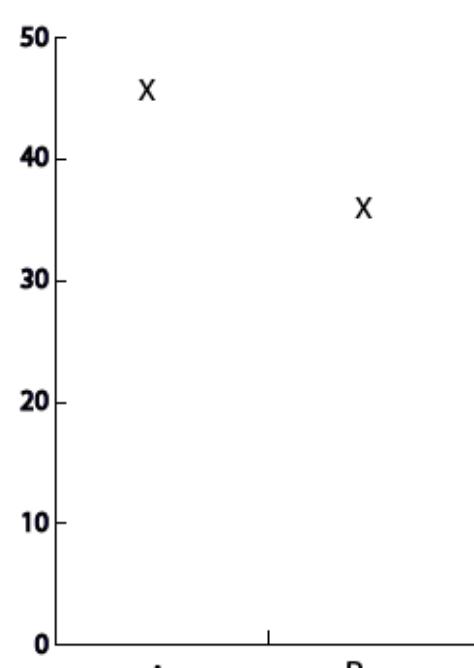
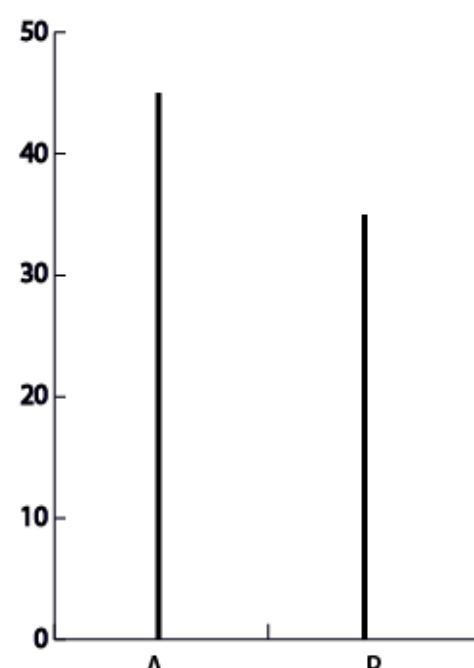
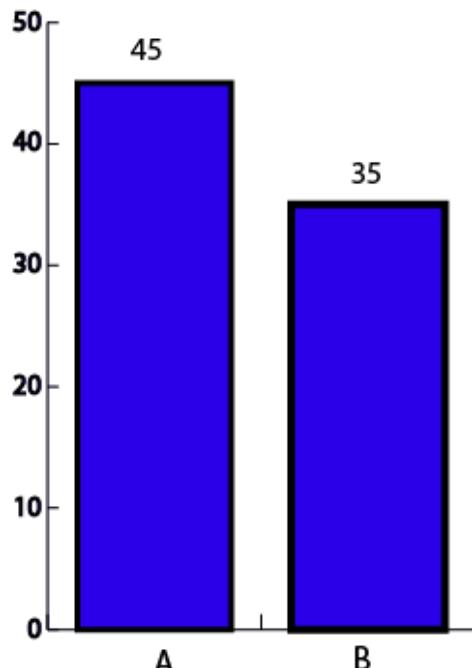
African Countries by GDP



# Redundant Encodings



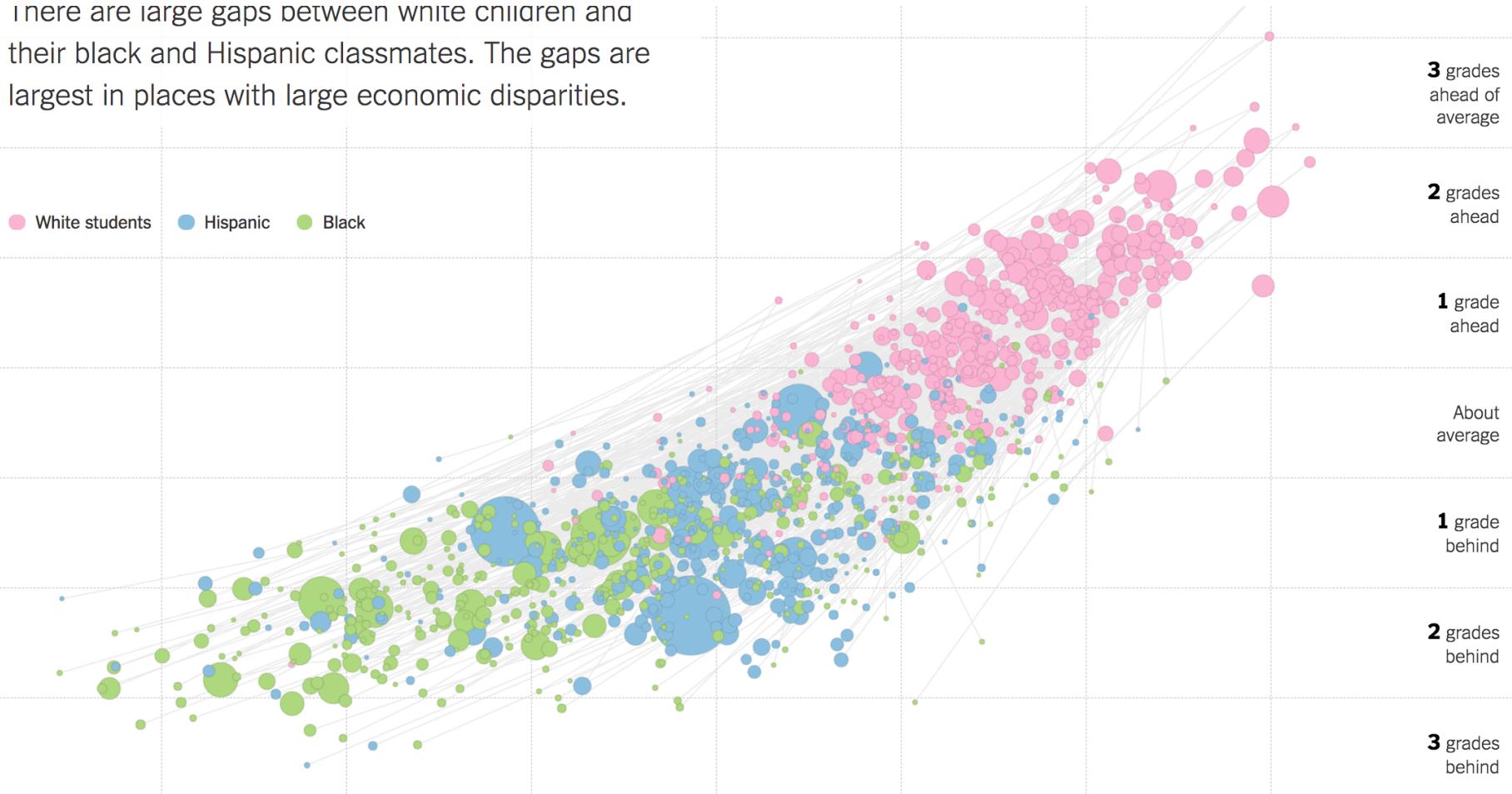




45  
A      35  
B

# What is this?

There are large gaps between white children and their black and Hispanic classmates. The gaps are largest in places with large economic disparities.



[NYTimes: How Your School District Compares](#)

# **Summer Olympic Medal Count\***

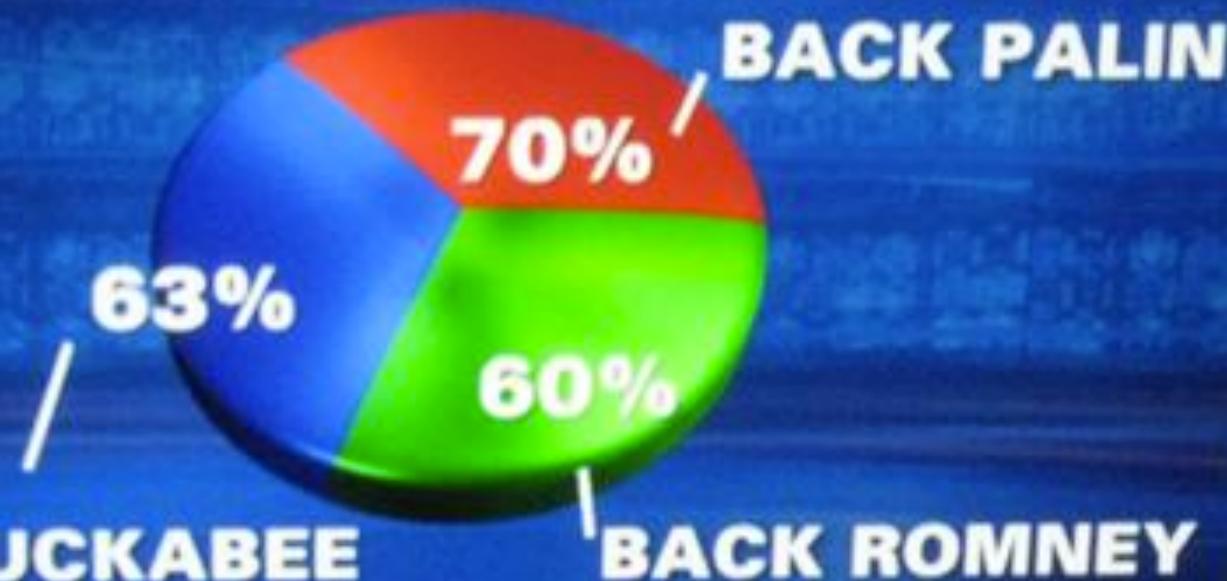
**(Up to August 2004)**

<u>Country</u>	<u>Medals</u>
<b>1. U.S.A.</b>	 1,975
<b>2. Russia</b>	 999
<b>3. Britain</b>	 615
<b>4. France</b>	 523
<b>5. Germany</b>	 499

\*This medal count was based on the records of Agence France-Press news service and may vary from other accounts. Initially, the International Olympic Committee frowned upon national medal counts and early reports are incomplete. In fact, from 1896 to 1906, athletes registered as individuals and it was not uncommon for them to play on the teams of other countries.

# 2012 PRESIDENTIAL RUN

GOP CANDIDATES



FOX

47°

SOURCE: OPINIONS  
DYNAMIC

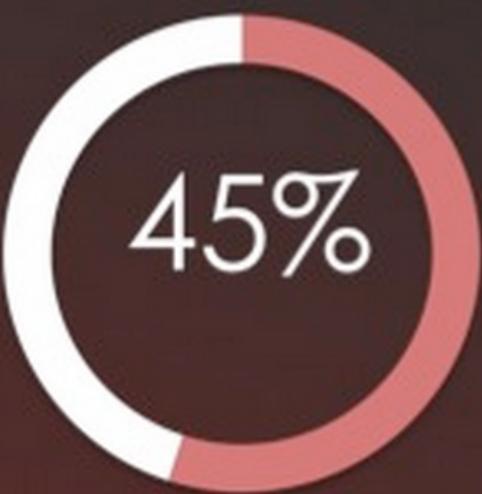
## Top 3 Goals of B2B Content Marketing



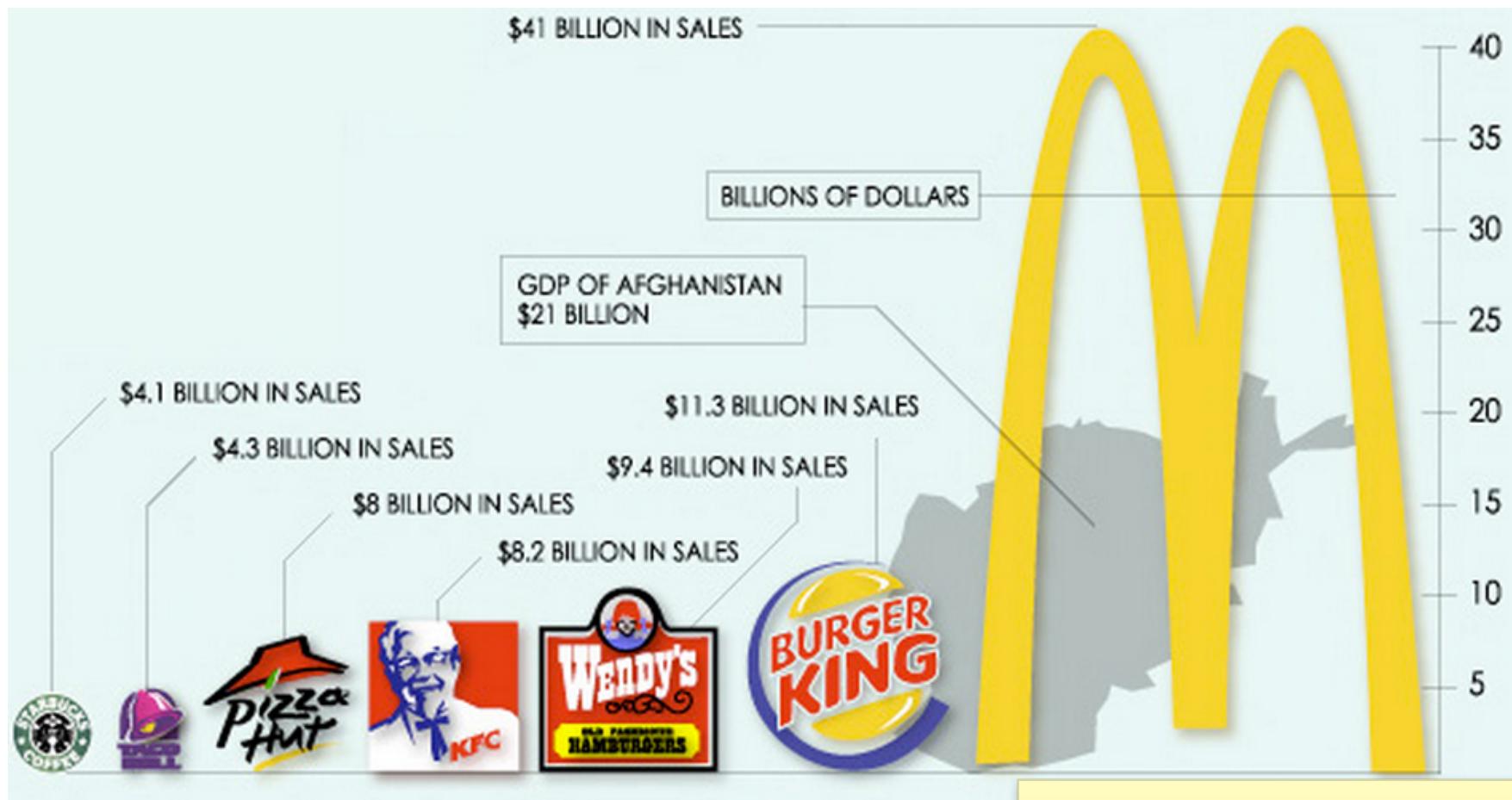
Lead  
Generation



Thought  
Leadership



Customer  
Acquisition



<http://www.princeton.edu/~ina/infographics/starbucks.html>

## JOB LOSS BY QUARTER



FOX NEWS  
.com

SOURCE: BLS

AMERICA'S  
NEWSROOM

FAIRFAX, VA... BYRD WAS ADMITTED TO THE HOSPITAL

S&P ▼ 3.08

[metro.us/truthfacts](http://metro.us/truthfacts)

STATISTICS SHOW THAT TEEN PREGNANCIES DROP  
DRASTICALLY AFTER THE AGE OF 20



BY WULFF & MORGENTHALER/TRUTHFACTS.COM

[metro.us/truthfacts](http://metro.us/truthfacts)

# SOUTHWEST BORDER APPREHENSIONS

OCTOBER - APRIL



**FOX**  
NEWS  
channel

Source: U.S. Border Patrol

\$43 BIL IN FEB, DOWN 3.4% FROM JAN'S REVISED

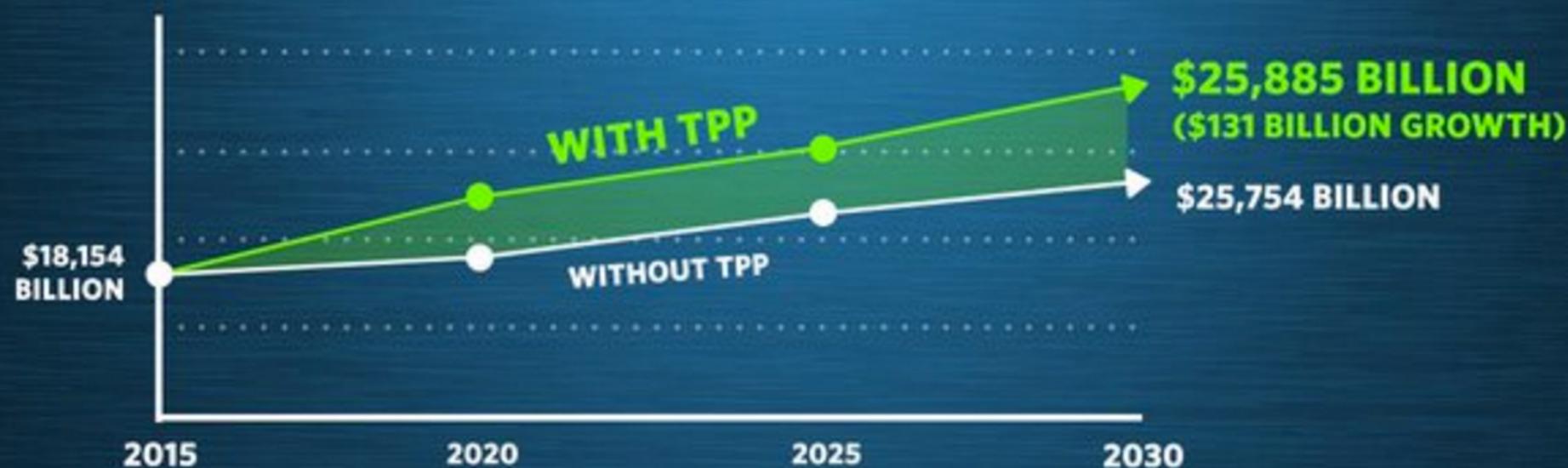
Happening  
now

NAS



35.18

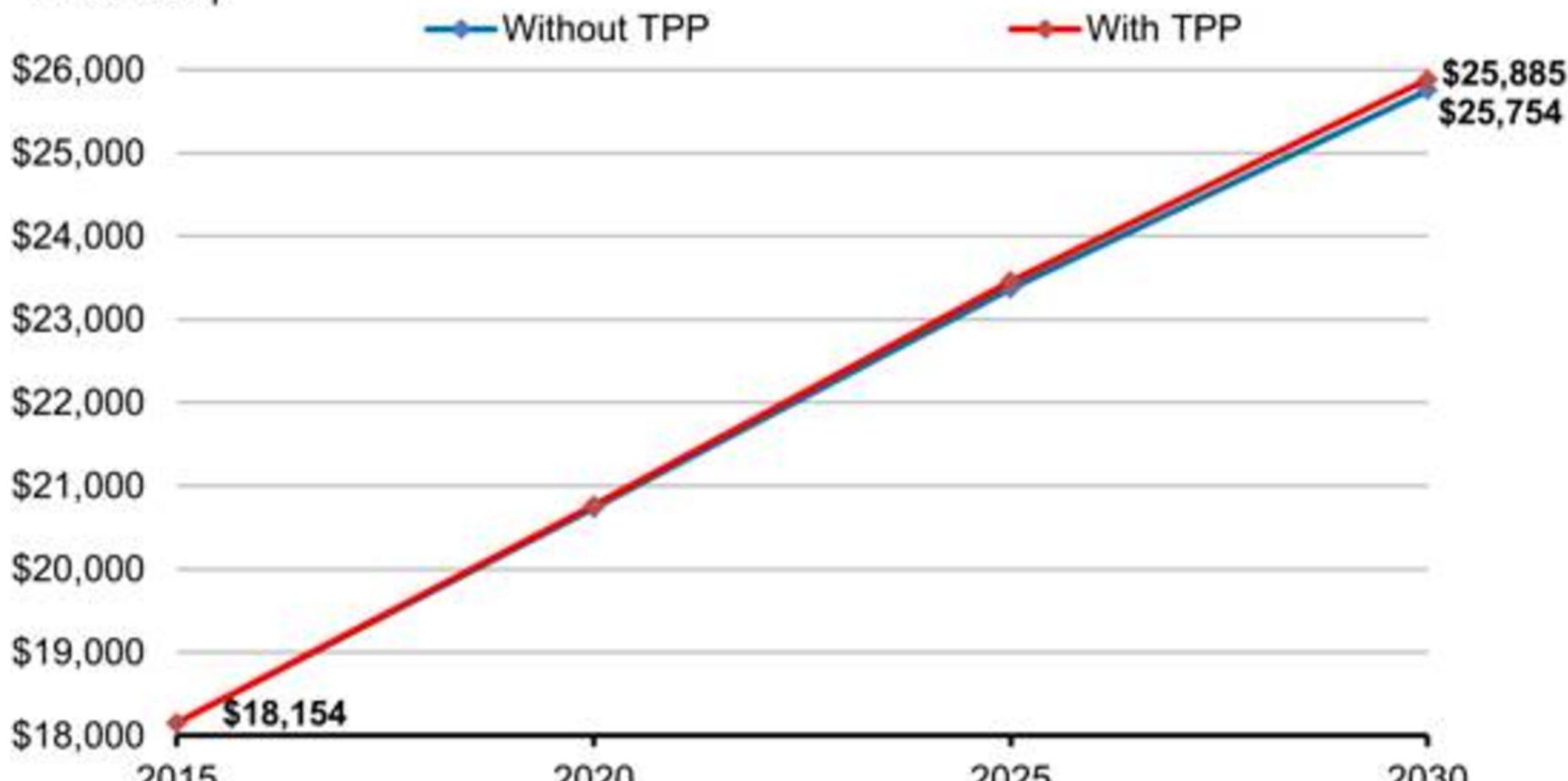
## THE TRANS-PACIFIC PARTNERSHIP IS ESTIMATED TO GROW U.S. NATIONAL INCOME BY **\$131 BILLION** BY THE YEAR 2030



SOURCE: Peterson Institute for International Economics

## National Income with TPP

Real U.S. national income (in billions) with and without passage of the Trans-Pacific Partnership



Source: Peterson Institute for International Economics | WSJ.com

# **Alternative to thinking in visual encodings is graph typologies**

These can still be useful for considering your options:

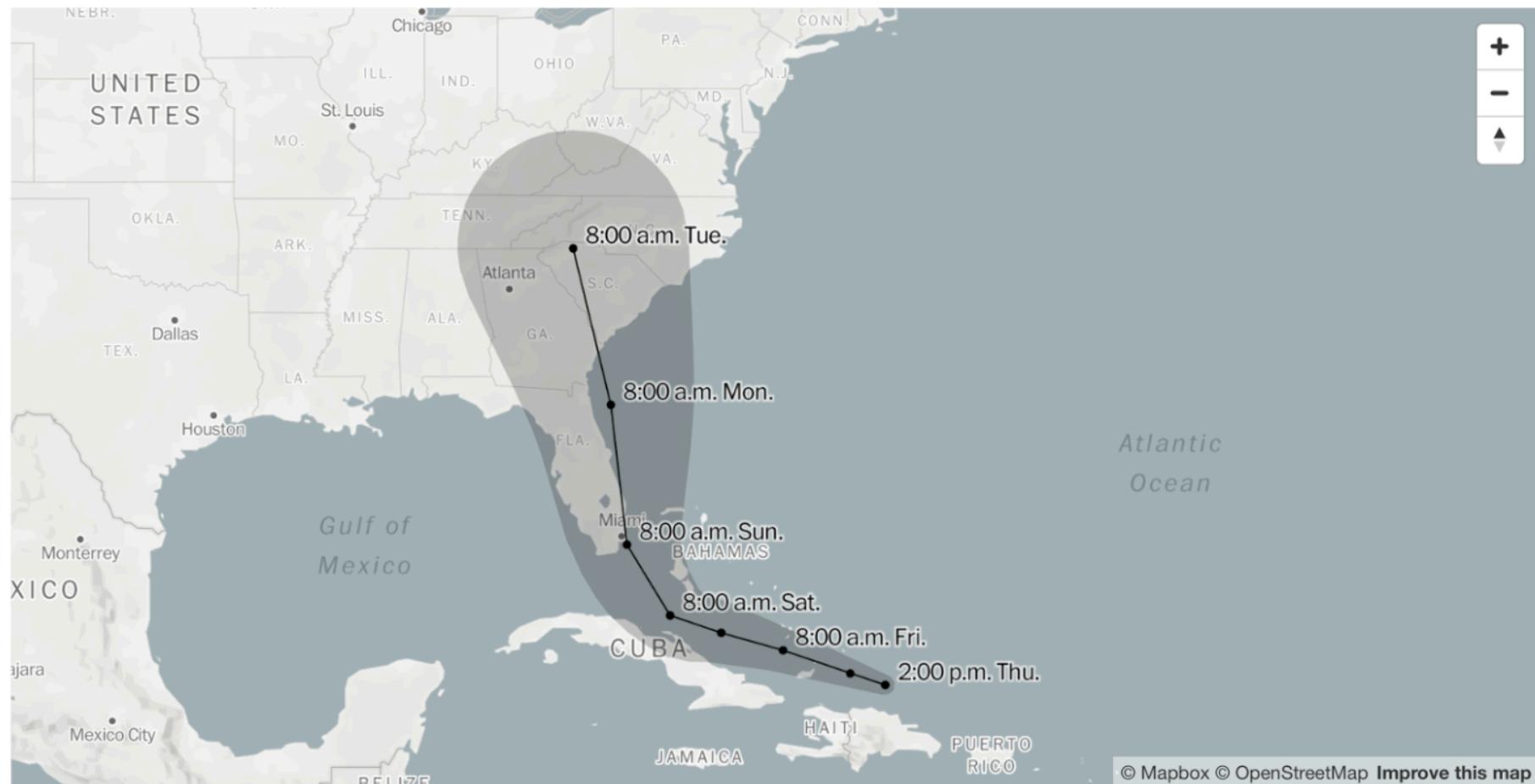
- From [Data to Viz](#)
- [Data Viz Catalog](#)
- [The Graphic Continuum](#)

# What's in the path of Hurricane Irma

The storm is big, fast and speeding through the Caribbean toward Florida

By **Bonnie Berkowitz, Laris Karklis, Reuben Fischer-Baum, John Muyskens, Gabriel Florit and Denise Lu**

Updated Sept. 7 3:15 p.m.



The future path of the center of Hurricane Irma could be anywhere within this cone.

## Model simulations of Irma's path

ECMWF forecasts at 8 p.m. Sept. 6

