



Inspire...Educate...Transform.

The Art and Science of Storytelling with Data Visualizations

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Executive VP – Academics, INSOFE

April 15, 2017

Do visualizations really make a big difference? **MOTIVATION**

CSE 7120c



How many numbers are less than 10?

You have 8 seconds

83 11 70 27 66 67 12 96 48 70
97 1 64 28 94 51 46 52 90 82
92 16 3 98 62 21 7 68 11 71 96
79 27 22 3 47 59 94 48 11 11
54 8 51 17 9 96 15 7 11 58 52
86 68 60 73 20 15 4 19 3 78 82
9 54 60 75 88 42 88 49 65 44
65 44 25 14 26 17 81 48 93 10
88 67 87 11 34 35 55 74 17 11
25 39 96 26 39 88 59



How many numbers are less than 10?

You have 4 seconds

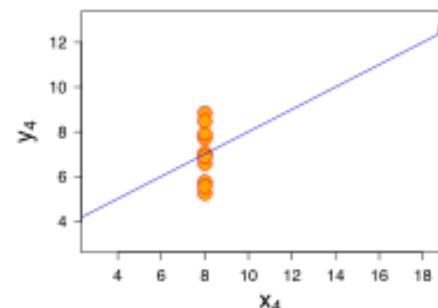
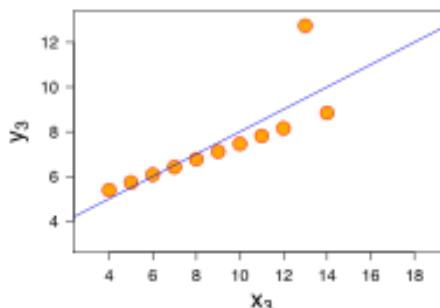
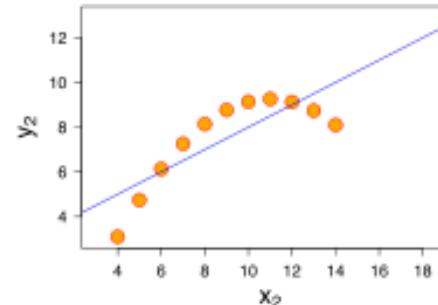
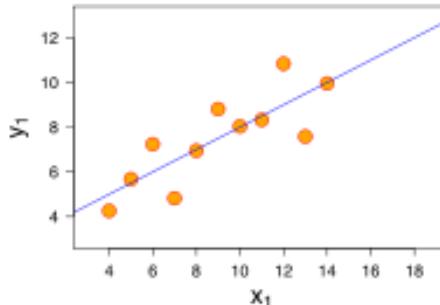
83 11 70 27 66 67 12 96 48 70
97 **1** 64 28 94 51 46 52 90 82
92 16 **3** 98 62 21 **7** 68 11 71 96
79 27 22 **3** 47 59 94 48 11 11
54 **8** 51 17 **9** 96 15 **7** 11 58 52
86 68 60 73 20 15 **4** 19 **3** 78 82
9 54 60 75 88 42 88 49 65 44
65 44 25 14 26 17 81 48 93 10
88 67 87 11 34 35 55 74 17 11
25 39 96 26 39 88 59



Are the 4 datasets the same?

Anscombe's quartet								
	I		II		III		IV	
x	y	x	y	x	y	x	y	
10	8.04	10	9.1	10	7.46	8	6.6	
8	6.95	8	8.1	8	6.77	8	5.8	
13	7.58	13	8.7	13	12.7	8	7.7	
9	8.81	9	8.8	9	7.11	8	8.8	
11	8.33	11	9.3	11	7.81	8	8.5	
14	9.96	14	8.1	14	8.84	8	7	
6	7.24	6	6.1	6	6.08	8	5.3	
4	4.26	4	3.1	4	5.39	19	13	
12	10.8	12	9.1	12	8.15	8	5.6	
7	4.82	7	7.3	7	6.42	8	7.9	
5	5.68	5	4.7	5	5.73	8	6.9	

Property	Value
Mean of x in each case	9 (exact)
Sample variance of x in each case	11 (exact)
Mean of y in each case	7.50 (to 2 decimal places)
Sample variance of y in each case	4.122 or 4.127 (to 3 decimal places)
Correlation between x and y in each case	0.816 (to 3 decimal places)
Linear regression line in each case	$y = 3.00 + 0.500x$ (to 2 and 3 decimal places, respectively)





Why and Where of Visualizations

Communication



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How to Communicate Effectively

STEP 1: Plan a STORY (flow) - Spend a lot of time on this



Always Focus on
the Big Picture

Always Put
Yourself in Your
Audience's Shoes

Always Pay
Attention to
Details

- What is the message you wish to get across?
- **Skill:** Know your subject well.
- Have you considered your audience's cultural differences, technical and intellectual levels, access to information or knowledge, and may be, even moods and/or stress levels?
- **Skill:** Look at the problem and your message from multiple perspectives.
- Is every detail related to the message you want to communicate or are you digressing?
- **Skill:** Know your language well.
- **Skill:** Know your process well.

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How to Communicate Effectively

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TRAFFIC STUDY

City's markets are most accident prone

■ OU research creates 'mishap map' of notorious areas

U. SUDHAKAR
REDDY | DC
HYDERABAD, FEB. 16

Geographic Information System-based studies by the transport engineers of Osmania University in Hyderabad have revealed that 66 per cent of road mishaps occur in busy market areas that have commercial establishments and that most of the accidents are multi-factor events.

The study says there are fewer accidents in non-commercial and residential localities.

The study also found that drunken driving, mechanical failures, overtaking, poor illumination, rash driving, sleeping at the wheel and negligent road crossing by pedestrians were the leading causes of accidents in Hyderabad.

Though drivers are responsible for a majority of accidents, others included bad road conditions, road engineering, traffic flow characteristics, behaviour of pedestrians and two-wheeler riders, absence of traffic signals and policemen.

The International Journal of Innovative Research in Science, Engineering and Technology has published the study by the O.U. Civil Engineering Department in its 2017 January edition.

Prof. Molugaram Kumar of the civil engineering department of OU said areas such as Madhapur, Kondapur, Gachibowli, Uppal, Medchal, LB Nagar and Shamshabad, with busy markets and commercial areas, reported the highest number of mishaps. "We have used spatial data which is generated

by scanning maps from Survey of India or Google Earth and digitized them. We have also collected road accident data from traffic police stations from the past four years. The computation has been done using the spatial relationship between traffic mishaps and road network elements. Maps are also made with GPS data and compared for accuracy with traditional accident records. This attempt will show how GPS and GIS combines to give accurate block identification, rather than relying on location," the professor said.

Prof. Kumar says accidents and fatalities can be reduced by having proper traffic control devices. "Any technology for bringing down accidents will depend on the analysis of traffic accident records at a given location," he said. "But the data required for such an analysis is not always available. Most of the information in accident records is incomplete and not useful to the entire extent," he added.

Lack of signage, trees and foliage that hide pedestrians from the view of drivers, improper design of pedestrian crossings, median openings at several places, and poor enforcement of traffic rules are areas that seriously need to be looked into, according to the researchers.

Motorists simply turn around the wrong way to avoid police checks along Necklace road in the city, on Thursday — DC

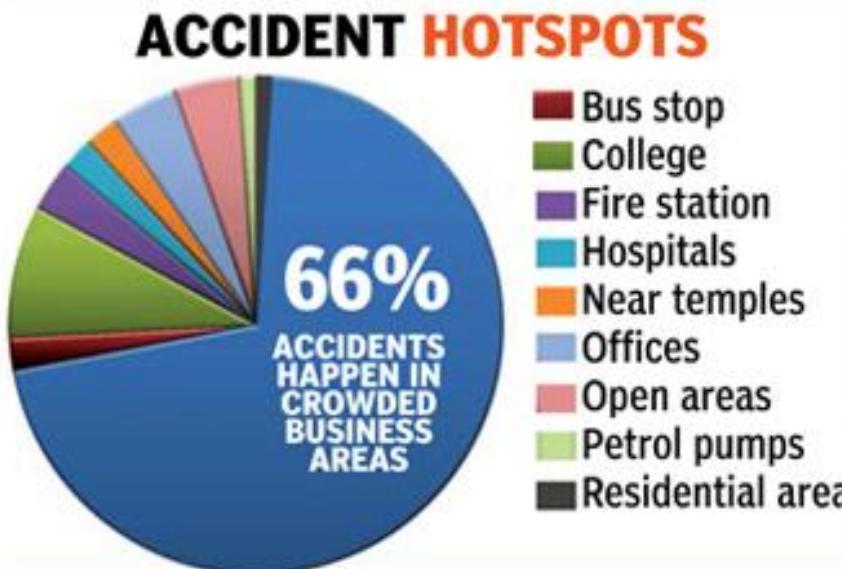
ACCIDENT HOTSPOTS

Location Type	Percentage
Bus stop	Red
College	Green
Fire station	Purple
Hospitals	Cyan
Near temples	Orange
Offices	Light Blue
Open areas	Pink
Petrol pumps	Light Green
Residential area	Dark Blue

The computation has been done using the spatial relationship between traffic mishaps and road network elements.



What is the Big Picture in this story?



■ **THE STUDY** found that motorists were to blame for most accidents.

■ **MADHAPUR, Kondapur, Gachibowli, Uppal, Medchal, LB Nagar and Shamshabad are accident prone.**

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by scanning maps from Survey of India or Google Earth to get accurate black spot identification, rather than relying on location," the professor said.

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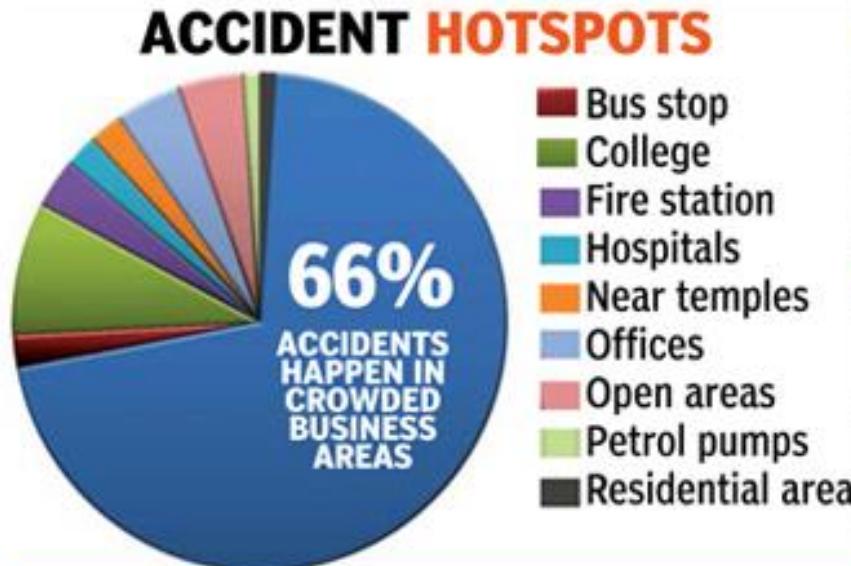
ACCIDENT HOTSPOTS

Location	Percentage
Bus stop	1%
College	8%
Fire station	3%
Hospitals	2%
Near temples	2%
Offices	1%
Open areas	5%
Petrol pumps	4%
Residential area	10%
Crowded business areas	66%

The computation has been done using the spatial relationship between traffic mishaps and road network elements.

Who is the Audience in this story?

Is this visualization good for the intended audience?



The computation has been done using the spatial relationship between traffic mishaps and road network elements.

Is this visualization good if the intended audience were the bureaucrats in the traffic department in charge of deploying improvement measures?

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The study says there are fewer accidents in non-commercial and residential localities.

The study also found that drunken driving, mechanical failures, overtaking, poor illumination, rash driving, sleeping at the wheel and negligent road crossing by pedestrians were the leading causes of accidents in Hyderabad.

Though drivers are responsible for a majority



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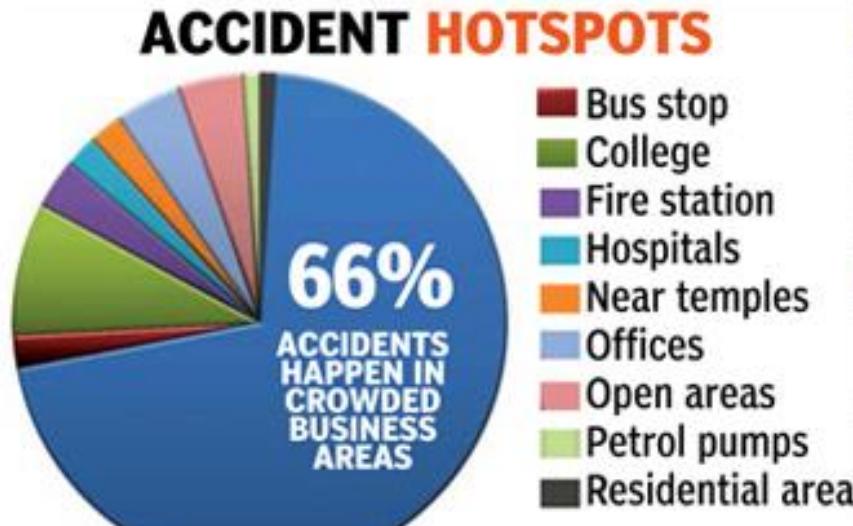
ACCIDENT HOTSPOTS

- Bus stop
- College
- Fire station
- Hospitals
- Near temples
- Offices
- Open areas
- Petrol pumps
- Residential area

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MADHAPUR

Pay Attention to Details – Technical and Non-technical alike



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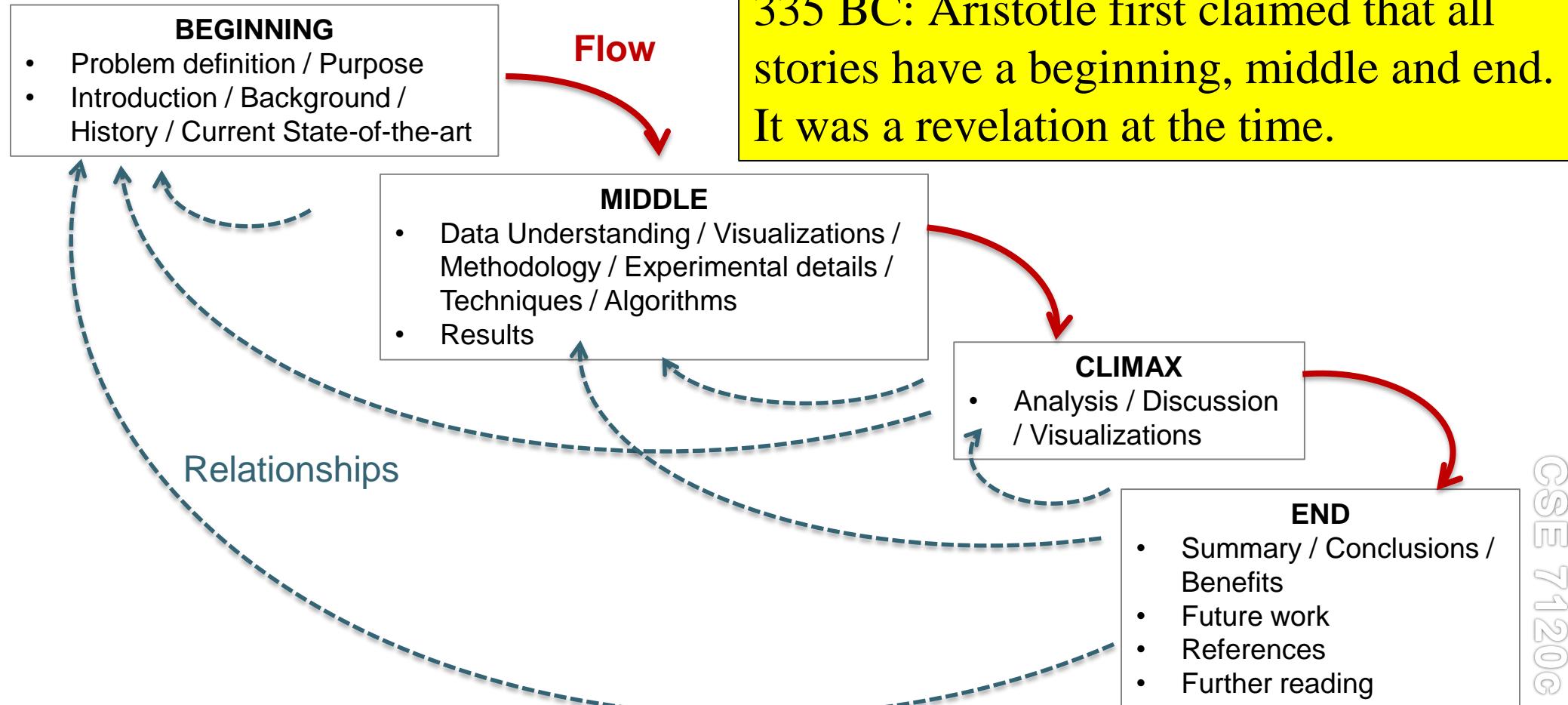
■ **MADHAPUR, Kondapur, Gachibowli, Uppal, Medchal, LB Nagar and Shamshabad are accident-prone.**

- Consistency
 - Plurals and Singulars
 - Why is “Near” mentioned for one but not other locations?
- Why is MADHAPUR in **bold**?
- What is the relationship between “markets”, “crowded business areas” and “offices”?
- Where is the data proving “motorists were to blame for most accidents.”?



How to Communicate Effectively

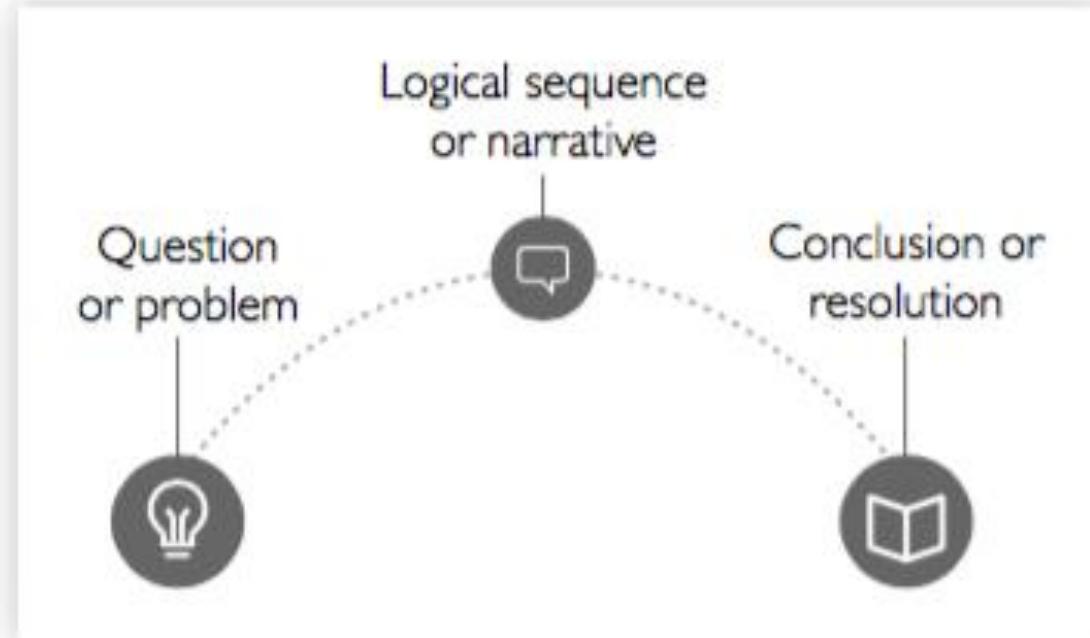
Step 2: Create / Build / Tell the STORY



How to Communicate Effectively

335 BC: Aristotle first claimed that all stories have a beginning, middle and end. It was a revelation at the time.

The story arc establishes causality as human brain inherently starts connecting the dots.

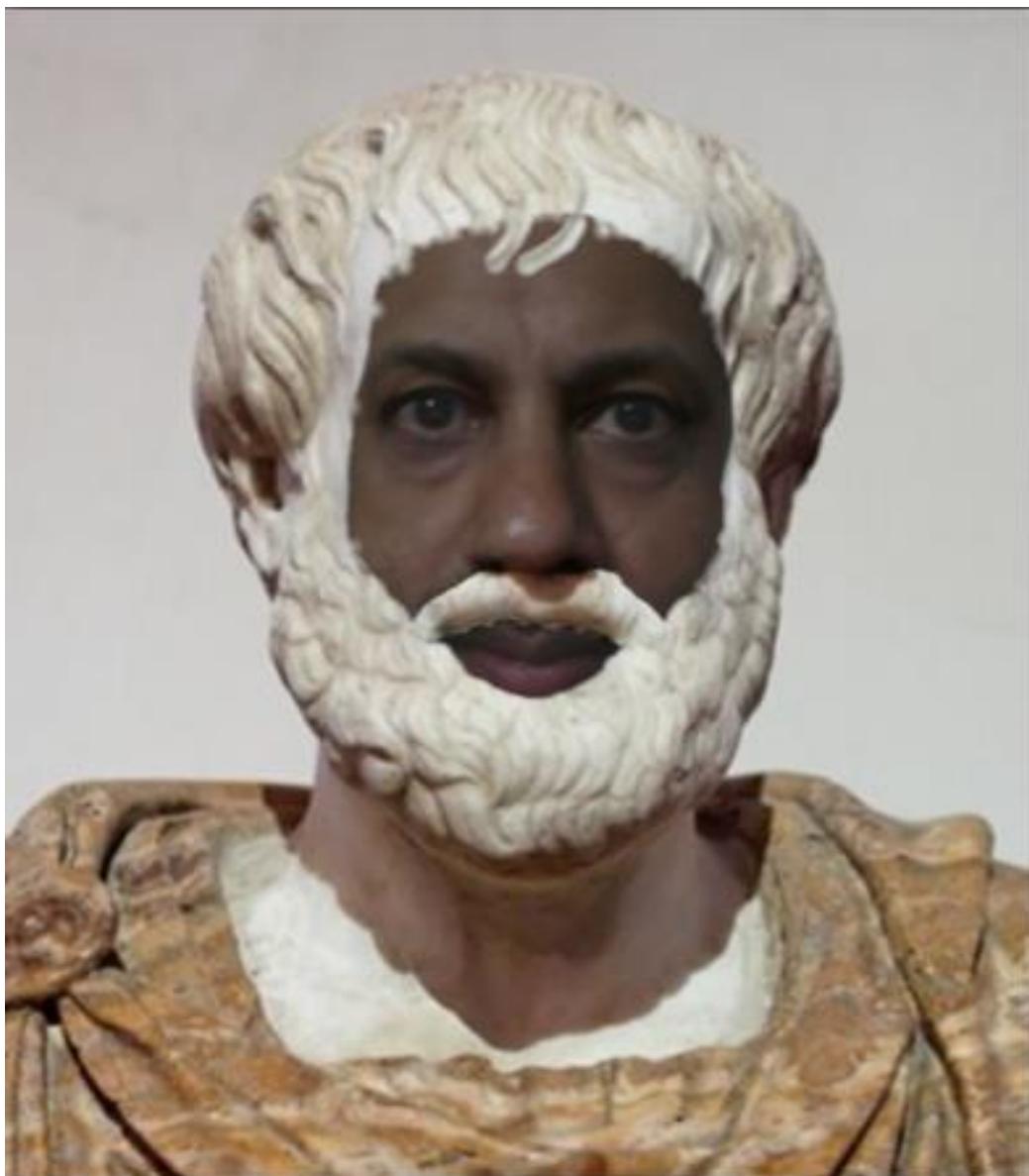


- ▶ A story arc consists of rising action and conflict, presented logically and fluently to lead to a conclusion.

Source: Data Storytelling: Using visualization to share the human impact of numbers, a Tableau Whitepaper, Jock Mackinlay, Robert Kosara and Michelle Wallace



How to Communicate Effectively



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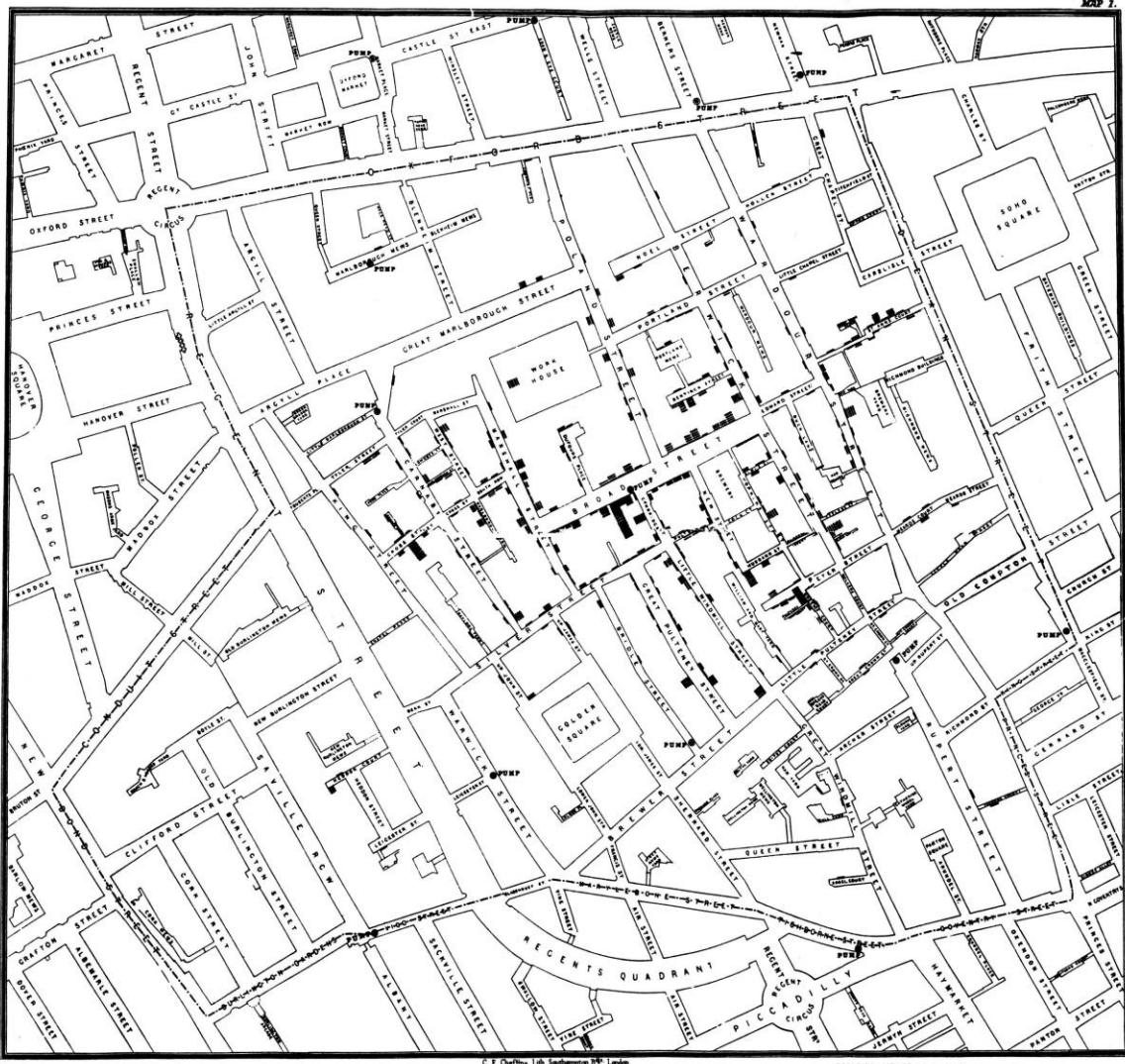
Circa 2012 AD: अरिस्टोलोहन्स pu> claimed that all stories have a beginning, middle, climax and an end, with seamless flow between them, and all related to each other with a focus on the big picture. **It still remains a revelation.**

अरिस्टोq Perfect, Safe, Unharmed
अरिस्टोq Evil

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How to Communicate Effectively



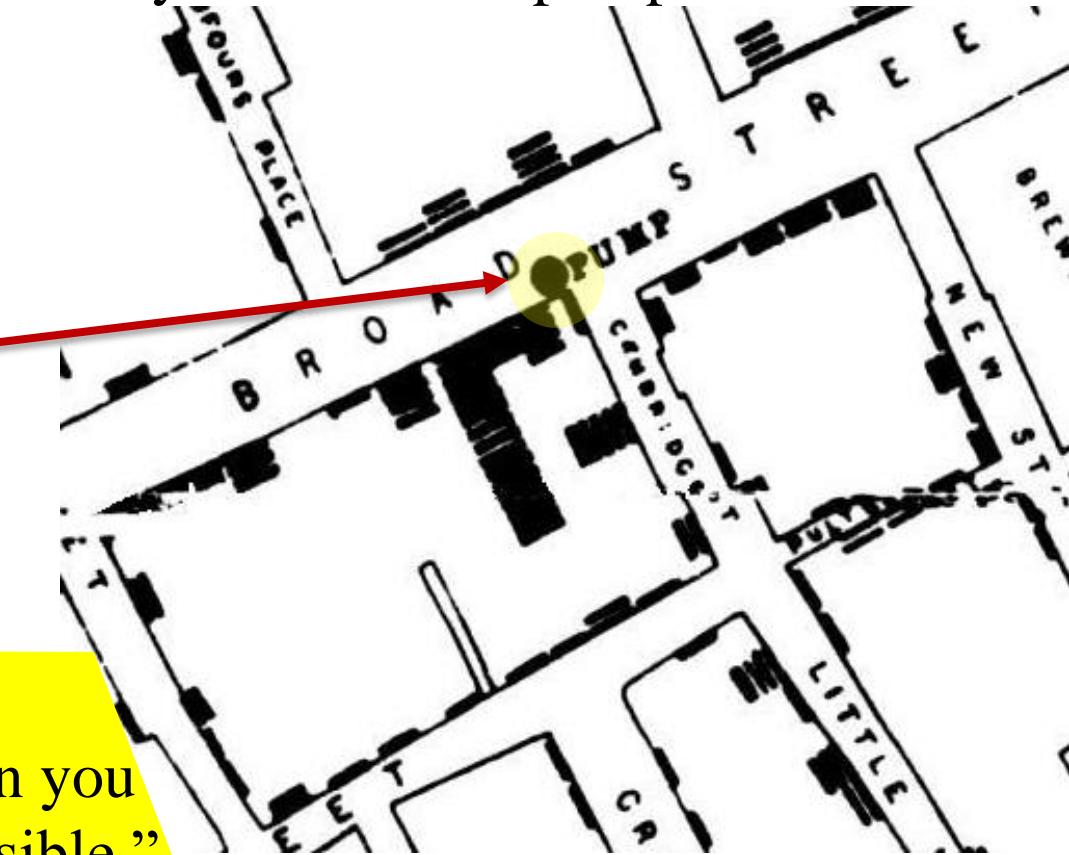
London 1854 Cholera Outbreak

Sources: Data Storytelling: Using visualization to share the human impact of numbers, a Tableau Whitepaper, Jock Mackinlay, Robert Kosara and Michelle Wallace; <https://upload.wikimedia.org/wikipedia/commons/2/27/Snow-cholera-map-1.jpg>; <http://www.ph.ucla.edu/epi/snow/broadstreetpump.html>

How to Communicate Effectively

Dr. John Snow's visualization of 1854 London cholera outbreak enabled city's leaders to immediately see an infected water pump in an area with no sewage system as the root cause. They immediately removed the pump handle.

The story arc establishes causality as human brain inherently starts connecting the dots.



“Data tells you what’s happening, and stories tell you why (it matters). When you put them together, great change is possible.”

Sources: <https://upload.wikimedia.org/wikipedia/commons/2/27/Snow-cholera-map-1.jpg>;
https://upload.wikimedia.org/wikipedia/commons/c/cb/John_Snow_memorial_and_pub.jpg

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How to Communicate Effectively

Now comment on what visualization might be better if the intended audience were the policy makers in the traffic department.

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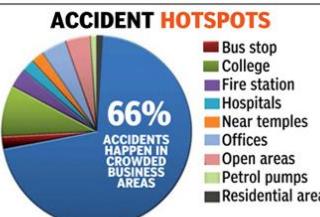
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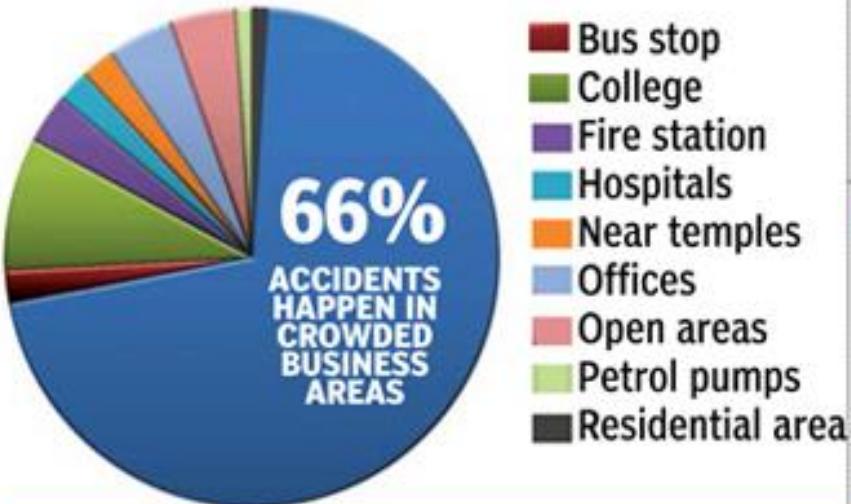
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ACCIDENT HOTSPOTS



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How to Communicate Effectively

The Visualizations that Launched a Company



Source: Good Charts: The HBR Guide to Making Smarter, More Persuasive Data Visualizations, Scott Berinato, Harvard Business School Publishing Corp, 2016

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Storytelling: A Great Art...





USA

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Source: <https://adland.tv/ooh/flags-meet-world>

Last accessed: October 3, 2016



ANGOLA

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Source: <https://adland.tv/ooh/flags-meet-world>

Last accessed: October 3, 2016



COLOMBIA

CSE 7120c



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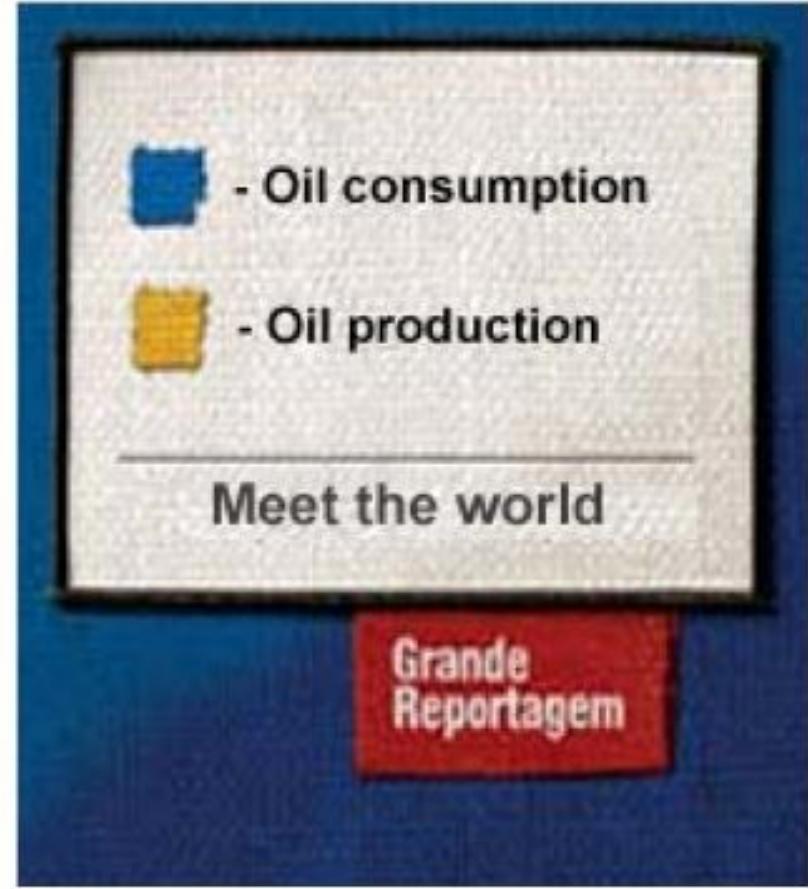
BRAZIL

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Source: <https://adland.tv/ooh/flags-meet-world>

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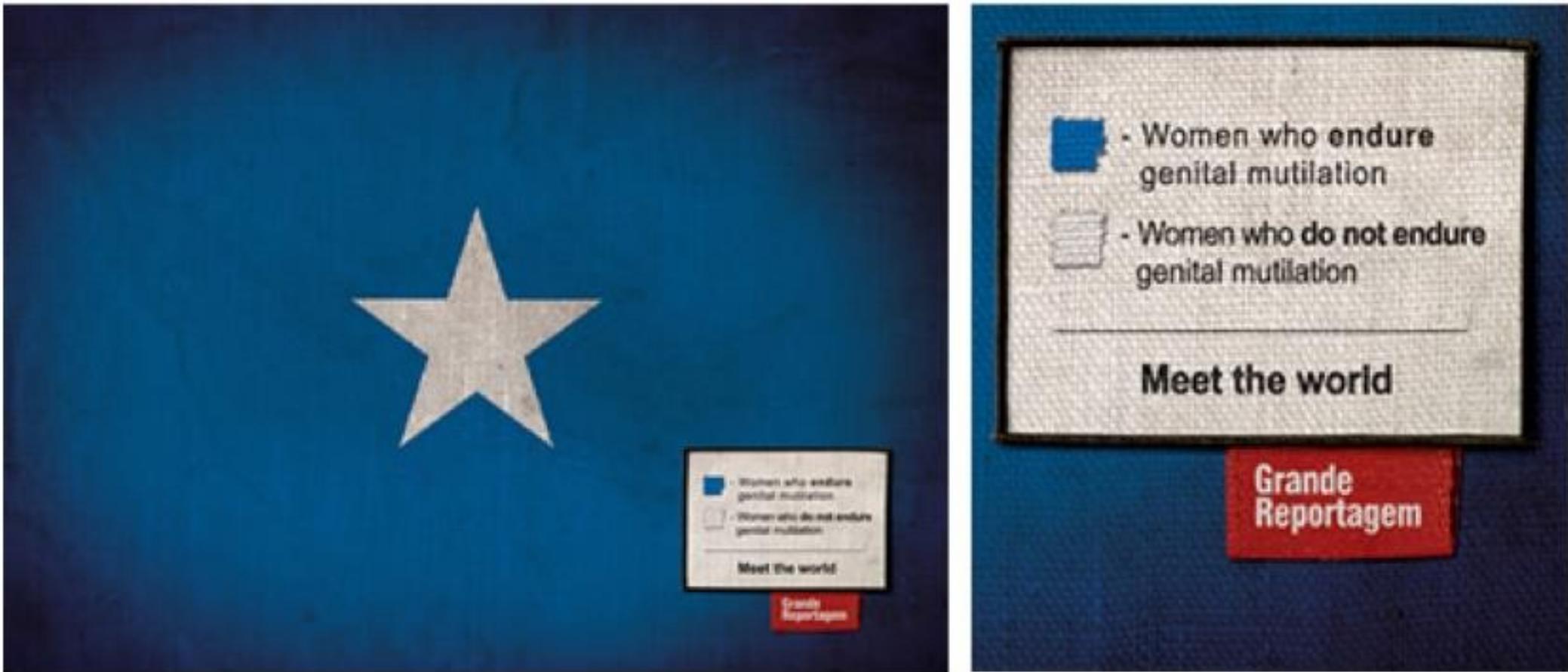


EUROPE

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Source: <https://adland.tv/ooh/flags-meet-world>

Last accessed: October 3, 2016



SOMALIA

Source: <https://adland.tv/ooh/flags-meet-world>

Last accessed: October 3, 2016



BURKINA FASO

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Source: <https://adland.tv/ooh/flags-meet-world>

Last accessed: October 3, 2016



CHINA

Source: <https://adland.tv/ooh/flags-meet-world>

Last accessed: October 3, 2016

 Submitted by AnonymousCoward (not verified) on 16. May 2005 - 19:48

Brilliant campaign. Doesn't matter if the 'figures' are accurate or not. The point is made.

Wish I'd done it.

 Submitted by Dabitch on 29. July 2013 - 5:00

Well, some don't find it so obvious: "Looking up those statistics does quickly bring some of these visuals into question though." They LOOKED IT UP!

The obvious idea wasn't obvious enough. One has to CHECK THE NUMBERS.

 Submitted by AnonymousCoward (not verified) on 29. July 2013 - 16:48

The inaccuracies matter because they perpetuate stereotypes and mislead. The Colombian flag perpetuates the notion that the number #1 Colombia export is cocaine. It isn't, petroleum is (twice as much petroleum as cocaine as a matter of fact).

This stuff then gets to uniformed Americans that proceed to vote for Pro-Drug War candidates. So, no, this campaign does more harm than good.

PS. Colombia exports more flowers than bananas. So why choose bananas? Banana Republic?

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Storytelling: A Great Art... and Science



Hans Rosling's TED Talk on Asia's Rise – How and When

[https://www.ted.com/talks/hans rosling
asia s rise how and when?language=en#t-691661](https://www.ted.com/talks/hans_rosling_asia_s_rise_how_and_when?language=en#t-691661)

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Rest in Peace Hans Rosling



GAPMINDER WORLD

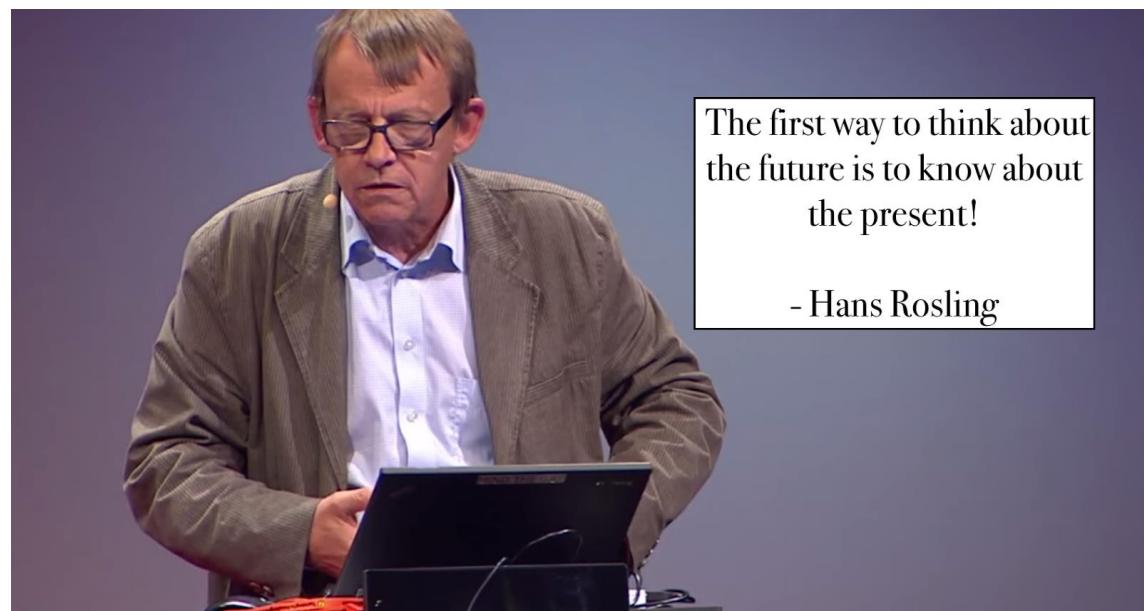
DOLLAR STREET

VIDEOS

DOWNLOADS

Sad to announce: Hans Rosling
passed away this morning

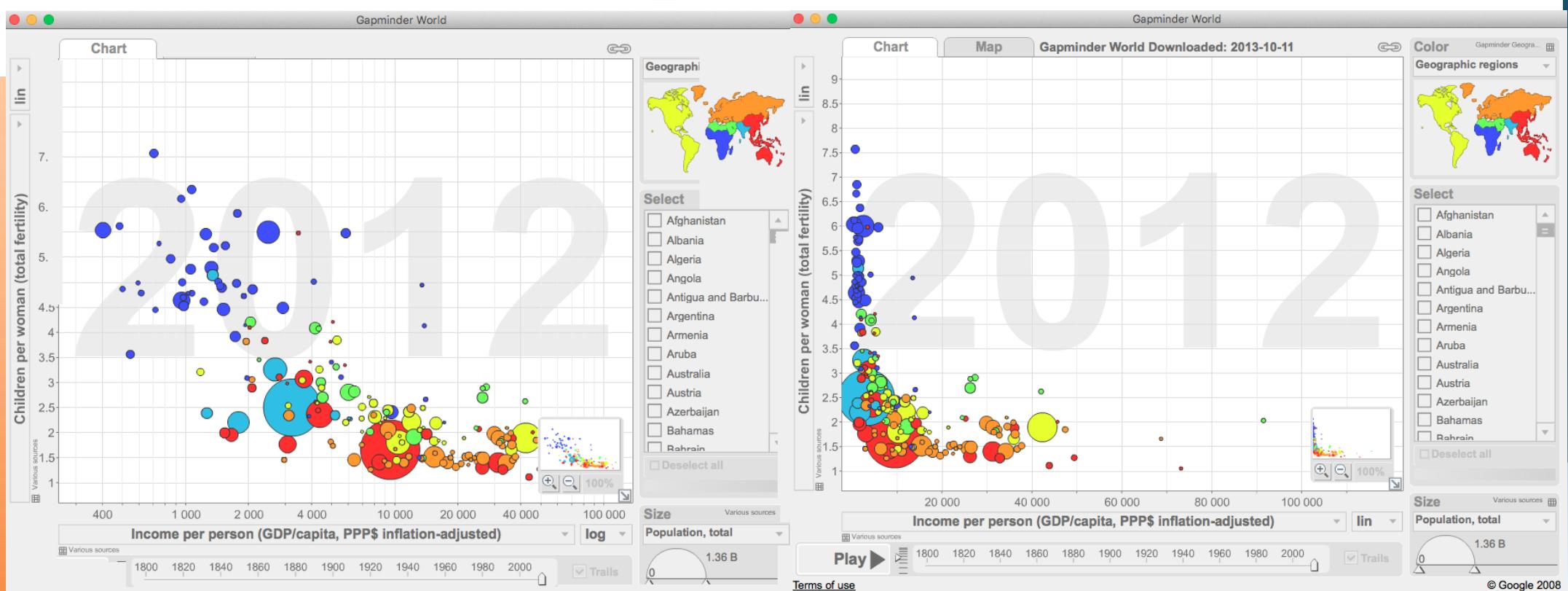
We are extremely sad to announce that Professor Hans Rosling died this morning. Hans suffered from a pancreatic cancer which was diagnosed one year ago. He passed away early Tuesday morning, February 7, 2017, surrounded by his family in Uppsala, Sweden.



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Watch your step scale



By the way, any comments on the usage of colour?



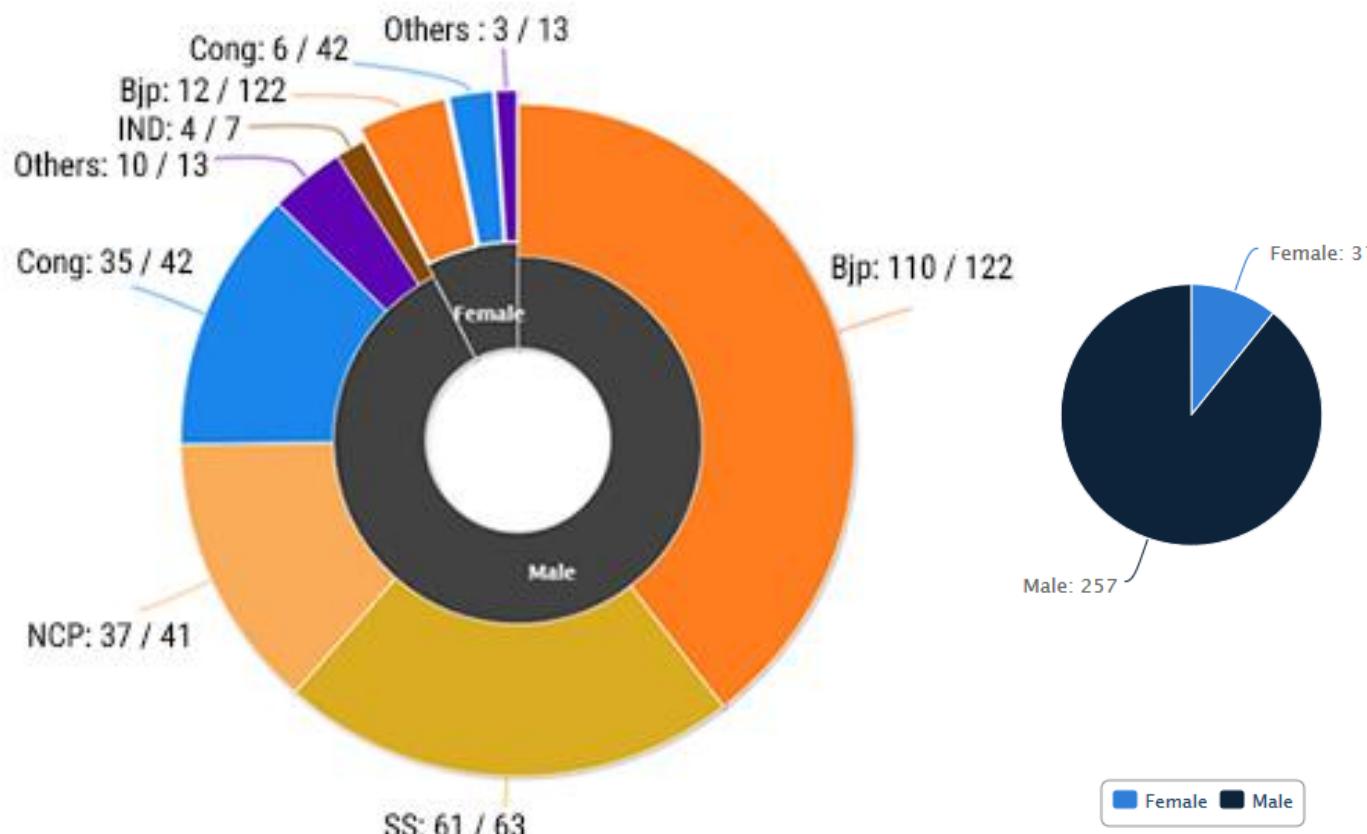
Communicating with Data

A FEW ISSUES

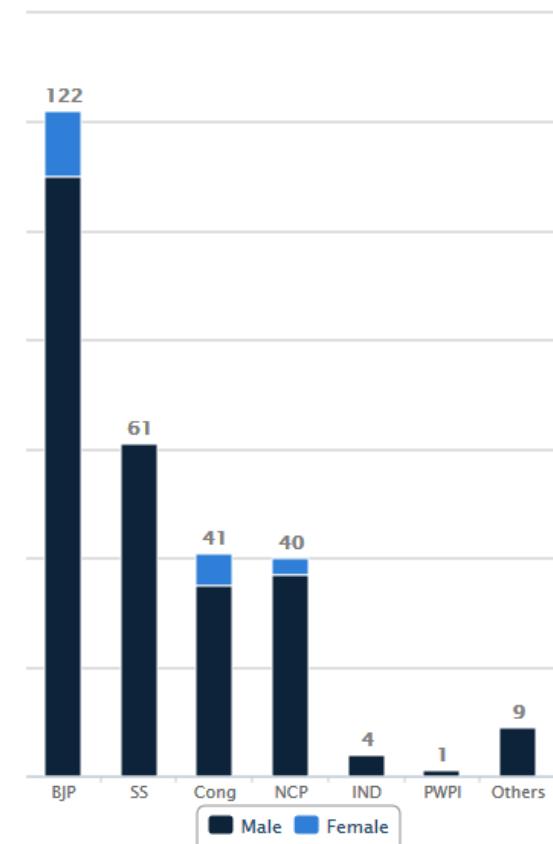


Data Quality Issues and Selecting the Right Chart

Maharashtra: Gender Break-up
Total MLAs: 288*



Maharashtra: Gender Break-up
Total MLAs: 288*



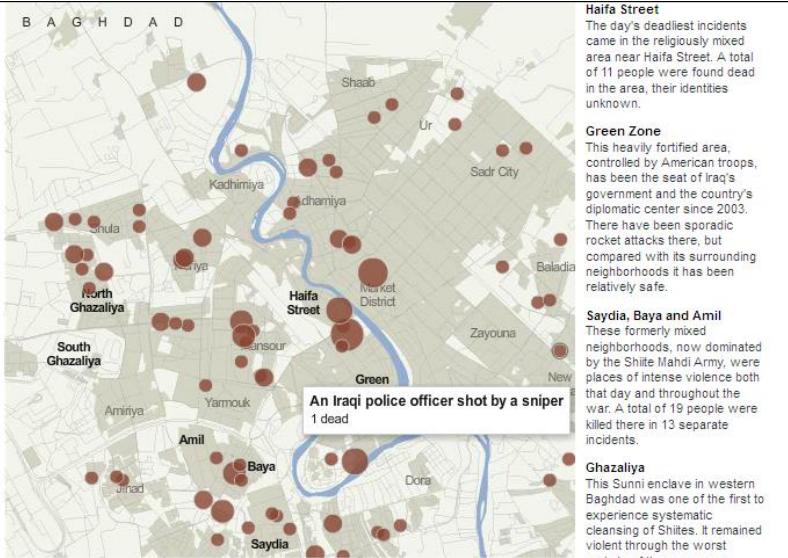
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Source: <http://www.ndtv.com/elections/assembly-cabinet/maharashtra>
Last accessed: October 24, 2014

Bad Data Visualization is worse than no visualization at all

A Deadly Day In Baghdad

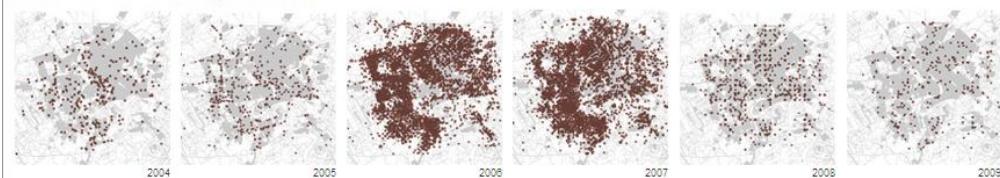
Violence peaked in December 2006, just two months before American troops arrived as part of what was later called "the surge." At right are the details of one of the city's deadliest days, Dec. 20. There were 114 separate episodes of violence that day, resulting in the deaths of about 160 Iraqi citizens and police officers.



Extreme Sectarian Violence in Baghdad

Secret military field reports reveal more than 32,000 deaths in the Baghdad area between 2004 and 2009. Many of the deaths were Iraqi civilians, although more than a third of the bodies were unidentified. Violence exploded in 2006 and early 2007, with more than 2,700 deaths in Baghdad in December 2006, the most of any month.

Locations of fatalities in Baghdad, 2004-9



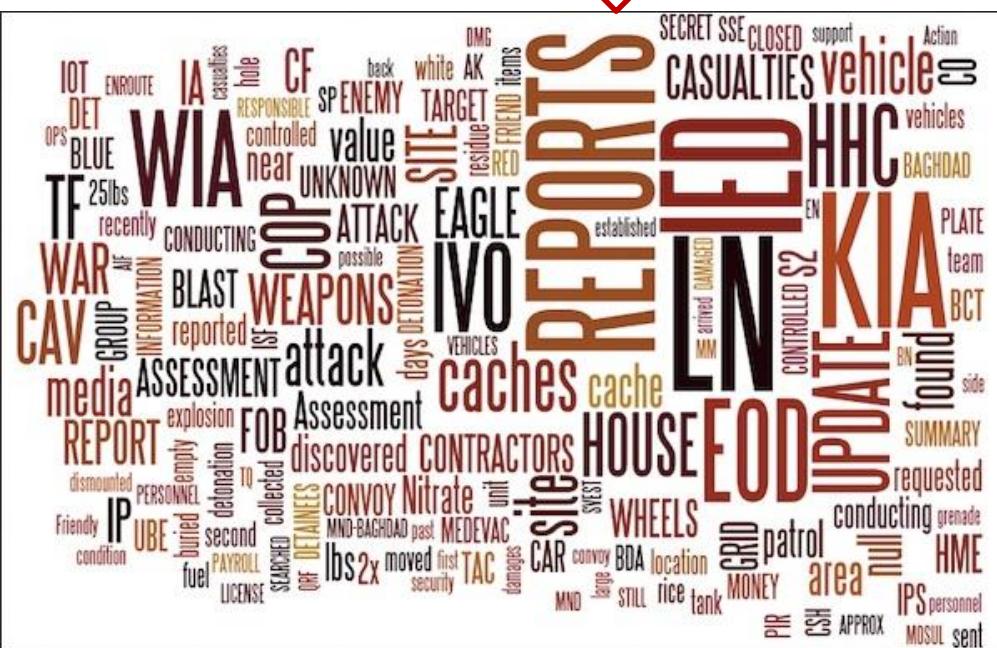
BY JACOB HARRIS, KEVIN QUEALY, SABRINA TAVERNIER and ANDREW W. LEHREN/THE NEW YORK TIMES | [Send Feedback](#)

Same Data set

Ref: <http://www.niemanlab.org/2011/10/word-clouds-considered-harmful/>

NY Times

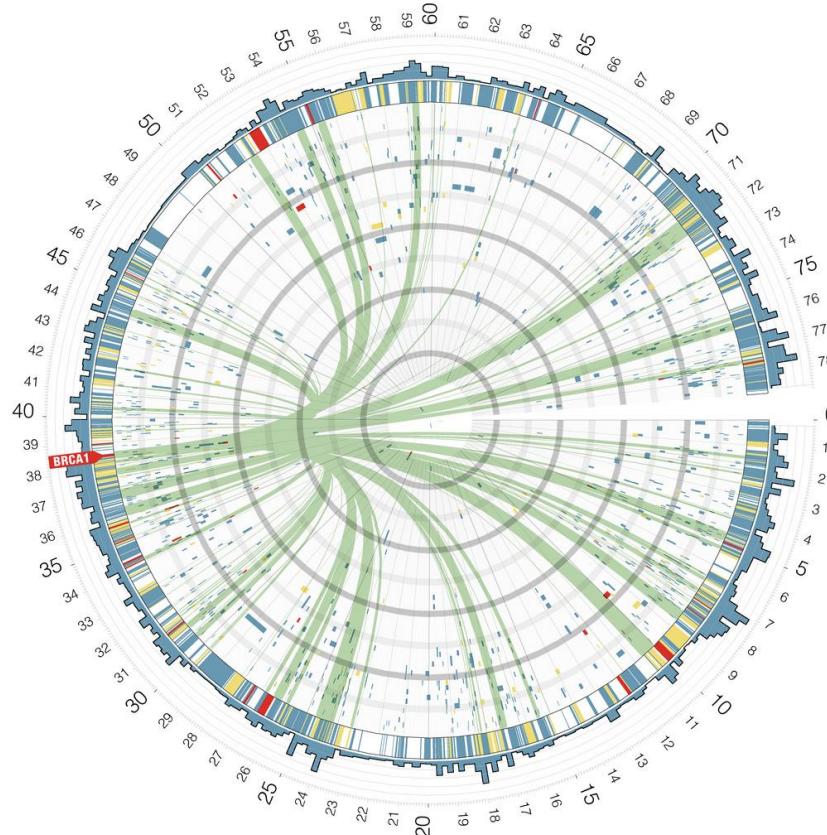
Fastcompany



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- Paul Hodge at eMetrics, Sydney, April 2013

Finding insights in data is useless if you are unable to communicate them



Source: <http://circos.ca/>

CSE 71206

Black box or complicated models are less likely to be successful than something your stakeholders can understand - EXPLICABILITY

Communicating with Data

GUIDING PRINCIPLES



Guiding Principles

- Clarity
- Transparency
- Integrity

<http://www.analytics-magazine.org/july-august-2013/836-fundamental-principles-of-analytic-communication>

CSE 7120c



Clarity

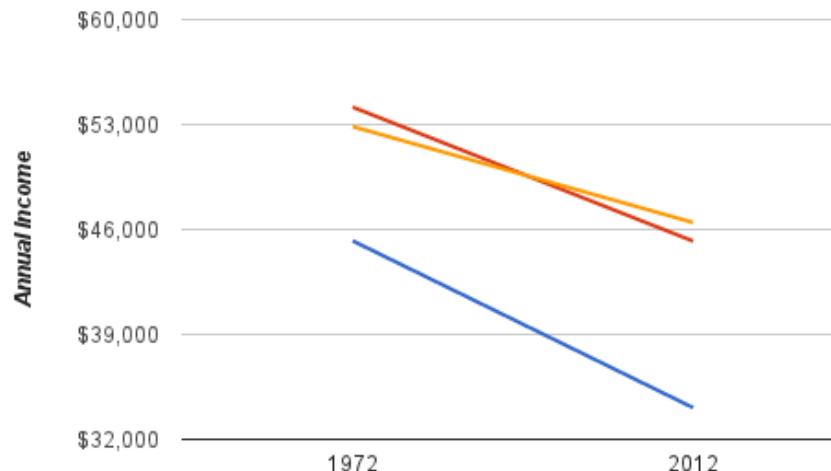
- Keep it Simple and Direct.
- Highlight key idea.
- Simplify but do not oversimplify such that findings or key data features are lost.
- Everything you state should be linked to or leading to the central idea. Remove everything else.

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Clarity (Do Not Oversimplify)

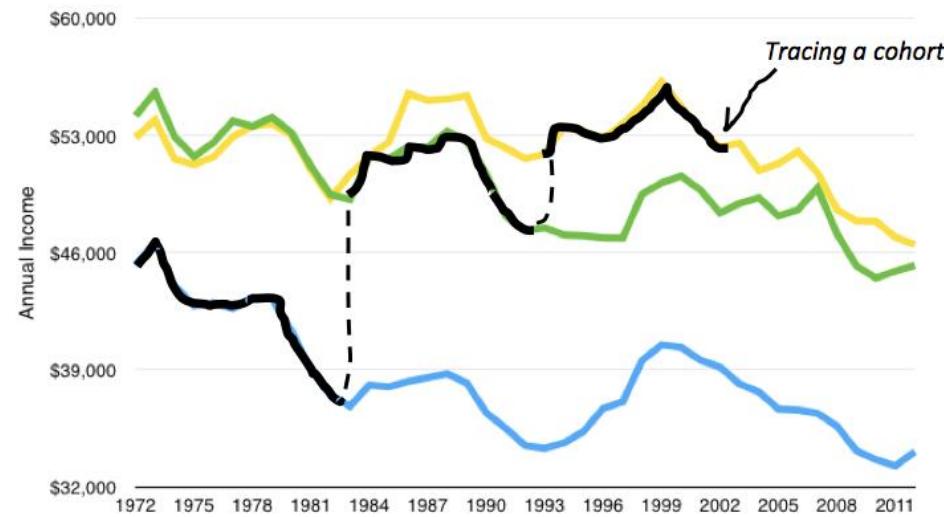
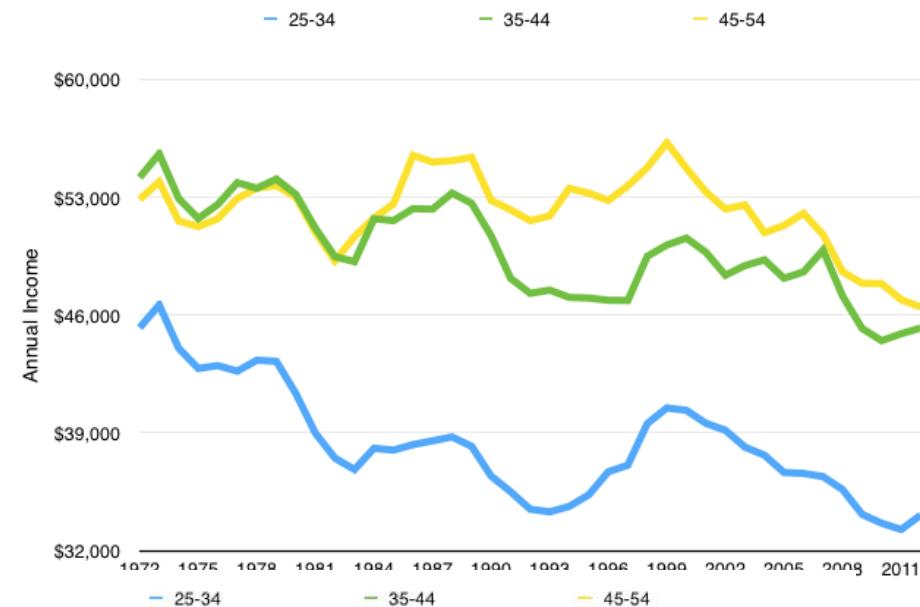
The Great Retrenchment



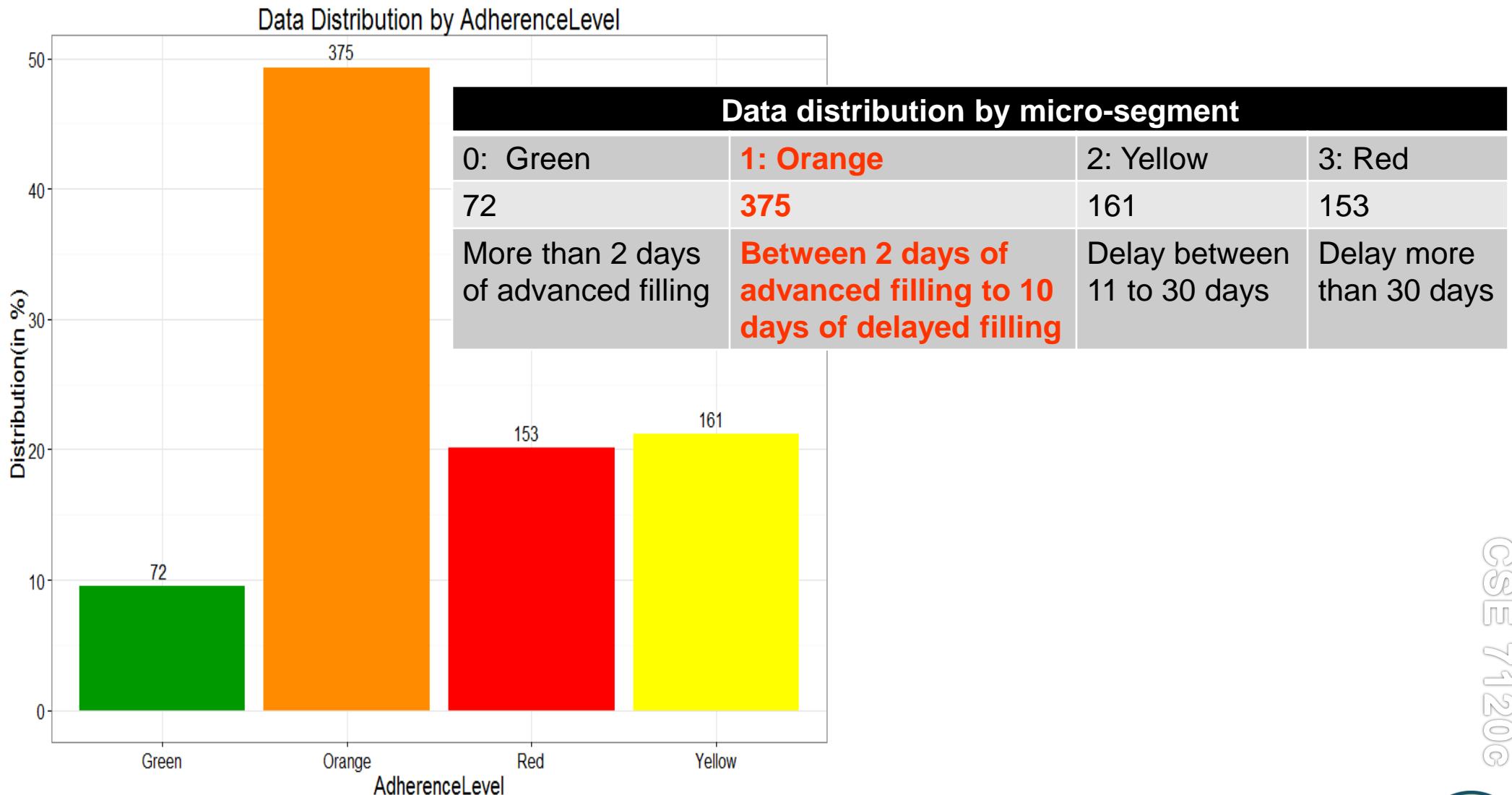
Median Income for U.S. Men by Age, in 2012 Dollars. Source: U.S. Census Bureau

http://junkcharts.typepad.com/junk_charts/2014/02/applying-numbersense-to-a-bloomberg-report.html and
http://junkcharts.typepad.com/junk_charts/2014/02/a-deeper-look-at-the-bloomberg-report.html

Last accessed: Feb 15, 2014



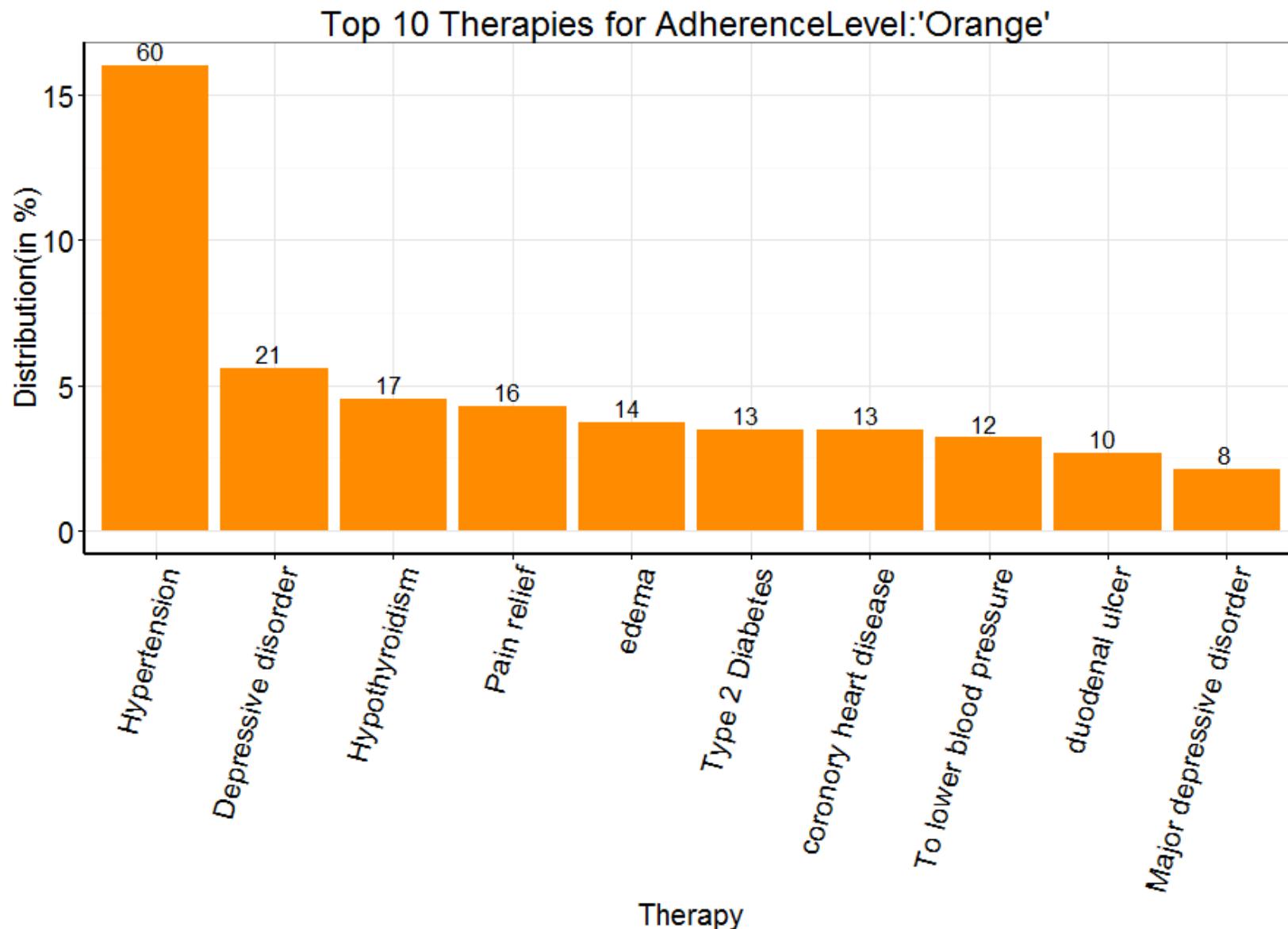
Clarity (Attention to Details)



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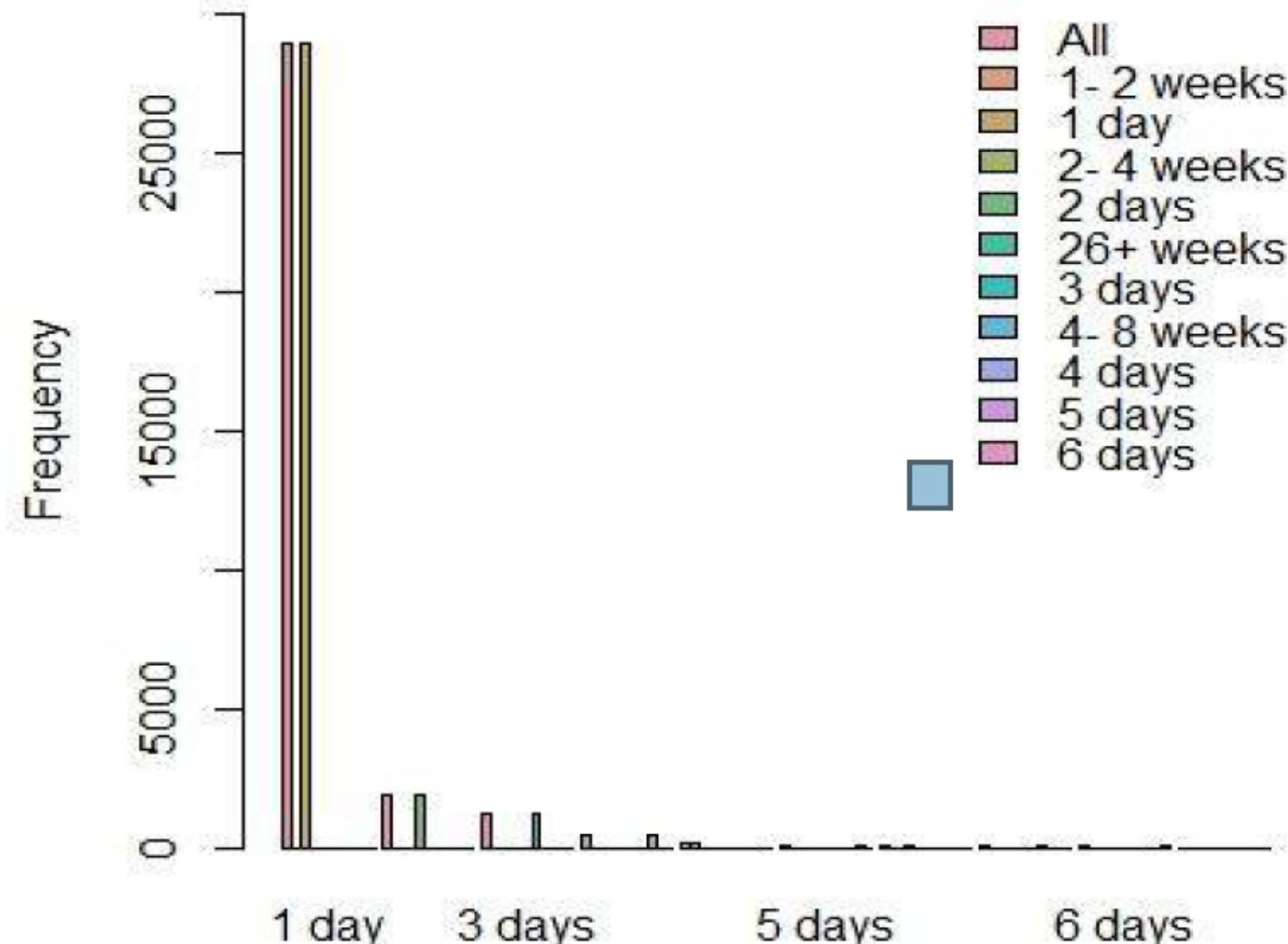


Clarity (Attention to Details)



Clarity (Attention to Details)

Distribution of LengthOfStay

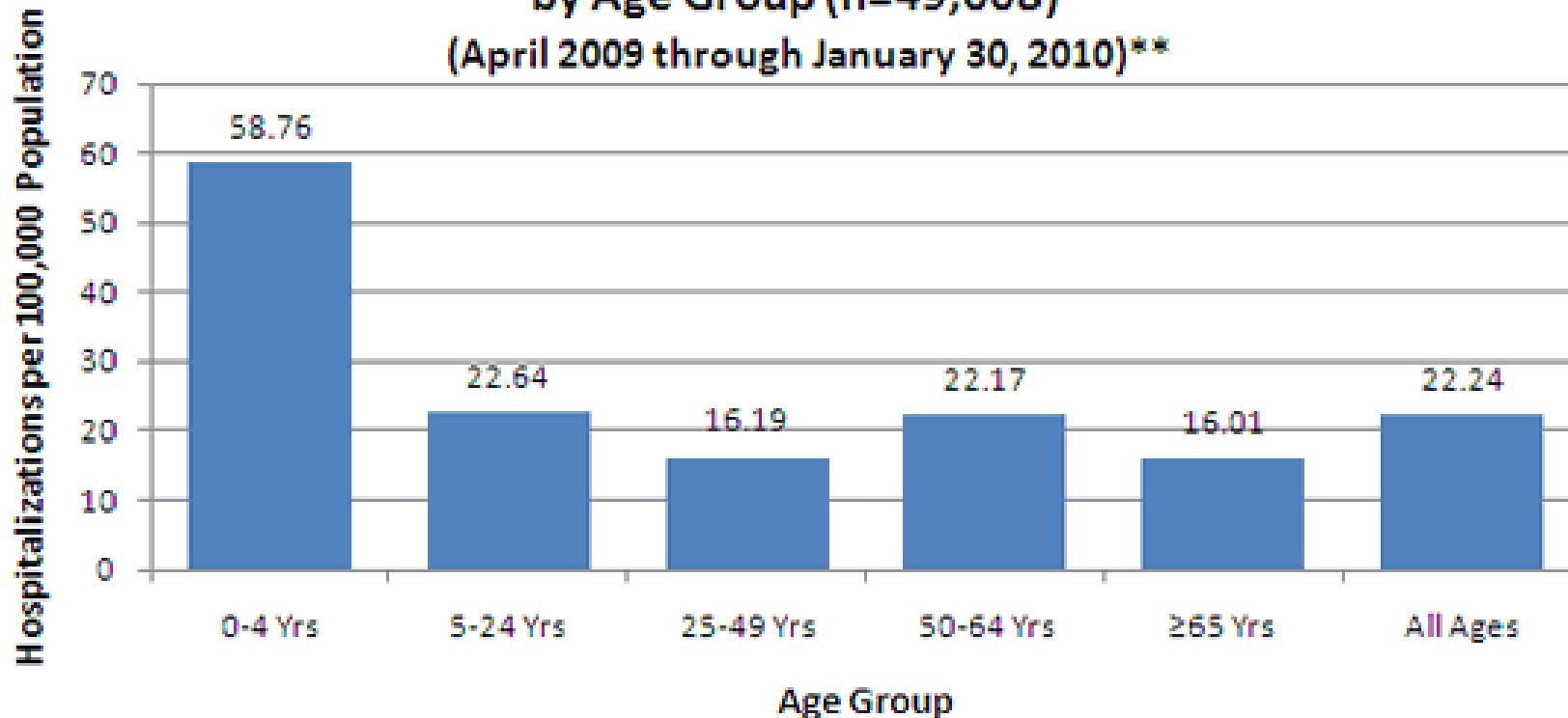


Clarity (Attention to Details)

Graph A: AHDRA

2009 H1N1 Cumulative Lab-Confirmed Hospitalization Rate
by Age Group (n=49,008)*

(April 2009 through January 30, 2010)**



*Hospitalizations with unknown ages are included (n=518) in All Ages rate.

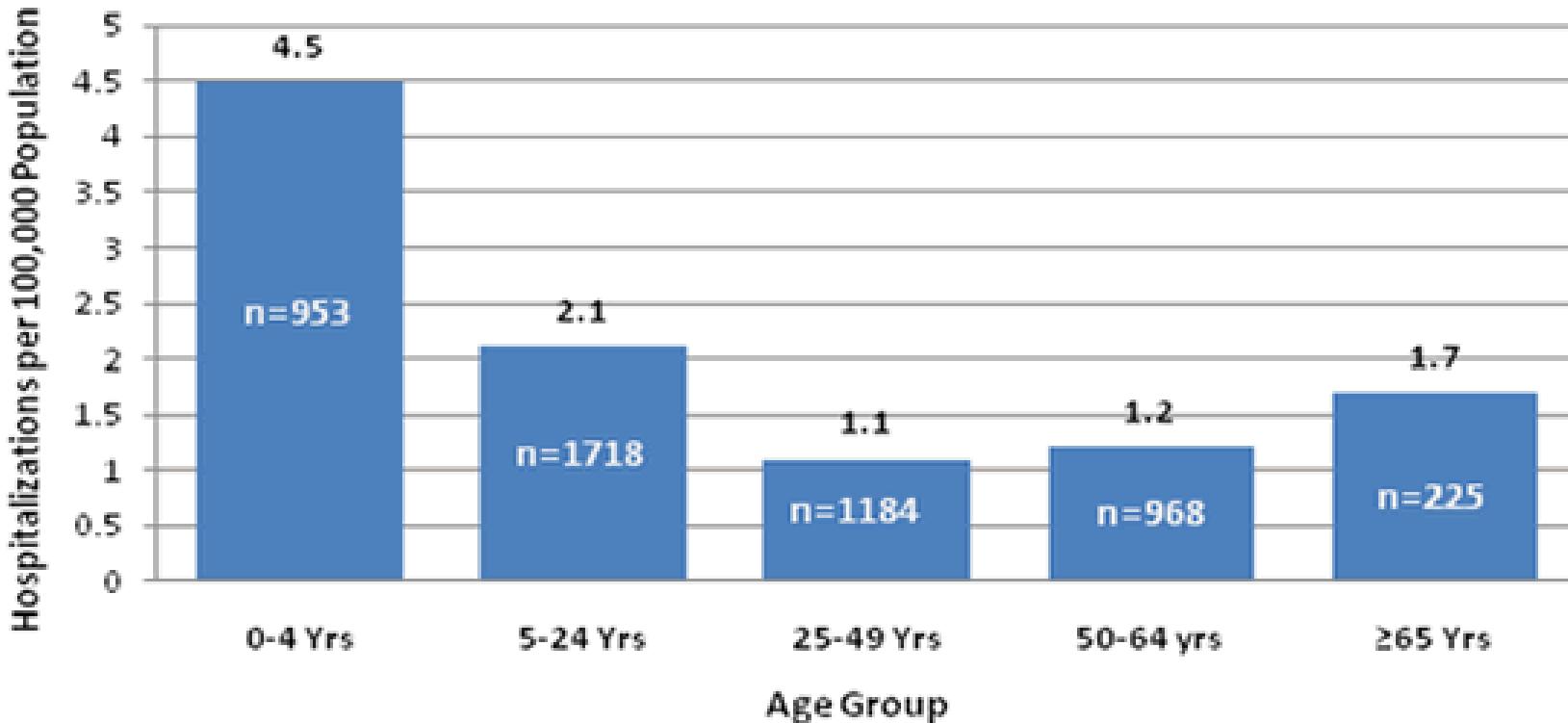
**Rate / 100,000 by Single Year Age Groups: Denominator source: 2008 Census Estimates, U.S. Census Bureau at: <http://www.census.gov/popest/national/asrh/files/NC-EST2007-ALLDATA-R-File24.csv>

Clarity (Attention to Details)

Graph B: 2009 H1N1 U.S. Hospitalization Rate by Age Group

(n=4,738)*

(April 15 - July 24, 2009)

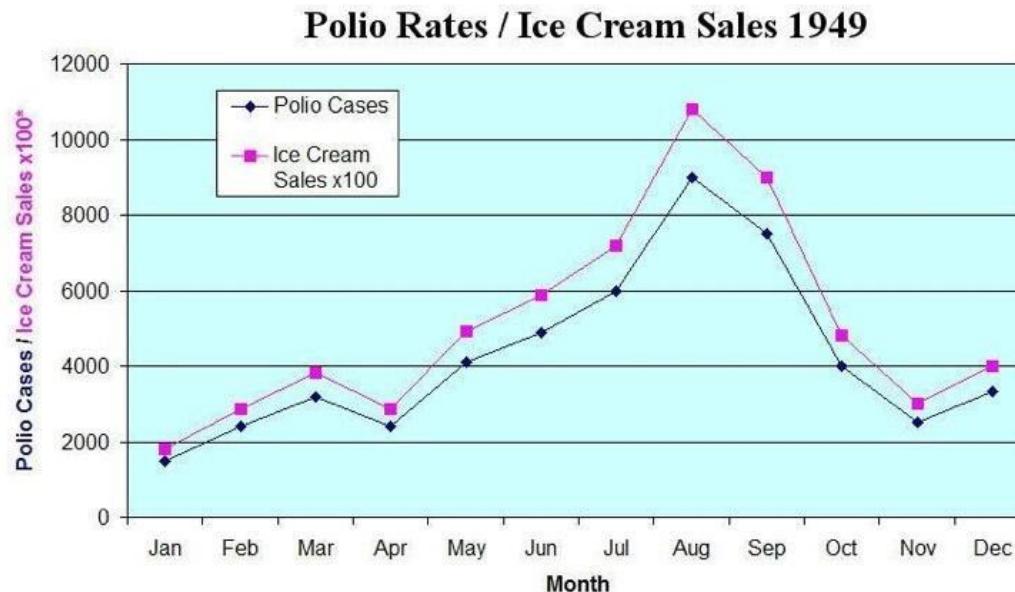


* Hospitalizations with unknown ages are not included (n=273).

* Rate /100,000 by Single Year Age Groups: Denominator source: 2008 Census Estimates, U.S. Census Bureau at: <http://www.census.gov/popest/national/asrh/files/NC-EST2007-ALldata-R-File24.csv>

Clarity (Attention to Details)

The Real Cause of Polio!



<http://www.nytimes.com/2009/08/06/technology/06stats.html>

* Ice cream sales for illustration purposes only



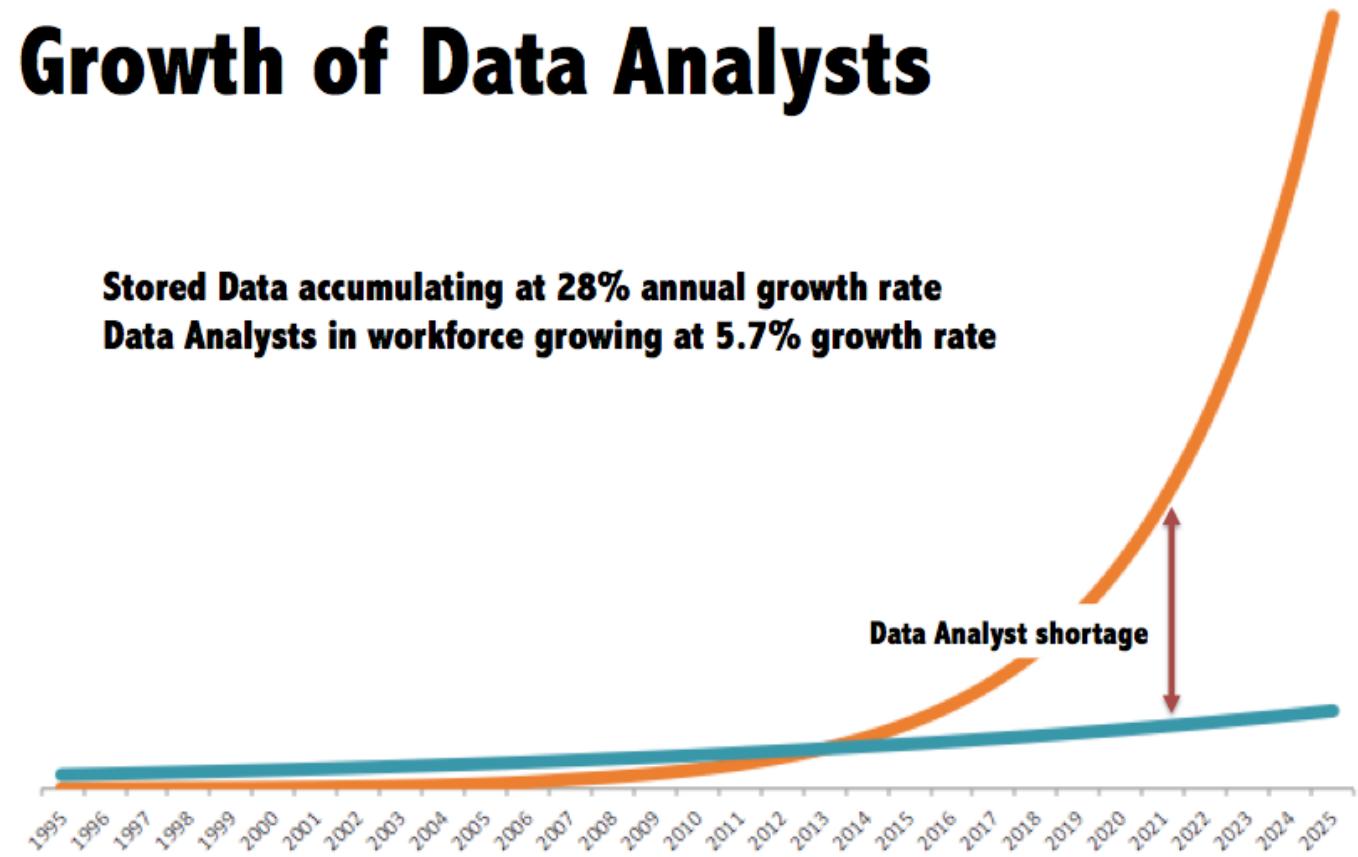
Source: <https://twitter.com/doctordoubter/status/438461856303177728/photo/1>
Last accessed: July 18, 2014



Transparency

- Explain methodology for deriving insights to appropriate depth.
- State assumptions underlying the analysis.

Growth of Data vs. Growth of Data Analysts



<http://www.delphianalytics.net/wp-content/uploads/2013/04/GrowthOfDataVsDataAnalysts.png>;
Last accessed: Feb 15, 2014

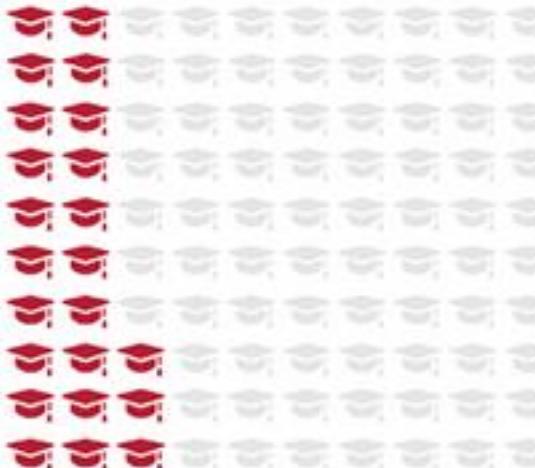
Transparency

“Today’s tight market for data science and analytics (DSA) skills involves data scientists, but it extends much further to existing job classifications from the C-suite to frontlines—all of which are increasingly enabled by analytics.

And when we look at the talent pool coming out of American colleges and universities, too few are likely have the skills employers are looking for.”

Data science and analytics skills, by 2021
How will employers fill the talent pipeline?

Student supply

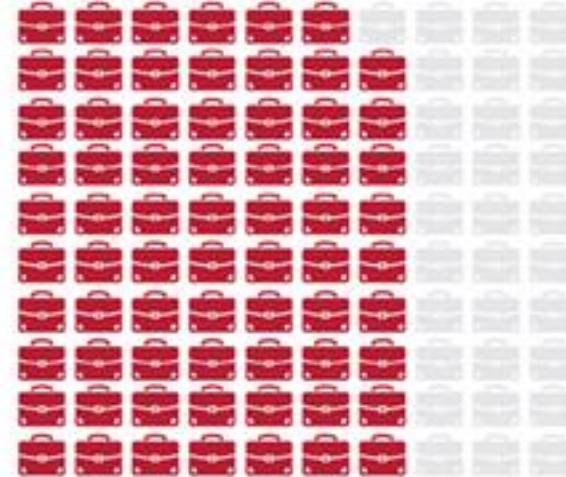


23% of educators say all graduates will have data science and analytics skills

Base: Higher education: 127; Business: 63

Source: Gallup and BHEF, Data Science and Analytics Higher Education Survey (December 2016).

Employer demand



69% of employers say they will prefer job candidates with these skills over ones without

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<http://www.pwc.com/us/dsa-skills>

Last accessed: Apr 11, 2017



Integrity

- Represent uncertainty and limitations accurately and honestly, because it is very common and tempting to exaggerate the implications of the data.
- Graphical excellence begins with telling the truth about the data.

- Edward Tufte, *The Visual Display of Quantitative Information*, 2001

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Integrity



<http://www.verticalmeasures.com/wordpress/wp-content/uploads/2013/11/Bad-Data-Size-Matters-In-Surveys.jpg>;
Last accessed: Feb 15, 2014



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Integrity

GAME THEORY

A look at what decides India-West Indies Twenty20 matches ahead of the semifinal

INDIA WINS EVERY TIME



When Virat Kohli bats at No. 3



When Badree's first three overs yield four boundaries

45

When it makes more than 45 in the PowerPlay



When West Indies is led by Darren Sammy

WEST INDIES WINS EVERY TIME



When Chris Gayle hits at least four fours

117

When two or more wickets fall in the PowerPlay



When it dismisses Rohit Sharma for 5



When it forces M.S. Dhoni out to bat

H2H: India 2, West Indies 2

GROUND REALITY: No one knows what's safe at the Wankhede. Targets of 183 and 230 have proven inadequate this tournament.

Average first-innings score

206.7

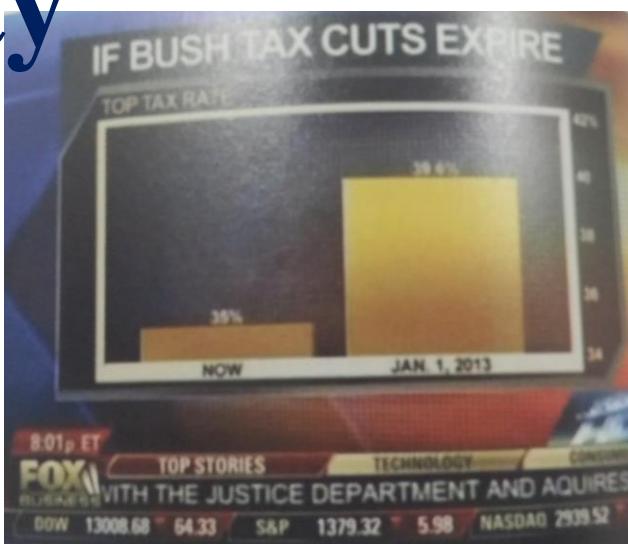
Average second-innings score

195

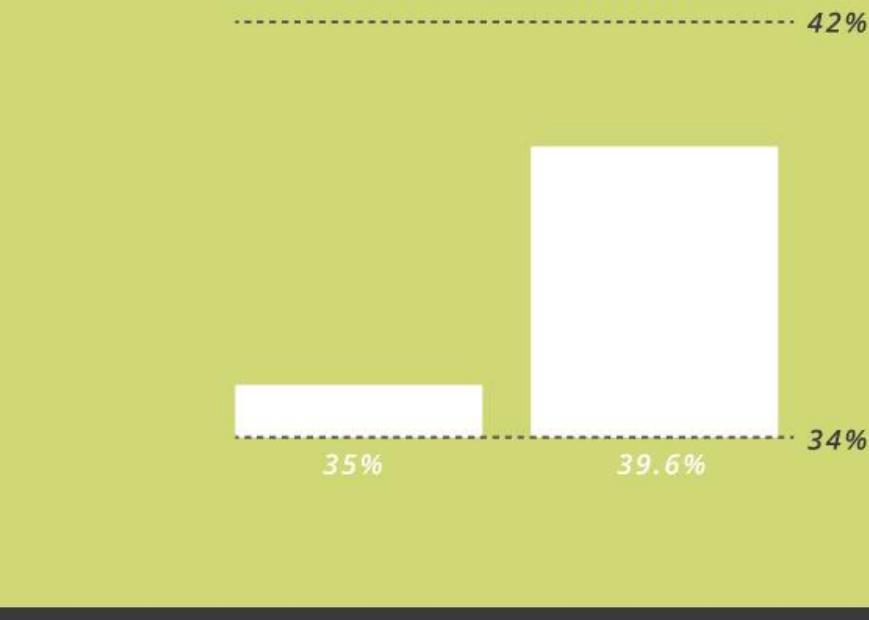
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Integrity



MISLEADING STATISTICS
THE TOP TAX RATE WILL SOON
SKYROCKET TO 39.6%



CONTENT SHOULD BE USEFUL, NOT JUST PRETTY
vert.ms/Baddata



Bar charts must have a
zero baseline



<http://www.verticalmeasures.com/wordpress/wp-content/uploads/2013/11/Skyrocketing-Tax-Rate-Increase.jpg>

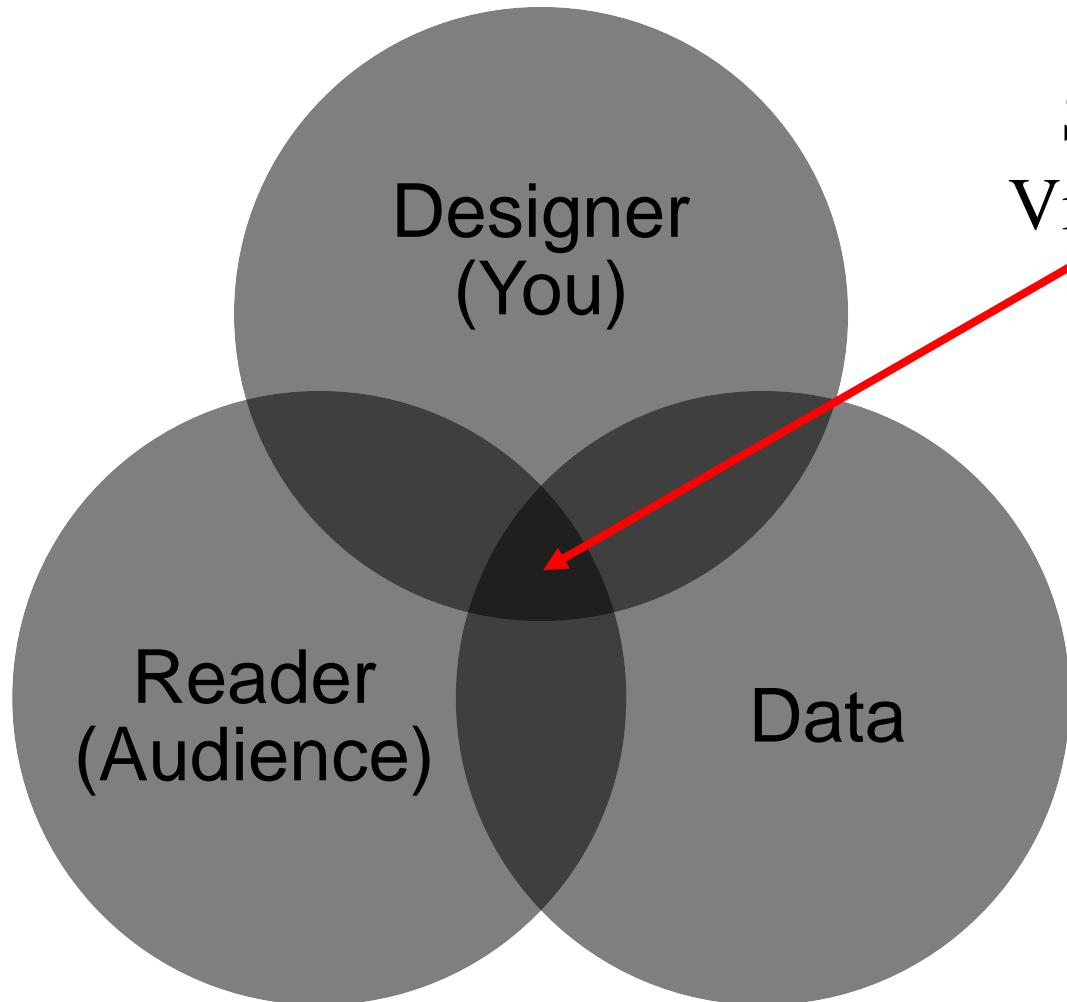
Last accessed: Feb 15, 2014

Communicating with Data

THE PRIMARY INGREDIENTS



The Key Ingredients



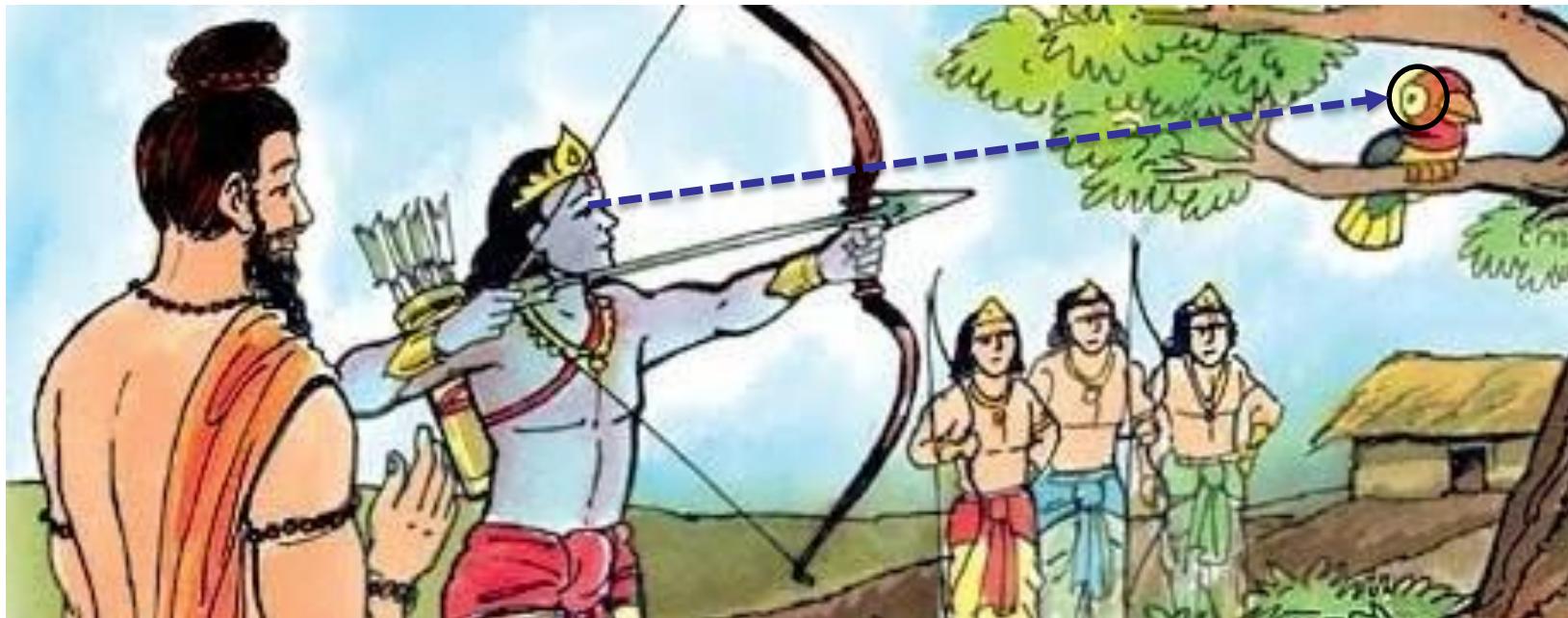
Successful
Visualizations

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Designer (You)

- What message are you trying to convey? As stated earlier, always focus on the big picture.
- Function first, suave second.



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Designer (You)

- Questions to ask:
 - What values or data dimensions are relevant in this context?
 - Which of these dimensions matter; matter most; and matter least?
 - What properties or values would make some individual data points more interesting than others?
 - What action might be taken once this information need is satisfied, and what values will justify that action?
- This will help state concisely the goal of visualization without getting into implementation details.

Designer (You)

Which of the below statements is better for planning visualizations?

Show the sales figures

✓ Show which product lines are performing best region-wise for each of the last 5 quarters

Create time series plots of region-wise sales for each of the last quarters



Designer (You)

Which of the below statements is better for planning visualizations?

Compare the demographics of Twitter and Facebook users

Build Box Plots to identify outliers in income levels of Twitter and Facebook users

✓ Compare the ages, education and income levels of Twitter and Facebook users



Designer (You)

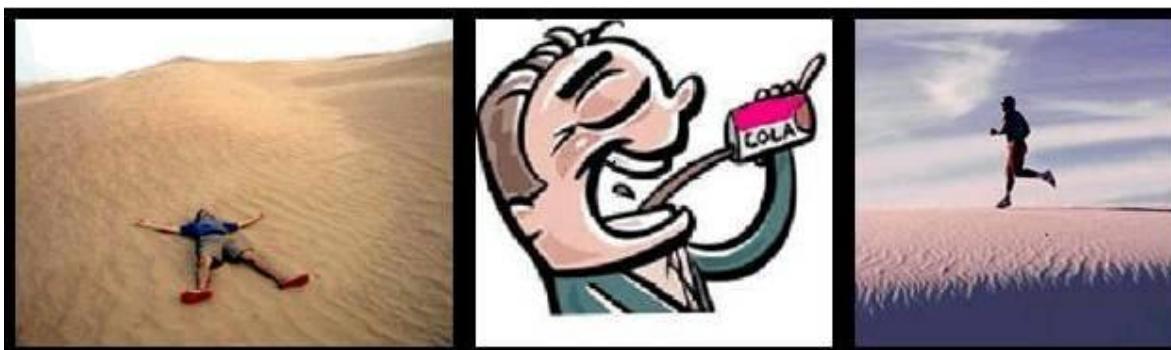
Which of the below statements is better for planning visualizations?

Show a timeline of every IPL team's performance in 2016

- ✓ Allow users to compare individual performance metrics for any pair of teams or for the entire league for the 2016 season

Reader (Audience)

- Put yourself in your audience's shoes. Don't create visualizations for yourself. What you understand may not be understood by your audience.
- Consider your audience's knowledge and needs.
- Consider social context:
 - What do colours mean?
 - Which direction is the reader used to reading in?



Reader (Audience)

- Simplify but not trivialize.
- How much detail is absolutely necessary?
 - Every encoding – labels, shading, colours, adding extra dimensions – must contribute directly to the main message



Brainpower used for decoding

Brainpower remaining
for understanding

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Data

- Different data require different types of visualizations.
- Questions to ask:
 - Is it a time series?
 - How many dimensions are there and which ones are important?
 - Is there one-to-one or one-to-many relationship between variables?
 - Are the values categorical or numerical? How many categories are present?
 - Are they discrete or continuous?
 - Is the data linear or non-linear?

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Communicating with Data

HOW TO PICK VISUAL ENCODINGS

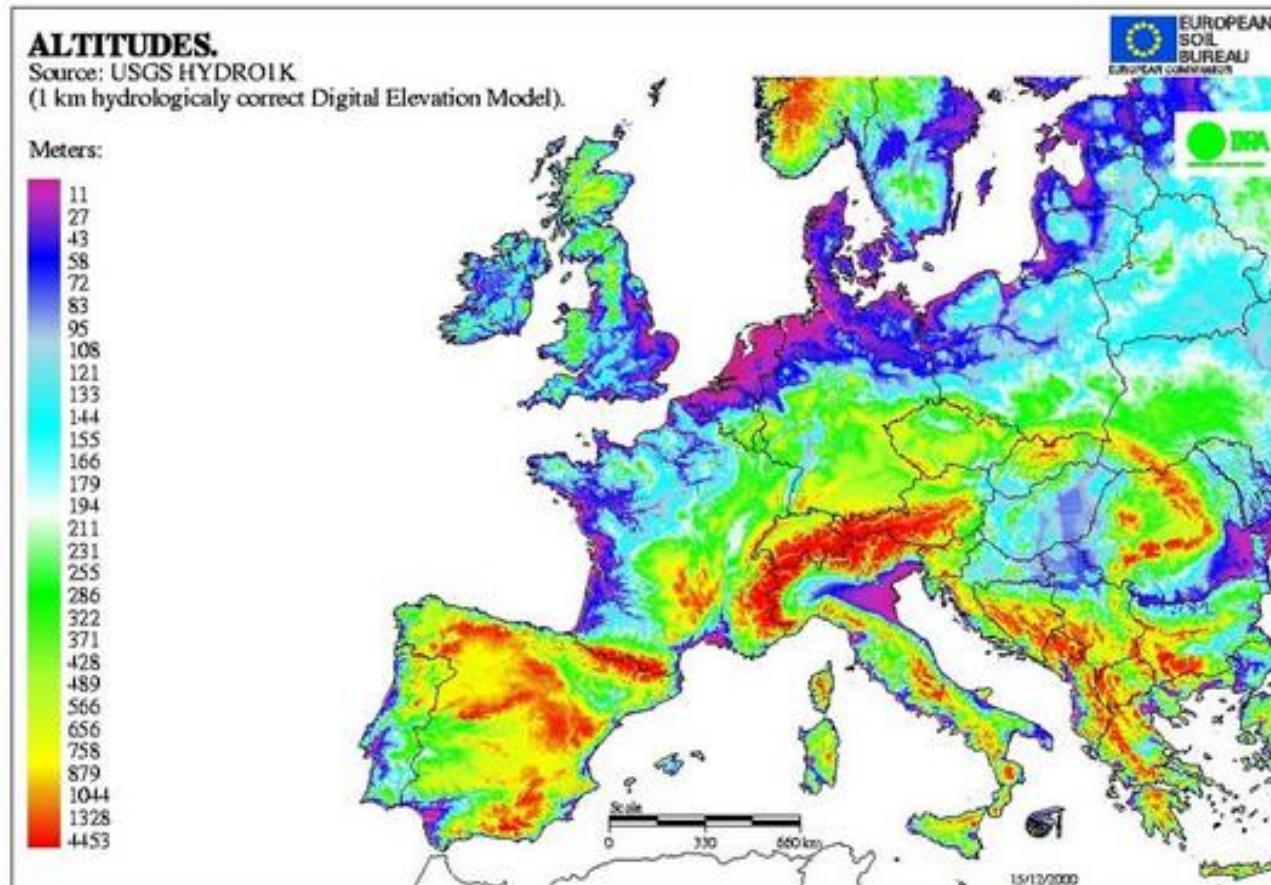


Selecting the Right Visual Encodings

- Types of visual encodings: Position, Shape, Text, etc.
- Two key factors
 - Natural Ordering
 - No. of Distinct Values of the property that readers can easily distinguish
- These properties help decide whether a visual property is best suited to one of the main data types:
Quantitative, Ordinal, Nominal or Relational

Selecting the Right Visual Encodings

Colour is not ordered (it is ordered by wavelength but not built into our brains) and is commonly misused.



Are Alps hotter than the rest of Europe?

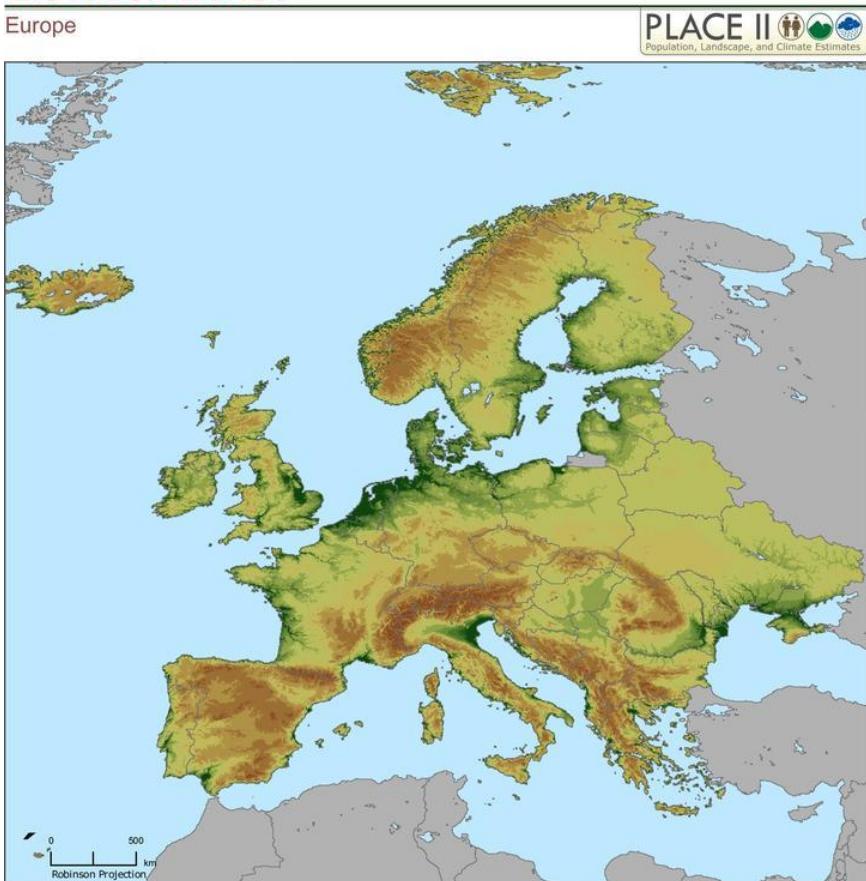
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Selecting the Right Visual Encodings

Elevation Zones

Europe



Digital elevation data (meters above mean sea level) were obtained as a 1 kilometer resolution elevation\bathymetry raster product from ISciences, L.L.C. Elevation zones were created by aggregating ranges of land elevation values into 12 thematic elevation classes. The 2004 ISciences data were resampled from their native 30 arc-second resolution to match GPW's population and land area 2.5 arc-minute spatial footprint. Source: ISciences, L.L.C., 300 N. Fifth Ave, Suite 120, Ann Arbor, MI 48104 <http://www.isciences.com/>.

CIESIN Copyright 2007. The Trustees of Columbia University in the City of New York. Source: Center for International Earth Science Information Network (CIESIN), Columbia University Population, Landscape, and Climate Estimates (PLACE). Further information available at: <http://sedac.ciesin.columbia.edu/place>

This document is licensed under a Creative Commons 2.5 Attribution License <http://creativecommons.org/licenses/by/2.5/>

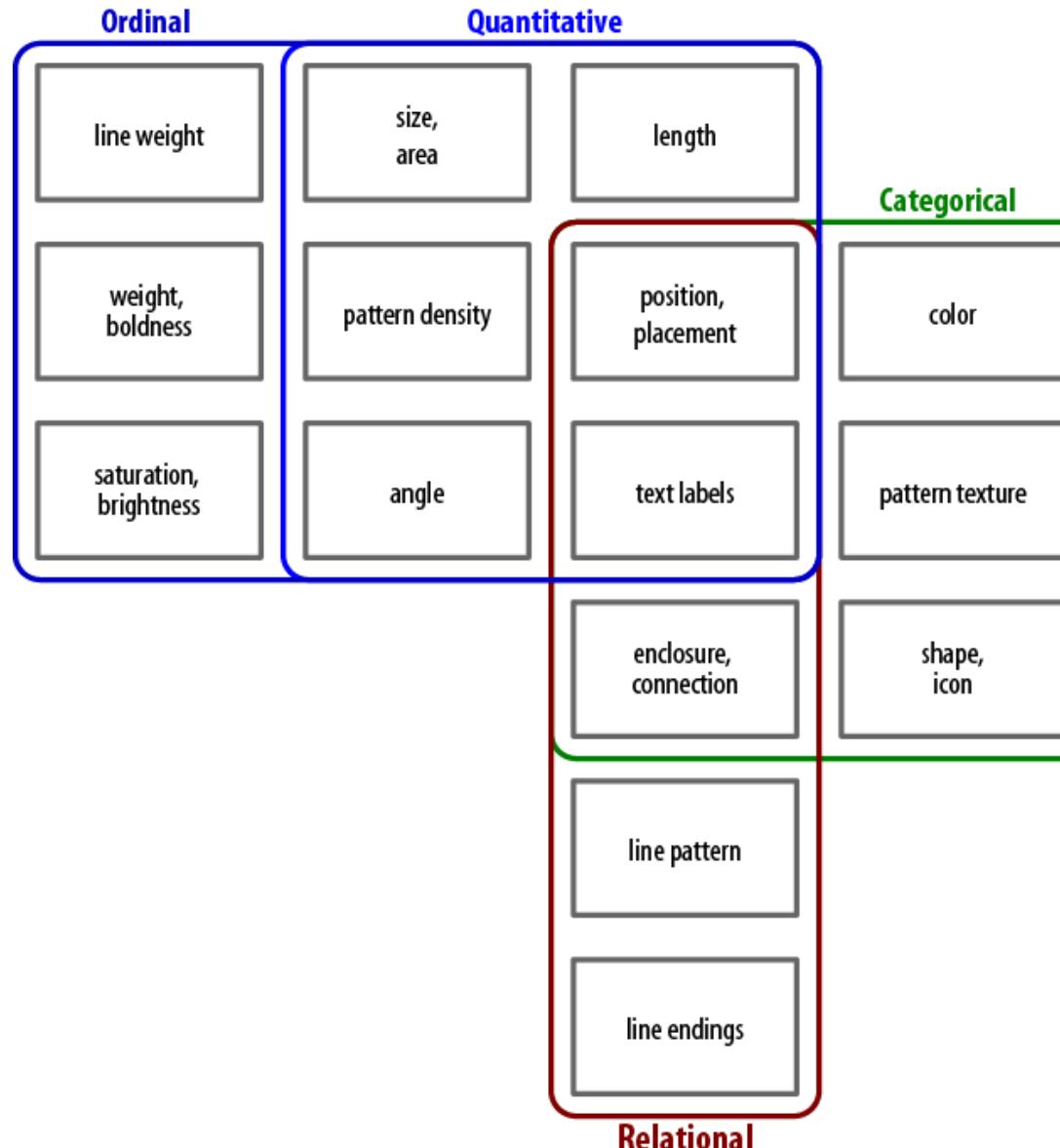
If colour must be used in ordered contexts (elevations, heat maps), consider varying brightness along one or two axes than using rainbow colours.

Here, colours diverge from one point, clearly indicating low, medium and high elevations.

Selecting the Right Visual Encodings

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		

Selecting the Right Visual Encodings

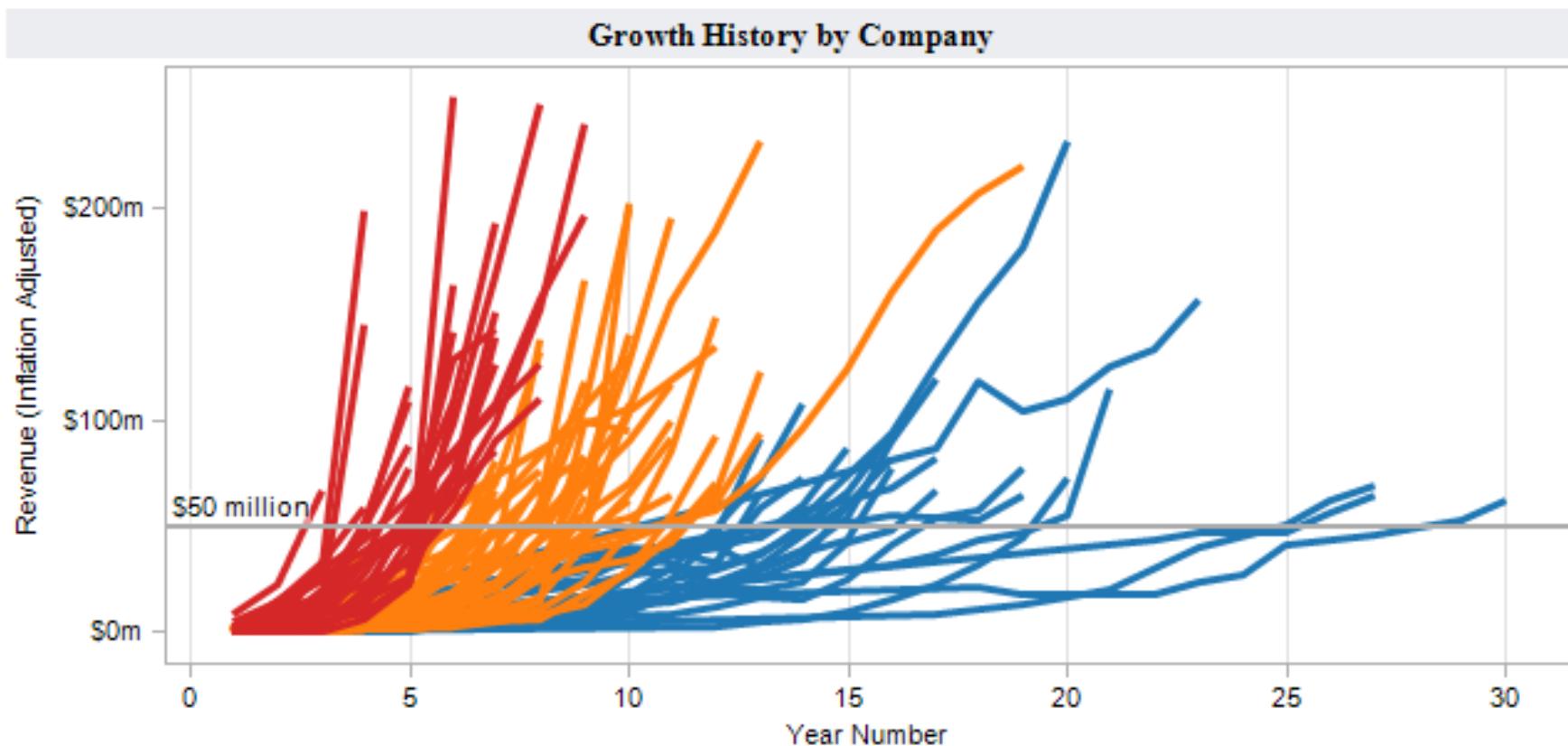


Selecting the Right Visual Encodings

Tale of 100 Entrepreneurs

Click to interact

■ Rocket Ship ■ Hot Company ■ Slow Burner



Selecting the Right Visual Encodings

Keep your core audience in mind always

Titles, tags and labels

- Is the reader from within your industry?
- Will a lay term suit better compared to an industry term?
- Consider spelling preferences of readers instead of making them lose focus due to spelling differences (colour, color)



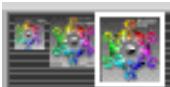
Selecting the Right Visual Encodings

Keep your core audience in mind always

Colours

- Consider cultural associations colours carry
- Choose colours friendly to those with colour-blindness:
 - <http://colorlab.wickline.org/colorblind/colorlab/>
 - <http://colorbrewer2.org/> (for maps)





Copyright © 1998, VisiBone International Color Laboratories



The 216-Color Webmaster's Palette

Color Simulation Controls (or switch to the [color selection controls](#))

Simulate colors as perceived by a user with

normal trichromatic color vision

✓ normal trichromatic color vision

protanopia red-green blindness (no red cones)

deutanopia red-green blindness (no green cones)

tritanopia blue-yellow blindness (no blue cones)

typical achromatopsia (no cones; rod monochromat)

protanomaly (anomalous red cones)

deutanomaly (anomalous green cones)

tritanomaly (anomalous blue cones)

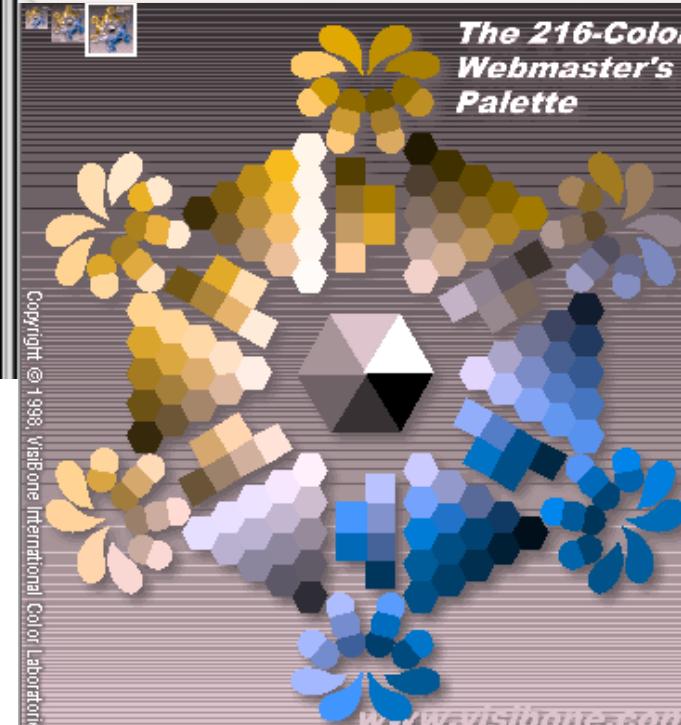
atypical achromatopsia (low cones; cone monochromat)

ess or [gamma values](#).)



The 216-Color Webmaster's Palette

Copyright © 1998 VisiBone International Color Laboratories



Color Simulation C (or switch to the [color sel](#))

Simulate colors as per

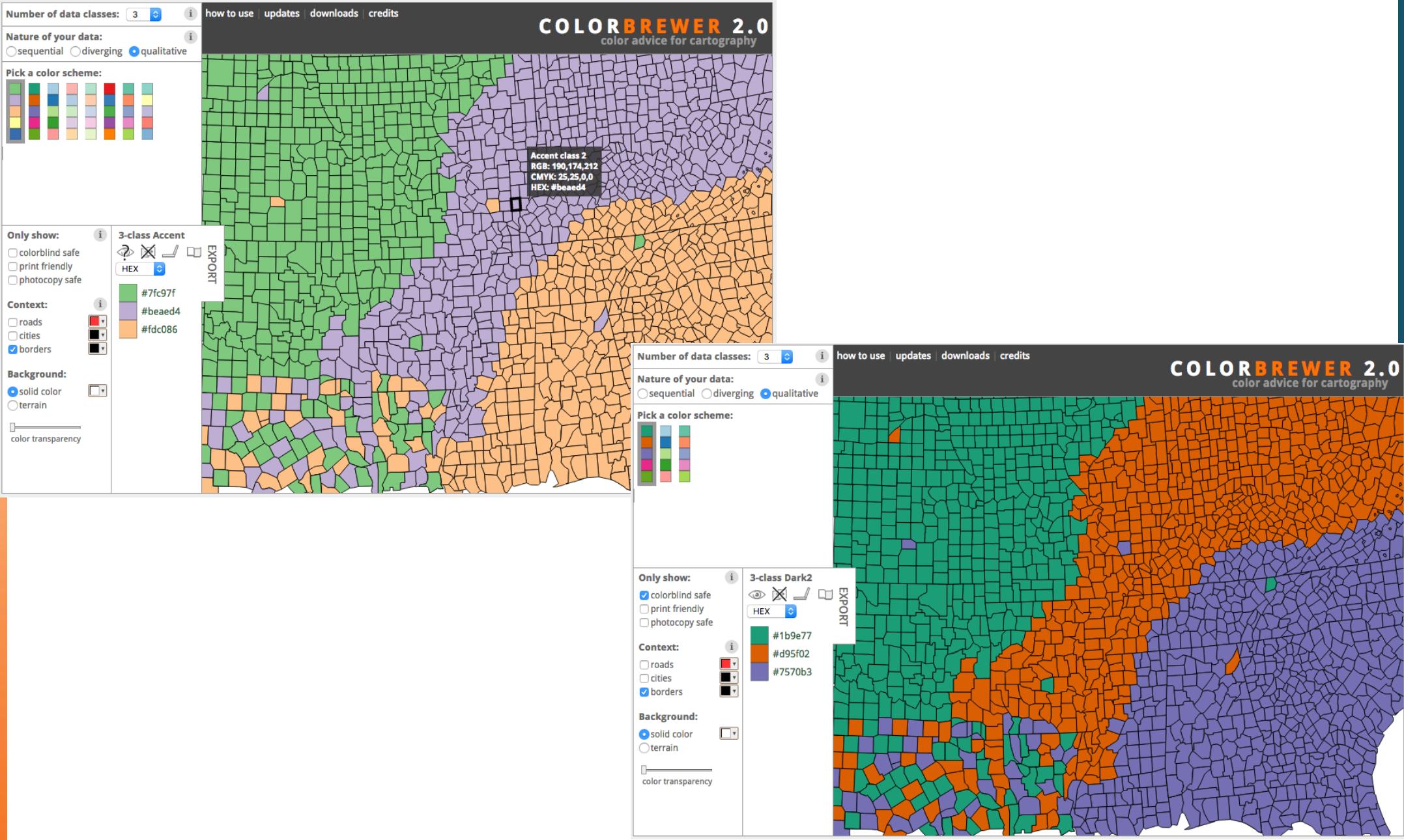
deutanopia red-green b
and a Mac col

[clear simulation setting](#)

(Open a new window wit

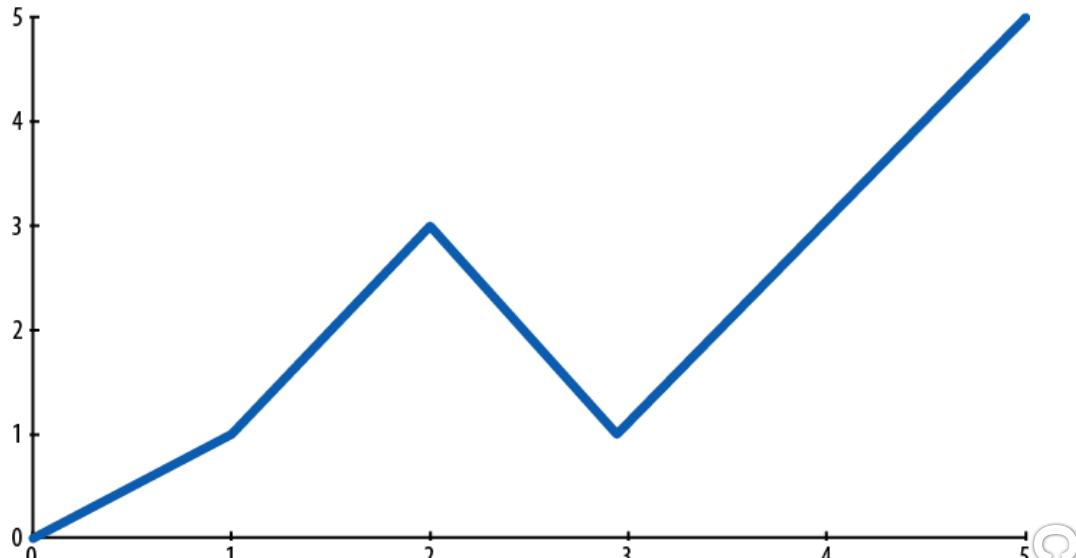
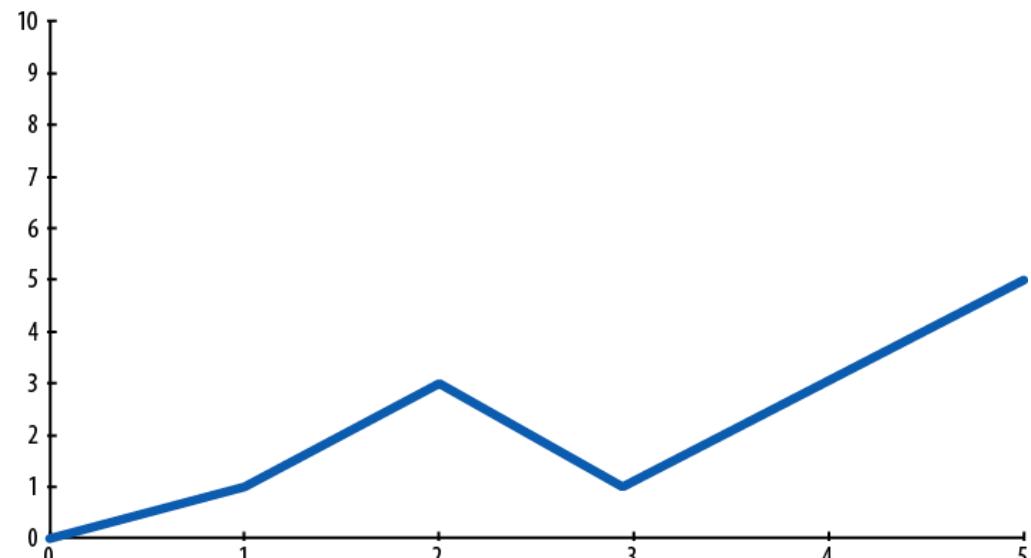


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Selecting the Right Visual Encodings

Comparisons should be done correctly



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Communicating with Data

WHICH CHART TO USE WHEN



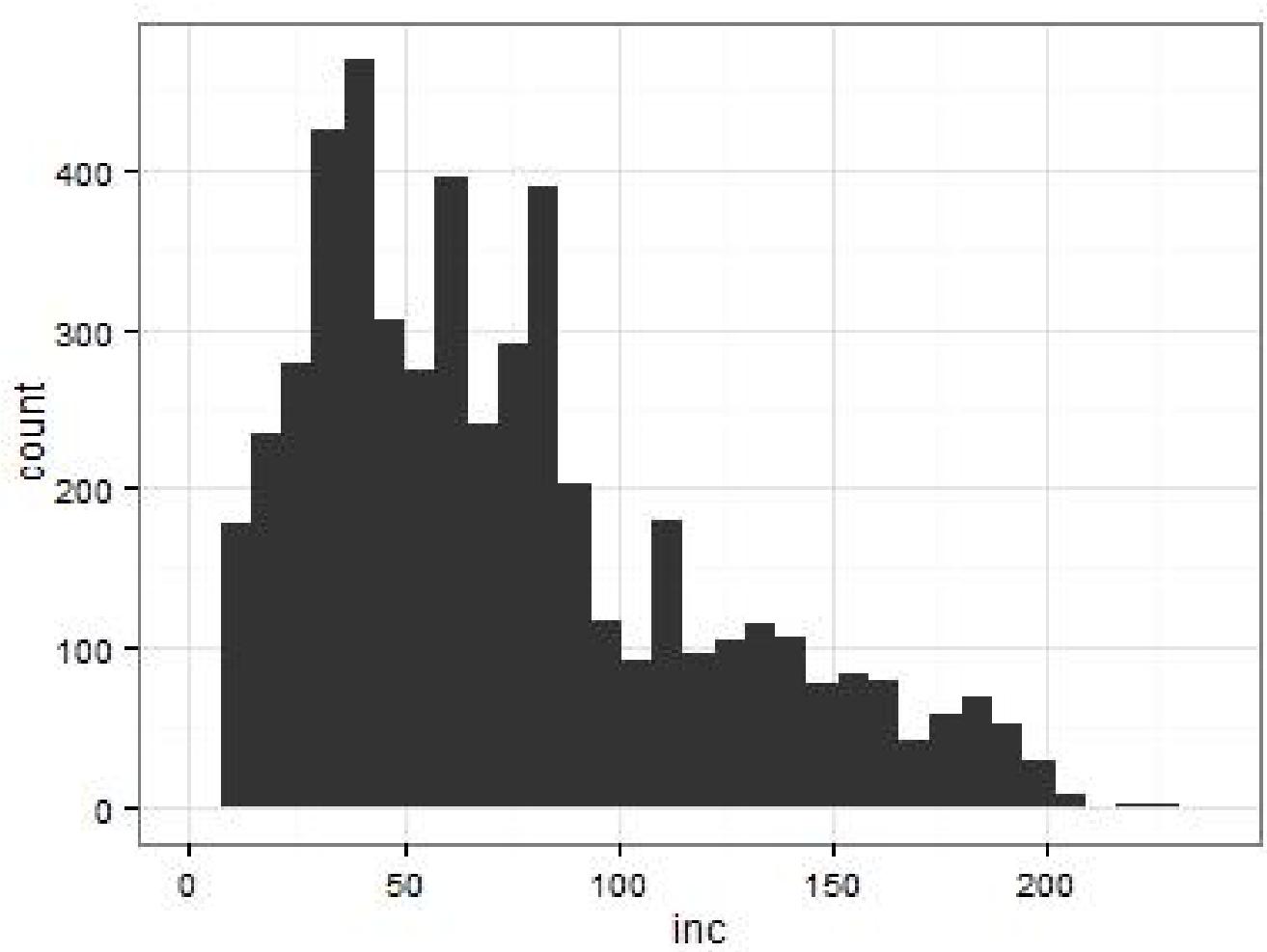
Which to use when

- Numeric
 - Histograms, Box plots and Time series
- Categorical
 - Bar charts
- Categorical-Numeric
 - Box plots



Recommended

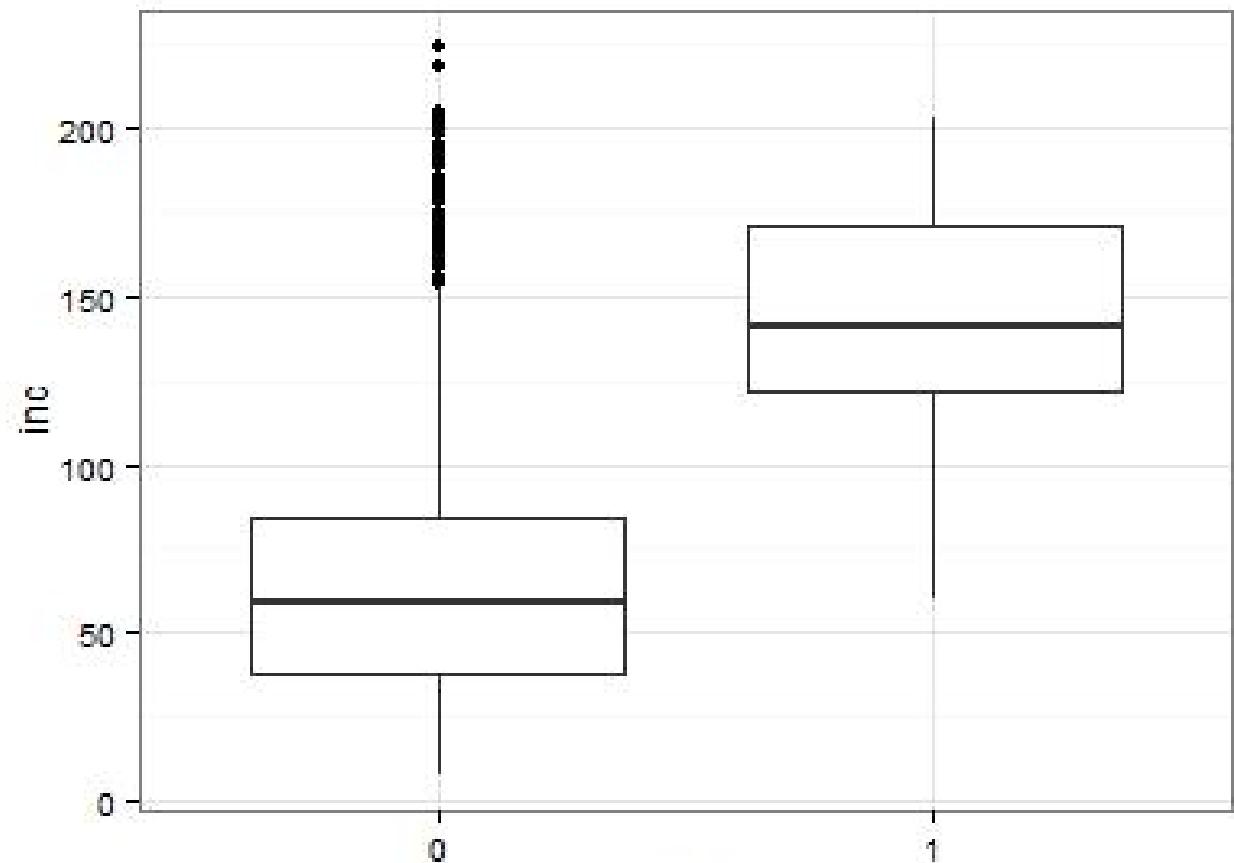
Numeric: Histogram



Simple box

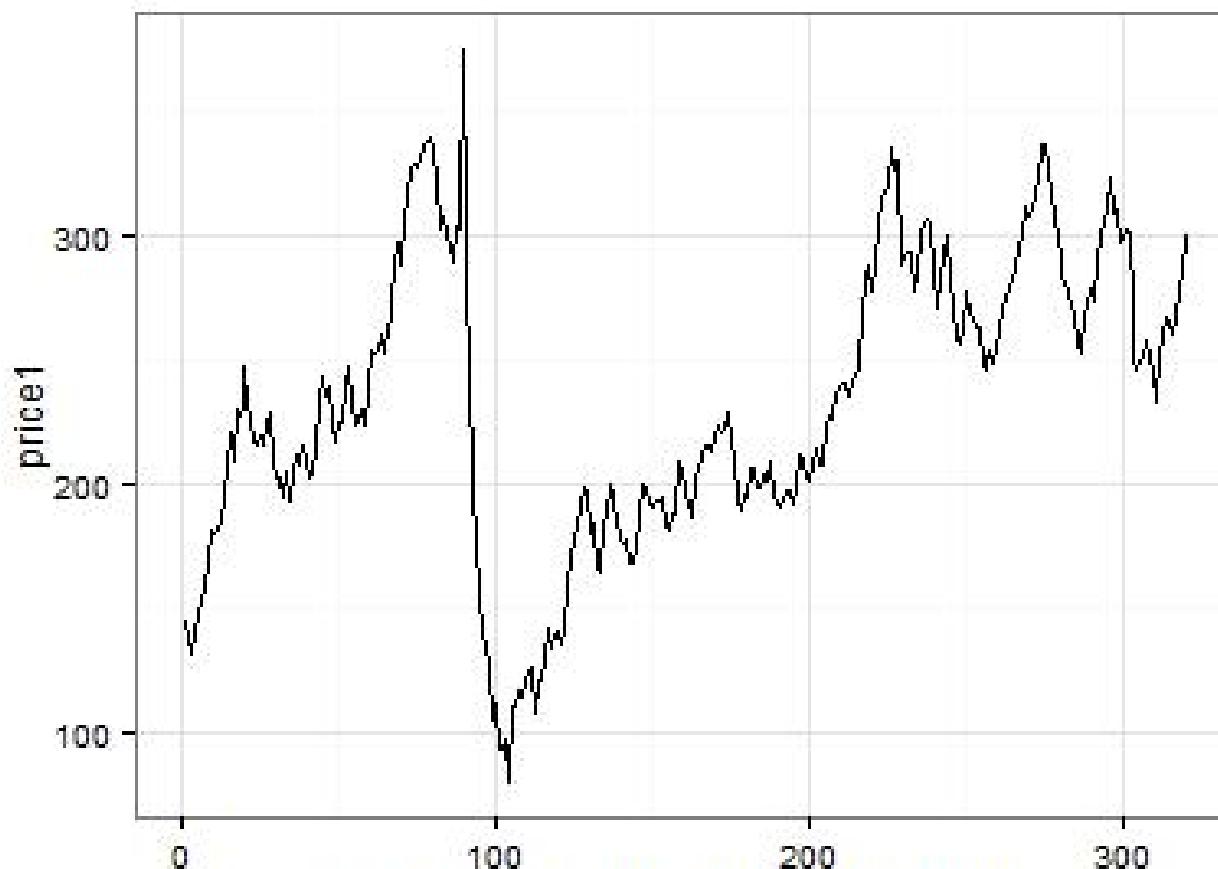


Power of Box

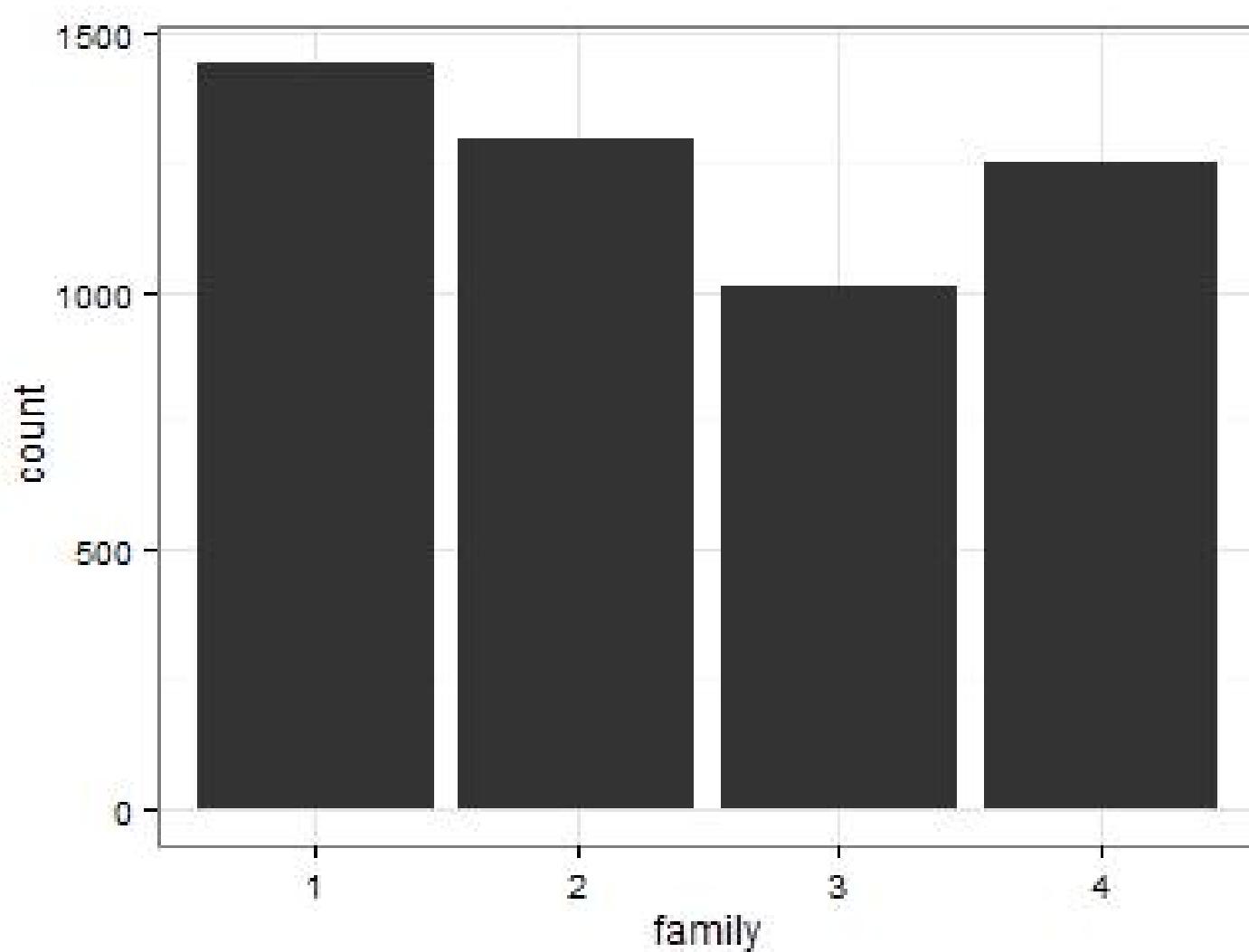


Will they take the program

Line chart



Bar chart

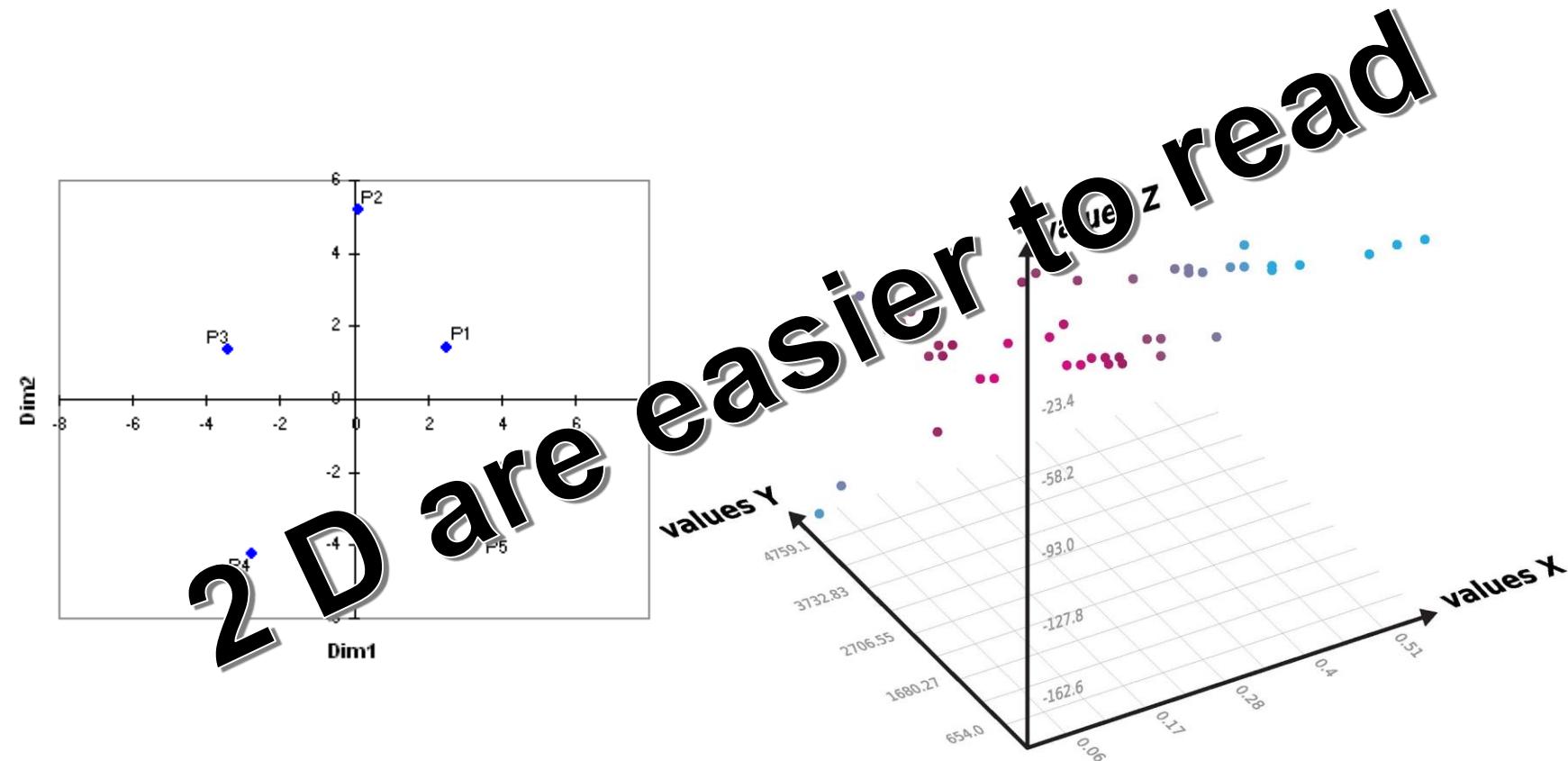


Communicating with Data

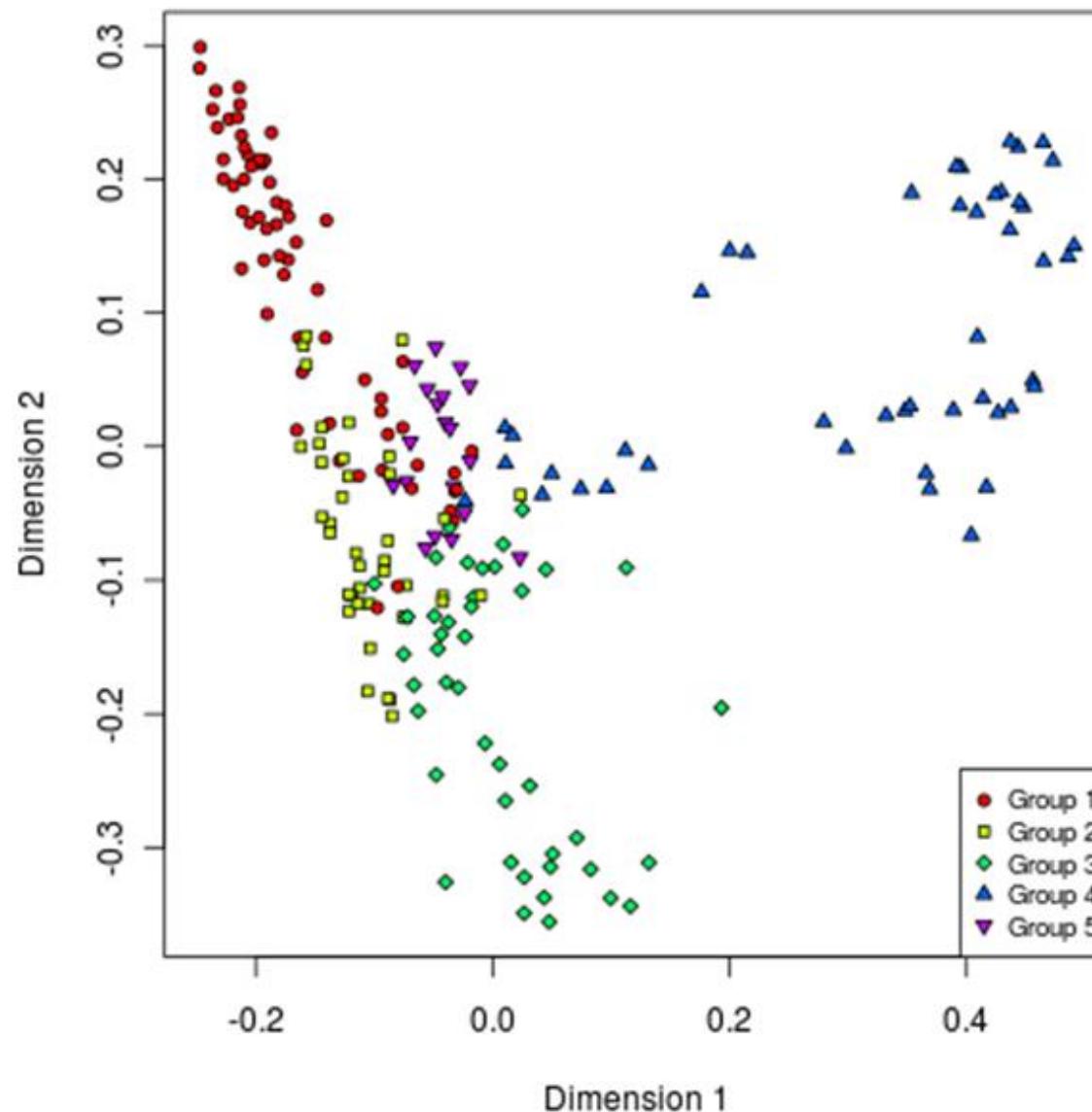
HOW TO ACCOMMODATE MORE THAN 2 DIMENSIONS



What if there are more elements?



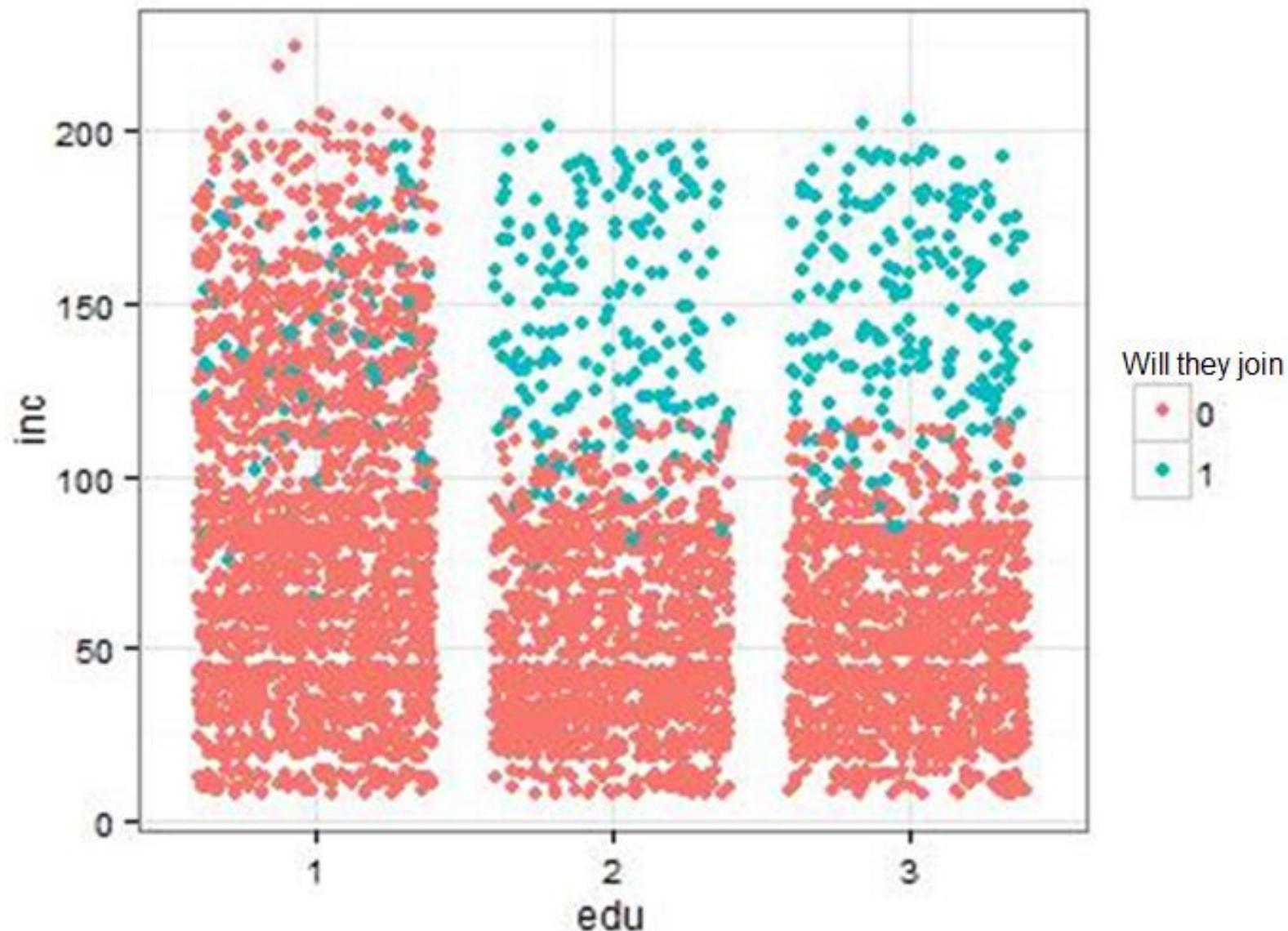
Use color, shape for additional features



Super powerful maps

- Size ( )
- Color ()
- Shape (  )

Multiple attributes: Scatter



Graphs and their Usage - Summary

Graph Type	Usage	Additional Comments
Bar graphs	Comparing data values within or across categories; Discrete data	Consider Line graphs for Continuous data
Histograms	Distribution of values across a possible range	
Line graphs	Continuous data; Display trends	
Time series	Data with a time dimension	
Pie graphs	Comparing fractions of a whole; Very few fractions and precision is not important	Avoid to the extent possible
Scatter plots	Understanding correlations between two quantitative dimensions of data	3 or 4 dimensions possible by encoding data points as bubbles, etc.
Heat maps	Area graphs that use colour or brightness to indicate values (or changes in value) of large data sets	

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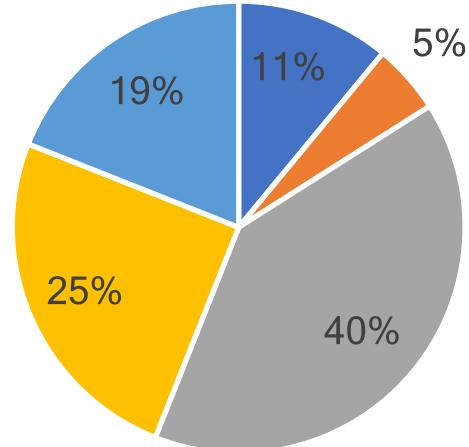
Alternatives to Pies



Survey results: Summer learning program on science

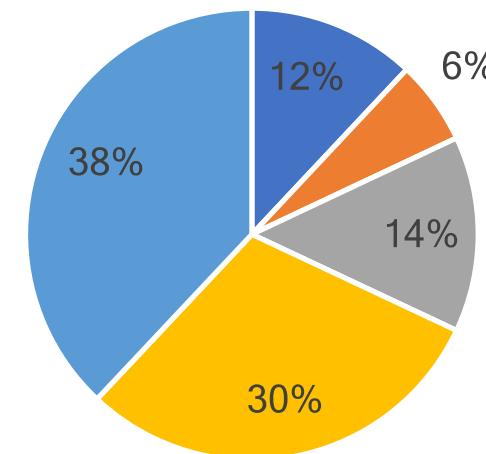
BEFORE: How do you feel about doing science?

■ Bored ■ Not great ■ OK ■ Kind of interested ■ Excited



AFTER: How do you feel about doing science?

■ Bored ■ Not great ■ OK ■ Kind of interested ■ Excited



Original visual by someone who has not been to INSOFE



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Pilot program was a success

After the pilot program,

68%

of kids expressed interest towards science,
compared to 44% before the program.

Based on survey of 100 students (100% response rate on both surveys).

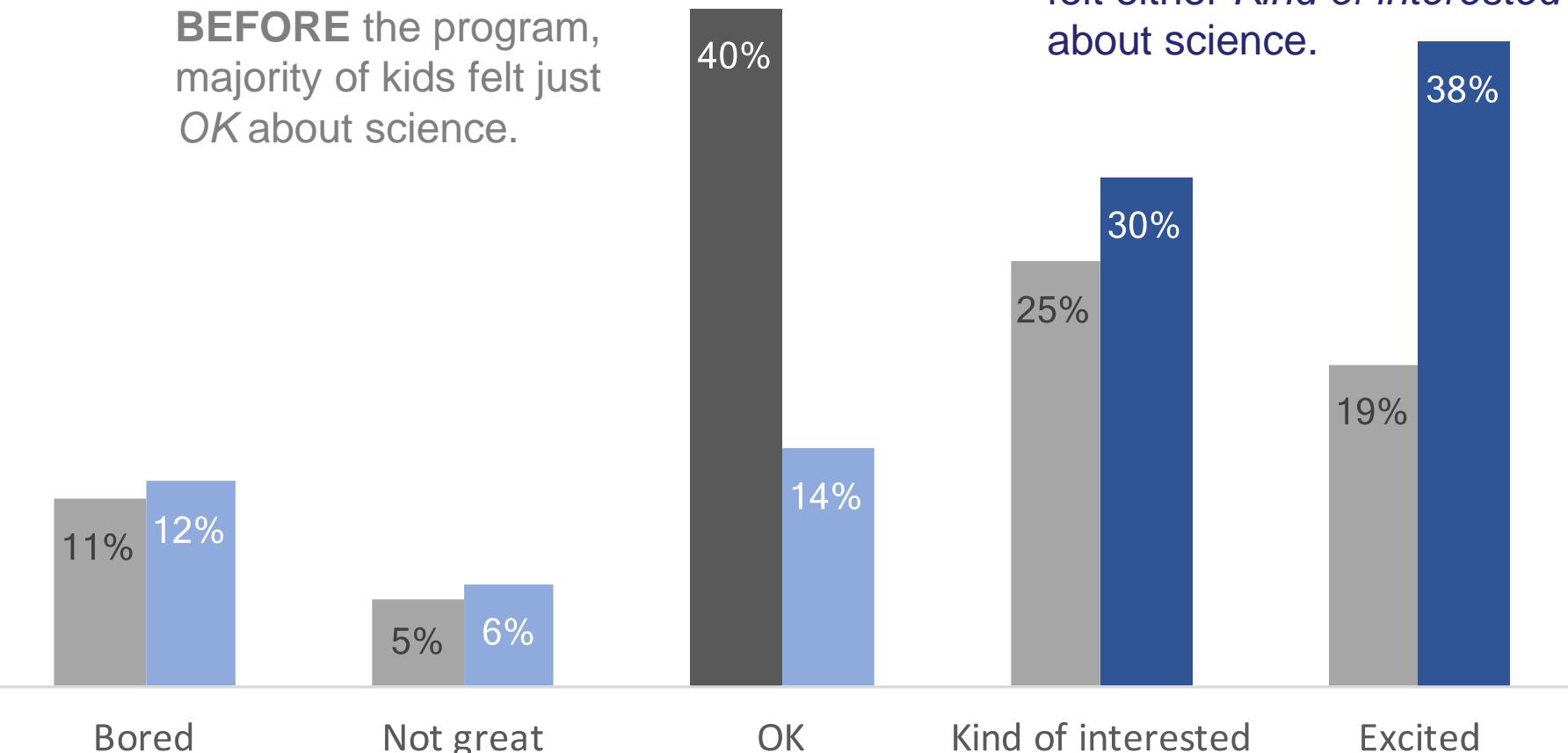
Show the numbers directly

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Pilot program was a success

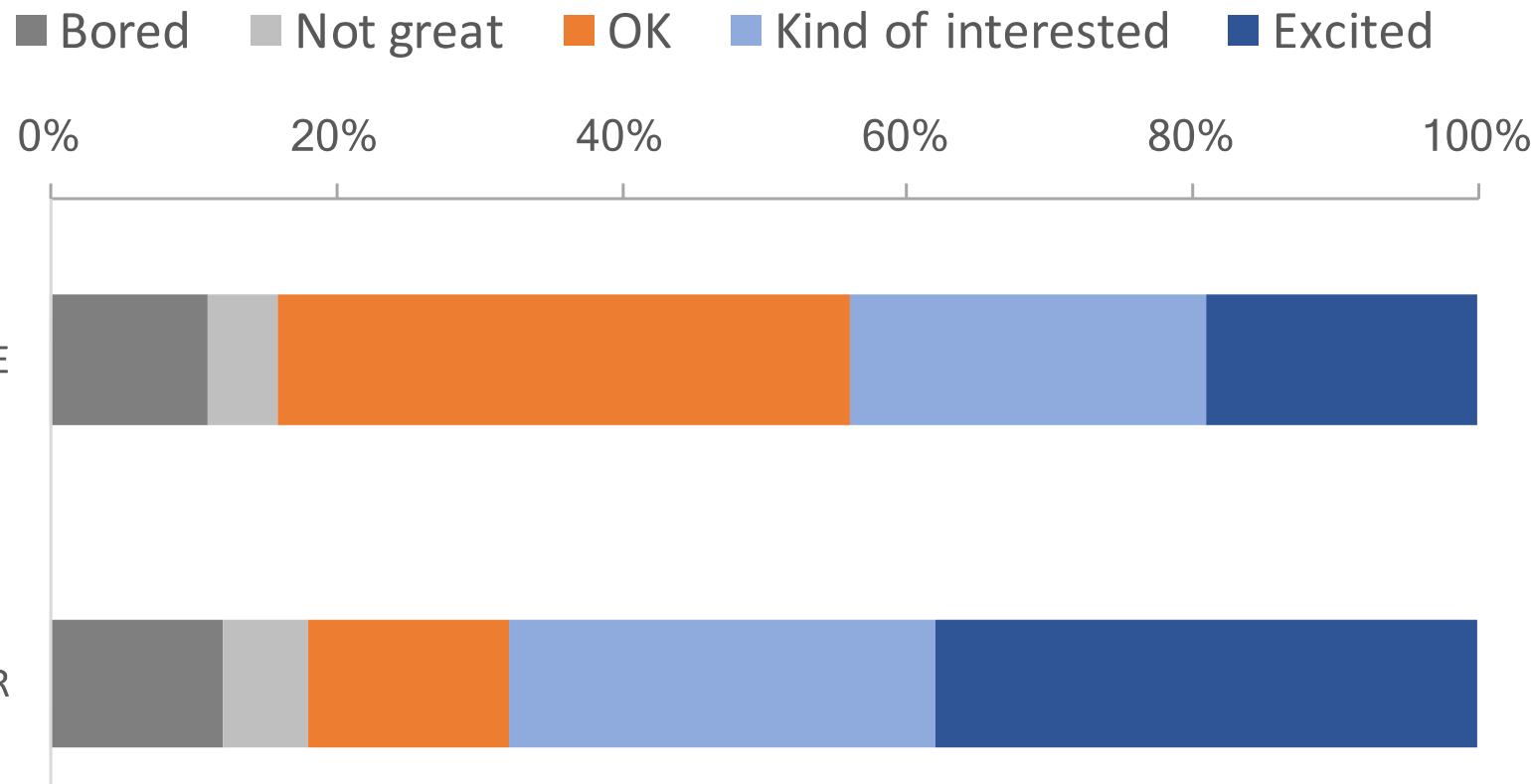
BEFORE the program,
majority of kids felt just
OK about science.



Based on survey of 100 students (100% response rate on both surveys).

Display a simple bar graph

Pilot program was a success



BEFORE the program, **majority of kids felt just *OK* (40%)** about science.

AFTER the program, **majority of kids felt either *Kind of interested* (30%) or *Excited* (38%)** about science.

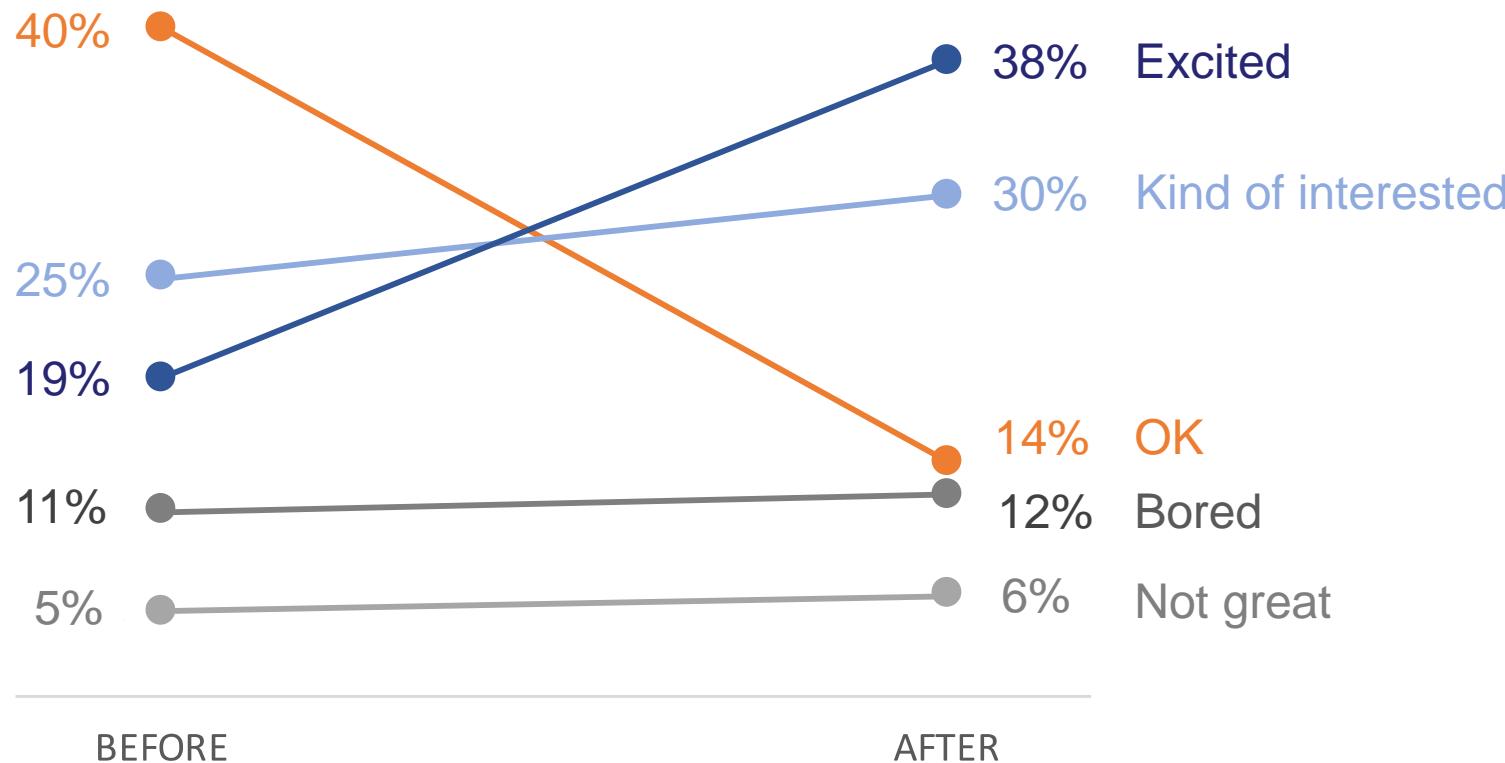
Based on survey of 100 students (100% response rate on both surveys).

Display a 100% stacked horizontal bar graph

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Pilot program was a success



BEFORE the program,
majority of kids felt just
OK (40%) about science.

AFTER the program,
majority of kids felt either
Kind of interested (30%)
or *Excited* (38%) about
science.

Based on survey of 100 students (100% response rate on both surveys).

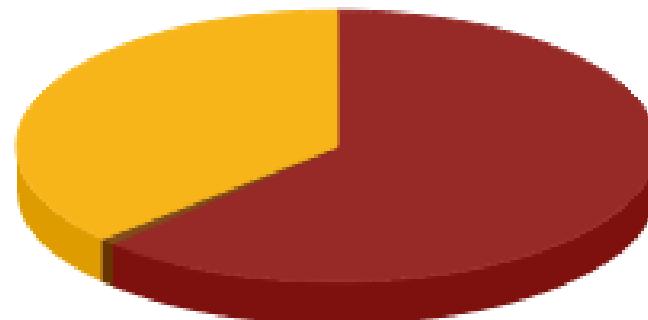
Display a slopegraph

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Beware of 3D

Asset class	Value	in %
Auto Loan	0.00	0 %
Mortgage	2,802,725.00	62.33 %
Credit Card	33,835.00	0.75 %
Personal Loan	1,660,000.00	36.92 %
Consumer Loan	0.00	0 %
Gold Loan	0.00	0 %
Loan Against Shares	0.00	0 %
Two-Wheeler Loan	0.00	0 %
Business Loan	0.00	0 %
Other Secured Loans	0.00	0 %
Other unsecured Loans	0.00	0 %
Total	4,496,560.00	100%



- Auto Loan
- Mortgage
- Credit Card
- Personal Loan
- Consumer Loan
- Gold Loan
- Loan Against Shares
- Two-Wheeler Loan
- Business Loan
- Other Secured Loans
- Other unsecured Loans

Why so many?

Even a **Table** is a better visualization of this data

How to build visualizations and dashboards

A lot of information in this section adapted from

[https://www.academia.edu/32299797/Data Visualization Through Tableau](https://www.academia.edu/32299797/Data_Visualization_Through_Tableau) and courtesy Mr. Ramesh Manickavel

Principal Agile Program Manager and Adjunct Faculty at CA Technologies

CPEE Batch 8 Joint Topper



TOOLS

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Visualization Tools

- For developers
 - ggplot2
 - ggvis
 - D3.js
 - NVD3
 - FusionCharts
 - Chart.js
 - Google Charts
 - Highcharts
 - Leaflet
 - Dygraphs
 - Ember Charts
- For Non-developers
 - Qlik Sense
 - QlikView
 - Tableau
 - Deducer
 - RAW
 - Timeline JS
 - Infogram
 - Plotly
 - Datawrapper
 - ChartBlocks
 - Microsoft Power BI

Visualization Tools

For these and more tools, refer:

- <https://www.devteam.space/blog/top-10-big-data-visualization-tools/>
- <https://www.upwork.com/hiring/data/19-data-visualization-tools/>
- https://thenextweb.com/dd/2015/04/21/the-14-best-data-visualization-tools/#.tnw_MoDlRPes
- <https://www.educba.com/10-best-data-visualization-tools/>
- <http://in.pc当地.com/cloud-services/106561/guide/the-best-data-visualization-tools-of-2016>
- <http://technologyadvice.com/data-visualization/>
- <http://bigdata-madesimple.com/review-of-20-best-big-data-visualization-tools/>

Tableau Demo

- Launch Tableau.
- Select file.

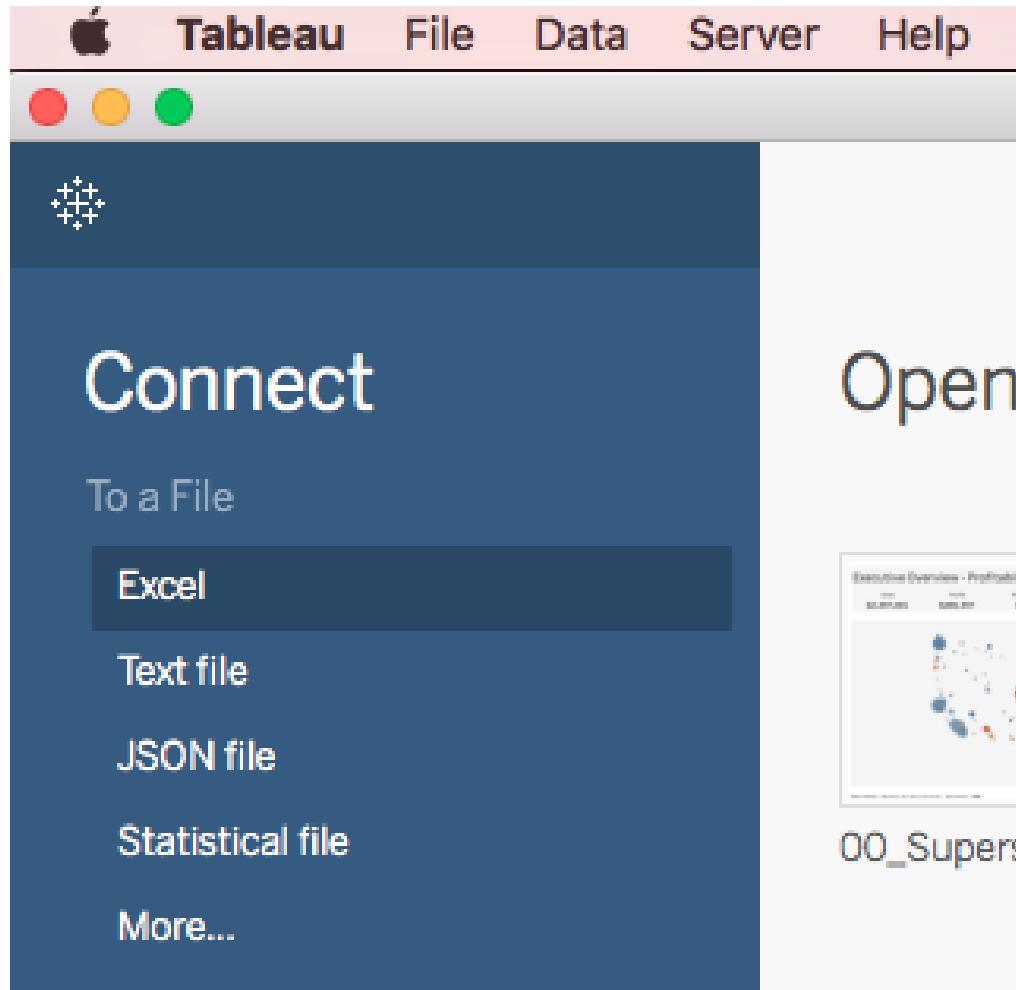
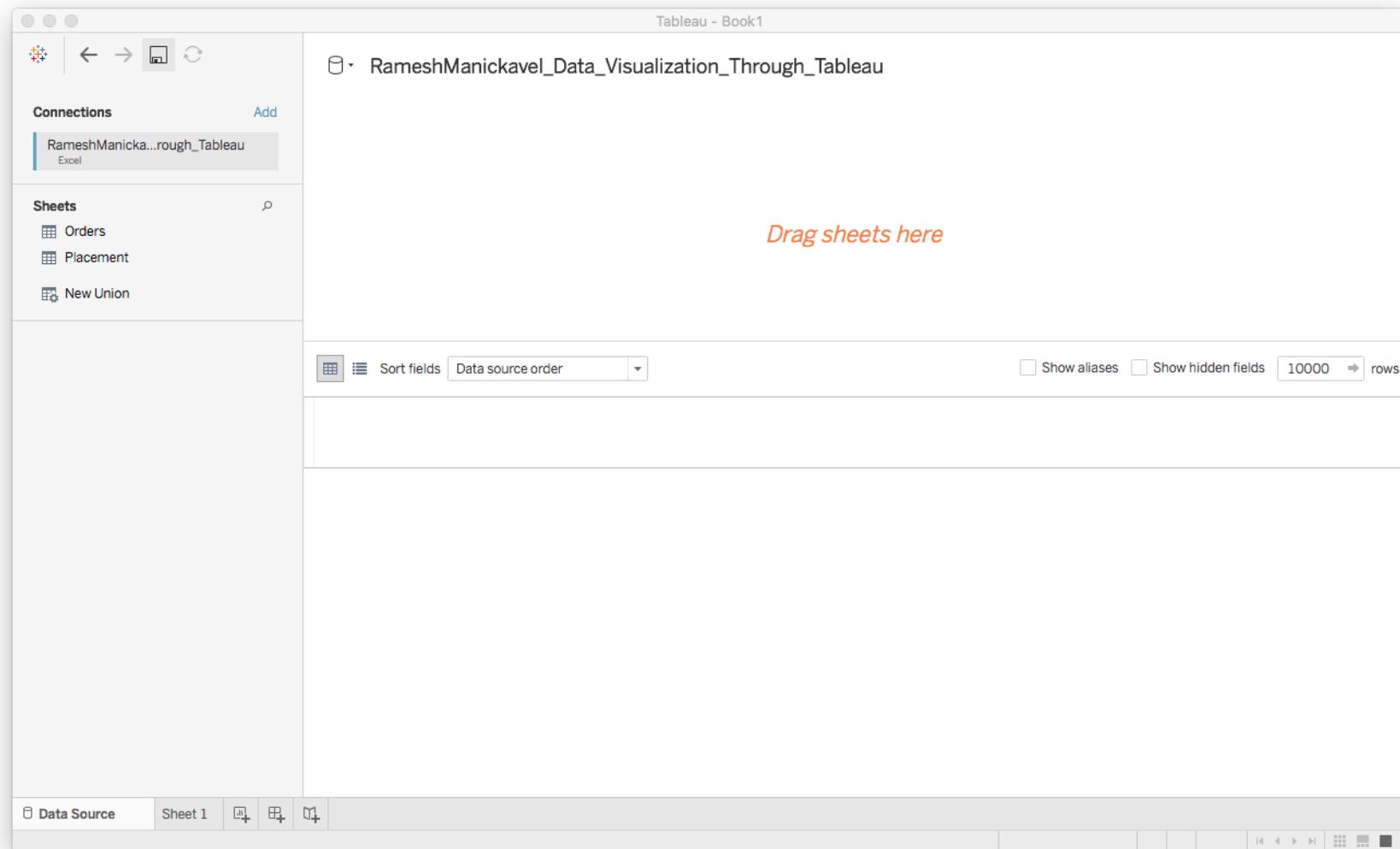


Tableau Demo

- Drag sheet.



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Tableau Demo

- Drag sheet.

Tableau - Book1

Placement (RameshManickavel_Data_Visualization_Through_Ta...)

Connection: Live | Extract

Filters: 0 | Add

Placement

Sort fields: Data source order ▾

Show aliases | Show hidden fields | 28 rows

# Placement Year	Abc Placement Branch	# Placement Total Students	# Placement Company A	# Placement Company B	# Placement Company C	# Placement Company D	# Placement Company E	# Placement Placed Students
2013	Post Graduate Diploma	24	3	1	8	0	1	
2013	PGDM - Retail Market	30	5	1	7	0	1	
2013	PGDM - Banking Insu...	19	1	3	8	0	0	
2013	PGDM - International...	15	1	2	8	0	1	
2013	PGDM - Human Reso...	22	2	1	4	0	2	
2013	Executive - PGDM	11	0	1	2	0	0	
2013	MBA - Practicing Exe...	3	0	1	1	0	0	
2014	Post Graduate Diploma	28	5	1	7	0	6	
2014	PGDM - Retail Market	32	8	0	5	6	2	
2014	PGDM - Banking Insu...	24	0	0	6	7	0	

Go to Worksheet

Data Source | Sheet 1 | + | +

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Tableau Demo

- Click Sheet 1.

The screenshot shows the Tableau desktop application interface. The title bar reads "Tableau - Book1". The top menu bar includes "File", "Edit", "View", "Data", "Analytics", "Pages", "Columns", "Rows", "Format", "Standard", and "Show Me". The left sidebar contains sections for "Dimensions" (Branch, Year) and "Measures" (Company A, Company B, Company C, Company D, Company E, Placed Students, Total Students, Number of Records, Measure Values). The main workspace is titled "Sheet 1" and features two large, empty rectangular areas labeled "Drop field here" for columns and rows. The bottom navigation bar includes "Data Source", "Sheet 1", and various icon buttons for saving, publishing, and sharing.

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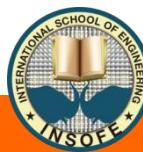


Tableau Demo – Line Chart

- Drag *Year* from Dimensions to Columns.
- Drag *Placed Students* from Measures to Rows.
- Check *Show mark labels* in Marks card.

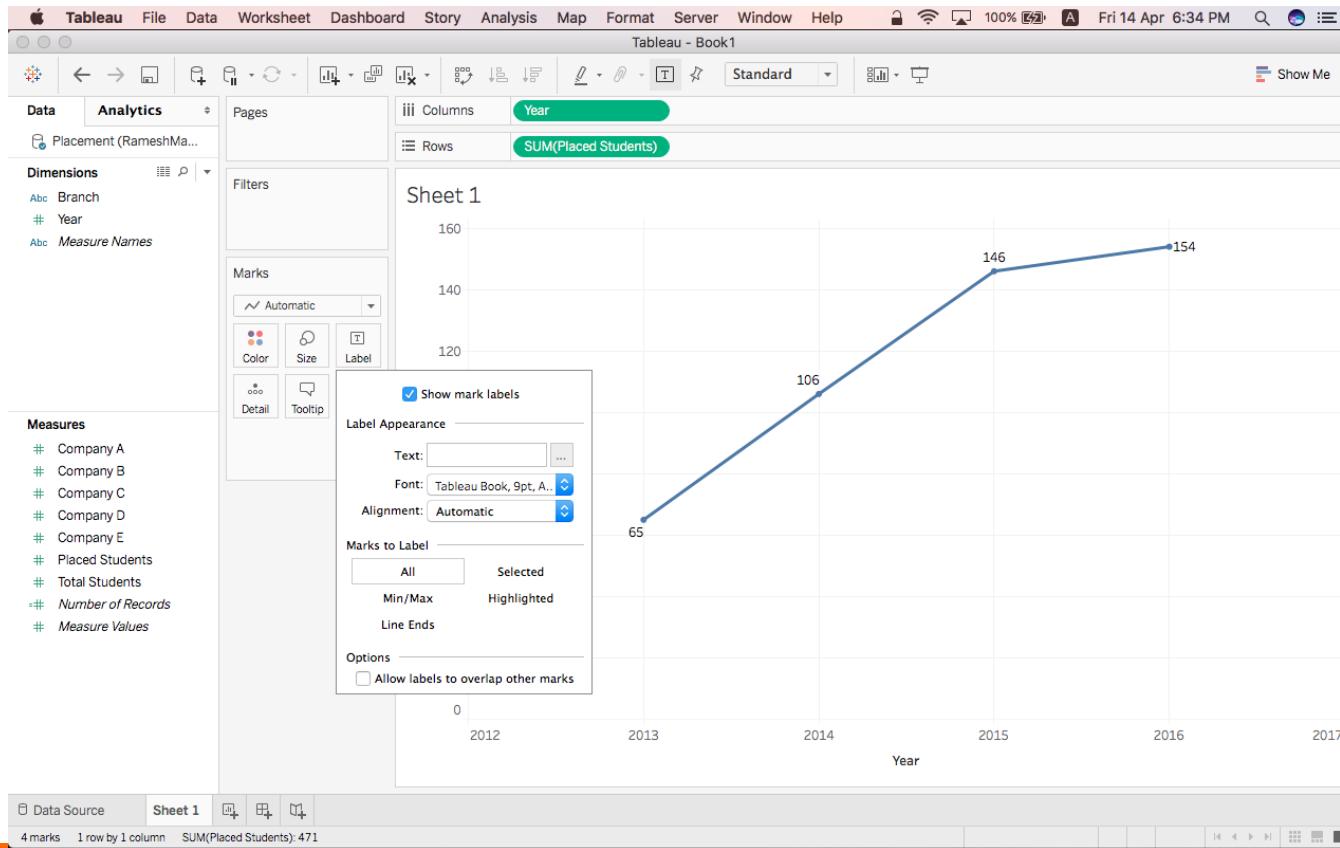
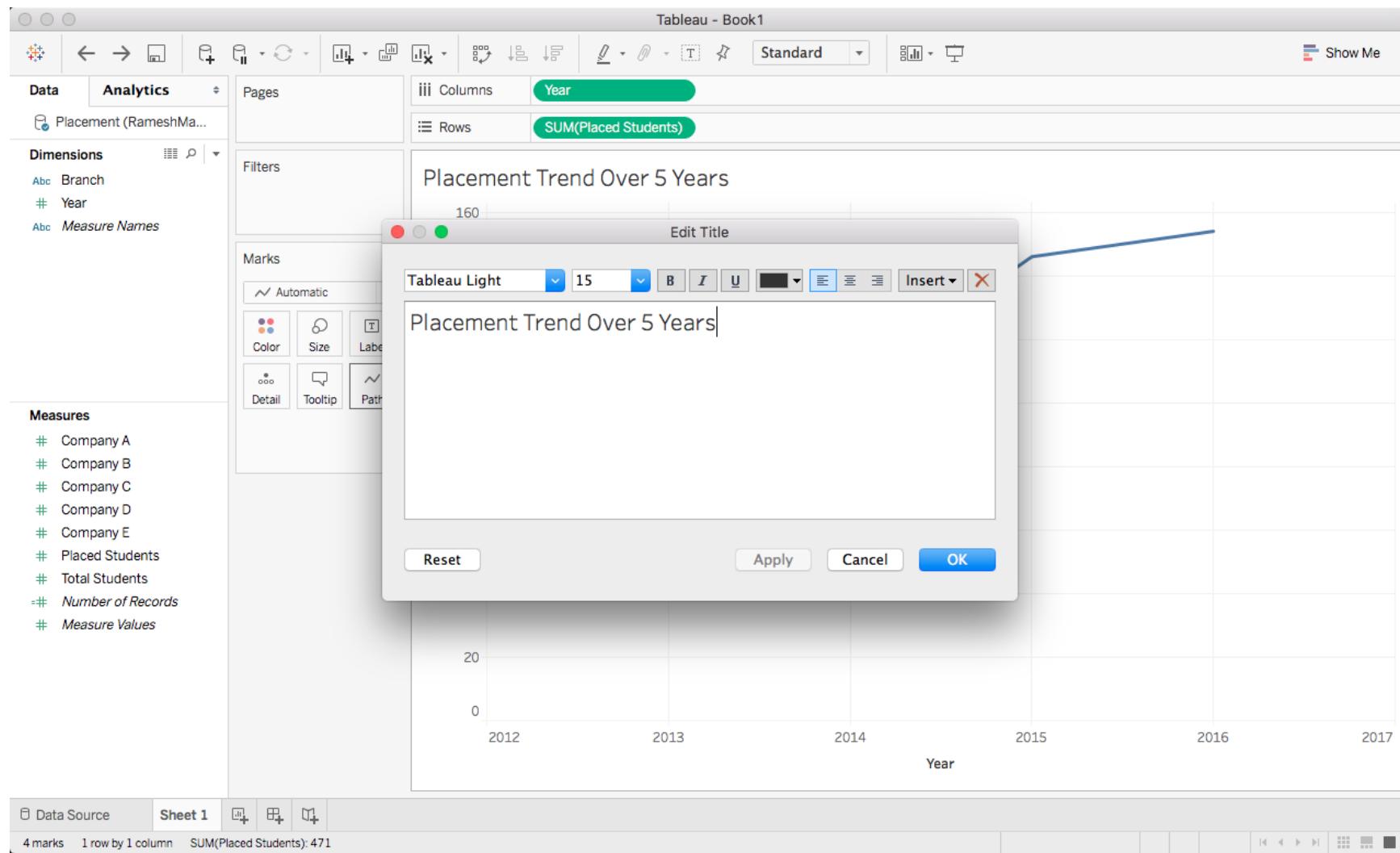


Tableau Demo – Line Chart

- Edit Title and attributes as desired.

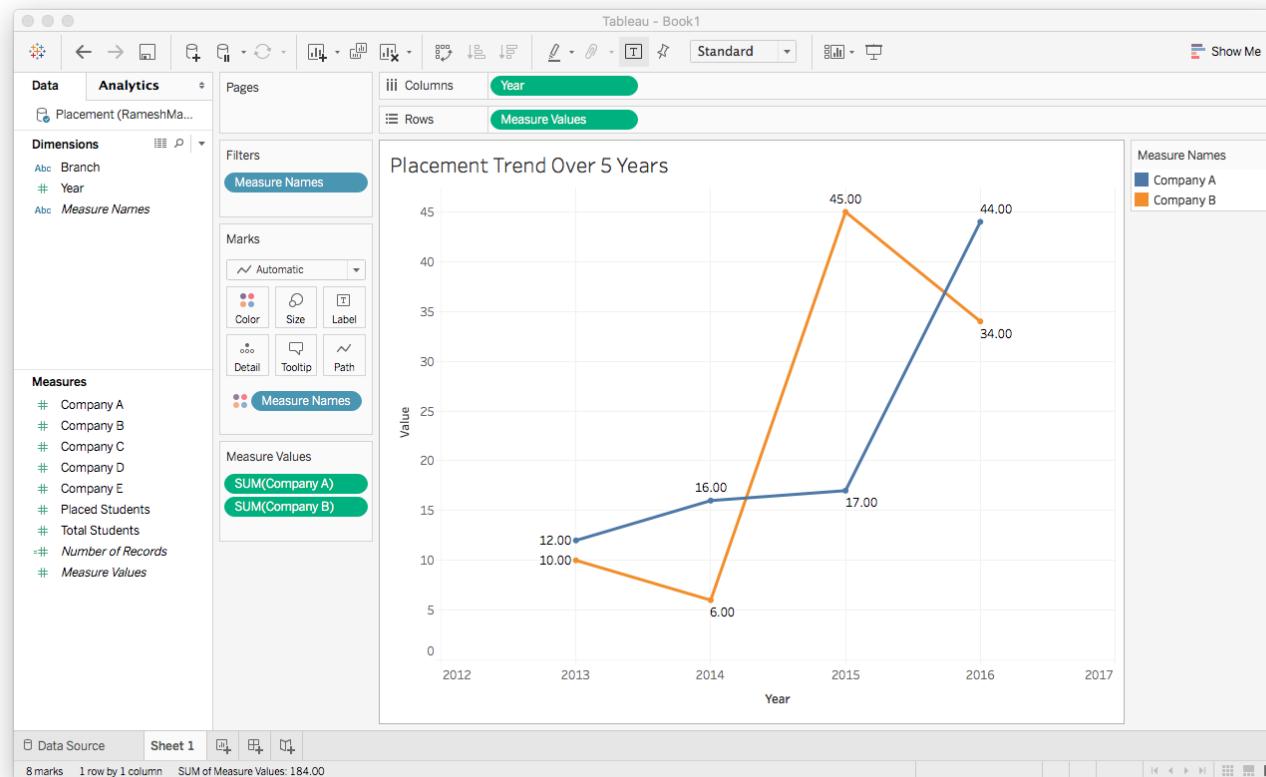


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Tableau Demo – Line Chart (Comparing More Than 1 Series)

- Drag *Company A* from Measures to Rows.
- Drag *Company B* from Measures and place it on the Y-axis title *Company A*.

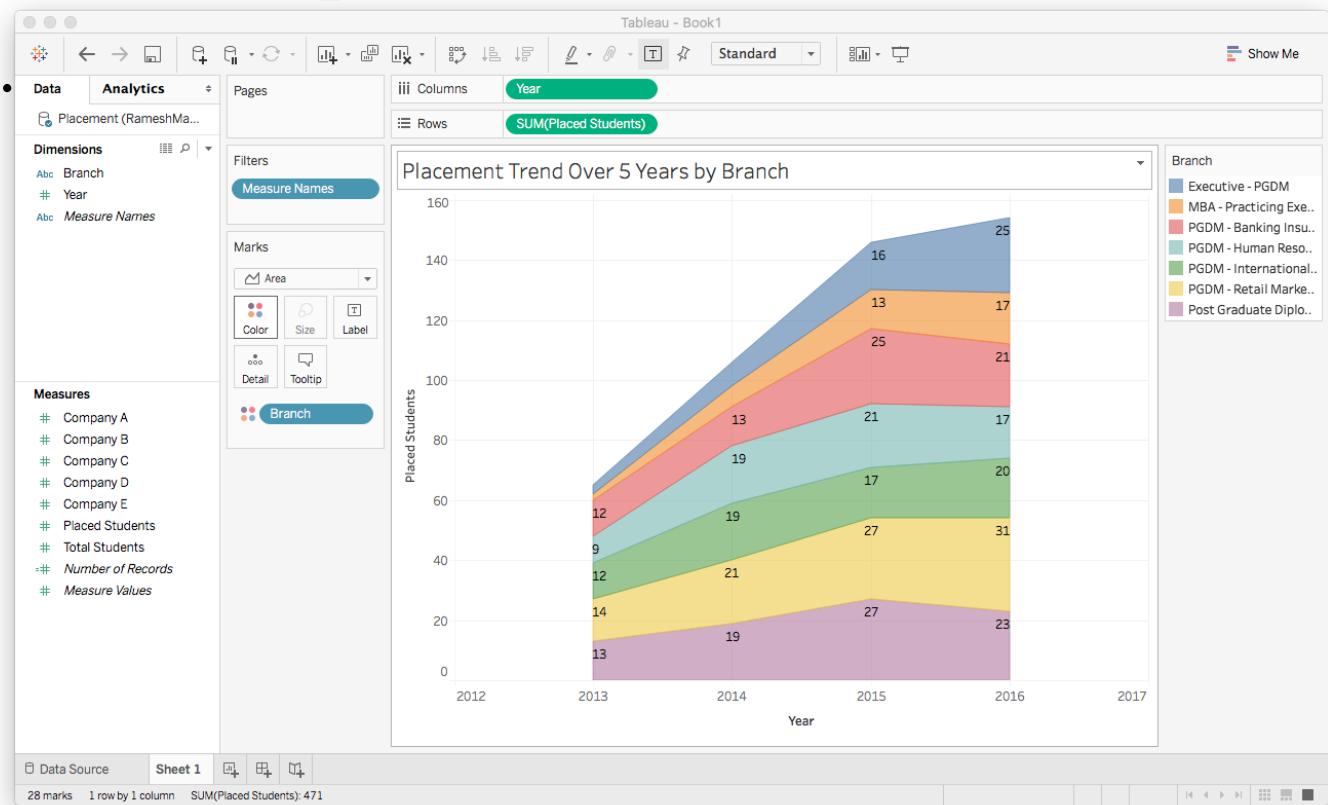


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Tableau Demo – Area Chart

- Drag *Branch* from Dimensions to Marks and place it over Color.
 - Select *Area* in Marks card dropdown.
 - Edit Title as desired.



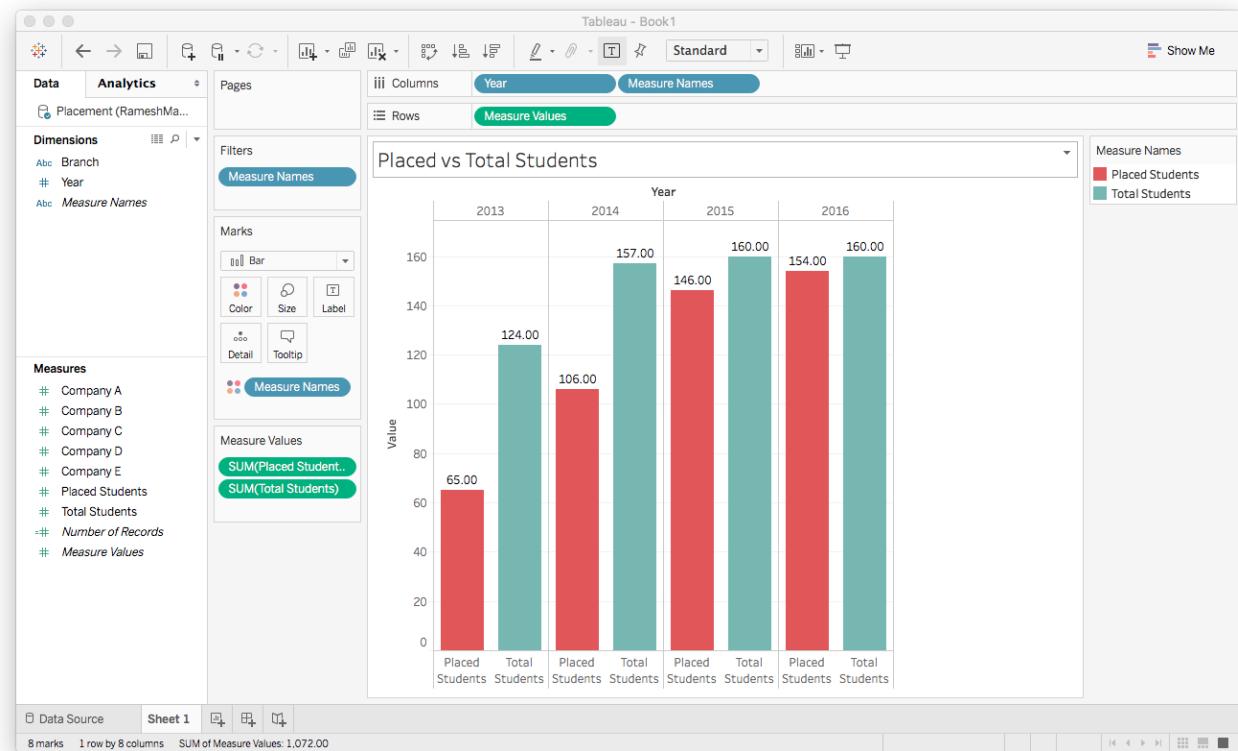
For Line vs Area Chart

- <http://www.fusioncharts.com/blog/2013/06/line-charts-vs-area-charts/>
- <https://visage.co/data-visualization-101-area-charts/>



Tableau Demo – Bar Chart

- Convert *Year* to Discrete.
- Drag *Year* and *Measure Names* to Columns.
- Select *Automatic* or *Bar* in Marks card dropdown.
- Edit Title as desired.

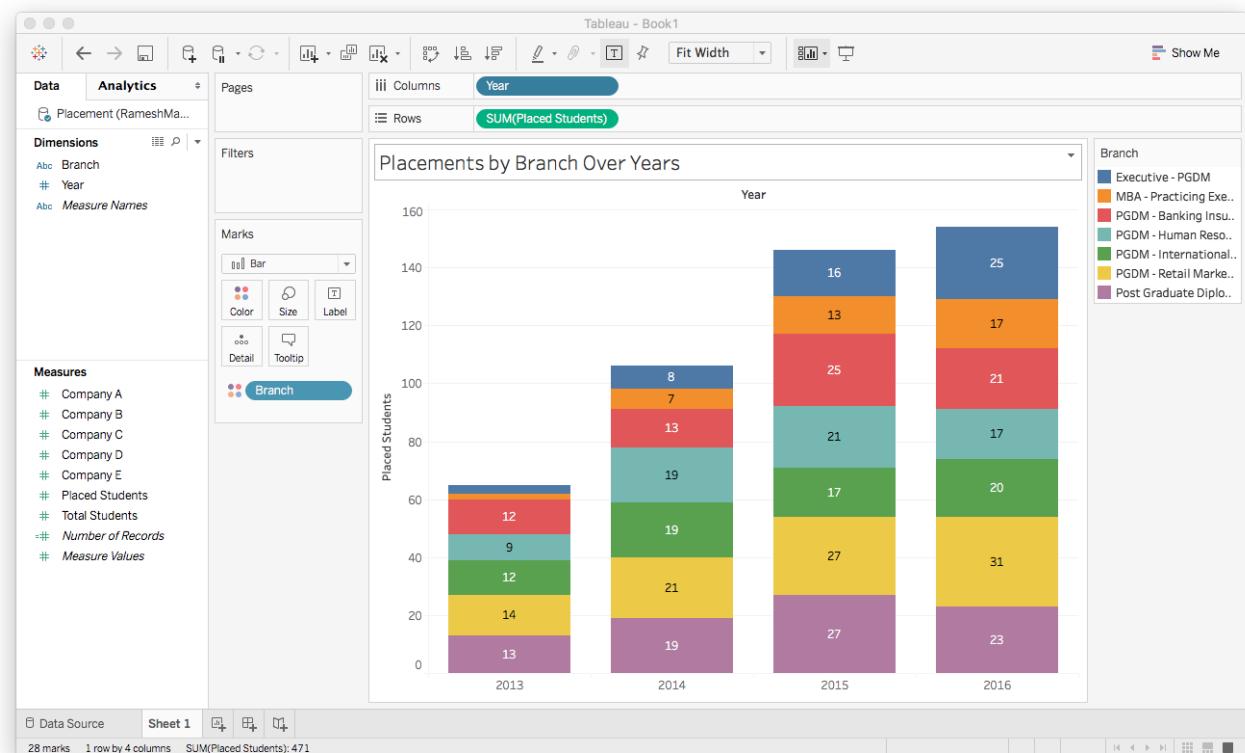


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Tableau Demo – Stacked Bar Chart

- Drag *Year* to Columns.
- Drag *Placed Students* to Rows.
- Drag *Branch* to Marks and place over Color.
- Edit Title as desired.

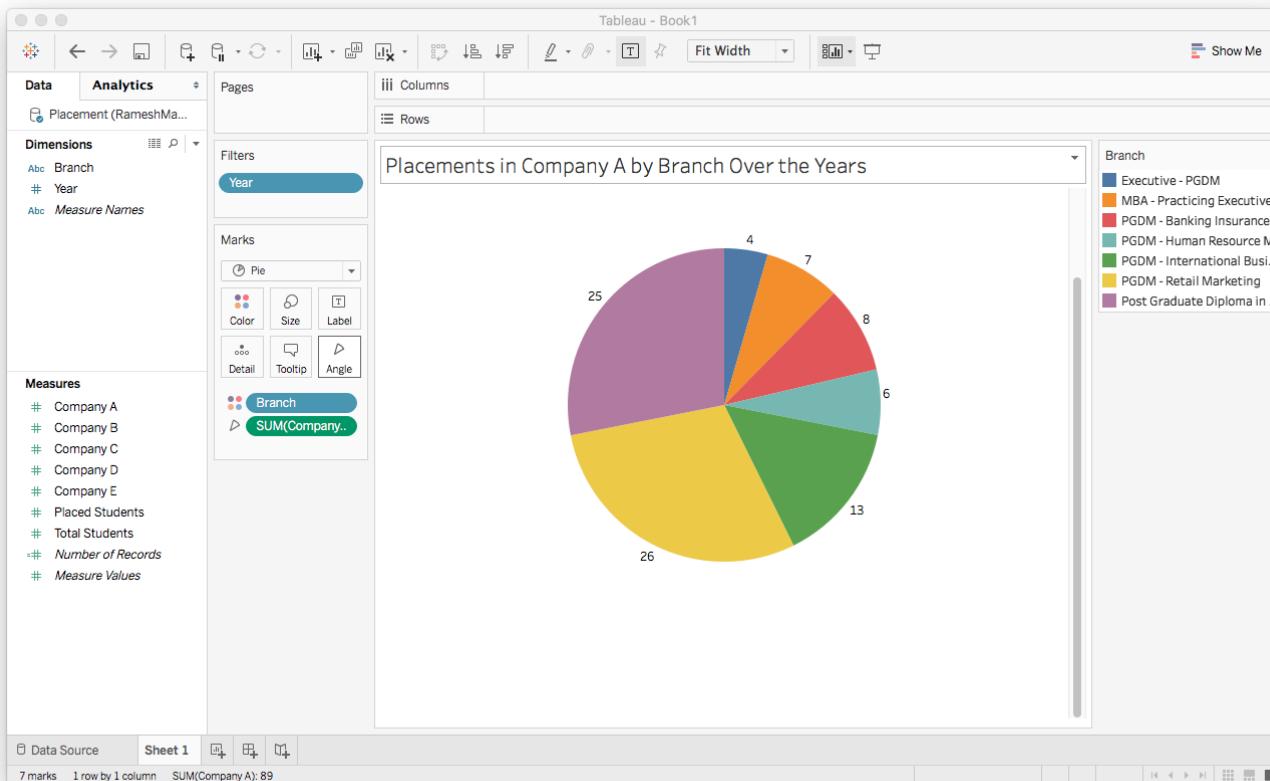


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Tableau Demo – Pie Chart

- Convert **Year** from **Dimensions** to **Filters**.
- Drag **Branch** from **Dimensions** to **Marks** and place over **Color**.
- Select **Pie** in **Marks** card dropdown.
- Press Ctrl (command)+Shift+B to increase the Pie size.



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Tableau Demo – Text Table

- Drag ‘Orders’ sheet to the work area.
- Drag *Order Date* from Dimensions to Columns.
- Drag *Sub-Category* from Dimensions to Rows.
- Select *Profits* from Measures to Marks and place over Text.

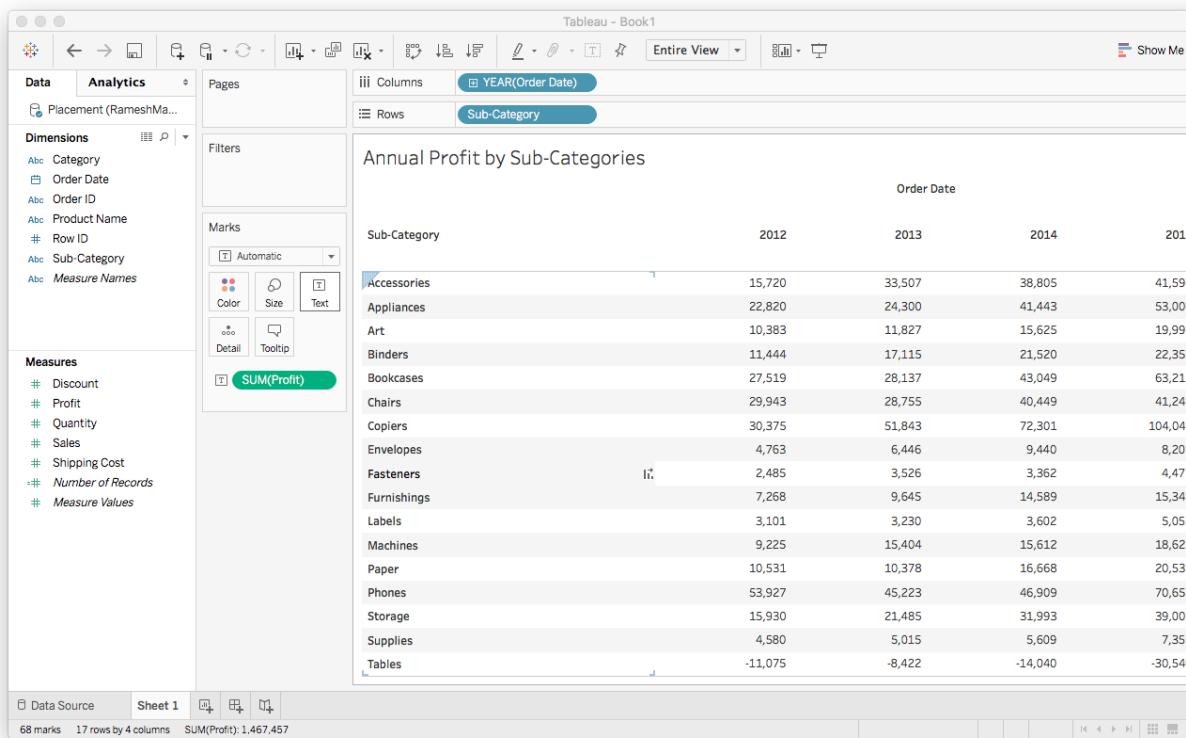
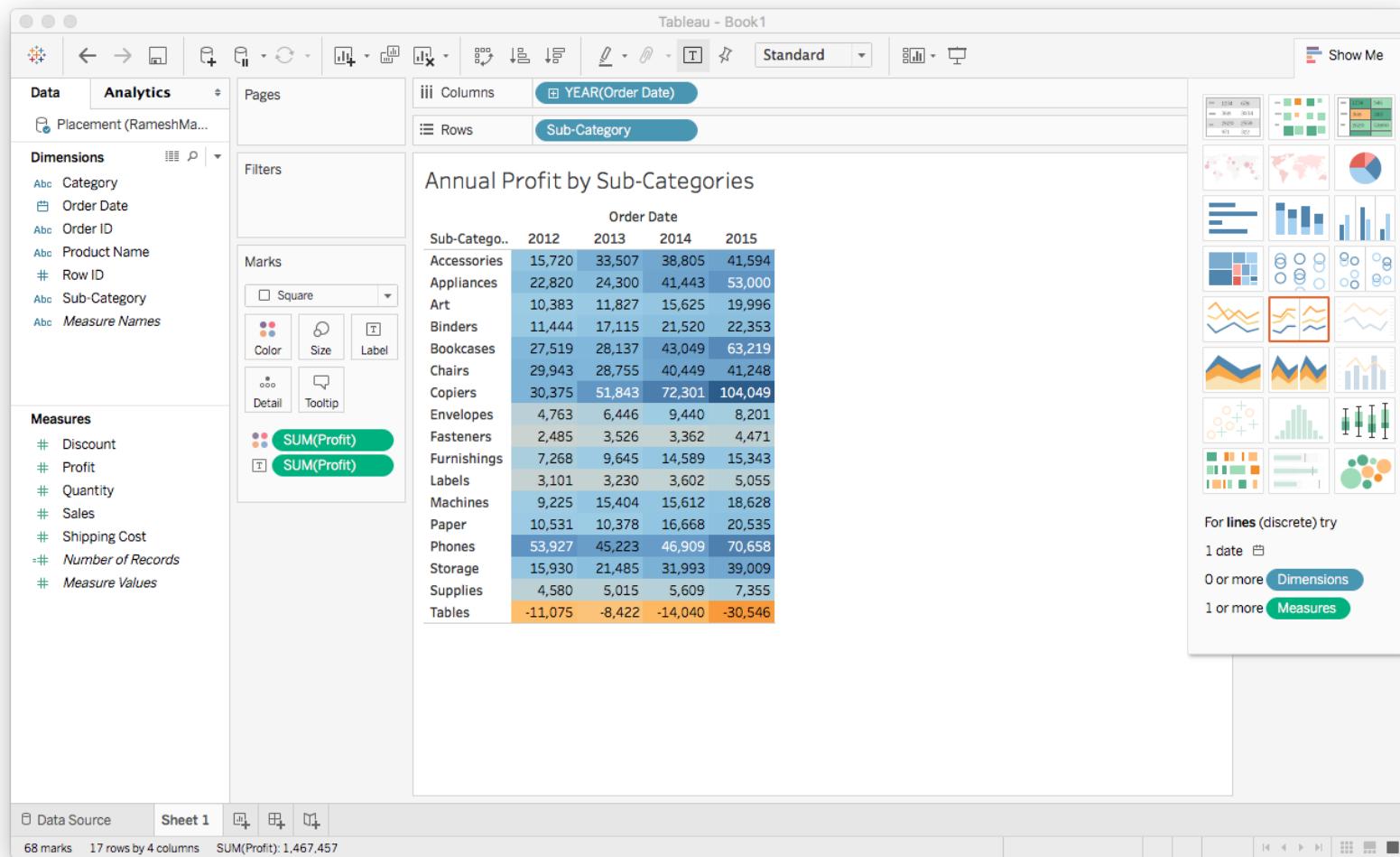


Tableau Demo – Highlight Table

- Select *Highlight tables* under Show Me on top right.
- Adjust colour schemes and ranges as desired.



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Tableau Demo – Heat Map

- Drag **Branch** from **Dimensions** to **Columns**.
- Drag **Year** from **Dimensions** to **Rows**.
- Drag **Placed Students** from **Measures** to **Marks** and place over **Color**.
- Change chart type to **Circle** under **Marks** dropdown.
- Adjust colour schemes and ranges as desired.

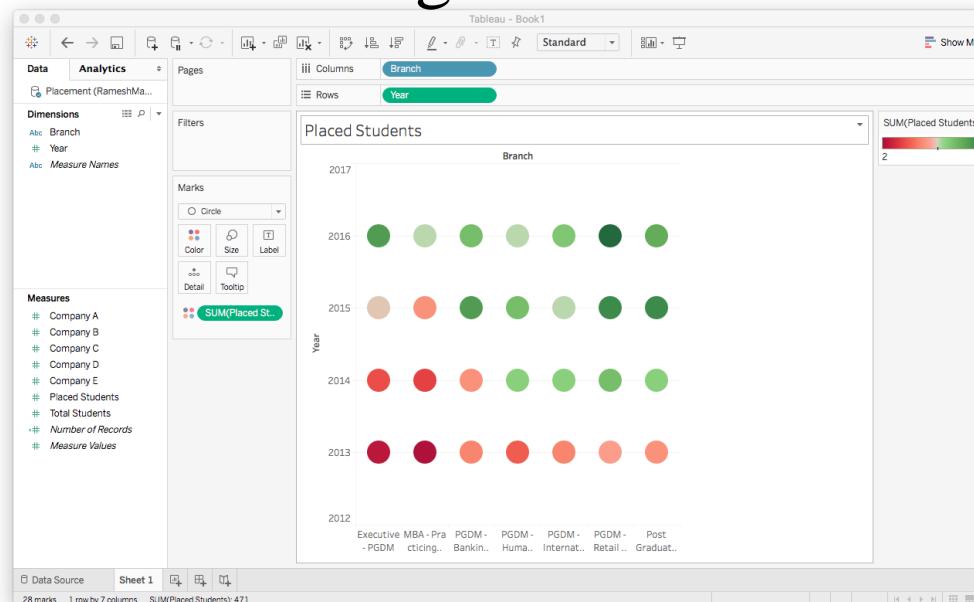
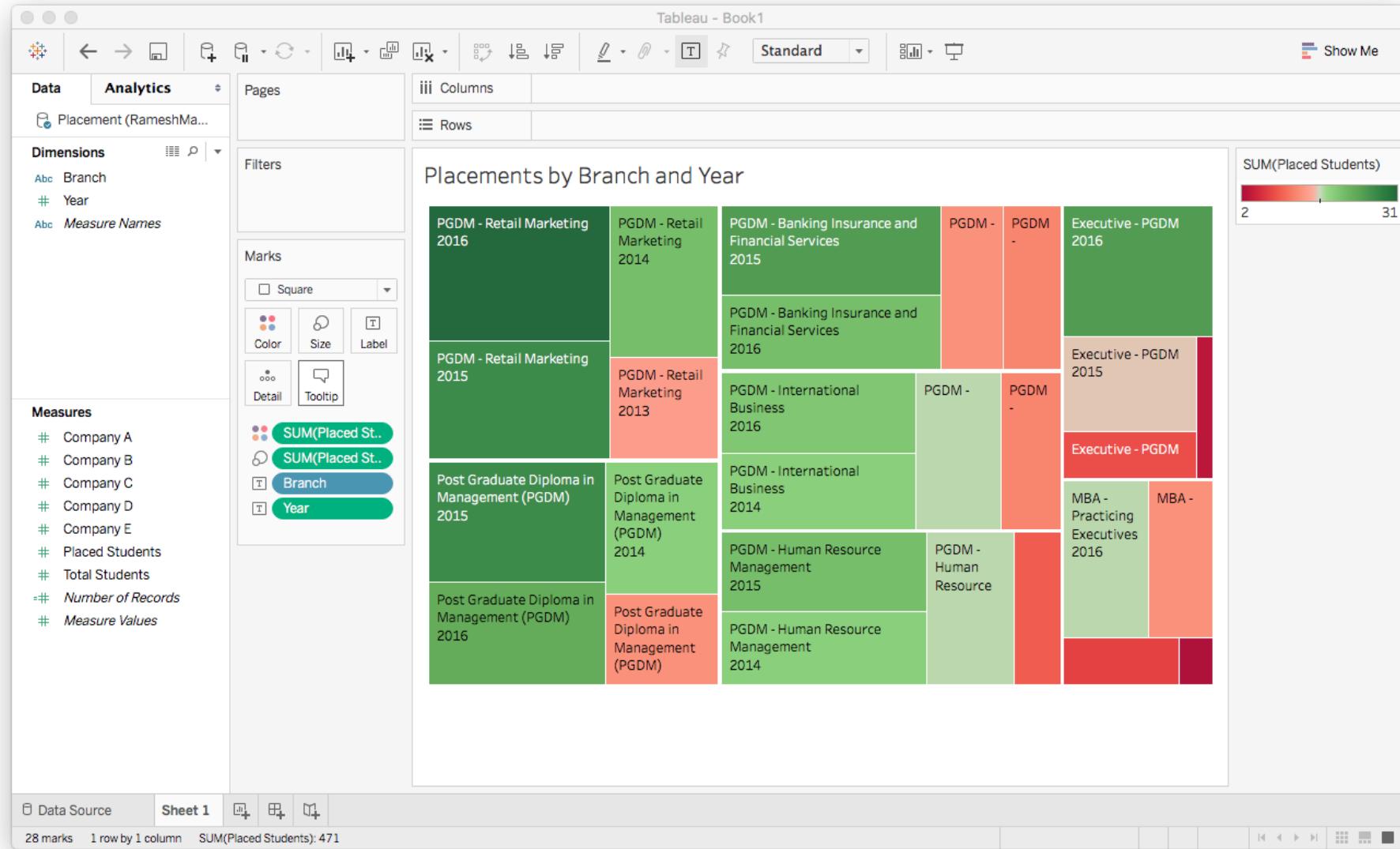


Tableau Demo – Tree Map

- To display hierarchical data in nested rectangles.
- Drag *Placed Students* from **Dimensions** to **Marks** and place over **Size**.
- Drag *Placed Students* from **Dimensions** to **Marks** and place over **Color**.
- Drag *Branch* from **Dimensions** to **Marks** and place over **Label**.
- Drag *Year* from **Dimensions** to **Marks** and place over **Label**.
- Change chart type to **Square** under **Marks** dropdown.
- Adjust colour schemes and ranges as desired.

Tableau Demo – Tree Map



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Tableau Demo – Dashboard

- Click Dashboard under top menu and select New Dashboard.

The screenshot shows the Tableau interface with a dashboard titled "Placements by Branch and Year". The dashboard contains a treemap chart with categories like PGDM - Retail Marketing, PGDM - Retail, Executive - PGDM 2016, Post Graduate, Post, and MBA, each represented by a colored rectangle. To the right of the chart is a color scale legend for "Placed Students" ranging from 2 (red) to 31 (green). Below the chart is a text placeholder: "Place objects to create dashboard". In the bottom left corner, there is a smaller embedded chart titled "Gapminder World" showing a scatter plot of children per woman vs. income per person. In the bottom right corner, there is a dark purple rectangular object with white text: "FORECASTING PRICES ACCURATELY IN SUPPLY CHAIN" and "INSOFE's machine learning based pricing models shatter industry benchmarks." The Tableau interface includes a sidebar for "Size" (Desktop Browser), "Sheets" (Sheet 1), and "Objects" (Horizontal, Vertical, Text, Tiled, Floating). The bottom navigation bar shows tabs for "Data Source", "Sheet 1", and "Dashboard 1".

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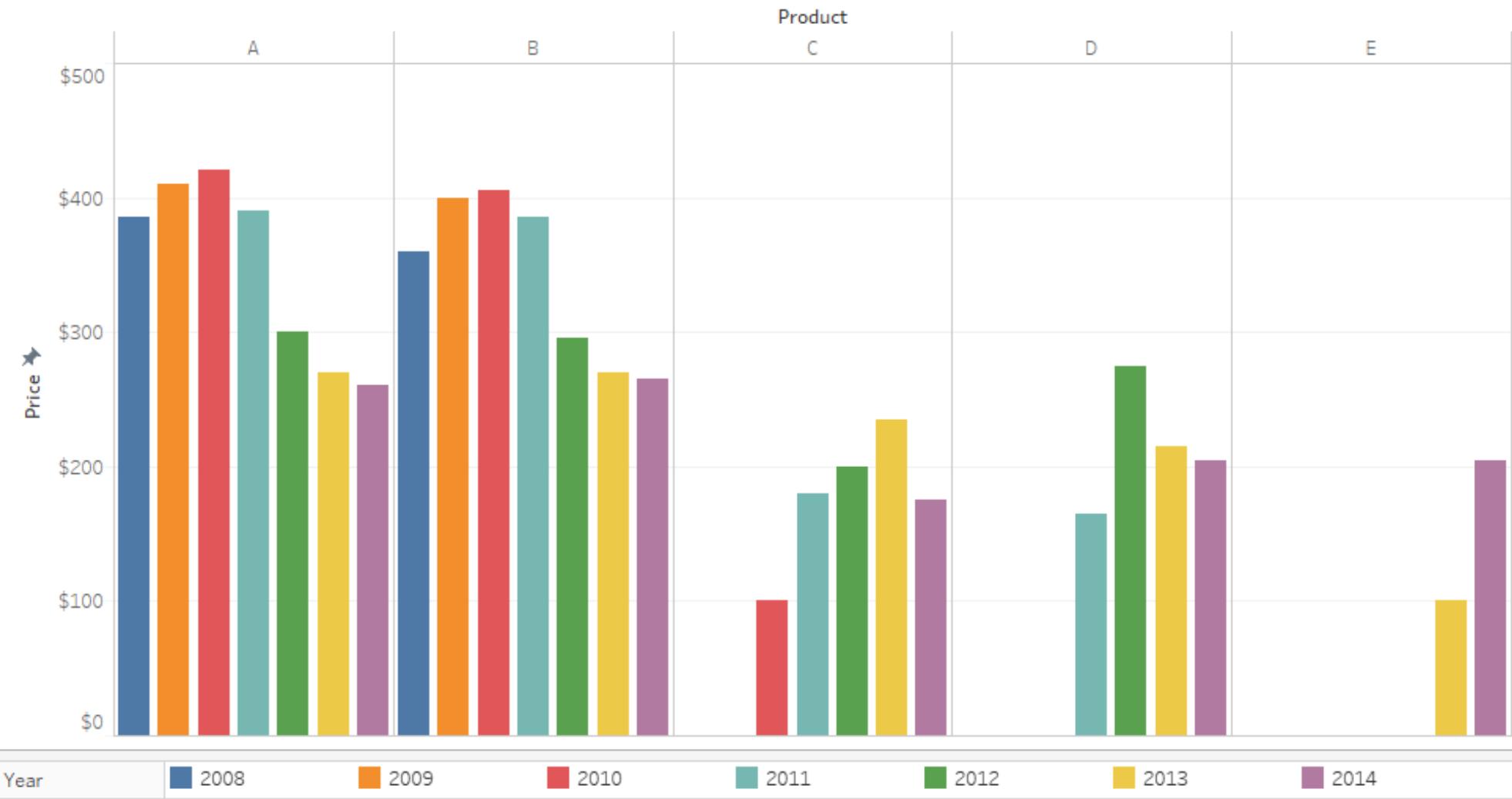
The Whole Process Revisited

CASE



Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



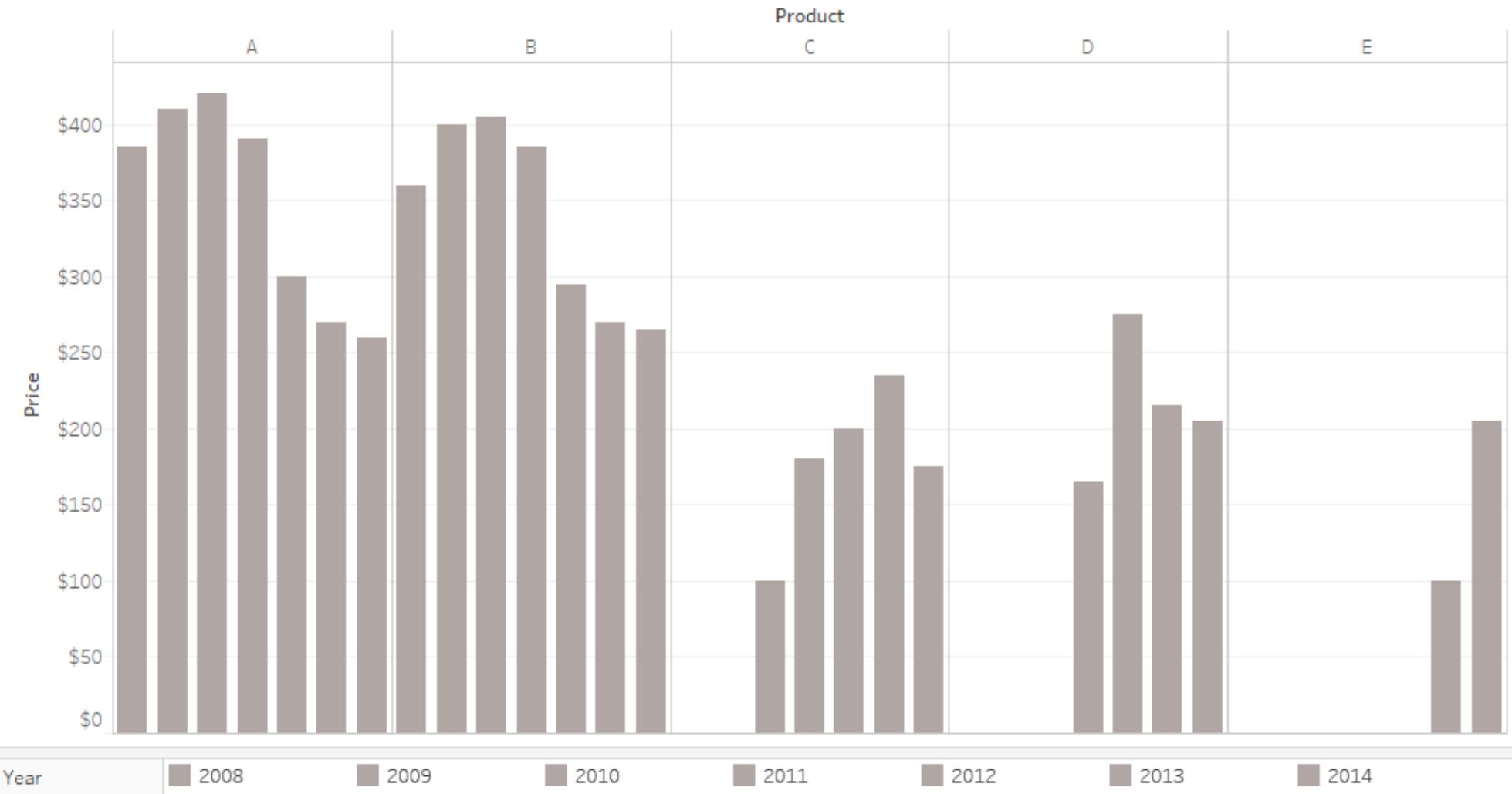
Original visual

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Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



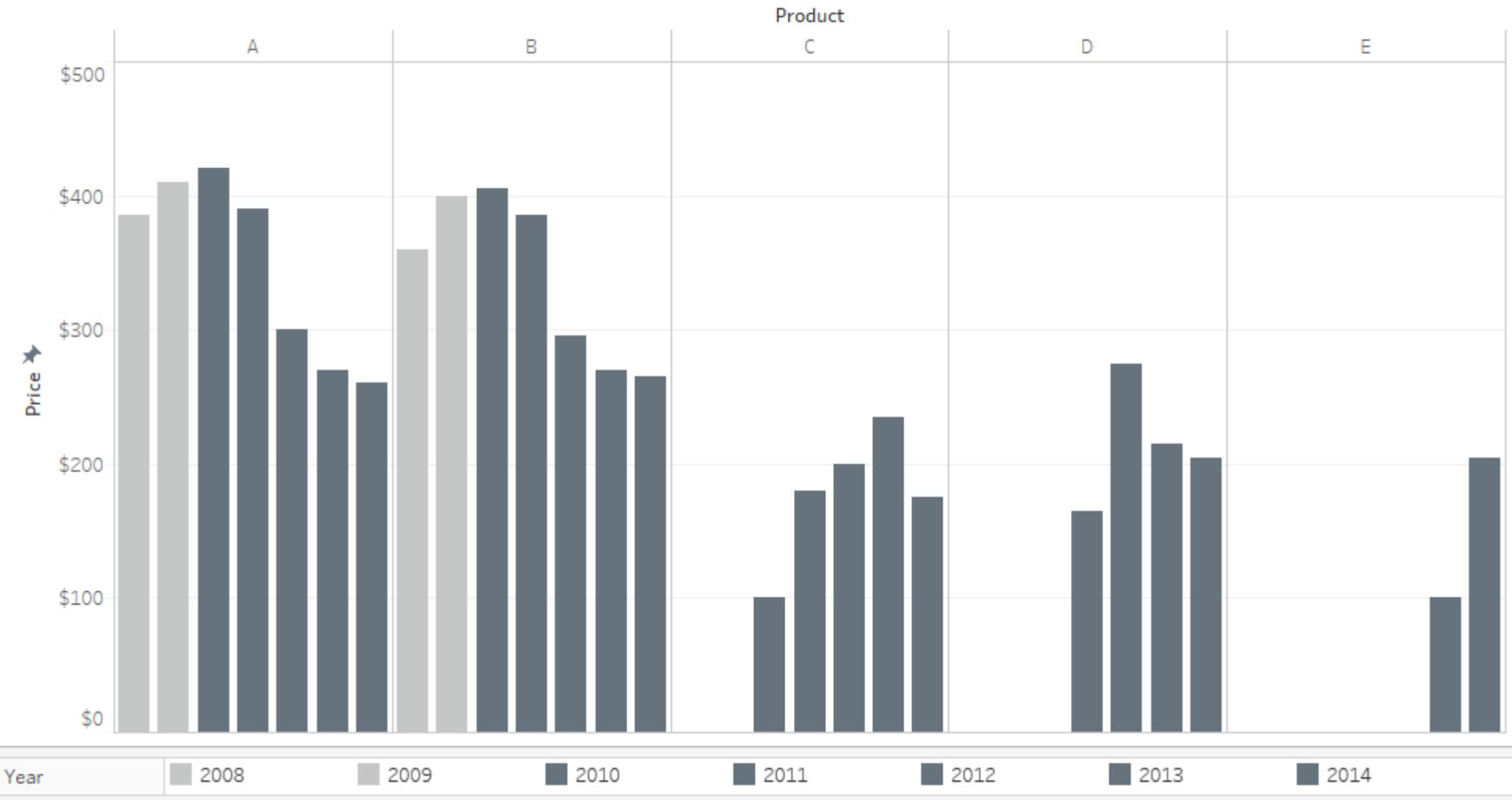
Remove the variance in colour

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Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



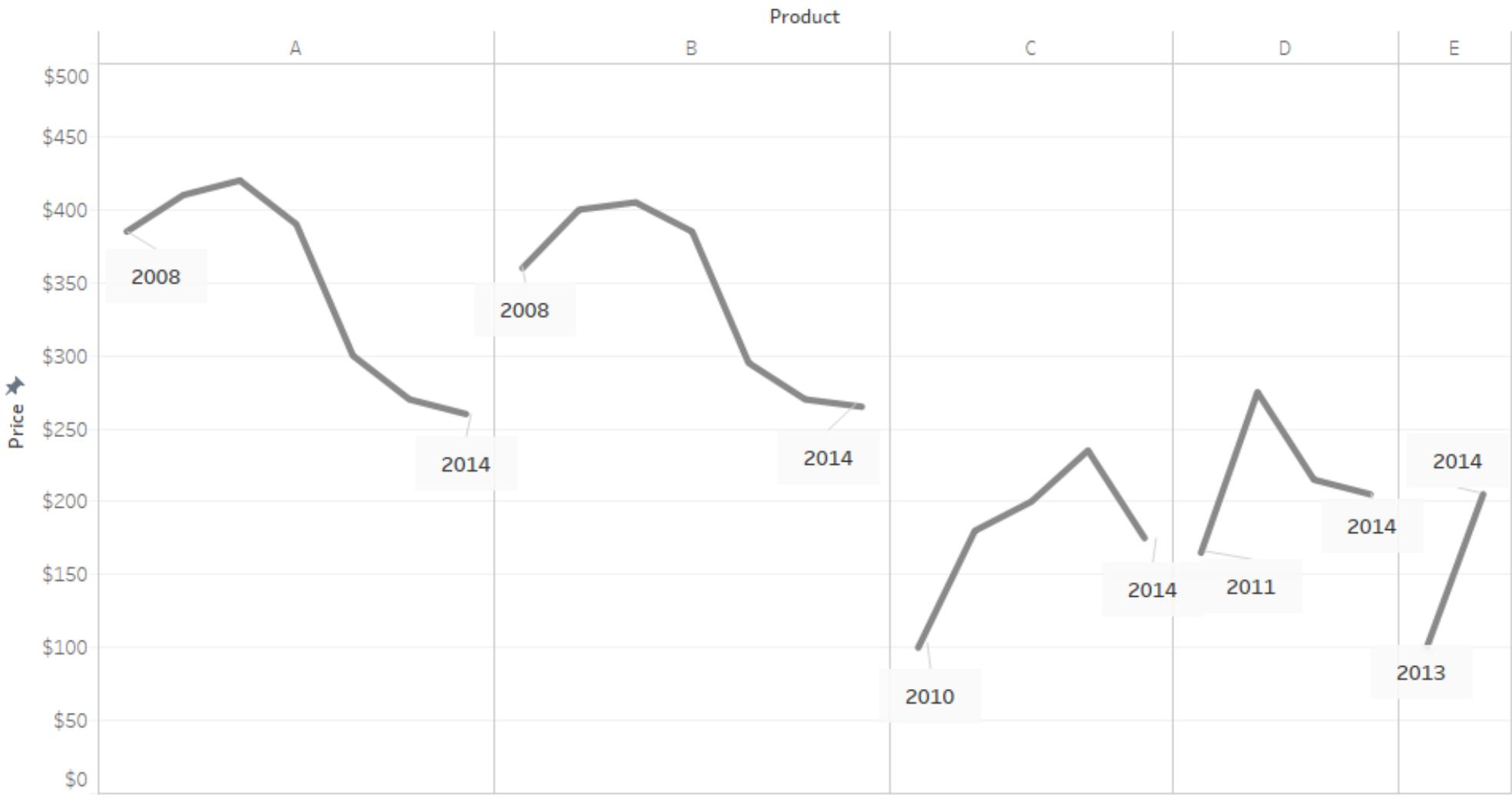
Emphasize 2010 forward

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Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



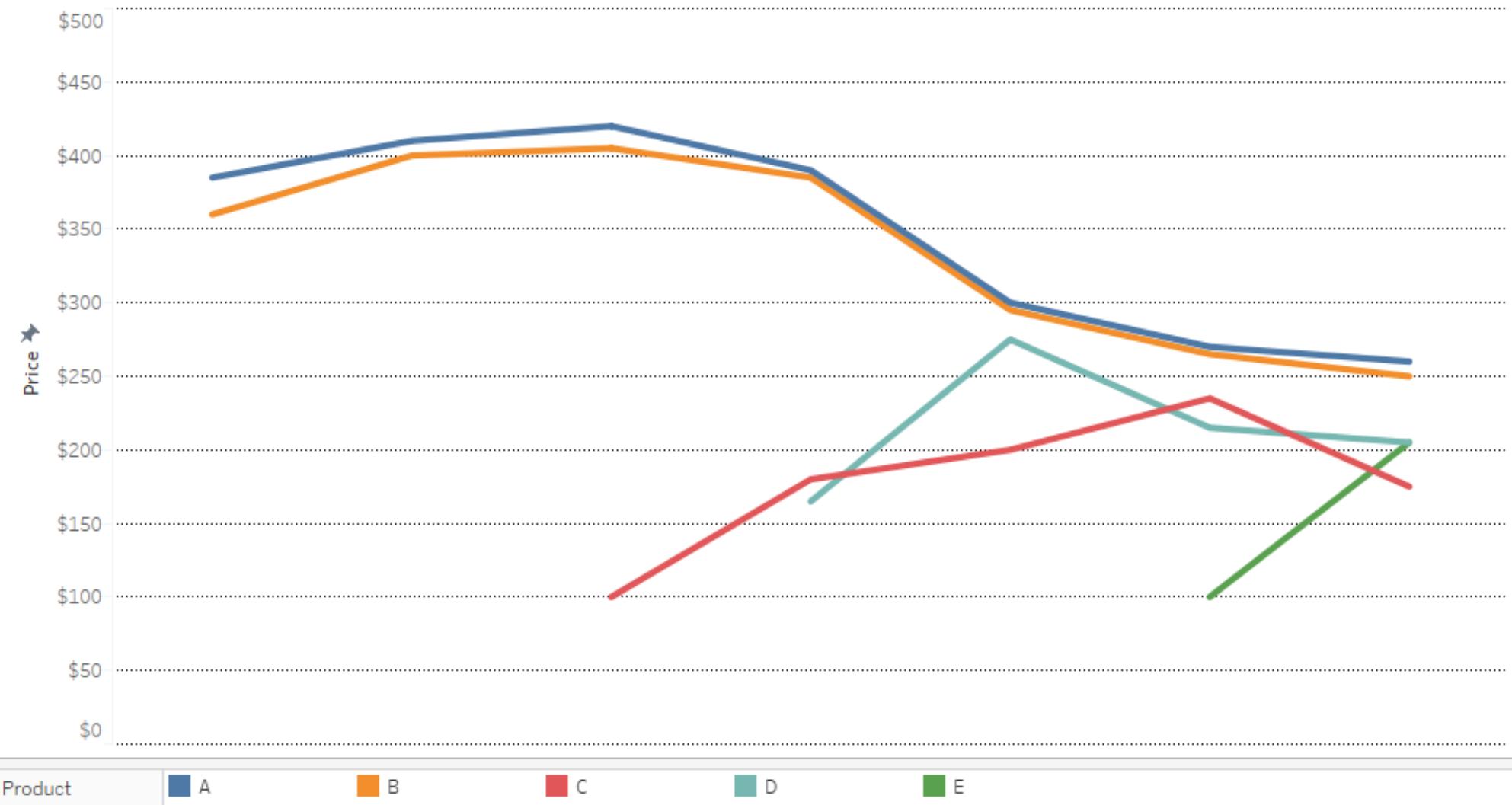
Change to line graph



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Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



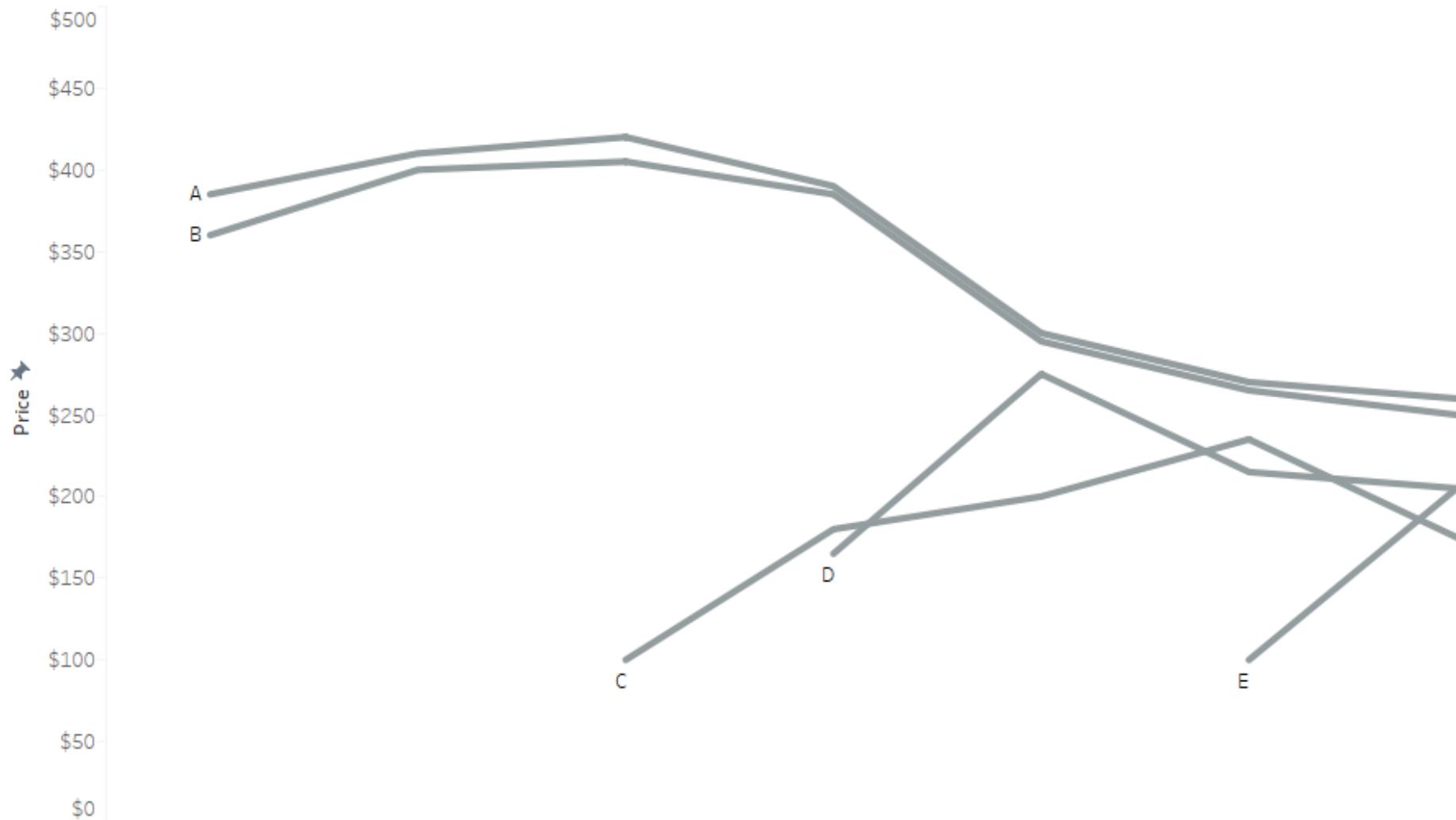
Single line graph for all products

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Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



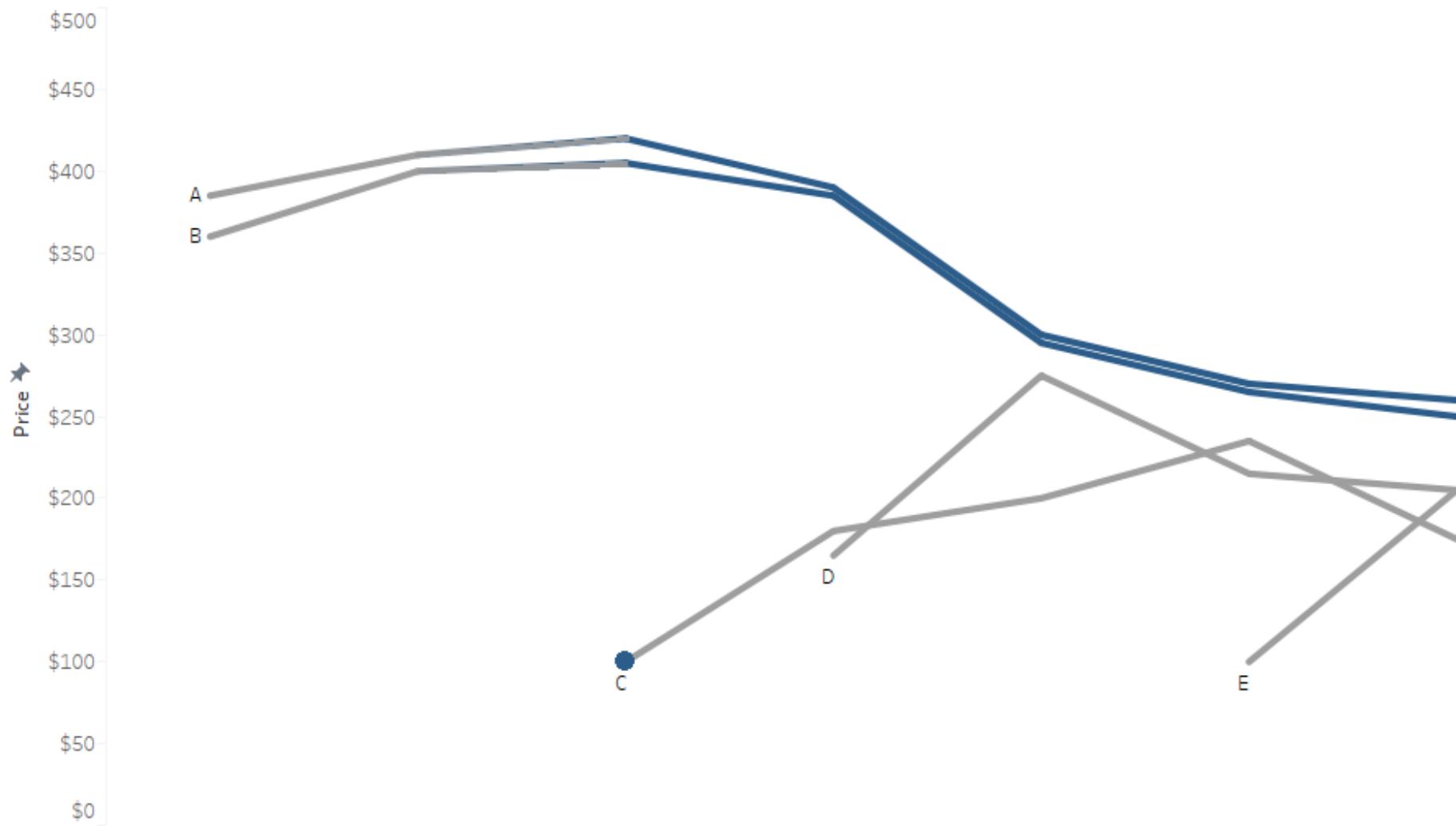
Eliminate clutter

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Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



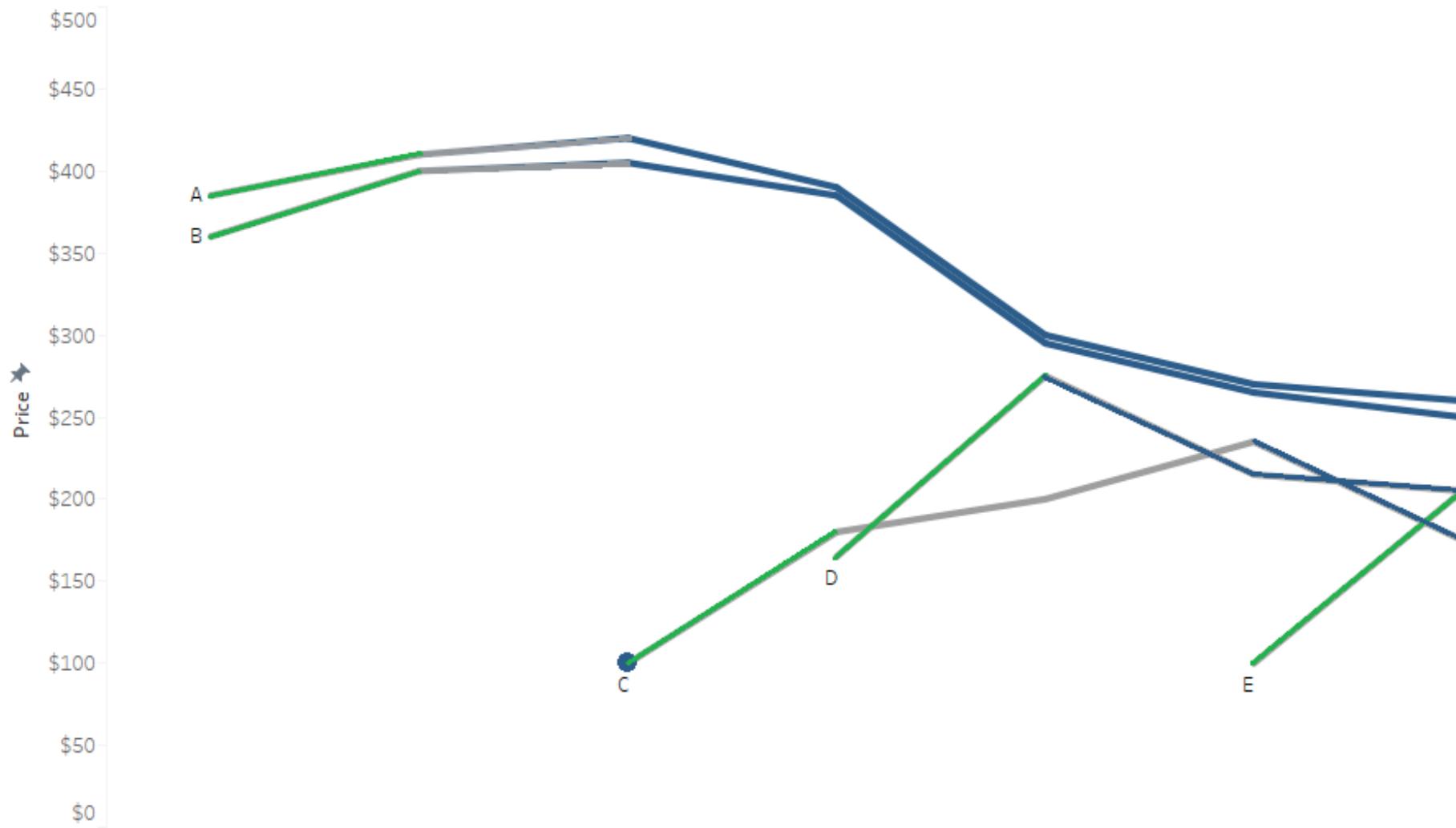
Focus the audience's attention

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Price has declined for all products on the market since the launch of product C in 2010

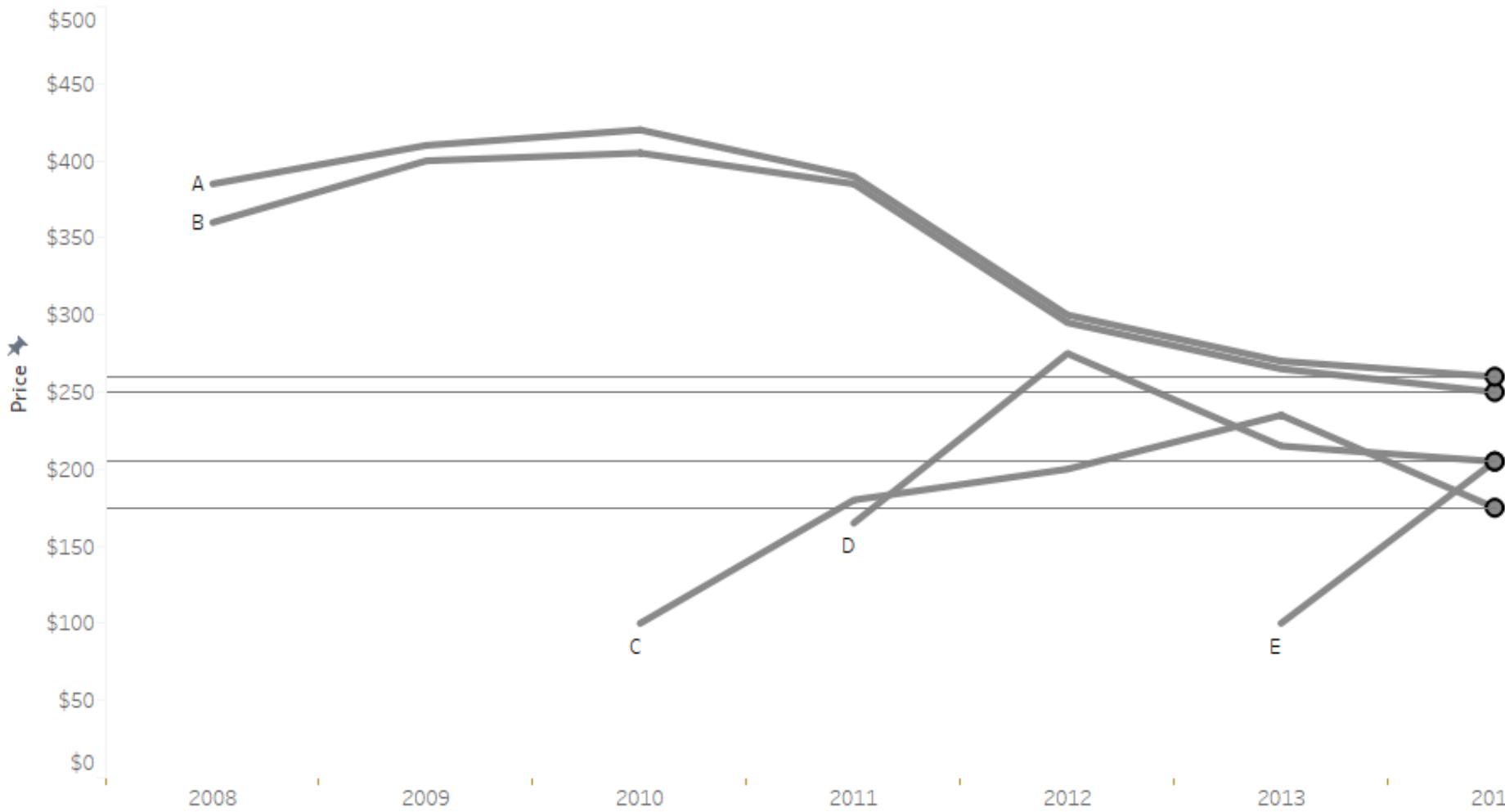
Average Retail Product Price Per Year



Refocus the audience's attention on another message

Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year



Refocus the audience's attention on yet another message



Tell it as a story



OUR GOAL:

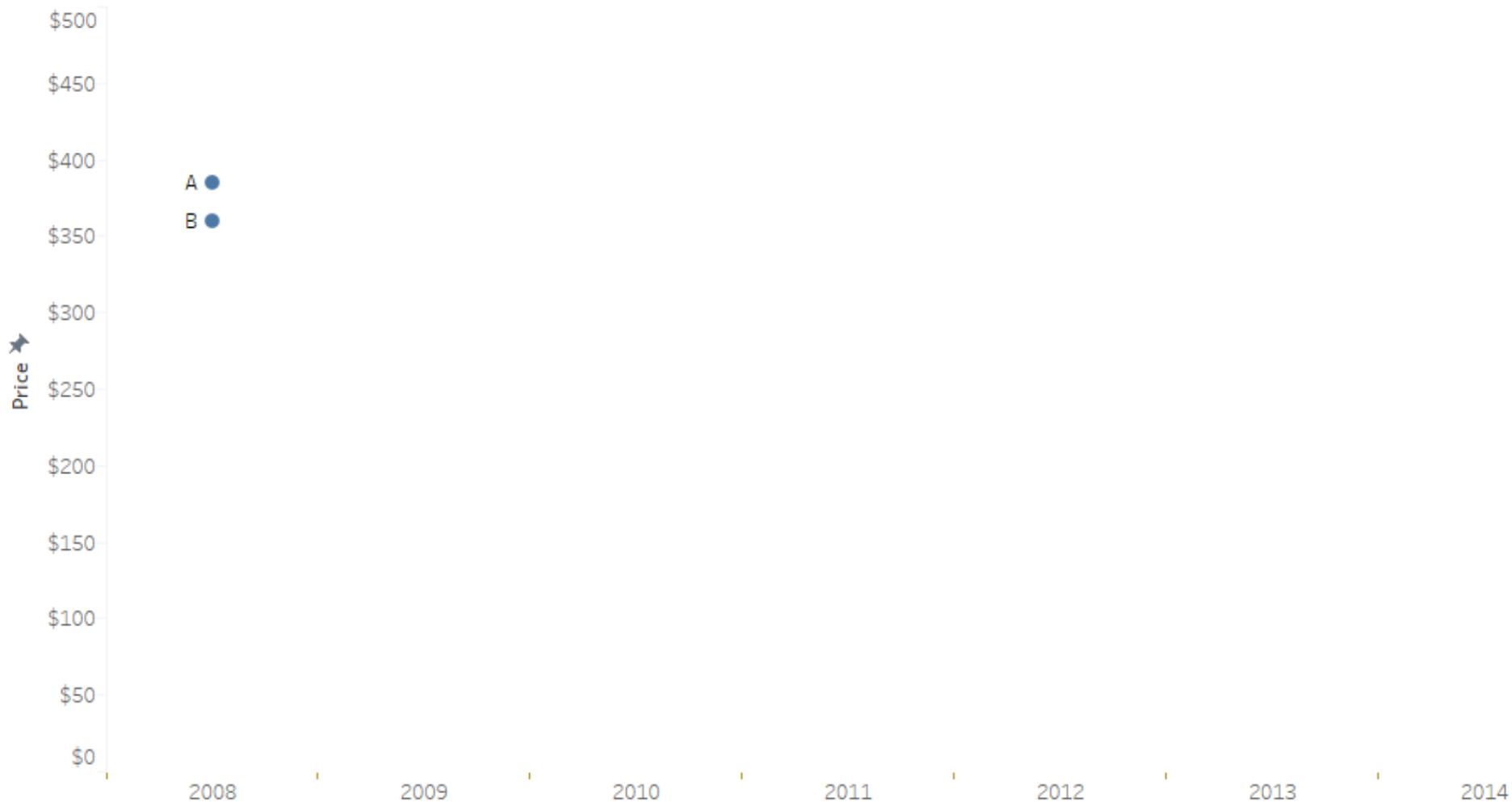
1. Understand **how prices have changed over time** in the competitive landscape.
2. Use this knowledge to **inform the pricing of our product**.

We will end with a **specific recommendation**.



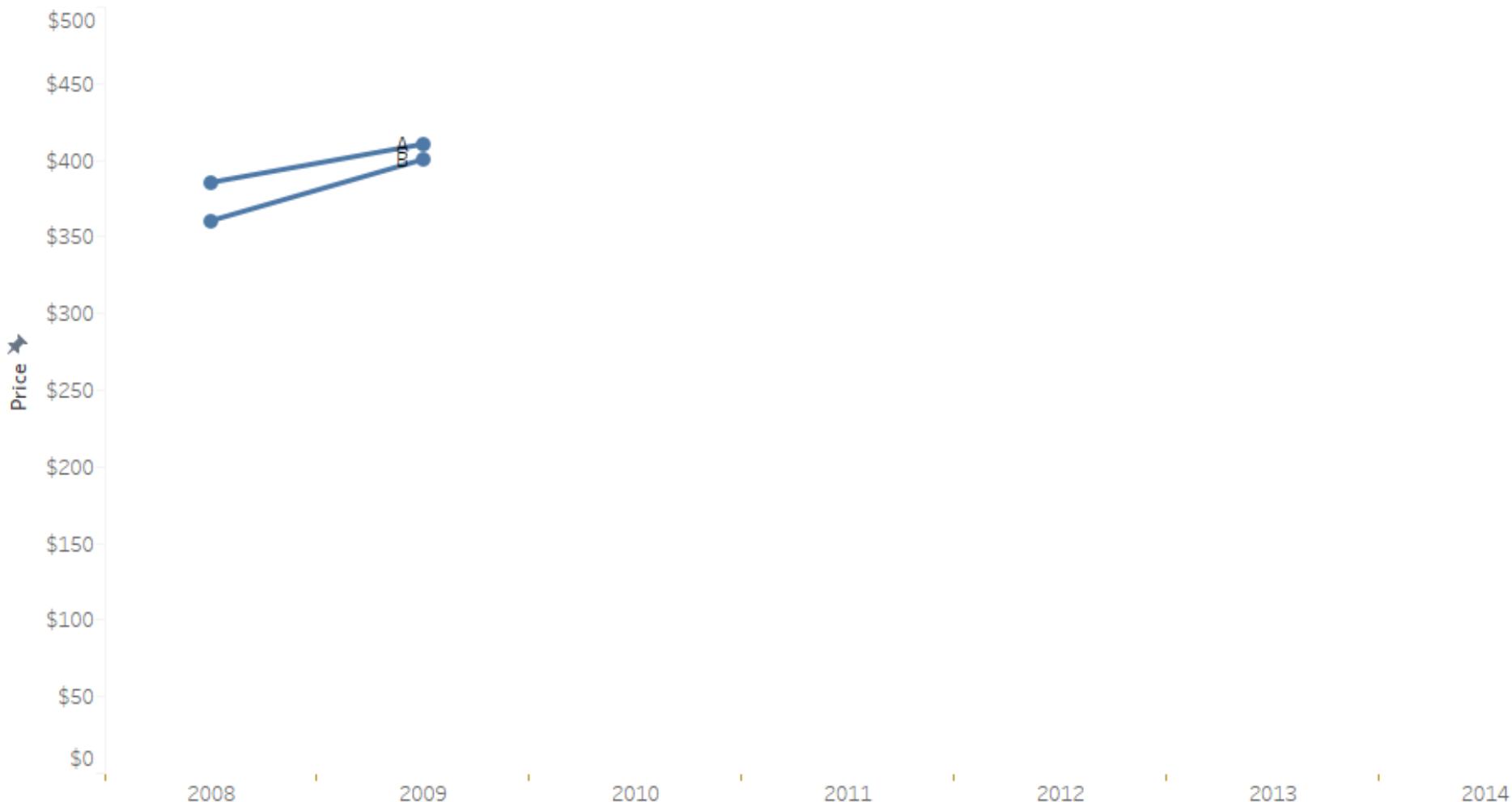
Products A and B were launched in 2008 at price points of over \$350

Average Retail Product Price Per Year



Products A and B were launched in 2008 at price points of over \$350

Average Retail Product Price Per Year

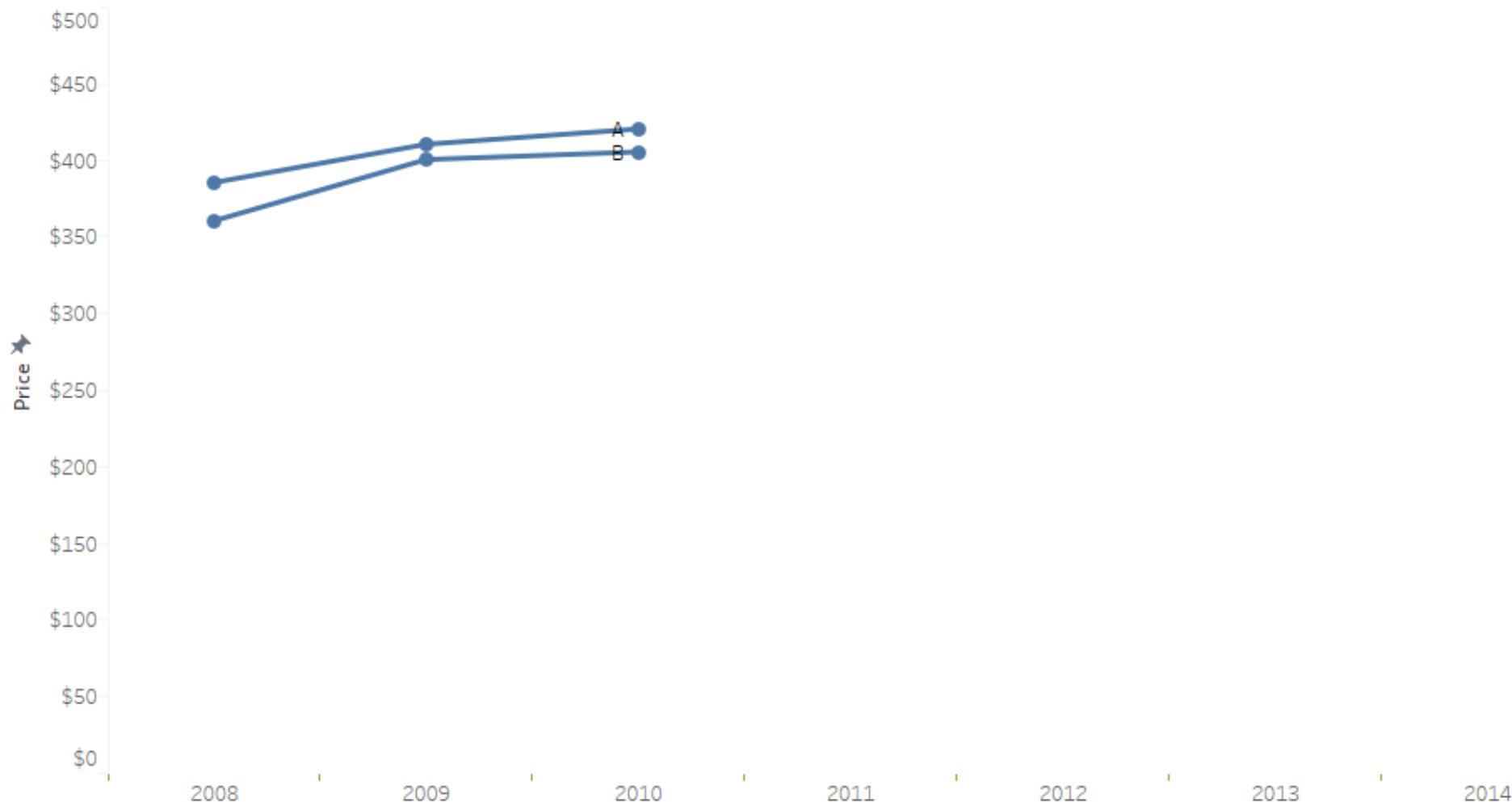


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Products A and B were launched in 2008 at price points of over \$350

Average Retail Product Price Per Year

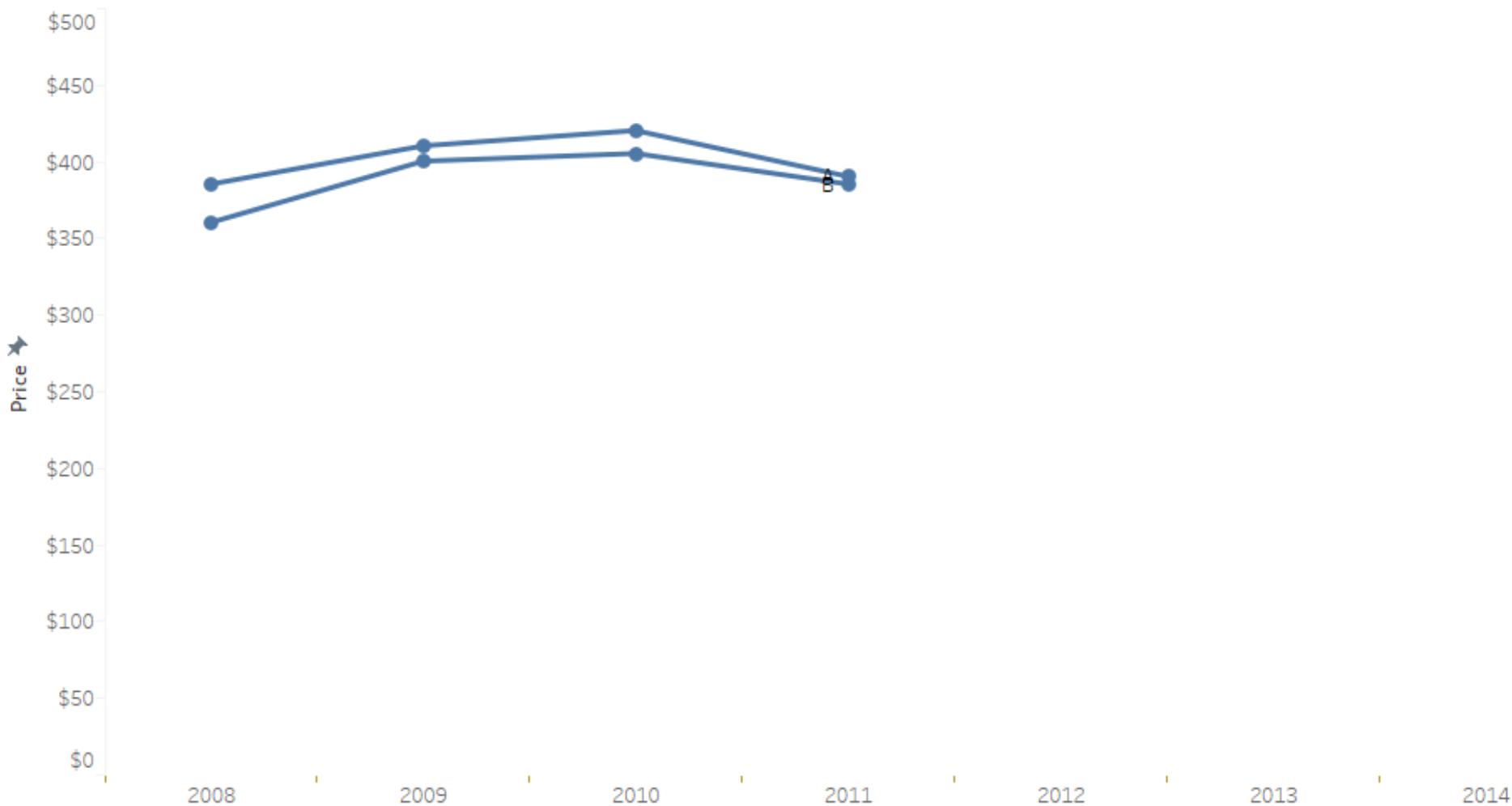


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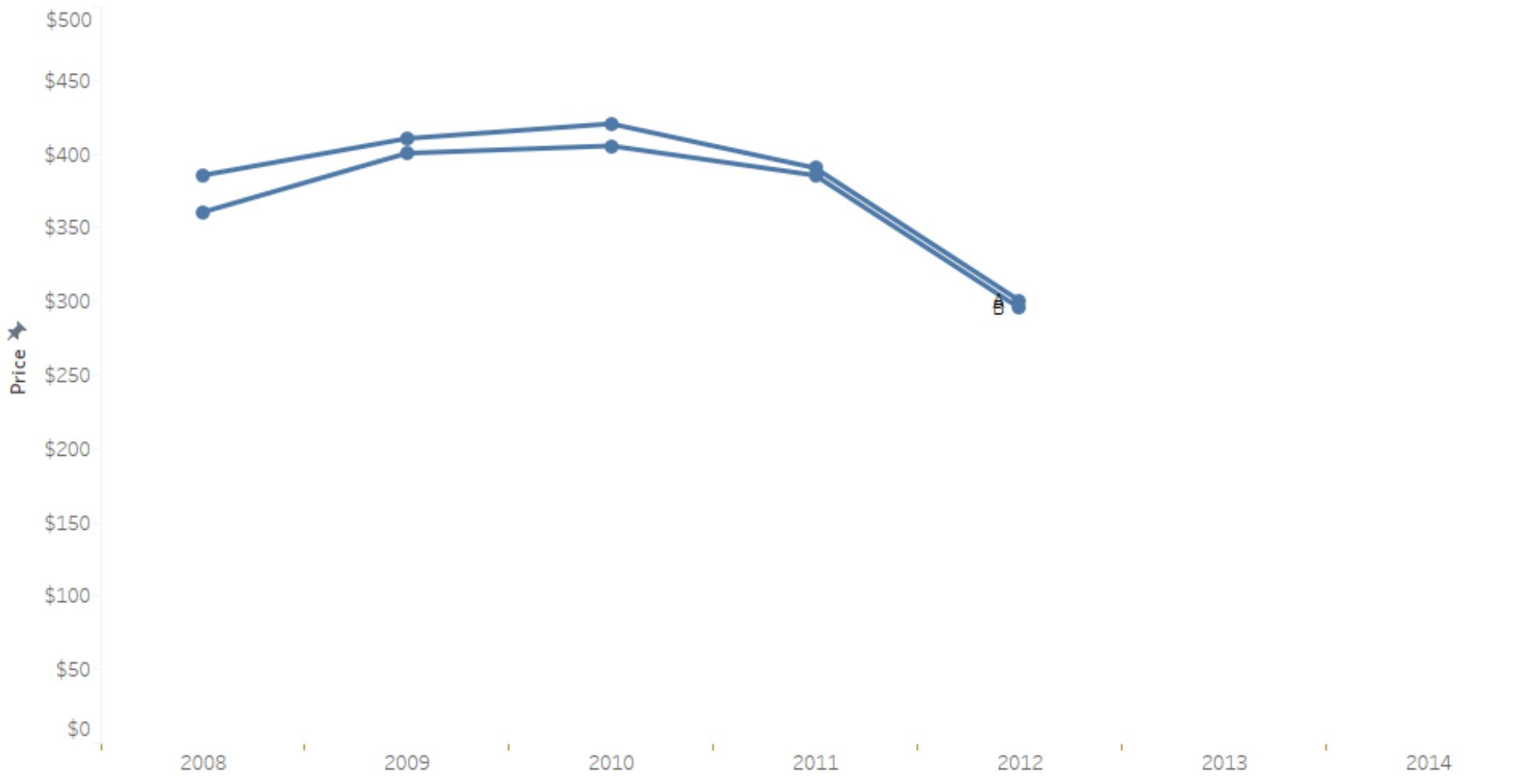
Products A and B were launched in 2008 at price points of over \$350

Average Retail Product Price Per Year



Both products followed similar trends over time with B consistently priced lower than A

Average Retail Product Price Per Year

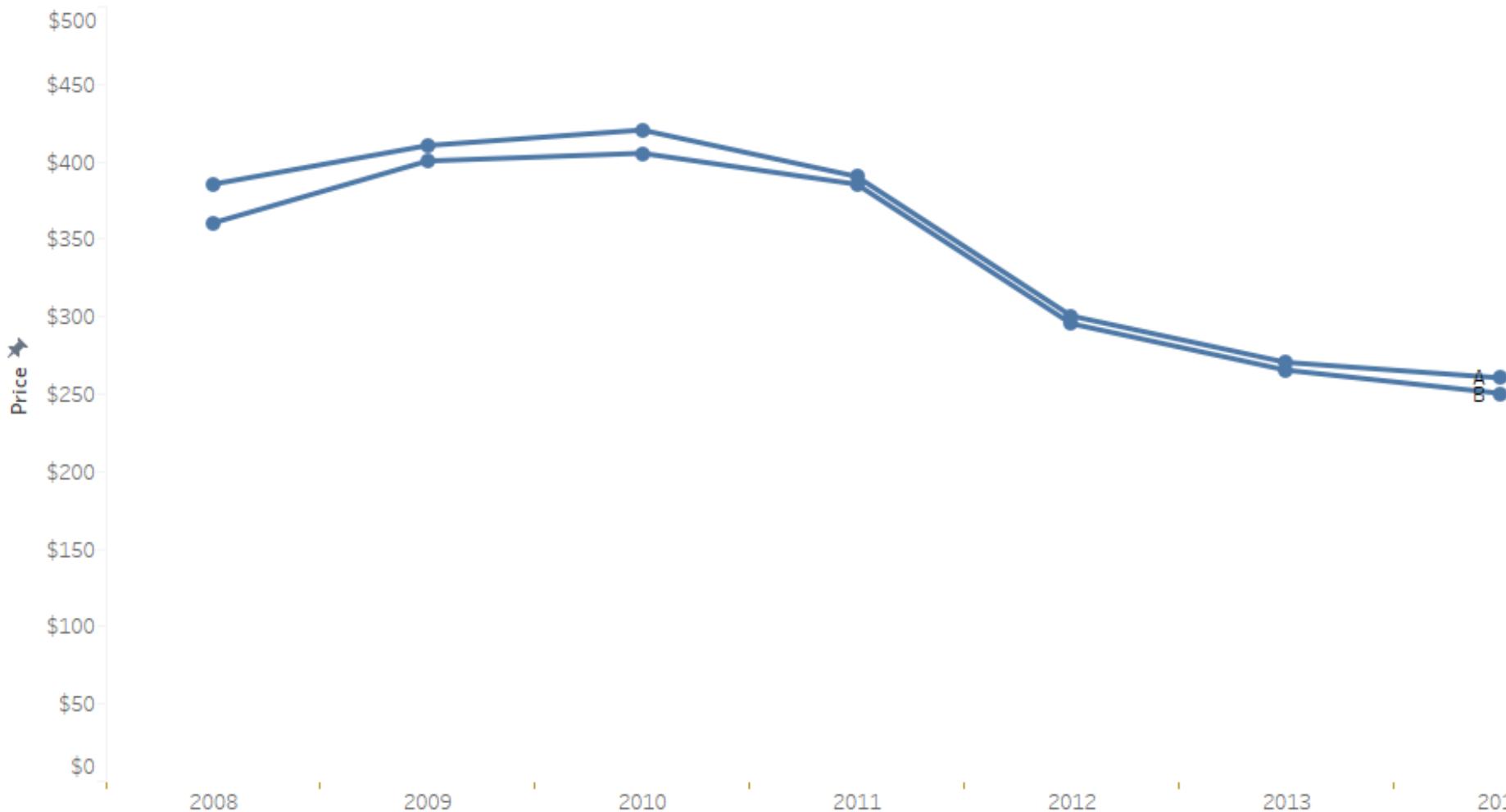


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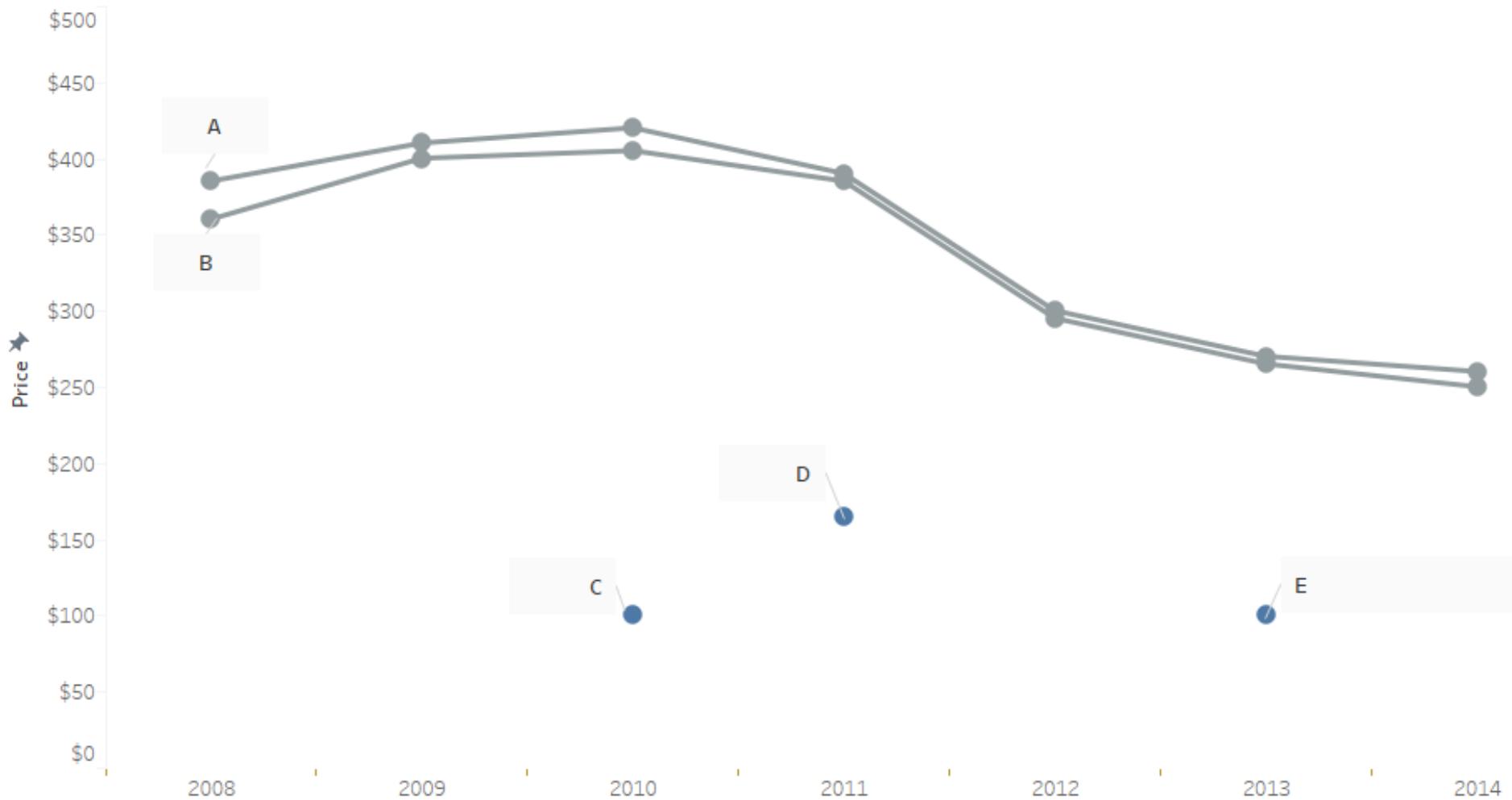
Both products converged around \$260 in 2014

Average Retail Product Price Per Year



Products C, D and E were introduced later at **much lower price points...**

Average Retail Product Price Per Year

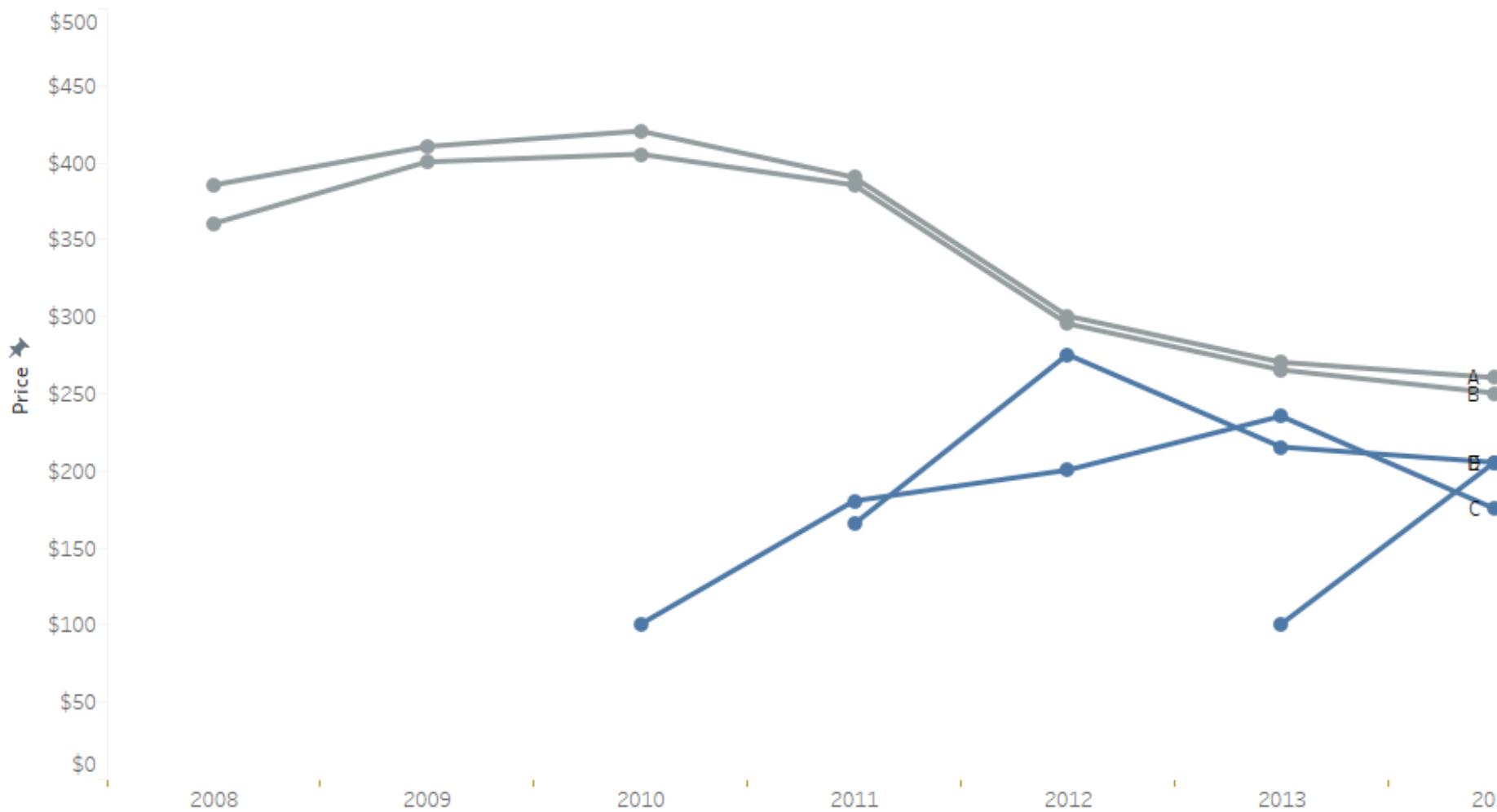


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...but all increased in price since their respective launches

Average Retail Product Price Per Year

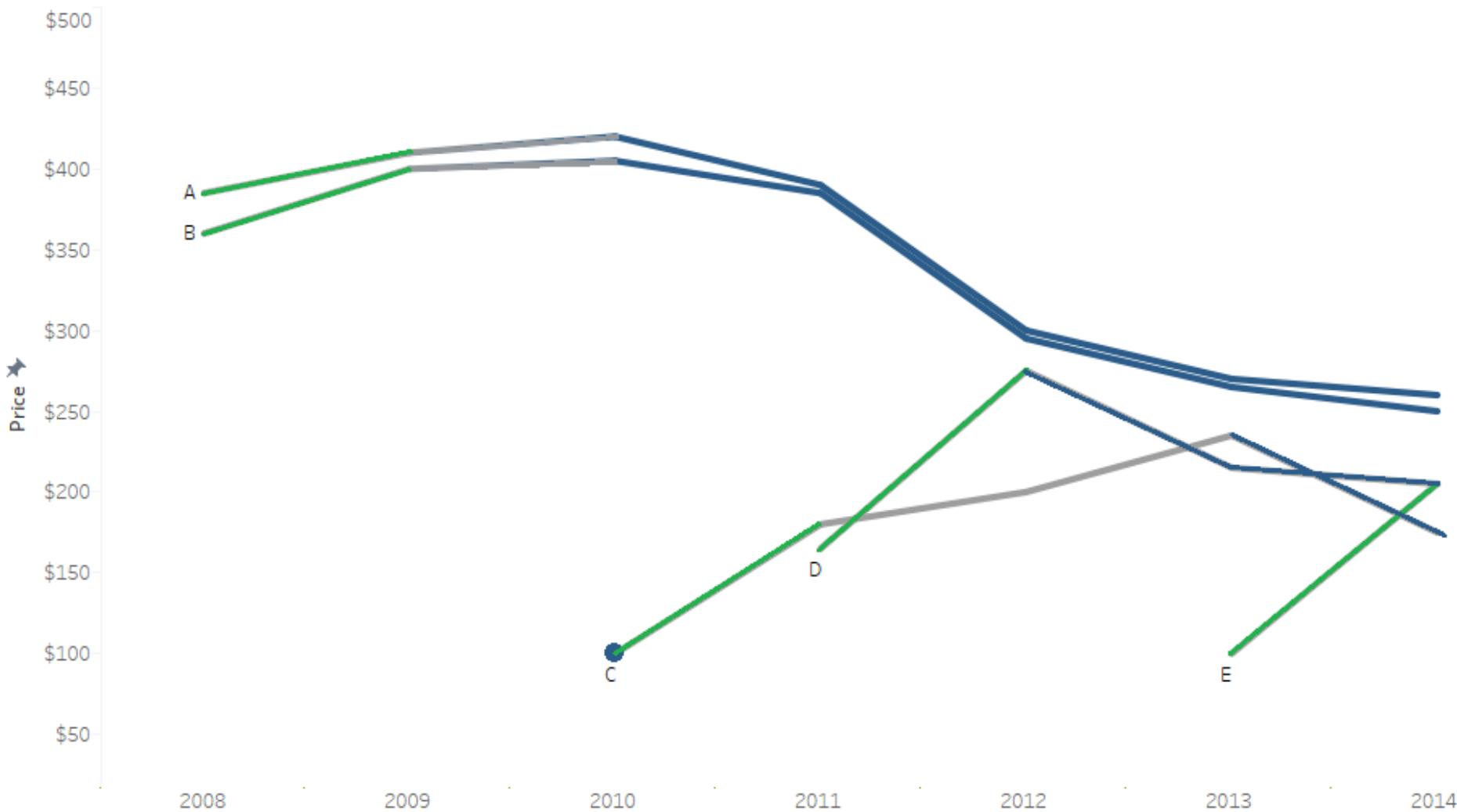


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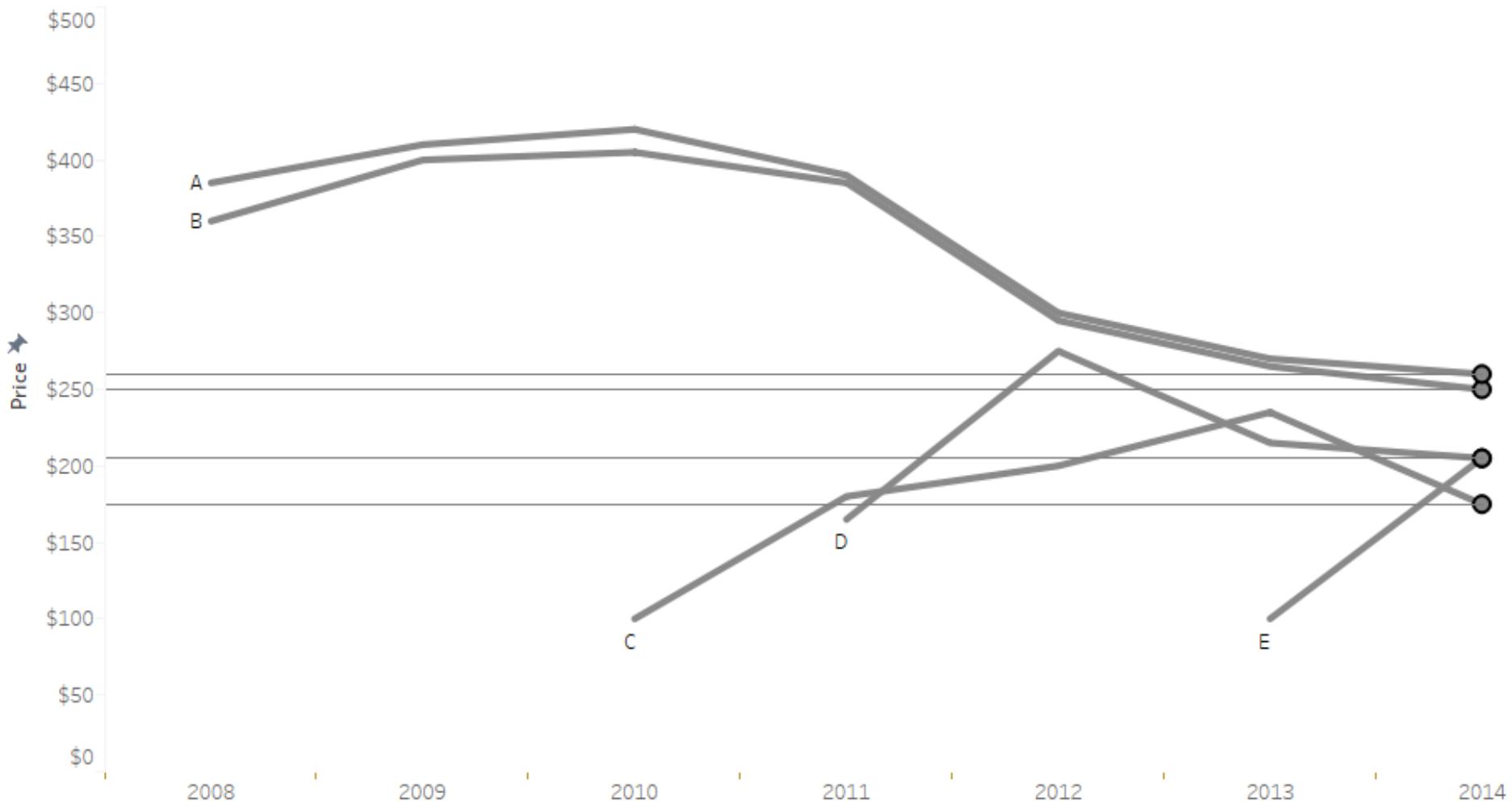
In this space, product prices **tend to rise initially followed by a decrease over time**

Average Retail Product Price Per Year



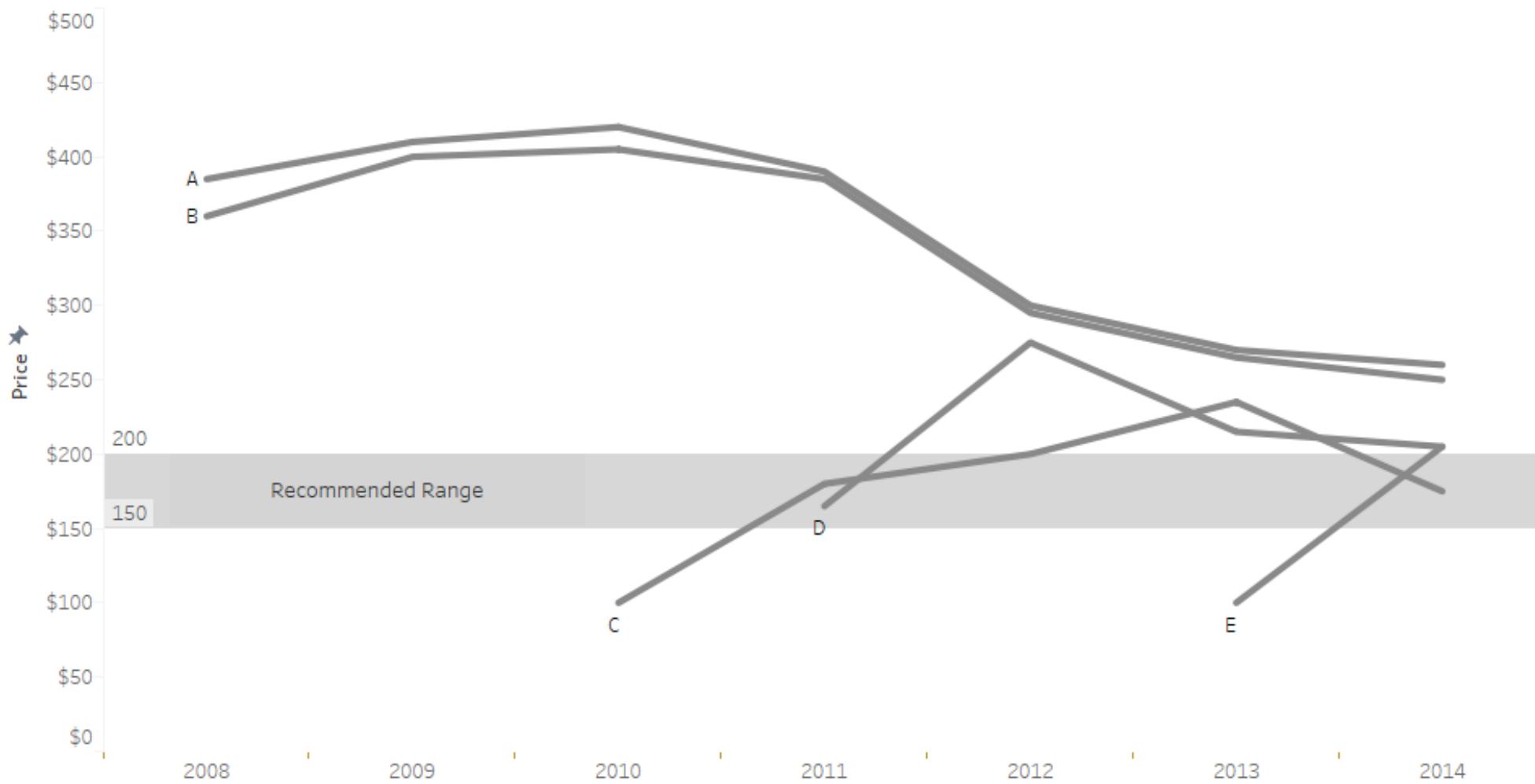
All products converged to a price between \$180 (C) and \$260 (A)

Average Retail Product Price Per Year



To remain competitive, it is recommended to price our product in \$150-\$200 range

Average Retail Product Price Per Year



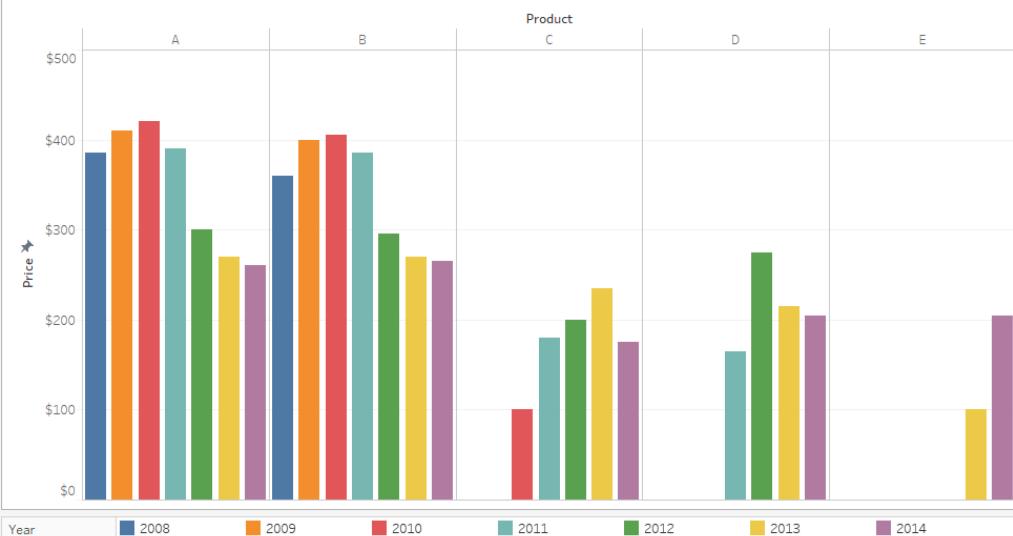
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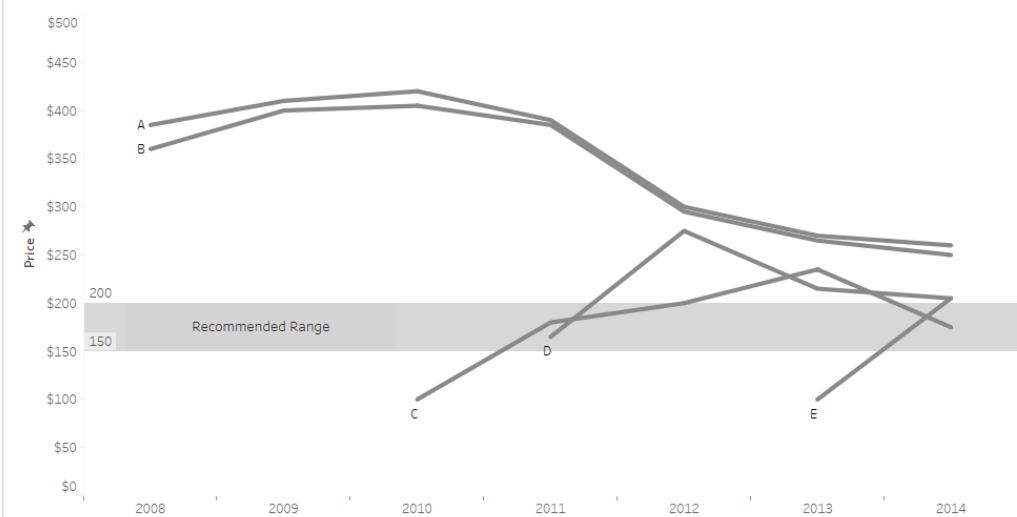
BEFORE AND AFTER

Price has declined for all products on the market since the launch of product C in 2010

Average Retail Product Price Per Year

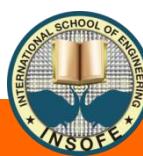


Average Retail Product Price Per Year



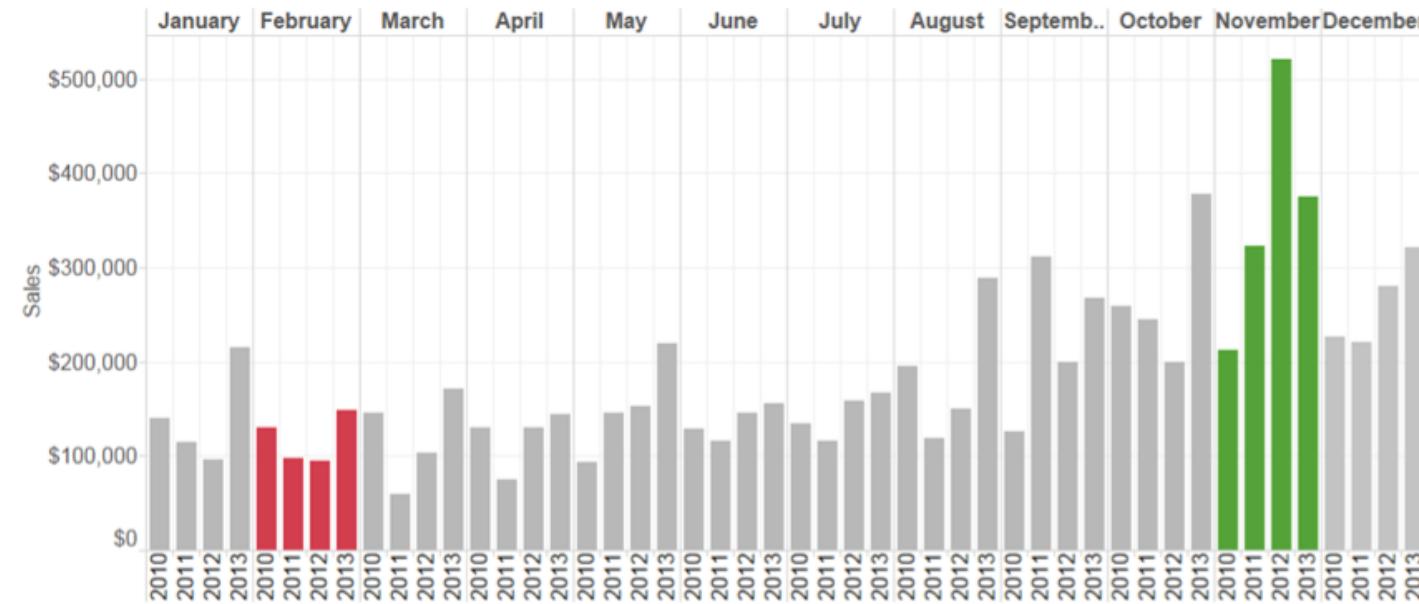
To remain competitive, it is recommended to price our product in \$150-\$200 range

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From Tableau whitepaper on “5 Charts Every Sales Leader Should Be Looking At”

The **SEASONALITY TIME TREND**



Can you suggest a better alternative(s)?

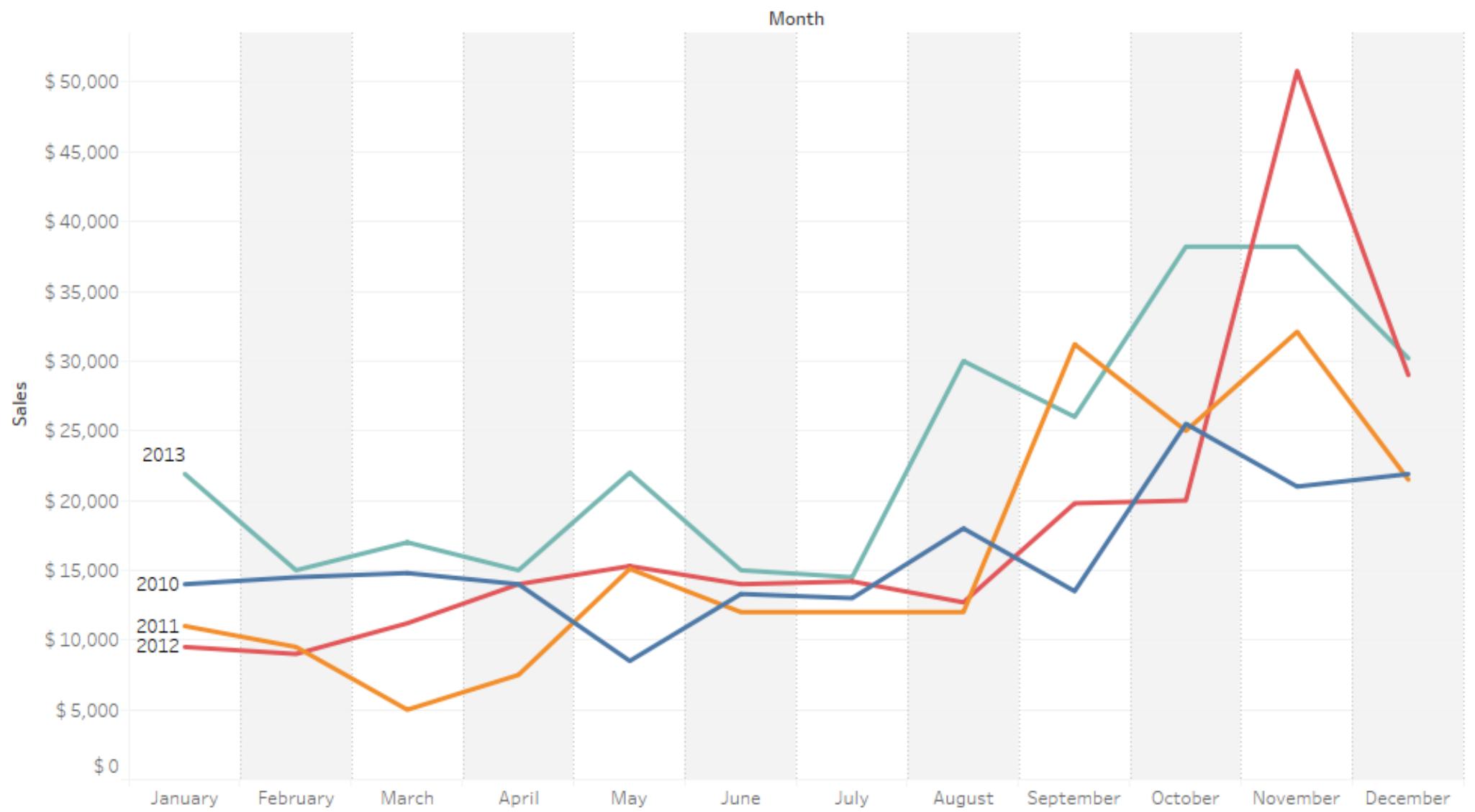
Looking at time trend for seasonal influences gives you the ability to **FORECAST** and **PLAN** appropriately.

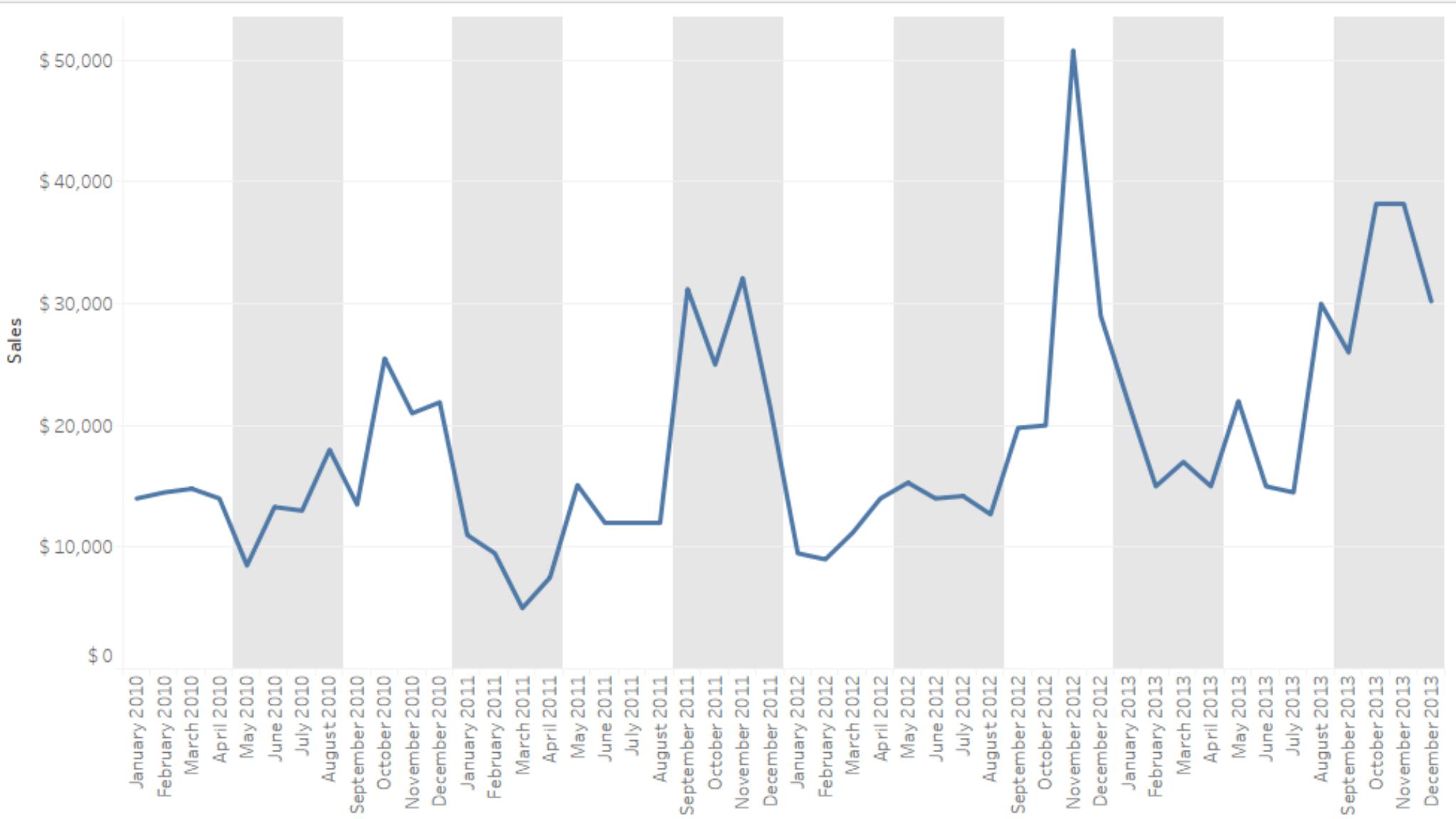
Summer Slump, or **SOMETHING ELSE?**

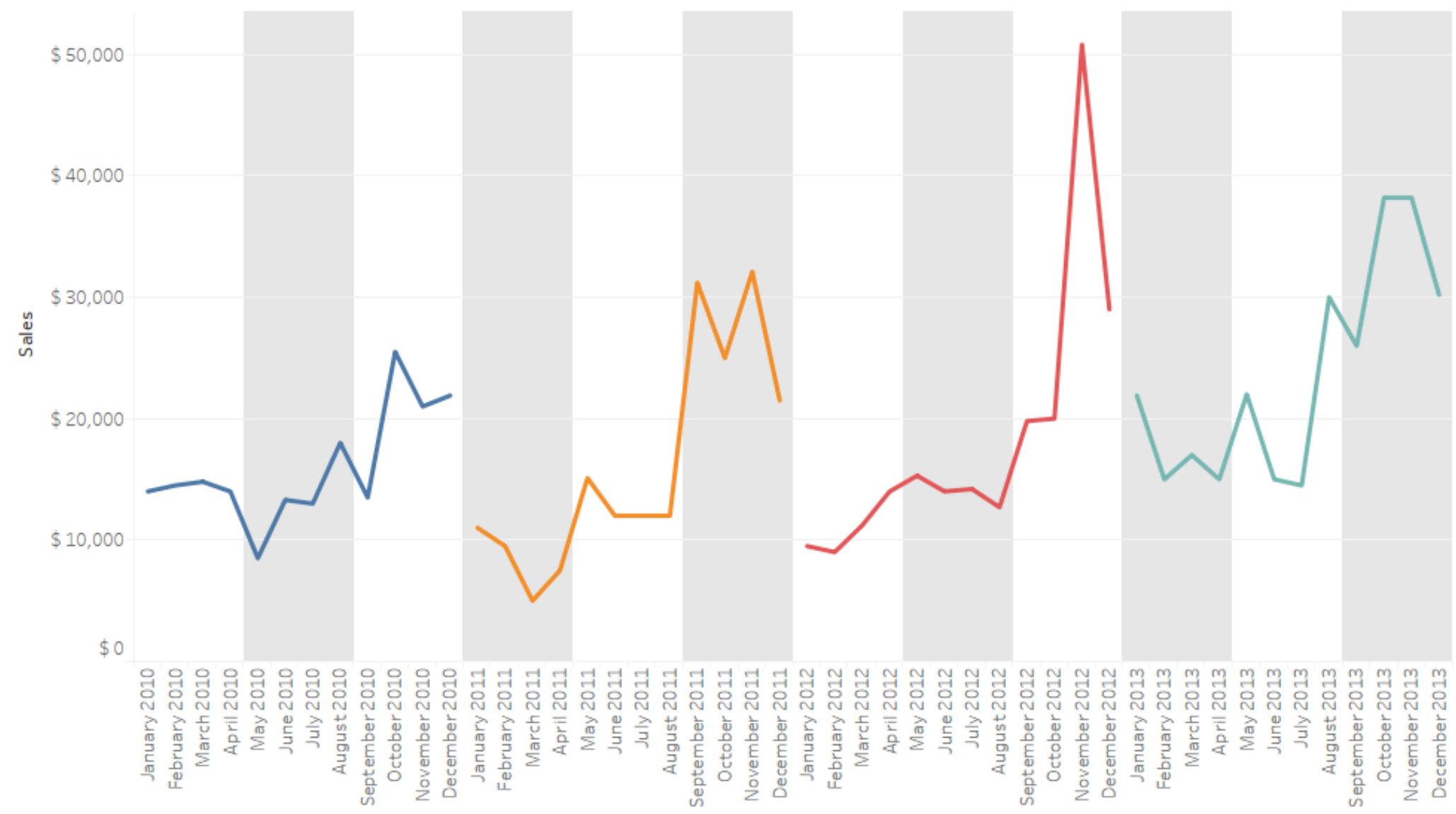
End of the Year
FLURRY

Historically
SLOW QUARTERS

CEE 74







References

A lot of the visualization material in these slides has been collated from:

- Designing Data Visualizations, Noah Iliinsky and Julie Steele, O'Reilly, August 2014
- Storytelling with Data: A Data Visualization Guide for Business Professionals, Cole Nussbaumer Knaflic, Wiley, 2015
- Good Charts: The HBR Guide to Making Smarter, More Persuasive Data Visualizations, Scott Berinato, Harvard Business School Publishing Corporation, 2016

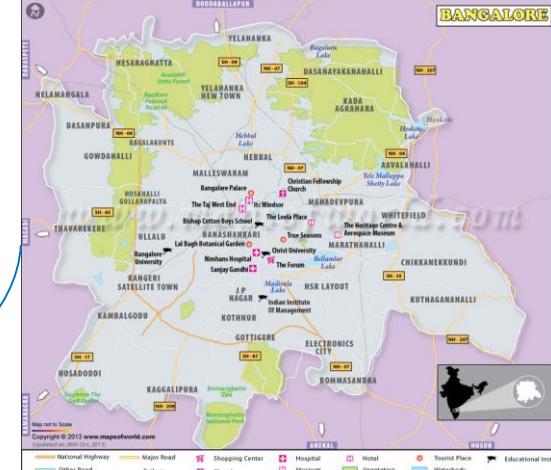


References

- 12 Great Charts and when to use them:
<http://www.stratigent.com/community/analytics-insights-blog/12-great-charts-and-when-use-them>
- Best Practices for Effective Dashboards:
http://onlinehelp.tableau.com/current/pro/desktop/en-us/dashboards_best_practices.html
- Building effective dashboards and scorecards (E-Book):
http://viewer.media.bitpipe.com/1178304416_32/1255101187_197/Tableau_sDataMgt_SO- 23765-EBook_10.5.pdf
- Data 101: <https://visage.co/category/data-101/>



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