BUAN 3500: Data Visualization and Descriptive Analytics in Business

Data Visualization

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Reminders

Reminder: Follow the instructions in the syllabus to download Tableau if you haven't already!

(You can download and use Tableau for free using the Product Key for our class: TCBG-E3E8-A290-0FAA-E898)

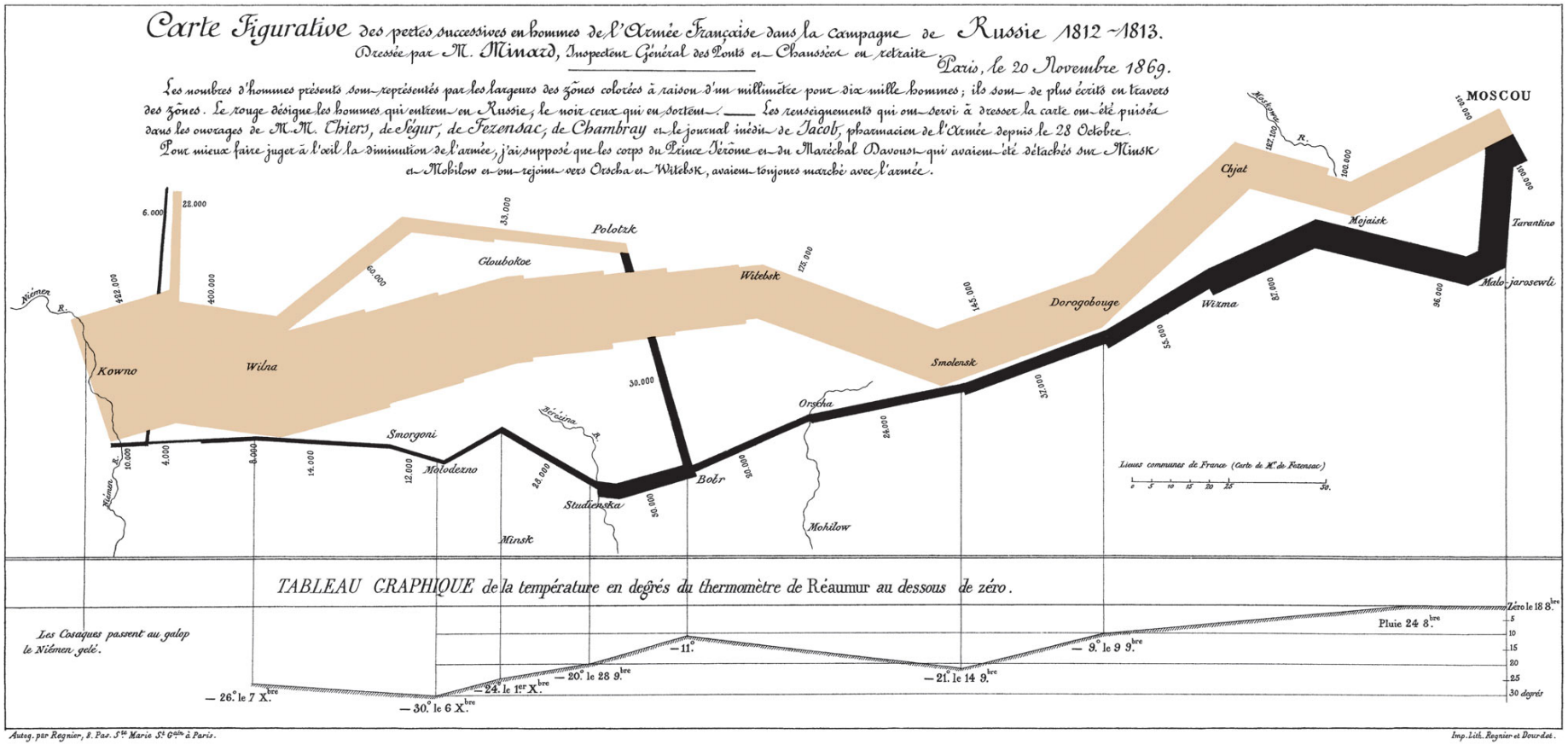
Reminder: Be sure you're reading the assigned sections in the textbook and the assigned pages in Tufte.

Tufte – Graphical Excellence

Graphical Excellence:

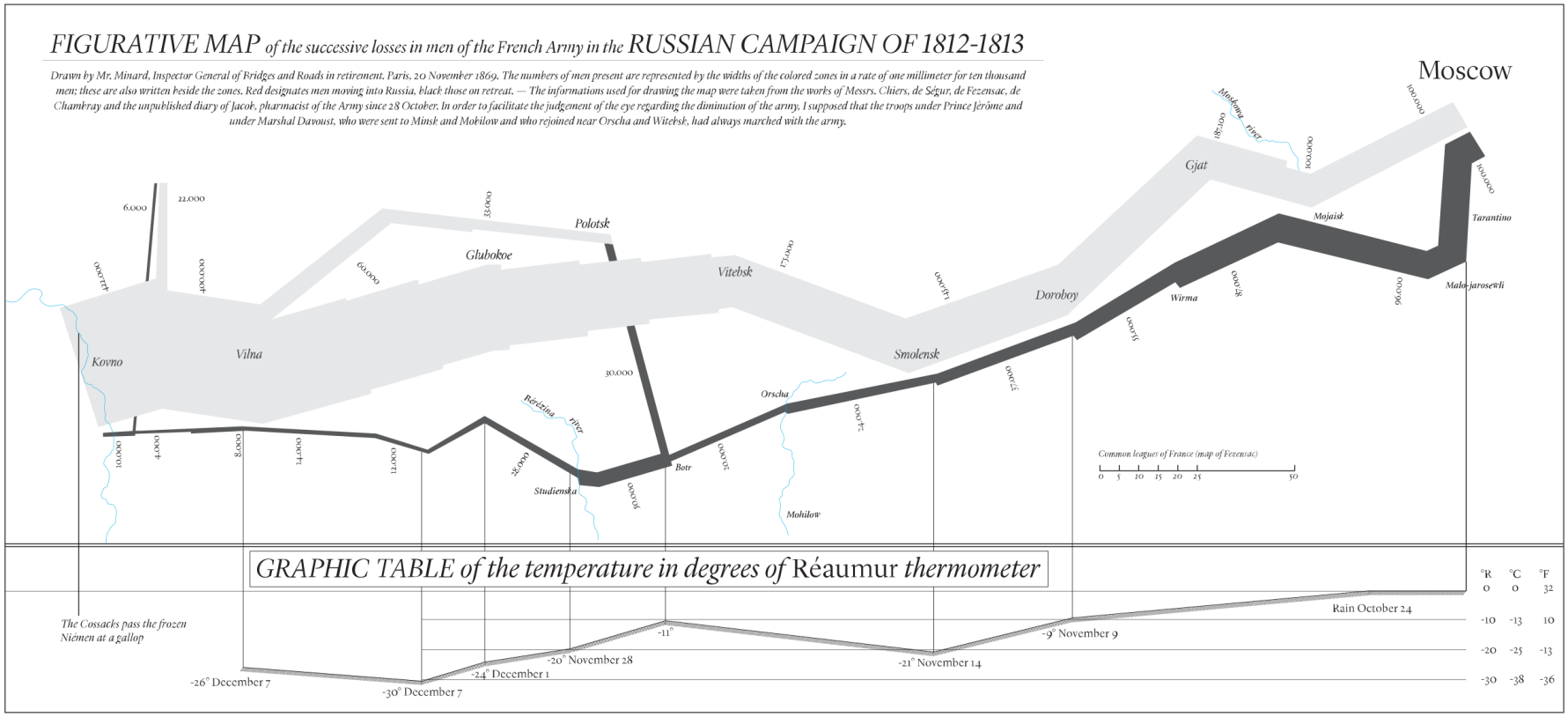
"the efficient communication of complex quantitative ideas"

Tufte – Graphical Excellence



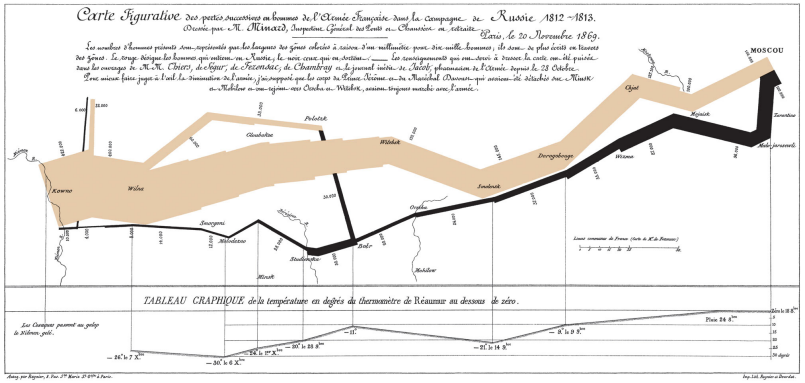
Charles Joseph Minard's portral of Napoleon's 1812 Russian Campaign
(English translation and redrawing is in the book)

Tufte – Graphical Excellence



A modern redrawing of Minard's graphic

Tufte – Graphical Excellence



Charles Joseph Minard's portral of Napoleon's 1812 Russian Campaign

Tufte says this "may wll be the best statistical graphic ever drawn". Why?

- It tells a story
- Shows six variables in a 2-D surface

Tufte – Graphical Excellence

Let's look at the map shown at the link below. A map is a data visualization – how much information (and what kinds) does it portray?

https://bit.ly/3BmWnvR

Tufte – Graphical Excellence

Tufte's Principles of Graphical Excellence (p. 51):

- Graphical excellence is the well-designed presentation of interesting data – a matter of substance, of statistics, and of design.
- Graphical excellence consists of complex ideas communicated with clarity, precision, and efficiency.
- Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.
- Graphical excellence is nearly always multivariate.
- Graphical excellence requires telling the truth about the data.

Tufte – Graphical Integrity

"Graphical excellence begins with telling the truth about the data."

Tufte (p. 53)

Graphical Integrity

YouTube Video:
How to spot a misleading graph - Lea Gaslowitz
https://youtu.be/E91bGT9BjYk

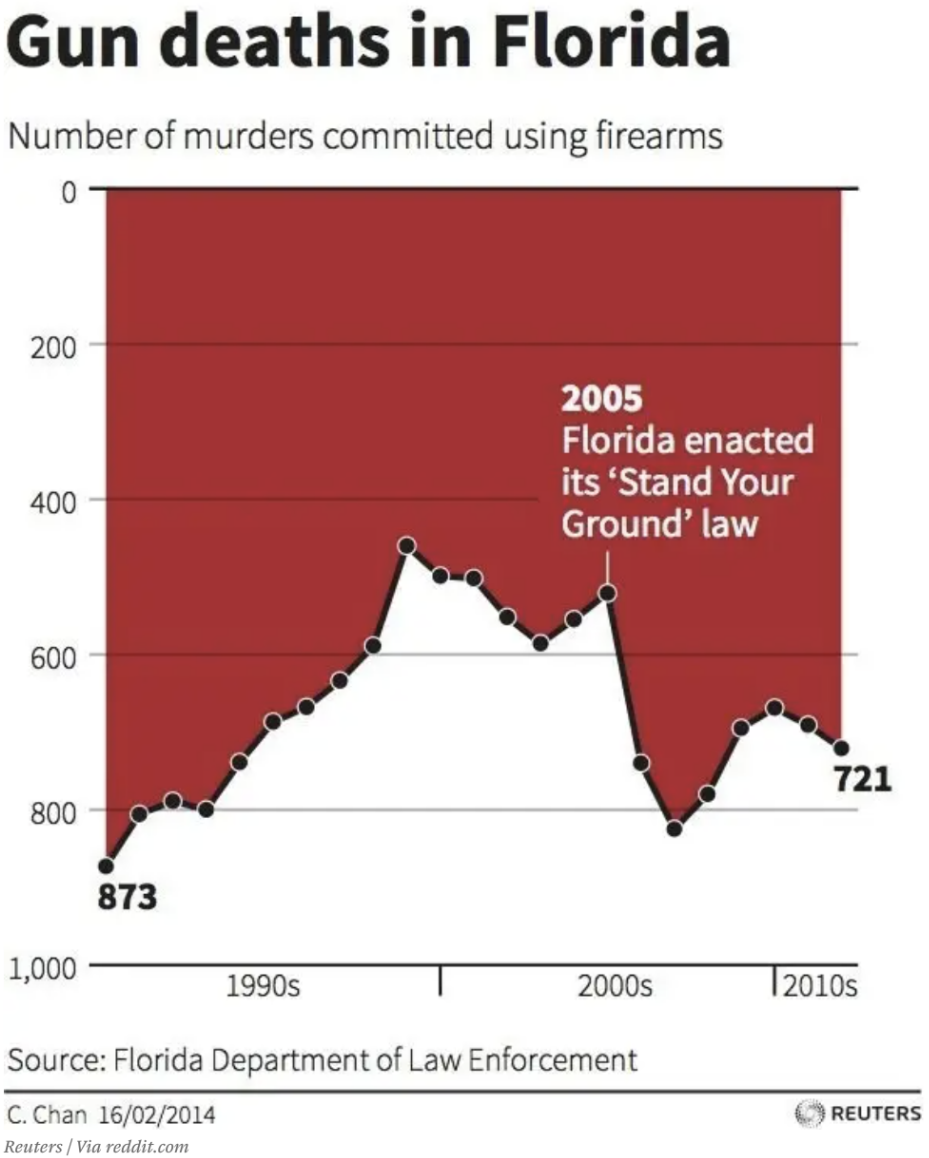
Graphical Integrity

Let's look at several graphics that are lying or are misleading.
(You might have seen some of these before!)

The images on the following slides are taken from the following websites:

- https://bit.ly/3rYJiYG
- https://bit.ly/3YwVj3B
- https://bit.ly/3DS7ILf

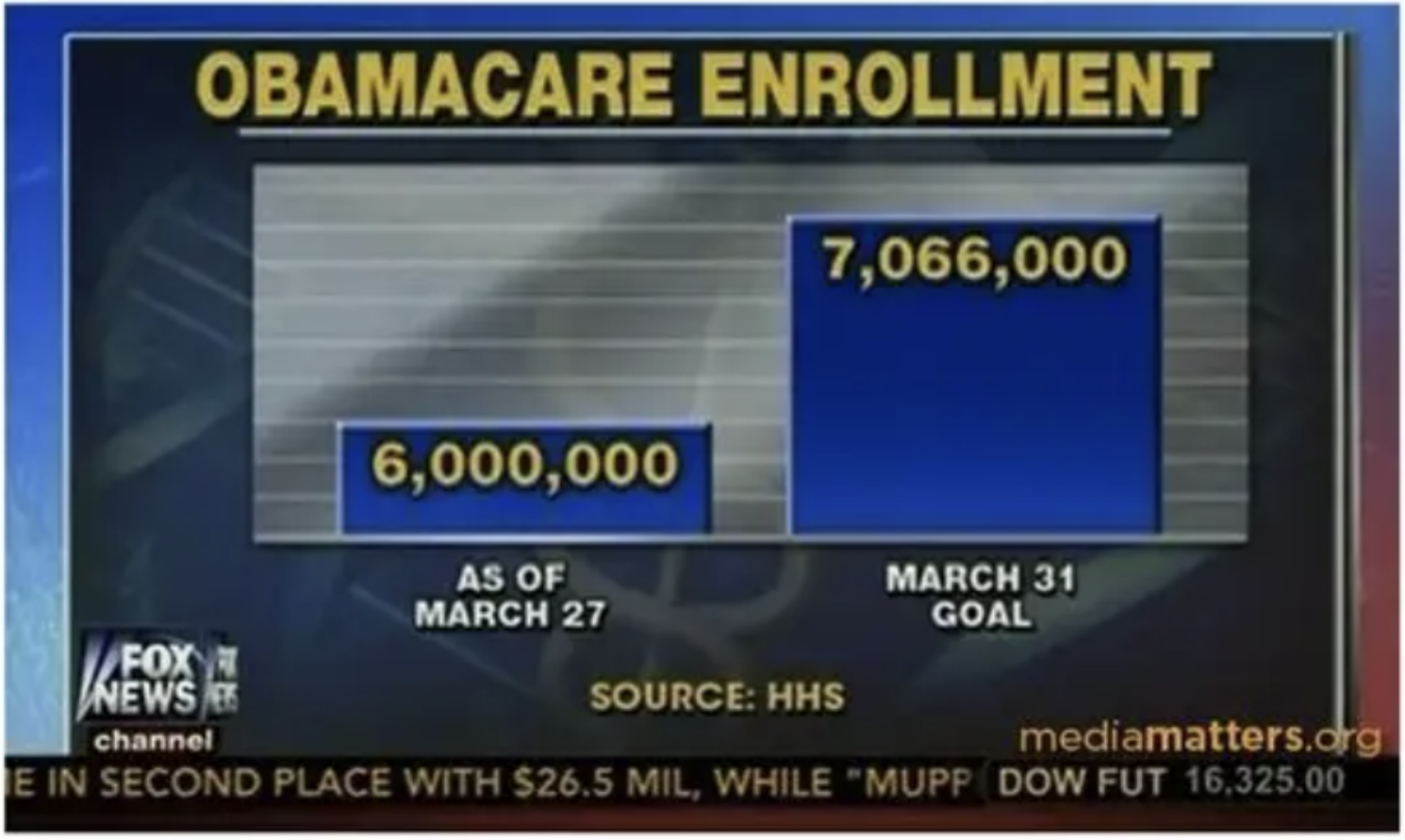
Graphical Integrity



Reuters / Via reddit.com

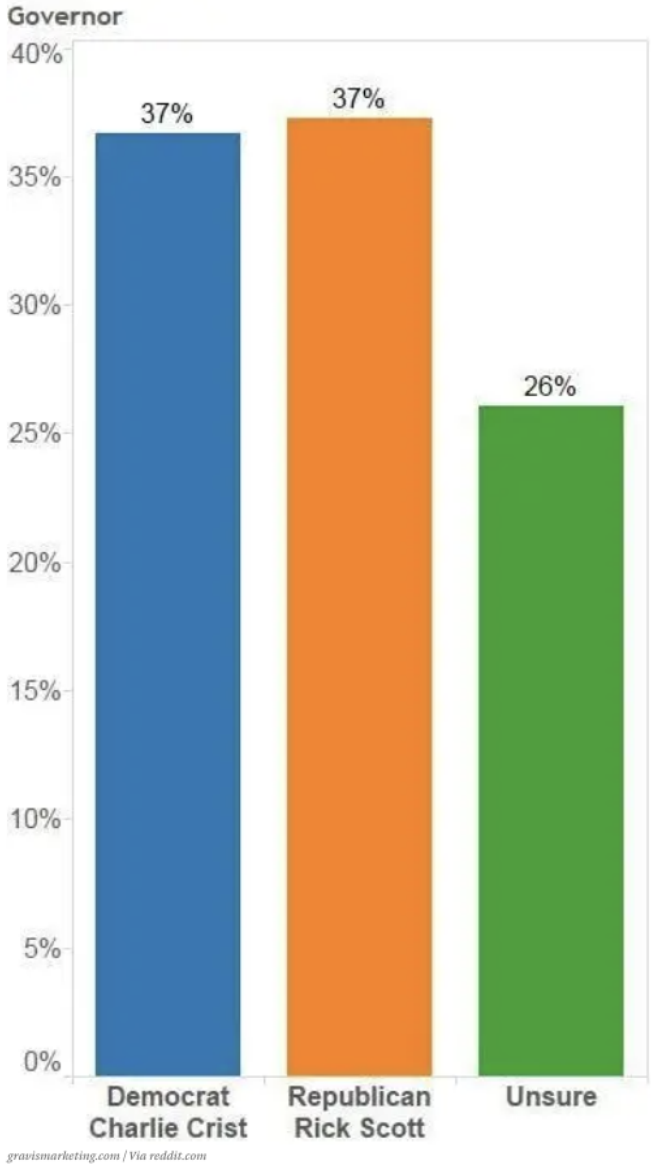
Graphical Integrity

Obamacare Signups, According to Fox News



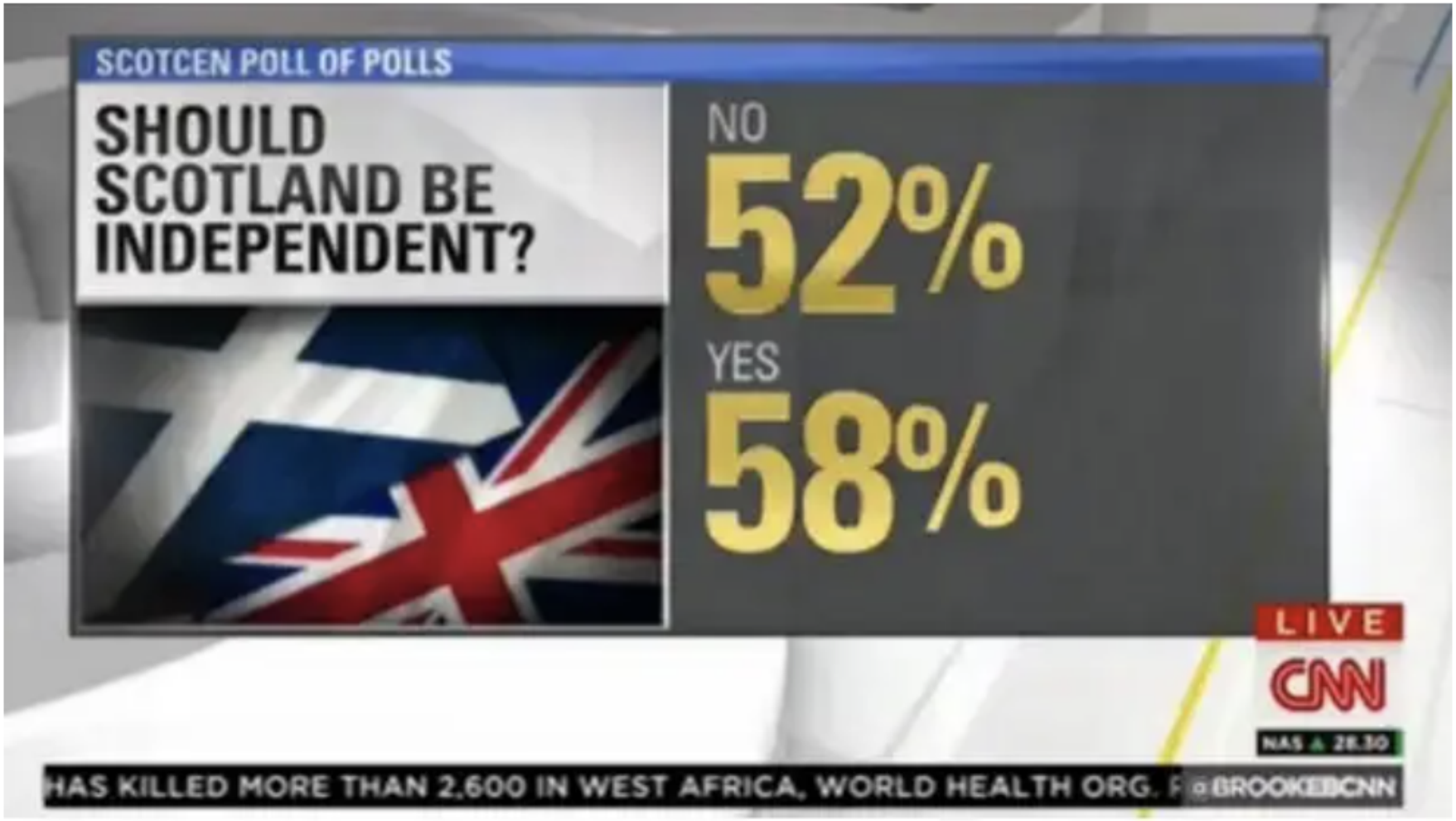
Source: Media Matters of America

Graphical Integrity



Graphical Integrity

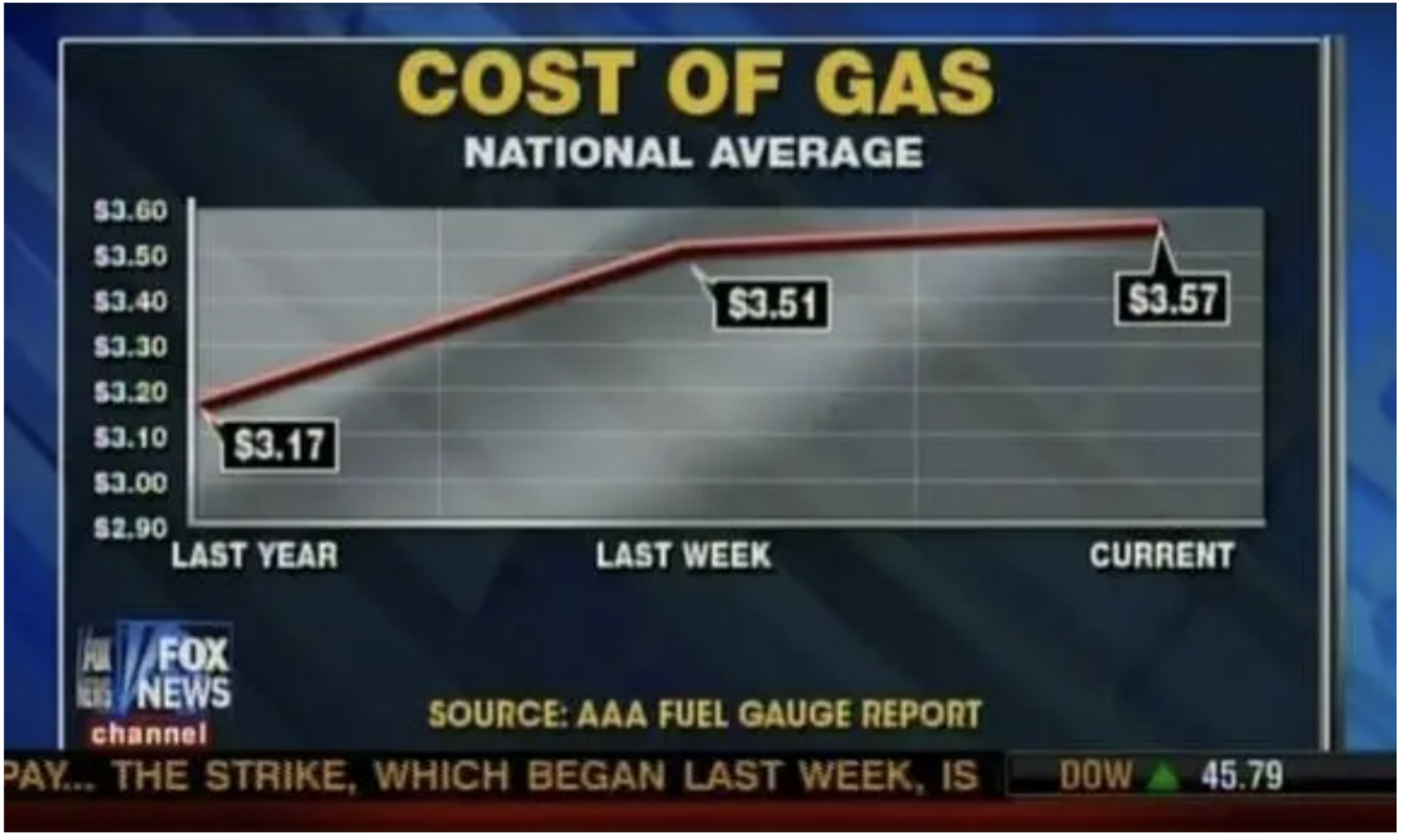
Graphical Integrity



Graphical Integrity

i.imgur.com | Via reddit.com

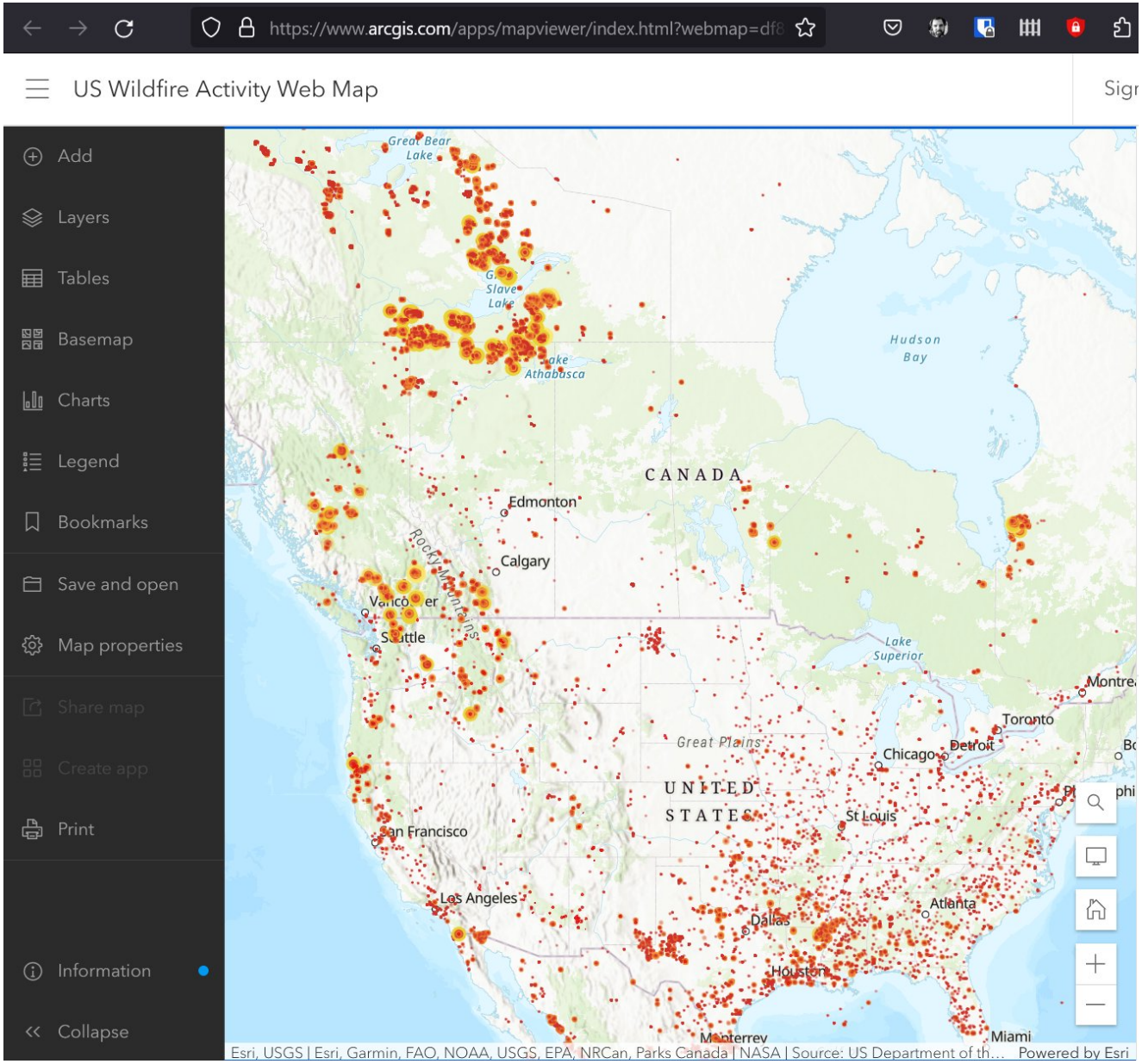
Graphical Integrity



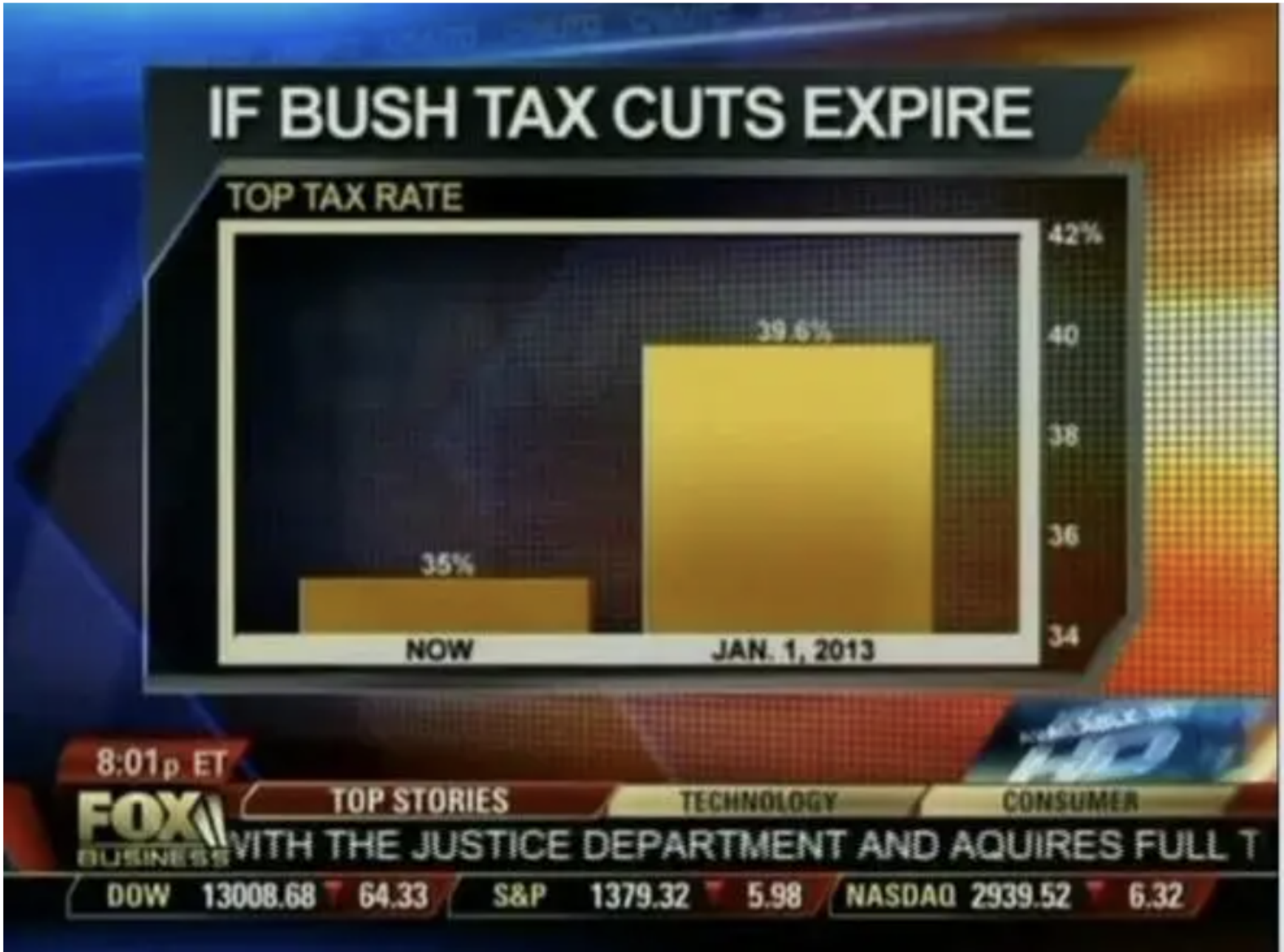
Fox News / Via mediamatters.org

Graphical Integrity

Graphical Integrity



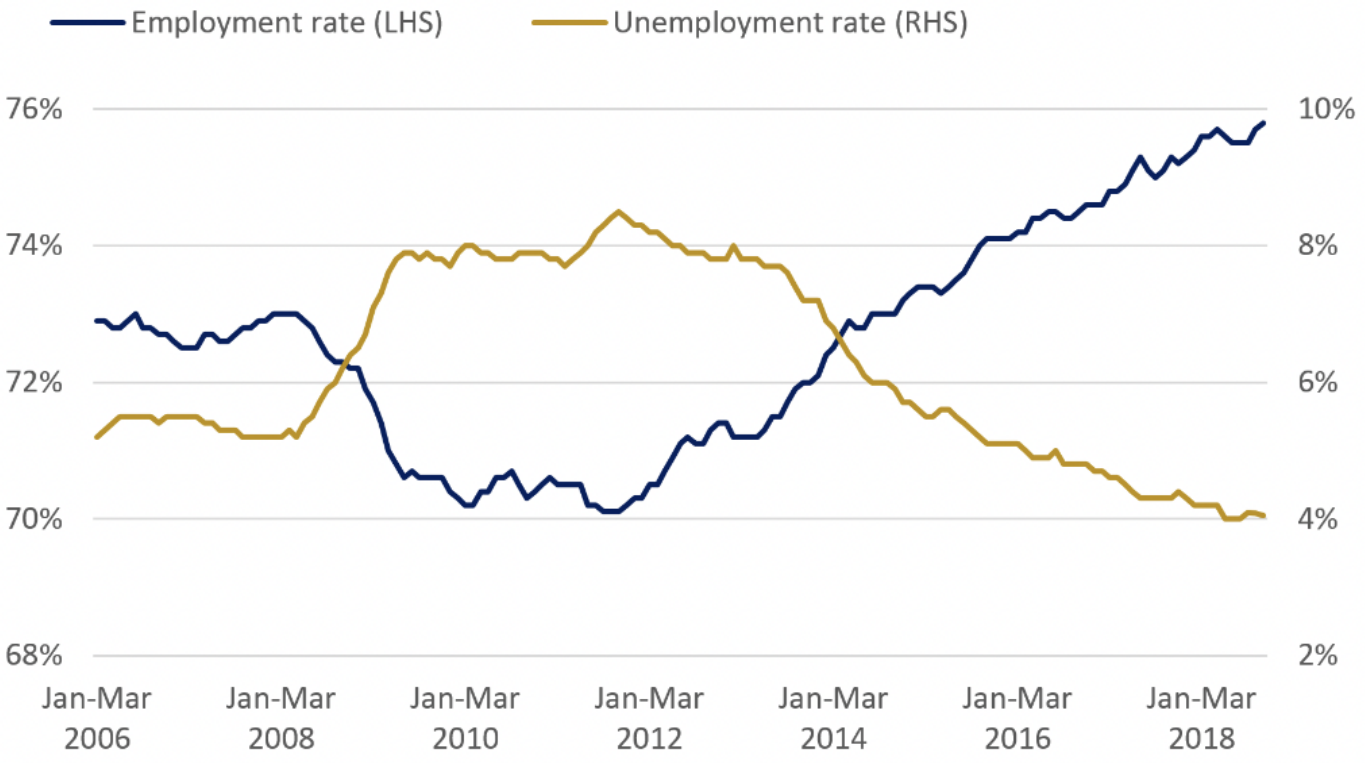
Graphical Integrity



Graphical Integrity

Employment and unemployment rates

UK, seasonally adjusted, January to March 2006 to September to November 2018

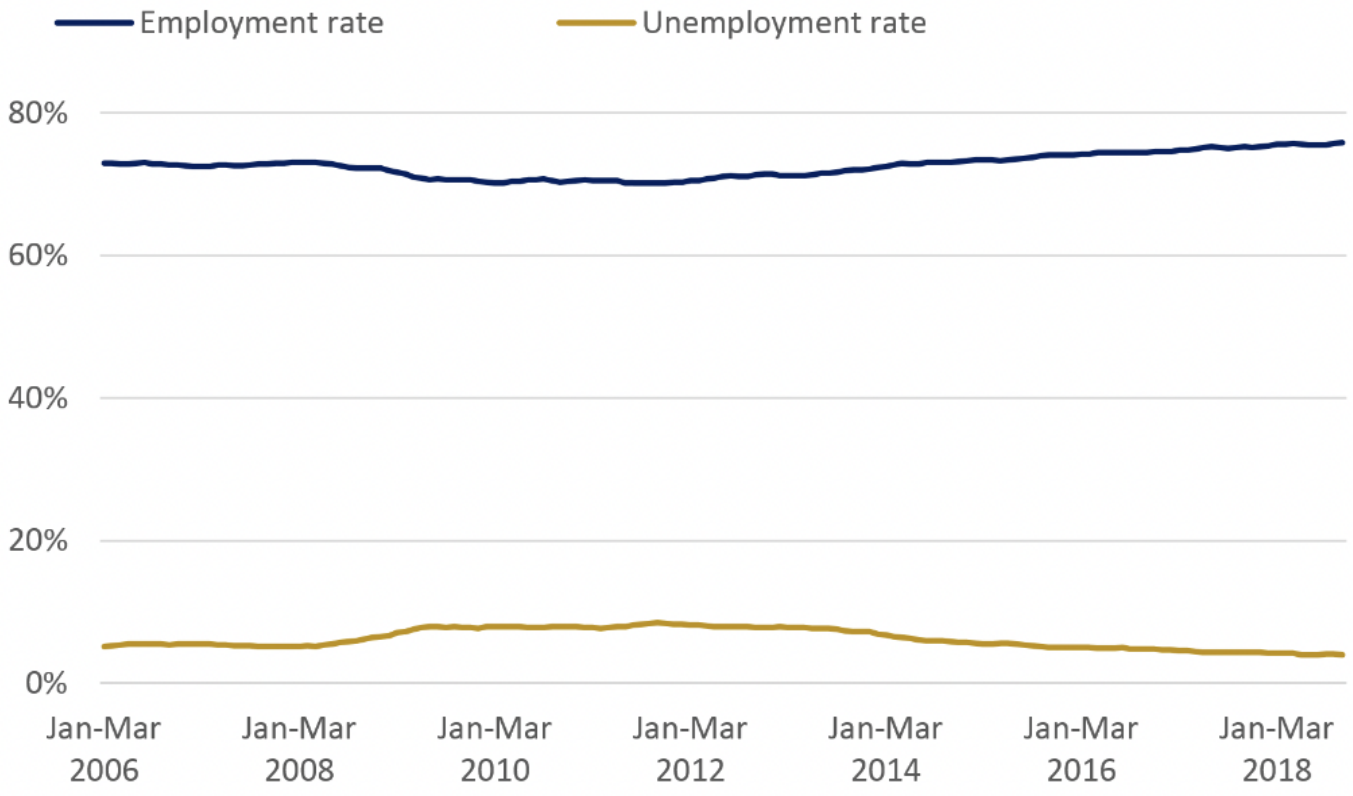


Source: Labour market economic commentary: January 2019, ONS

Graphical Integrity

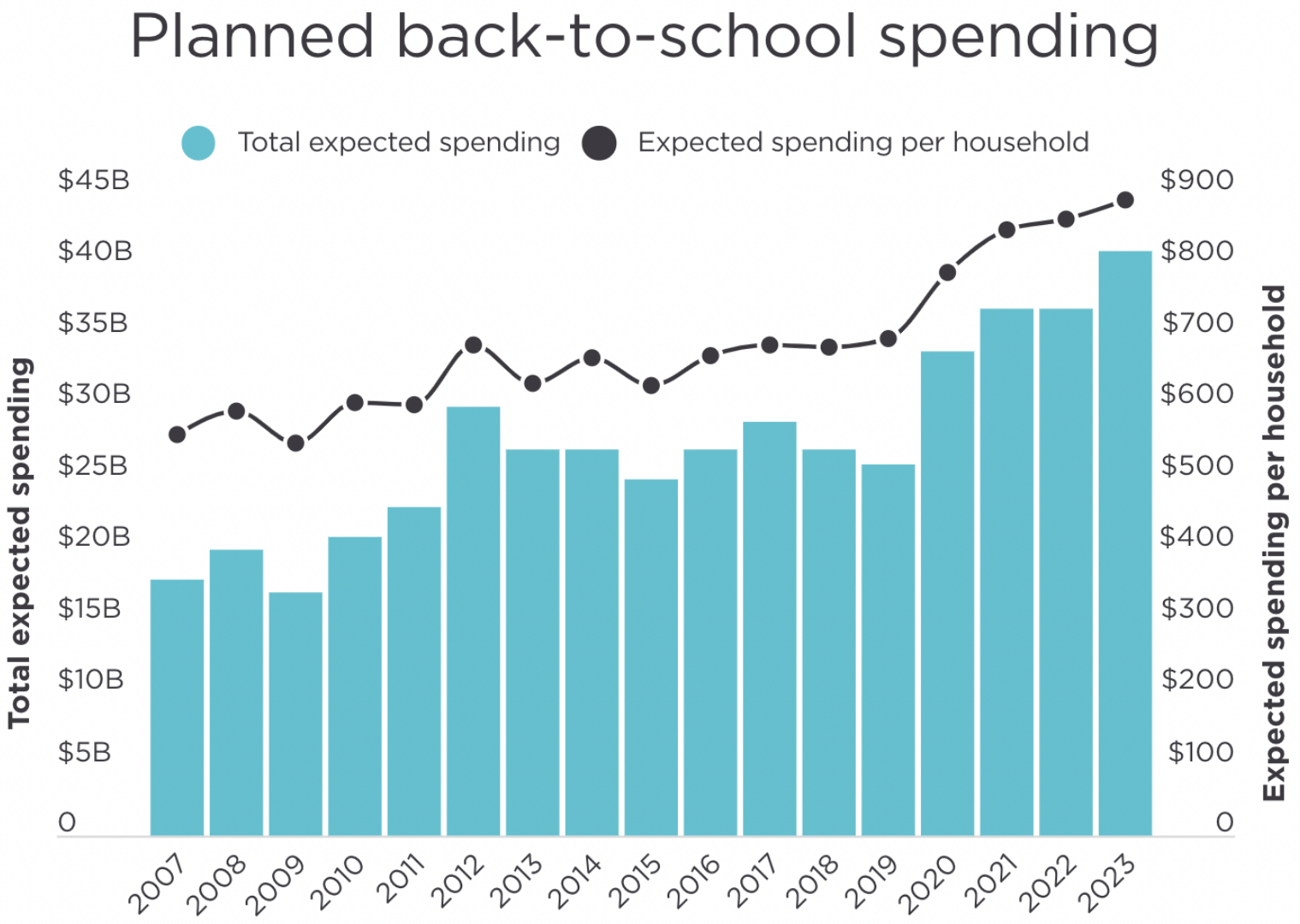
Employment and unemployment rates

UK, seasonally adjusted, January to March 2006 to September to November 2018



Source: Labour market economic commentary: January 2019, ONS

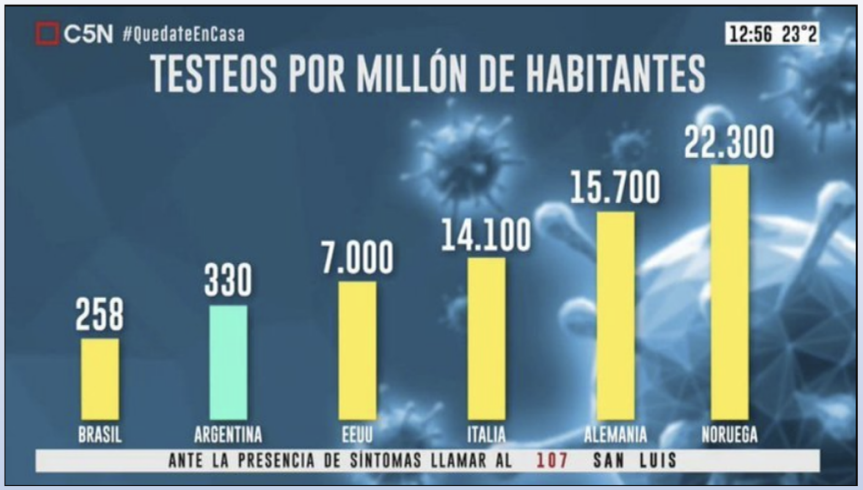
Graphical Integrity



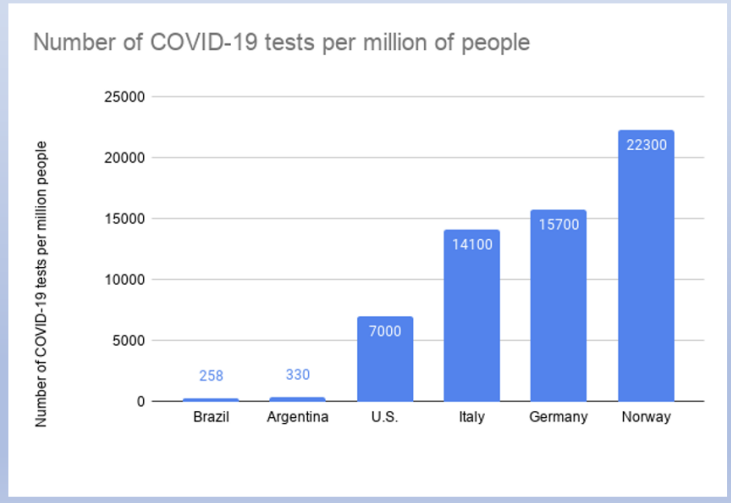
Source: NRF's Annual 2023 Back-to-School Survey, conducted by Prosper Insights & Analytics

NRF National Retail Federation

Graphical Integrity



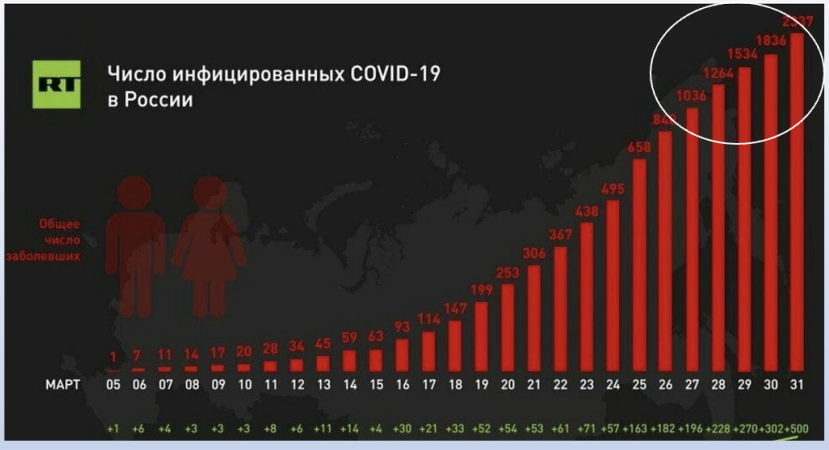
COVID testing - Argentine television lies!



Data without manipulation

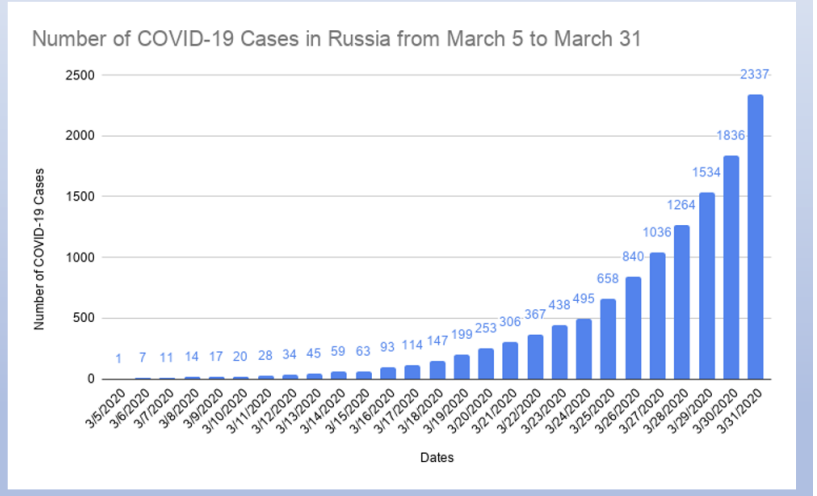
(Image from Dave Leupp)

Graphical Integrity



COVID cases – “Flattening the curve”
Russian television lies!

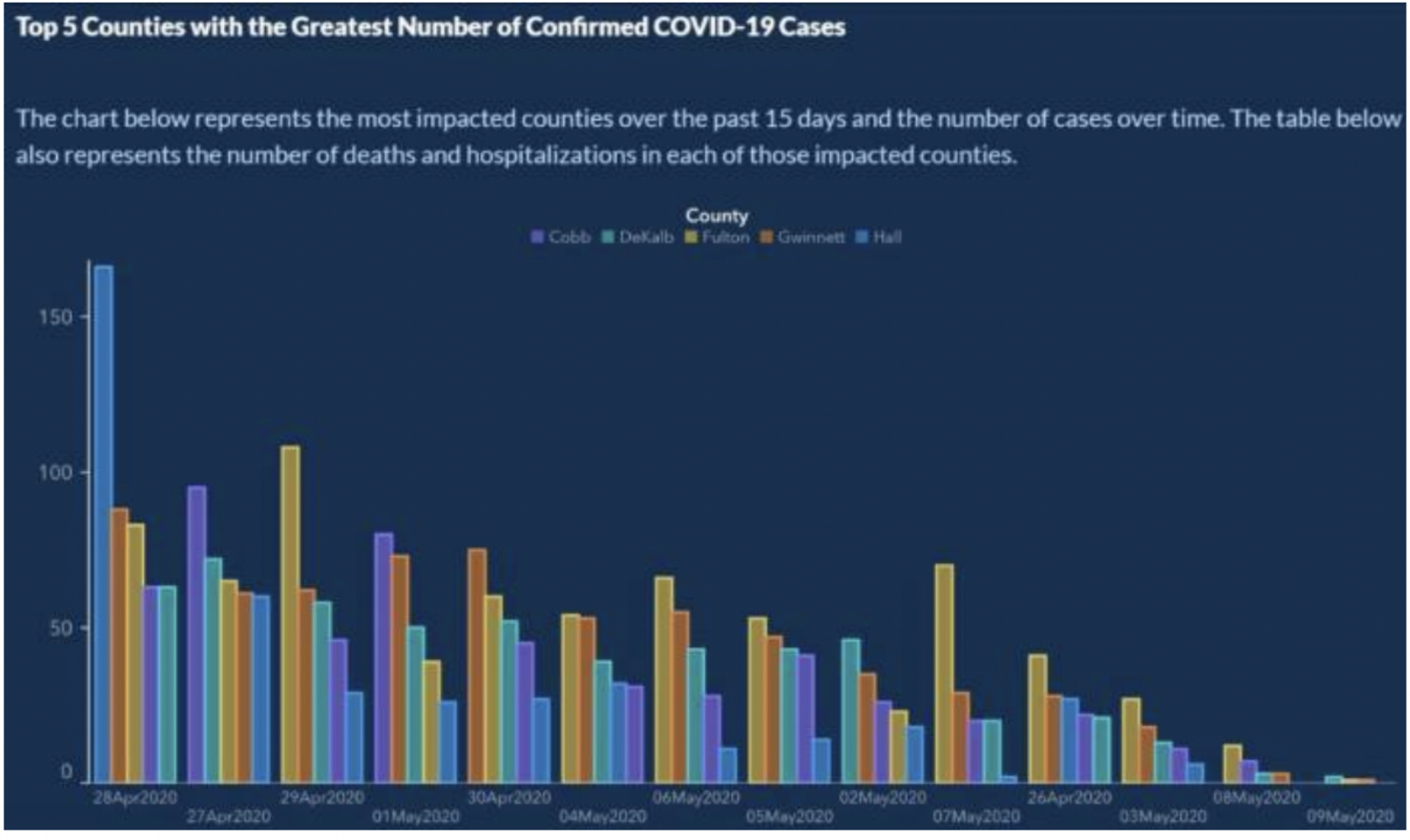
Later bars are arbitrary heights not truly reflecting the data values.



Data without manipulation (no flattening)

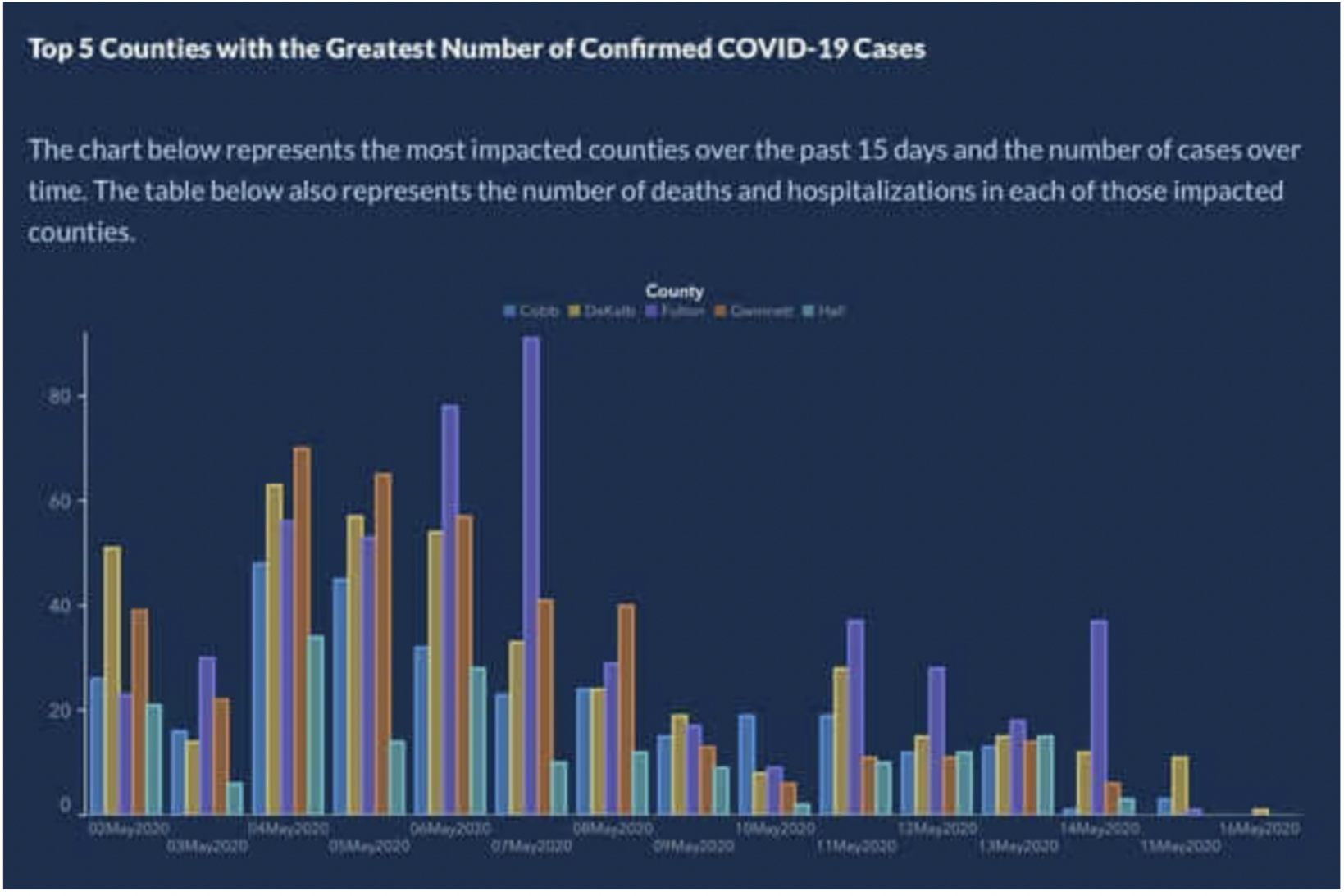
(Image from Dave Leupp)

Graphical Integrity



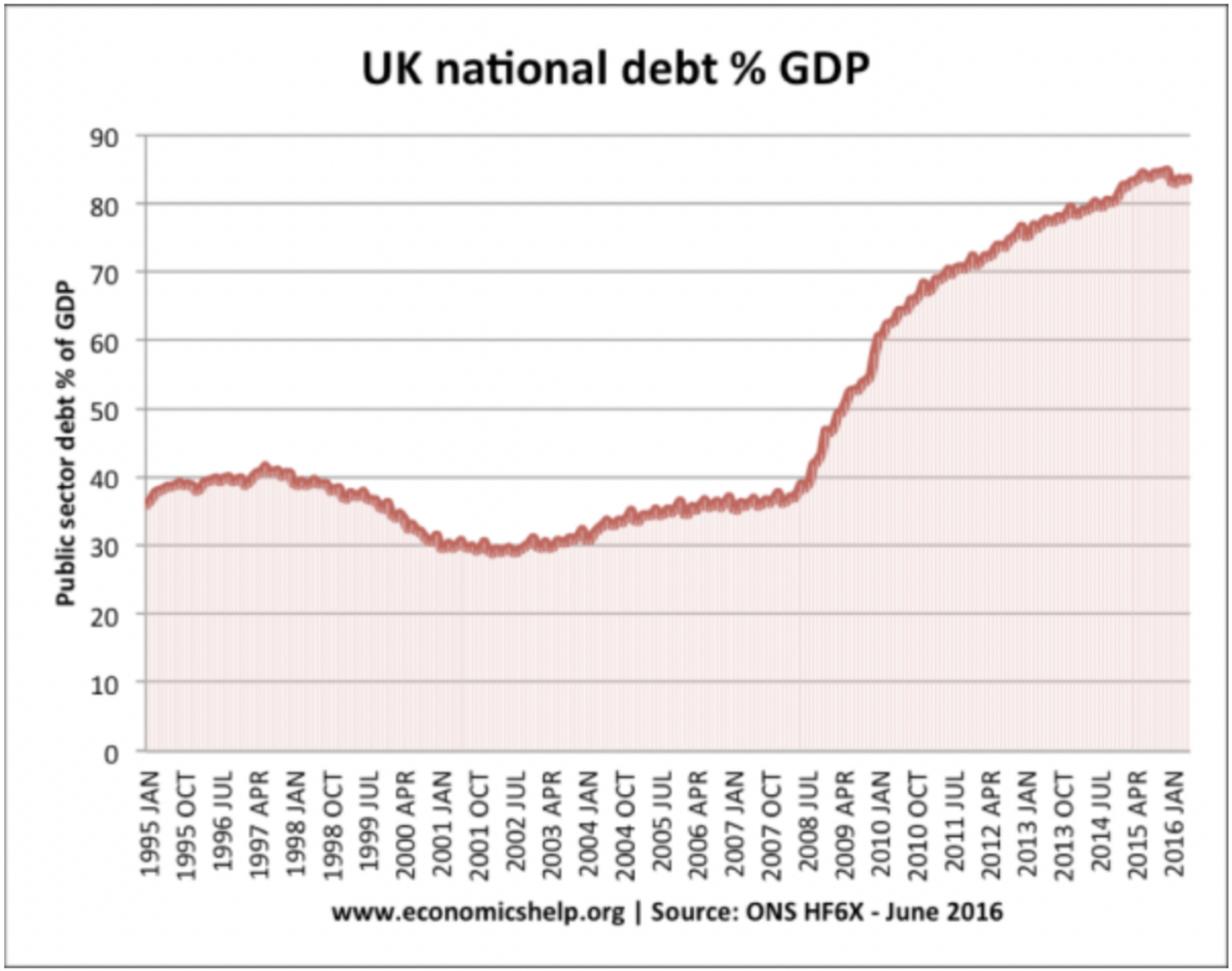
Source: Vox

Graphical Integrity



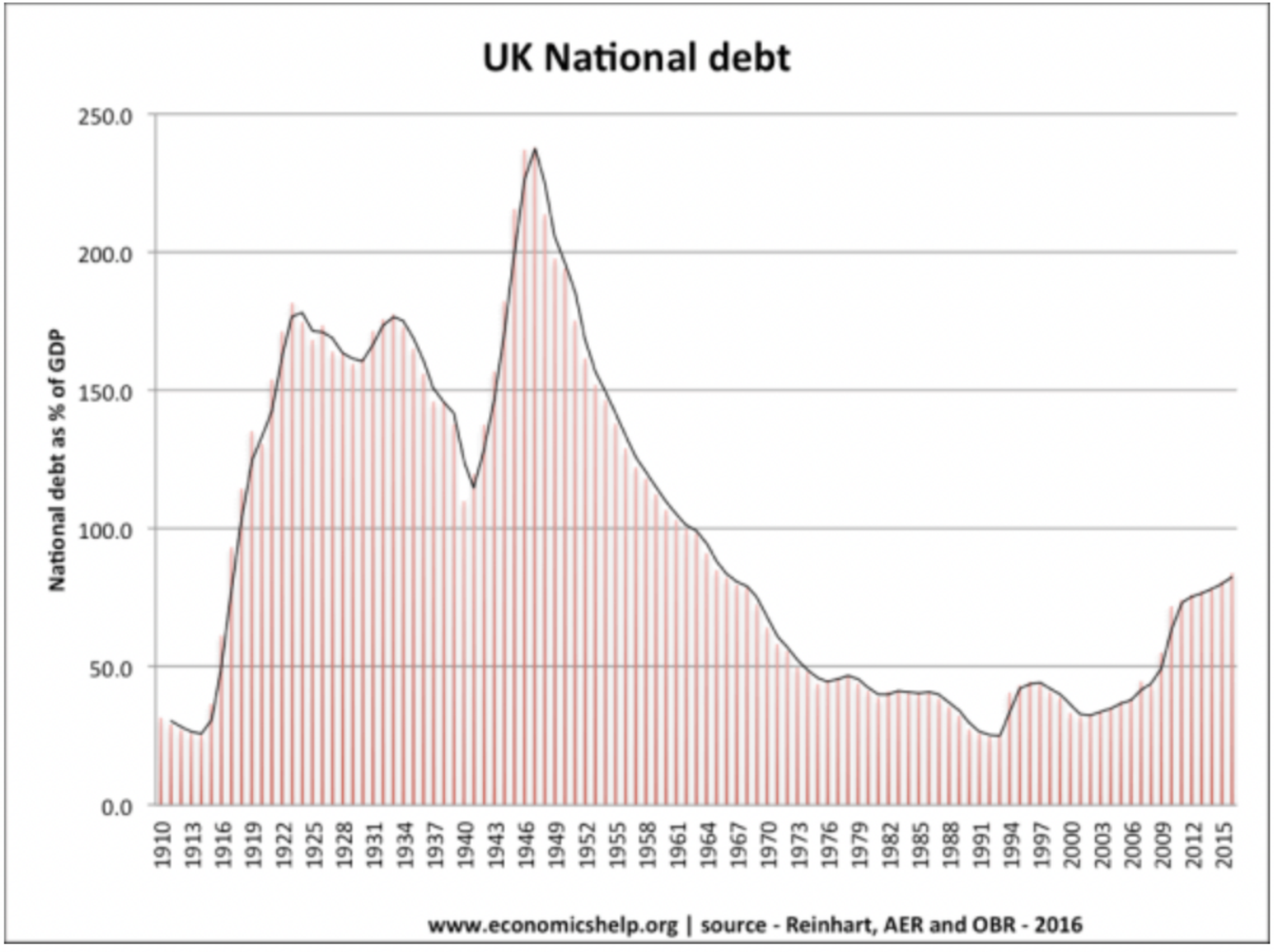
Source: Business Insider

Graphical Integrity



Source: www.economicshelp.org

Graphical Integrity



Source: www.economicshelp.org

Graphical Integrity

- Data graphics can either intentionally or unintentially distory the data they represent.
- Tufte gives many other examples that you should carefully study!
- Always be aware of this danger in your own work!

"Graphical excellence begins with telling the truth about the data."

Guidelines

Primary Guidelines for Data Visualization:[1]

- Show the data
- Reduce the clutter
- Integrate the graphics and text
- Avoid the spaghetti chart
- Start with gray

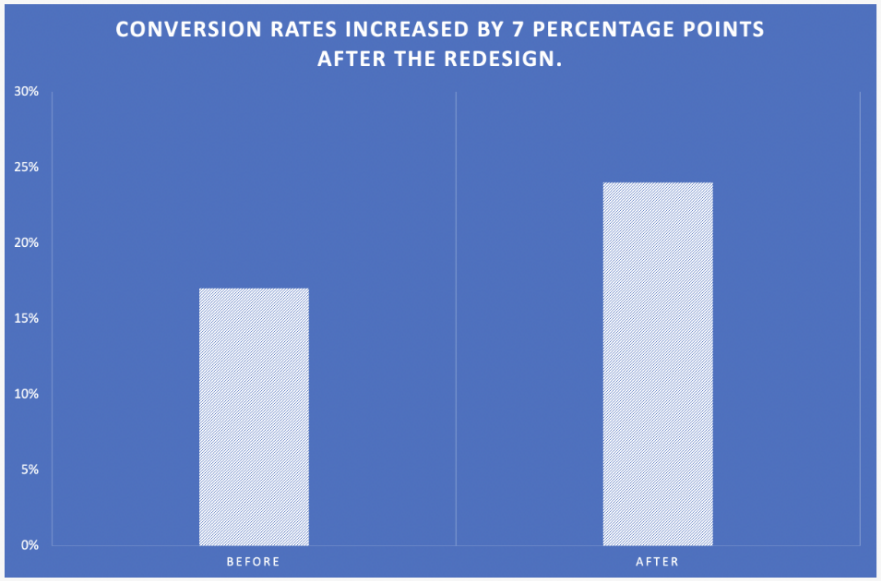
[1] "Better Data Visualizations, A Guide for Scholars, Researchers, and Wonks" by Jonathan Schwabish

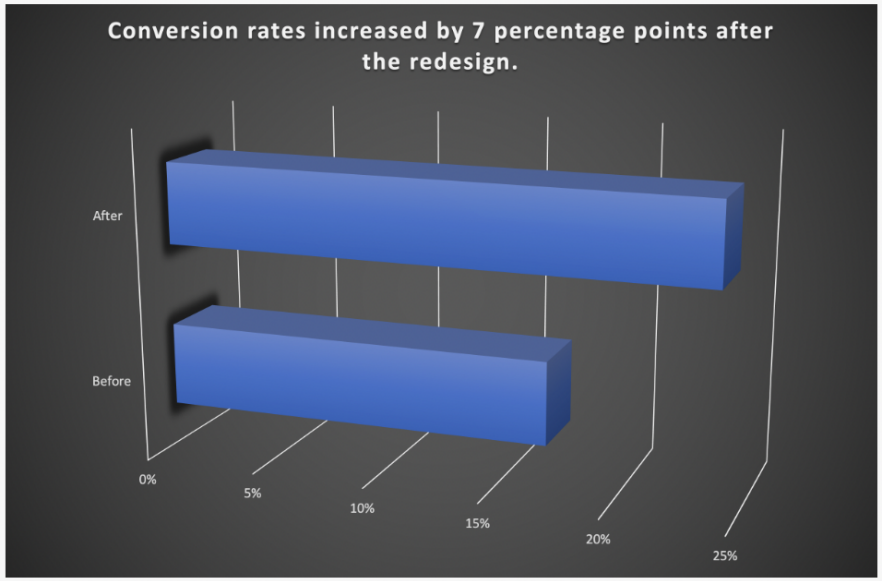
Guidelines

- Show the data
  - (This does not mean we show ALL the data all the time!)

Guidelines

- Reduce the clutter





Bad: *Two examples of Excel's chart styles. Funky colors, fonts, 3D effects, gradients, shadows, and textures don't add informational value to your visual — in fact, they're just distracting.*

Guidelines

- Integrate the graphics and text

> "The annotation layer is the most important thing we do...otherwise it's a case of 'here it is, you go figure it out.'"
> -Amanda Cox, Data Editor at the *New York Times*

Guidelines

- Avoid the spaghetti chart

  https://www.data-to-viz.com/caveat/spaghetti.html

  Sometimes we face the challenge of including lots of data in a single graph, but we don't need to try to pack everything into a single graph.

Guidelines

- Start with gray
  - `https://bit.ly/3shWs2R`

Overview of Data Visualization

Effective Design Techniques

- **data-ink ratio:** measures the proportion of what Tufte terms "data-ink" to the total amount of ink used in a table or chart

  (non-data ink is ink used in a table or chart that serves no useful purpose in conveying the data to the audience)

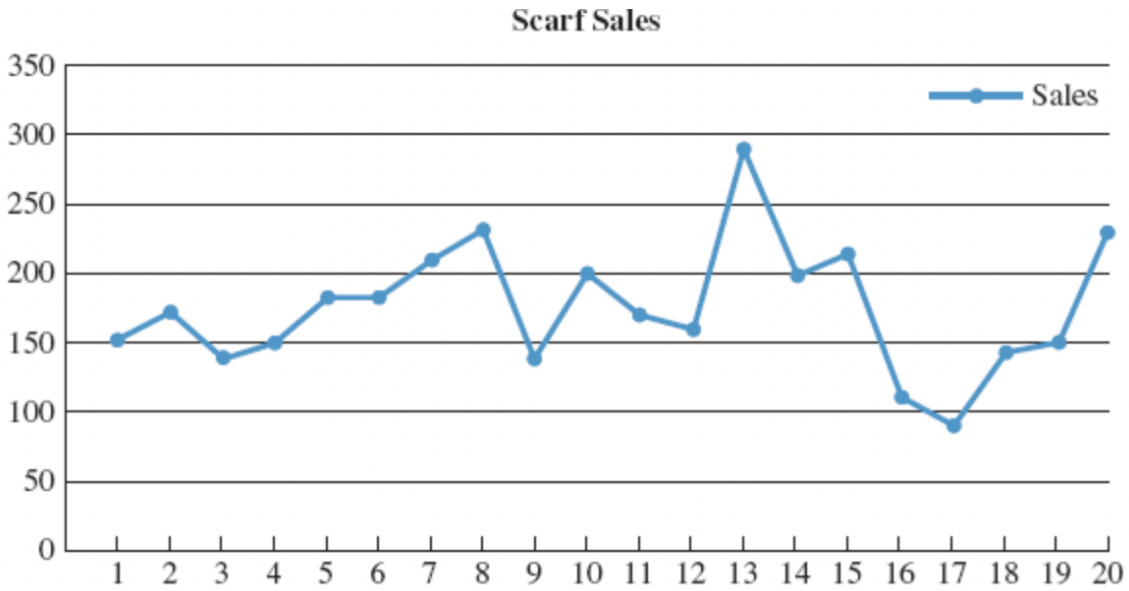
Overview of Data Visualization

Table 3.1 **Example of a Low Data-Ink Ratio Table**

Scarf Sales			
Day	Sales (units)	Day	Sales (units)
1	150	11	170
2	170	12	160
3	140	13	290
4	150	14	200
5	180	15	210
6	180	16	110
7	210	17	90
8	230	18	140

Overview of Data Visualization

Figure 3.3 **Example of a Low Data-Ink Ratio Chart**



Overview of Data Visualization

Figure 3.4 **Increasing the Data-Ink Ratio by Adding Labels to Axes and Removing Unnecessary Lines and Labels**

Overview of Data Visualization

Table 3.2 **Increasing the Data-Ink Ratio by Removing Unnecessary Gridlines**

Scarf Sales			
Day	Sales (units)	Day	Sales (units)
1	150	11	170
2	170	12	160
3	140	13	290
4	150	14	200
5	180	15	210
6	180	16	110
7	210	17	90
8	230	18	140
9	140	19	150

Tables

Our textbook says: **"The first decision in displaying data is whether or a table or a chart will be more effective."**

Questions:

- Is Minard's depiction of Napoleon's invasion of Russa a table or a chart?
- Is a map a table or a chart?

Displaying data is a creative process. Tables and charts are not the only options!

Tables

When tables might be a good choice:

- Tufte says that tables usually outperform graphics when depicting small data sets of 20 numbers or less. (p. 56)
- (Also see Tufte pg. 178-180.)

Tables should be used when:

- the reader needs to refer to specific numerical values
- the reader needs to make precise comparisons between different values and not just relative comparisons
- the values being displayed have different units or very different magnitudes

Tables

Table design:

- Data-ink ratio
  - Don't clutter with unnecessary grid lines, colors, fonts, etc.

Figure 3.7 from the text shows variations of the same data table:

Figure 3.7 **Comparing Different Table Designs**

Design A:

	Month						
	1	2	3	4	5	6	Total
Costs ($)	48,123	56,458	64,125	52,158	54,718	50,985	326,567
Revenues ($)	64,124	66,128	67,125	48,178	51,785	55,687	353,027
Profits ($)	16,001	9,670	3,000	(3,980)	(2,933)	4,702	26,460

Design B:

	Month						
	1	2	3	4	5	6	Total
Costs ($)	48,123	56,458	64,125	52,158	54,718	50,985	326,567
Revenues ($)	64,124	66,128	67,125	48,178	51,785	55,687	353,027
Profits ($)	16,001	9,670	3,000	(3,980)	(2,933)	4,702	26,460

Design C:

	Month						
	1	2	3	4	5	6	Total
Costs ($)	48,123	56,458	64,125	52,158	54,718	50,985	326,567
Revenues ($)	64,124	66,128	67,125	48,178	51,785	55,687	353,027
Profits ($)	16,001	9,670	3,000	(3,980)	(2,933)	4,702	26,460

Design D:

	Month						
	1	2	3	4	5	6	Total
Costs ($)	48,123	56,458	64,125	52,158	54,718	50,985	326,567
Revenues ($)	64,124	66,128	67,125	48,178	51,785	55,687	353,027
Profits ($)	16,001	9,670	3,000	(3,980)	(2,933)	4,702	26,460

Tables

Crosstabulation (Pivot Tables): provides a tabular summary of data for two variables

- a way to reorganize and summarize data in a table (or database in general)
- very broad and flexible uses

(You should have used Pivot Tables in Excel in previous classes, so this should be review.)

Tables

PivotTables in Excel

Example

The data file "restaurant" contains data from Zagat's Restaurant Review. Data on the quality rating, meal price, and the usual wait time for a table during peak hours were collected for a sample of 300 Los Angeles area restaurants.

- What if we want to know the number of restaurants in each combination of Quality and Price?
  - We could manually count how many restaurants are rated Good with mean prices between \$10 and \$19 for example, and so on, and create a table like Table 3.7 in the book:

Table 3.7 Crosstabulation of Quality Rating and Meal Price for 300 Los Angeles Restaurants

	Meal Price				
Quality Rating	**\$10–19**	**\$20–29**	**\$30–39**	**\$40–49**	**Total**
Good	42	40	2	0	84
Very Good	34	64	46	6	150
Excellent	2	14	28	22	66
Total	78	118	76	28	300

Tables

Example

Restaurant Example Continued:

Let's use PivotTables!

Charts

Examples of commonly used chartes to display and analyze data:

- Scatter charts (plots)
- Line charts
- Bar charts and column charts

You have done all of these before – your challenge in this course will be to apply good data visualization principles when you make them.

(Be sure to read this section in the textbook, because we will not work through everything together in class!)

Charts

Note: Excel default charts normally DO NOT follow good design principles.

Charts

Scatter charts:

Example

Open the file "Ajax" on Canvas. We're going to make a scatter plot using some of this data. Let's think about how we can improve on the default chart that Excel displays so that the data stands out.

Charts

Line Charts:

Example

Open the file "KirklandRegional" on Canvas that shows regional sales data by month for air compressors at Kirkland Industries. We're going to investigate some of the charts we can make with this data. (These steps are in the textbook if you want to follow along.)

Charts

Bar Charts and Column Charts:

Example

Open the file "AccountsManaged" on Canvas. We're going to create a sorted bar chart with data labels for this data.

Charts

Pie Charts:

For the last example, we could have made a pie chart:

Figure 3.25 **Bar Chart with Data Labels for Accounts Managed Data**

	A	B
1	Manager	Accounts Managed
2	Williams	6
3	Edwards	11
4	Jones	15
5	Smith	21
6	Davis	24
7	Francois	28
8	Lopez	29
9	Gentry	37

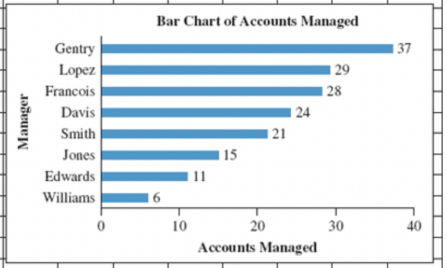
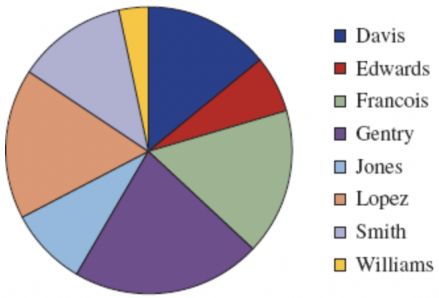


Figure 3.26 **Pie Chart of Accounts Managed**



Question: What thoughts do you have when you compare the figures above?

Charts

Pie Charts:

Not good!

- It's harder for our brains to compare the size of the wedges. (Comparing the lengths of the bars is much easier!)
- It's recommended to not use pie charts in most situations.
- Bar charts are often better for comparing categorical data.

Charts

3-D Charts:

Also usually bad!

- Excel makes it easy to create 3-D bar, line, pie, and other charts. BUT in most cases this effect adds unnecessary detail that does not help explain the data.
  - The third dimension is not data – so it just adds noise (chartjunk)

Charts

3-D Charts:

> Just because we **can** create a certain in Excel does not mean we **should**!

Example

Open the file "AutoProduction" in Canvas. Let's see how we can create bad pie charts and 3-D charts in Excel (and why they are not helpful ways to visualize the data).

Charts

Bubble charts and heat maps:

Definition

- A **bubble chart** is a graphical means of visualizing three variables in a two-dimensional graph
- A **heat map** is a two-dimensional graphical representation of data that uses different shades of color to indicate the magnitude.

- Can be useful when used properly, but can take a lot of work to create.
- (These might be easier to create in Tableau!)

Charts

Example

Bubble chart example: Open the file "billionaires" on Canvas. We're going to create a bubble chart using Excel to further exam the data.

Example

Heat map example: Open the file "samestoresales" on Canvas. We're going to create a heat map in Excel.

Charts

Note the “sparklines” in the previous example.

Sparklines is a term coined by Tufte for “data-intense, design-simple, word-sized graphics” (in his book, *Beautiful Evidence*)

Charts

"Additional Charts for Multiple Variables": Be sure to read the coverage of these topics in the book. (We might not have time to talk about these together in class.)

- These are useful, but you need to be very careful in their design.
- (The reader needs to understand them!)

Charts

Example

Let's look at an example of what is called a "parallel coordinates" plot. (There is a homework problem about this type of plot.)

https://bit.ly/47IP54P

This example uses something called Python to create the visualization.

Charts

PivotCharts in Excel: Excel pairs PivotCharts with PivotTables to summarize and analyze data with both a crosstabulation and charting.

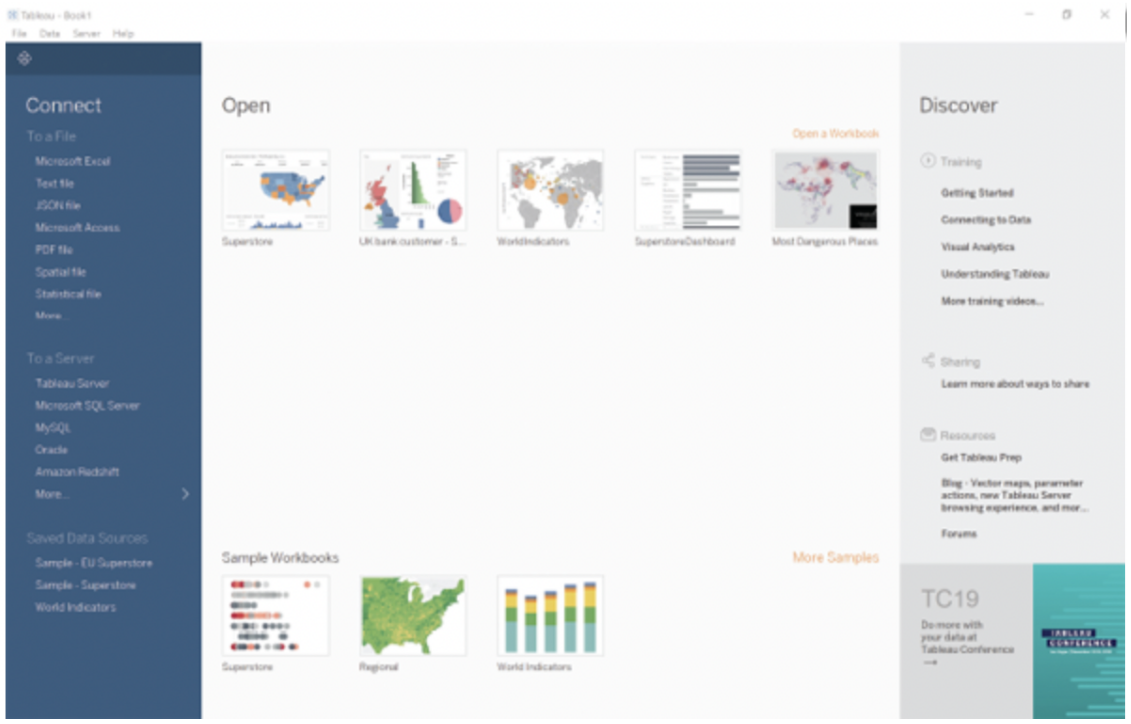
Example

Open the "restaurant" file again. We'll work through how to create a PivotChart together. (If we don't have time for this in class, then work through this on your own following the steps in the textbook!)

Data Visualization in Tableau

Note: This part of the textbook is on pg. 141-156.

Tableau Desktop is a powerful visualization tool that is widely used for data visualization.



Data Visualization in Tableau

- Tableau can do far more than we will ask it to do.
- It is capable of connecting to a huge variety of data sources, from Excel files, to databases, to text files, to cloud services like Google Analytics and SalesForce

Data Visualization in Tableau

Tableau has some jargon that can be confusing for beginner users.

- "Measures": are numeric variables
- "Dimensions": are categorical variables

Tableau is already installed on classroom computers, but you should also have already downloaded a copy of Tableau Desktop onto your own computer.

(You can do this for free using our class activation key that is in the announcement on Canvas.)

Data Visualization in Tableau

Example

We're going to see how to create several visualizations in Tableau using the files listed below that you can find on Canvas:

- "NewHouseSalesUS"
- "electronics"
- "KirklandRegional"
- "AccountsManaged"
- "billionaires"
- "NYCityData"
- "global100"
- "WorldGDP2014"
- "AuditTime"
- "HomeSalesStacked"

Data Visualization in Tableau

Visual Analysis Best Practices
Simple Techniques for Making Every Data Visualization Useful and Beautiful

https://www.tableau.com/sites/default/files/media/whitepaper_visual-analysis-guidebook_0.pdf

Data Visualization in Tableau

Tableau is a lot of fun to use!

If you want to play around with it, here are some sources for data that you could use:

- Colorado Information Marketplace:
  https://data.colorado.gov/
- UC Irvine Machine Learning Repository
  https://archive.ics.uci.edu/
- Pew Research Center
  https://www.pewresearch.org/internet/datasets/
- Buzzfeed News
  https://github.com/orgs/BuzzFeedNews/repositories?type=all
- FiveThirtyEight
  https://data.fivethirtyeight.com/
- U.S. Government Open Data
  https://data.gov/