

Data Visualization

ISTP Summer JC

Anthony Hung

Outline

- Data visualization: Data exploration vs Data explanation
 - Tips/Tricks/Resources
- Grammar of Graphics
- Exercise in R: ggplot2

Data visualization is important not only to present data to others, but to better understand it yourself

- Data exploration
 - Find the message in the data
 - Usually not very visually appealing
 - Often requires generating many visualizations to look at the data from multiple angles
- Data explanation
 - Present the message in the data to others (who may or may not be familiar with your work)
 - Paying attention to aesthetics and simplicity becomes important

Data exploration

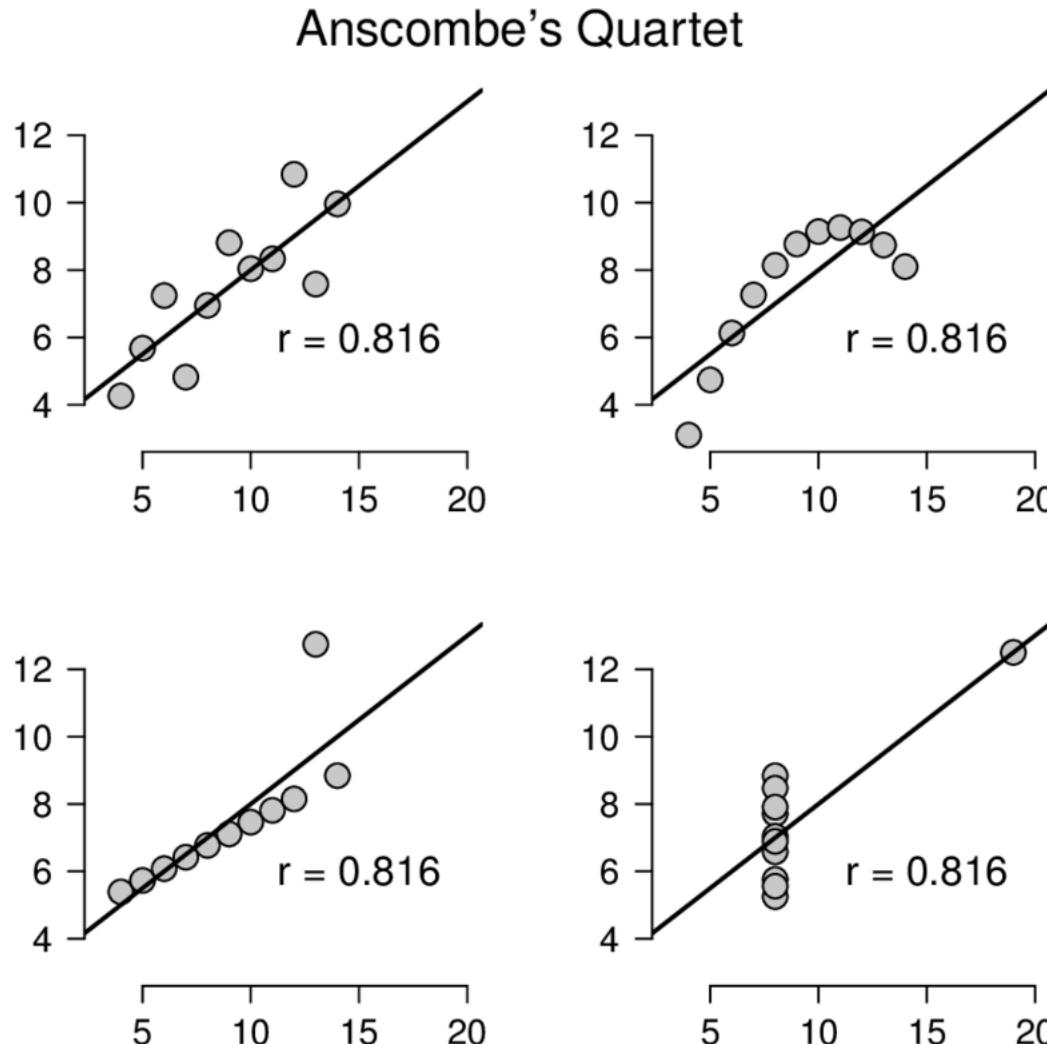
I		II		III		IV		
x	y	x	y	x	y	x	y	+
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58	
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76	
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71	
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84	
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47	
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04	
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25	
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50	
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56	
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91	
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89	

Data exploration

I		II		III		IV		
x	y	x	y	x	y	x	y	+
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58	
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76	
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71	
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84	
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47	
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04	
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25	
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12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56	
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91	
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89	

Summary					
Set	mean(X)	sd(X)	mean(Y)	sd(Y)	cor(X,Y)
1	9	3.32	7.5	2.03	0.816
2	9	3.32	7.5	2.03	0.816
3	9	3.32	7.5	2.03	0.816
4	9	3.32	7.5	2.03	0.817

Visualization reveals hidden relationships



Data explanation

- Summarize information and present in a meaningful, non-confusing, non-manipulative way
- Consider what the *message* of each visual is, and use tools to best present that message
 - Best type of chart
 - Best way to discriminate datapoints

Choosing the right type of chart

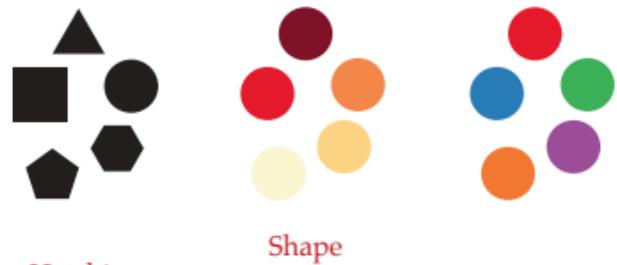
- <https://datavizcatalogue.com/>
- <http://datavizproject.com/>
- <https://github.com/ft-interactive/chart-doctor/blob/master/visual-vocabulary/poster.png?raw=true>
- <http://chartmaker.visualisingdata.com/>
- <https://xeno.graphics/>

Discriminating between datapoints

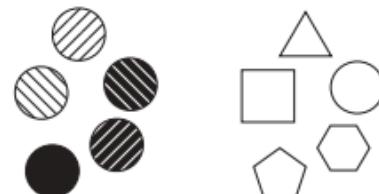
Categorical Variables

Low Efficiency in Decoding Separate Groups High

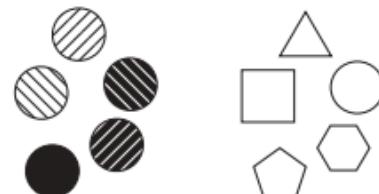
Filled Shapes Sequential Colours Qualitative Colours



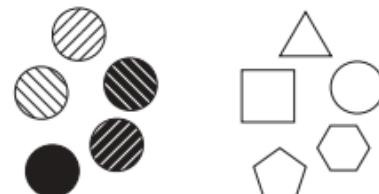
Hatching



Line Width



Line Type



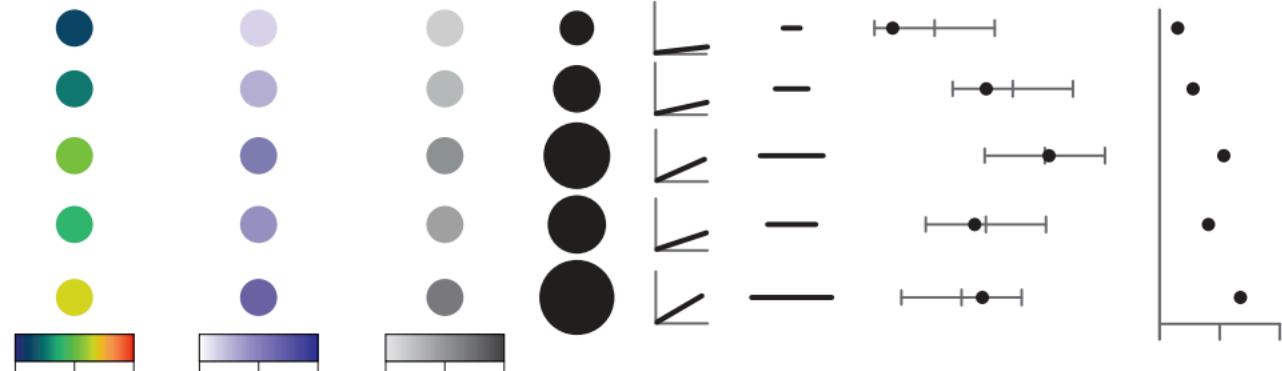
Line Colours



Continuous Variables

Low Efficiency and Accuracy of Decoding High

Colour Spectrum Monochromatic Spectrum Grey-Scale Spectrum Area Angle Length Position - on same, but unaligned, scale Position - on a common scale



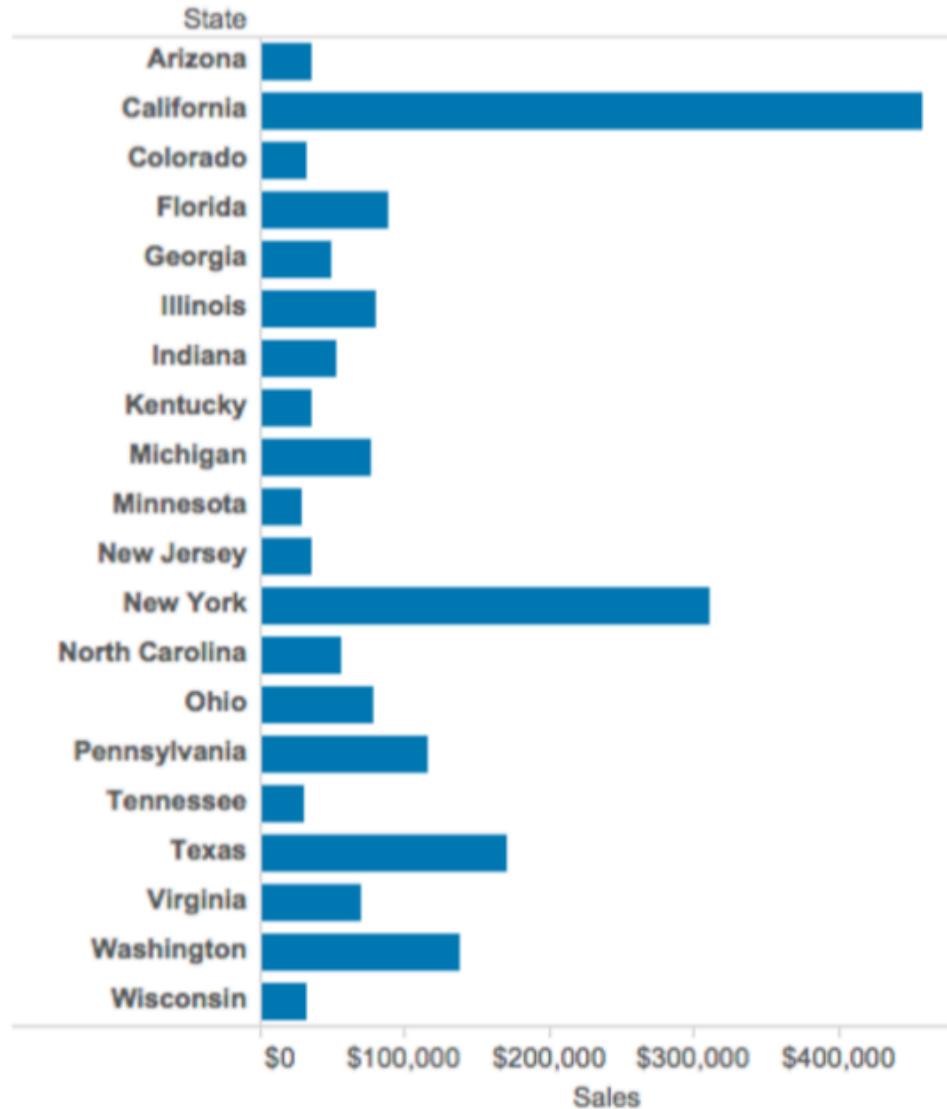
Choosing color palettes

- <https://color.adobe.com/explore>
- <https://coolors.co/fcfafe-c8d3d5-a4b8c4-6e8387-0cca4a>

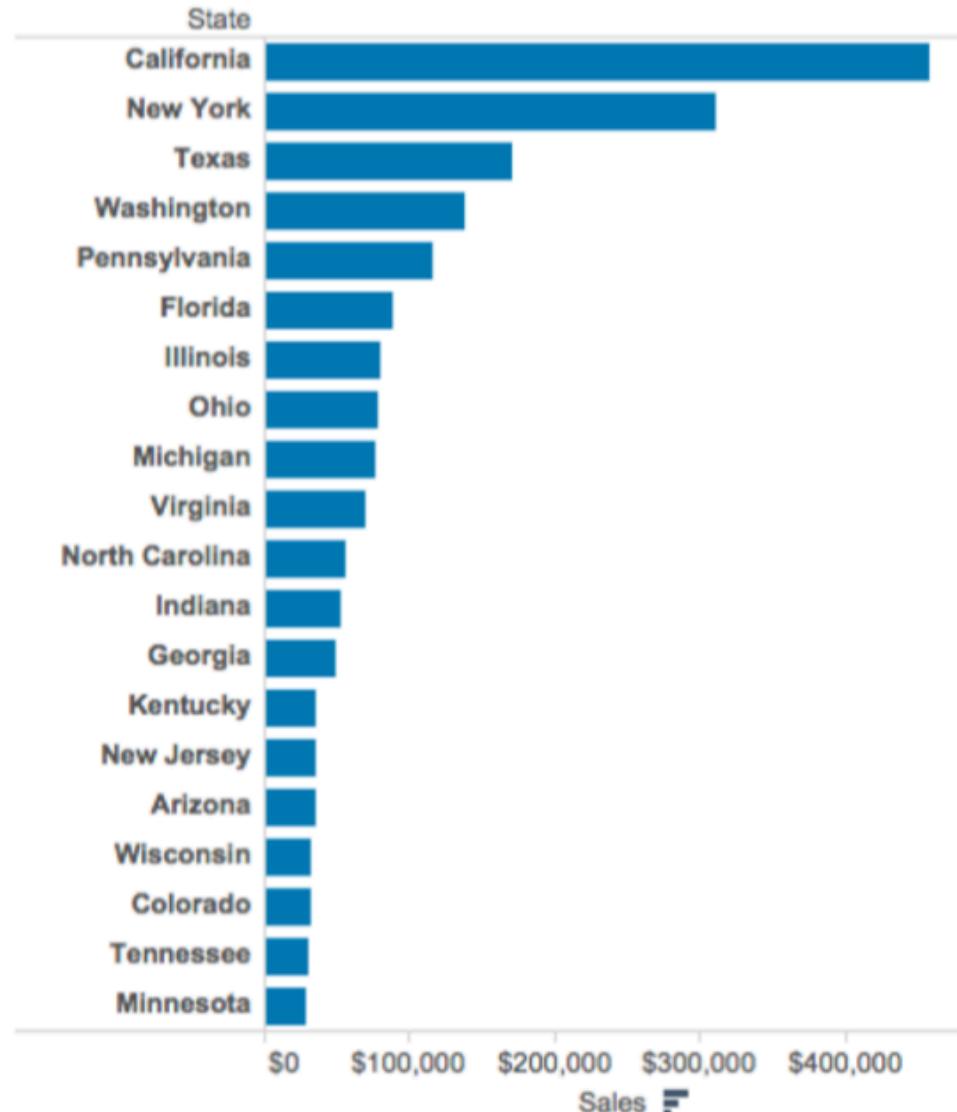
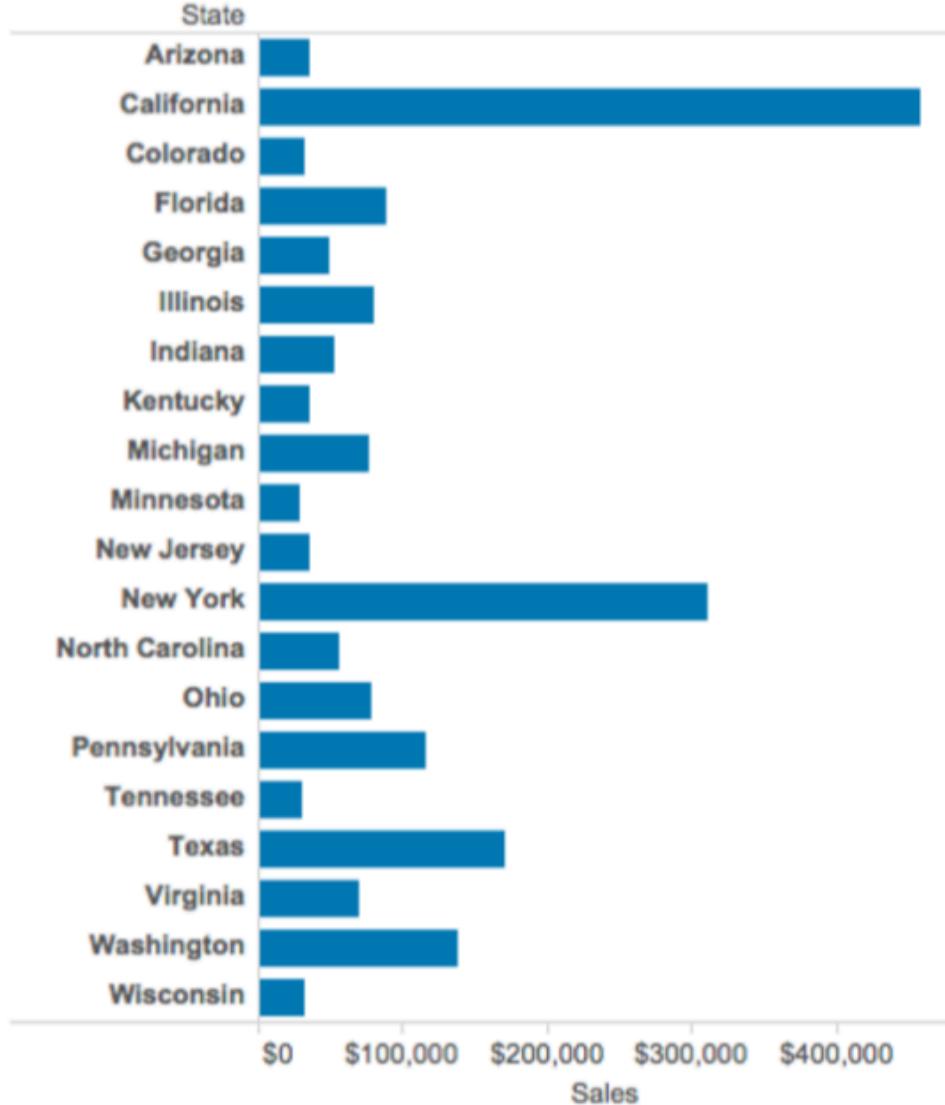
Missteps to avoid

- Default ordering/Alphabetical ordering hides patterns in data
- Not all the data tells a story (emphasize the important data)

Default ordering/Alphabetical ordering hides patterns in data



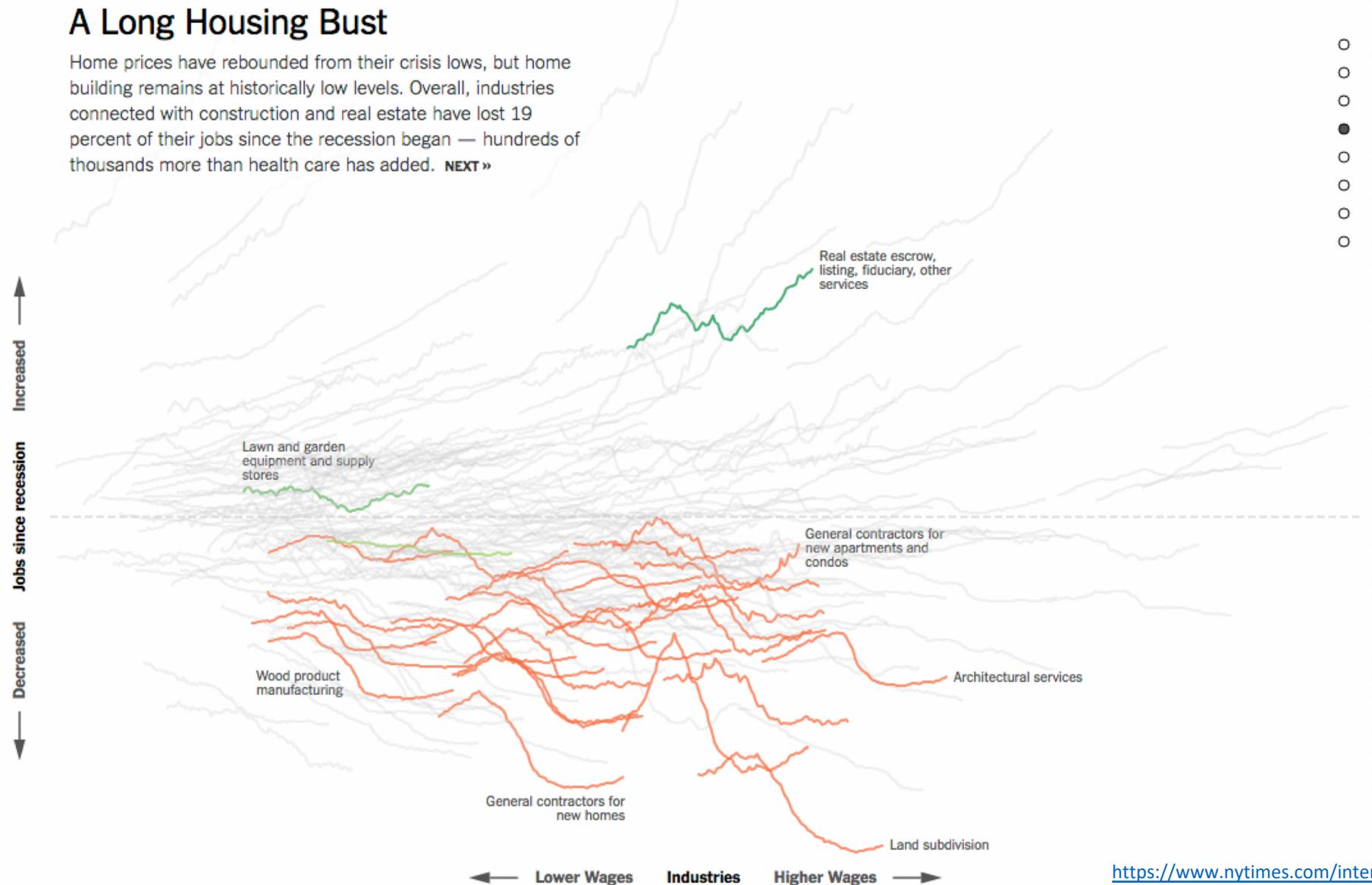
Default ordering/Alphabetical ordering hides patterns in data



Not all the data tells a story

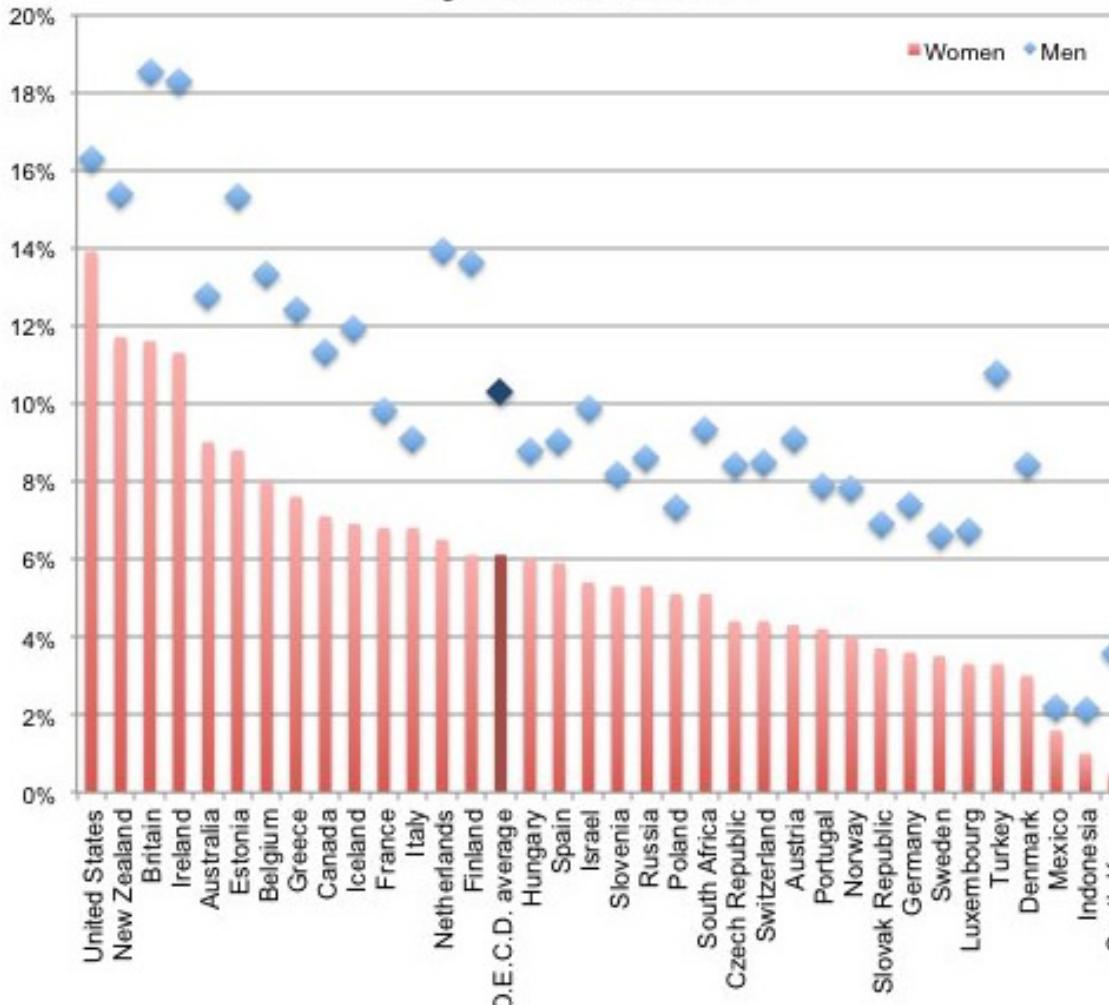


Not all the data tells a story



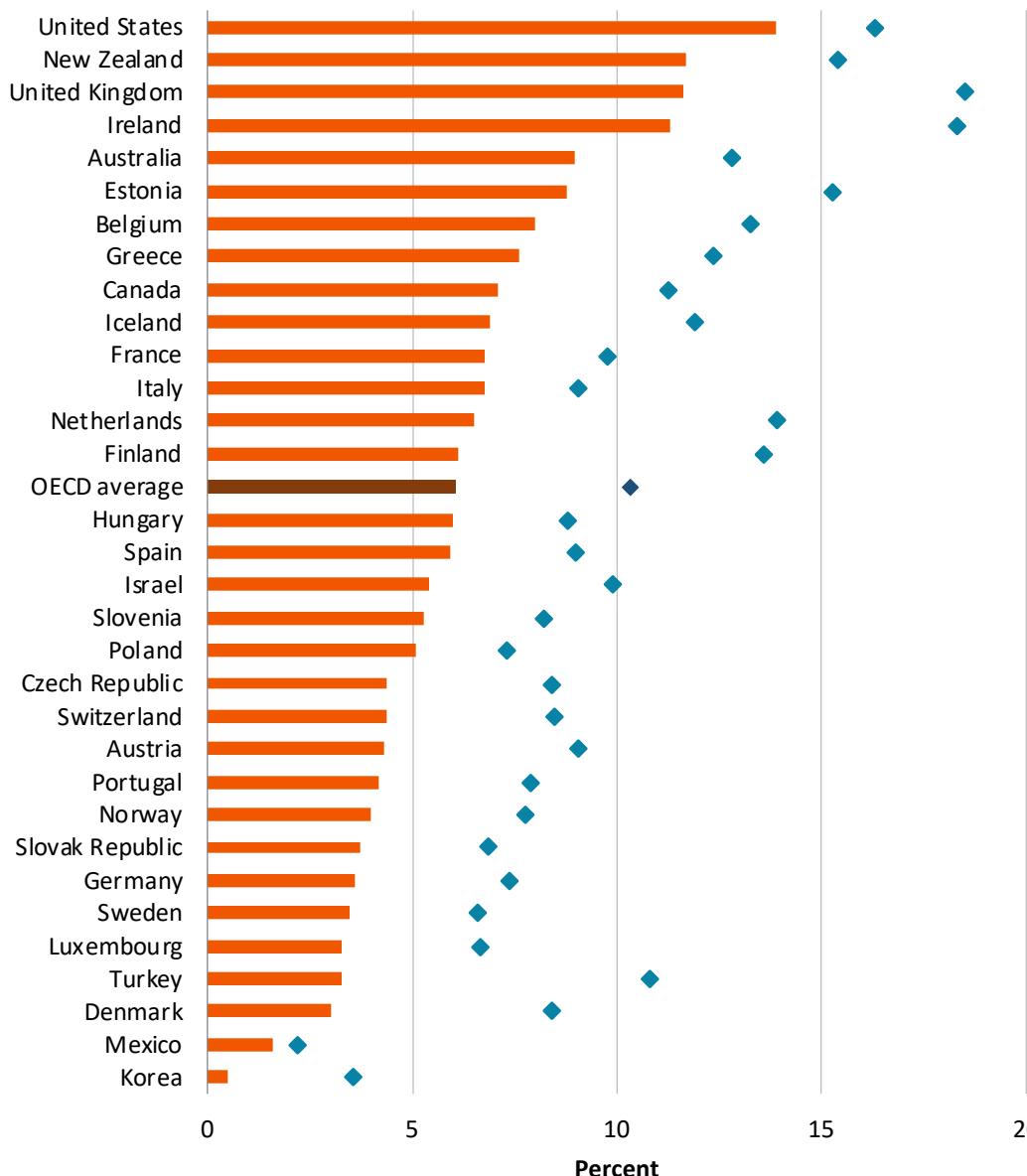
Critique/Fix some issues

Percentage of Employed Who Are Senior Managers,
by Gender, 2008

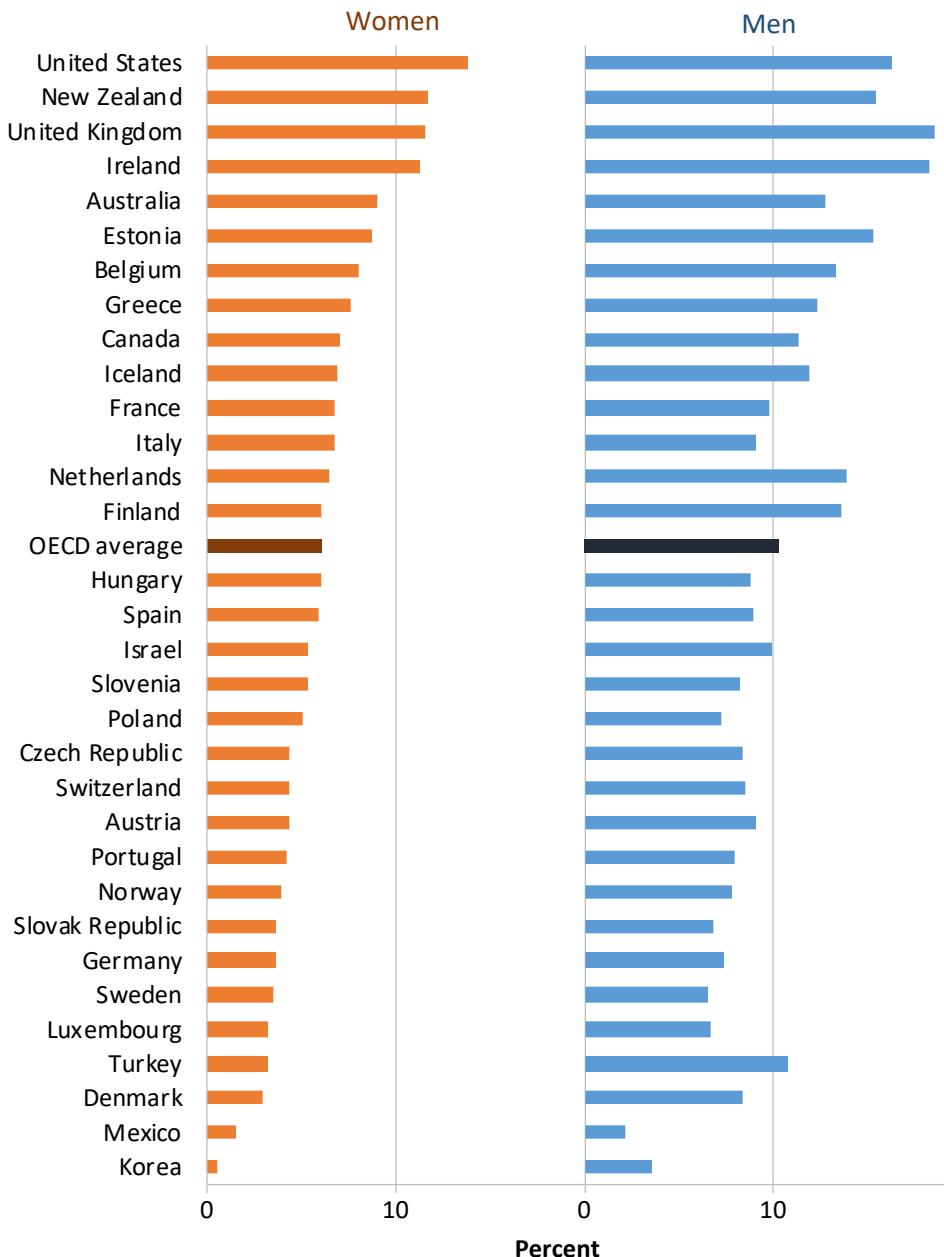


<http://economix.blogs.nytimes.com/2013/04/02/comparing-the-worlds-glass-ceilings/?smid=tw-share>

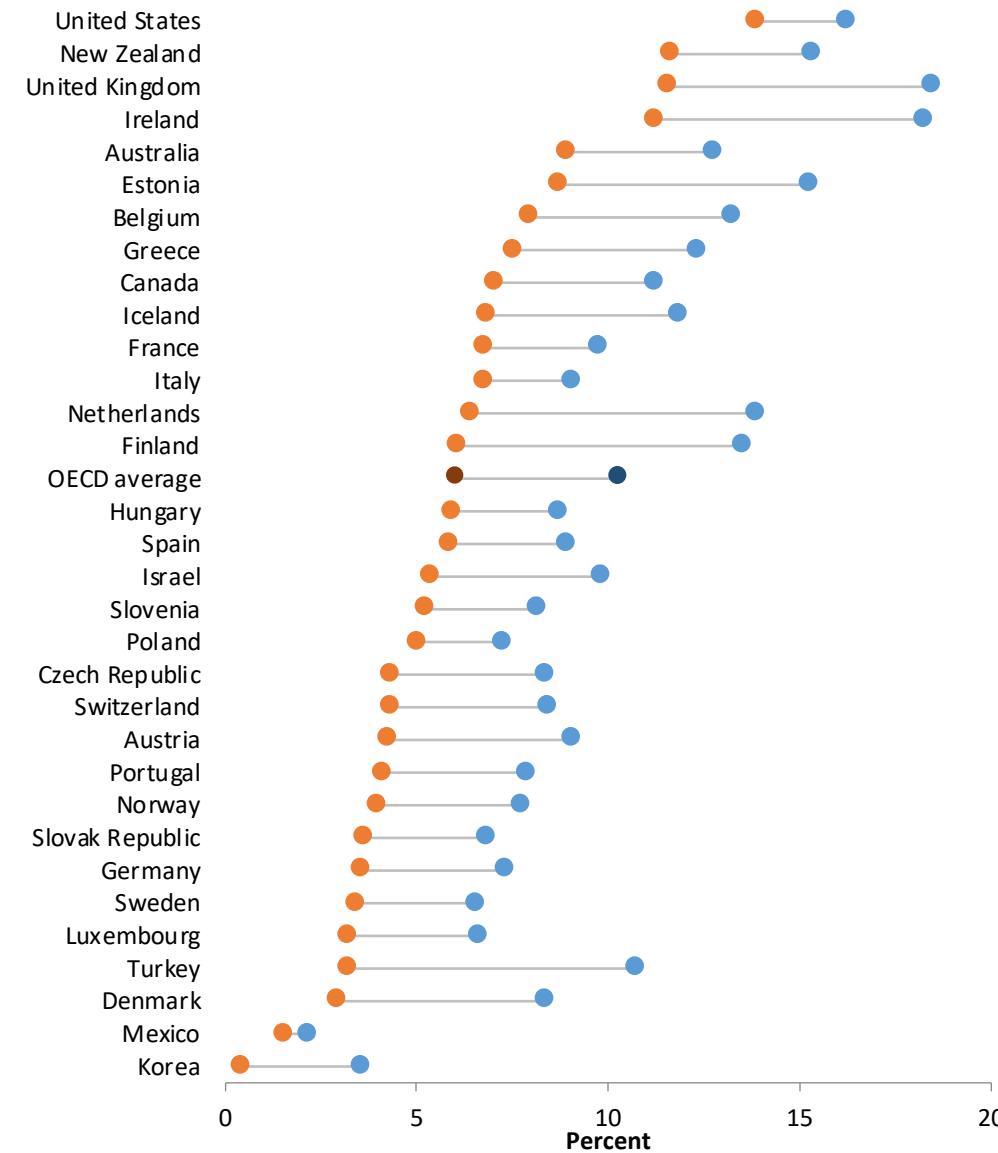
**Percentage of Employed Who are Senior Managers, by
Gender, 2008**
(Percent) □ Women □ Men



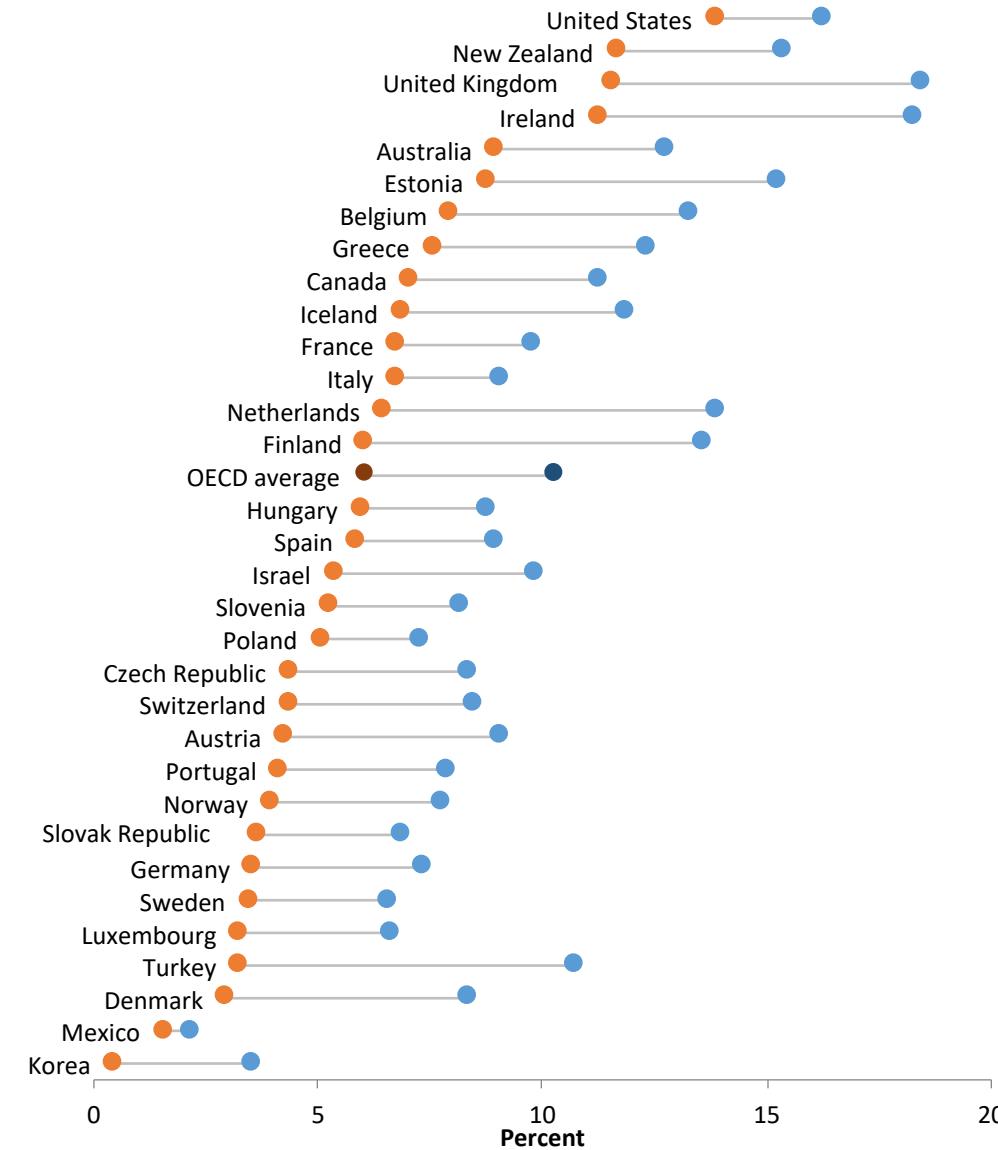
**Percentage of Employed Who are Senior Managers, by
Gender, 2008**
(Percent)



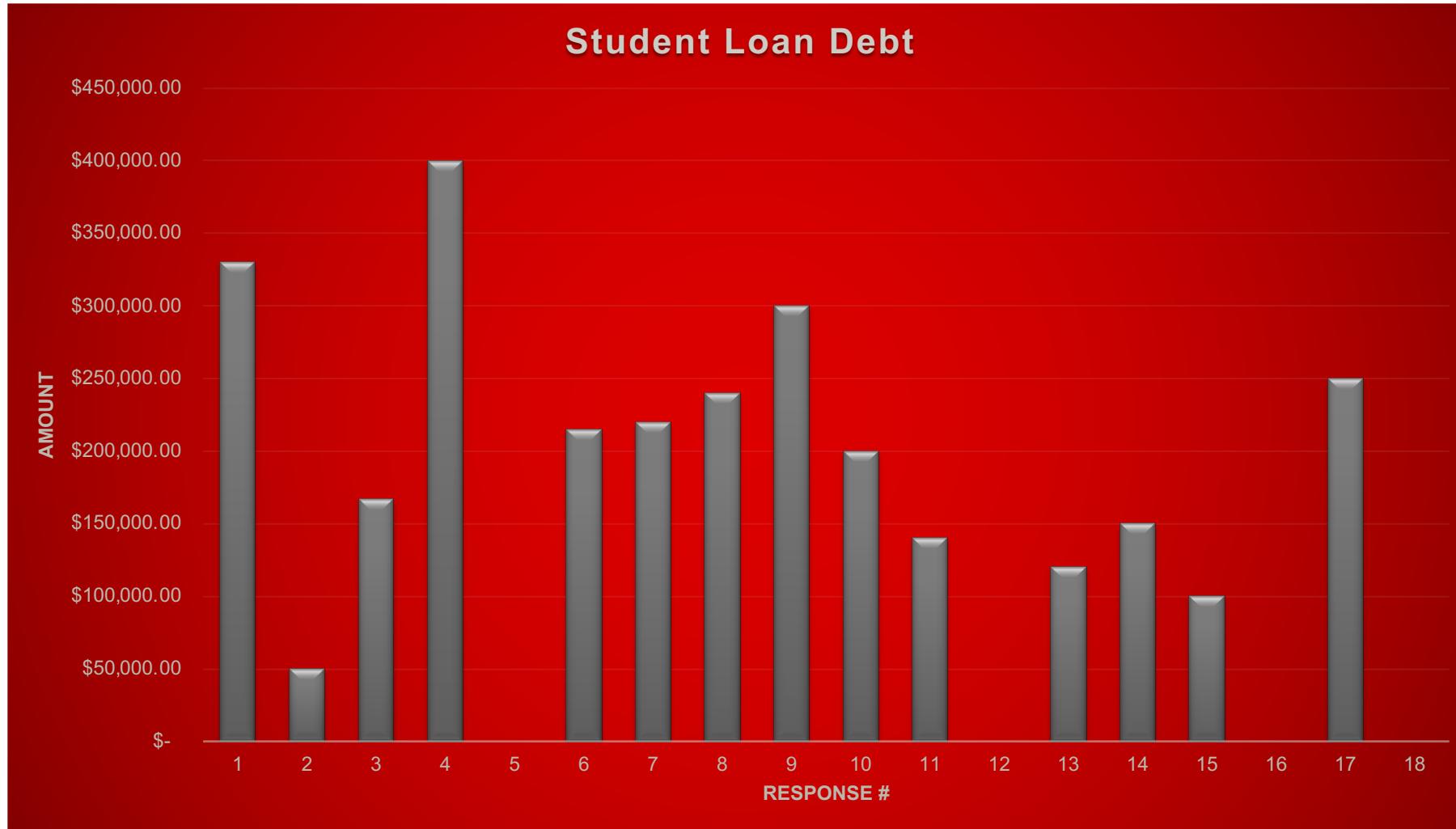
Percentage of Employed Who are Senior Managers, by Gender, 2008
(Percent) ● Women ● Men



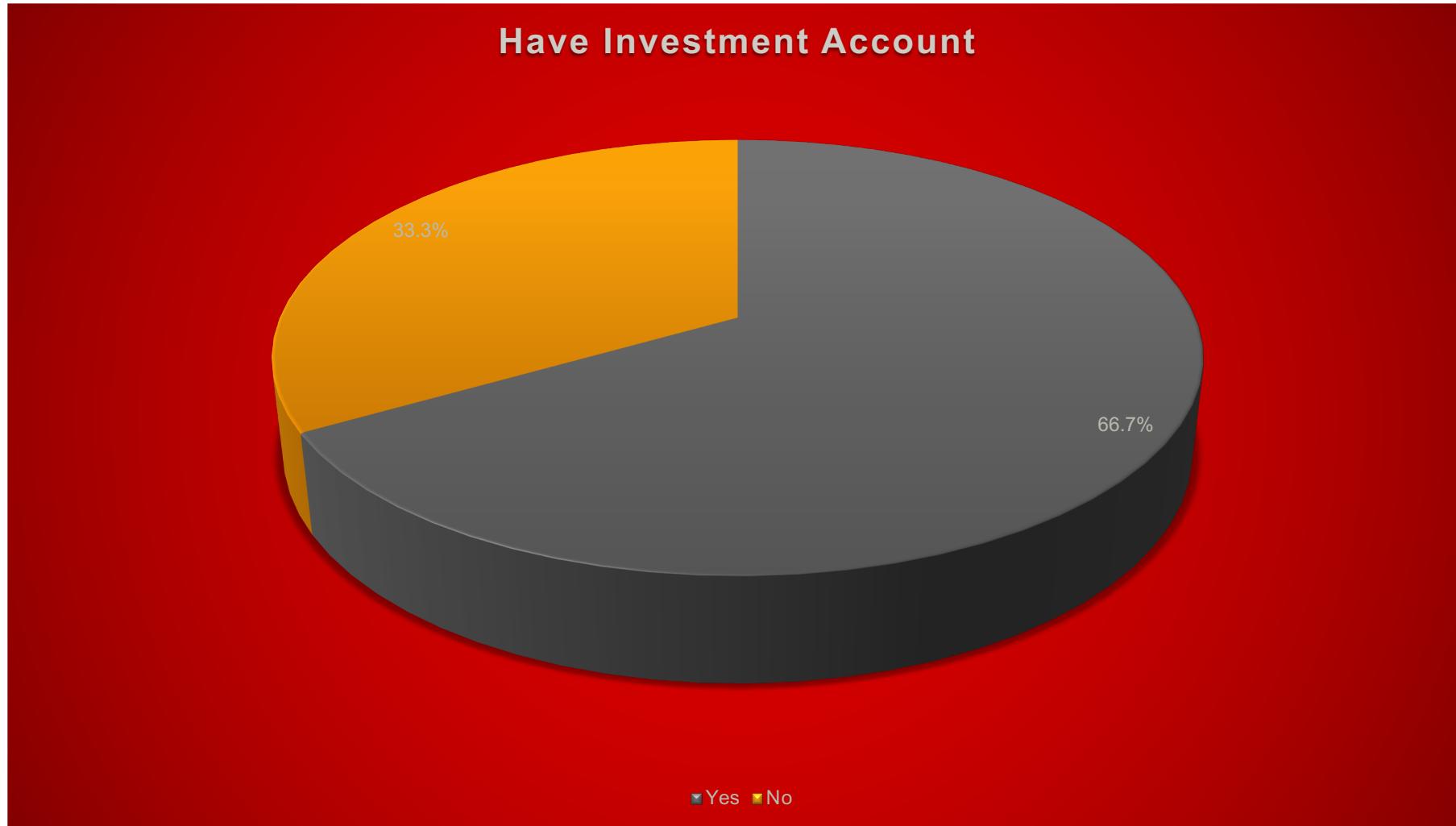
Percentage of Employed Who are Senior Managers, by Gender, 2008
(Percent) • Women • Men



Survey: How much do you currently owe in student loans?



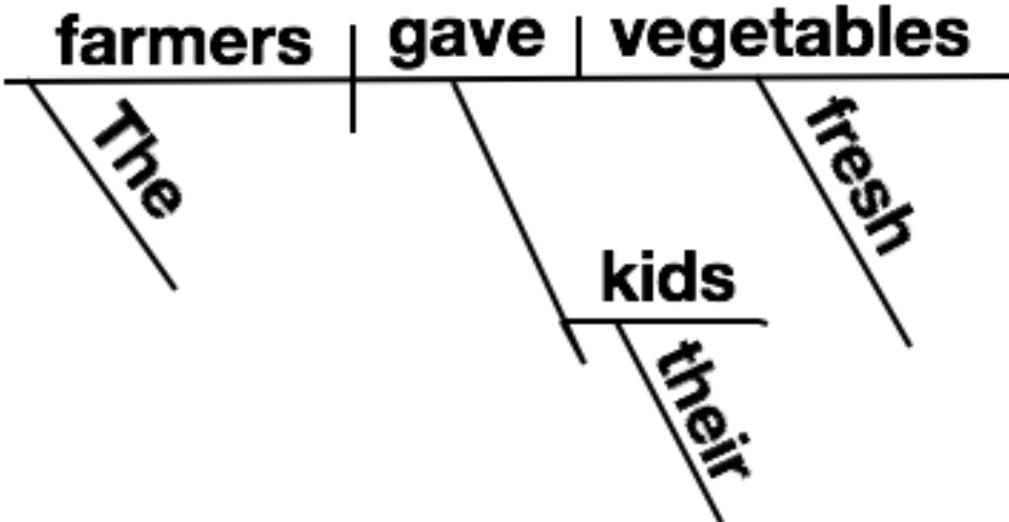
Survey: Do you have an investment account?



Grammar of Graphics

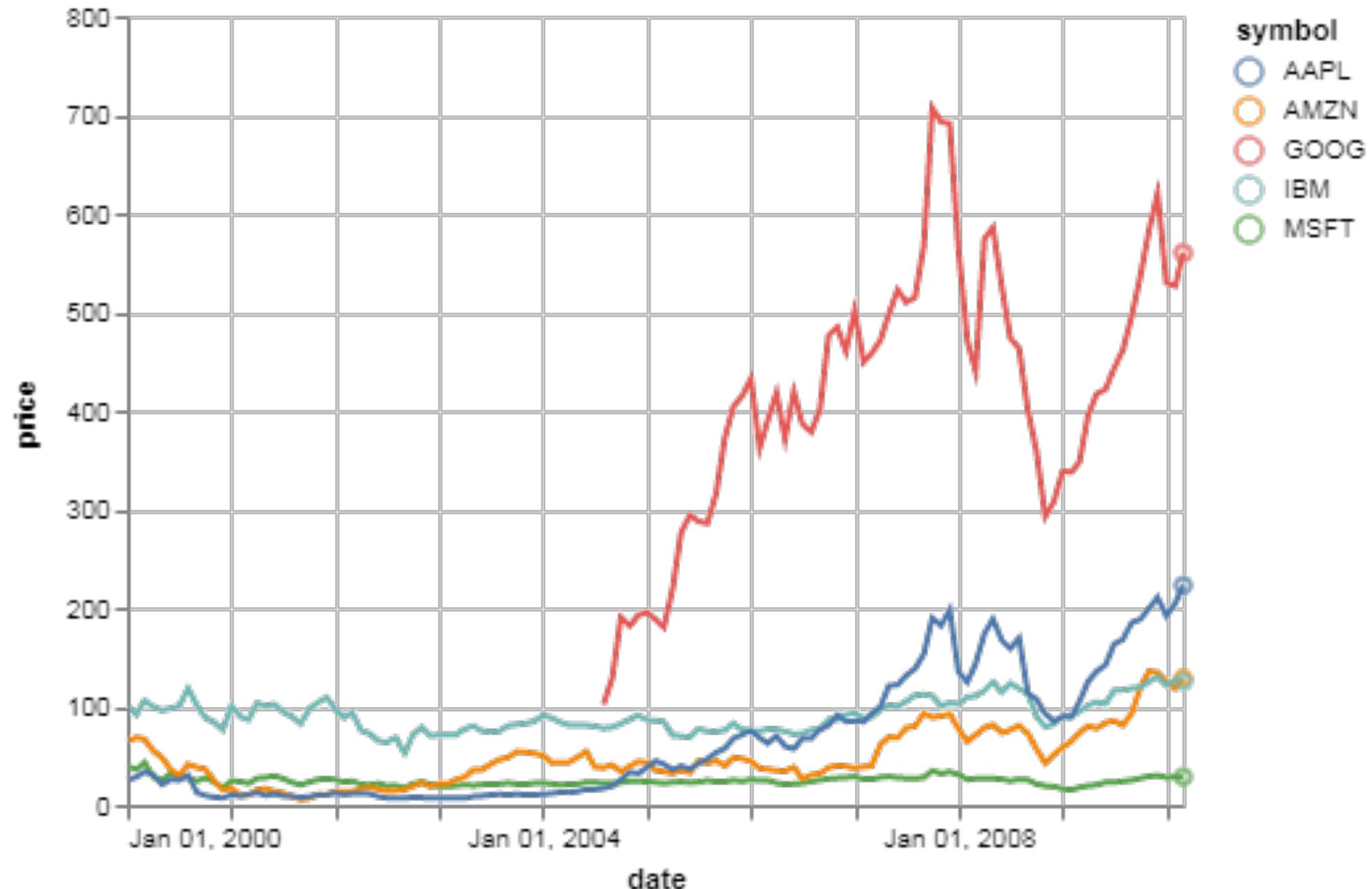
Grammar: framework that defines and establishes the structure of a language.
If words are the lego blocks of language, grammar is the instruction booklet for how to put them together to make meaningful sentences.

A grammar of graphics is a framework that breaks down any graphic into its components (layers) to allow us to concisely describe it.



Layers of any visualization

- 1. Data:** Always start with the data, identify the dimensions you want to visualize.
- 2. Aesthetics:** Confirm the axes based on the data dimensions, positions of various data points in the plot. Also check if any form of encoding is needed including size, shape, color and so on which are useful for plotting multiple data dimensions.
- 3. Scale:** Do we need to scale the potential values, use a specific scale to represent multiple values or a range?
- 4. Geometric objects:** These are popularly known as ‘geoms’. This would cover the way we would depict the data points on the visualization. Should it be points, bars, lines and so on?
- 5. Statistics:** Do we need to show some statistical measures in the visualization like measures of central tendency, spread, confidence intervals?
- 6. Facets:** Do we need to create subplots based on specific data dimensions?
- 7. Coordinate system:** What kind of a coordinate system should the visualization be based on — should it be cartesian or polar?



Exercise in R

- Ggplot2 cheat sheet:

<https://rstudio.com/wp-content/uploads/2015/03/ggplot2-cheatsheet.pdf>

References

- Everything Data course: “Effective Visualizations”, Duke University