

Fundamental Graphs

From data to (basic) visual representations

M. Cristina

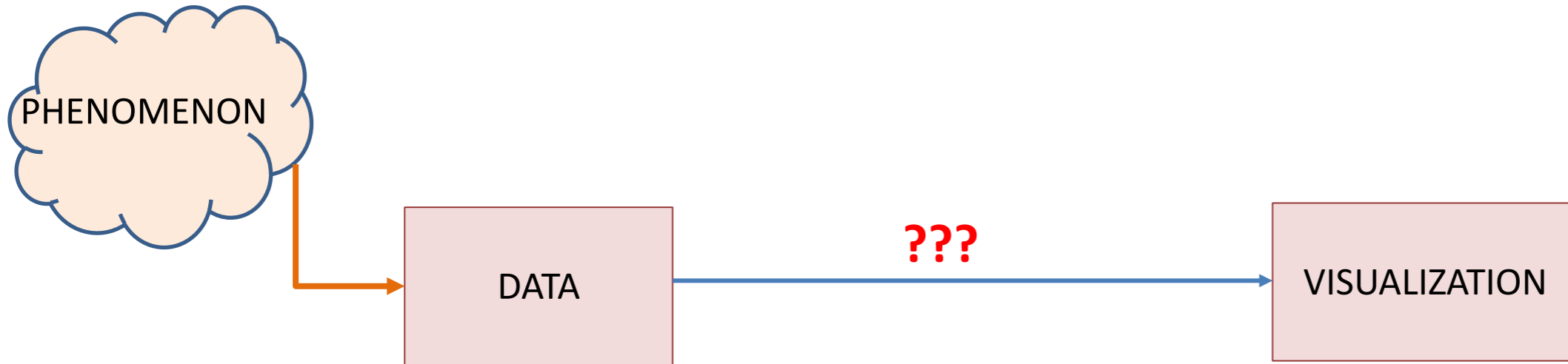
SCC5836/0252 Visualização Computacional

Summary

- (previous) Data abstraction => graph design
- (now) Fundamental graphs and variations
- (next) Data transformation/pre-processing

Data abstraction

How can I visualize this data?



Data table

M	N	O	P	Q	R	S	T	U	V
City	Zip Code	State	Region	Customer Segment	Product Category	Product Sub-Category	Product Name	Product Container	Product Base Margin
Bowie	20715	Maryland	East	Home Office	Office Supplies	Storage & Organization	Safco Industrial Wire Shelving	Large Box	
McKeesport	15131	Pennsylvania	East	Small Business	Office Supplies	Storage & Organization	Perma STOR-ALLI Hanging File Box, 13 1/8"W x 12 1/4"D x 10 1/2"H	Small Box	0.68
Prior Lake	55372	Minnesota	Central	Consumer	Office Supplies	Binders and Binder Accessories	Avery Trapezoid Ring Binder, 3" Capacity, Black, 1040 sheets	Small Box	0.36
Napa	94559	California	West	Corporate	Furniture	Chairs & Chairmats	Hon 4070 Series Pagodal Armless Upholstered Stacking Chairs	Jumbo Drum	0.56
Napa	94559	California	West	Corporate	Furniture	Chairs & Chairmats	Hon ValutaskI Swivel Chairs	Jumbo Drum	0.69
Napa	94559	California	West	Corporate	Office Supplies	Storage & Organization	Dual Level, Single-Width Filing Carts	Small Box	0.59
Montebello	90640	California	West	Consumer	Office Supplies	Paper	Black Print Carbonless Snap-Off® Rapid Letter, 8 1/2" x 7"	Wrap Bag	0.4
Montebello	90640	California	West	Consumer	Office Supplies	Paper	White GlueTop Scratch Pads	Wrap Bag	0.39
Lake Oswego	97035	Oregon	West	Home Office	Office Supplies	Pens & Art Supplies	Dixon Prang® Watercolor Pencils, 10-Color Set with Brush	Wrap Bag	0.44
Baton Rouge	70802	Louisiana	South	Corporate	Technology	Computer Peripherals	Fellowes Mobile Numeric Keypad, Graphite	Small Box	0.66
Baton Rouge	70802	Louisiana	South	Corporate	Technology	Office Machines	Polycom ViaVideoI Desktop Video Communications Unit	Large Box	0.37
Baton Rouge	70802	Louisiana	South	Corporate	Office Supplies	Paper	Staples Wirebound Steno Books, 6" x 9", 12/Pack	Wrap Bag	0.36
Draper	84020	Utah	West	Home Office	Furniture	Office Furnishings	36X48 HARDFLOOR CHAIRMAT	Medium Box	0.78
Layton	84041	Utah	West	Corporate	Technology	Office Machines	Panasonic KX-P2130 Dot Matrix Printer	Jumbo Drum	0.59
Kearney	68847	Nebraska	Central	Corporate	Office Supplies	Paper	Xerox 4200 Series MultiUse Premium Copy Paper (20Lb. and 84 Bright)	Small Box	0.4
Kearney	68847	Nebraska	Central	Corporate	Technology	Telephones and Communication	T18	Small Box	0.57
Phenix City	36869	Alabama	South	Home Office	Office Supplies	Binders and Binder Accessories	Avery Heavy-Duty EZD I Binder With Locking Rings	Small Box	0.37
Phenix City	36869	Alabama	South	Home Office	Furniture	Tables	Bush Advantage Collection® Round Conference Table	Jumbo Box	0.64
Pharr	78577	Texas	Central	Corporate	Office Supplies	Binders and Binder Accessories	Cardinal Poly Pocket Divider Pockets for Ring Binders	Small Box	0.4
Pharr	78577	Texas	Central	Corporate	Office Supplies	Paper	"While you Were Out" Message Book, One Form per Page	Wrap Bag	0.35
Bryan	77803	Texas	Central	Home Office	Furniture	Chairs & Chairmats	Office Star - Professional Matrix Back Chair with 2-to-1 Synchro Tilt and Me	Jumbo Drum	0.61
Deer Park	11729	New York	East	Home Office	Office Supplies	Paper	Rediform Wirebound "Phone Memo" Message Book, 11 x 5-3/4	Wrap Bag	0.36
Fort Dodge	50501	Iowa	Central	Consumer	Technology	Computer Peripherals	Memorex 4.7GB DVD+RW, 3/Pack	Small Pack	0.4
Fort Dodge	50501	Iowa	Central	Consumer	Technology	Telephones and Communication	3285	Small Box	0.59
Ormond Beach	32174	Florida	South	Corporate	Office Supplies	Storage & Organization	Perma STOR-ALLI Hanging File Box, 13 1/8"W x 12 1/4"D x 10 1/2"H	Small Box	0.68
Norman	73071	Oklahoma	Central	Small Business	Furniture	Office Furnishings	Electrix Halogen Magnifier Lamp	Large Box	0.59
Norman	73071	Oklahoma	Central	Small Business	Furniture	Office Furnishings	Luxo Professional Fluorescent Magnifier Lamp with Clamp-Mount Base	Large Box	0.59
Norman	73071	Oklahoma	Central	Small Business	Technology	Office Machines	Panasonic KX-P1150 Dot Matrix Printer	Jumbo Drum	0.56
Dubuque	52001	Iowa	Central	Corporate	Furniture	Chairs & Chairmats	Hon Deluxe Fabric Upholstered Stacking Chairs, Rounded Back	Jumbo Drum	0.55
Mount Prospect	60056	Illinois	Central	Home Office	Technology	Office Machines	Canon S750 Color Inkjet Printer	Jumbo Drum	0.38
Bedford	76021	Texas	Central	Consumer	Furniture	Chairs & Chairmats	Metal Folding Chairs, Beige, 4/Cartron	Jumbo Drum	0.58
Bedford	76021	Texas	Central	Consumer	Furniture	Chairs & Chairmats	Hon 4700 Series MobuisI Mid-Back Task Chairs with Adjustable Arms	Jumbo Drum	0.64
Bedford	76021	Texas	Central	Consumer	Furniture	Office Furnishings	Telescoping Adjustable Floor Lamp	Large Box	0.6
Bedford	76021	Texas	Central	Consumer	Furniture	Tables	Iceberg OfficeWorks 42" Round Tables	Jumbo Box	0.7
Bedford	76021	Texas	Central	Consumer	Technology	Telephones and Communication	232	Small Box	0.55
Monroe	71203	Louisiana	South	Home Office	Office Supplies	Paper	IBM Multi-Purpose Copy Paper, 8 1/2 x 11", Case	Small Box	0.4
Royal Palm Beach	33411	Florida	South	Consumer	Office Supplies	Binders and Binder Accessories	GBC VeloBinder Strips	Small Box	0.35
Royal Palm Beach	33411	Florida	South	Consumer	Furniture	Office Furnishings	G.E. Longer-Life Indoor Recessed Floodlight Bulbs	Small Pack	0.37
Hilton Head Island	29915	South Carolina	South	Consumer	Furniture	Chairs & Chairmats	Novimex Swivel Fabric Task Chair	Jumbo Drum	0.74

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How do I visualize this?

Items x Attributes: items in rows, attributes in columns

How

- Two steps:

Step 1: Decide **what** to visualize

Step 2: Decide **how** to visualize it

How

- Two steps:

Step 1: Decide **what** to visualize

– selecting and transforming the data

Step 2: Decide **how** to visualize it

How

- Two steps:

Step 1: Decide **what** to visualize

- selecting and transforming the data

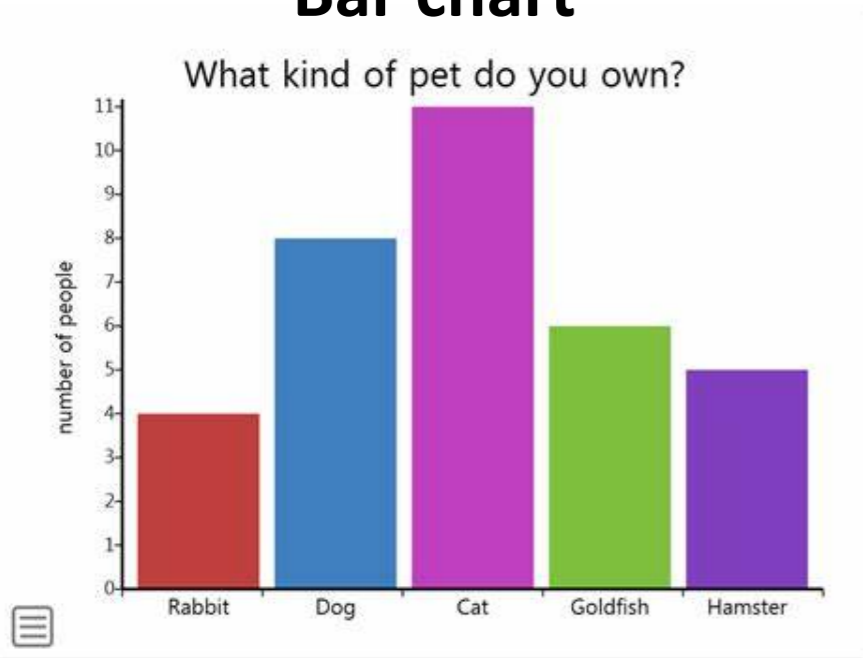
Step 2: Decide **how** to visualize it

- choosing (selecting from existing) or designing (a novel) an appropriate representation

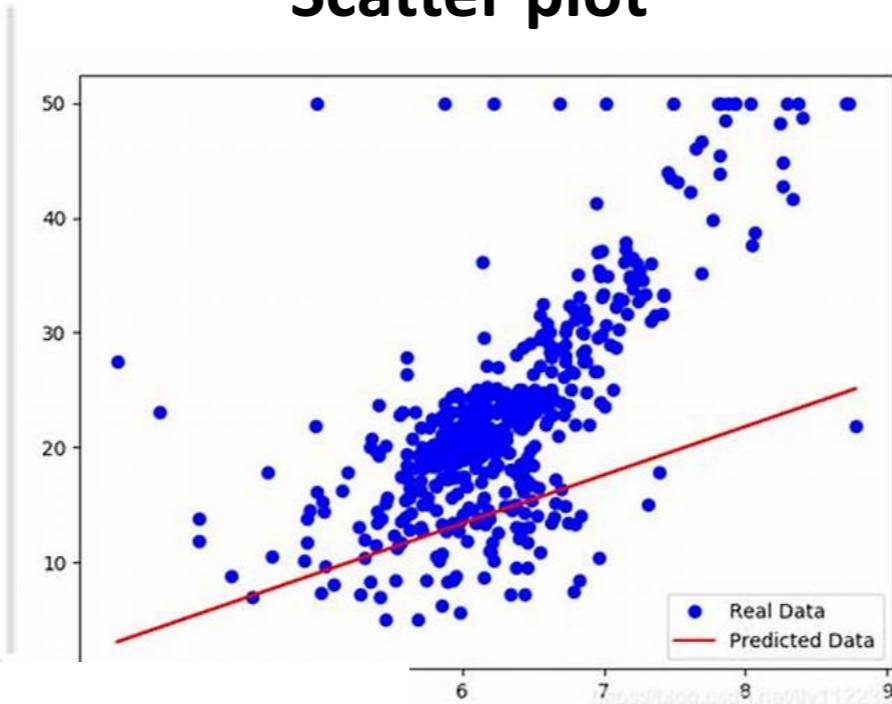
Fundamental graphs



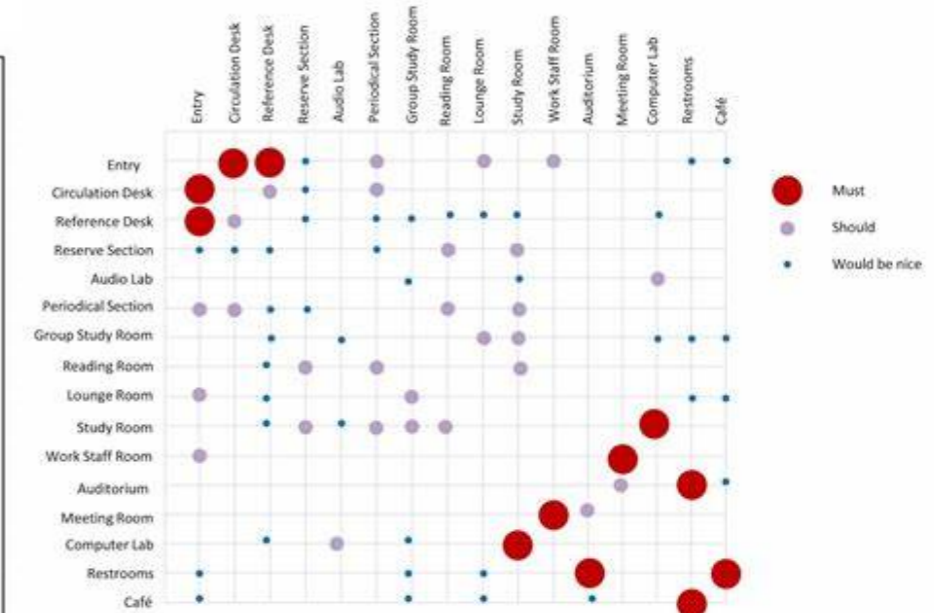
Bar chart



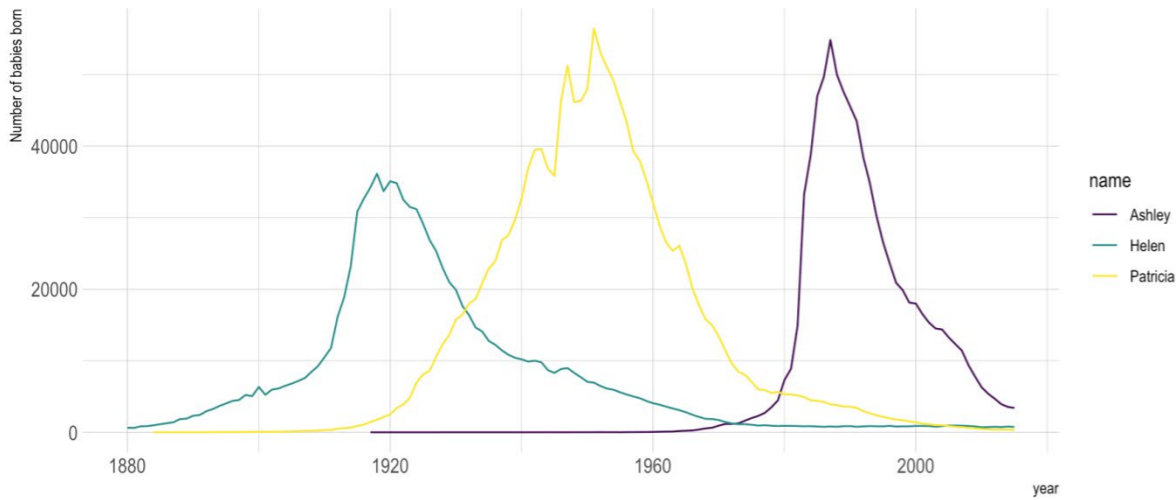
Scatter plot



Matrix

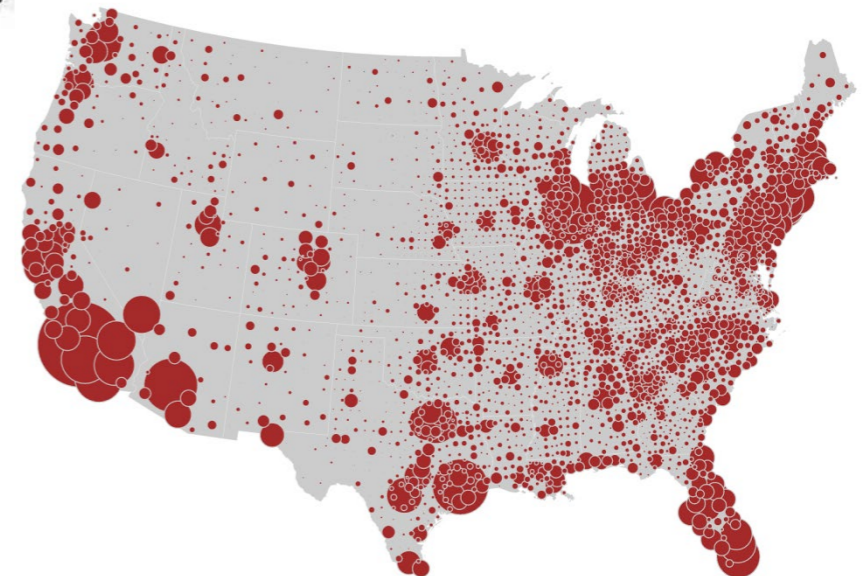


Popularity of American names in the previous 30 years



Line chart

Symbol map



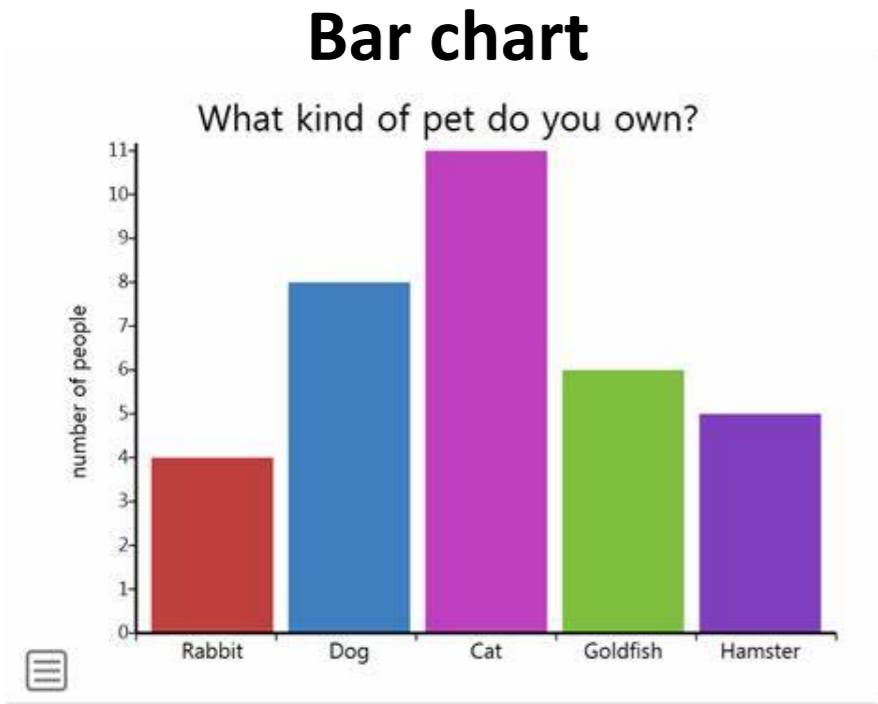
Why these?

- Widely adopted, effective, useful
- Solve very large percentage of visualization problems
- Training ground for more sophisticated graphs

Fundamental graphs

- Graphs suitable for showing combinations of two, maybe three attributes.

Bar chart: visualize how a **quantity** distributes across a set of **categories**

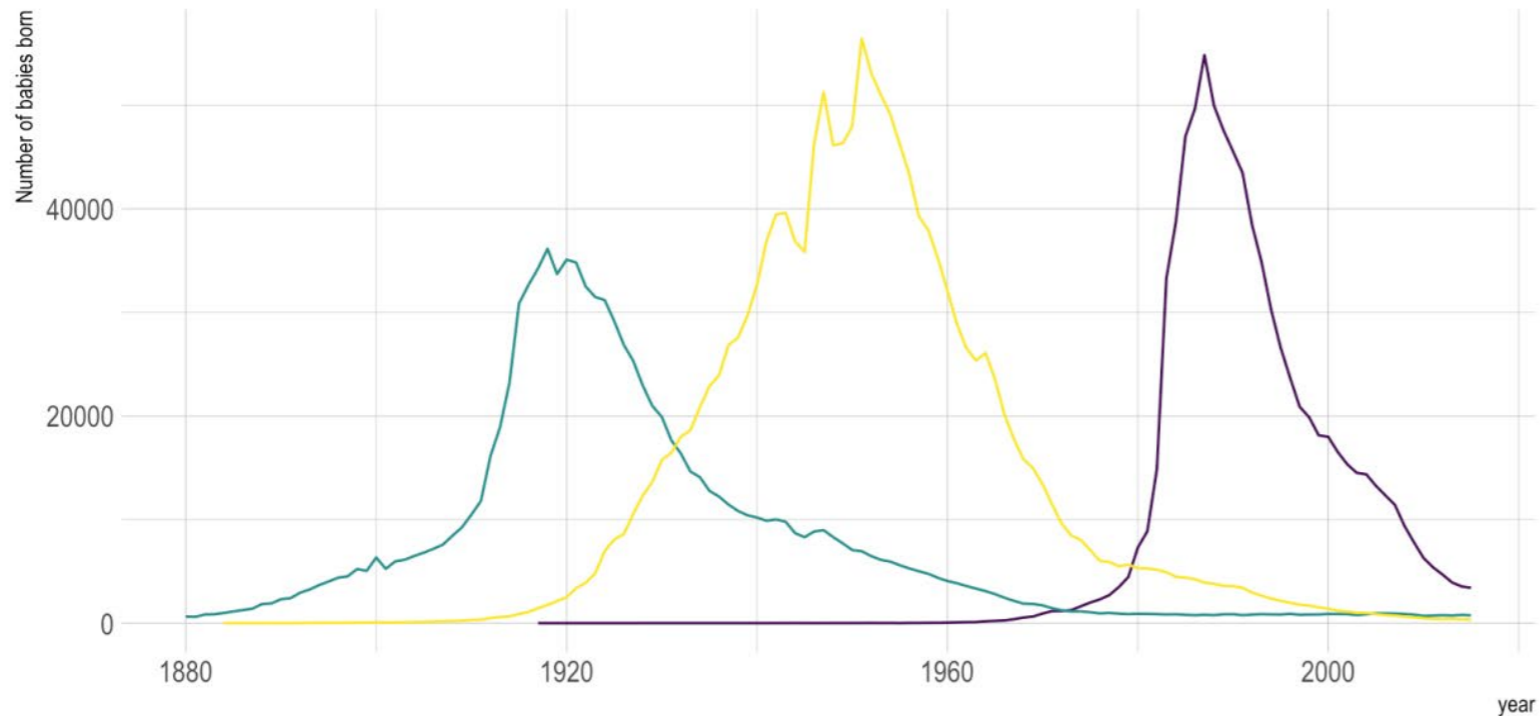


[From data to Viz | Find the graphic you need \(data-to-viz.com\)](https://data-to-viz.com)

[Barplot – from Data to Viz \(data-to-viz.com\)](https://data-to-viz.com)

Line chart: visualize how a **quantity** changes in relation to another **quantity** (typically **time**)

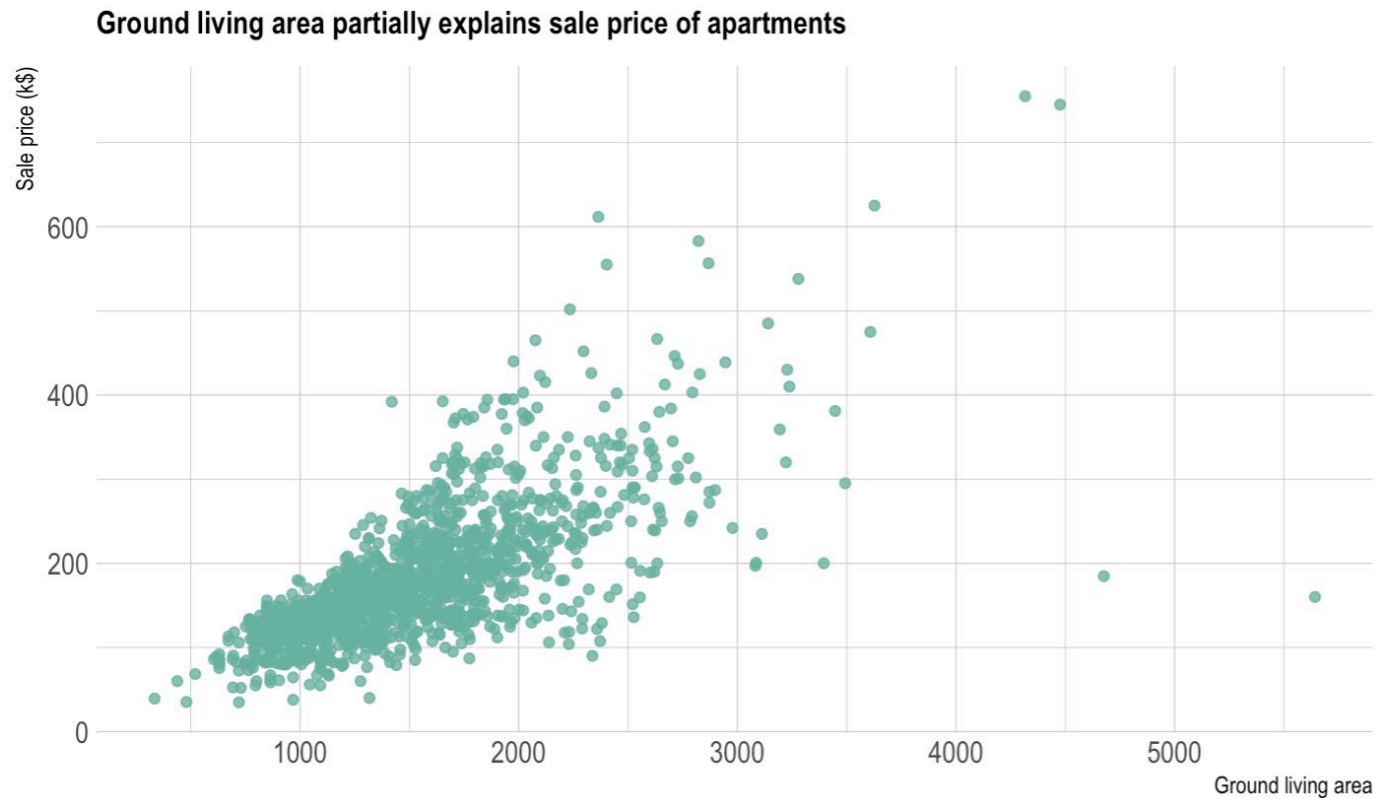
Popularity of American names in the previous 30 years



[From data to Viz | Find the graphic you need \(data-to-viz.com\)](https://data-to-viz.com)

name
— Ashley [Line chart – from Data to Viz \(data-to-viz.com\)](https://data-to-viz.com)
— Helen
— Patricia

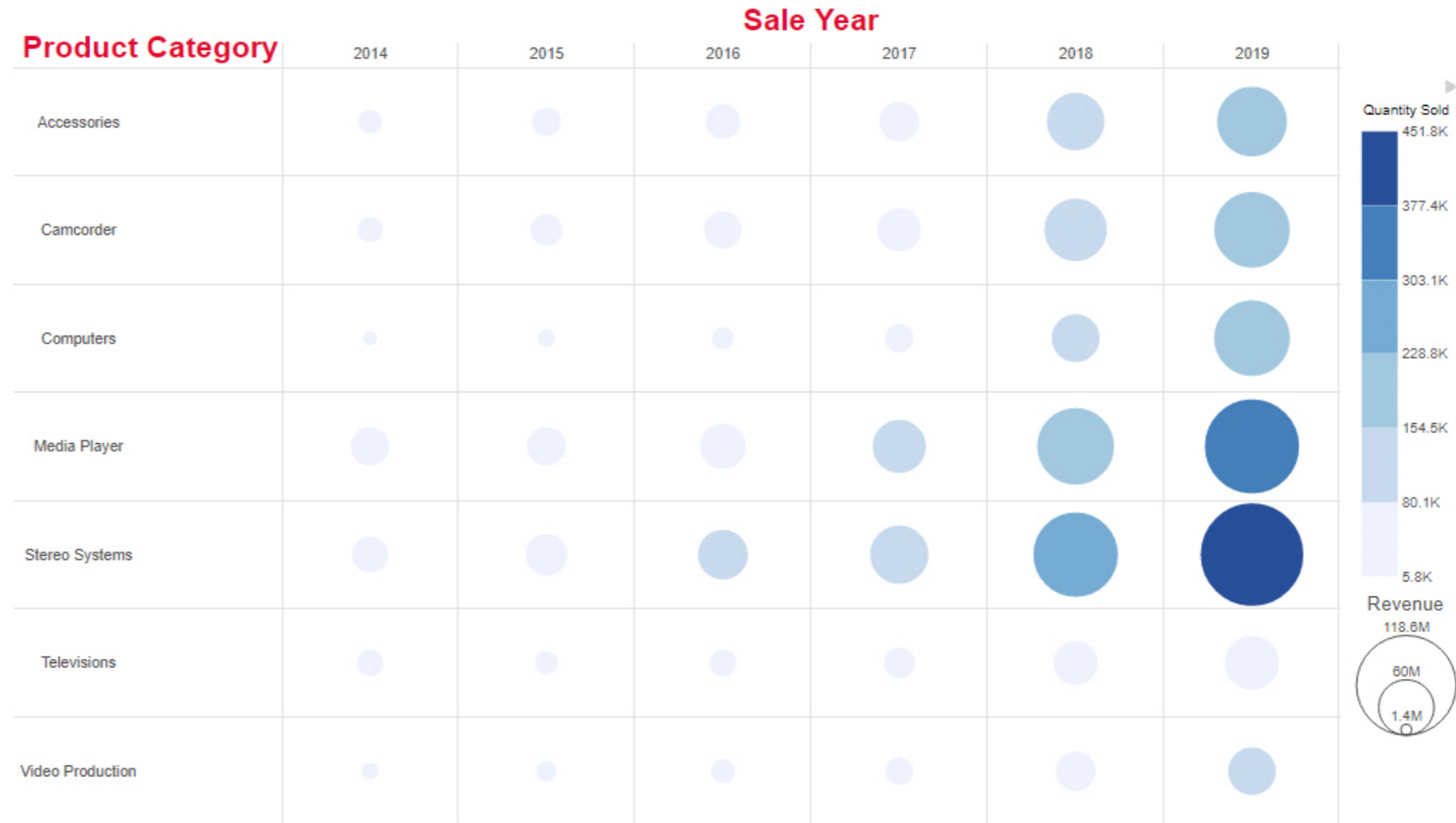
Scatter plot: visualize how a **quantity** relates with another **quantity**



[From data to Viz | Find the graphic you need \(data-to-viz.com\)](#)

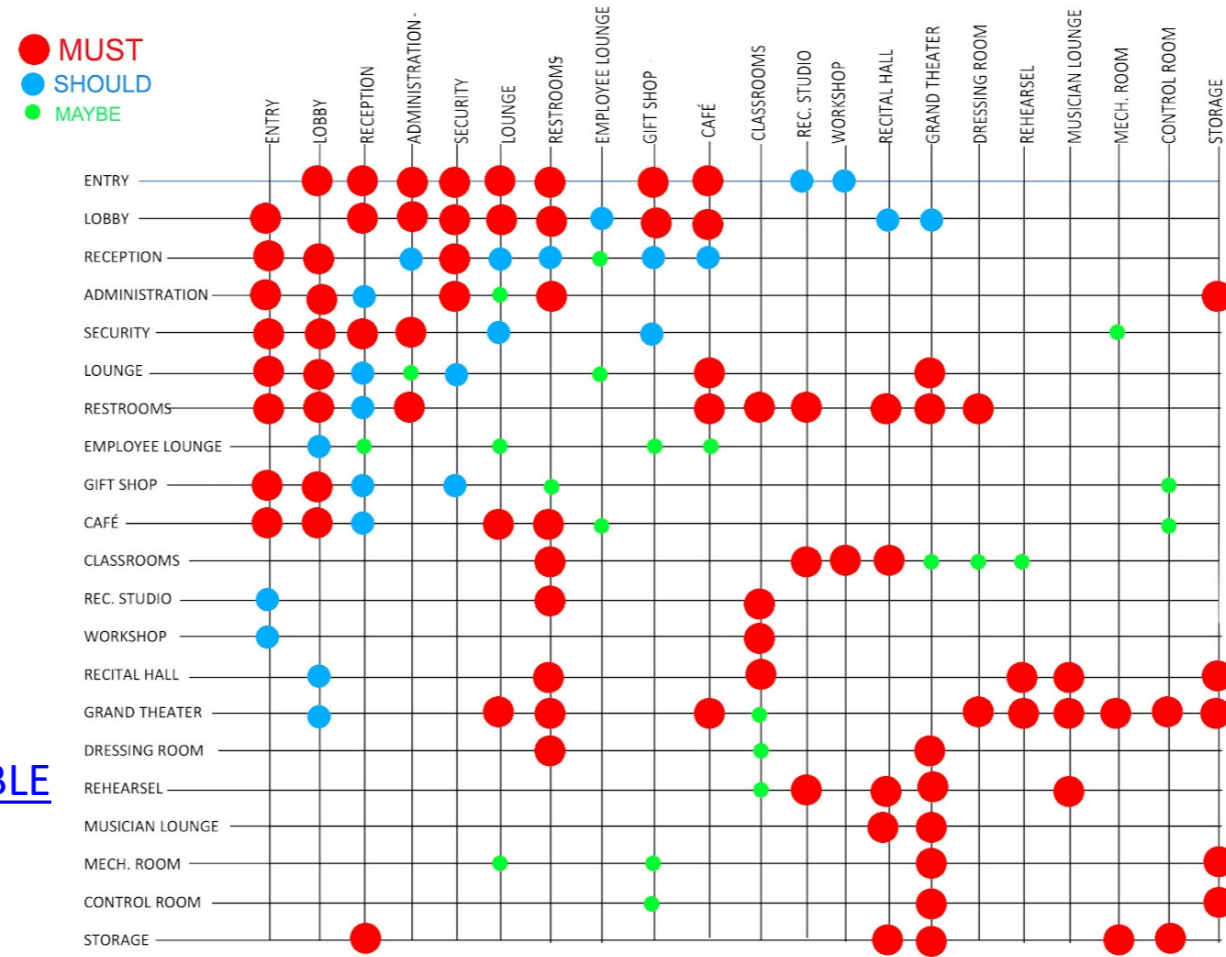
[Scatter plot – from Data to Viz \(data-to-viz.com\)](#)

Matrix chart: visualize how a **quantity** distributes across **two categories**



[Formatting Matrix Charts | ibi™ WebFOCUS® KnowledgeBase \(informationbuilders.com\)](#)

Matrix chart: visualize how a **category** distributes across **two categories**

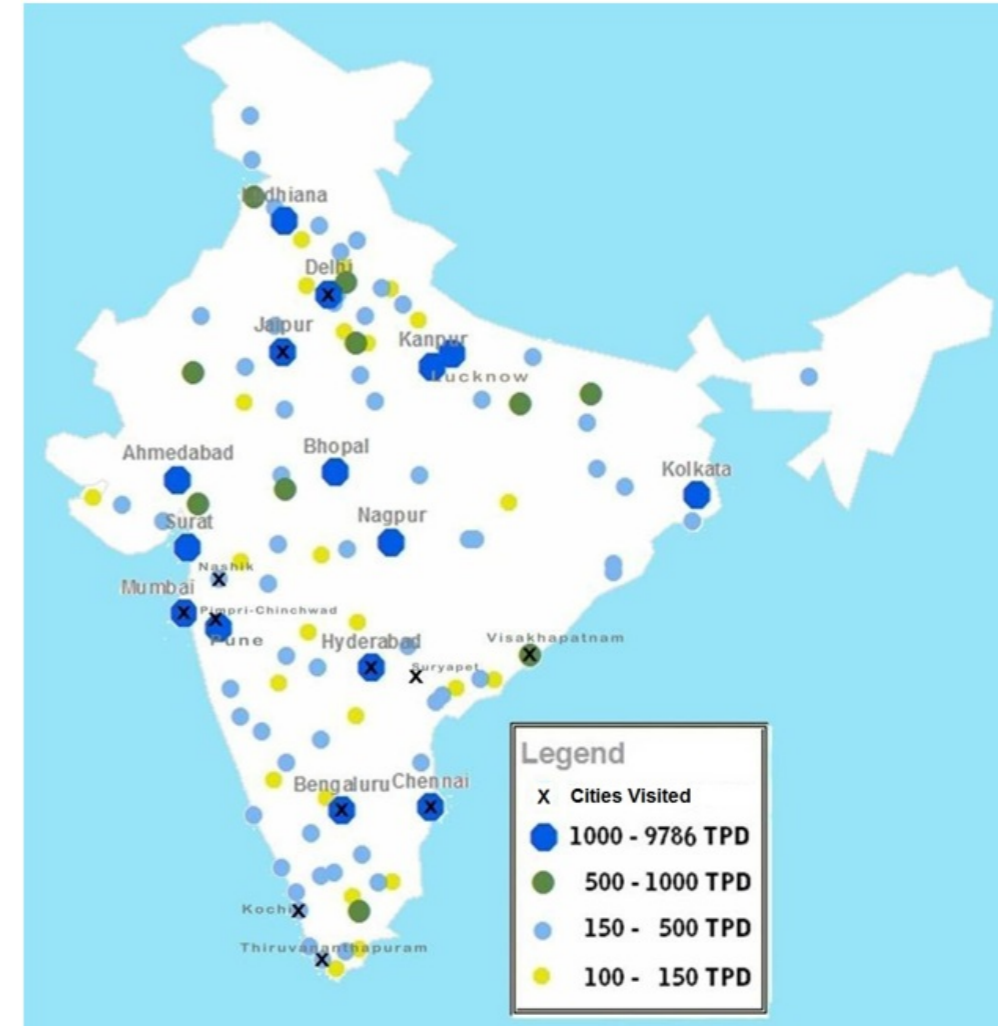


[ML+ARCHITECTURE: MATRIX AND BUBBLE DIAGRAM \(arch3611fall12ml.blogspot.com\)](http://arch3611fall12ml.blogspot.com)

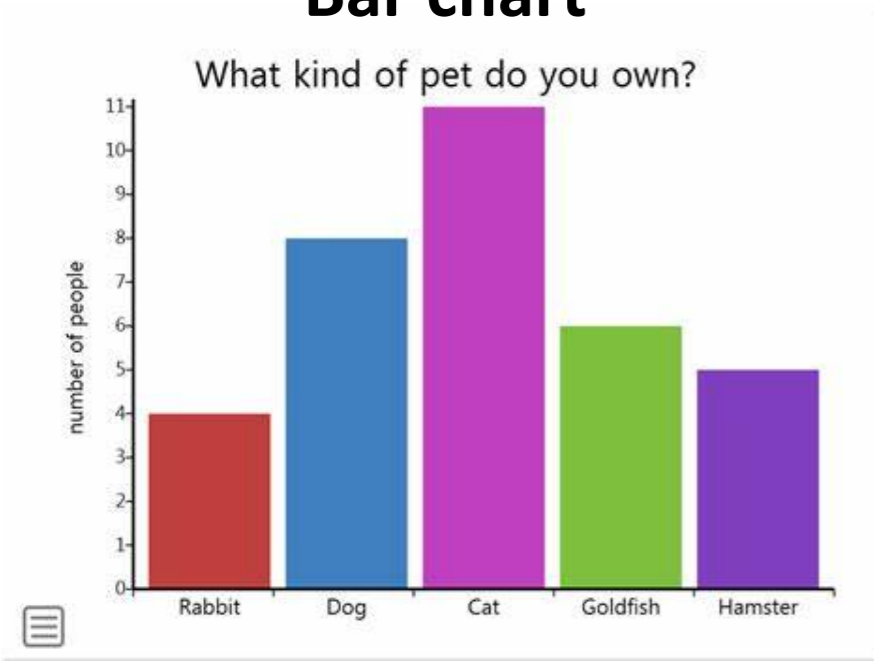
Symbol map: visualize how a **quantity** distributes across **two spatial coordinates**

Figure 1. Map of Cities Generating Different Quantities (2001 Values) of MSW; Cities Visited by the Author during Research Visits. Source: [Sustainable Solid Waste Management in India: Research Summary \(swmindia.blogspot.com\)](http://swmindia.blogspot.com)

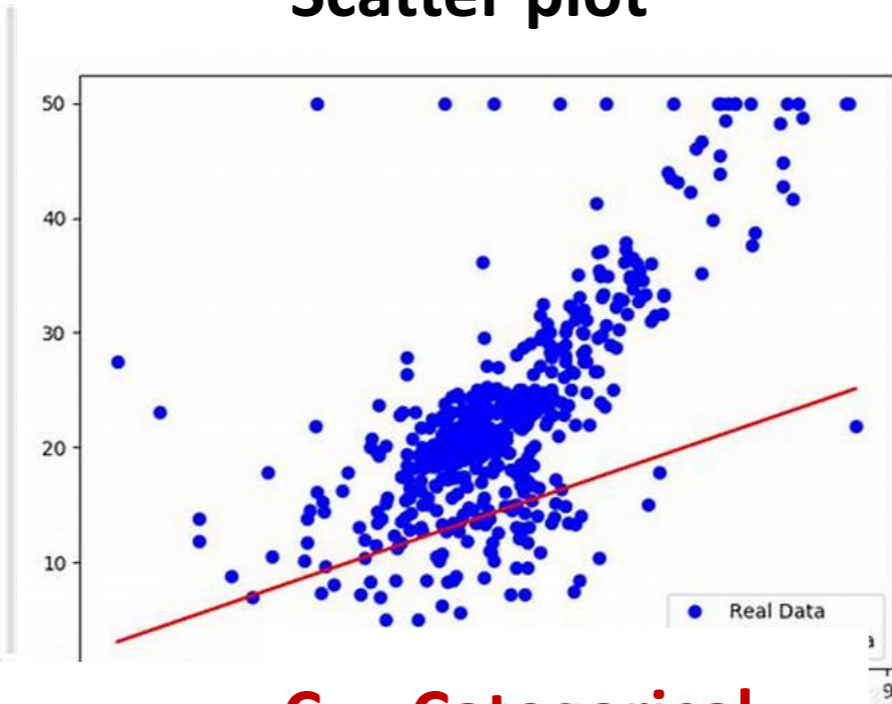
[Bubble map – from Data to Viz \(data-to-viz.com\)](http://data-to-viz.com)



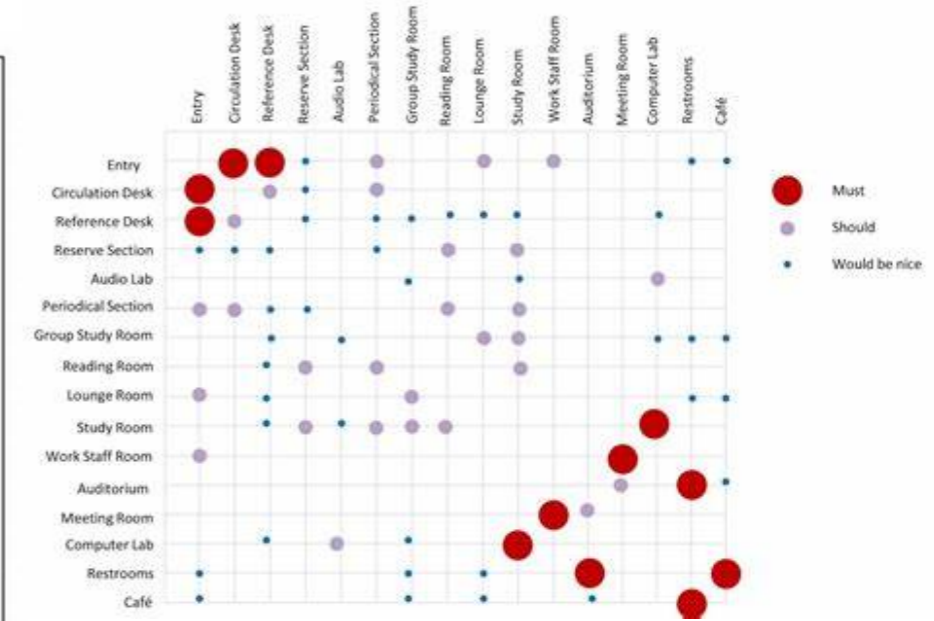
Bar chart



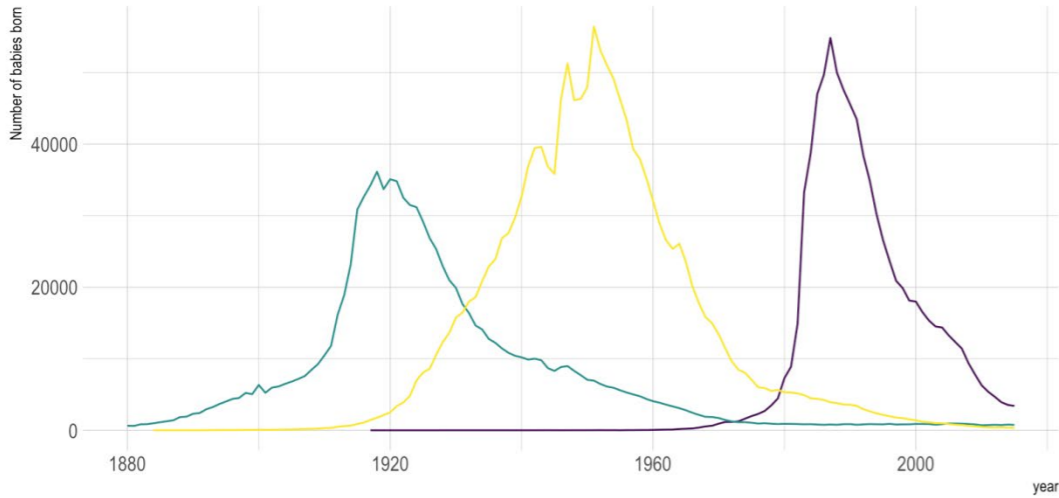
Scatter plot



Matrix

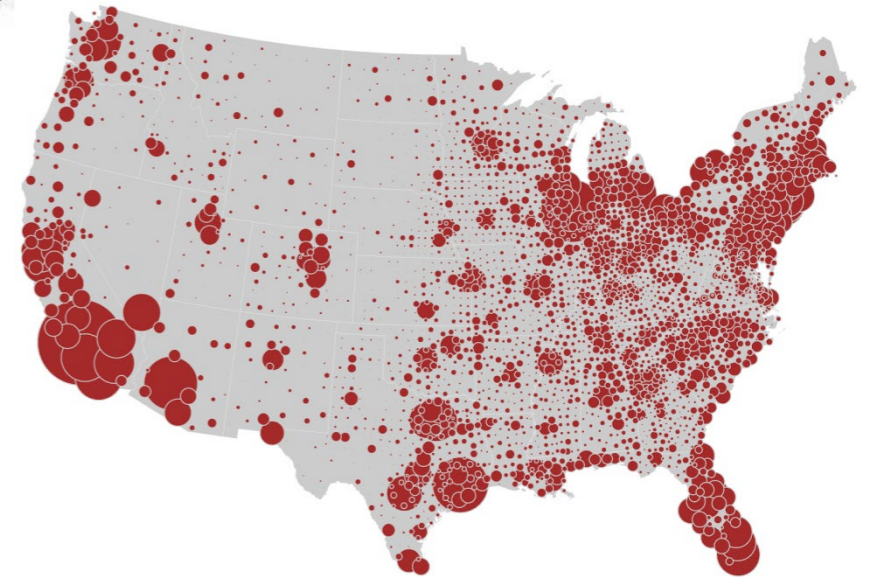


Popularity of American names in the previous 30 years



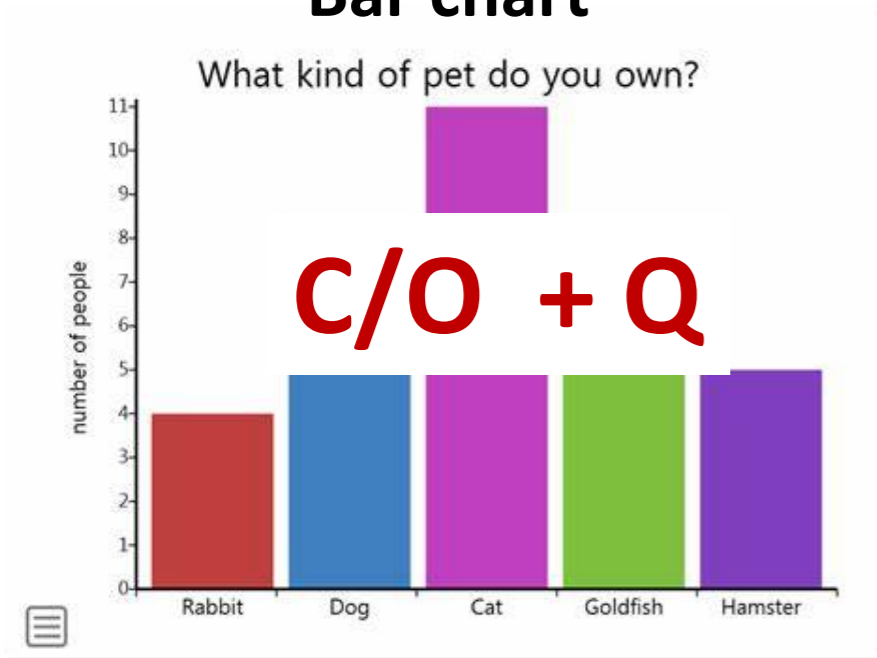
Line chart

- C = Categorical**
- O = Ordinal**
- Q = Quantitative**
- T = Temporal**
- S = Spatial**

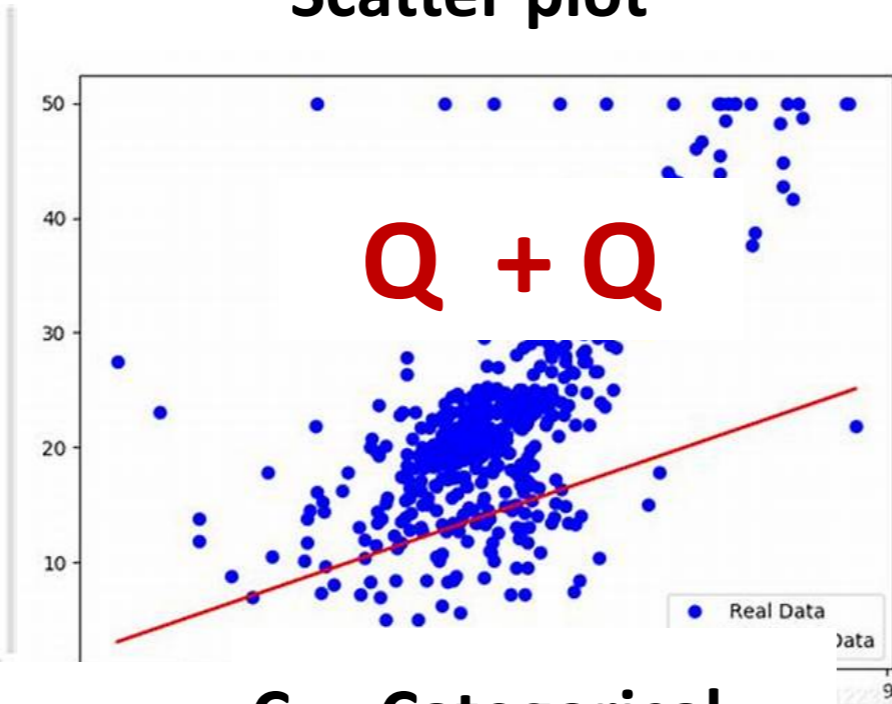


Symbol map

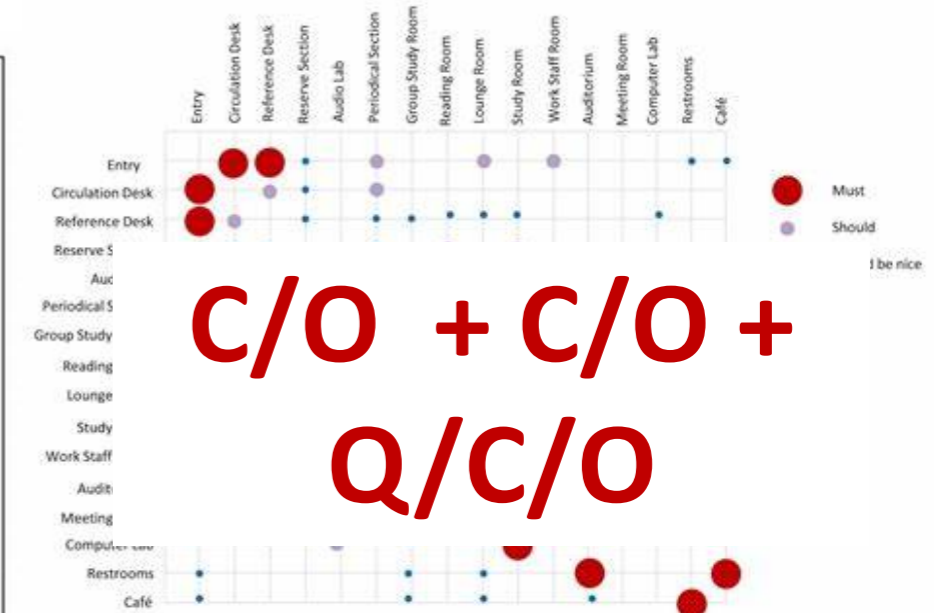
Bar chart



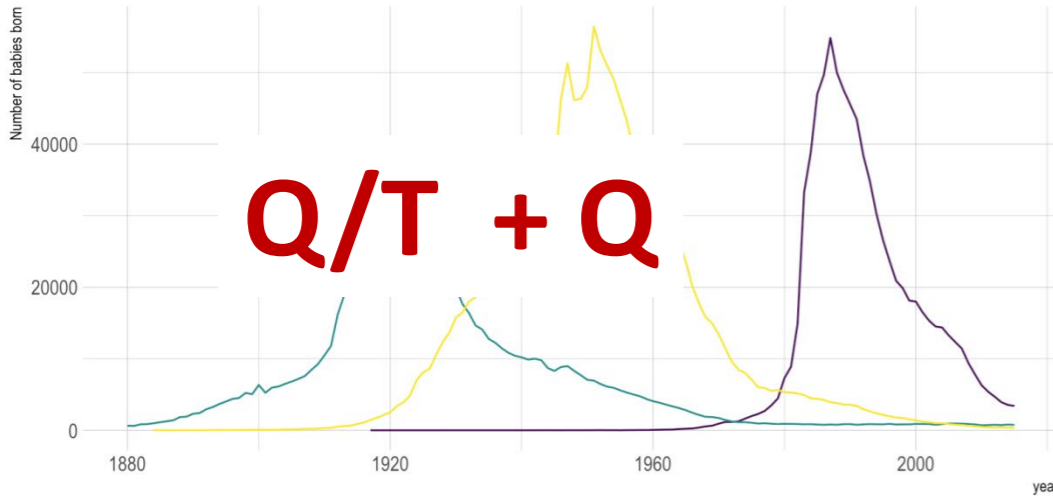
Scatter plot



Matrix



Popularity of American names in the previous 30 years



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Line chart

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Other representations

- Is it possible to create other visual representations that could be used with those types of data?
- Considering alternative representations of the same information is important

Other representations

- Is it possible to create other visual representations that could be used with those types of data?
- Considering alternative representations of the same information is important
 - Useful to reason about different graphical encodings (some solutions may fit best a particular purpose/task) and advantages/disadvantages of alternate designs
 - Useful to develop your skills as a visualization designer

Bar chart alternatives?

- E.g., could use instead...

Bar chart alternatives?

- E.g., could use instead
 - Position (y position) of simple dots?
 - Area of `bubbles`?
 - is area size as effective as bar height/length for comparing quantities?

Bar chart alternatives?

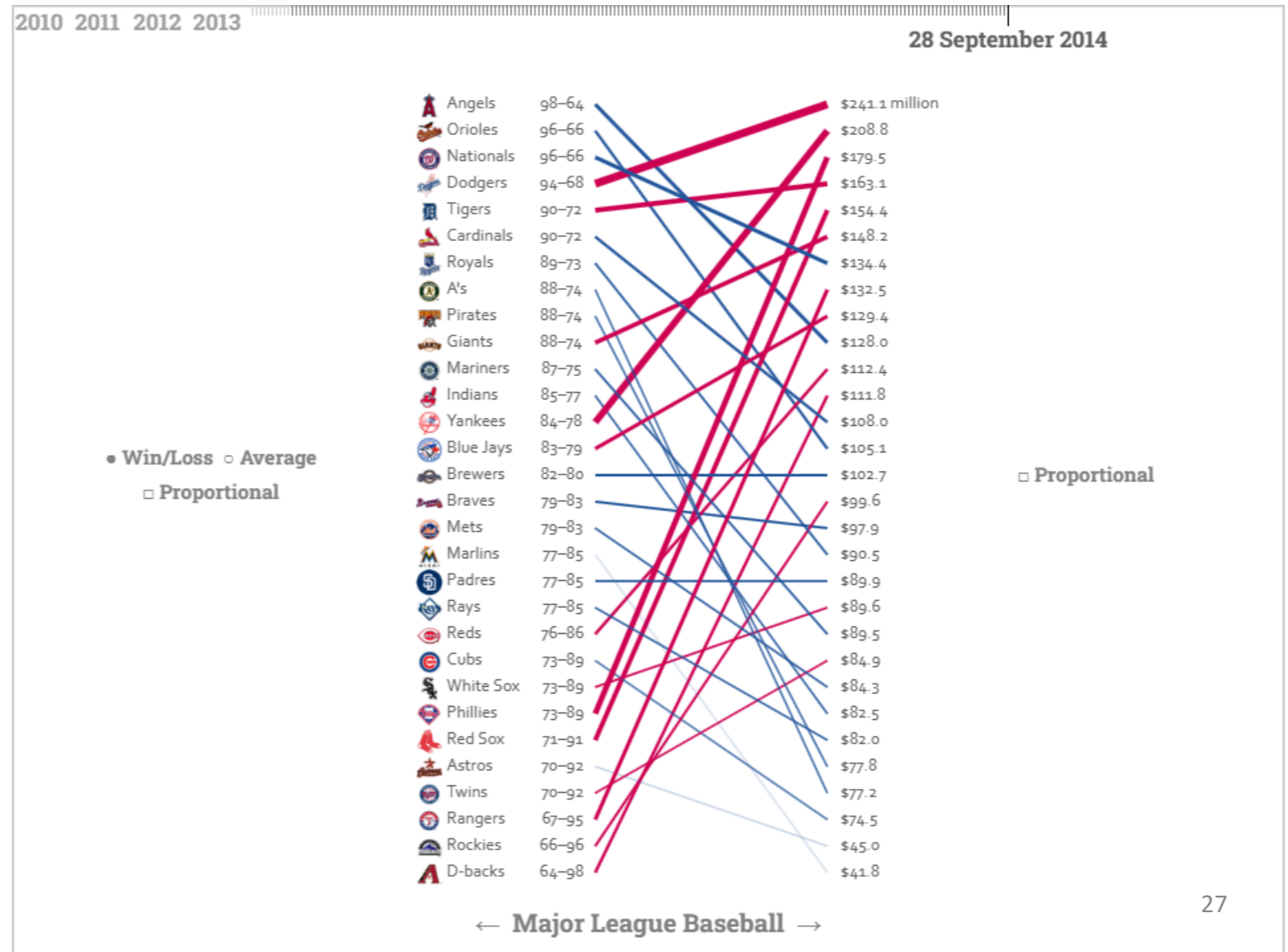
- E.g., could use simple dots instead?
- [Dot plots in Python \(plotly.com\)](#)
- [Barplot – from Data to Viz \(data-to-viz.com\)](#)

Scatter plot alternatives?

Scatter plot alternatives?

Slope chart

<https://fathom.info/embed/salaryper/embed.html>

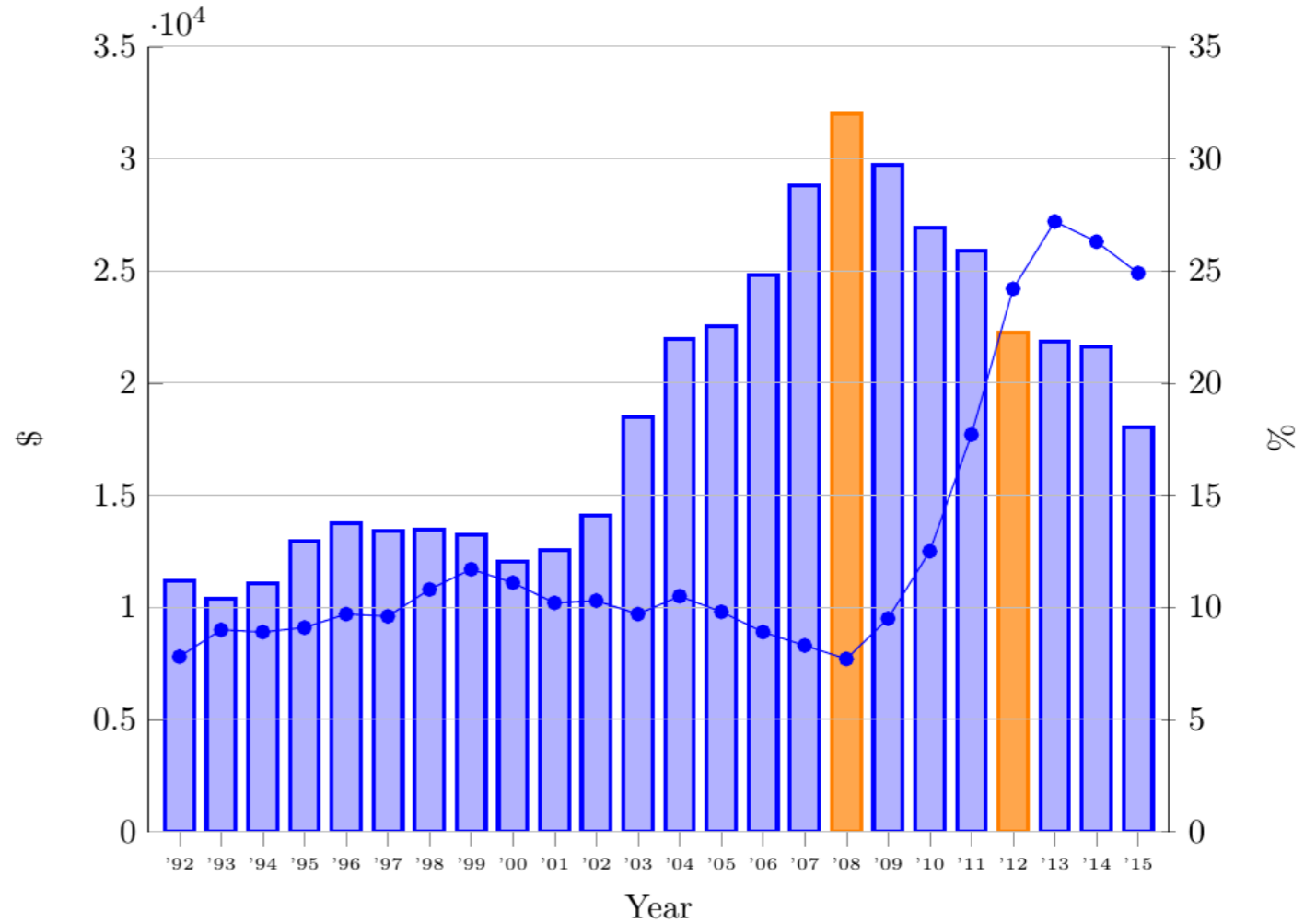


Scatter plot alternatives?

- [Scatter plot – from Data to Viz \(data-to-viz.com\)](https://data-to-viz.com)

Line graph alternatives

Could use bars instead?



[tikz pgf - double y-axis figure with bars and line graph - TeX - LaTeX Stack Exchange](#)

■ GDP per capita (current US\$) ● Unemployment Rate, total (% of total labour force)

Line graph alternatives

- [Line chart – from Data to Viz \(data-to-viz.com\)](https://data-to-viz.com)
- Area chart
- Simple dots?

Matrix chart alternatives?

Symbol map alternatives?

More than two/three attributes

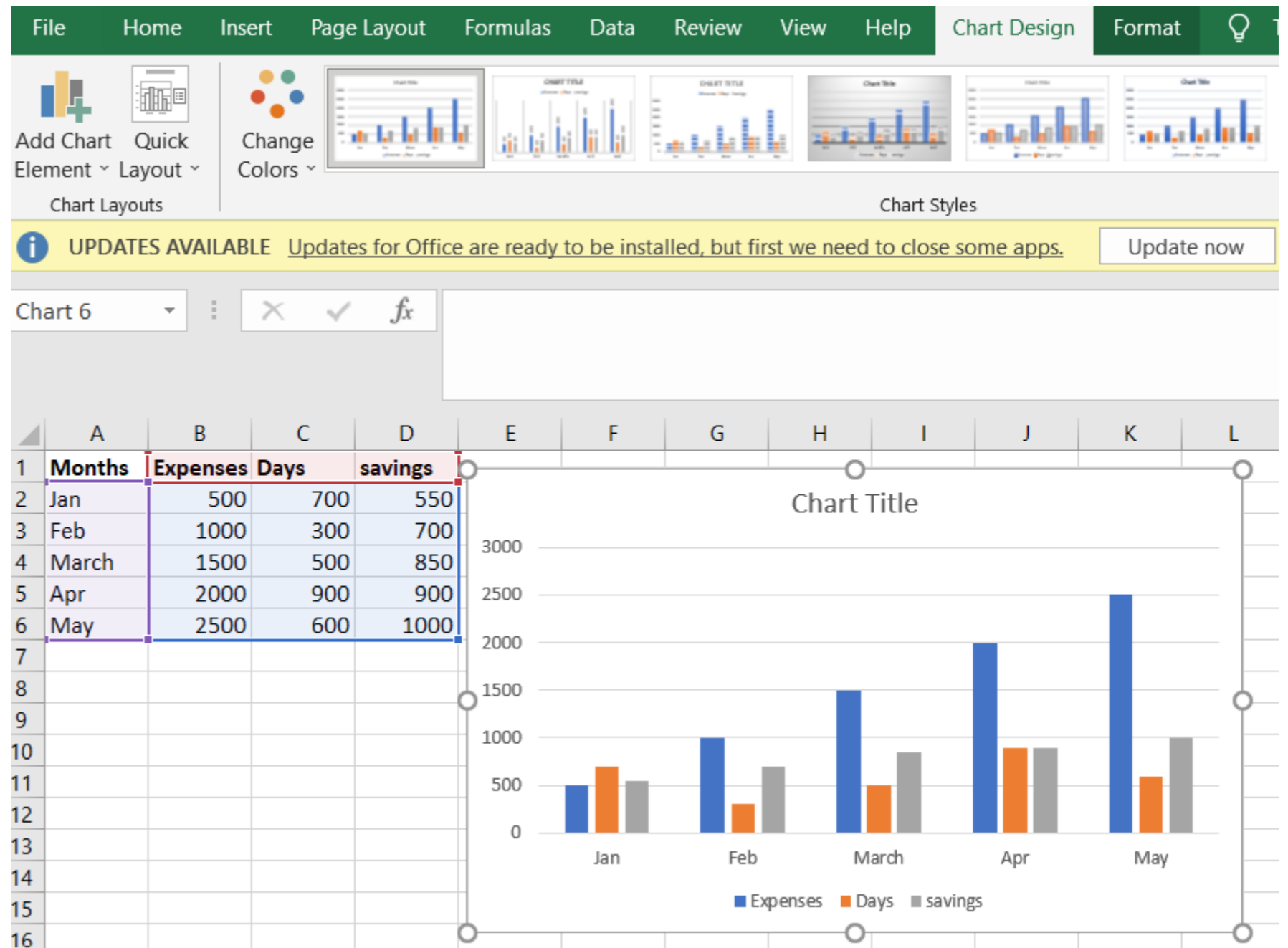
- What if we want to visualize more than two attributes at the same time?
- For example, you have three categorical attributes...

More than two/three attributes

- What if we want to visualize more than two attributes at the same time?
- For example, you have three categorical attributes...
- Two designs possible (bar charts)

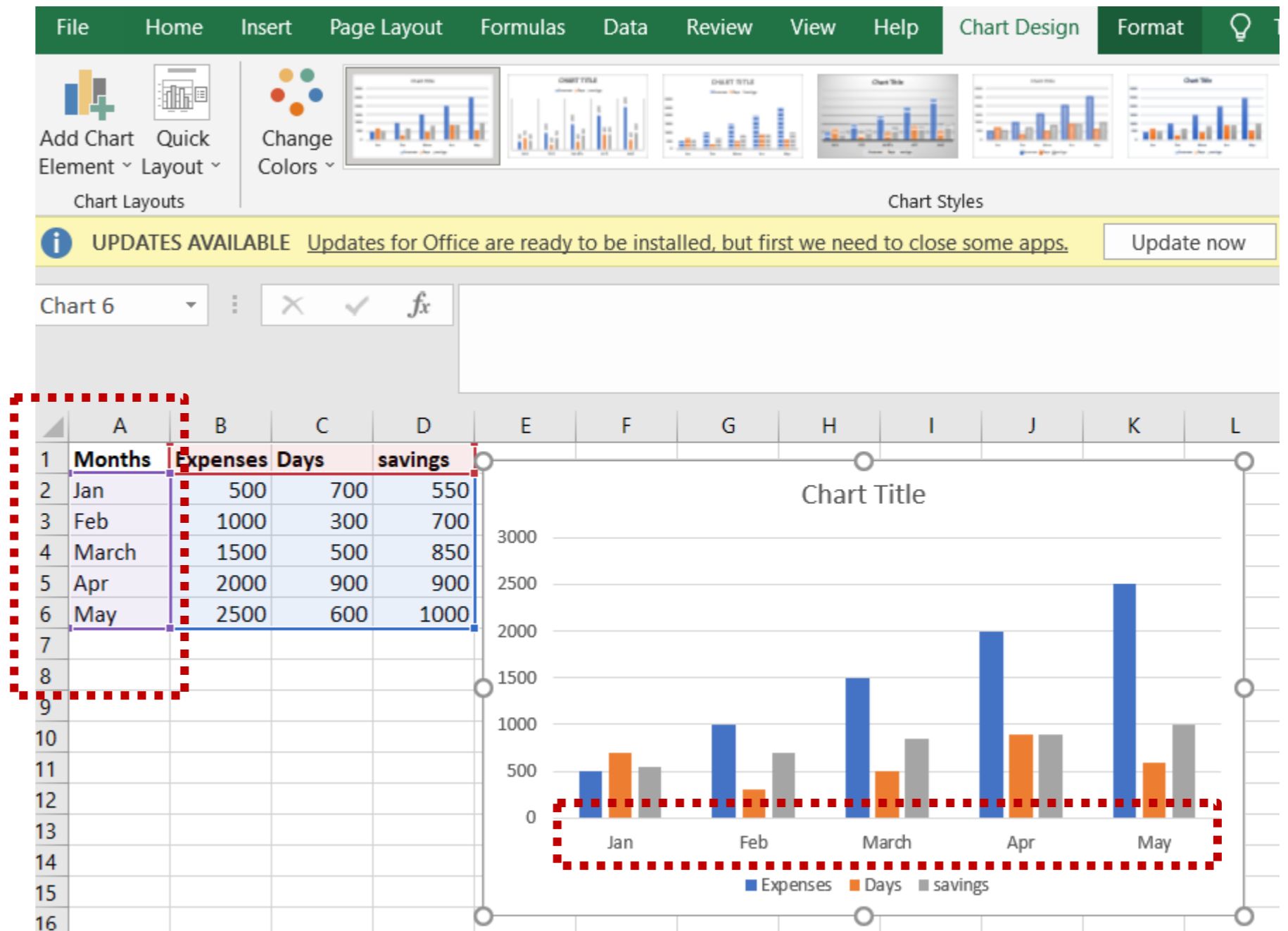
Grouped

- Three variables



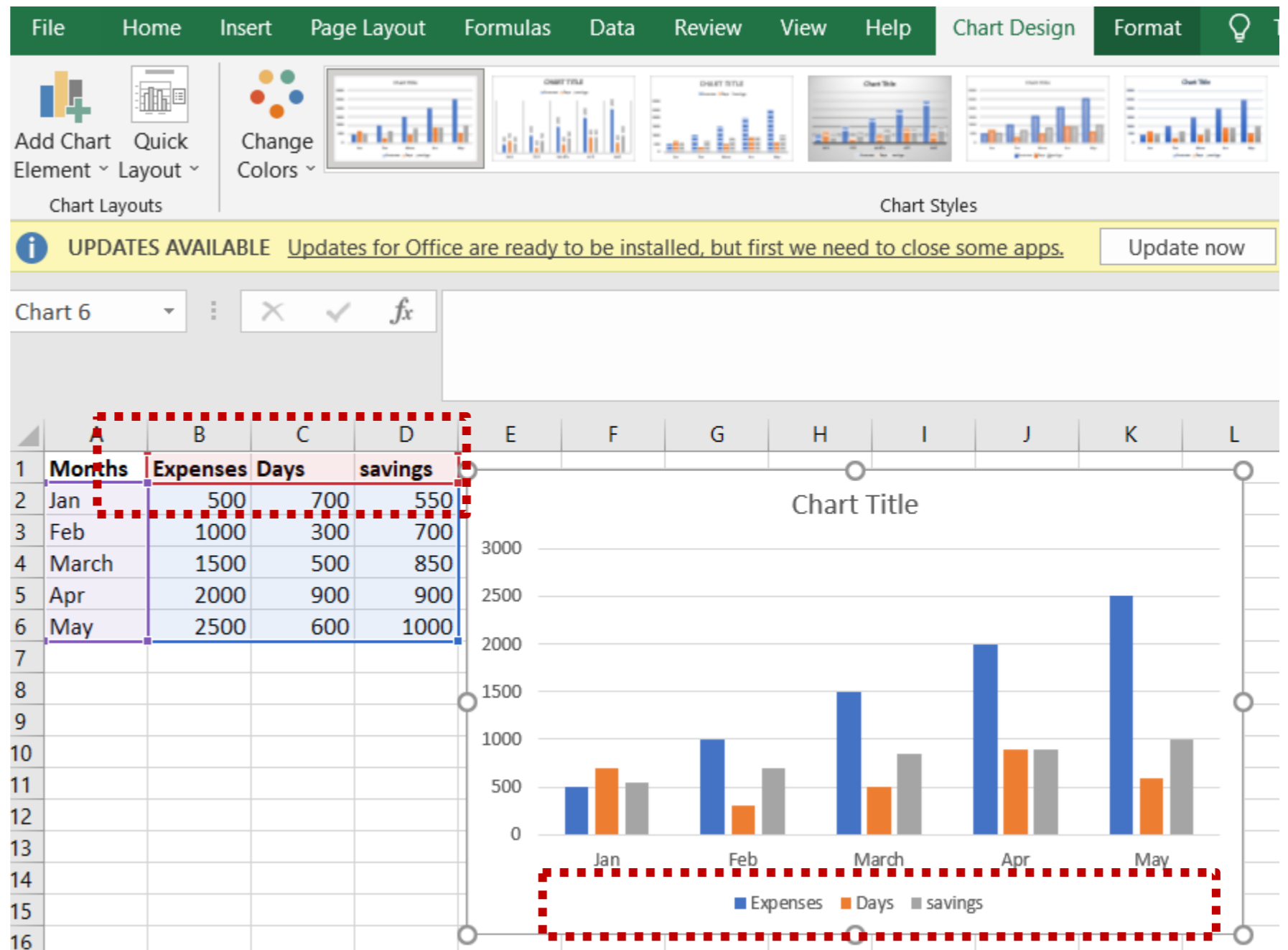
Grouped

- Three variables



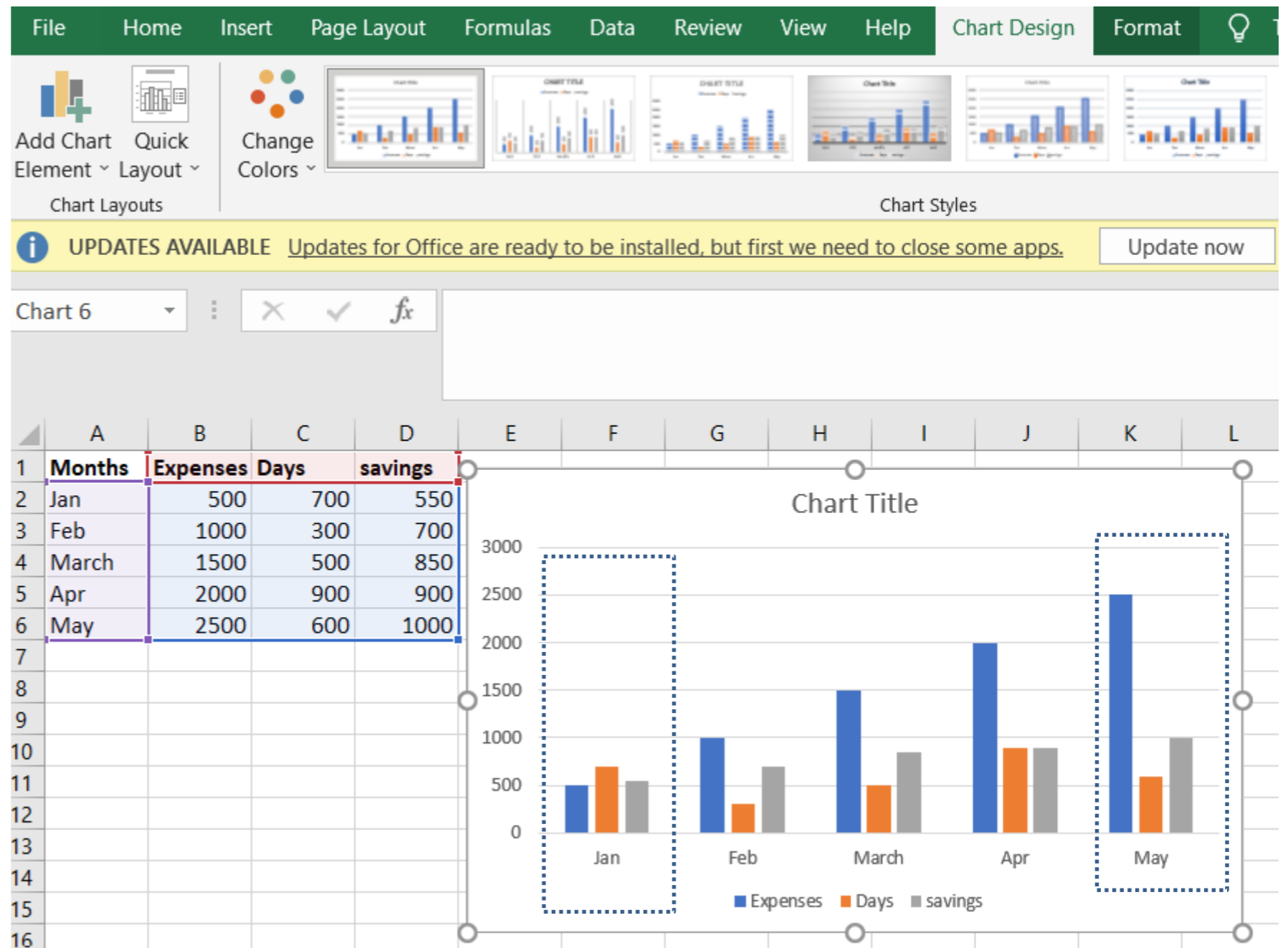
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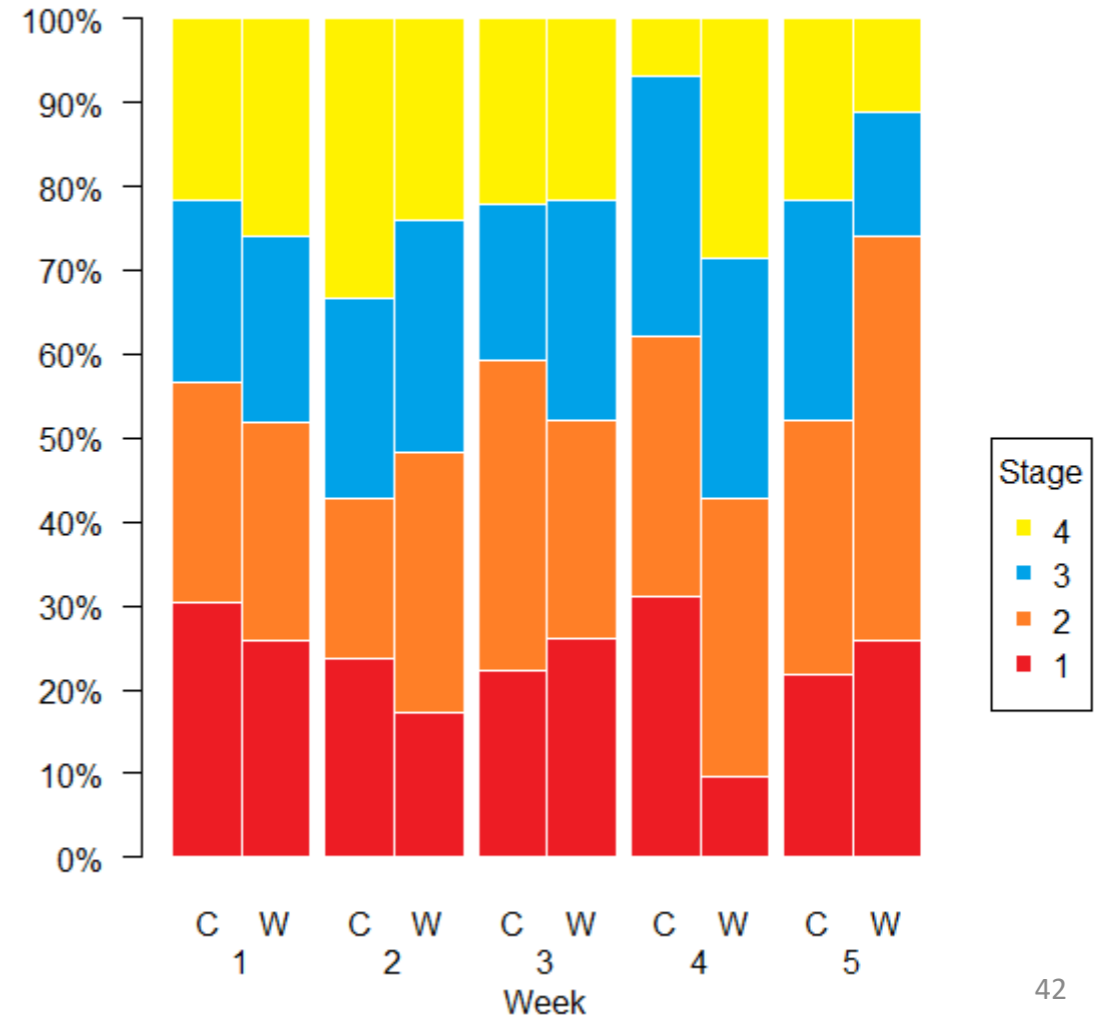
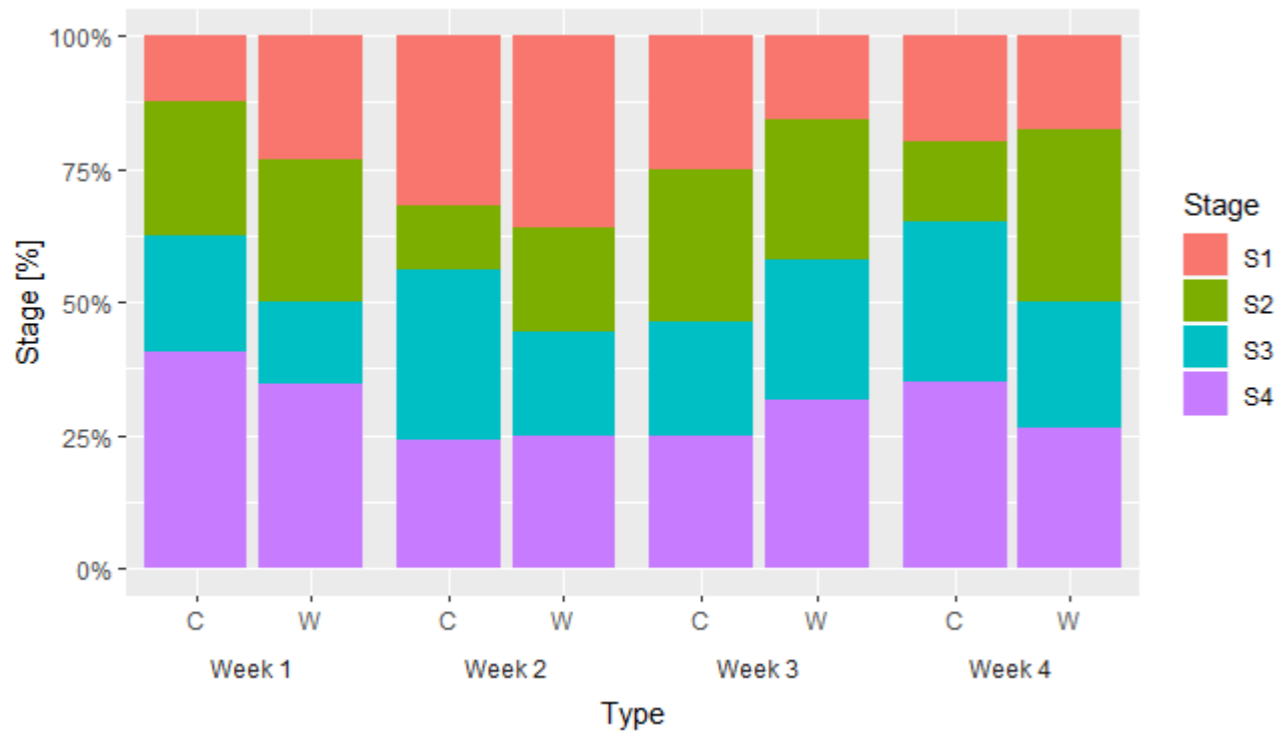
Grouped

- Three variables



Stacked bar charts (4 variables shown)

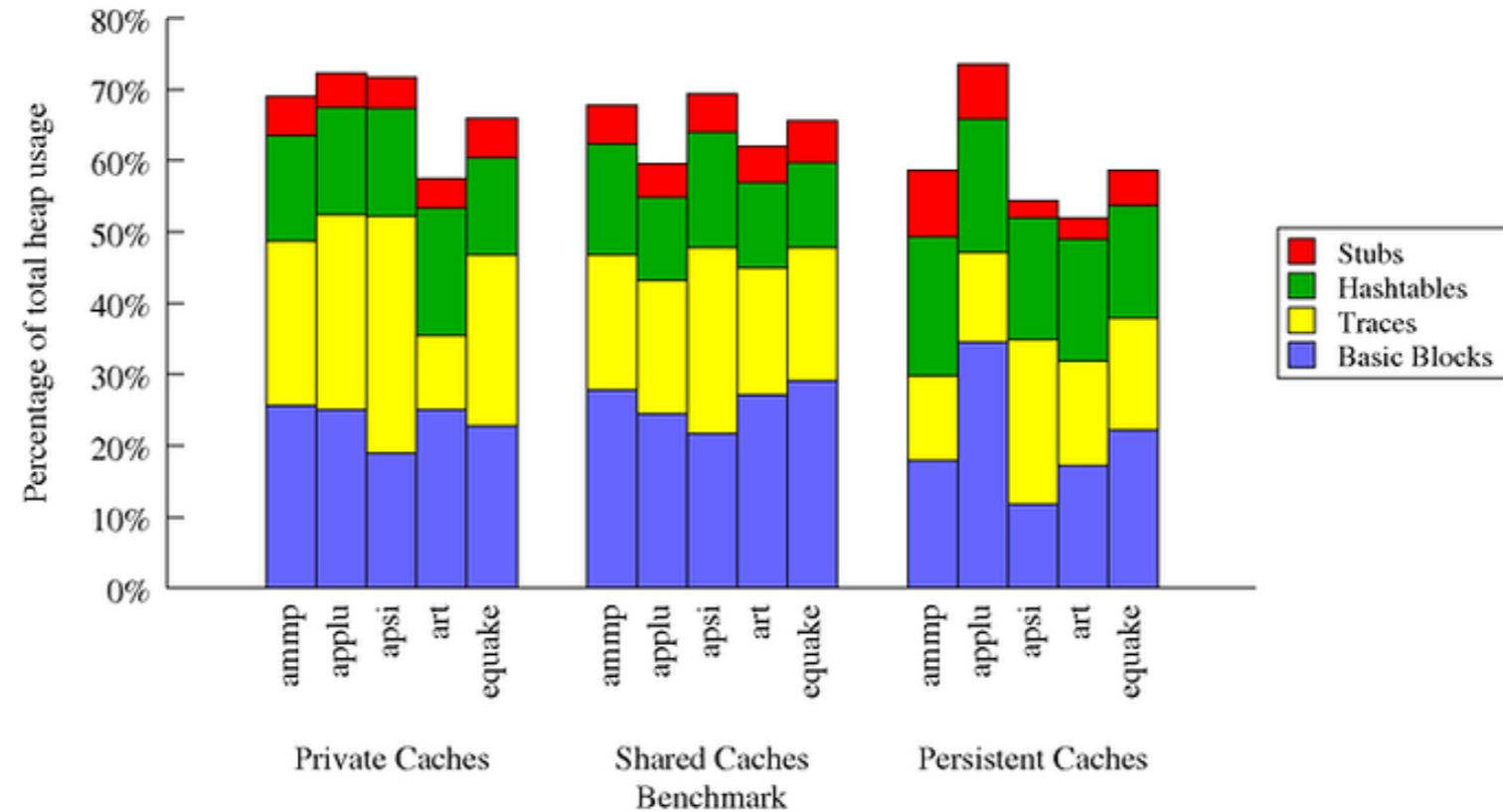
Stacked/nested bar charts



<https://stackoverflow.com/questions/54667358/how-to-make-a-stacked-barplot-with-nested-grouping-variables?noredirect=1>

Grouped/stacked bar charts

- Four variables



Stacked/Grouped

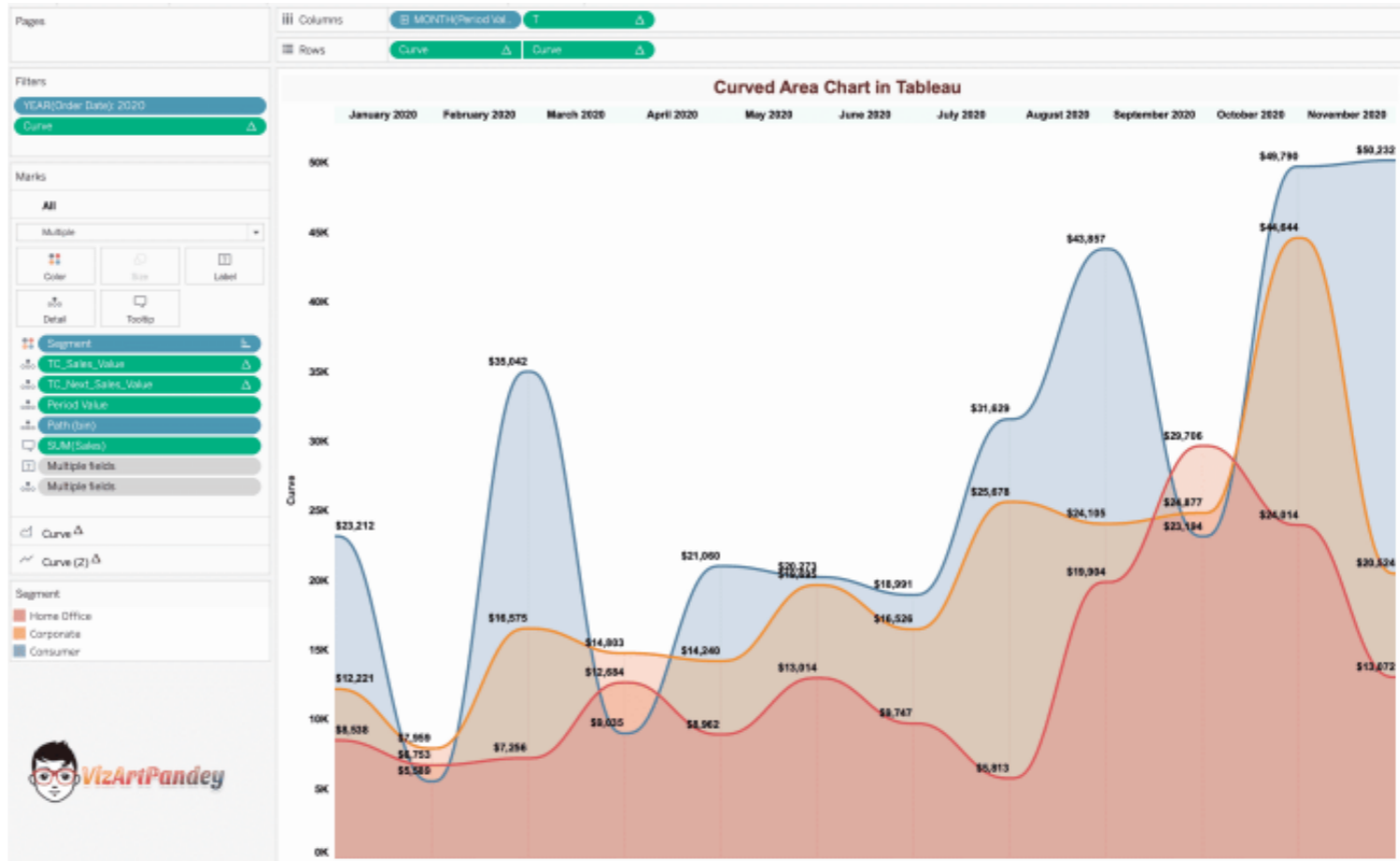
- Advantages and disadvantages of each?

Line charts – multiple variables

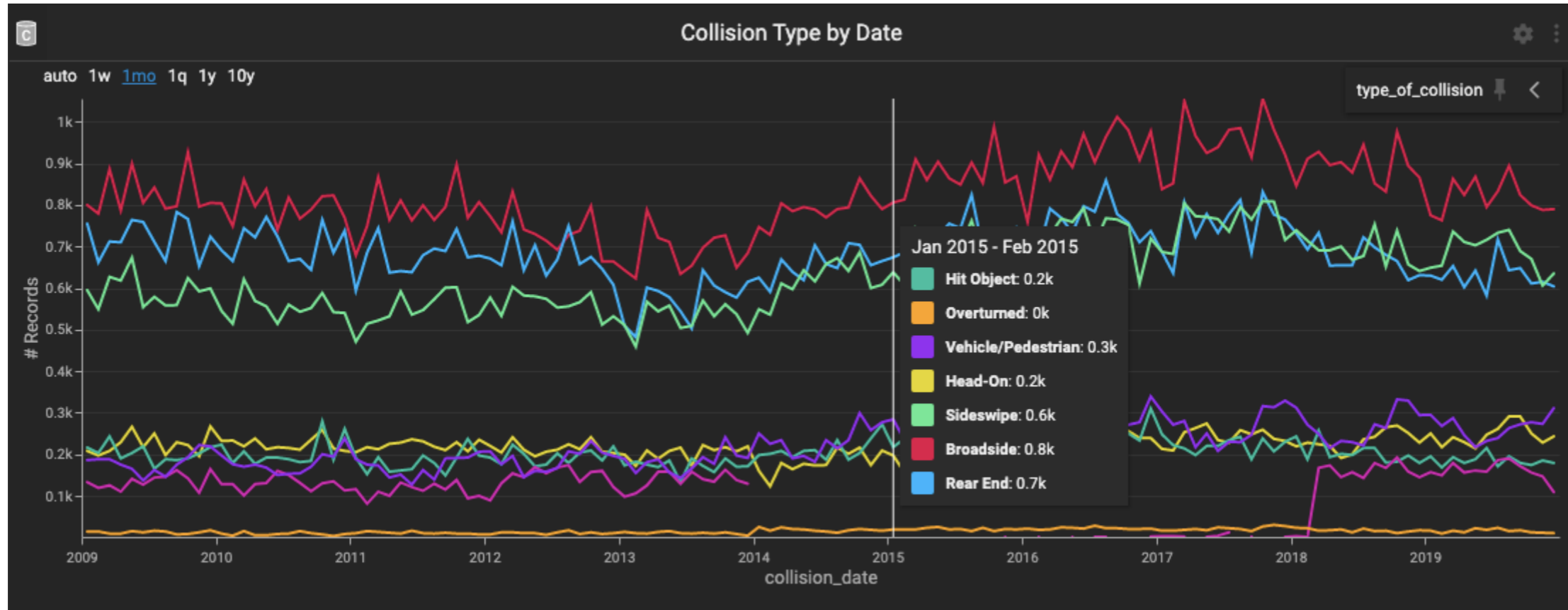


Line charts – multiple variables

- Area charts

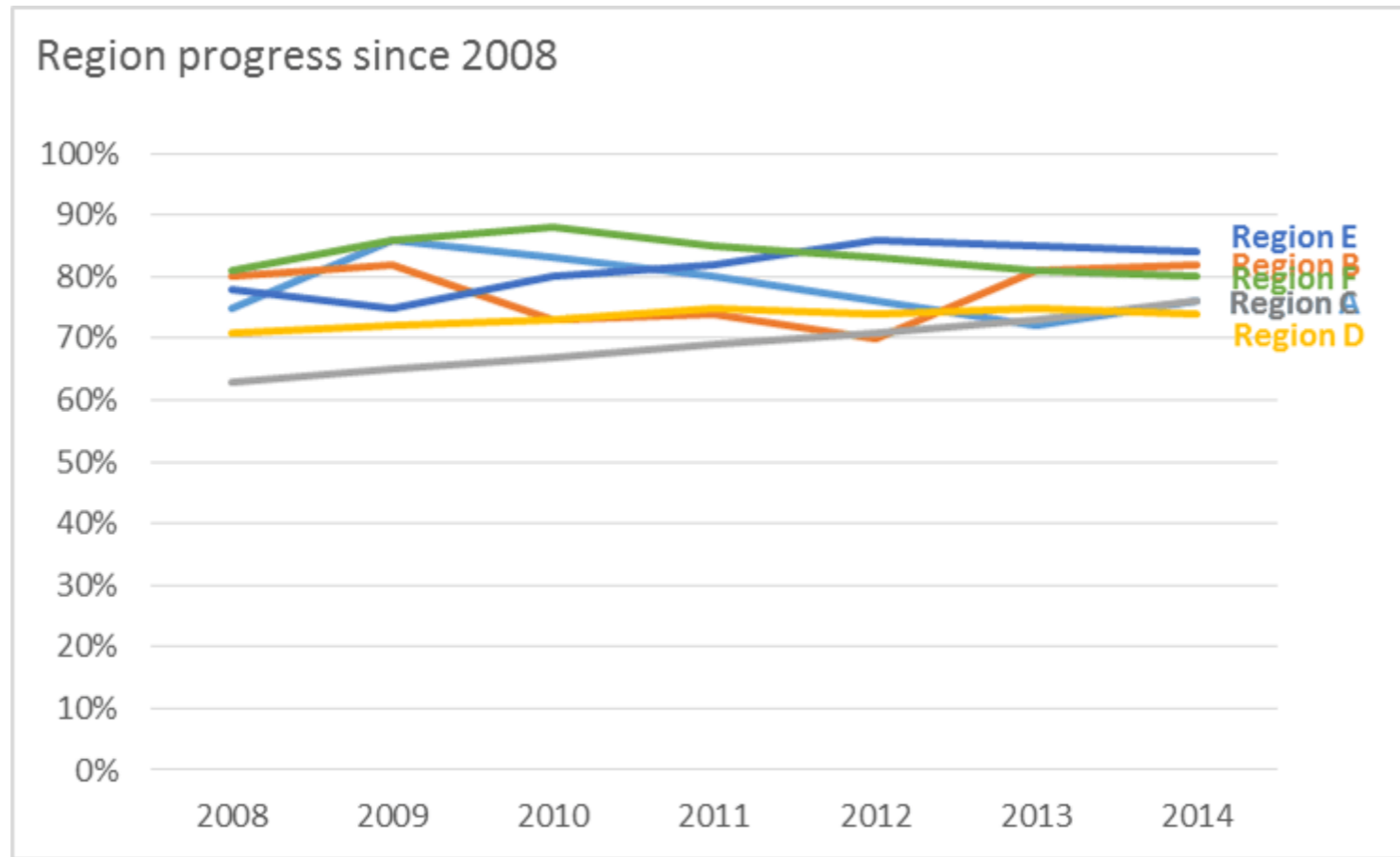


Line charts – multiple variables

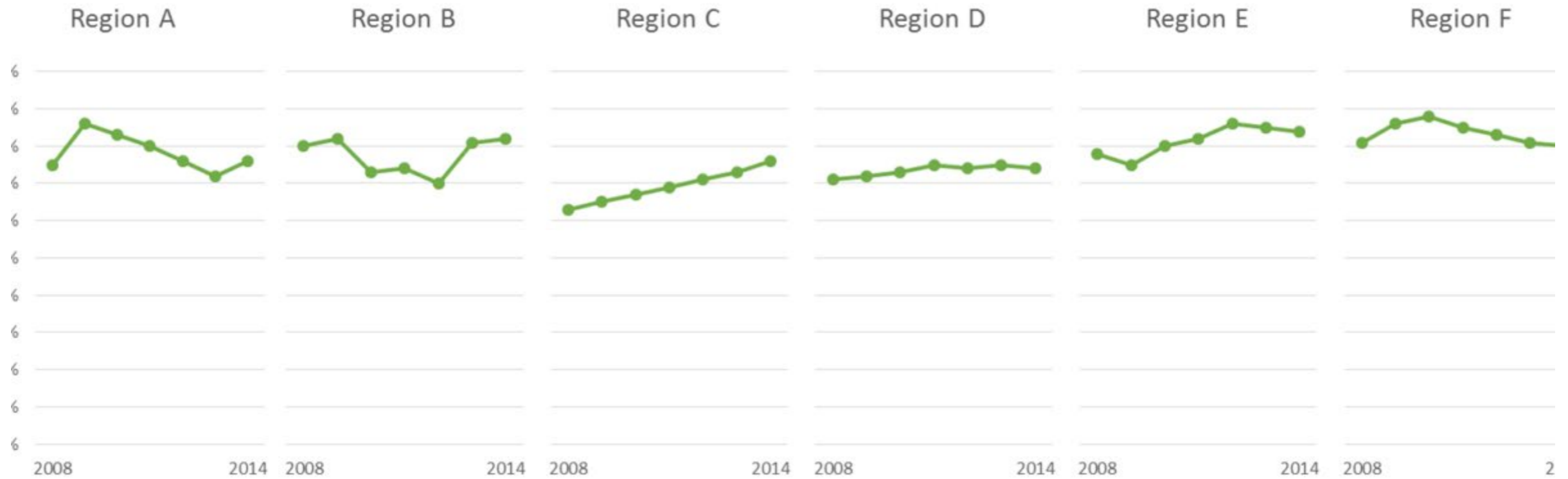


[12 Data Visualization Color Palettes for Telling Better Stories with Your Data \(heavy.ai\)](https://heavy.ai)

Line charts – multiple variables



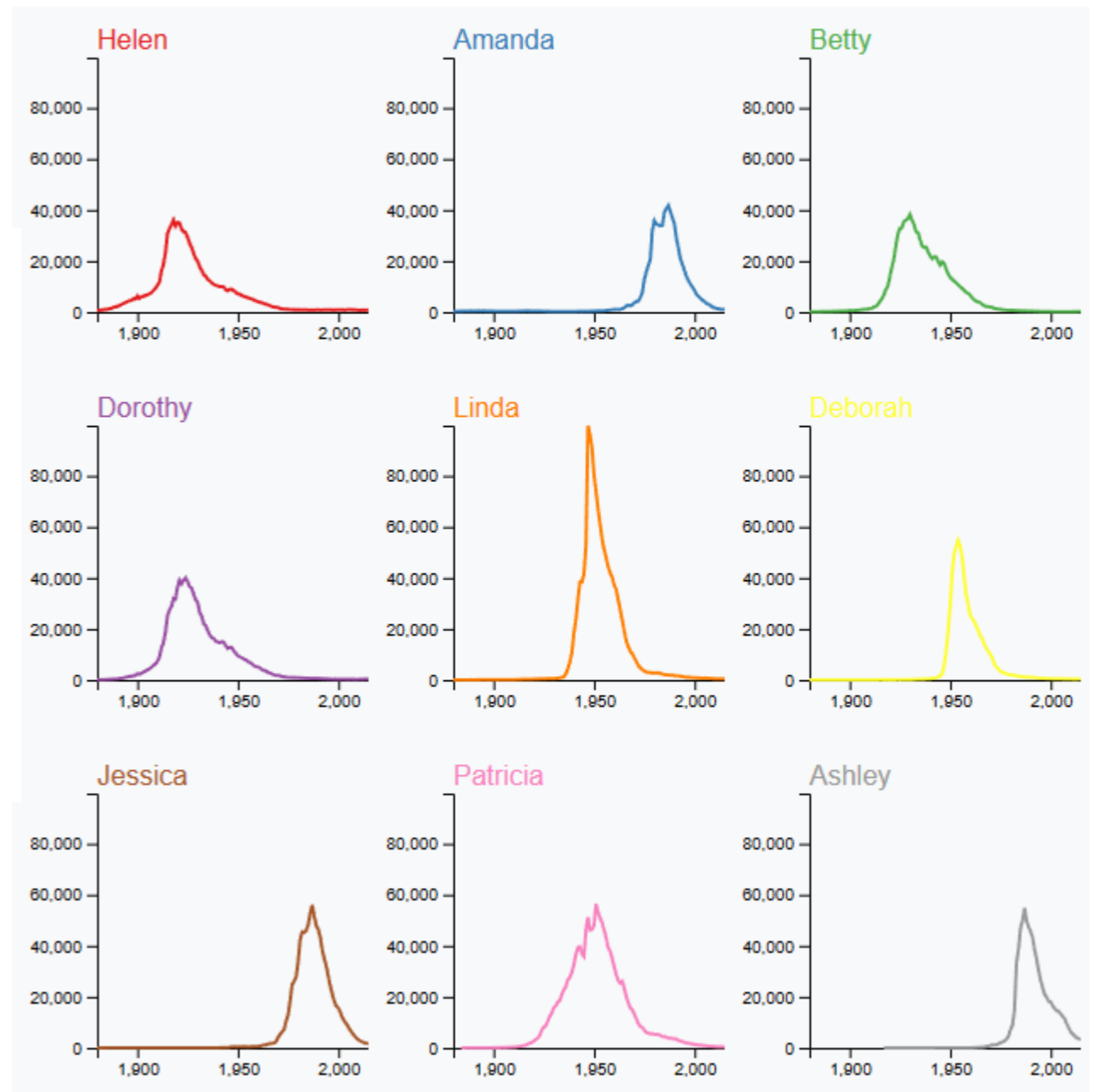
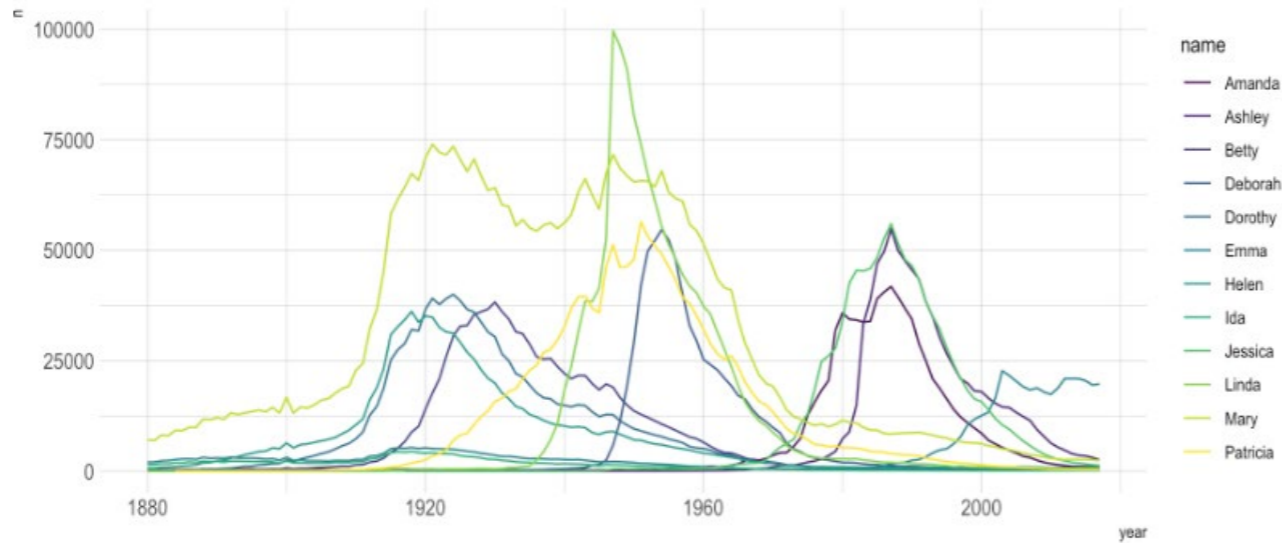
Line charts – faceting (small multiples)



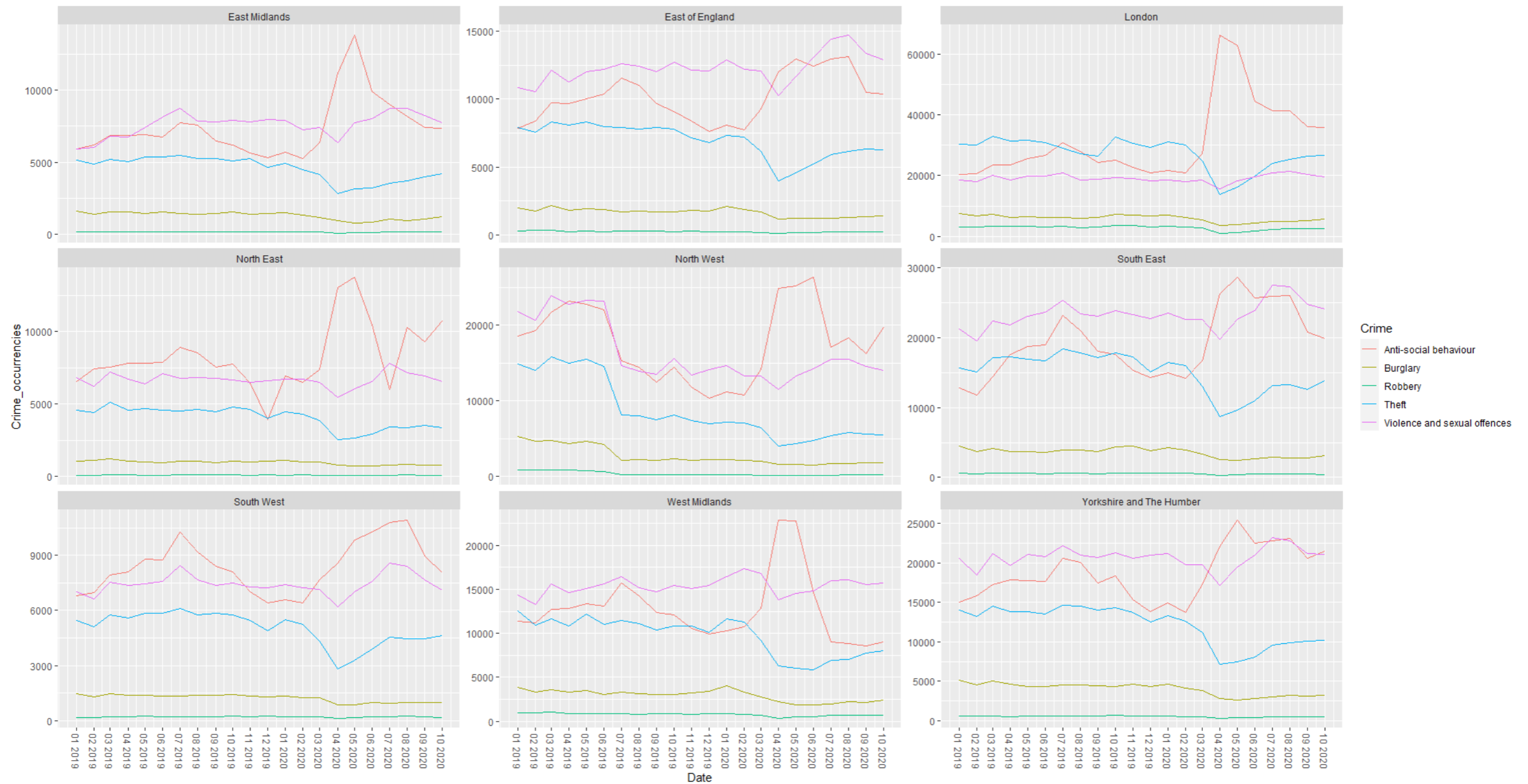
Line charts – multiple variables

- [Making an Interactive Line Chart in D3.js v.5 \(datawanderings.com\)](http://datawanderings.com)

A spaghetti chart of baby names popularity



https://d3-graph-gallery.com/graph/line_smallmultiple.html



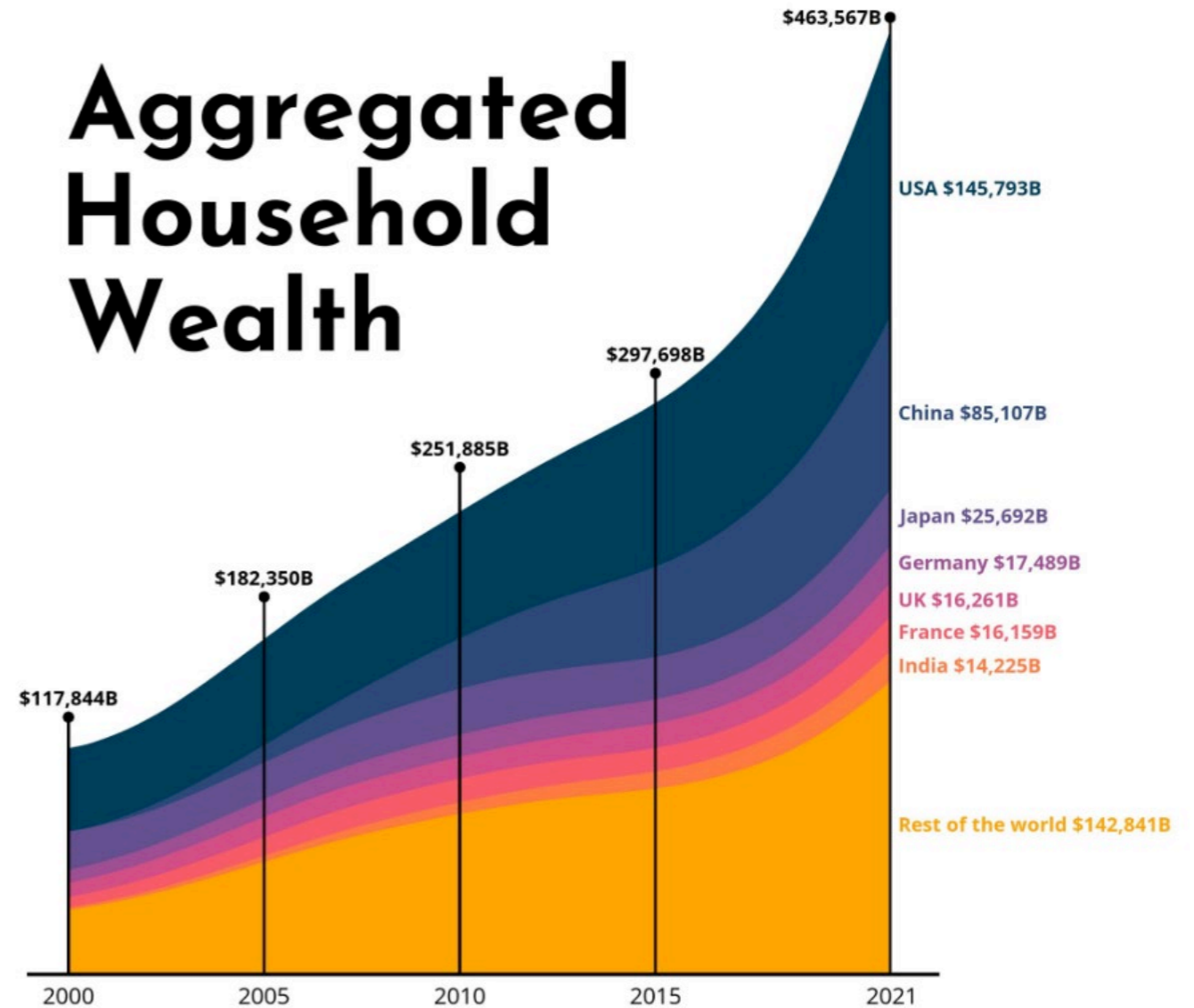
Crime Rate across 9 English regions from 01/2019 until 10/2020.
[ggplot2 - Overlaying two faceted line graphs with different Y axis in R - Stack Overflow](#)

Stacked area charts

- <https://r-graph-gallery.com/stacked-area-graph.html>

Stacked area charts

- <https://r-graph-gallery.com/web-stacked-area-chart-inline-labels.html>



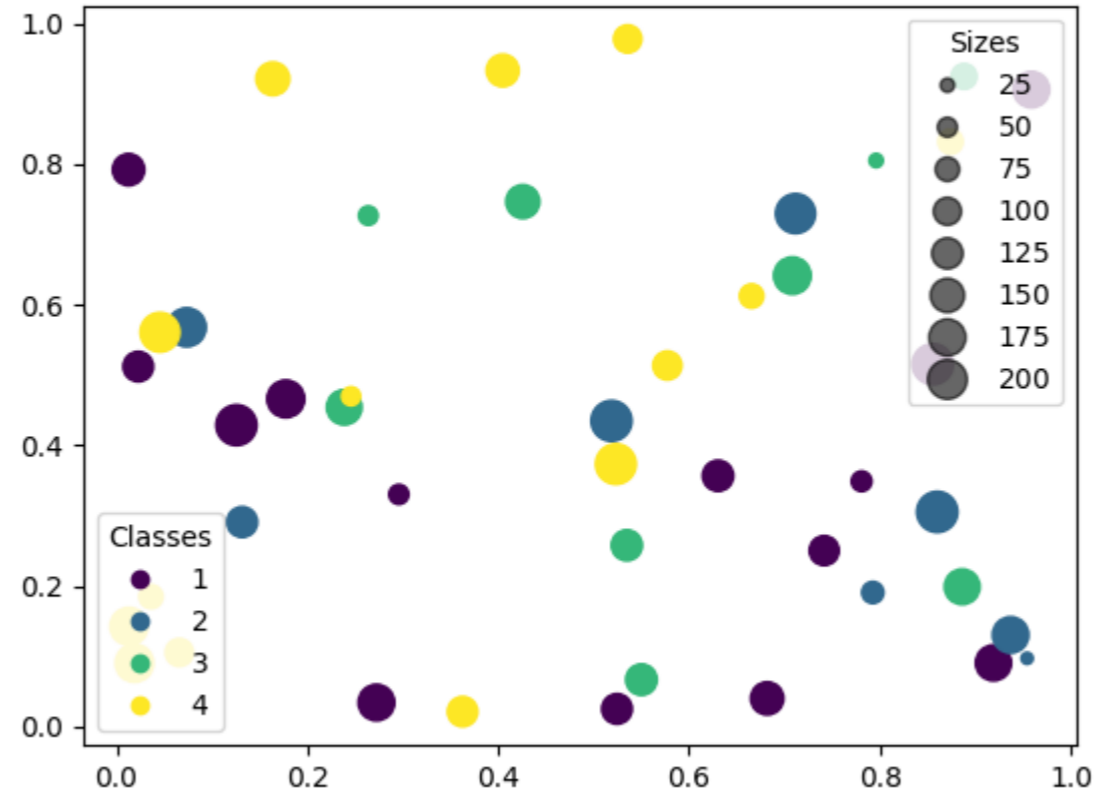
Data: James Davies, Rodrigo Lluberas and Anthony Shorrocks, Credit Suisse Global Wealth Databook 2022
Design: Gilbert Fontana

gilbertfontana
GilbertFontana
gilbert.fontana

Scatterplots and Faceting

- Scatterplots can show how many attributes?
- 2 (or 3) numerical (line axes) + 1 (or 2) categorical (color/shape of symbols) + 1 numerical (size/area of symbols)

Scatterplots and Faceting

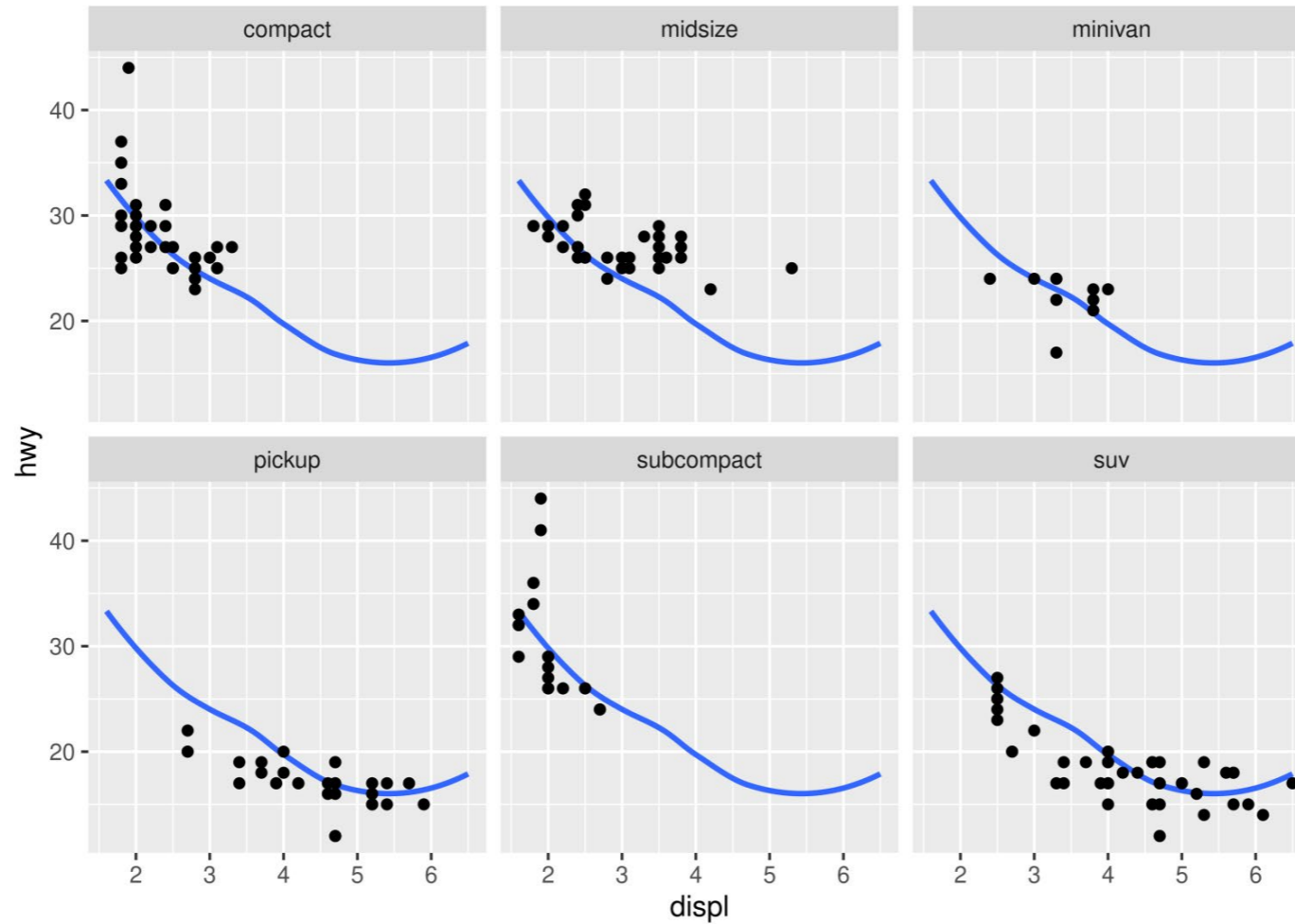


https://matplotlib.org/stable/gallery/lines_bars_and_markers/scatter_with_legend.html

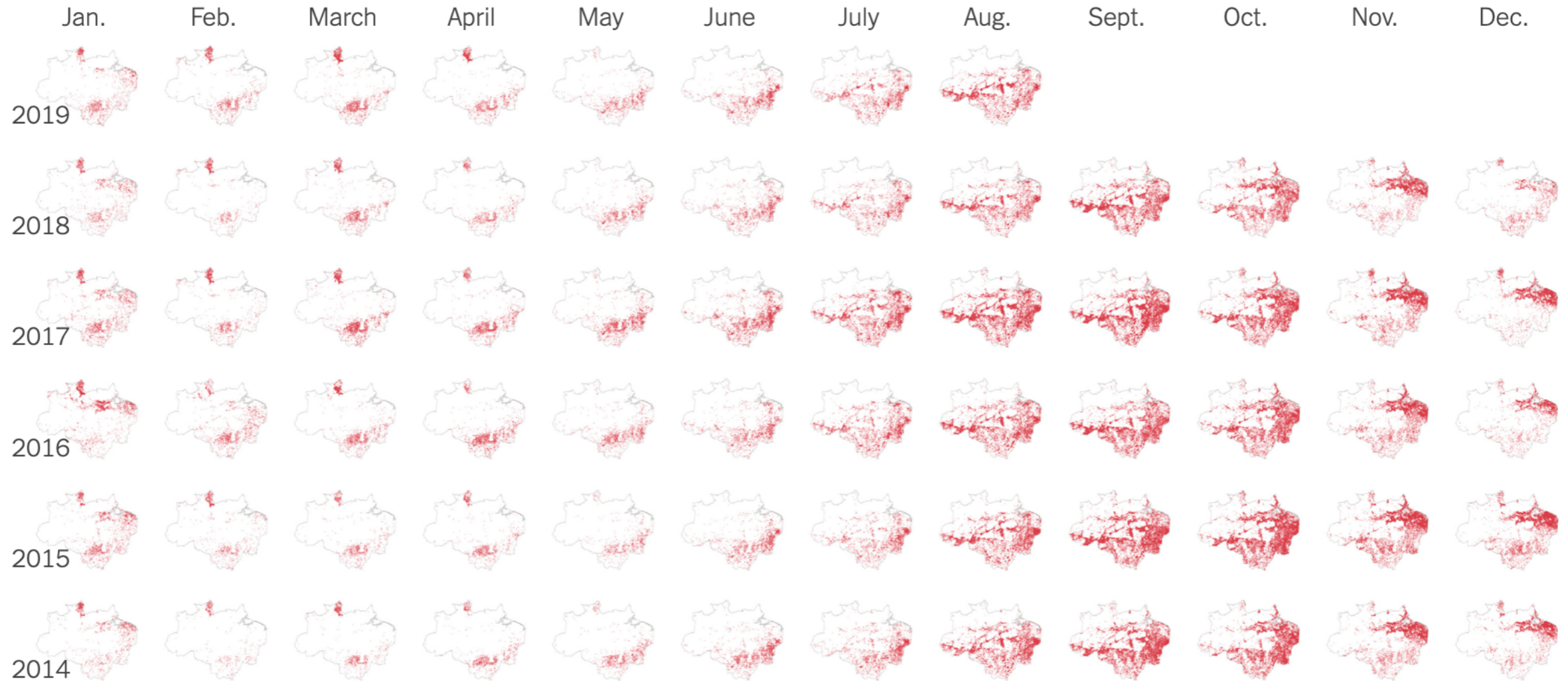
Scatterplots and Faceting

- Scatterplots can show how many attributes?
- 2 (or 3) numerical (line axes) + 1 (or 2) categorical (color/shape of symbols) + 1 numerical (size/area of symbols)
- The more visual channels/attributes, the harder is interpretation...
- And what if you have many categories/classes?

Scatterplots and Faceting



Maps and faceting



Small multiples

- Allow for the display of many variables with less risk of confusing your audience (avoid overplotting).
- A reader can quickly learn to read an individual chart and apply this knowledge as they scan the rest of the charts. This shifts the reader's effort from understanding *how the chart works* to *what the data says* (a worthy goal in all data presentation).
- Enable comparison across variables and identify potential patterns in the data.

Small multiples

- Placement of the charts should reflect some logical order, e.g. dimensional matrix, geography, or time.
- Charts should share the same measures, scales, size, and shape (changing one of these factors undermines the ability of readers to re-use their understanding of the chart).
- The simplicity of the chart is critical: users should be able to process information across many of these charts

Faceting/Small Multiples

- [Other examples: Better Know a Visualization: Small Multiples — Juice Analytics](#)

Back to the beginning...

- Two steps:

Step 1: Decide **what** to visualize

Step 2: Decide **how** to visualize it – so far...

Summary

- Data abstraction => graph design
- Fundamental graphs and variations

- **Data transformation**

Sources/material

T. Munzner, Visualization Analysis & Design

Information Visualization Fundamentals, Enrico Bertini, online course
in Coursera