

# Improving How We Observe Our Observability Data: Techniques for SREs

**SRE**  
**CON**<sup>®</sup>  AMERICAS

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# whoami

## Dan Shoop

- Senior System Reliability Engineering Manager
- Few decades of experience in systems engineering, production operations, incident management
- Where I've Worked
  - Wall Street & Sesame Street
  - HBO where we conquered dragons and discovered as a team how to operate early SRE practices at Game of Thrones scale
  - Lead original SRE Team at Venmo
  - Involved in Emergency Management as an EMT, charter member of a Search & Rescue organization
  - Currently Senior Manager of Systems Reliability Engineering at a location-based Ad-Tech company, GroundTruth ,where I'm responsible for Infrastructure, DevOps and Incident Management and currently building out these teams -- I'm Hiring

# What we're going to talk about

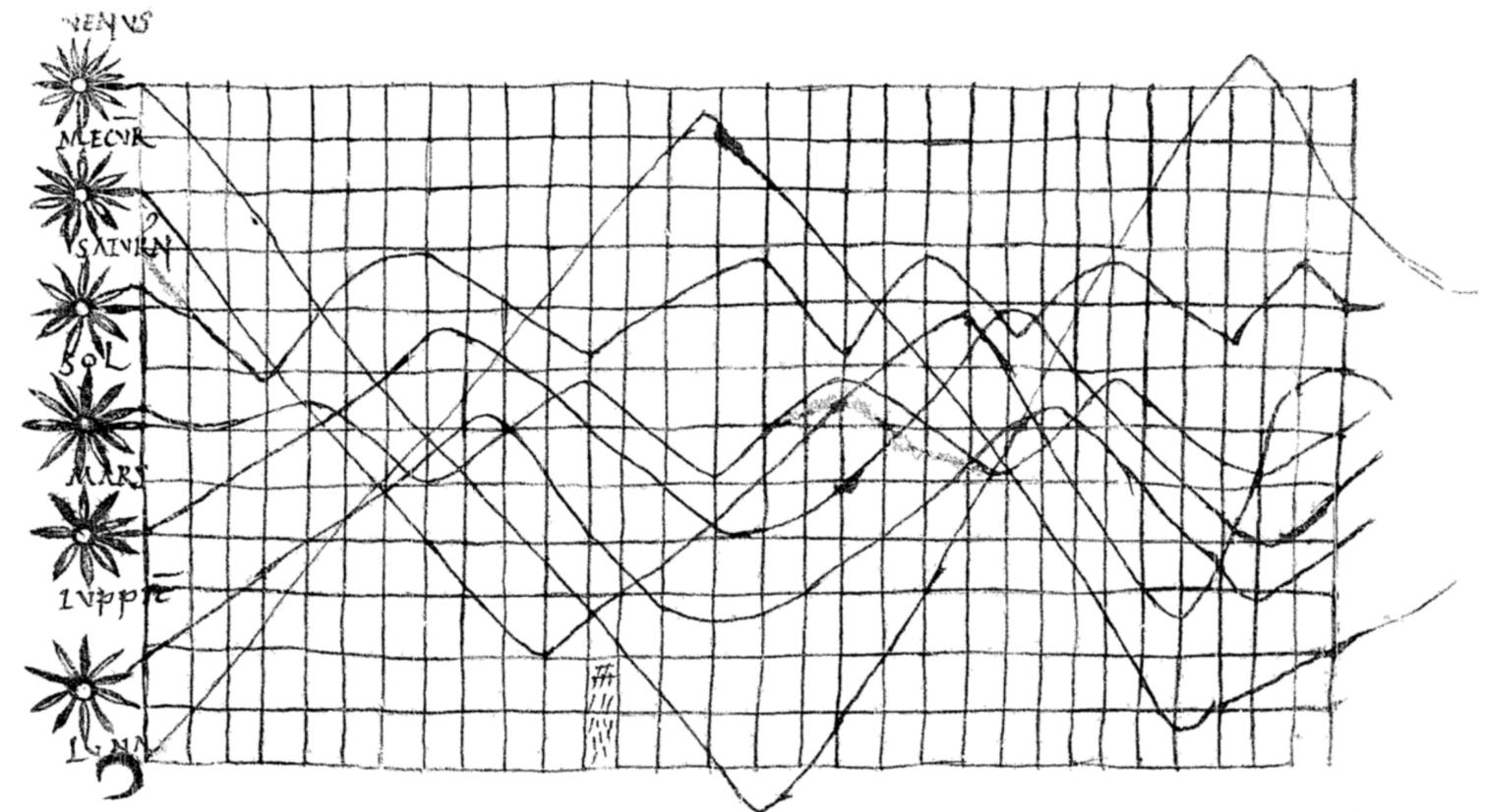
- Talk about how we observe or look at our observability data
- Explore why Time Series charts were developed and critical take-aways
- Encourage engineers to improve the data density & multivariate relationships in your observability data displays
- Simple pitfalls to avoid when dealing with observability data
- Some tips for improving your observability data presentations

# **Building Data Narratives with Multivariate Observability Visualizations**

# Time Series Data

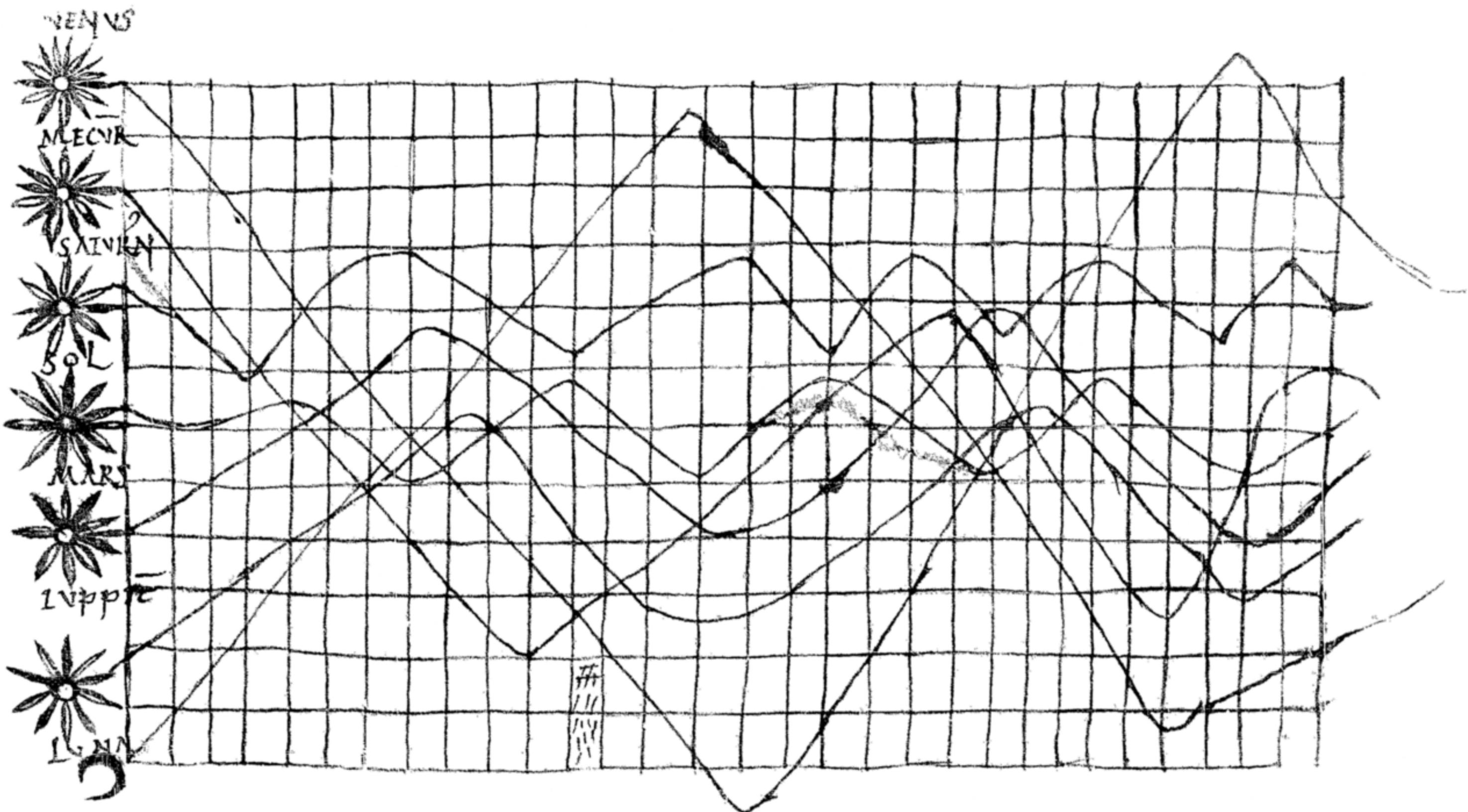
## Motion of the Planets

- Oldest known example of the attempt to show changing values graphically
- Appears in a 10th Century text used in early monastery schools, in an appendix, as part of commentaries by A. T. Macrobius on Somnium Scipionus
- Technique then is seemingly lost for 800 years



Planetary inclinations by unknown astronomer, appearing in a 10 century appendix to commentaries by A. T. Macrobius on Cicero's In Somnium Scipionus

[https://commons.wikimedia.org/wiki/File:Mouvement\\_des\\_planètes\\_au\\_cours\\_du\\_temps.png](https://commons.wikimedia.org/wiki/File:Mouvement_des_planètes_au_cours_du_temps.png)



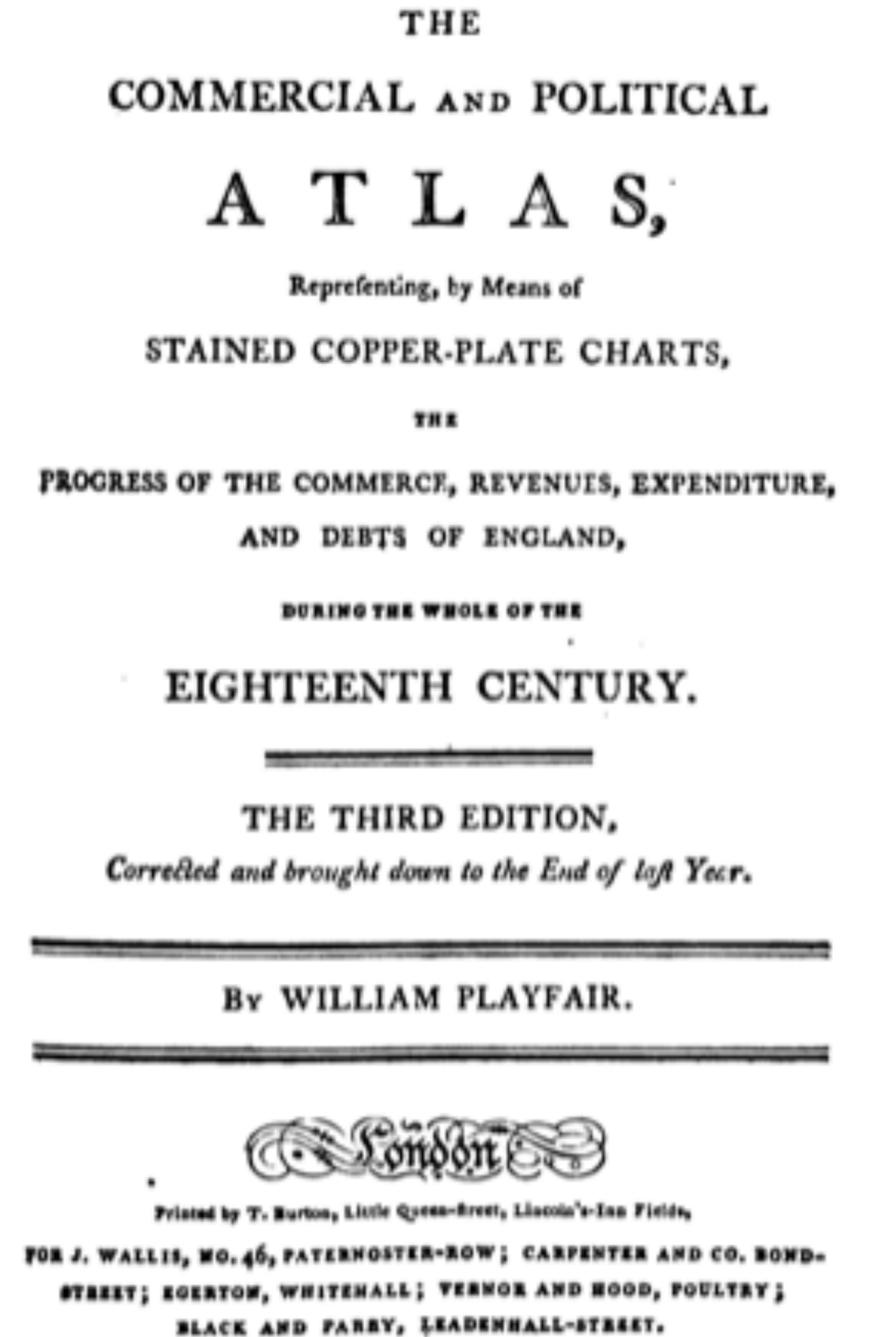
# Time Series

## William Playfair – 1786

- In 1786 William Playfair, a “trouble making” Scottish political economist, statistical inventor, and secret agent, publishes  
*“The Commercial and Political Atlas, Representing by Means of Stained Copper-Plate Charts, the Progress of the Commerce, Revenues, Expenditure, and Debts of England, During the Whole of the Eighteenth Century”*
- As secret agent, Playfair reported on the French Revolution and organized a clandestine counterfeiting operation in 1793 to collapse the French currency.
- As a political economist he sought to promote policies through time series narratives that were easy to visually observe and consume
- As a statistician he was the founder of graphical methods in statistics, inventing the line, area, bar, pie chart and circle graph, used to show part-whole relations.

William Playfair, The Commercial and Political Atlas, London 1786

[https://www.google.com/books/edition/The Commercial and Political Atlas/dgRdAAAAcAAJ?hl=en](https://www.google.com/books/edition/The_Commercial_and_Political_Atlas/dgRdAAAAcAAJ?hl=en)



# Time Series

## William Playfair

- His problem: Wanted to encourage certain economic and trade policies
- More problems:
  - State of Art in data was just tables of values which doesn't tell a good story
  - Wanted to address a broad audience and provide a clear, lasting impression
  - WTF is a time series?

“ Information that is imperfectly acquired is  
“ generally as imperfectly retained ; and a man  
“ who has carefully investigated a printed table  
“ finds, when done, that he has only a very  
“ faint and partial idea of what he has read,  
“ and that like a figure imprinted on sand it is  
“ soon totally erased and defaced.

# Time Series

## William Playfair

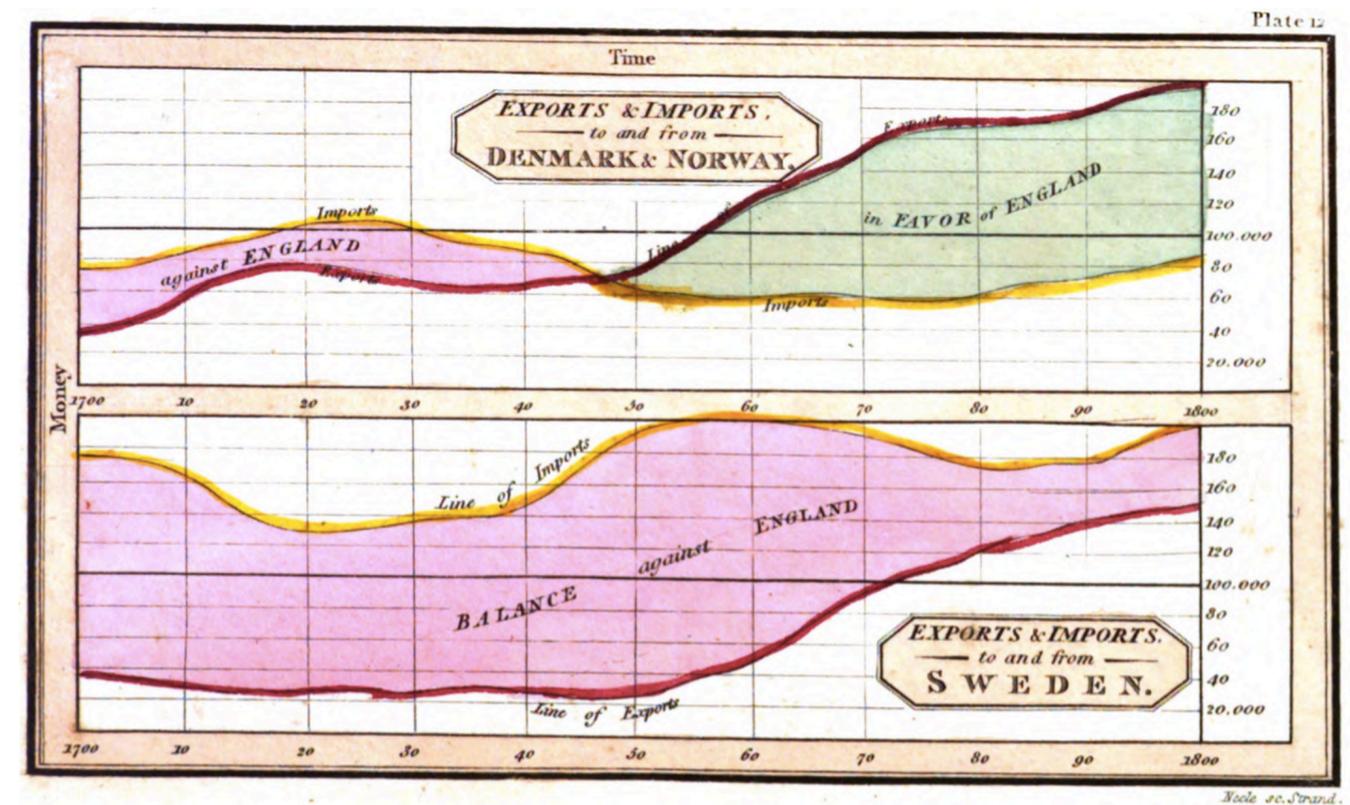
- 43 of his 44 charts in the *Atlas* were time series.
- The odd chart out was the first known example of a *bar chart*, something he apologized for inventing because year to year data for that plot was missing so he couldn't plot a time series chart. He wrote that he was "*skeptical*" that bar charts would ever be a good method for presenting data. They don't demonstrate narrative relationships in a multivariate relationship, there's only one measure and no variation for change over time.
- He had to explain this "novel approach" of time series data and using two axes to present time and money together and how time series data can be seen as composed.
- "*This method has struck several persons as being fallacious because geometrical measurement has not any relation to money or to time; yet here it is made to represent both. Supposed the money received by a man in trade were all in guinea coins, and that every evening he made a single pile of all the guineas received during the day, each pile would represent a day, and its height would be proportionated to the receipts of the day; so that by this plan operation, time, proportion and amount, would all be physically combined.*"
- Playfair binds metrics together: time, proportion and amount.

*This method has struck several persons as being fallacious, because geometrical measurement has not any relation to money or to time; yet here it is made to represent both. The most familiar and simple answer to this objection is by giving an example. Suppose the money received by a man in trade were all in guineas, and that every evening he made a single pile of all the guineas received during the day, each pile would represent a day, and its height would be proportioned to the receipts of that day; so that by this plain operation, time, proportion, and amount, would all be physically combined.*

# Time Series

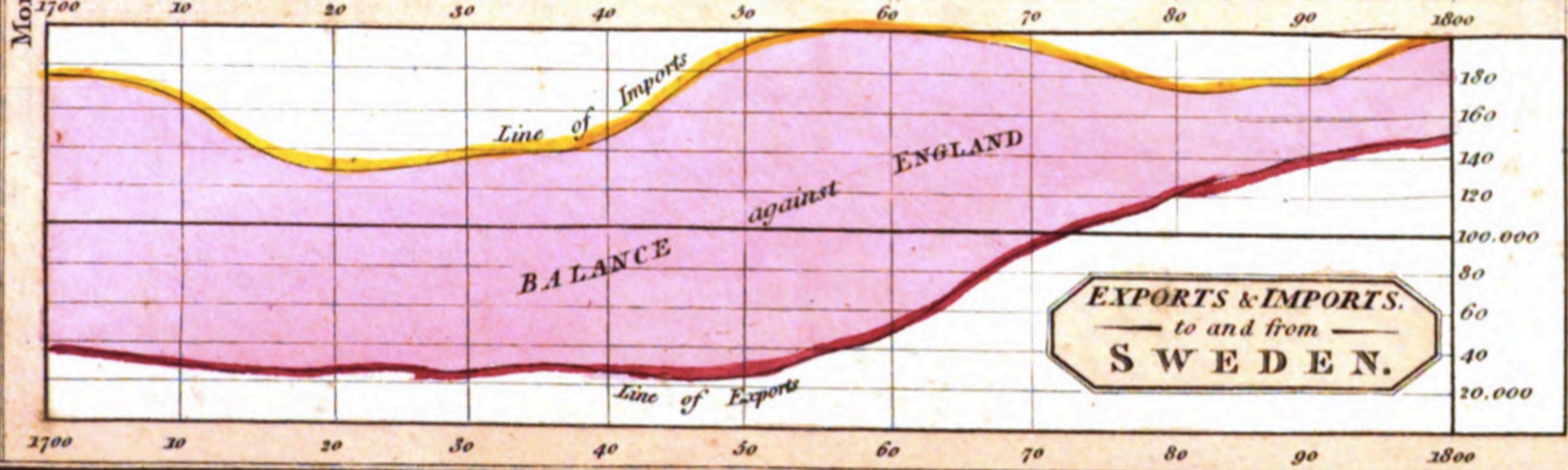
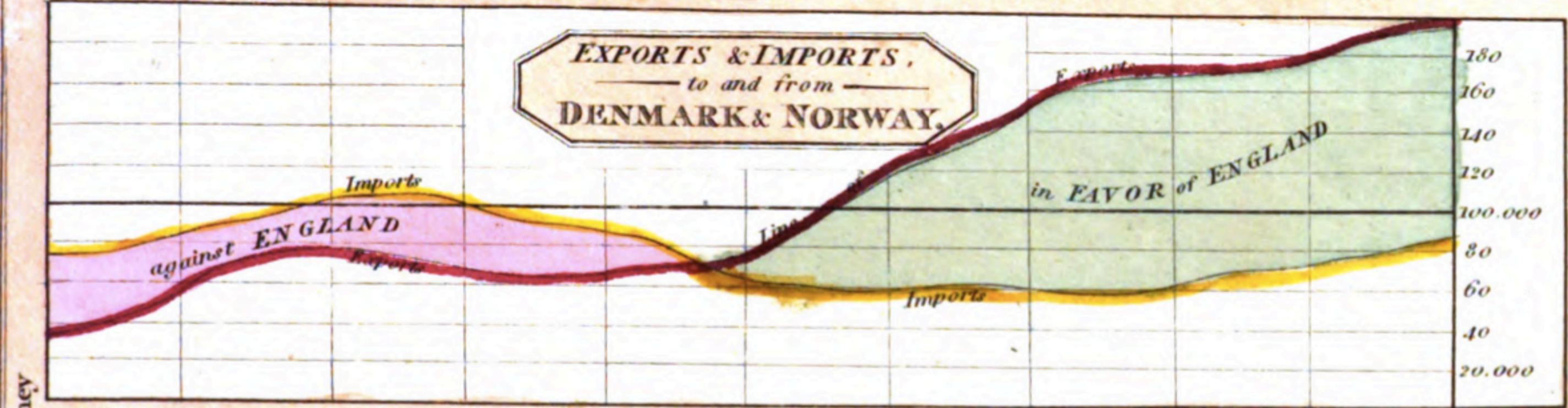
## William Playfair - British Imports and Exports

- He was the first to show imports and exports on one chart over time, and explaining that the intersection of the lines showed a shift in favor of one country or the other.
- Here we see two related plots, critically with the same time and value scales
- This is an example of one of his charts, demonstrating the balance of trade (shifting) between England and the combined exports & imports from Denmark and Norway on the top and on the bottom the balance of trade between England and Sweden
- In what may seem evident today, he first visualizes the implied deltas of the two linear metrics, imports and exports, as the shaded areas and demonstrates the shift in trade balances.
- Playfair's socio-economic goal was to push for more trade with Denmark and Norway and less with Sweden.



Time

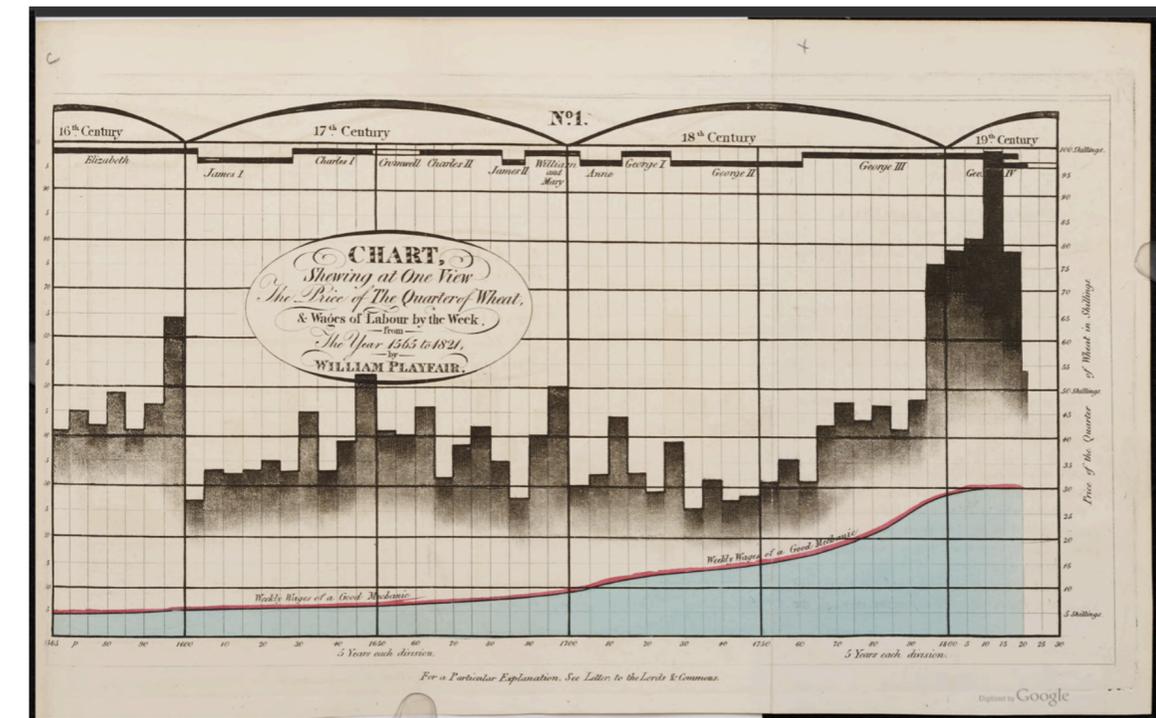
**EXPORTS & IMPORTS,**  
to and from  
**DENMARK & NORWAY.**

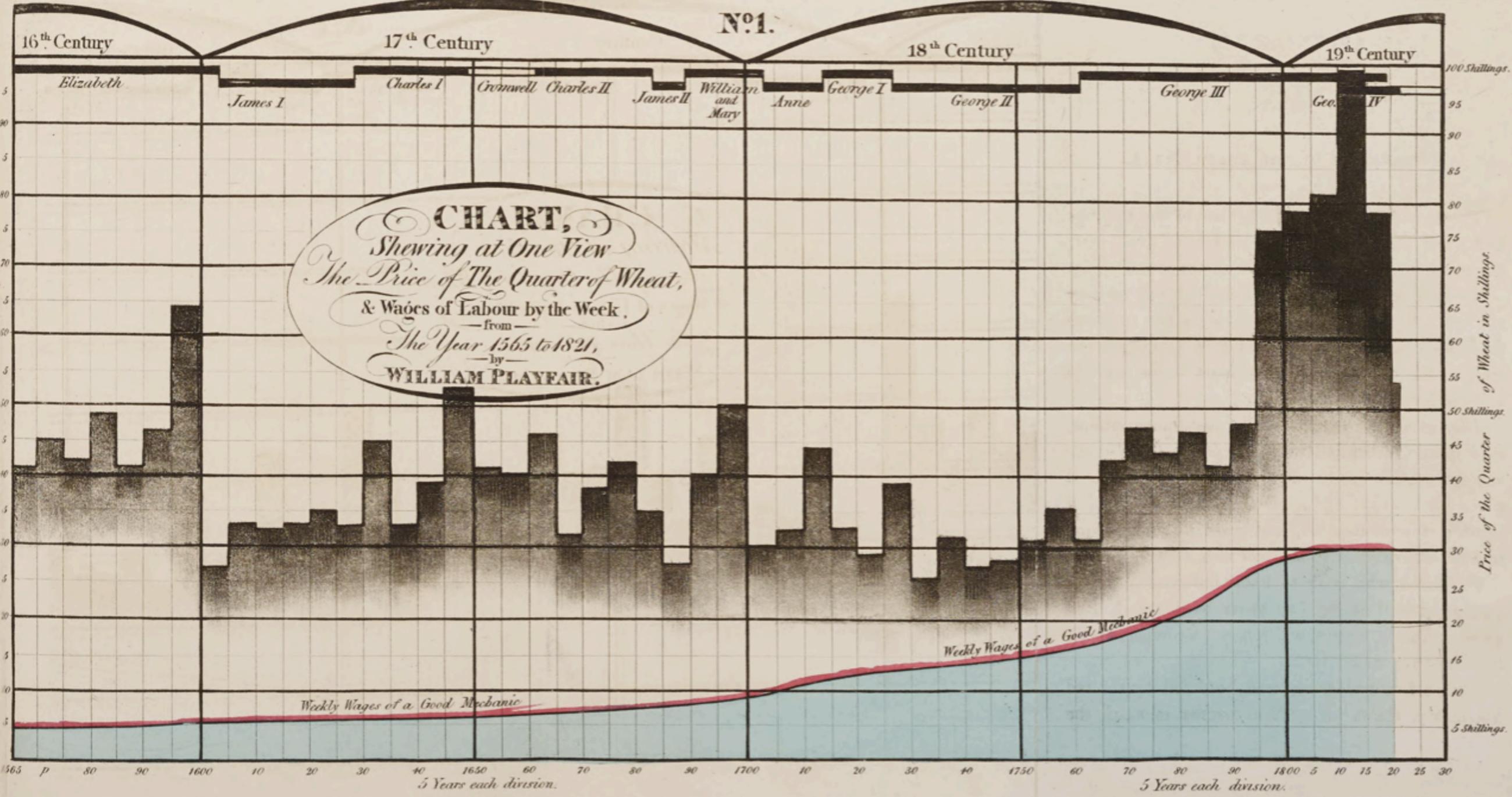


# Time Series

**CHART Shewing at One View the Price of The Quarter for Wheat & Wages of Laborer by the Week – “A Letter on Our Agricultural Distresses, Their Causes and Remedies”**

- Actual "letter" he sent to the "Lords & Commons"
- Playfair uses this time series chart to show not just the relationship of a singular cardinality dimension over time, but demonstrates multivariate metric relations of orthogonal cardinality on a single chart
- Plots four different metrics displayed on four different axes
  - Time - bottom axis in years with decade spans (Centuries also denoted on top)
  - Price of Wheat – right axis, price of quarter of wheat in shillings
  - Wage of a Good Mechanic – left
  - Reigning Monarch – top



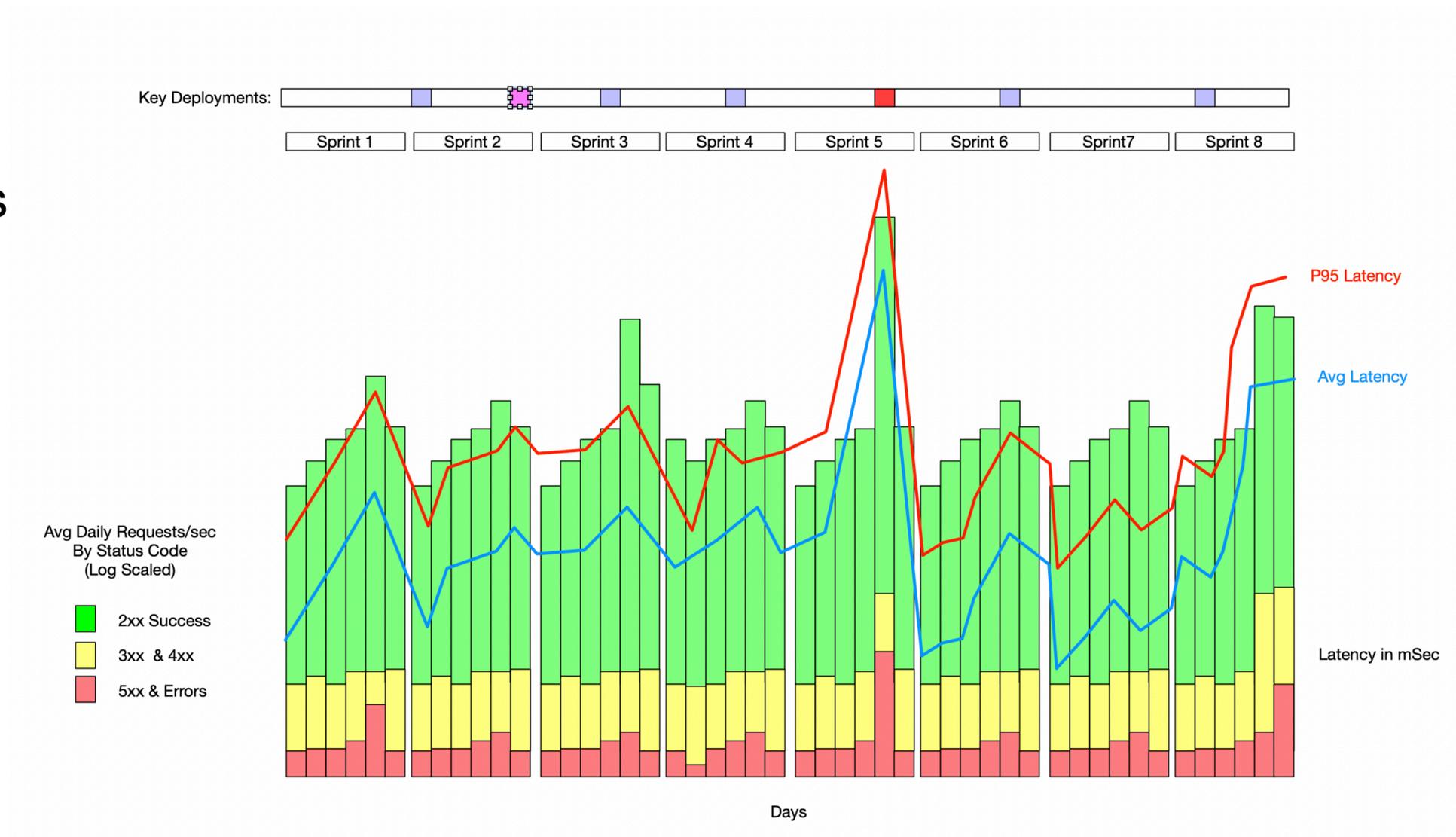


For a Particular Explanation, See Letter to the Lords & Commons.

# MultiVariate Time Series Chart

## *Steal Playfair's chart!*

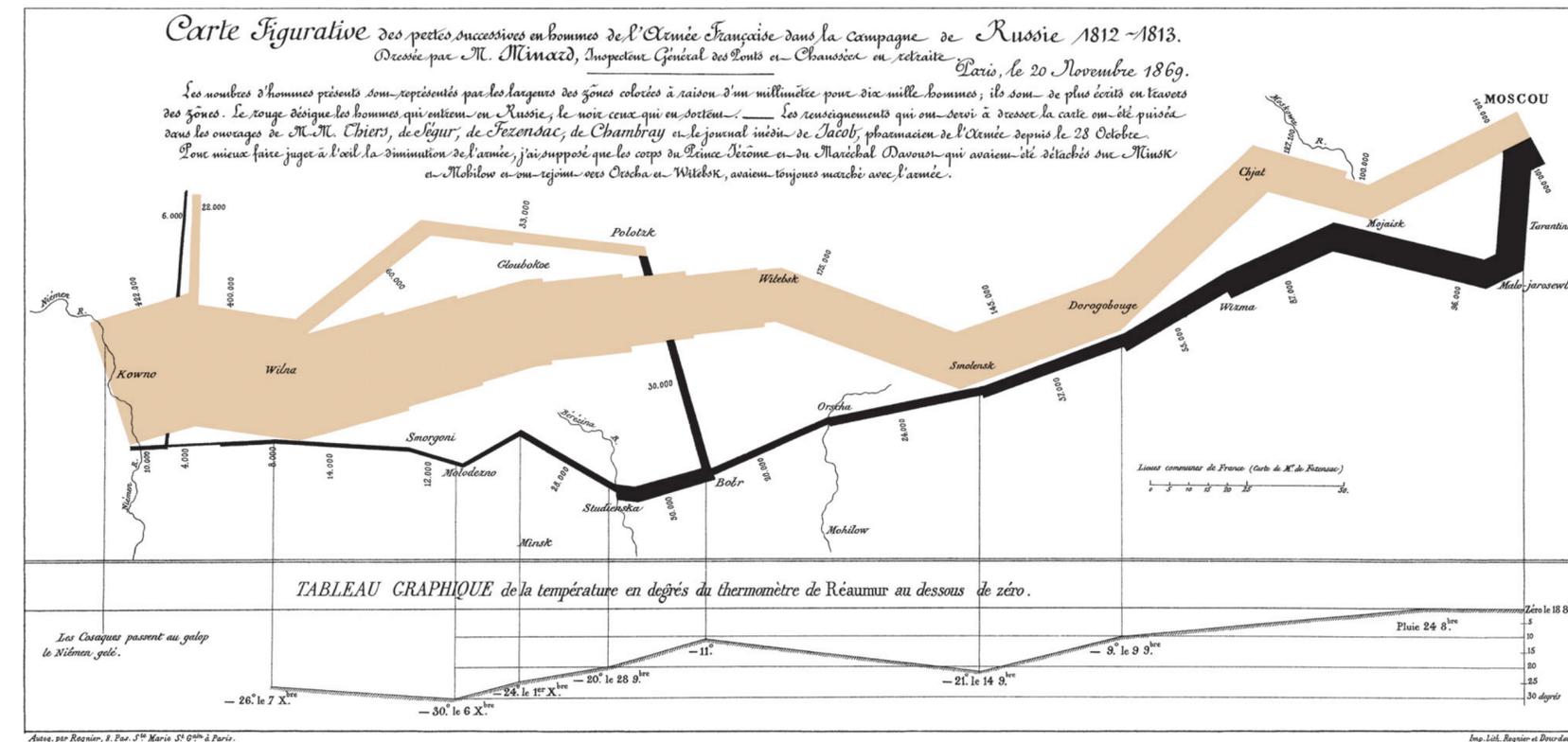
- This is a wonderfully reusable pattern
- You can produce many similar charts with your metrics to tell the same sort of narratives with your SLIS
- This greatly improves the data density of the display over separate dashboard charts competing for screen real estate and increases the cardinality of the metrics displayed.
- Use log scale to emphasize metrics lost in weeds



# Multivariate Observability Visualizations

## The Minard

- “May well be the best statistical graphic ever produced.”  
Edward Tufte – “The Visual Display of Quantitative Information
- One of many "Figurative Maps" Minard produced
- Ostensibly a time series graph
- Extensive use of multivariate data
- Forms a distinctive and powerful narrative: story of Napoleon’s disastrous march on Moscow in 1812



<https://upload.wikimedia.org/wikipedia/commons/2/29/Minard.png>

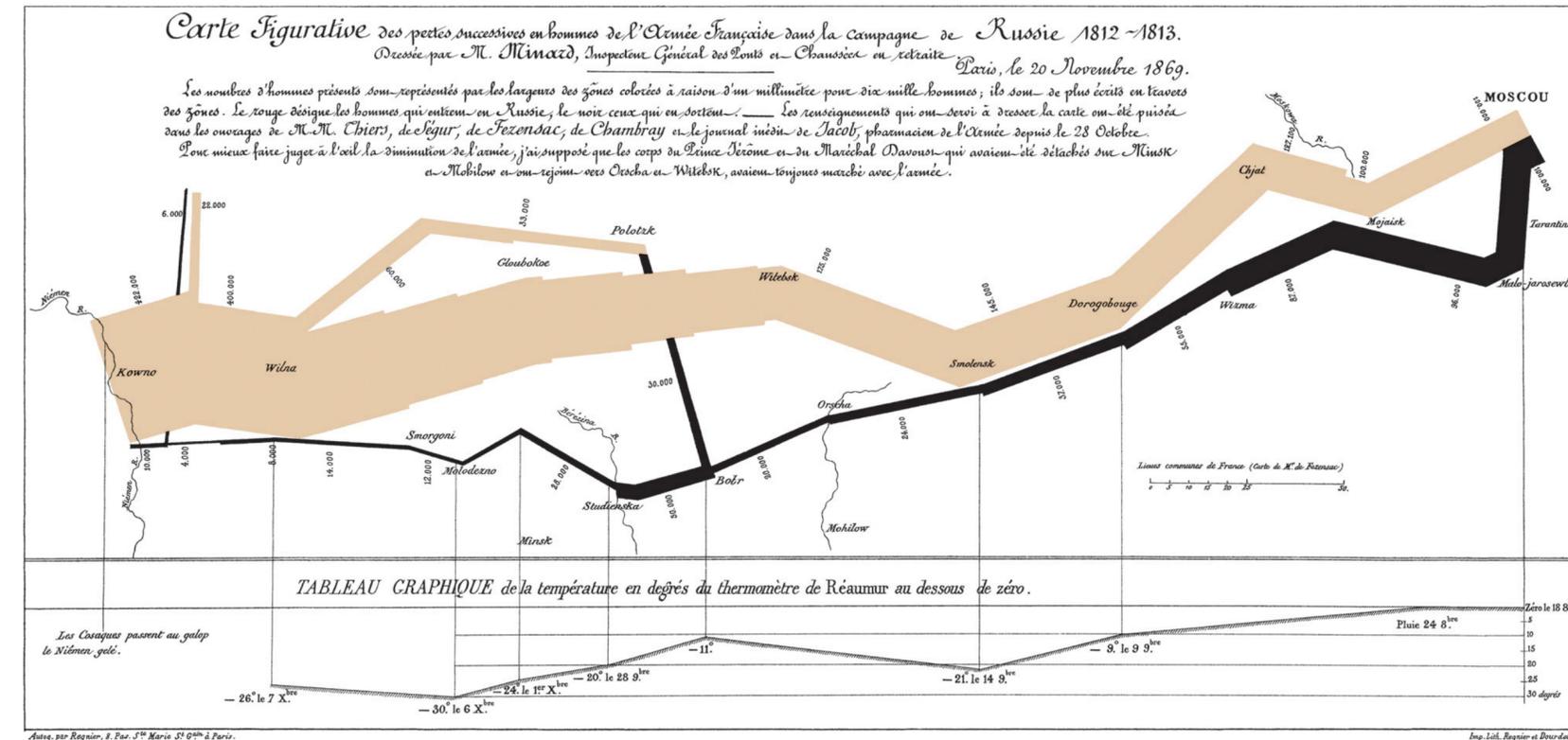
# Multivariate Observability Visualizations

## The Minard

- Minard illustrates successive French Army losses as a time series, and what he believed was the root cause of the defeat, the cold, also as a time series, in a multivariate data display that incorporates six different variables to tell it's tale

- Size of army in men, scaled and labeled
- Two dimensional location (latitude & longitude) and annotations for key places
- Distance traveled in leagues
- Direction of army movement (red/black)
- Time
- Temperature

Scale here starts at freezing, or zero degrees Reaumur, and drops to -30 degrees (-38C, -36F)



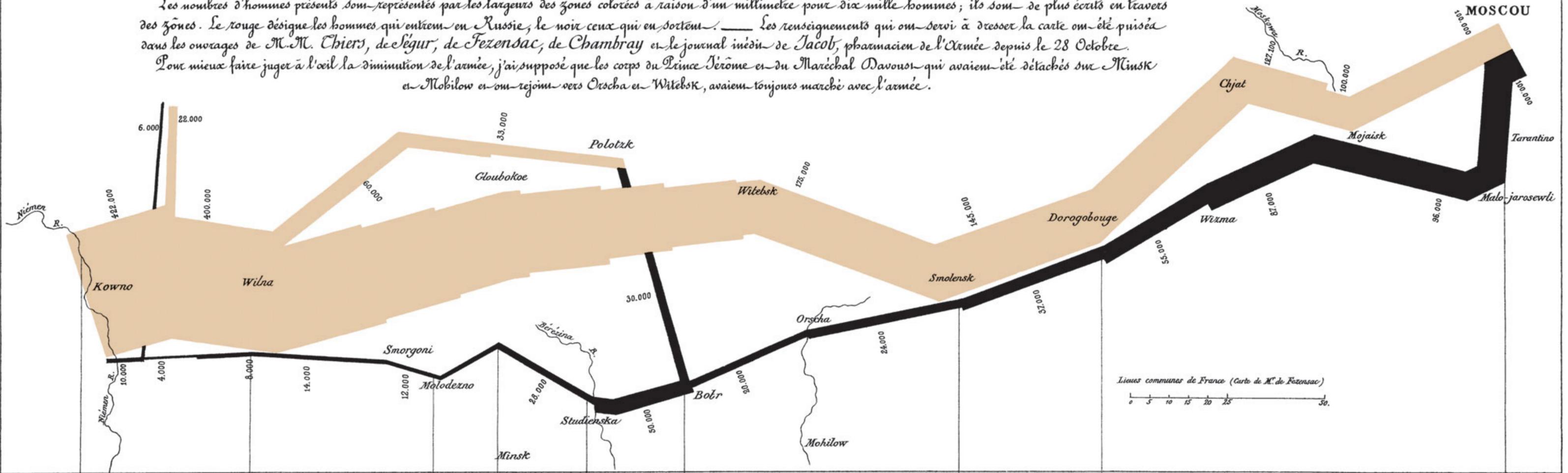
<https://upload.wikimedia.org/wikipedia/commons/2/29/Minard.png>

# Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M.M. Thiers, de Ségur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

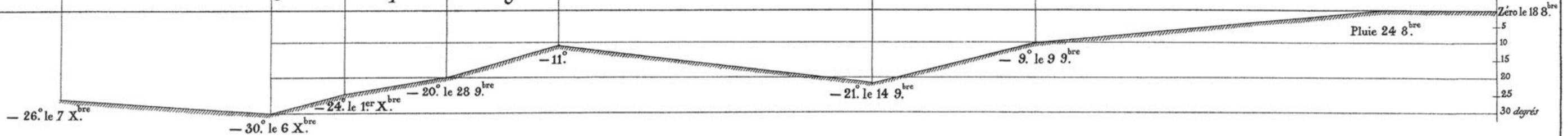
Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilow en ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.



Lieux communes de France (Carte de M. de Fezensac)  
0 5 10 15 20 25 30

## TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

Les Cosaques passent au galop le Niemen gelé.



# Multivariate Observability Visualizations

What makes this graphic notable is that it exemplifies Tufte's Key Principles of Analytic Design

“Beautiful Evidence”, pages 122-139

- Show comparisons, contrast differences
- Show causality, mechanism, explanation and systemic structure
- Completely integrate evidence using words, numbers, images, diagrams
- Multivariate Analysis – *"Nearly everything we look to understand is multivariate in nature"*
- Documentation – *"Thoroughly describe the evidence. Provide a detailed title, indicate the authors and sponsors, documentation the data sources, show complete measurement scales, point out relevant issues."*

*Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.*  
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Figurative Map of the successive losses in men of the French Army in Russian Campaign 1812-1813.

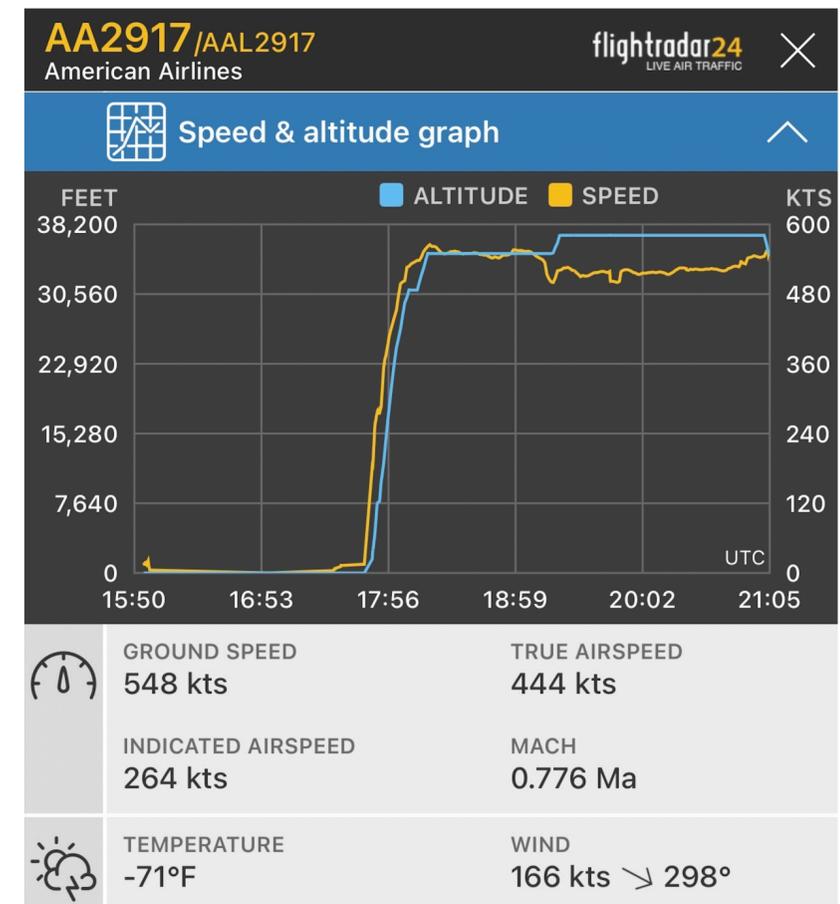
Drawn up by Minard, Inspector General of Bridges and Roads in retirement.  
Paris, November 21, 1869

The number of men present are represented by the widths of the colored zones at a rate of one millimeter for every thousand men; they are further written across the zones. The red designates the men who entered into Russia, the black this who leave it. — The information which has served to draw up the map has been extracted from the works of M M Thiers, of Ségur, of Fezensac, of Chambray and the unpublished diary of Jacob, pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and Marshal Davout who had been detached at Minsk and Moghilev and have rejoined around Orcha and Vitebsk, had always marched with the army.

# Multivariate Observability Visualizations

## Visualizing SLIs as a multivariate SLO narrative

- Goal of good charts & dashboards: efficient communication of complex quantitative ideas
- "Most everything interesting is a multivariate relationship" == complex ideas
- "Graphics reveal data"
  - Why do we call it o11y? Because we're supposed to "see" it
- Build better charts for on-call engineers to more quickly consume
- Translate changing SLIs into a narrative picture of SLO decline (or improvement!)
  - Build metrics into narrative charts to include on dashboards
  - Multivariate charts allow on-call engineers to connect more SLI data together
  - On Incident Retrospective Reports speak through visualizations illustrating all the SLO changes and recoveries as evidence



# Multivariate Observability Visualizations

*They're everywhere! Example from a presentation yesterday*

**COMPLEXITY**

**2010** | **13** | **16** | **18** | **2022**

**CHEF** | **DAG** | **W3** | **V3** | **V4**

**SAME API**

**DRP com**

**2021**

**RackN**  
@zehicle

**Hello 10k Machines**

We build A LOT of the some object types - challenge is denormalizing

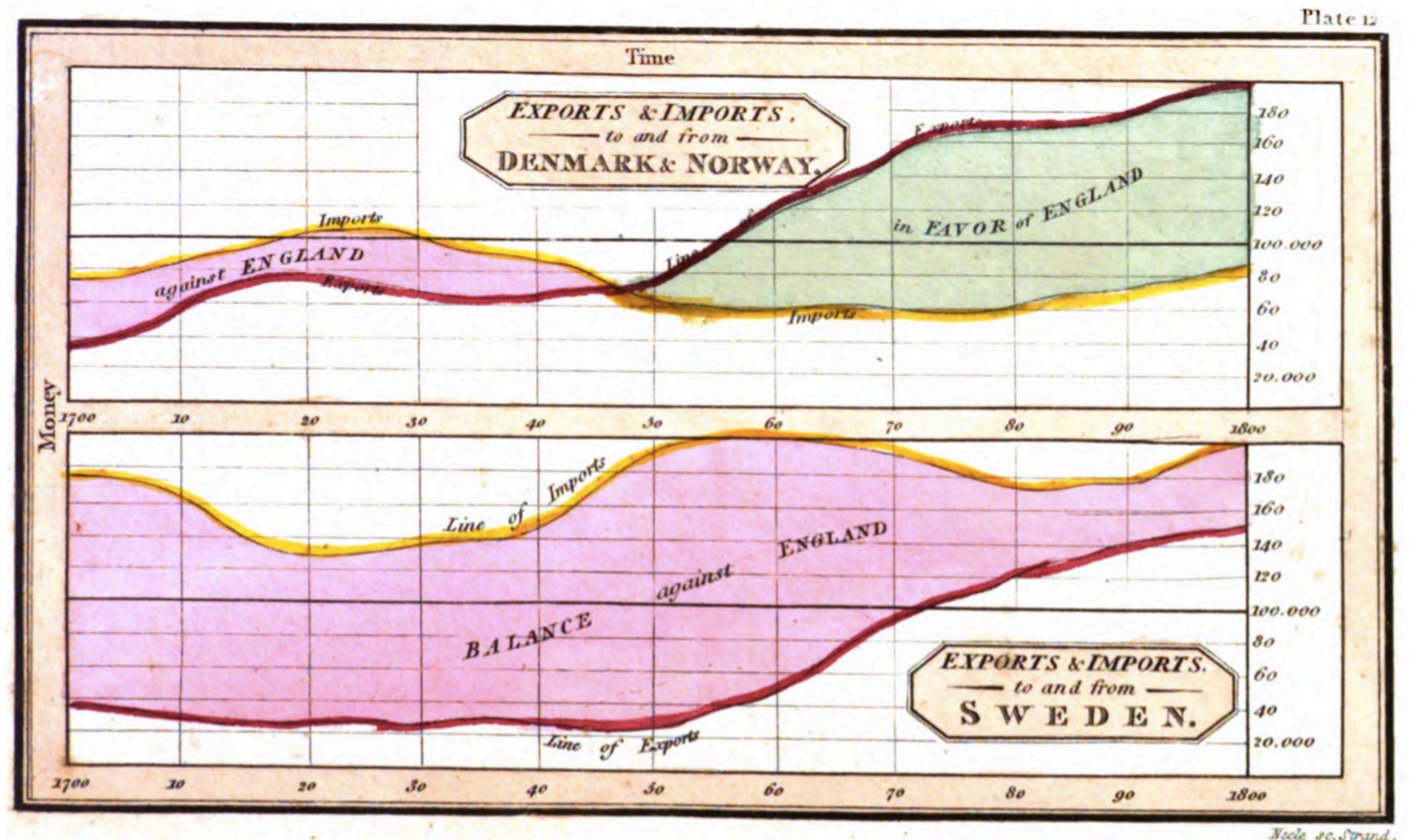
# Common pitfalls that distract from good observability in your visualizations

Observed in Slack, Incident Reports, engineering presentations, dashboards

# Common pitfalls that distract from good observability

*Use common scales displaying similar metrics on adjacent graphs*

- Our eye/brain wants to form visual relationships
- It's confusing to engineers, especially during incidents, when multiple similar graphs of same type use different scales
- Often the default "out of box behavior" from visualization tools to auto-scale to fit range
- Skewed scales lead to skewed decision making

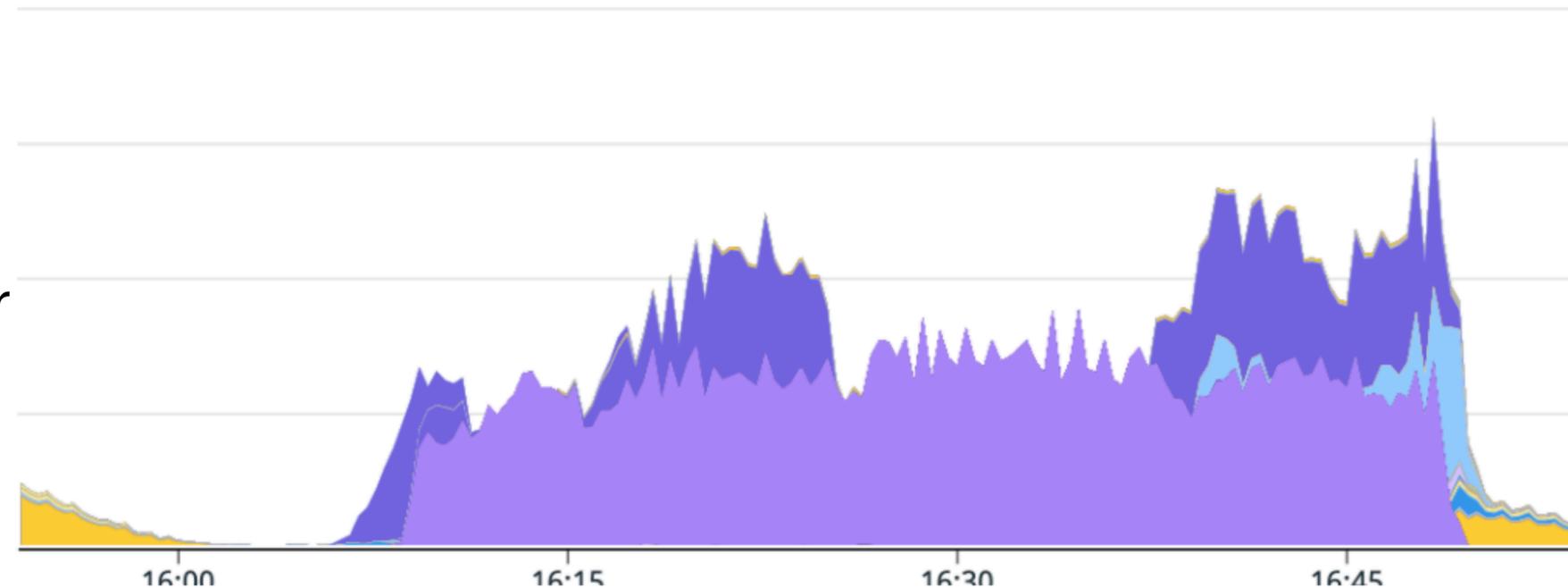


Playfair's graphs all shared common scales to make the visual comparisons intuitively observable

# Common pitfalls that distract from good observability

*Avoid obscuring your data with shaded and stacked data*

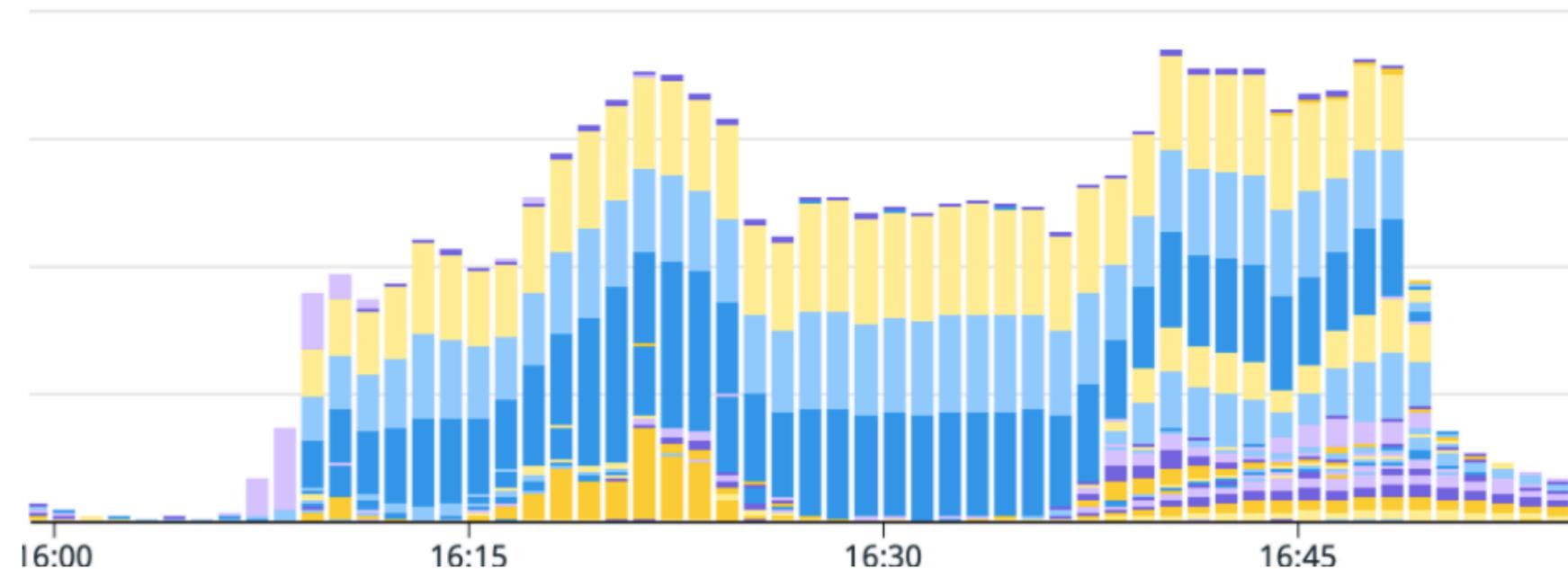
- "Just say no" to shading, prefer lines for metrics
- Often default behavior from plotting tools
- Shading is most often just chartjunk, distracting from the data and the journey of the metric
- Where shading is appropriate: stacked bars in bar charts, areas in pie charts — where you're expressing multiple variables summarized together
- Tufte on chartjunk:  
[https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg\\_id=00040Z](https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=00040Z)  
Google: TUFTE CHARTJUNK
- If you must shade something, shade your grids and other *non-data ink*, it's administrivia



# Common pitfalls that distract from good observability

*Missing scales, keys and other critical explanations when cutting and pasting data in slack and reports*

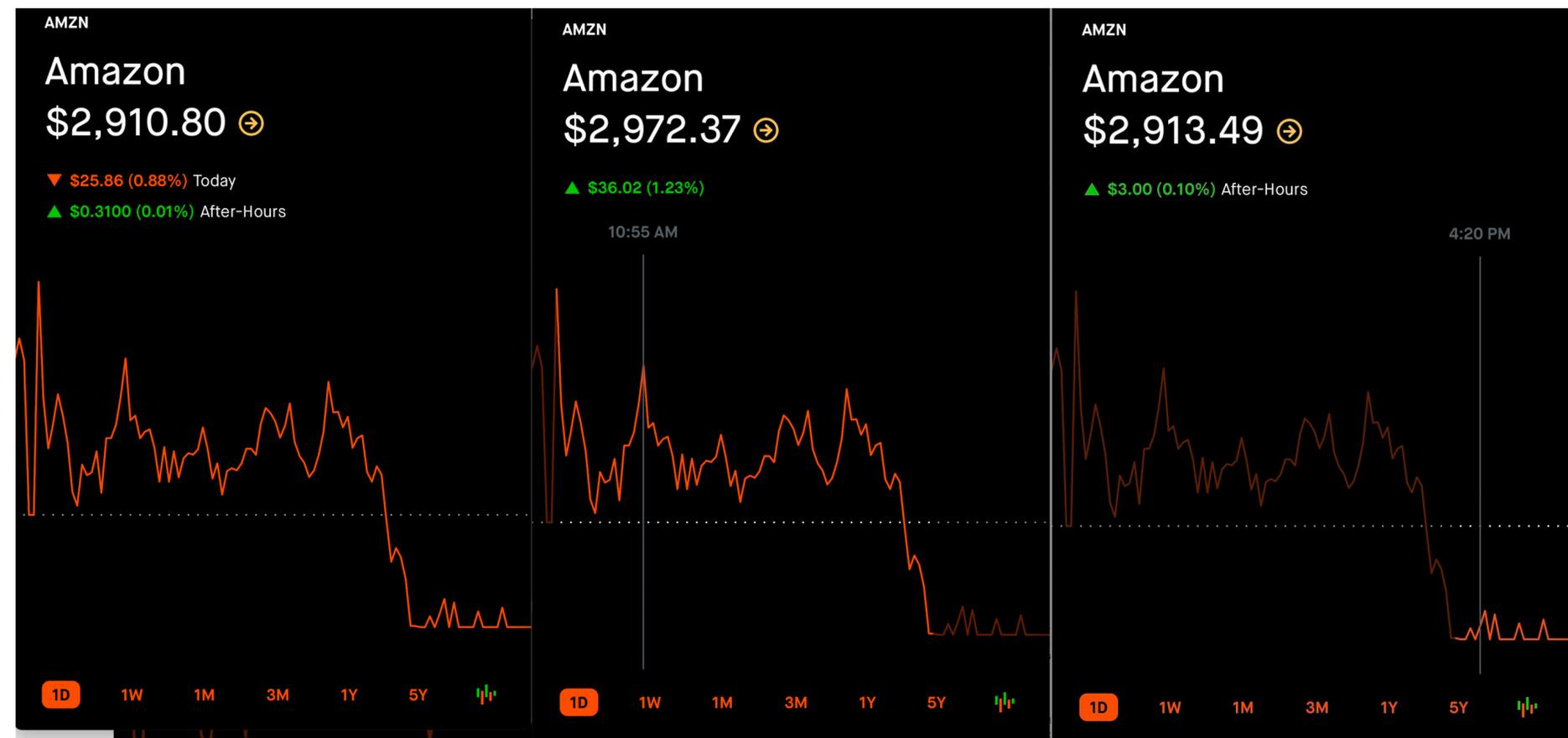
- What metric is this charting?
- What's the scale?
- What are the sources in the different bars?
- We're missing the data narrative



# Common pitfalls that distract from good observability

## *Missing scales & Truncated or Torn Graphs*

Missing scales call into question credibility and how I may need to account for the data, for instance if the scale starts at a non-zero value as in a truncated or torn graph. The charts below paint a deceiving picture of a crashing stock dropping to the floor, yet when we examine a peak value and one in the weeds we note that it's really off only about \$60 out of near \$3000, not as significant of a drop as it appears because the bottom of the axis doesn't start at zero. I suppose there are times when such a implied narrative might be what you're attempting to convey, especially if you wanted to push the conclusion to sell the stock.



# Common pitfalls that distract from good observability

*Not linking back the source url of a graph in slack, in a retro, or report*

- Often need to get a better copy for Incident Report
- Makes it easy to recollect data for reports, retrospectives, or for those trying to "play along at home"
- Science and engineering is about being able to repeat experiments and obtain same results, engineers may benefit from understand how to obtain same results or "steal" a good pattern for reuse
- Allows confirmation of observations and allows credibility of the evidence to be explored

# Common pitfalls that distract from good observability

## *Percentages and Averages*

### Percentage Problems

- How much is 30% of string?
- Not a metric, metrics imply a measurement
- It's a relation, not a value
- Too easy to subvert, dependent of samples
  - Alerting case:
    - Would alert of a 25% error rate?
    - What if that was just one error out of only four events?
    - Skewed to much by scaling
    - How do retries affect results?

### "Averages"

- Did you really want the median (the "middle" of your bell curve)?
- Lots of outliers skew the mean
  - Lots of quickly returned errors can skew the mean lower in the average response time
  - Range of outliers (min and max) can be far removed from most of the values
  - Utilizing p50, p75, p90, p95 instead of the trio of min/avg/max most often portrays a clearer view

# Improving Data Density and Observations in Tables

## Sparklines

- Playfair create graphical methods of statistical expression of what he complained had been tables of numbers, yet we often see this on our dashboards.
- We often still see a lot of tables
- For each of these server metrics we get just current, average and max values one some duration, with a limited understanding into server3's above average cpu utilization
- On the right is basically the

CPU Utilization			
Metric ▲	Current	Avg	Max
server1	74%	58%	97%
server10	53%	54%	95%
server2	73%	56%	92%
server3	88%	56%	97%
server4	48%	56%	97%
server5	41%	56%	95%
server6	36%	53%	99%
server7	55%	56%	93%
server8	48%	55%	99%
server9	88%	54%	98%

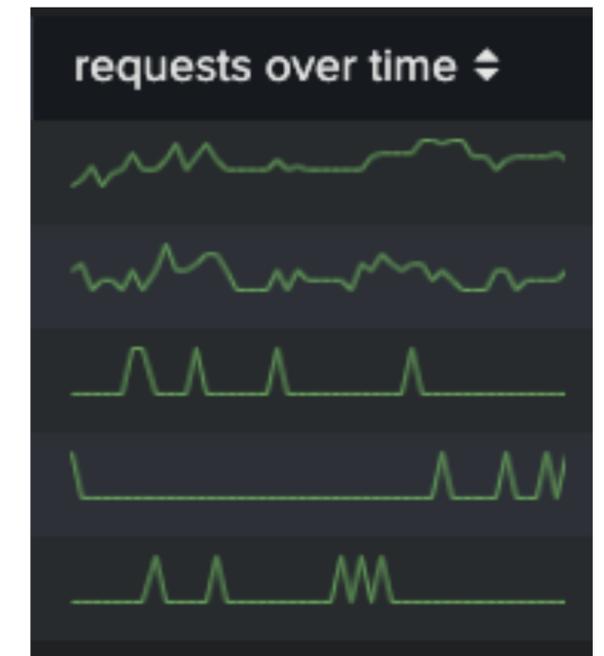
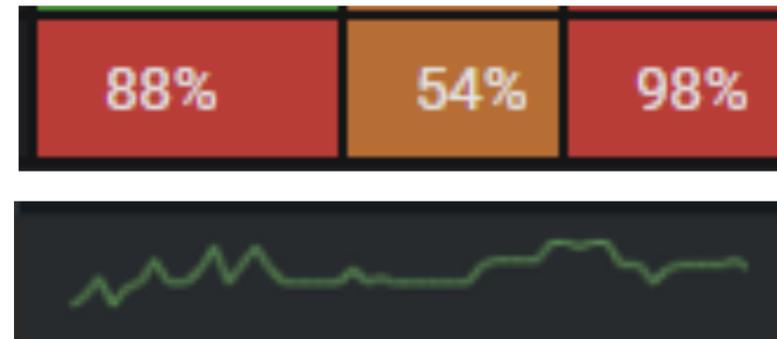
### Watchlist

	Bitcoin BTC		\$48,845.73 +2.04%
	Ethereum ETH		\$3,212.80 +0.84%
	Bitcoin Ca... BCH		\$646.35 +0.69%
	XRP XRP		\$1.17 +1.69%
	Litecoin LTC		\$177.44 +1.20%
	Stellar Lum... XLM		\$0.36 +0.96%
	Dogecoin DOGE		\$0.29

# Improving Data Density and Observations in Tables

## Sparklines

- Sparklines are "data-words"
- Small graphic the size of a word and can be used inline with text
- Can present hundreds more data points in same size space of a number
- Show the whole data range, not just summary
- Easily stack in a small area to form comparisons or enhance a table



pkg_tab	http_method	requests	requests over time	unique packages	unique IPs
media	GET	2,262		15	14
partnerPackages	GET	75		20	16
importTimings	PUT	5		5	4
partnerPackages	PUT	5		5	2
accept	PUT	5		5	3

# Improving Data Density and Observations in Tables

## Sparklines

While most sparklines express hundreds to thousands of data-points in the space of a few characters and are the ultimate high data density inline data words, even at low data density they can be effective and easy to generate to incorporate in your text.

“When the Xyzzy service dropped out, on recovery we’ve observed a pattern  where the queued requests exceed the nominal load for a period as it caught up on work before reverting back to expected stable load pattern.”

```
% `brew install spark`
```

```
% spark -h
```

USAGE:

```
spark [-h] VALUE,...
```

EXAMPLES:

```
spark 1 5 22 13 53
```



```
spark 0,30,55,80,33,150
```



```
echo 9 13 5 17 1 | spark
```



# Conclusion

- Build data narratives
- Use multivariate information displays to demonstrate relationships of critical metrics in incident retrospectives and dashboards
- Increase data density and increase cardinality by relating your key metrics together on a single chart by utilizing orthogonal axes for different metric types
- Increase data density in tables and paragraphs using sparklines
- Avoid common pitfalls that distract from good observations of your data

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