Time and Motion
Part 1: Representing Time Variation

John Keyser

Patterns of Time-Series Data

- Several types of typical patterns seen
  - Trend of Change
  - Variability
  - Covariation
  - Rate of Change
  - Cycles
- Often, simple line graphs are best for displaying data

Trend of Change

- What is the overall nature of change?
  - Can assist by plotting a trend line, fitting a curve, or showing a moving average

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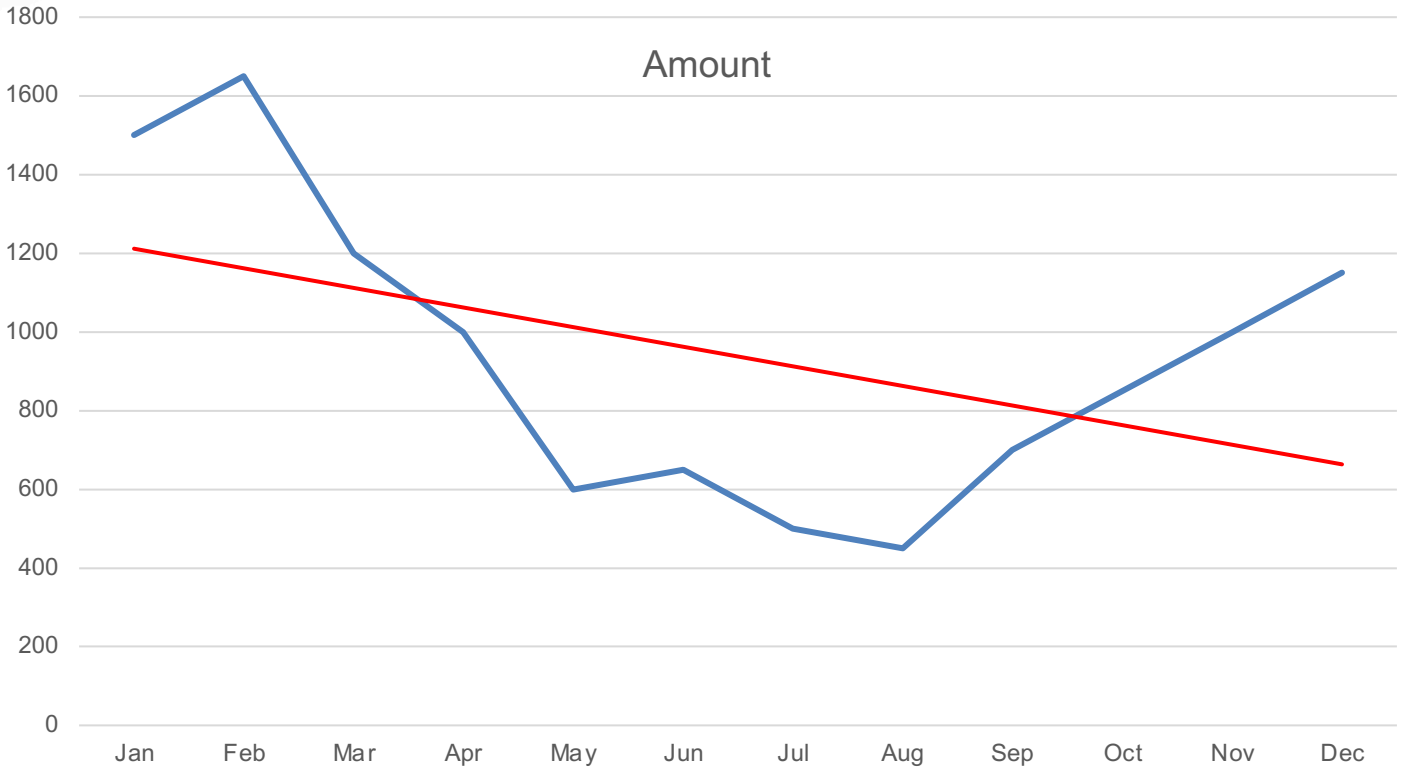

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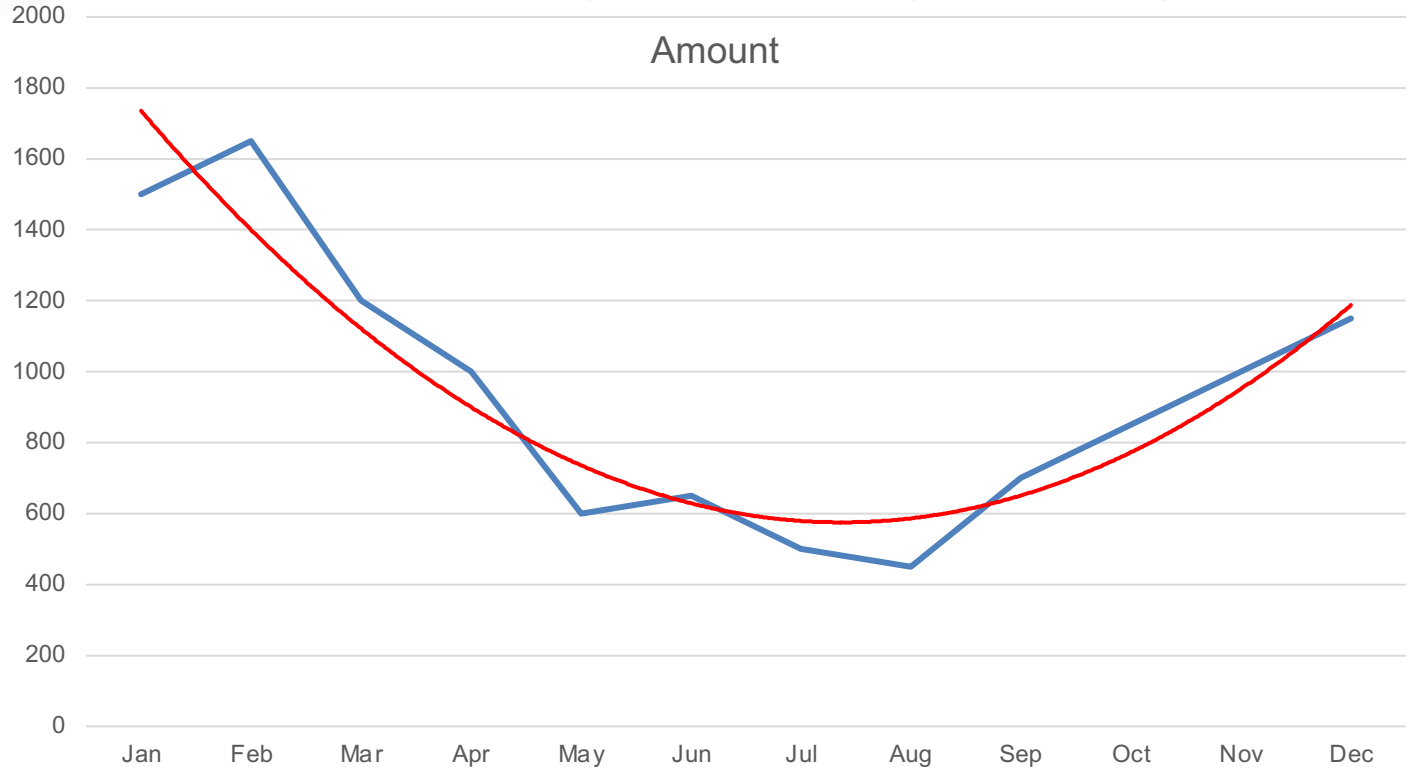

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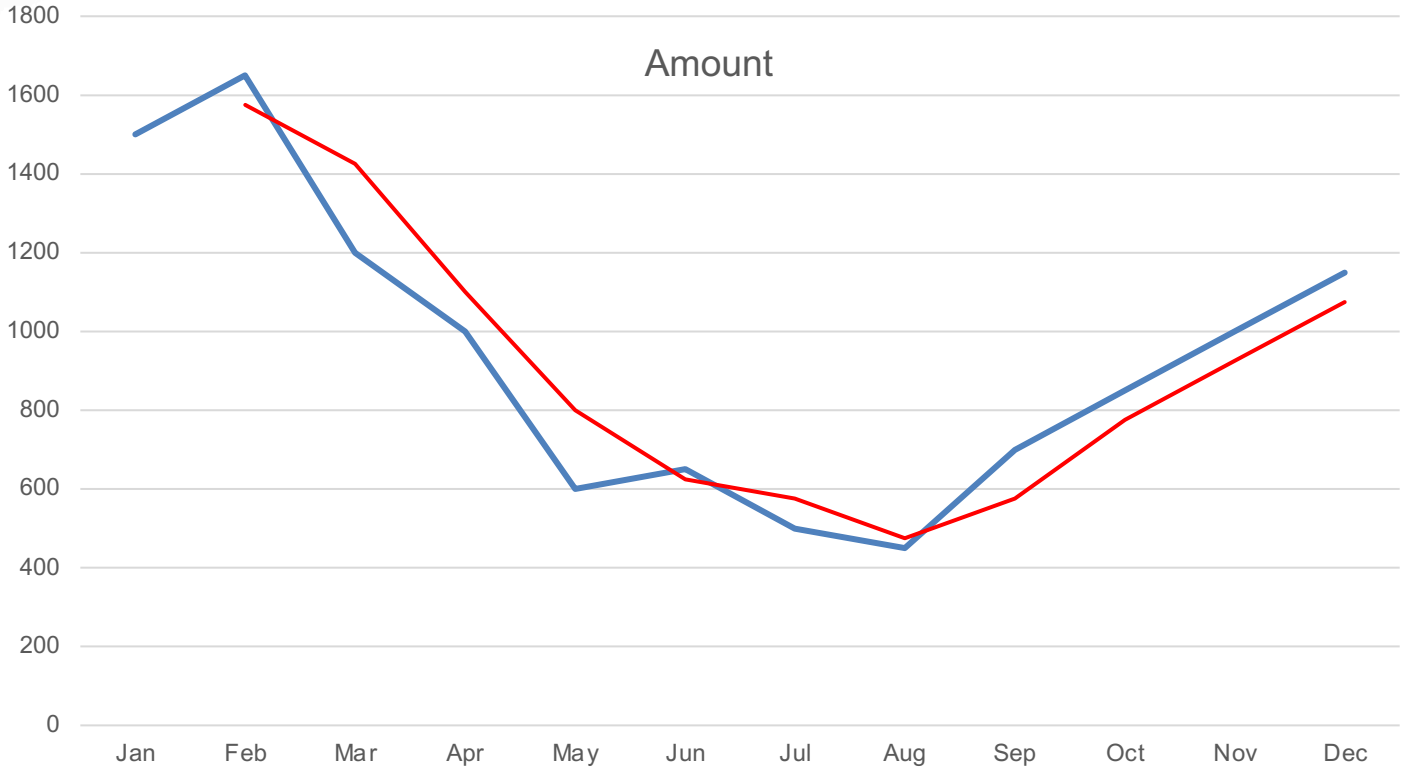

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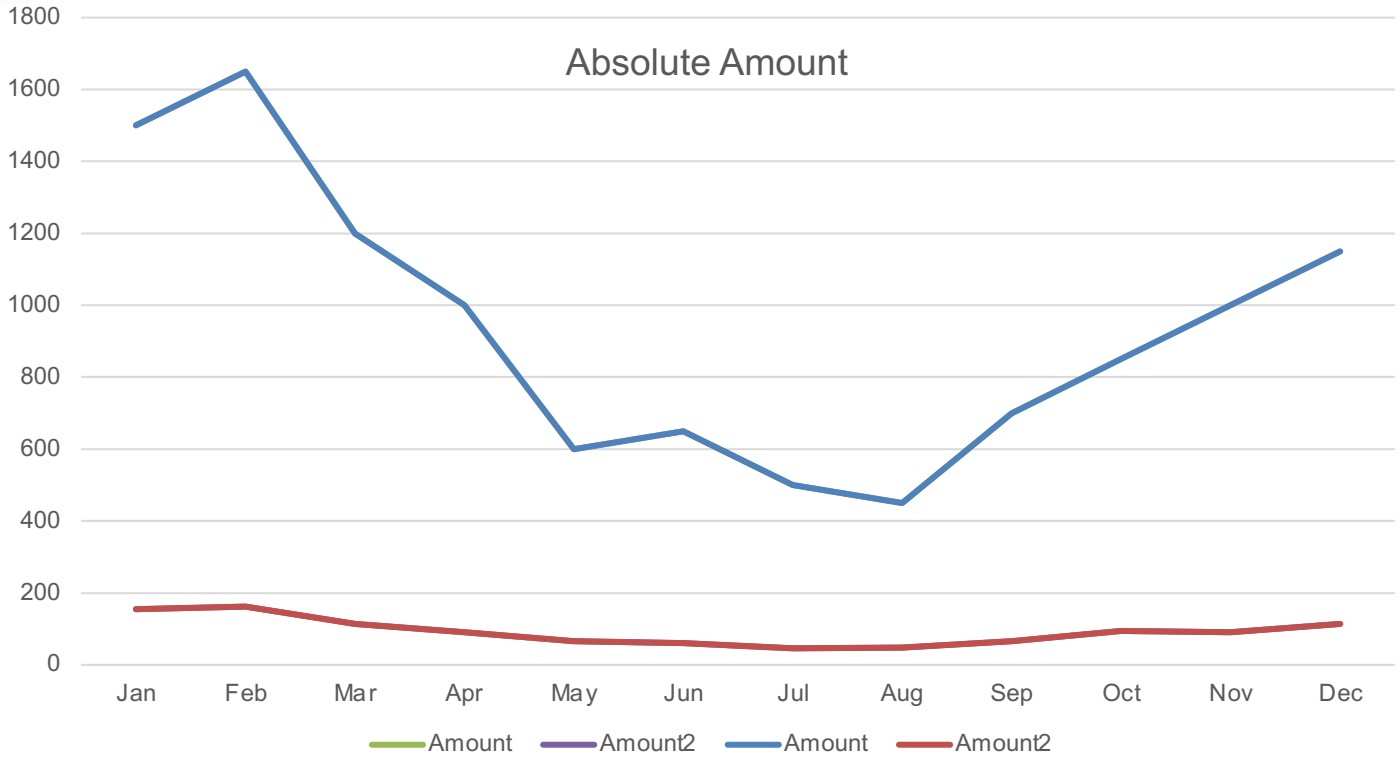
  - For multiple items, visualizing relative amounts can be better than absolute



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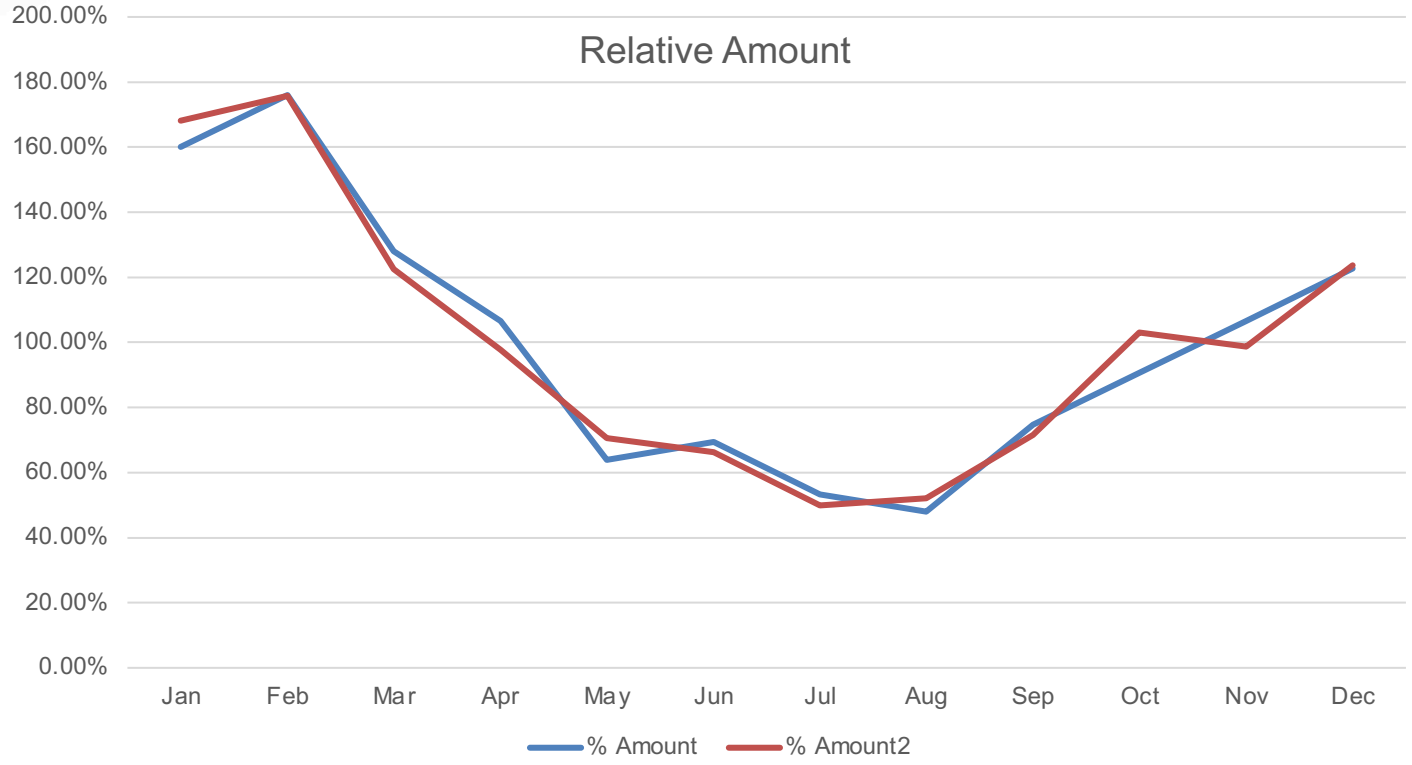
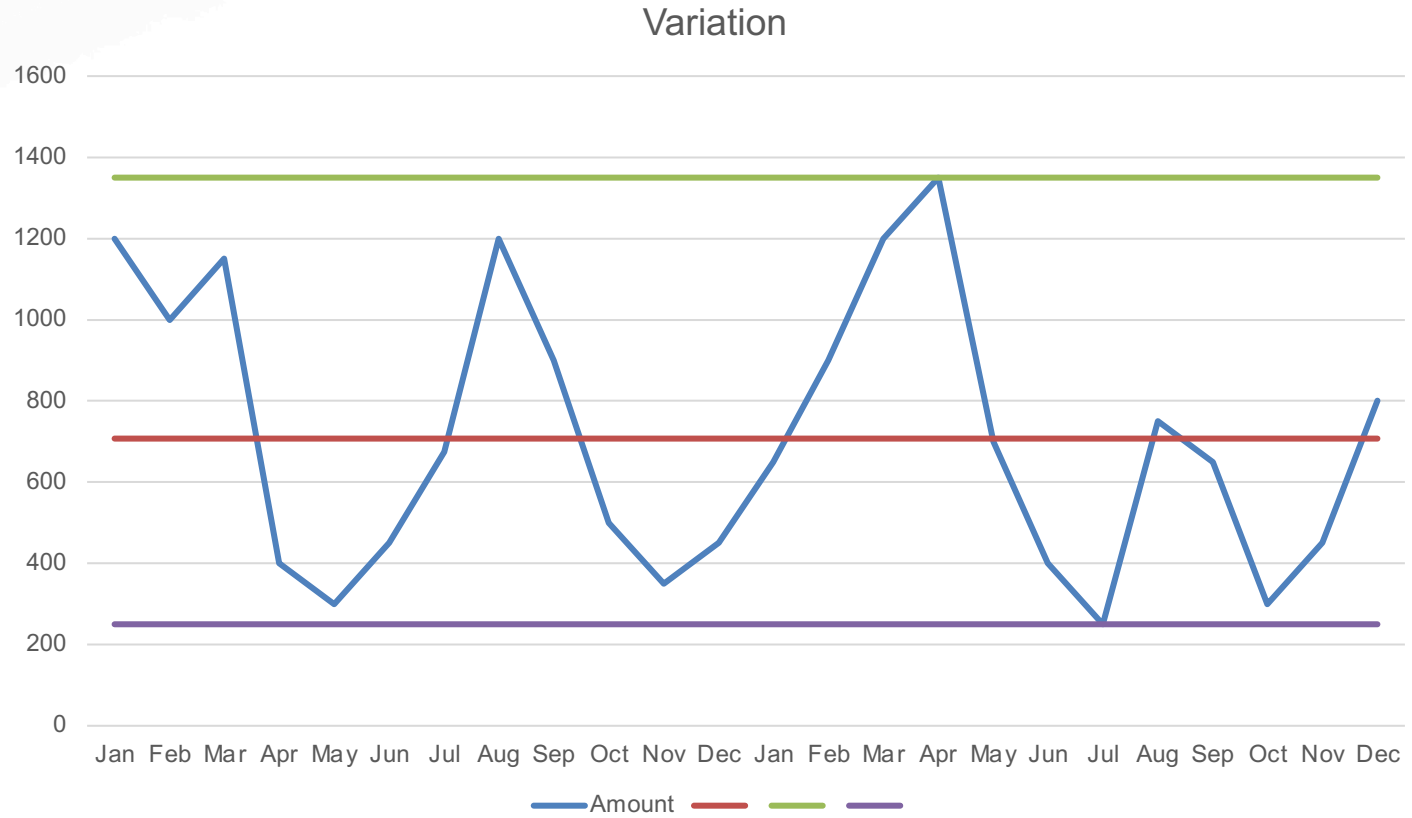


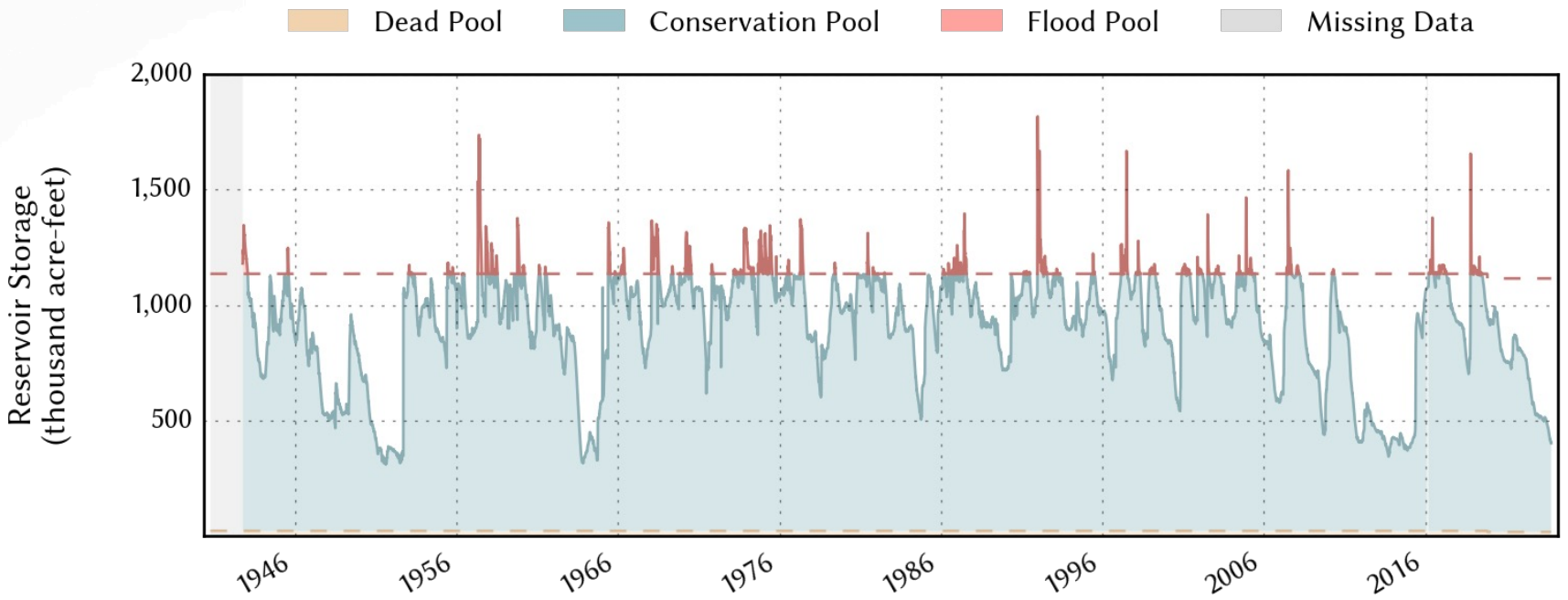
Variability

- How do values go up/down through time?
  - Clearly showing max/min/mean can be useful



Variability

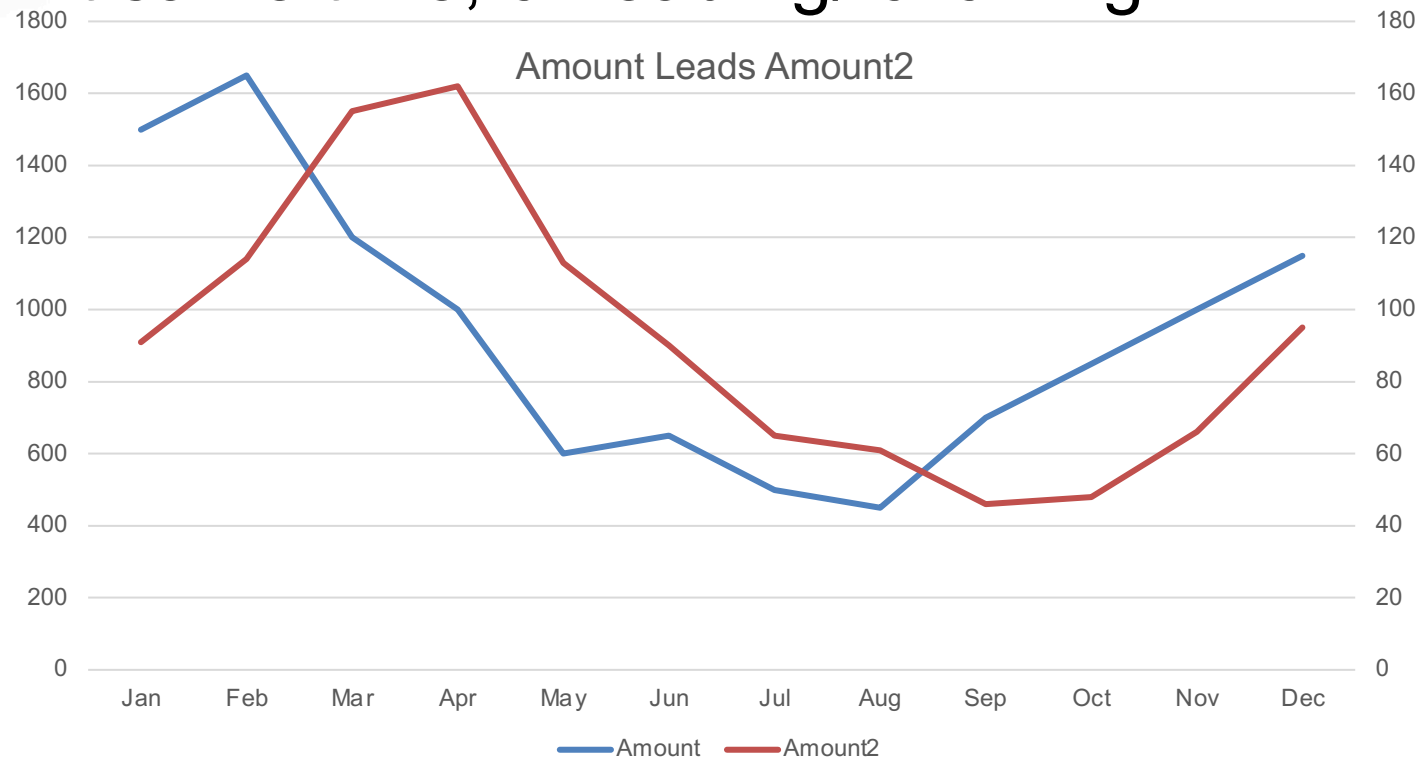
- How do values go up/down through time?
  - Clearly showing variation vs. a base is useful



Taken from: https://waterdatafortexas.org/reservoirs/individual/travis

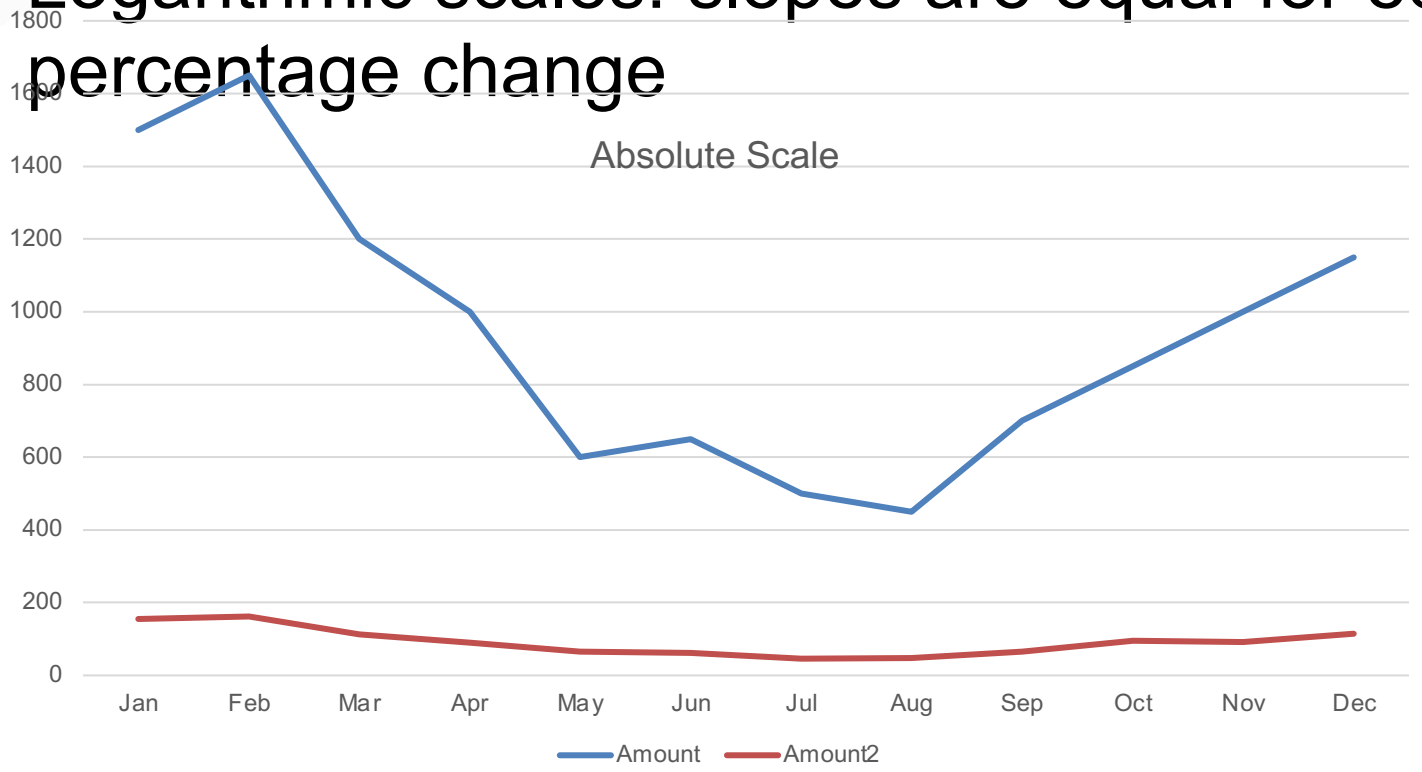
Covariation

- How does one value change relative to another
  - At same time, or leading/following



Rate of Change

- Show percentage change in intervals instead of absolute change
  - Logarithmic scales: slopes are equal for equal percentage change



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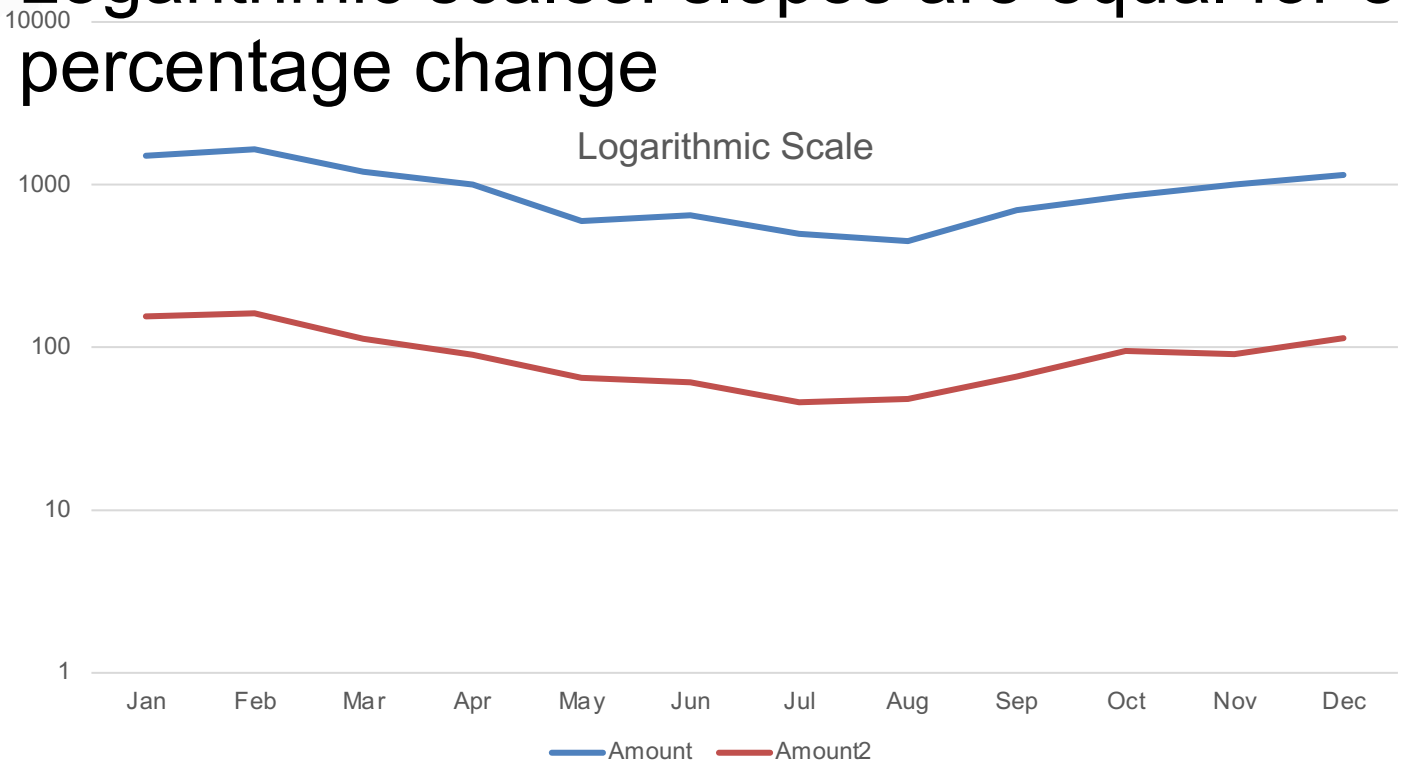
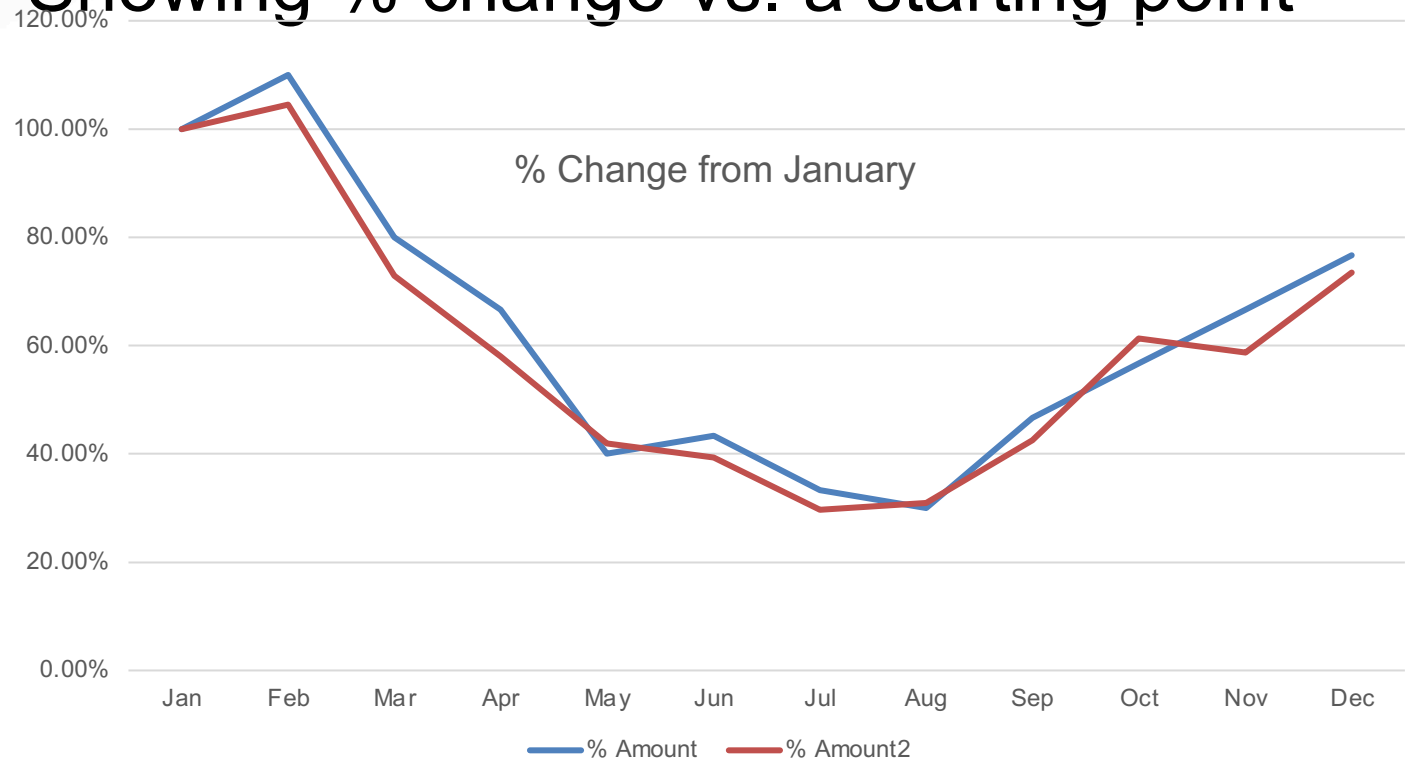


Rate of Change

- Show percentage change in intervals instead of absolute change
  - Showing % change vs. a starting point

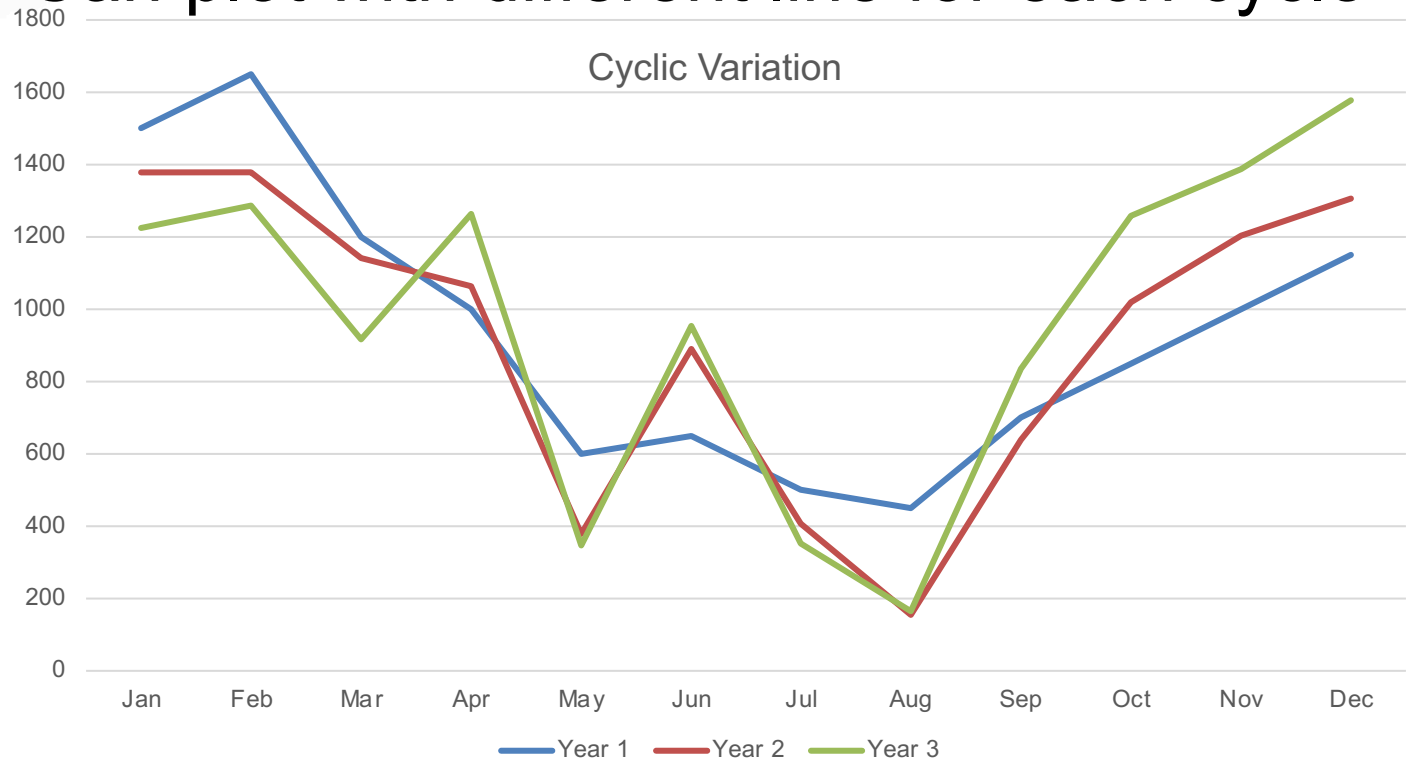


Rate of Change

- Show percentage change in intervals instead of absolute change
- Careful! Choices made can influence impression made if people aren't careful
  - Starting point for % change can make a big difference
  - Logarithmic scale needs to be clearly labeled and used by people who understand it

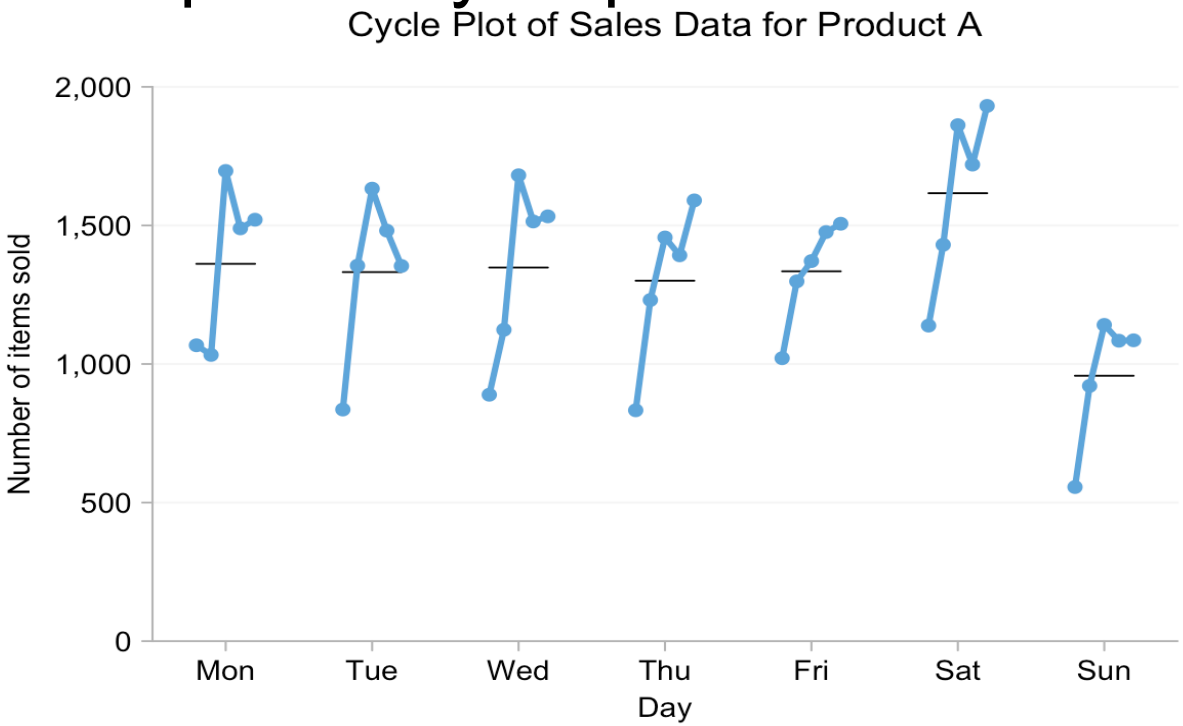
Cycles

- Show data that tends to follow regular repeating pattern over time
  - Can plot with different line for each cycle



Cycles

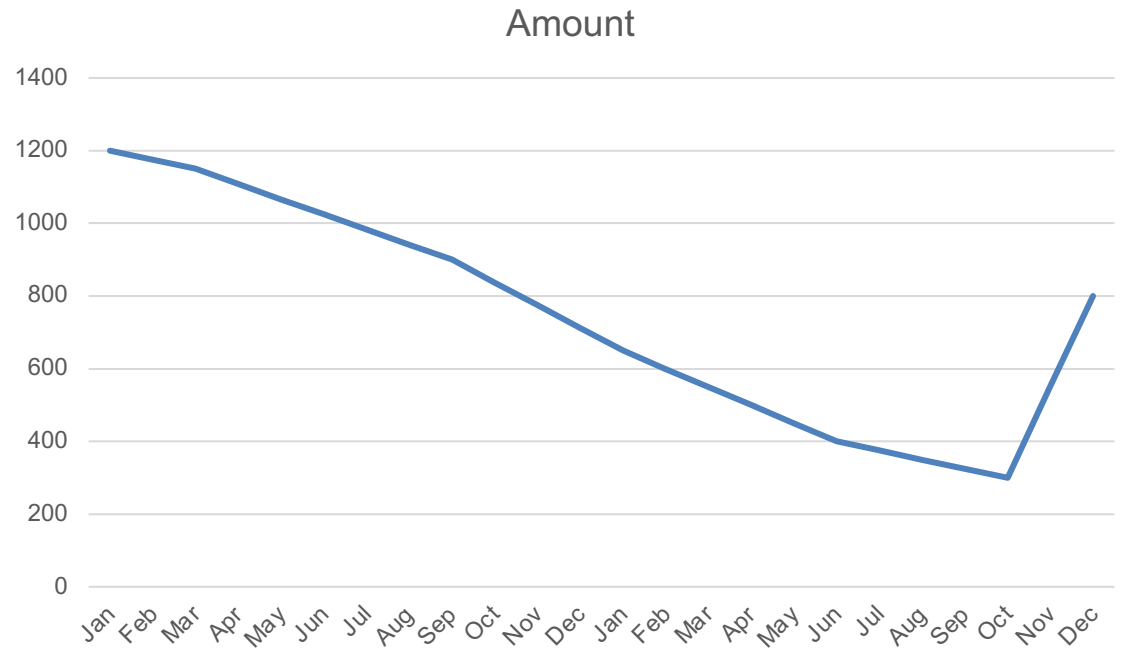
- Show data that tends to follow regular repeating pattern over time
  - Also specific cycle plots



Taken from: https://www.infragistics.com/community/blogs/b/tim_brock/posts/charts-and-cycles-of-time-part-2

Considerations for Time Series Visualizations

- Careful when using lines
  - Implies that there is smooth variation from sample to sample, which might not be true
  - Dots can be better



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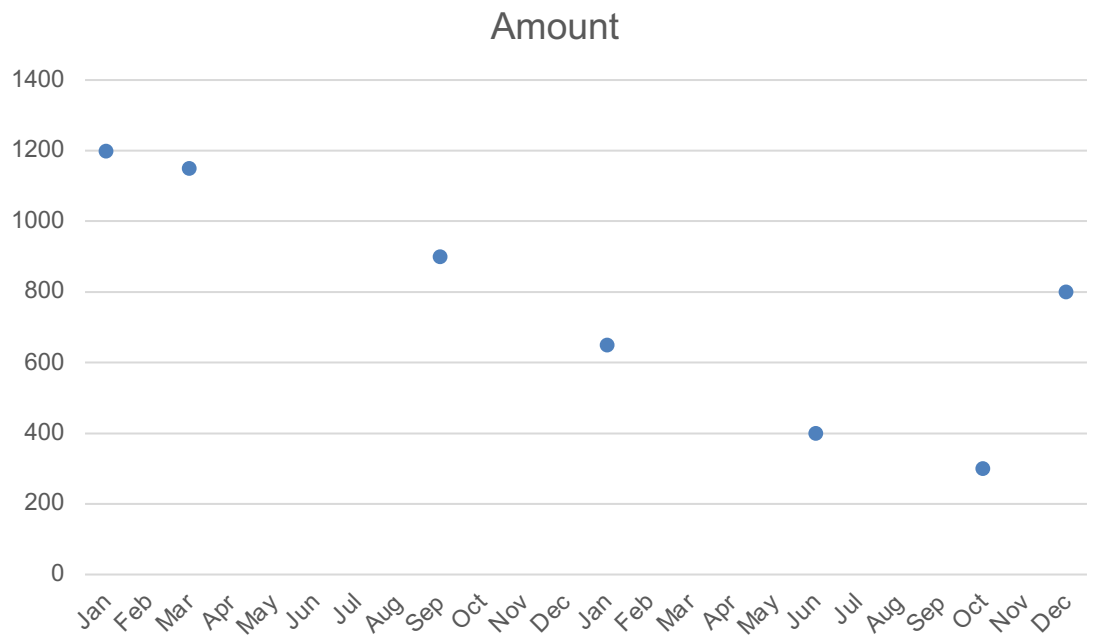

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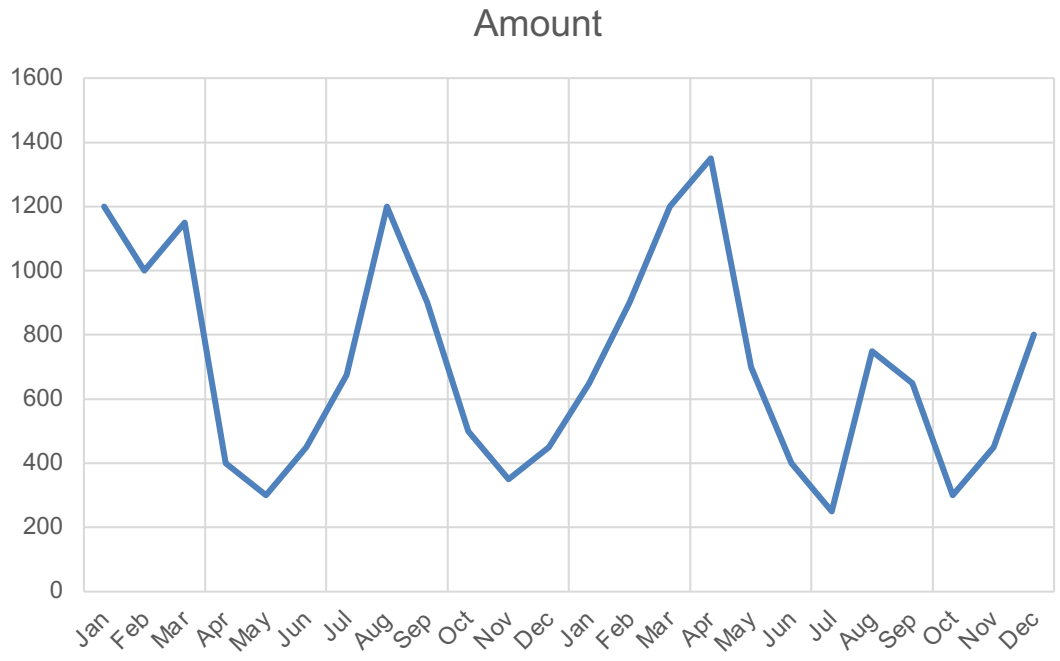
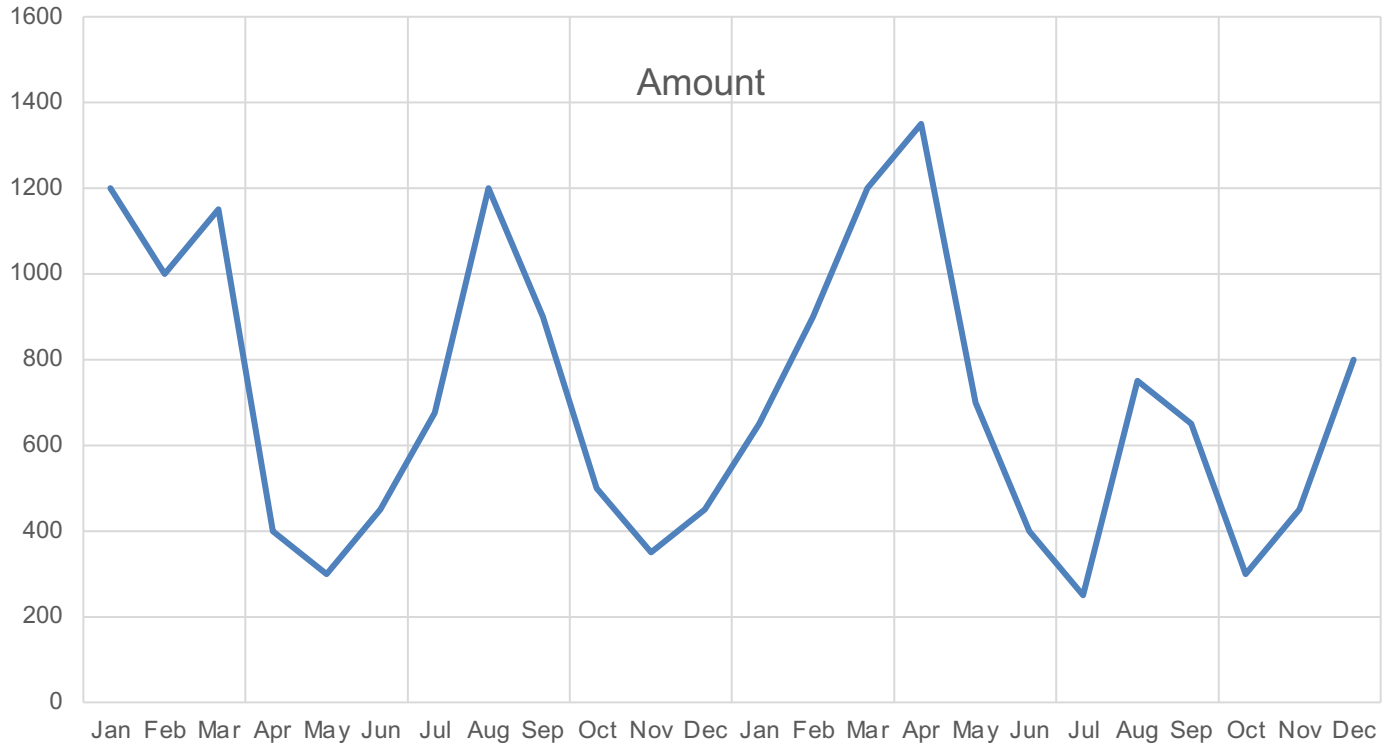


Considerations for Time Series Visualizations

- Aggregation level can tell very different stories
  - Year vs month vs day vs hour
- Choosing right level for the concept you are wanting to demonstrate is important
- Can also allow for user to select if interactive

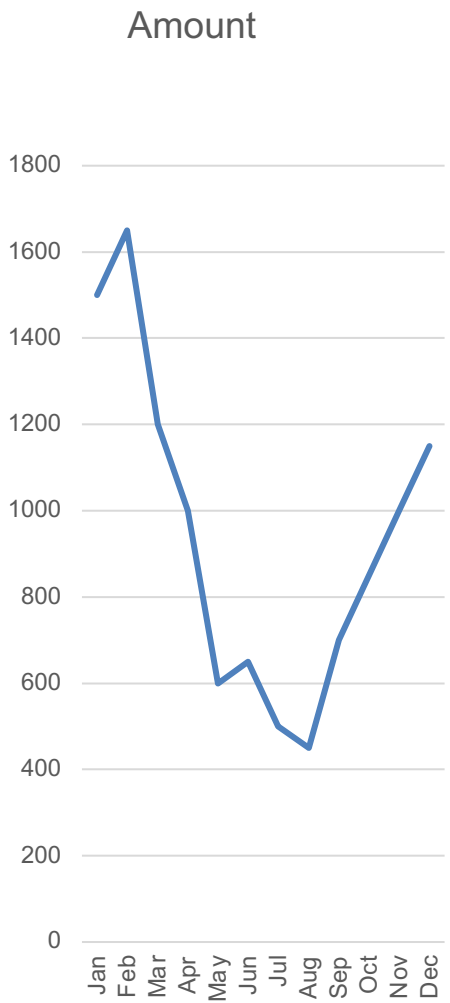
Considerations for Time Series Visualizations

- Adding lines to group data of similar types can help provide context
  - Visually separate regions, see cycles, etc.
  - e.g. adding lines to show beginning of year, or quarter
  - e.g. adding shading to show weekdays



Considerations for Time Series Visualizations

- Aspect ratios
  - In general, can change perception of data
- Ideal seems to be slopes of about 45 degrees



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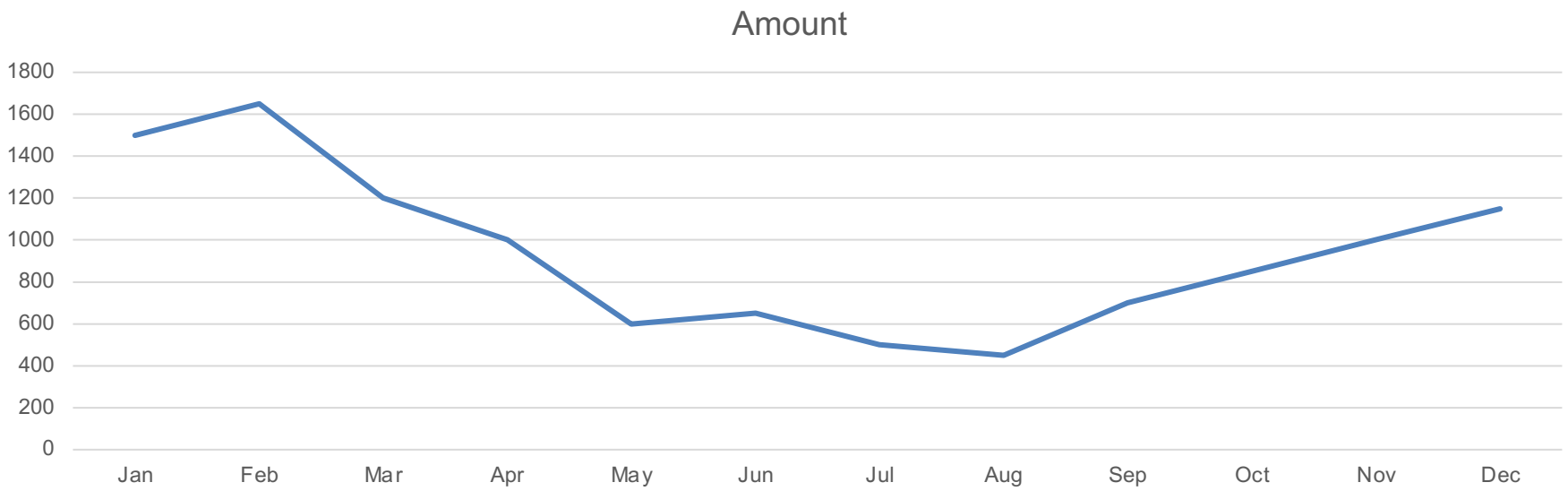

Considerations for Time Series Visualizations

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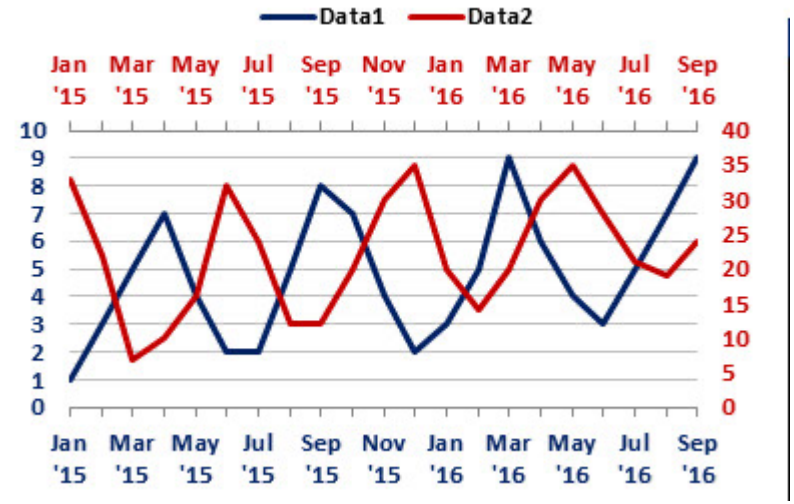
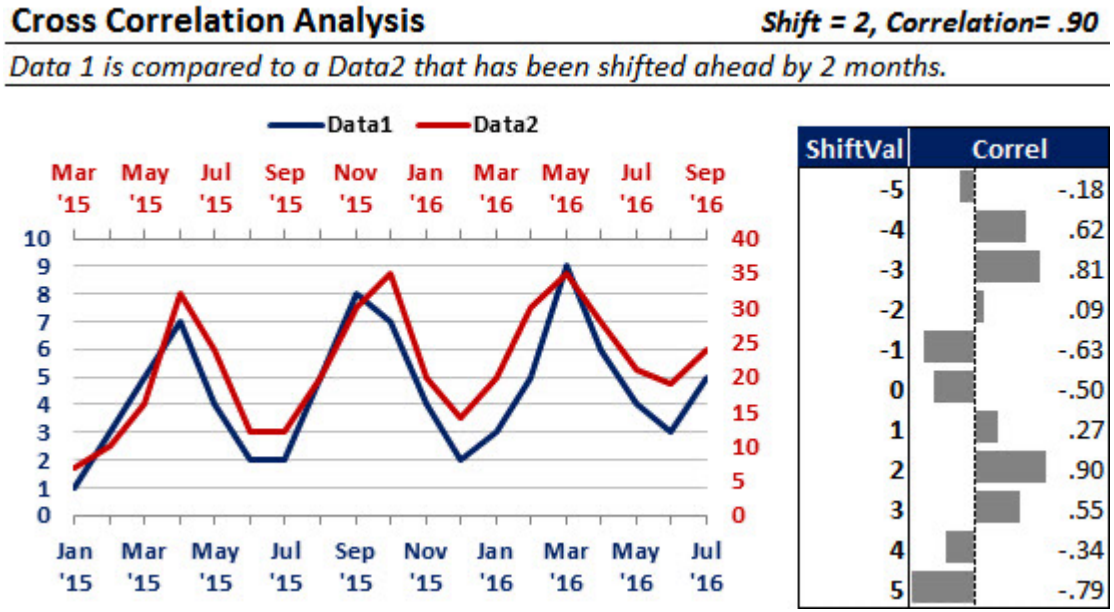
Considerations for Time Series Visualizations

- For leading/lagging indicators, can shift the time axes and offset the values so the alignment is more obvious

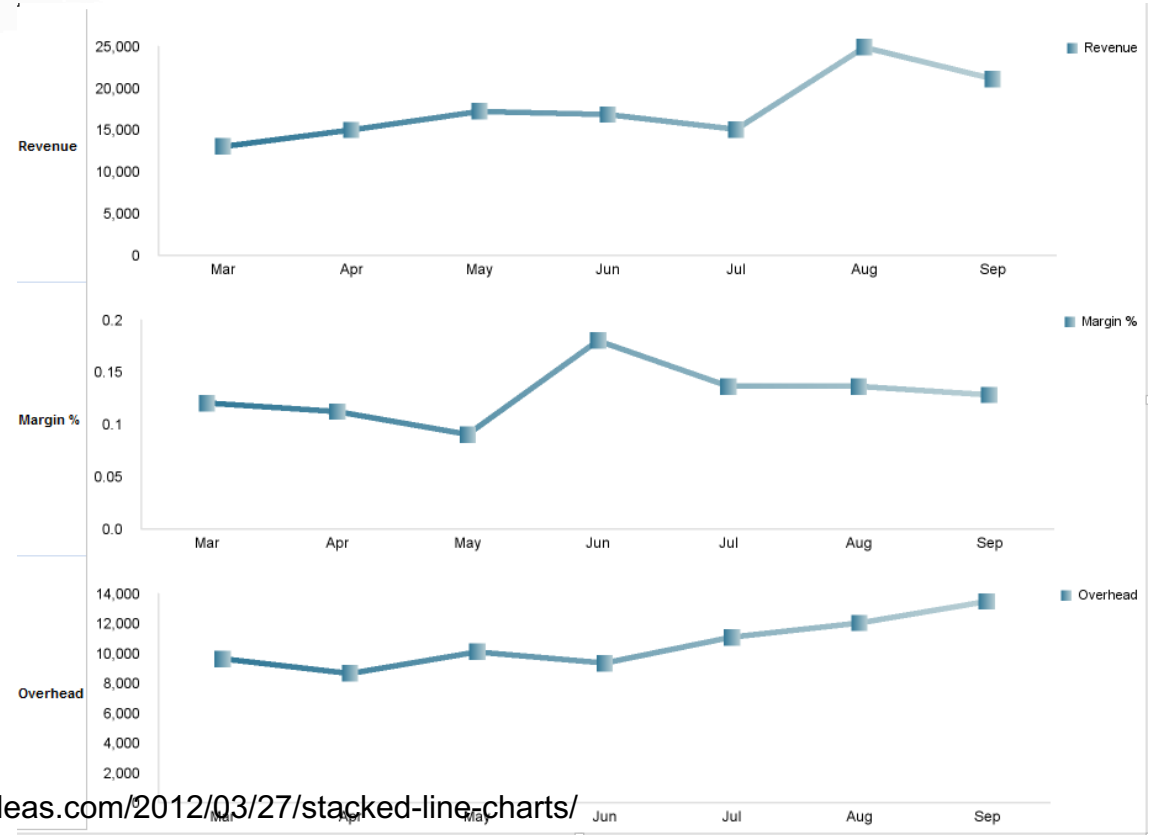




https://exceluser.com/1069/use-automated-cross-correlations-in-excel-to-find-leading-indicators-part-1/

Considerations for Time Series Visualizations

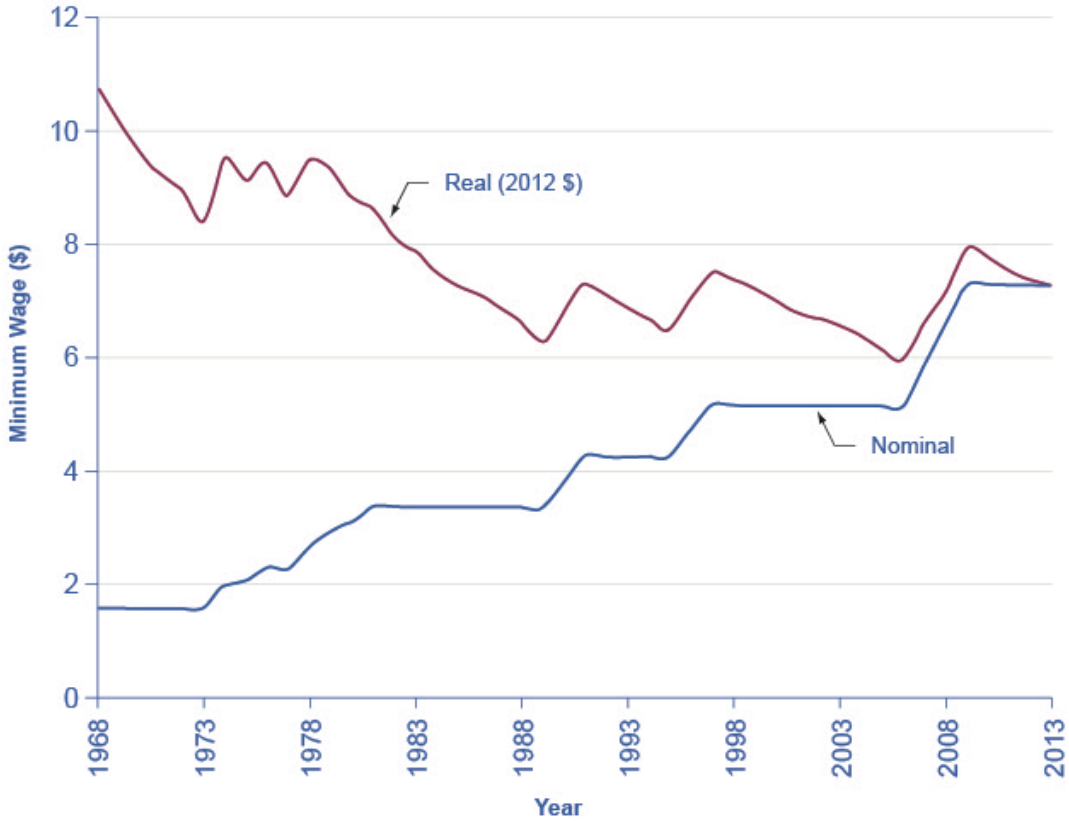
- If too many lines to draw on one graph, can stack graphs one above another so that all can be seen
  - Time axis still aligns among all of them



https://performance-ideas.com/2012/03/27/stacked-line-charts/

Considerations for Time Series Visualizations

- For visualizations involving money, often should account for inflation



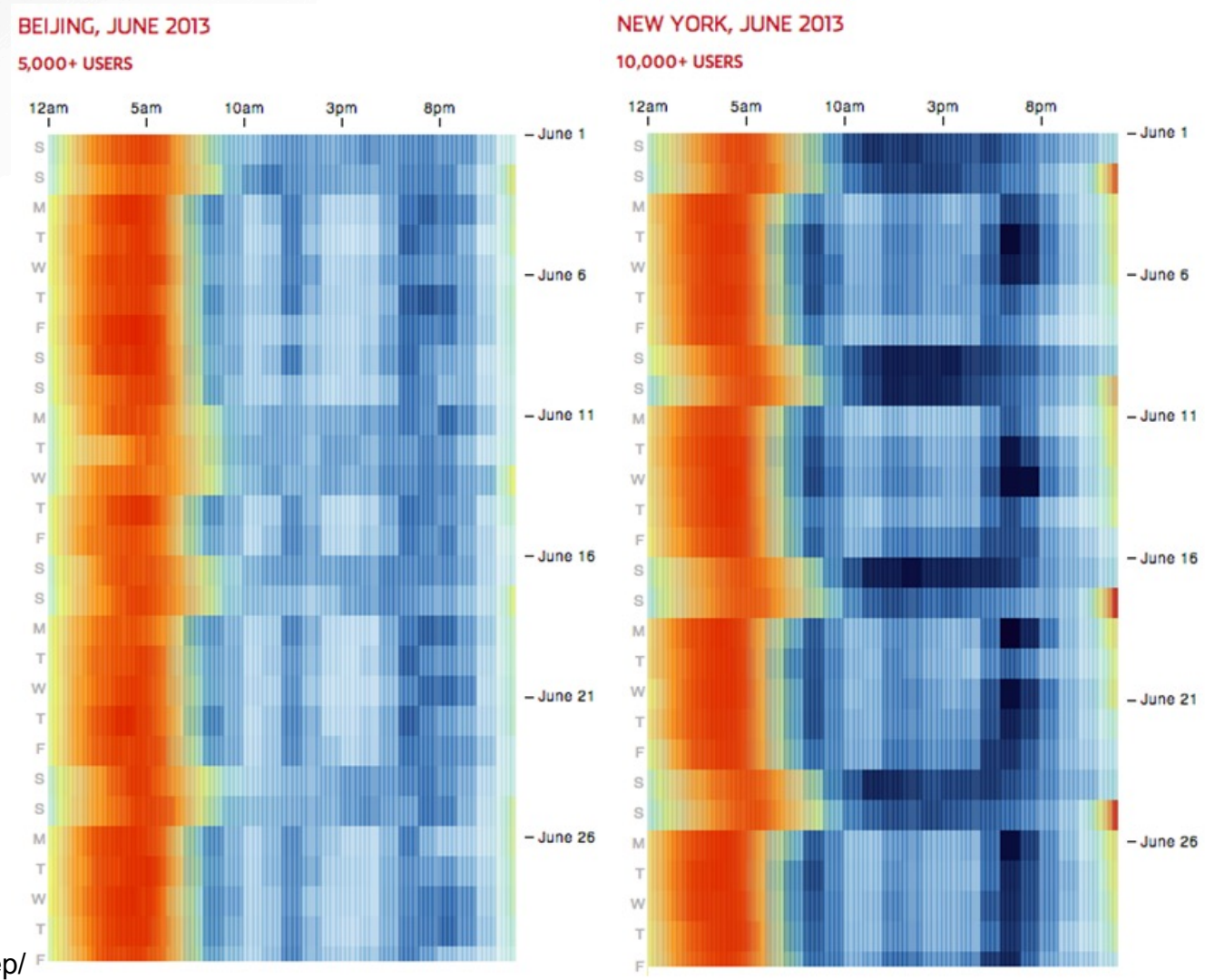
https://www.coursesidekick.com/economics/study-guides/openstax-macroecon/the-confusion-over-inflation

More Time Series Charts

- Other types of charts can be used to draw time series
  - Including specialized techniques that have been developed

Heat Map

- Heat map for cyclic time series
- Cycle on one axis, time on other

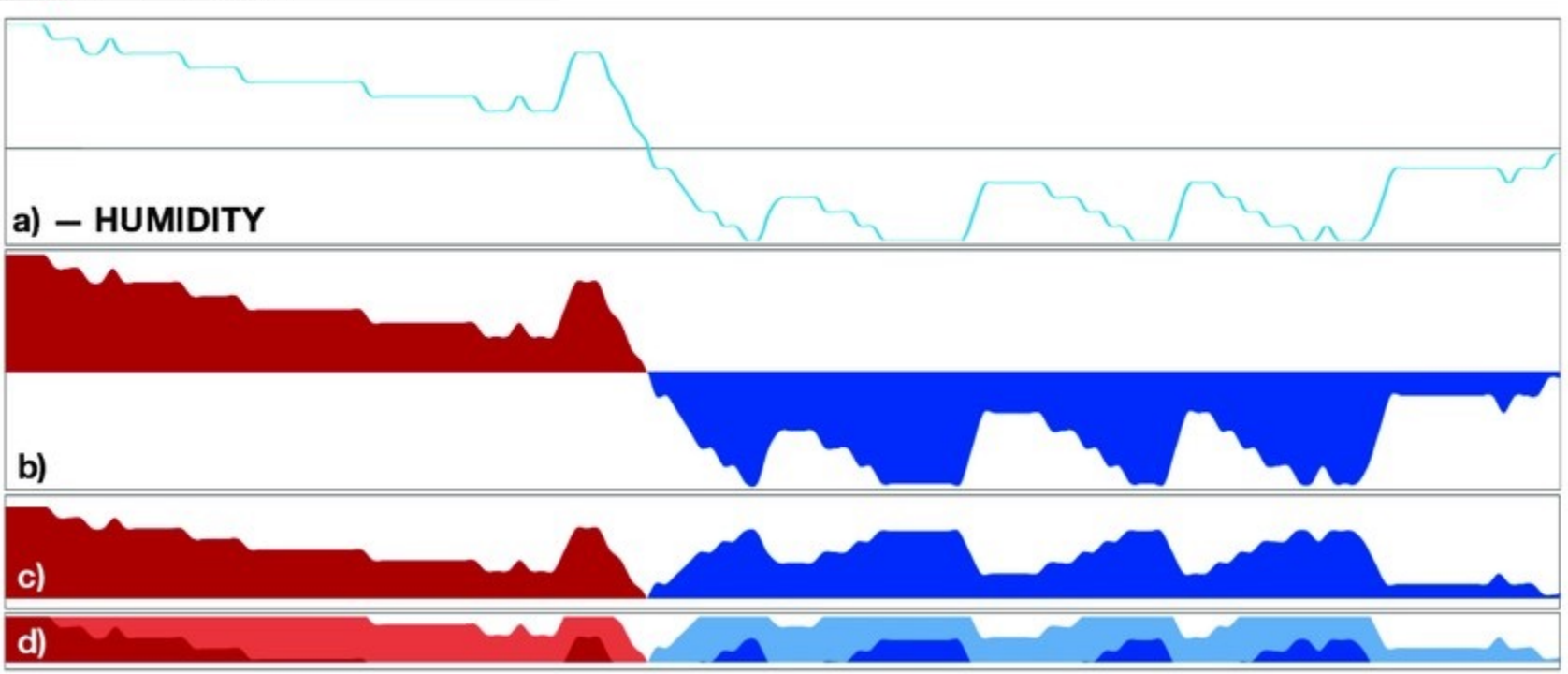


Taken from:
https://graphics.wsj.com/how-we-sleep/

Horizon Graph

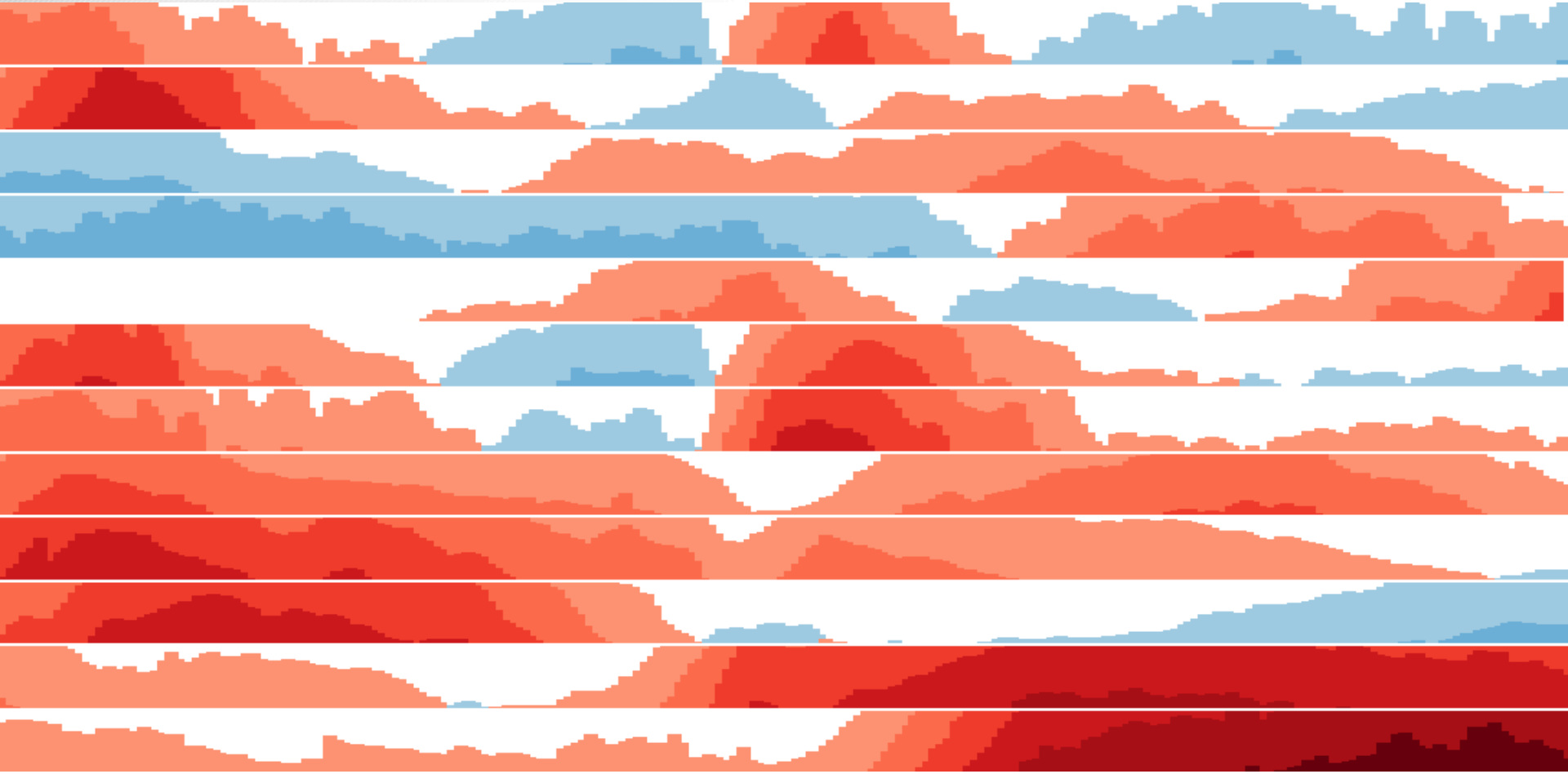
- Used to visualize many time series simultaneously
- Conceptual Process:
  - Draw graph of data
  - Fill positive blue, negative red (or vice versa)
  - Flip negative value so everything is above line
  - Divide vertical into bins of increasing saturation
    - Highest parts are most saturated
  - Draw each bin on same line
    - Most saturated in front

Horizon Graph Steps



Taken from:
https://www.researchgate.net/figure/Horizon-Plot-with-some-of-the-most-notable-features-extracted-from-the-ACC-and-BAR_fig7_301683665

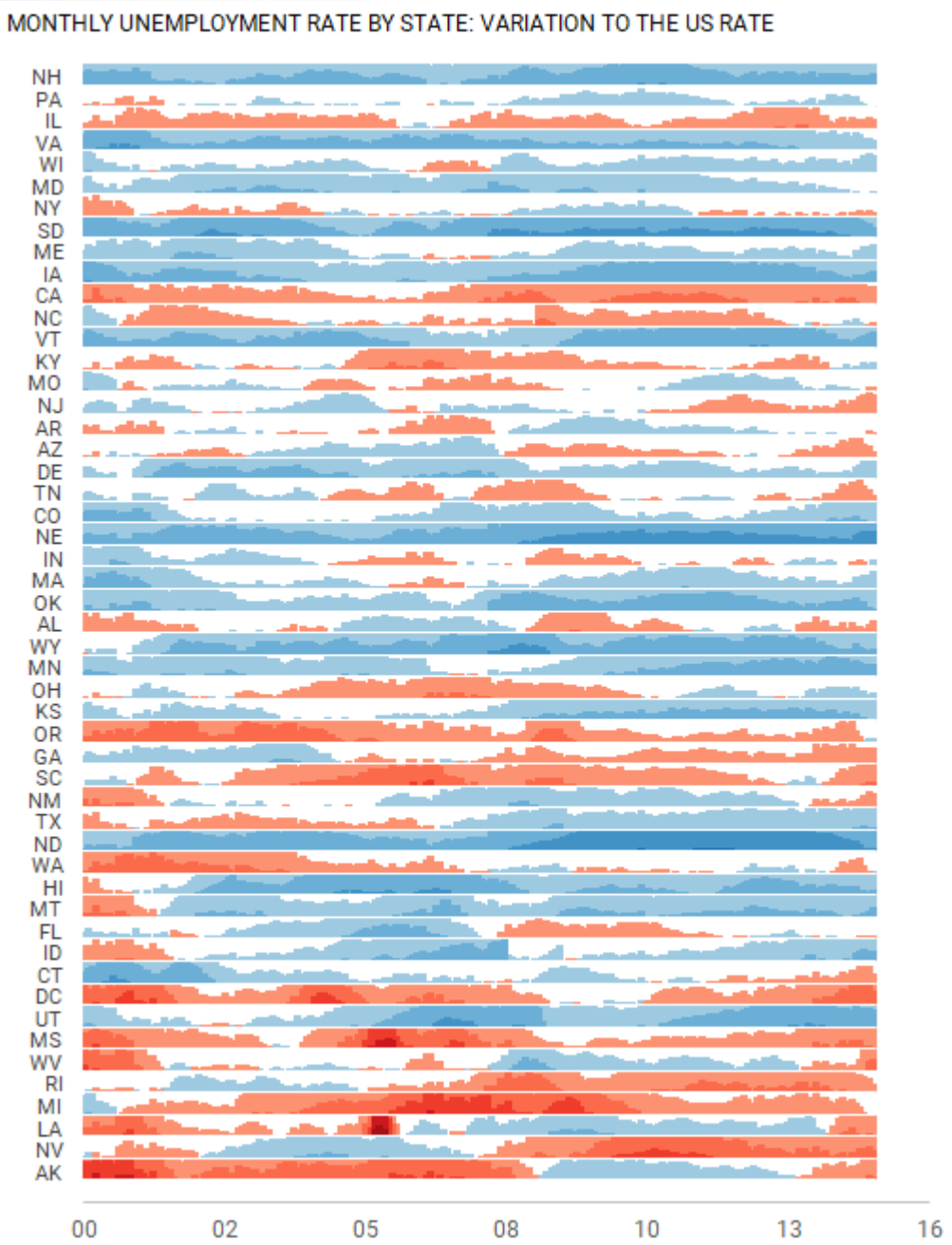
Horizon Graph



Taken from: https://excelcharts.com/horizon-charts-in-excel-bonus-file/

Horizon Graph

- Can display several time series at once
- Has been shown that people can learn to use these to compare large amounts of data well



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