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Best Practices for Scaling Sparklines in Dashboards

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Visual Business Intelligence Newsletter
October/November/December 2012

When Edward Tufte invented sparklines a few years ago and introduced them in his book *Beautiful Evidence*, he didn't have dashboards in mind as the primary venue for their use. I was writing my book *Information Dashboard Design* at the time, however, and immediately recognized their potential for performance monitoring displays. Measures of current activity require context, to be meaningful and useful. In general, no context is more useful than history—what has happened in the past leading up to the present. Sparklines provide a simple, abbreviated, space-efficient means of displaying historical time-series values. They are often ideal for dashboards.

In their raw form as originally introduced by Tufte, sparklines are primarily used to display patterns and trends of change through time. These are not the only characteristics of change through time, however, that are potentially useful on a dashboard. When designed in particular ways they may also display the following features:

- Magnitudes of values
- Magnitudes of change
- Rates of change
- Degree of variability

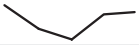
Not all of these features may be displayed simultaneously, however, because they require different design characteristics, especially related to the sparkline's quantitative scale. The quantitative scale of a sparkline, by definition, is never visible, but it exists nonetheless behind the scenes. The purpose of this article is to identify the different ways in which one or more sparklines may be scaled to reveal various features of change through time.

The quantitative range that should be associated with a sparkline hinges on the following factors:

- Whether the sparkline stands alone or is part of a series of sparklines
- Whether a particular range of values other than the range between the lowest and highest values in the sparkline should be featured to support the sparkline's use (e.g., the potential range of values, such as 0 through 10 for a 10-point customer satisfaction rating)
- When part of a series, whether the sparklines will be viewed independently or compared to one another
- When sparklines in a series are compared to one another, which of the following comparisons are required, if any, in addition to patterns and trends of change:
  - Magnitudes of values
  - Magnitudes of change
  - Rates of change
  - Degree of variability

Sparklines may be scaled for various purposes using any of the following methods:

1. Fill the vertical space by beginning with the lowest value of the sparkline at the bottom and ending at the highest value at the top.

Student Name	Assignment Scores	Avg Score
Frederick Chandler		65%
Roshawn Dawson		72%
James Martin		74%
Jaime Goss		84%
James Snow		94%
Holly Norton		98%

   Taking full advantage of the vertical space that's available for each sparkline provides the clearest possible view of patterns and trends through time. In their raw form, illustrated above, sparklines provide no information about magnitude (i.e., the actual values that are represented and differences between them). As such, the only comparisons that can be made among a series of sparklines involve patterns and trends. The same pattern or trend seen in two sparklines may represent significantly different values, magnitudes of change, degrees of variability, and rates of change.

2. Consistently display a quantitative range that is specifically useful for interpreting the values.

Region	Daily System Uptime	Avg System Uptime
North		98%
South		97%
East		99%
West		94%

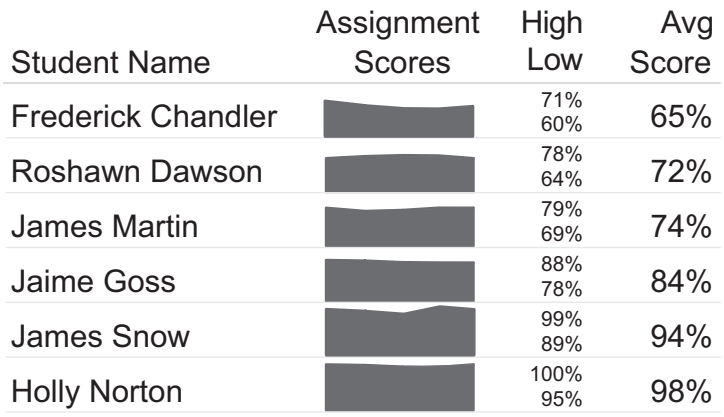
   In this case, because system uptime routinely falls within the 90-100% range, using this range provides a useful consistency from day to day rather than scaling from the lowest to highest values in the series, which in the case above would range from 94-99%, but would likely change from day to day. This method may be applied to a single sparkline or to a series, as illustrated above. In both cases, day-to-day consistency is potentially useful.

3. Maintain a consistent scale among a series of sparklines by beginning with the lowest value and ending with the highest value of the entire series.

Student Name	Assignment Scores	High Low	Avg Score
Frederick Chandler		71% 60%	65%
Roshawn Dawson		78% 64%	72%
James Martin		79% 69%	74%
Jaime Goss		88% 78%	84%
James Snow		99% 89%	94%
Holly Norton		100% 95%	98%

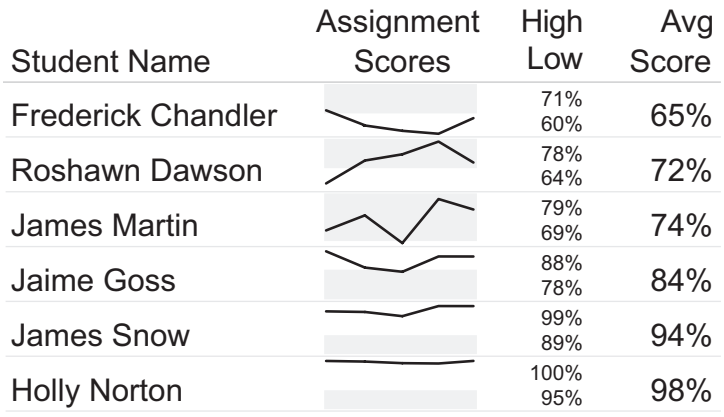
Because one assignment received the lowest possible score and one received the highest possible score, this scale ranges from 60-100%. Using a consistent scale makes it possible to see differences in magnitude. On the other hand, the large spread in values causes the lines to appear relatively flat, which obscures patterns of change.

4. Maintain a consistent scale among a series of sparklines by beginning with zero and ending with the highest value of the entire series.



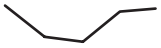
By beginning the scale at zero, the differences in the distance from the baseline (zero) to each data point along a sparkline accurately represents the differences in the values that they represent. Scaling a series of sparklines in this manner provides the best view for comparing the magnitudes of values among the entire series. Perceptually, this works best when those magnitudes are not only represented by the vertical positions of data points along the sparkline, but also by the height of the region between the baseline and the data points. By filling the regions with a color that makes it them easy to see, the reader's eyes are assisted in making height comparisons.

5. View all sparklines in relation to a particular sub-range of values that is significant (e.g., mid-spread or 1 standard deviation from the mean) by always including that sub-range but also independently scaling each sparkline to include its lowest and highest value.



The shaded band that appears with each sparkline in this case represents the range of scores that equals a "C" letter grade (70-79%). Notice that all but one of James Martin's scores falls within the C grade range, and therefore the gray band spans almost the entire height of the sparkline's plot area. Notice also that James Snow's and Holly Norton's scores are all well above the C range, which can be easily seen by the fact that the gray bands are relatively short and top out well below the sparklines. By including a common range in every sparkline, a rough sense of magnitude has been added, as well as an approximate means to compare magnitudes. Including this common range, however, causes some of the lines to appear flatter than we would ideally prefer when examining patterns of change, but the effect is less severe than that caused by using the same scale for all sparklines in the series.

6. Maintain a consistent spread (distance between the lowest and highest values) among a series of sparklines.

Student Name	Assignment Scores	High Low	Avg Score
Frederick Chandler		71% 60%	65%
Roshawn Dawson		78% 64%	72%
James Martin		79% 69%	74%
Jaime Goss		88% 78%	84%
James Snow		99% 89%	94%
Holly Norton		100% 95%	98%

Because the largest spread from the lowest to the highest value in any one sparkline is 14% in this case (Roshawn Dawson), each sparkline is scaled to span a 14% range. A consistent spread, despite the fact that the scales begin and end with different values, makes it possible to compare slopes along different lines and provides a means to compare magnitudes of change. Notice that the sparklines for James Martin and James Snow appear to have nearly identical magnitudes of change across the five-value series spanning 10% points in total, yet one ranged from 69-79% and the other from 89-99%. Scaling in this manner provides the means to compare magnitudes of change, but sacrifices the ability to compare the magnitudes of the values themselves.

7. Display sparklines scaled logarithmically rather than linearly.

Student Name	Assignment Scores	High Low	Avg Score
Frederick Chandler		71% 60%	65%
Roshawn Dawson		78% 64%	72%
James Martin		79% 69%	74%
Jaime Goss		88% 78%	84%
James Snow		99% 89%	94%
Holly Norton		100% 95%	98%

I recommend using a logarithmic scale in a series of sparklines for two purposes only: to compare rates of change and degrees of variability. With a log scale, equal slopes along the lines represent equal rates of change. A line that exhibits greater variation in the vertical positions of its values than another represents greater variability. No other characteristics of change through time, however, can be accurately discerned using a log scale.

Based on what we've seen in the examples and descriptions above, the following conditions should determine which method to use when scaling sparklines:

- For sparklines that function independently, or are part of a series but are nevertheless read independently, use method 1 or 2.
- For a series of sparklines, when only patterns and trends of change must be compared, use method 1.
- For a series of sparklines, when the magnitudes of values must be compared, use method 3, 4, or 5.

- For a series of sparklines, when only the magnitudes of change and degrees of variability must be compared, use method 6.
- For a series of sparklines, when rates of change must be compared, use method 7.

It is important to keep in mind that no one scaling method can support all of the ways that someone might need to view and compare time series values. In a particular dashboard, for a particular sparkline or series of sparklines, choose the scaling method that best fits the primary uses of the data.

In cases when all of the user's primary requirements cannot be supported by a particular scaling method, alternate methods may be provided as well. It is best, however, to provide alternate scaling methods in a way that only shifts the display temporarily when needed and then automatically shifts back to the default method. Allowing a user-selectable choice of scaling methods via a series of radio button controls is not ideal because the user can easily forget that an alternate scaling method has been invoked and remains in effect, resulting in misinterpretations of the data. A better approach would involve a shift in the scaling method only while a control is temporarily invoked, such as by holding down a mouse button, which shifts back to the default scaling method when the button is released, or by hovering over a control to invoke the alternate display, which then shifts back to the default display when the mouse is moved from that hover position.

Whenever you include sparklines on a dashboard, you must teach people how to use them. Explaining how the sparklines are scaled and how that scaling affects their use—the features of change through time that they reveal and the comparisons that they support—is imperative. You cannot leave it to users to figure this out on their own.

The sparkline scaling methods that I've proposed in this article are derived from principles of graphical perception. They have not been subjected to usability studies, however, or refined through experience. I fully expect that these scaling practices will evolve through further study and actual use and invite you to contribute your observations to support this process.

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About the Author

Stephen Few has worked for over 25 years as an IT innovator, consultant, and teacher. Today, as Principal of the consultancy Perceptual Edge, Stephen focuses on data visualization for analyzing and communicating quantitative business information. He provides training and consulting services, writes the quarterly *Visual Business Intelligence Newsletter*, and speaks frequently at conferences. He is the author of three books: *Show Me the Numbers: Designing Tables and Graphs to Enlighten*, Second Edition, *Information Dashboard Design: The Effective Visual Communication of Data*, and *Now You See It: Simple Visualization Techniques for Quantitative Analysis*. You can learn more about Stephen's work and access an entire library of articles at www.perceptualedge.com. Between articles, you can read Stephen's thoughts on the industry in his blog.