perceptual edge

Displaying Change Between Two Points in Time

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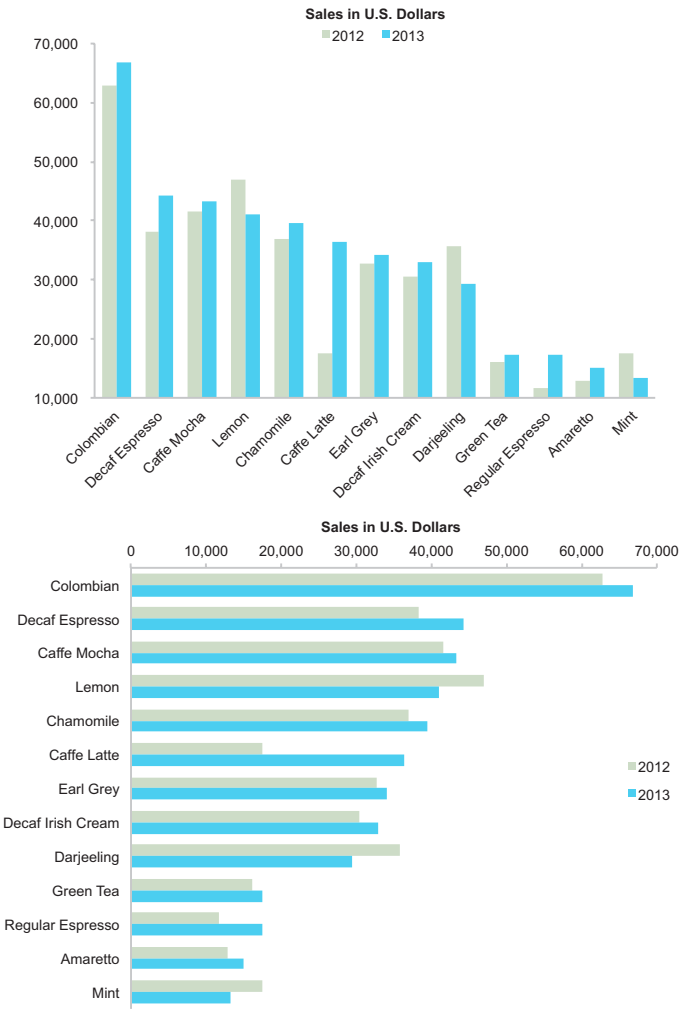
On occasion it is useful to present data that features change between two points in time (e.g., between this year and last year, this quarter and last quarter, this month and last month, and so on). Sometimes this is done in ways that are misleading. For example, viewing change in sales from one day to the next without a series of many days to reveal the nature of routine variation could lead to unnecessary fire drills and even employee terminations in reaction to random variation. When it is appropriate to display two points in time only, however, this can be done using one or more of three specific graphical approaches:

1. A line graph with a line for each time series
2. A range bar graph that begins each time series at the first value and ends at the second value
3. A bar graph that directly displays the difference between the first and second values in each time series

People often use the approach illustrated in the two bar graphs below, but this is of limited use. The only thing we can easily do with this approach is compare the two points in time for one item at a time, such as for Colombian coffee. For all other uses of the data, the approaches that I've listed above are more effective.



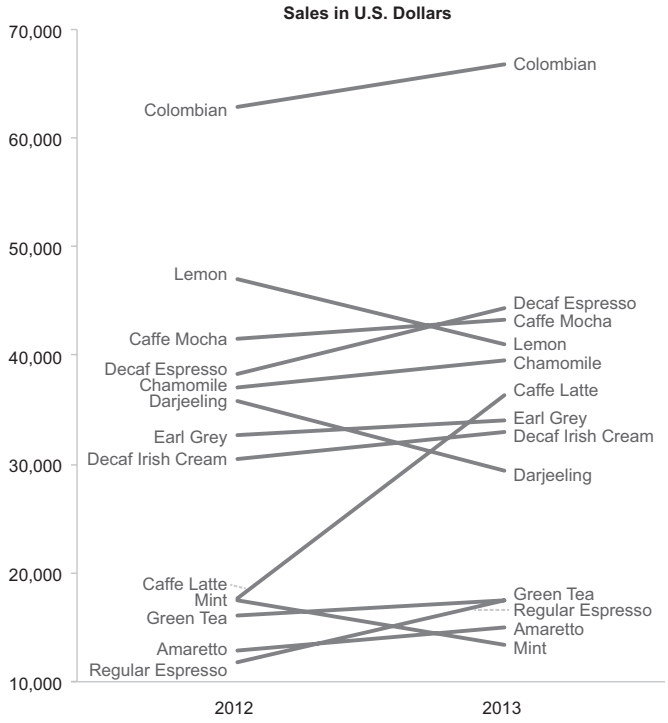
In addition to this simple comparison, there are many other qualities that we need graphs of this type to exhibit. In particular, we want them to make it easy to perform each of the following tasks:

- Compare magnitudes of change
- Compare directions of change
- Compare values of multiple time series at the same point in time
- Compare rates of change
- Spot changes in rank

Let's take a look at each of the three effective approaches that I listed above to see which of these tasks they support.

Line Graph

When a line graph includes two points in time only, it is sometimes called a *slope graph*. Here's the same time series that appear in the bar graphs above, this time displayed as lines:



I could have assigned a different color to each line, but this fails to clearly distinguish the lines beyond about 10 colors or so, and by labeling the lines directly as I have, different colors aren't necessary. This approach has the following major strengths:

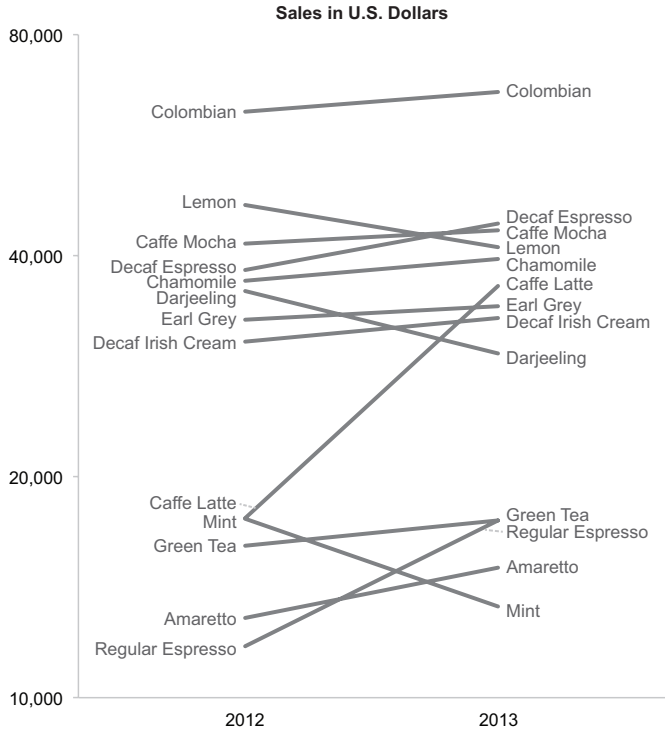
- Easy to compare values at the same point in time
- Easy to spot changes in rank (revealed by line crossings)

It also has the following minor strengths:

- Easy to compare magnitudes of change (slopes of the lines)
- Easy to compare directions of change (upwards vs. downwards slopes)

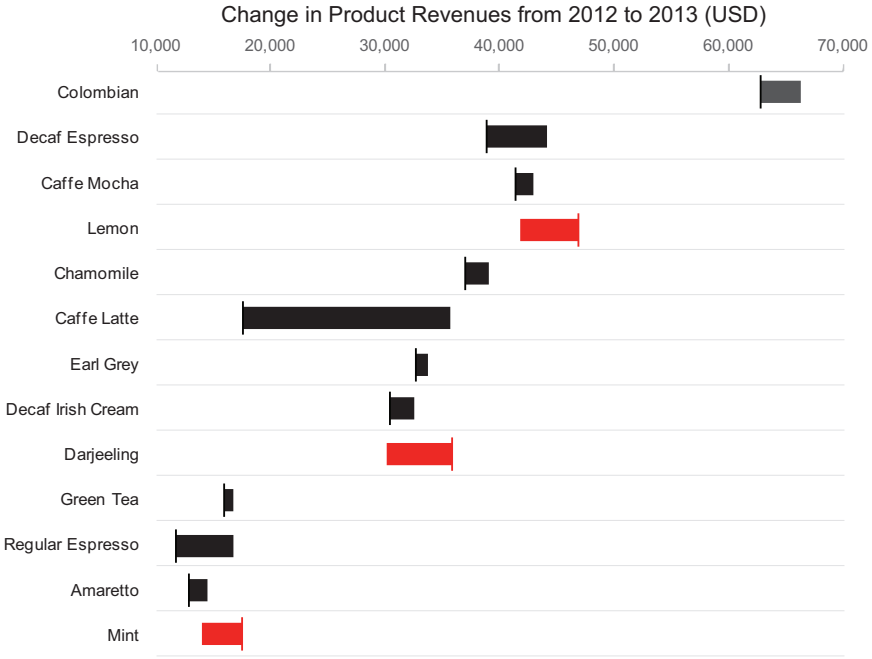
By changing from a linear to a logarithmic scale, line graphs provide an easy way to compare rates of change. With a logarithmic scale, lines of equal slopes represent equal rates of change. In the next example, by comparing the slopes of the lines we can see that Colombian, Chamomile, Decaf Irish Cream, and Green Tea

increased in sales at nearly the same rate and that Darjeeling and Mint decreased at similar rates, slightly more than Lemon.



Range Bar Graph

The following example, using range bars, features the amount of change as bar lengths, as well as the beginning and ending values as the left and right ends of the bars. By using different colors for increases (black) and decreases (red), it also features the direction of change.



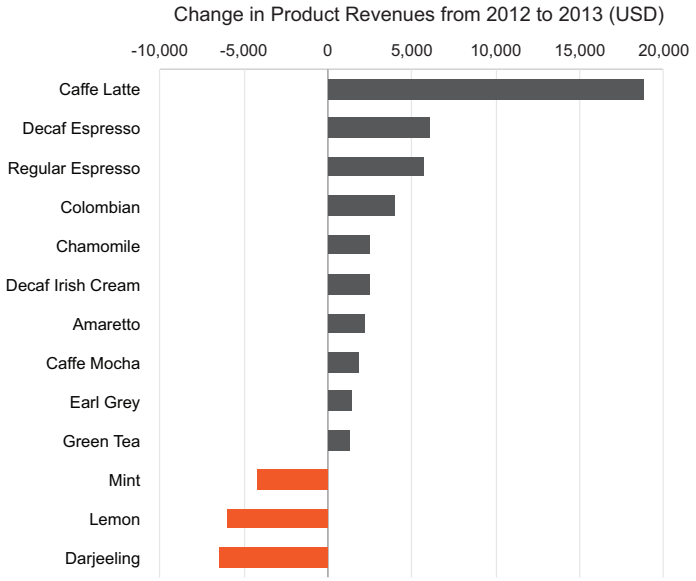
Although it certainly isn't necessary, I've further delineated the direction of change by adding a short vertical line that functions as a base of sorts to identify the starting value. Range bars used for this purpose can be

designed in a number of different ways to show the range and direction of change.

I used this approach for the first time several years ago when doing some work for UNESCO. At the time, I hadn't seen change between two points in time displayed in this way, but came up with the approach to solve a particular problem. Since then, I have learned that others had used this design before me. This approach does a reasonably good job of supporting two tasks simultaneously—comparing the magnitudes of values and magnitudes of change—although it does not support these tasks individually as well as some of the other approaches.

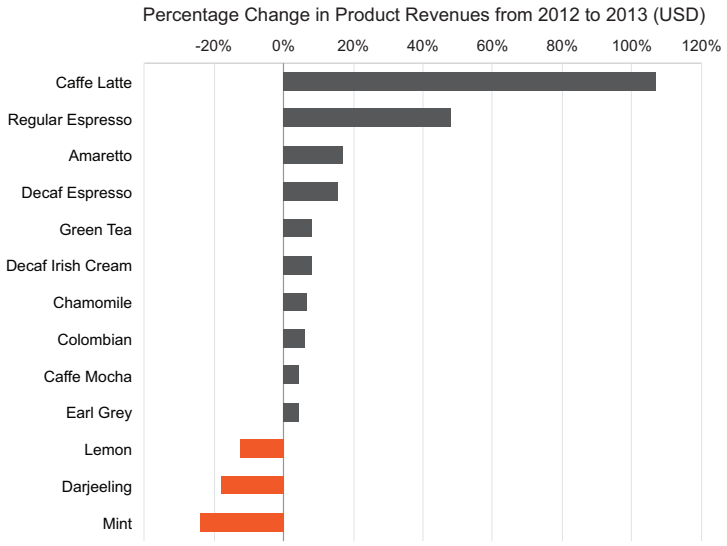
Deviation Bar Graph

A bar graph that displays the amount or degree of change directly supports some tasks best. Notice what you can do with the example below that would be more difficult using any other approach.



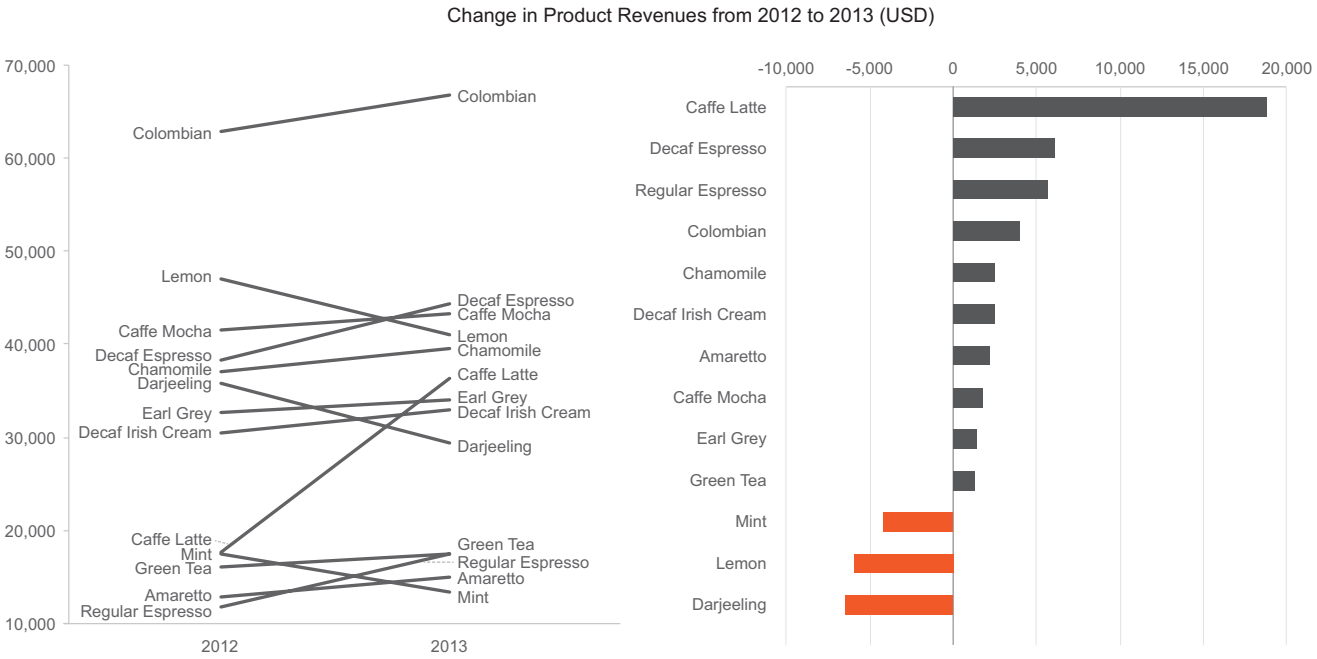
With this approach, we've lost sight of the actual values, but by displaying the amount of change directly, either positive or negative, we can see the direction of change and compare amounts of change more easily and accurately than with any other approach.

When we want to see and compare degrees of change (i.e., percentage change) rather than amounts of change, the same approach can be used, as follows:

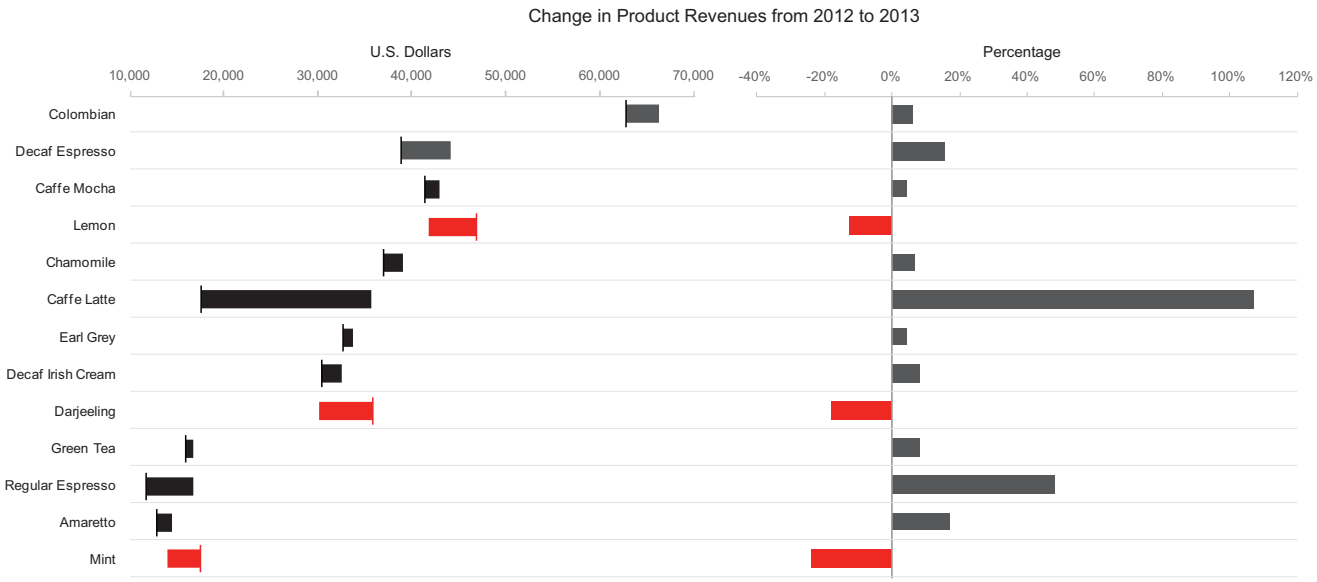


Combinations of Graphs for Richer Views

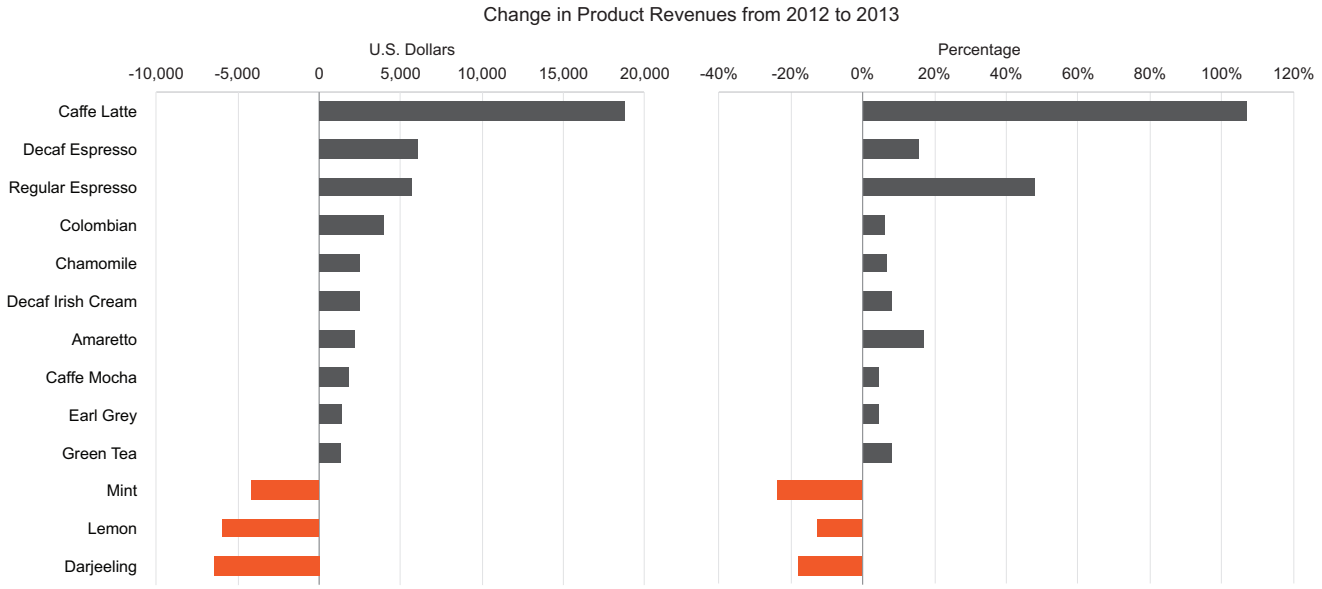
The best solution often involves multiple graphs, each best enabling different tasks. In the example below, I've combined a slope graph and a deviation bar graph. The slope graph primarily makes it possible to compare the values associated with products in either of the years with ease and to see changes in rank, and it secondarily allows us to see and compare the directions and amounts of change. The deviation bar graph on the right primarily makes it easier to see the rank order of products based on the amount of change from highest to lowest. It also makes it easy to compare amounts of change more precisely than we can do comparing the slopes of the lines in the other graph. For example, looking at the slope graph alone, we might be tempted to think that Caffe Mocha and Chamomile changed by almost exactly the same amount because the slopes of their lines are similar, but the deviation bar graph reveals that Caffe Mocha increased by a lesser amount, whereas Chamomile and Decaf Irish Cream increased by precisely the same amount.



In the next example below, I've combined a range bar graph and a deviation bar graph that displays percentage change. They complement one another, each bringing different benefits.



In the final example below, I've combined two deviation bar graphs: one that displays the amount of change and another that displays percentage change. The unranked order of the bars in the right-hand graph drives home the fact that amount (dollars) and degree (percentage) of change are different.



In some cases we might want to show three side-by-side graphs, such as a slope graph combined with both deviation bar graphs above. The point is to understand what people need to see in the data and do with the data and then give them a display consisting of one or more graphs to support their needs.

I'll conclude this article by summarizing the primary points that I've made. The following table rates the strengths of each individual approach:

Feature	Line Graph	Range Bar Graph	Deviation Bar Graph
Easy to compare magnitudes of change	Good	Satisfactory	Excellent
Easy to compare directions of change	Good	Excellent	Excellent
Easy to compare values at the same point in time	Excellent	Good	N/A
Easy to compare rates of change	Good [1]	Poor	Excellent [2]
Easy to spot changes in rank	Excellent	Satisfactory	N/A

[1] Quantitative scale must be switched from linear to logarithmic
[2] Quantitative scale must directly express the rate of change

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About the Author

Stephen Few has worked for nearly 30 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: Displaying Data for at-a-Glance Monitoring*, Second Edition, 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.