

# CS 867: Displaying Multiple Time Series

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## 1 Introduction

Time-oriented data might be one of the most common forms of data, used in numerous fields such as medicine, economics, ecology, engineering, and meteorology. Typically, time series are visualized using line charts, which appear frequently in newspapers, textbooks, and academic papers. However, it can be difficult to display many concurrent time series at once in an understandable manner using a line chart. Therefore, we have introduced a new visualization technique called a stack graph, which we propose may be suitable for showing many time series—i.e., fifteen—at once. To test the merits of our creation, we have evaluated the stacked graph against two existing methods—small multiples and horizon graphs.

### 1.1 Background

Since it was first introduced by William Playfair in 1786 [2], the line chart has been a popular choice for displaying temporal data. However, it has its limitations when it comes to multiple time series. To be plotted on a single chart, each time series must be distinctly colored and/or patterned; as the number of time series increases, it becomes more difficult to make each series visually distinct. Even if each time series are designed uniquely, it may be difficult to distinguish two time series which overlap frequently.

Recognizing the limitations of the line chart for many time series leads to a question: what is a suitable alternative? Javed et al. set out to answer this

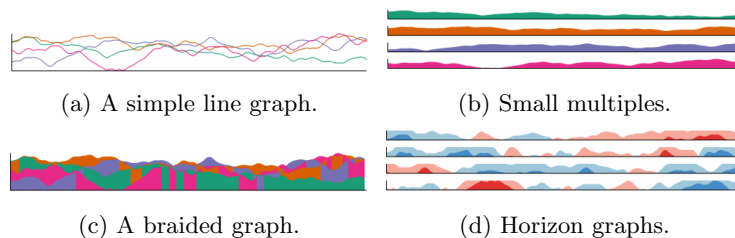


Figure 1: Four possible methods for visualizing multiple time series [1].

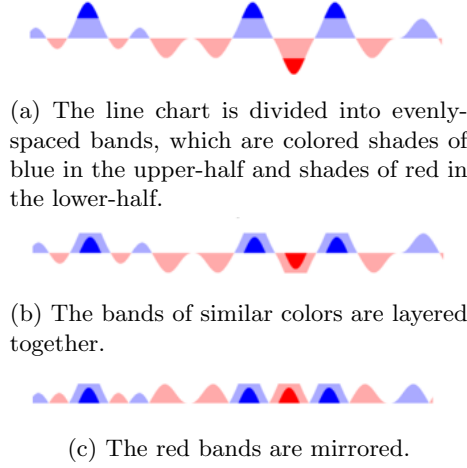


Figure 2: Four possible methods for visualizing multiple time series [1].

question with their evaluation that compared the line chart, as in Figure 1a, with three alternative techniques [1]. The first alternative, called “small multiples” simply places each time series on its own line chart, shown in Figure 1b. The screen space must be split with this approach, which leads to less resolution in the vertical direction. Therefore, Javed et al. introduced a shared space approach called the “braided graph” seen in Figure 1c, which attempts to be easier to read than a line chart by coloring the areas underneath the curves. Additionally, Saito et al.’s horizon graph, as in Figure 1d, was included in the evaluation [3].

Saito et al. designed horizon graphs to increase the amount of data that can be displayed without increasing graph size [3]. To construct a horizon graph, some “mid-line” must be defined; it could represent zero or it could be the average of the global minimum and global maximum values in the dataset. The areas between the mid-line and the data values are filled in, as in Figure 2a, with blue for areas above the mid-line and red for areas below the mid-line. The data is then further divided into evenly spaced bands, with the color of the band darkening as distance from the mid-line increases. Next, these bands are offset to align with the mid-line, as in Figure 2b. Finally, the red bands are mirrored. The result is the vertical resolution can be increased by a factor of four, as in Figure 2, or even more if more bands are used.

Javed et al. evaluated these four techniques illustrated in Figure 1 by having participants complete three tasks on randomly-generated data:

1. **Maximum:** for a given time point, identify the time series with the highest value
2. **Slope:** for the entire time period, find the time series with the highest increase

3. **Discrimination:** at a time point specific to each series, determine which series has the highest values

In addition to chart type, their study varied the number of time series (2, 4, and 8) and the total chart height (48, 96, and 192 pixels). They found that the simple line chart and the braided graph were best suited for the maximum task, while the small multiples and horizon graphs were better for the slope and discrimination tasks. In general, they concluded that simple line charts and small multiples were generally more robust than horizon graphs and their newly introduced braided graphs. Additionally, they found that decreases in chart size did not affect completion time, but did decrease accuracy. Lastly, as the number of concurrent time series increased, accuracy decreased and completion time increased.

## 7 References

- [1] Waqas Javed, Bryan McDonnel, and Niklas Elmqvist. Graphical perception of multiple time series. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):927–934, November 2010.
- [2] William Playfair. *The Commerical 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*. 1786.
- [3] Takafumi Saito, Hiroko Nakamura Miyamura, Mitsuyoshi Yamamoto, Hiroki Saito, Yuka Hoshiya, and Takumi Kaseda. Two-tone pseudo coloring: Compact visualization for one-dimensional data. *IEEE Symposium on Information Visualization*, 0:23, 2005.