How to Avoid Some Common Graphical Mistakes

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Summary of Session

1. Understand human perception and our ability to decode graphs
2. Avoid misleading your audience
3. Make the data stand out
4. Eliminate problems with tick marks and labels
5. Use color properly
6. Learn two useful graphical methods

Understand Human Perception and Our Ability to Decode Graphs

7. The angles of the wedges of pie charts are difficult to judge. Dot plots are much clearer.
8. It is difficult to judge lengths that do not have a common baseline.

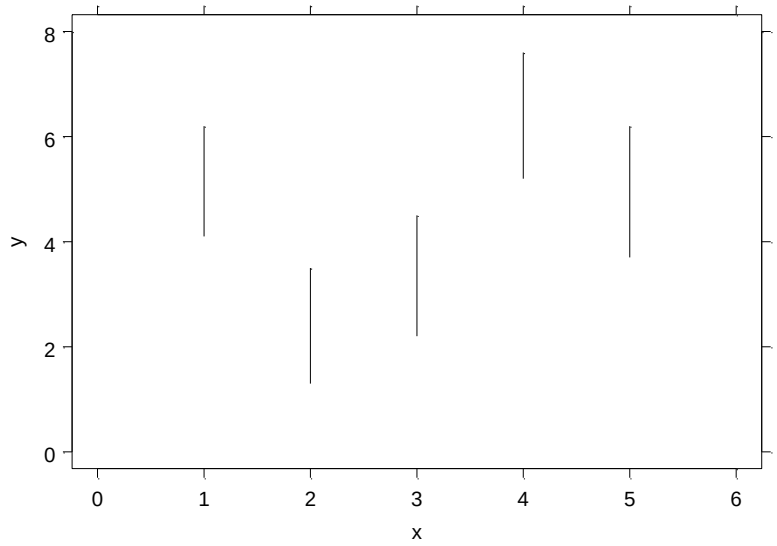


Figure 1. It is difficult to compare lengths without a common baseline. The percentage increase in length matters more than the absolute increase when detecting differences in length.

9. We judge position along a common scale and position along identical, non-aligned scales more accurately than other judgments in decoding information from graphs.
10. Cleveland's hierarchy of tasks ordered by our ability to perform accurate judgments:
    1. Position along a common scale
    2. Position along identical, nonaligned scales
    3. Length
    4. Angle - Slope
    5. Area
    6. Volume
    7. Color hue - Color saturation – Density

11. Distance - The closer together objects are, the easier it is to judge attributes comparing them. As distance between the objects increases, accuracy of judgments decrease.
12. Detection - Before we can perform any of the elementary tasks, we must be able to detect the data. We often cannot if data points overlap or are hidden in the axes or tick marks.
13. Creating a more effective graph involves choosing a graphical construction where the visual decoding uses tasks as high as possible on the ordered list of elementary graphical tasks while balancing this ordering with distance and detection.

Avoid Misleading Your Audience

14. Do not use evenly spaced tick marks for uneven intervals or unevenly spaced tick marks for the same intervals on a linear scale. In Excel, an XY chart will scale properly.
15. Groups of charts should have consistent scales, colors, and other graphical elements.
16. All bar graphs require a zero baseline. Dot plots do not.
17. Draw the data to scale.

17a. If used at all, pie charts should only be used to show parts of a whole.

Make the Data Stand Out

18. Deemphasize non-data elements.
19. Label the axes to avoid repeating dollar signs and percent signs on all tick marks or data points.
20. Too many decimal places distract the reader as do too many trailing zeros.
21. Avoid putting extra dimensions in your charts. The pseudo three-dimensional charts are difficult to read. If you know categories and values for each category, a two-dimensional chart will be clearer than a pseudo three-dimensional one.

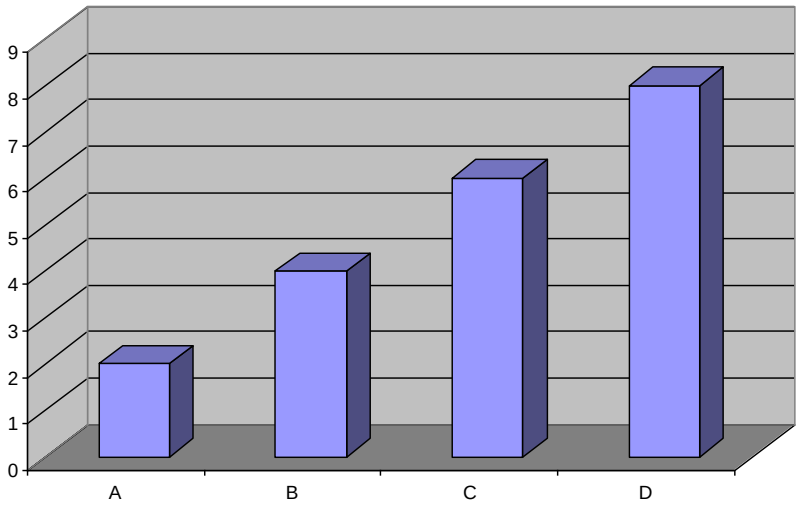


Figure 2. Pseudo 3D bar charts are difficult to read.

22. Data labels don't help; they confuse the reader even more.
23. True three-dimensional charts are even more difficult to read.
24. Make grid lines barely perceptible.

Eliminate Problems with Tick Marks and Labels

25. Do not overdo the number of tick marks or tick mark labels.
26. Tick marks should be at sensible values.
27. Axes, tick mark labels and data should not interfere with one another. To move the horizontal axis in Excel, you need to click on the vertical axis.
28. Proofread graphs. Do all digits of your labels show?
29. Check that the labels point to the correct data.

Avoid misusing color

30. Color should have meaning.
31. Consider those with color vision deficiencies. See vischeck link om page 4.
32. Avoid gradient backgrounds.

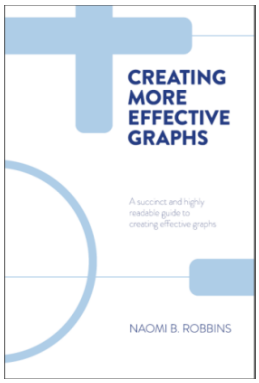
Figure 3. Avoid gradient backgrounds.

33. Use an appropriate color scheme.

Learn Two Useful Graphical Methods

34. Dot plots allow us to decode the data by making judgments of positions along the common horizontal scale. William Cleveland and his colleagues introduced dot plots after running experiments that showed that this is the most accurate of the elementary graphical tasks.
35. Dot plots get less cluttered than bar charts.
36. Error bars show up better on dot plots than on bar charts.
37. Dot plots are better suited for logarithmic scales than bar charts.
38. Trellis plots are useful when you have more than two variables. In a trellis plot you hold one or more variables constant while you plot the remaining variables.
39. Trellis plots are similar to Tufte's small multiples. However, Trellis plots have more structure since the default ordering is by size.

The options you use in everyday graphics software determine whether you communicate with or confuse your audience. Choose them carefully, striving for clarity and conciseness.



Recommended Reading

Cleveland, William S. 1994. *The Elements of Graphing Data Revised edition.* Hobart Press, Summit, NJ. (#10 on the numbered list comes from the original 1985 edition.)

Robbins, Joyce and Naomi B. Robbins. 2010. "Quantitative Literacy across the Curriculum: Improving Graphs in College Textbooks", February 2010 issue of http://www.perceptualedge.com/library.php#Articles.

Robbins, Naomi B. and Joyce Robbins. 2016. "*Effective Graphs with Microsoft R Open*"

Robbins, Naomi B. 2006. "Dot Plots: A Useful Alternative to Bar Charts," http://www.b-eye-network.com/view/2468

Robbins, Naomi B. 2013. *Creating More Effective Graphs*, Chart House, Ramsey, NJ (Reprinted from Wiley (2005))

Tufte, Edward. 2001. *The Visual Display of Quantitative Information.* Graphics Press, Cheshire, CT.

Useful Web Sites

- ***http://www.nbr-graphs.com/resources/other-resources/***
- ***http://www.peltiertech.com***
- ***http://www.vischeck.com***

About the Presenter

Naomi B. Robbins is a consultant and seminar leader who specializes in the graphical display of data. She offers keynotes, short courses and workshops to train employees of corporations and organizations on the effective presentation of data. She also reviews documents and presentations for clients, suggesting improvements or alternative presentations as appropriate. She is the author of *Creating More Effective Graphs*, published by Chart House (2013). Dr. Robbins has been the keynote speaker at international conventions and has spoken on graphs to universities, professional societies, corporations, and non-profits. She received her Ph.D. in mathematical statistics from Columbia University, M.A. from Cornell University, and A.B. from Bryn Mawr College. She had a long career at Bell Laboratories before forming NBR, her consulting practice. Naomi was chair of the Statistical Graphics Section of the American Statistical Association and is the organizer of the Data Visualization New York Meetup.