Data Visualization and the Elements of Design

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Data visualization is about effective visual communication. In essence, data visualizations are visual essays that aim to make abstract data comprehendible and visually engaging so that viewers are able to easily "read" the information and make inferences.[1] Unlike a textual essay, a data visualization relies primarily on visual means to convey meaning through its design and expressive elements. As Nathan Yau points out, when you visualize data, you represent it with a mixture of "visual cues," which are scaled, coloured, and positioned according to values.[2] Yau further delineates these cues as position, length, angle, direction, shapes, area, volume, colour saturation and colour hue.[3] Becoming familiar with how different visual cues work together to create meaning will help you choose the most suitable visual forms to represent your data.

Mapping data onto geometry and color works because the brain innately seeks out patterns. However, as Isabel Meirelles maintains representing "multidimensional information in two-dimensional visual displays is not trivial," and the process of design calls for both analytical and visual/spatial ways of reasoning.[4] Effective visual design of information and data is therefore important for "increasing perceptibility" and also for "revealing the patterns within complex information."[5] Though an important factor in data visualization, aesthetic appeal must not overshadow the fundamental story being told. In practical terms, Yau argues that you must ensure that "the essence of the data isn't lost in that back and forth between visual and the value it represents because if you can't map back to the data, the visualization is just a bunch of shapes."[6] It is necessary to always be mindful of the audience and consider the limitations and the strengths of the visual elements employed. For example, never assume a universal meaning for visual cues that, in fact, often have cultural biases, and also that not everyone perceives colour the same way. Below is a selection of texts available at Carleton that explore the elements of design in data visualizations and suggest guidelines and methods for the effective graphic representation of data.

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[1] Randy Krum (2016, April 15) The Truthful Art by Alberto Cairo: Interview & Giveaway, retrieved from http://www.coolinfographics.com/blog/2016/4/15/the-truthful-art-by-alberto-cairo-interview-giveaway.html.
[2] Nathan Yau, *Data Points: Visualization that Means Something* (Indianapolis, IN: John Wiley and Sons; Norwood, MA: Books24x7.com), 2013, available at http://catalogue.library.carleton.ca/record=b3506923
[3] Yau, "Chapter 3: Representing Data: Visualization Components," in *Data Points.*
[4] Isabelle Meirelles, *Design for Information: An Introduction to the Histories, Theories, and Best Practices Behind Effective Information Visualizations* (Beverly, MA: Rockport Publishers), 9.
[5] Banu Inanc Uyan Dur, "Data Visualization and Infographics in Visual Communication Design Education at the Age of Information," *Journal of Arts and Humanities* (JAH) 3, no. 5 (2014), 39.
[6] Yau, "Chapter 3: Representing Data: Visualization Components," in *Data Points.*

Introductory texts on methods of data visualization:

Börner, Katy, and David E. Polley. *Visual Insights: A Practical Guide to Making Sense of Data*. Cambridge, MA: The MIT Press; Norwood, MA: Books24x7.com, 2014. Available at http://catalogue.library.carleton.ca/record=b3817679

- Appropriate for beginners, this text is the core of the author's information visualization course, and aims to teach nonprogrammers how to use open code and open data to design astute visualizations. The text also explores how to apply advanced data mining and visualization techniques in order to make sense of temporal, geospatial, topical, and network data.[7]

Yau, Nathan. *Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics*. Indianapolis, IN: John Wiley and Sons; Norwood, MA: Books24x7.com, 2011. Available at http://catalogue.library.carleton.ca/record=b3232983

- This text provides step-by-step tutorials on how to visualize and tell stories with data. Yau investigates gathering, parsing, and formatting data and instructs readers on designing high quality graphics that explore and present patterns, outliers, and relationships.

Texts that focus on the design elements of data visualizations:

Yau, Nathan. *Data Points: Visualization that Means Something*. Indianapolis, IN: John Wiley and Sons; Norwood, MA: Books24x7.com, 2013. Available at http://catalogue.library.carleton.ca/record=b3506923

- In this text Yau focuses on the graphics side of data analysis. He uses examples from art, design, business, statistics, cartography, and online media, to explore both standard-and not so standard-concepts and ideas about illustrating data.

Meirelles, Isabelle. *Design for Information: An Introduction to the Histories, Theories, and Best Practices Behind Effective Information Visualizations*. Beverly, MA: Rockport Publishers; Safari Books Online, 2013. Available at http://catalogue.library.carleton.ca/record=b3588424

- Familiarizes readers with data visualization design methods and concepts, it provides concrete examples of visualizations that work. This text discusses the histories, theories and best practices in the field of data visualizations using case studies, which thoroughly examine a variety of design principles and approaches.

[7] Summaries for the texts are either adapted from or taken directly from Amazon.

Ware, Colin. *Information Visualization: Perception for Design*. 3rd ed. Waltham, MA: Morgan Kaufmann; Norwood, MA: Books24x7.com, 2013. Available at http://catalogue.library.carleton.ca/record=b3436339

- This book explores the art and science of why we see objects the way we do. Based on the science of perception and vision, the author presents the key principles at work for a wide range of applications--resulting in visualization of improved clarity, utility, and persuasiveness. The book offers practical guidelines that can be applied by anyone: interaction designers, graphic designers of all kinds (including web designers), data miners, and financial analysts.[8]

Steele, J., Iliinsky, Noah P. N. *Beautiful visualization: Looking at Data Through the Eyes of the Experts* (1st ed.). Sebastopol, CA: O'Reilly Media, 2010. Available at http://catalogue.library.carleton.ca/record=b2955639

- This book examines the methods of visualization experts from diverse fields who approach their projects from a variety of perspectives. Explores the importance of storytelling and how successful visualizations are beautiful not only for their aesthetic design, but also for elegant layers of detail that efficiently generate insight and new understanding.

Munzner, Tamara. *Visualization Analysis & Design*. Boca Raton, FL: CRC Press; Safari Books Online, 2015. Available at http://catalogue.library.carleton.ca/record=b3708251

- Suitable for a broad audience, this book breaks down visualization design according to three questions: *what* data users need to see, *why* users need to carry out their tasks, and *how* the visual representations proposed can be constructed and manipulated. It walks readers through the use of space and color to visually encode data in a view, the trade-offs between changing a single view and using multiple linked views, and the ways to reduce the amount of data shown in each view. The text concludes with six case studies analyzed in detail.

[8] Quoted directly from Amazon https://www.amazon.ca/Information-Visualization-Perception-Colin-Ware/dp/0123814642 directly from Amazon

Websites

Information is Beautiful

http://www.informationisbeautiful.net/

- A site described by its creator as "dedicated to distilling the world's data, information and knowledge into beautiful, interesting and, above all, useful visualizations, infographics and diagrams."

Polygraph

http://polygraph.cool/

- Polygraph is an online publication that explores popular culture with data and visual storytelling.

Visual Complexity

http://www.visualcomplexity.com/vc/

- This site aims to be a unified resource space for anyone interested in the visualization of complex networks by providing visualization examples across multiple disciplines.

Recommended Guide for Citing Data

Simon Fraser University Library Guide to Citing Tables and Figures: APA [6th. Ed] citation guide

- This guide includes examples of how to cite figures and tables created by compiling information from multiple sources.
- When citing data visualizations you create using an app or online tool, be sure to add the name of the website or dedicated visualization app you used to create the visual representation of your data. For example, "Data visualization created using Datawrapper http://www.datawrapper.de."

Recommended guides from Carleton University Library:

https://library.carleton.ca/help/citing-data-and-statistics