FOREWORD

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Envisioning Information

In 1990, Edward R. Tufte published the first edition of *Envisioning Information*,[1] a book that showcases design excellence for charts, maps, computer interfaces, exhibits, and other important means of information exploration and communication.

Envisioning the Framework: A Graphic Guide to Information Literacy—published thirty years later—offers a visual introduction to *The Framework for Information Literacy for Higher Education* for librarians, designers, and others. The Framework aims to empower anyone to extract information from data so it can be converted into knowledge and wisdom for the benefit and enjoyment of all. If you are interested to become an effective information explorer, navigator, manager, or communicator, this book is for you.

Defining and Measuring Information Literacy

There exist many definitions of information literacy, data literacy, and data visualization literacy[2] and they are often used interchangeably. In general, it is assumed that the ability to read, make, and explain data via visual depiction of information requires three general types of literacy: (1) Textual literacy—the ability to read and write text in titles, axis labels, legends, (2) Visual literacy—the ability to find, interpret, evaluate, use, and create images and visual media, and (3) Mathematical literacy—the ability to formulate, employ, and interpret math in a variety of contexts. Fortunately, there exist standardized tests for all three of these types of literacy. The tests are administered regularly to understand and compare current literacy levels and to improve the effectiveness of different engagement and teaching strategies. Many of the existing tests do not just focus on reading and recall; they aim to measure writing and production of text, images, or data visualizations.

Most information literacy frameworks build on and consolidate prior work in library science, cartography, psychology, cognitive science, statistics, scientific visualization, data visualization, learning sciences, etc. in support of a de facto standard. Many frameworks take human perception and cognition into account. Almost all frameworks aim to be theoretically grounded, practically useful, and easy to learn and use. Frameworks must be used in different applications, tested rigorously, and optimized. Ideally, frameworks are modular and extendable so new data, methods, and tools can be incorporated.

Enjoying and Acquiring Information Literacy

Given an information literacy framework, it can be used to systematically construct information descriptions or visualizations. For example, the *Places & Spaces: Mapping Science* exhibit features 100 large-format maps and 20 interactive data visualizations that exhibit visitors can explore, enjoy, and play with, see http://scimaps.org and Figure 1.

Figure 1: Mapping Science exhibit at Duke University (left) and The Immersion Theater, Hunt Library, North Carolina State University (right) https://cns.iu.edu/all_news/event/ncstate.html

Among others, there are maps that communicate *The History of Science* [3] using ebook data from Project Gutenberg (http://www.gutenberg.org), maps that introduce organizational structures such as the *MACE Classification Taxonomy* developed within the European MACE project[4] see Figure 2, left, but also maps that depict *Literary Empires: Mapping Temporal and Spatial Settings of Victorian Poetry* [5] see Figure 2, right.

Figure 2: *MACE Classification Taxonomy* by Moritz Stefaner (top) and *Literary Empires* by Walsh et al. (bottom)

In addition, there are courses that empower many to improve their literacy via practical hands-on material and case studies. Almost every institution of higher education now offers data visualization, information visualization, or information literacy classes taught by faculty and/or librarians. Many courses are available online and are taught as Massive Open Online Courses (MOOC) scaling to 1000s of students. In January 2020, 226 'visualization' courses are listed on https://www.classcentral.com.

Most courses target students and require 8-15 weeks of substantial effort to complete. However, there is a growing number of courses that are designed for the working professional. One example is the *Visual Analytics Certificate* (https://visanalytics.cns.iu.edu) that introduces data-driven decision making, a data visualization framework, and general data analysis and visualization workflow design in 30 hours of concentrated work over six weeks. Students learn how to answer "When" (Temporal Data Analysis and Visualization), "Where" (Geospatial Data Analysis and Visualization), "What" (Topical Data Analysis and Visualization), and "With Whom" (Network Analysis and Visualization) questions.[6] The course concludes with information on likely future developments and value creation via data-driven decision making. Students apply new knowledge and skills in personally relevant projects that require identifying user needs and priorities; selecting the best data, algorithms, and workflows for temporal, geospatial, topical, and network case studies; communicating actionable insights using standard terminology; and gaining efficiencies for delivering high-quality results on time and on budget.

Practicing Information Literacy

Data is valuable. Information, knowledge, and wisdom extracted from data are invaluable. However, only good data—mined and interpreted correctly—supports good decisions. Hence, it is of utmost importance to capture highest quality data; to manage, analyze and visualize it correctly; and to use it effectively to inform personal and professional decision making. Librarians, teachers, and others aim to meet the data and information needs of millions. They teach billions how to find and utilize relevant information and expertise. They invent new means to use machine intelligence to support navigation and exploration of a digital universe that will reach 44 zettabytes by 2020.[7] Last but not least, they promote visual literacy and utilize data visualizations to create a highly effective interface between what computers and algorithms do best (e.g., storage, computation) and uniquely human capabilities (e.g., pattern recognition, creative problem solving). This book tries to explain how visual literacy and data visualizations are defined, developed, implemented, and taught.

Notes

1. Edward Tufte, *Envisioning Information,* (Cheshire, Conn.: Graphics Press, 1990).

2. Katy Börner, Andreas Bueckle, and Michael Ginda, "Data Visualization Literacy: Definitions, Conceptual Frameworks, Exercises, and Assessments," *PNAS* 116, no. 6 (2019): 1857-1864, https://doi.org/10.1073/pnas.1807180116.

3. W. Bradford Paley, "*TextArc Visualization of the History of Science*," courtesy of W. Bradford Paley, in "2nd Iteration (2006): The Power of Reference Systems," in *Places & Spaces: Mapping Science*, edited by Katy Börner and Deborah MacPherson, http://scimaps.org.

4. Martin Wolpers, Martin Memmel, and Moritz Stefaner, "Supporting Architecture Education Using the MACE System," International Journal of Technology Enhanced Learning 2, no. ½ (2010): 132-144. DOI: 10.1504/IJTEL.2010.031264; Moritz Stefaner, "MACE Classification Tree," courtesy of Moritz Stefaner, in "7th Iteration (2011): Science Maps as Visual Interfaces to Digital Libraries," in Places & Spaces: Mapping Science, edited by Katy Börner and Michael J. Stamper, http://scimaps.org.

5. “The Swinburne Project,” September 7, 2011, http://swinburneproject.org; John A. Walsh, David Becker, Bradford Demarest, Theodora Michaelidou, Laura Pence, and Jonathan Tweedy, “*Literary Empires: Mapping Temporal and Spatial Settings of Victorian Poetry*,” courtesy of Indiana University, with content provided by the David Rumsey Historical Map Collection. In “6th Iteration (2009): Science Maps for Scholars,” in *Places & Spaces: Mapping Science*, edited by Katy Börner and Elisha F. Hardy. http://scimaps.org.

6. Katy Börner and David E. Polley, *Visual Insights: A Practical Guide to Making Sense of Data* (Cambridge, MA: The MIT Press, 2014); Katy Börner, *Atlas of Knowledge: Anyone Can Map* (Cambridge, MA: The MIT Press, 2015).

7. Jeff Desjardins, “How Much Data is Generated Each Day?” World Economic Forum, April 2019, https://www.weforum.org/agenda/2019/04/how-much-data-is-generated-each-day-cf4bddf29f/

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Biography

KATY BÖRNER is the Victor H. Yngve Distinguished Professor of Engineering and Information Science in the Departments of Intelligent Systems Engineering and Information Science, Luddy School of Informatics, Computing, and Engineering; core faculty of the Cognitive Science Program; and founding director of the Cyberinfrastructure for Network Science Center (http://cns.iu.edu)—all at Indiana University in Bloomington, Indiana.

She is also a visiting professor at the Royal Netherlands Academy of Arts and Sciences (KNAW) in the Netherlands and Humboldt Fellow, Dresden University of Technology, Germany. Börner became a Fellow of the American Association for the Advancement of Science (AAAS) in 2012, a Humboldt Research Fellow in 2017, and an Association for Computing Machinery (ACM) Fellow in 2018. Since 2005, she serves as a curator of the international *Places & Spaces: Mapping Science* exhibit (http://scimaps.org).

Börner’s research focuses on the development of data analysis and visualization techniques for information access, understanding, and management. She is particularly interested in the formalization, measurement, and systematic improvement of people’s data visualization literacy; the study of the structure and evolution of scientific disciplines; the analysis and visualization of online activity; and the development of cyberinfrastructures for large-scale scientific collaboration and computation.

She holds an MS in electrical engineering from the University of Technology in Leipzig and a PhD in computer science from the University of Kaiserslautern.