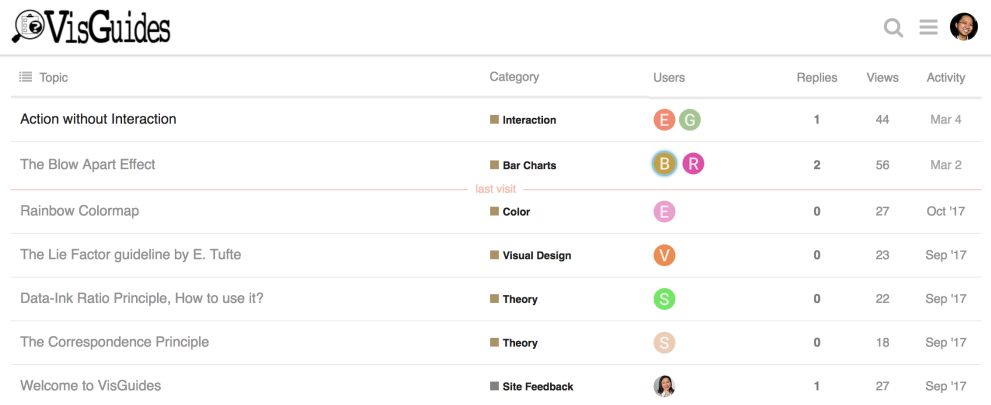


VisGuides: A Forum for Discussing Visualization Guidelines

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Topic	Category	Users	Replies	Views	Activity
Action without Interaction	Interaction	E G	1	44	Mar 4
The Blow Apart Effect	Bar Charts	B R	2	56	Mar 2
Rainbow Colormap	Color	E	0	27	Oct '17
The Lie Factor guideline by E. Tufte	Visual Design	V	0	23	Sep '17
Data-Ink Ratio Principle, How to use it?	Theory	S	0	22	Sep '17
The Correspondence Principle	Theory	S	0	18	Sep '17
Welcome to VisGuides	Site Feedback		1	27	Sep '17

Figure 1: A screenshot of VisGuides, a discussion platform that supports the creation, critique, and curation of visualization guidelines.

Abstract

This paper presents VisGuides, a discussion platform to facilitate the collection, evaluation, critique, revision, and dissemination of visualization guidelines. As visualization becomes a more widespread discipline with much more attention by designers and the general public, we need to ensure mechanisms for communicating, transferring, and accessing visualization knowledge. A visualization guideline can be anything ranging from good practices, empirical studies, and survey reports with the goal to inform visualization design and understanding. Thus, our forum aims (i) to collect visualization guidelines, (ii) to discuss guidelines and collect respective empirical references, and in the long run, (iii) to establish formal knowledge about guidelines by analyzing the forum content and the consensus of discussions. This paper describes the VisGuides forum and outlines our preliminary research towards shedding more light on visualization guidelines. VisGuides is accessible online at visguides.org.

1. Introduction

Chen et al. defined a **visualization guideline** as: “a guideline embodies wisdom advising a sound practice in creating a visualization image, designing a visual representation, or developing a visualization system.” [CGJ*17]. Specific guidelines are often hard to grasp, they come in various forms and are not always formalized as guidelines. For example, Tufte introduced the notion of *Data-Ink ratio* [Tuf86], Shneiderman introduced the information seeking mantra [Shn03], and other guidelines are manifested in the plethora of recent textbooks on information visualization (e.g., [War12, Nus15, Kir12, Mun14, WGK10]). In addition, many studies propose and test guidelines based on empirical research (e.g., [EF10, KW11, SOK*16]).

Guidelines are important (i) to guide novices and practitioners, alike, in the design and application of visualizations for specific problems, and (ii) to structure the vast knowledge and research in

the area. The scientific community has amassed a wealth of empirical knowledge, case studies, tools, and techniques over the past decades. However, most of the knowledge is naturally spread across scientific papers, inaccessible to the general audience of designers and visualization practitioners. Moreover, knowledge about visualization, as most other disciplines, is not as static and definitive as the rather static and definitive nature of scientific publishing—i.e., printed or electronic versions of PDFs—suggests. First, the danger of undiscussed guidelines is the perception of these guidelines being universal and imperative. Many researchers are particularly careful in formulating or critiquing guidelines that may potentially be falsifiable or have specific application conditions. For example, Charles Darwin, expressed his reluctance in making his view public as “It is as if one were confessing to a murder.” [Hoo09]. It was young Alfred Russel Wallace who prompted Darwin to break away from such reluctance and reshape biology. Eventually, year-long experiences and hard-to-formalize intuitions are transformed

to a huge body of formal knowledge, evidences, and best practices, which can be disseminated beyond the scientific community.

Our research works towards a transparent, collaborative, and democratic mechanism for discussing guidelines in visualization. The *VisGuides* (visguides.org) forum described in this paper is open and accessible to everybody and is meant as a platform to foster such constructive discussions (see Figure 1). Any registered users can propose guidelines, pose questions, share their positive as well as negative experience about certain guidelines, reason about the successes, report failures, and conflicts of guidelines, and eventually refine the statements of specific contexts. The purpose of this platform is threefold, (i) to enable a comprehensive study of guidelines and perfect the description of each guideline in a way similar to the development of mission-critical guidelines such as in medicine [WL12], (ii) to provide educational content and a pedagogical material for visualization courses and activities, and (iii) to stimulate new research activities about guidelines (e.g., taxonomies, ontologies, studies, design spaces, etc.) [CGJ*17], as well as embedding guidelines into the design and evaluation of visualization systems [MSQM15, ZSN*06]. In the long run, (iv) qualitative and quantitative data collected by *VisGuides* will enable studying visualization guidelines using, e.g., grounded theory [GS67]—a research methodology from social science. Grounded theory will be used as an inductive theory, labeling, and categorizing concepts to create taxonomies and ontologies. We believe our efforts will provide a common place for establishing guidelines and will contribute to a better understanding of the collective knowledge in information visualization.

2. Related Work

Guidelines for Visualization: The past years have seen plenty of efforts to collect, organize, and abstract models from guidelines. For example, guidelines have been issued for working with novice users [MLM17]; for visual analytics systems [SKBE17]; for working with provenance of insight and rationale in the analytical process [HARV17]; for text highlighting [SOK*16]; and how to avoid misunderstandings when working with domain experts [DPW*15]. More general, for the design and validation of visualization systems, Meyer et al. [MSQM15] introduced the nested blocks and guidelines model (NBGM). They also highlighted the need of developing taxonomies for visualization guidelines. In face of this, in 2014, Tarrell et al. [TFB*14] presented a framework for heuristics and guidelines for visualization and encouraged the visualization community to get involved in this process. More recently, Chen et al. [CGJ*17] discussed the need to examine visualization guidelines scientifically using the social science methodology grounded theory. They proposed the use of grounded theory to study the proposed concepts, theory, models, causal relation, and guidelines in a systematic, thorough, detailed manner.

VisGuides is our approach to expand on the previous work by Chen et al. [CGJ*17] with some specifics. Our platform sets the foundation to apply grounded theory on the collected guidelines, make them accessible, and realize them into a conceptual model. With the introduction of new techniques, new guidelines appear, others adapt, and some of them perish.

Scientific and Technological Discussion Platforms: A variety of discussion forums and platforms exist (*Quora* [Quo18], *Reddit* [Red18], *Stack Overflow* [Sta18], *Medium* [Med18], etc.), each providing particular mechanisms for discussion, collaboration, and consensus-finding. In the area of visualization, the reddit channel *Data is Beautiful* [Dat13], provides examples of data visualization and discussions. *vis.social* [vis18] serves as a social media platform specific for the visualization community. The *IBM Visualization Forum* [IBM18] discusses visualization related topics and questions. *VisGuides* is a discussion forum created specifically by the visualization community for the visualization community, complementing the existing discussion that is ongoing in many channels. There exists several efforts from our community to spread ideas and knowledge. Among them, is the *InfoVis:Wiki* [Inf13], an iconic source of information for practitioners and novices in visualization. The *Perceptual Edge* [Few04] site that provides viewpoints and discussions about different visualization techniques and concepts. The *EagerEyes* [Kos06] blog that reflects on the different directions, visions, and activities that take place in the visualization community. Other web application is *Rate your visualization* [Eve18] that rates how much a visualization follows the visualization guidelines in five areas: text, lines, color, arrangement, and overall. *Visual Vocabulary* [Fin18] provides guidance to which chart to use for your data. Our platform aims to integrate the efforts of the visualization community to serve the visualization community in different ways: as a discussion forum specific for the visualization community, as a teaching resource, and as a research resource. To ensure this, our commitment is to open the data collected in our forum for research purposes. By doing so this will ensure that the knowledge generated remains publicly accessible to everyone.

3. VisGuides

The *VisGuides* forum collects guidelines, study references, examples, supporting and contradicting evidence, as well as opinions and questions. Figure 2 shows a general schema of the different components of our forum.

Guidelines: A guideline in *VisGuides*, can be a single thread, span across multiple threads, or can be the result from a discussion that is based on an existing thread (Figure 2-left). However, essential is the underpinning of claims with examples and references. To start populating the forum with an initial set of guidelines, we collected 20 guidelines from the literature as well as by consulting colleagues in the visualization community. Currently, the forum contains six guidelines, each organized in its own thread: 1) the blow-apart effect [Duk17], 2) the rainbow colormap usage [BI07], 3) the lie-factor guideline, 4) action-without-interaction, 5) the data-ink ratio [Tuf86], and 6) the correspondence principle [KS14]. For example, one guideline reads as follows: “Do not use blow apart effects”; the thread then states a source (e.g., [Duk17]) and eventually, the user has added a more specific description of the usage context and question: “*Can I use the blow apart effect as feedback for a linked-view interface? As part of a dashboard, [...] The color channel has been used to indicate [...] A visualization researcher told me that I should not do this as it is a blow apart effect. But what he suggested seems to be equally problematic (e.g., making thicker outline, changing size, animation, and so on). Please help.*”

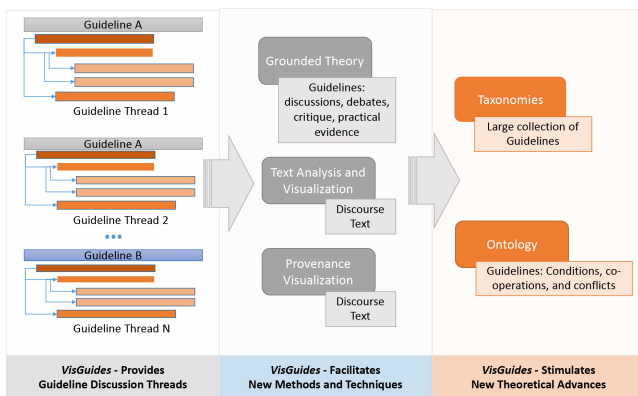


Figure 2: Schema showing the components of VisGuides. On the left, an example of different guideline threads (discussions). Guideline A is an example of a guideline with more than one active thread. Guidelines, discussions, and evidence are assimilated to construct taxonomies and ultimately an ontology of guidelines and visualization concepts.

(Figure 3). As part of this effort we have begun an online questionnaire to collect additional guidelines and a comprehensive survey of visualization guidelines.

3.1. Extracting Structured Data

The platform will offer a corpus of raw data that can be used to gain insights into the guidelines landscape, analyzing how they are discussed. This data will consist of a collection of structured and unstructured information that is either directly extracted from our platform or computed using advanced Natural Language Processing techniques. This data contains:

- **Structured data:** consists of tags, users, views, replies, likes, links, categories, etc. This could be used as a source of knowledge (similar to blogs). This requires much more commitment and user moderation, i.e., content creation, answering, updating.
- **Unstructured data:** contains questions, answers, contexts, examples, pictures, activity profiles, titles, etc. Used as an exchange platform, similar to *Stack Overflow* [Sta18] or *Reddit* [Red18]. This arrangement is useful for content creation and engagement. It is open to a large audience to ask questions and provides answers and, thus, requires some expert moderation or crowd-sourced moderation such as up/down voting, signaling, tagging.
- **Induced structure:** structured data can eventually be gleaned from analyzing unstructured data, e.g., through text analysis or analyzing change and activity logs over time. Text mining can help us monitor the activity of the community, analyze the discussion behaviors, detect trending topics, etc.

Based on such data, we can build guideline ontologies and analyze the controversy (and high activity) of linked discussions. In addition, we can cluster some guidelines and their related references and studies, find research gaps, and list supporting vs. contradicting arguments. A particularly important aspect of having such an open forum as a data source is that it provides an indication of agree-

The Blow Apart Effect

Visual Design Bar Charts

bigdata-unlimited

Guideline: Do not use blow apart effects
Source: <http://guides.library.duke.edu/datavis/topen>

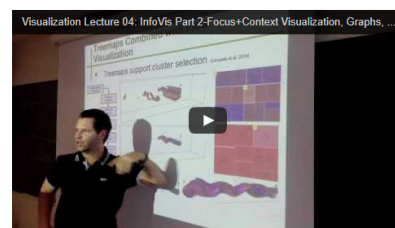
Can I use the blow apart effect as feedback for a linked-view interface? As part of a dashboard, I have implemented a bar chart showing data from 20-50 sources. The color channel has been used to indicate the 7 categories of these sources. When one source is selected in another view, I move other bars on both sides of the selected source a little away. A visualization researcher told me that I should not do this as it is a blow apart effect. But what he suggested seems to be equally problematic (e.g., making thicker outline, changing size, animation, and so on). Please help.

Reply

created Sep '17 last reply Oct '17 2 replies 32 views 2 users 1 like 2 links

rlaramee

Actually, in my opinion, you could use the blow apart effect in this scenario and I think it would be fine. In fact, most focus and context techniques should work very well as far as I can see. Here is some more information on focus + context if you're interested:



-cheers, bob

Figure 3: An example use of VisGuides: A question is displayed about the guideline “Do not use blow apart effects”, followed by the answer of the expert and reply from the user.

ment and consensus across different communities concerning the collected guidelines.

3.2. Implementation

VisGuides is built on top of the *Discourse Software Platform* [Dis18]. Other platforms that were considered include *Flarum* [Fla18a] and *FlaskBB* [Fla18b]. *Discourse* was chosen because it is a threaded forum, flexible, and customizable. It also allows for different users’ settings and permissions, posting media data, tracing changes, logging, among other features. We use the user trust level schema that *Discourse* provides to differentiate between visitors (trust level zero), users (trust level one), regular users (trust level two), experts (trust levels three and four), and the flags moderator and administrator for the core team. This schema auto-regulates seamlessly, upgrading the user trust level depending on well-defined rules.

The user interface presents a top level menu with the latest posts, new posts, unread posts, top ranking, and a summary overview of the hierarchy of categories and topics (Figure 1). The user can overview the list of guideline threads or search for a specific thread using the search box. When a guideline thread is selected, the forum shows the guideline thread and all the suggested threads based on the user preferences. The user can watch, track, be notified when s/he is @named, or mute the thread to avoid receiving further notifications. Depending on the trust level users can enrich their posts with images and attachments (trust level one), invite others to par-

ticipate in a given topic (trust level two), re-categorize and rename topics (trust level three), edit all posts, pin or unpin topics, close topics (trust level four), among many other customizable features.

4. Use Cases

We want to foster the use of our tool (i) as a common place for guidance and advice for researchers and practitioners, (ii) as a pedagogical tool, and (iii) as a research platform for studying and improving guidelines where discourses, discussions, and debates are means of applying grounded theory to guidelines. This section describes three usage scenarios around the forum.

Seeking Guidelines and Advice: Novices to visualization might be seeking advice in a specific question when working on a visualization problem/design and searching the Internet, they may come across a set of guidelines that could be useful or contradictory. The *VisGuides* forum aims to bundle knowledge and resources about guidelines and possible sources of information such as papers, blogs, and other related questions. A user might browse or search the existing threads and find out if the question is already solved. If a user does not find any suitable information in the forum, s/he can join an existing thread about the same topic (e.g., a question about the use of the rainbow-color map), or likewise open a new thread to the forum. This new thread can start with a statement about a new guideline or a specific question and context:

“I represent a group of environmental scientists. We see and create visualizations with rainbow colormaps in thousands. It would be a pain if everyone uses a different colormap for each variable in these visualizations. Is there a standard colormap we can use as a default map that everyone understand? Can visualization researchers be more constructive by recommending a colormap that maximizes the perceptual bandwidth while minimizing the problems such as being unsuitable for color blindness?” [BI07]

For every new question/thread posted, the system triggers an automated message to the administrators or the domain experts in the forum. Figure 3 shows an example of a thread discussion with a question posed and the answer from the expert.

Pedagogical Tool: *VisGuides* can support teaching visualization in a variety of ways. In the simplest case, a teacher can use existing material (guidelines, arguments, references, examples, etc.) to prepare her/his class and discuss a guideline in the classroom. Alternatively, a teacher can assign students specific guidelines and have them retrieve and organize a discussion; students might seek new guidelines, complement them with resources and examples and eventually contribute to the forum. Students eventually can contribute to the forum as part of class-work, which in turn allows a teacher to track learning engagement for specific students through their forum activity. Lastly, similar to the previous scenario, *VisGuides* can be a complimentary source for class projects and beyond a specific course.

Research Platform We expect the material in the forum to be very rich and we want to open the forum to all researchers. For example, we plan on organizing workshops that discuss guidelines and

content in the forum and invite colleagues to contribute to the forum. We believe the forum can be a live-monitoring device to track emerging fields and knowledge in the community.

5. Conclusions

In this short paper, we present the current work-in-progress for developing *VisGuides* as a platform for collecting, evaluating, discussing, refining, and disseminating visualization guidelines. As pointed out in [CGJ*17], this work is one of the pathways for making theoretical advances in visualization. There is a wide availability of some visualization guidelines in many online blogs, while many more guidelines are out of sight, wrapped up in books, journal articles, and inside experts’ mind. Hence, there is an urgent need for visualization scientists to study visualization guidelines in ways similar to the ways in which physicists study physical laws, chemists study reactions of chemical elements and the essential conditions, biologists study animals’ behaviors in different environments, and so on. Without such scientific approaches, we risk undermining visualization as a scientific discipline through over-generalization based on anecdotal evidence and reasoning and obstruction of scientific and technical progresses due to our inability to challenge existing doctrines.

We have made a fair amount of effort to invite individual experts who have worked on the topics of the questions yet with a little impact in the results. One hypothesis could be that the questions currently posed on *VisGuides* are difficult to answer for a number of different reasons such as broad scope or ambiguity. This suggests that many visualization guidelines are less concrete than the way they are perceived. Also, the conditions under which these guidelines would work are not yet established. Some guidelines are likely disagreeable or doubtful to some experts, who may be reluctant to contradict those who proposed or advocated the guidelines. These difficulties were also addressed in social epistemology by the work of Ziman [Zim00]. The author posed that scientists must learn from the format of political debates to contribute in effective debates and discussions. We will continue our efforts to engage the visualization community to discuss more guidelines and to raise open questions. We believe that *VisGuides* has the potential to help in the urgent need to study visualization guidelines more seriously through scientific analysis and critiques and scholarly discussions and debates. The discussion forum will bring more challenges associated to the validity of the guidelines, the polarized discussions, and the concept of truth. We will analyze validity and truth in the scope of Grounded Theory [Lev13, LK03]. We will address the challenges of polarized discussions in collaboration with social scientists.

Future Work Establishing the *VisGuides* forum is an important first step. To make that possible, we are contacting our colleagues, crowd-sourcing guidelines from our peers and posting those guidelines in the forum. The pilot was not public until now, but we are ready to make the forum publicly available to be consulted by practitioners, lecturers, and used in the classrooms. We are actively engaging our peers to use the tool in courses and seminars. We hope that through the EuroVis Conference, *VisGuides* can reach a much broader participation of the visualization community.

References

- [BI07] BORLAND D., II R. M. T.: Rainbow color map (still) considered harmful. *IEEE Computer Graphics & Applications* 27, 2 (2007). 2, 4
- [CGJ*17] CHEN M., GRINSTEIN G., JOHNSON C. R., KENNEDY J., TORY M.: Pathways for theoretical advances in visualization. *IEEE Computer Graphics & Applications* 37, 4 (2017), 103–112. 1, 2, 4
- [Dat13] DATA IS BEAUTIFUL: Data is beautiful, 2013. (Accessed on: 2 Mar 2018). URL: <https://www.reddit.com/r/dataisbeautiful/>. 2
- [Dis18] DISCOURSE: Discourse, 2018. (Accessed on: 23 Feb 2018). URL: <https://www.discourse.org/>. 3
- [DPW*15] DASGUPTA A., POCO J., WEI Y., COOK R., BERTINI E., SILVA C. T.: Bridging theory with practice: An exploratory study of visualization use and design for climate model comparison. *IEEE Trans. Visualization & Computer Graphics* 21, 9 (Sept 2015), 996–1014. 2
- [Duk17] DUKE UNIVERSITY LIBRARIES: Data visualization: Chart dos and don'ts, 2017. (Accessed on: 1 Mar 2018). URL: <https://guides.library.duke.edu/datavis/topten>. 2
- [EF10] ELMQVIST N., FEKETE J.-D.: Hierarchical aggregation for information visualization: Overview, techniques, and design guidelines. *IEEE Trans. Visualization & Computer Graphics* 16, 3 (2010), 439–454. 1
- [Eve18] EVERGREEN S.: Rate your visualization, 2018. (Accessed on: 2 Mar 2018). URL: <https://datavizchecklist.stephanieevergreen.com/rate>. 2
- [Few04] FEW S.: Perceptual edge, 2004. (Accessed on: 2 Mar 2018). URL: <http://www.perceptualedge.com/>. 2
- [Fin18] FINANCIAL TIMES: Visual vocabulary, 2018. (Accessed on: 2 Mar 2018). URL: <https://ft-interactive.github.io/visual-vocabulary/>. 2
- [Fla18a] FLARUM: Flarum, 2018. (Accessed on: 23 Feb 2018). URL: <http://flarum.org/>. 3
- [Fla18b] FLASKBB: FlaskBB, 2018. (Accessed on: 23 Feb 2018). URL: <https://flaskbb.org/>. 3
- [GS67] GLASER B., STRAUSS A.: *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Observations (Chicago, Ill.). Aldine Publishing Company, 1967. 2
- [HARV17] HALL A., AHONEN-RAINIO P., VIRRANTAUS K.: Insight provenance for spatiotemporal visual analytics: Theory, review, and guidelines. *Journal of Spatial Information Science*, 15 (Dec 2017), 65–88. 2
- [Hoo09] HOOPER R.: Charles Darwin: Writing origin 'like confessing a murder', November 2009. 1
- [IBM18] IBM: IBM developerWorks forum: Visualization, 2018. (Accessed on: 2 Mar 2018). URL: <https://www.ibm.com/developerworks/community/forums/html/forum?id=eb8a1fa2-f0a0-4672-9dae-a97f04dde74f>. 2
- [Inf13] INFOVIS:WIKI: InfoVis:Wiki, 2013. (Accessed on: 2 Mar 2018). URL: <http://www.infovis-wiki.net>. 2
- [Kir12] KIRK A.: *Data Visualization: A successful design process*. Packt Publishing Ltd, 2012. 1
- [Kos06] KOSARA R.: Eagereyes, 2006. (Accessed on: 2 Mar 2018). URL: <https://eagereyes.org/>. 2
- [KS14] KINDLMANN G., SCHEIDEGGER C.: An algebraic process for visualization design. *IEEE Trans. Visualization & Computer Graphics* 20, 12 (Nov. 2014), 2181–2190. 2
- [KW11] KELLEHER C., WAGENER T.: Ten guidelines for effective data visualization in scientific publications. *Environmental Modelling & Software* 26, 6 (2011), 822–827. 1
- [Lev13] LEVERS M.-J. D.: Philosophical paradigms, grounded theory, and perspectives on emergence. *Sage Open* 3, 4 (2013). 4
- [LK03] LOMBORG K., KIRKEVOLD M.: Truth and validity in grounded theory—a reconsidered realist interpretation of the criteria: Fit, work, relevance and modifiability. *Nursing Philosophy* 4, 3 (2003), 189–200. 4
- [Med18] MEDIUM: Medium, 2018. (Accessed on: 2 Mar 2018). URL: <https://medium.com>. 2
- [MLM17] MCKENNA S., LEX A., MEYER M.: Worksheets for guiding novices through the visualization design process. In *IEEE VIS Workshop on Pedagogy of Data Visualization (PDV)* (2017). 2
- [MSQM15] MEYER M., SEDLMAIR M., QUINAN P. S., MUNZNER T.: The nested blocks and guidelines model. *Information Visualization* 14, 3 (2015), 234–249. 2
- [Mun14] MUNZNER T.: *Visualization Analysis and Design*. AK Peters Visualization Series. CRC Press, 2014. 1
- [Nus15] NUSSBAUMER C.: *Storytelling with Data. A Data Visualization Guide for Business Professionals*. Wiley, 2015. 1
- [Quo18] QUORA: Quora, 2018. (Accessed on: 2 Mar 2018). URL: <https://www.quora.com/>. 2
- [Red18] REDDIT: Reddit, 2018. (Accessed on: 1 Mar 2018). URL: <https://www.reddit.com/>. 2, 3
- [Shn03] SHNEIDERMAN B.: The eyes have it: A task by data type taxonomy for information visualizations. In *The Craft of Information Visualization*. Elsevier, 2003, pp. 364–371. 1
- [SKBE17] SAKET B., KIM H., BROWN E. T., ENDERT A.: Visualization by demonstration: An interaction paradigm for visual data exploration. *IEEE Trans. Visualization & Computer Graphics* 23, 1 (Jan 2017), 331–340. 2
- [SOK*16] STROBELT H., OELKE D., KWON B. C., SCHRECK T., PFISTER H.: Guidelines for effective usage of text highlighting techniques. *IEEE Trans. Visualization & Computer Graphics* 22, 1 (2016), 489–498. 1, 2
- [Sta18] STACK OVERFLOW: Stack Overflow, 2018. (Accessed on: 1 Mar 2018). URL: <https://stackoverflow.com/>. 2, 3
- [TFB*14] TARRELL A., FRUHLING A., BORGIO R., FORSELL C., GRINSTEIN G., SCHOLTZ J.: Toward visualization-specific heuristic evaluation. In *Proc. Fifth Workshop on Beyond Time and Errors: Novel Evaluation Methods for Visualization* (2014), BELIV 14, pp. 110–117. 2
- [Tuf86] TUFTE E. R.: *The visual display of quantitative information*. Graphics Press, 1986. 1, 2
- [vis18] VIS.SOCIAL: vis.social, 2018. (Accessed on: 2 Mar 2018). URL: <https://vis.social>. 2
- [War12] WARE C.: *Information visualization: Perception for design*. Elsevier, 2012. 1
- [WGK10] WARD M., GRINSTEIN G., KEIM D.: *Interactive Data Visualization: Foundations, Techniques, and Applications*. A. K. Peters, Ltd., Natick, MA, USA, 2010. 1
- [WL12] WATLING C. J., LINGARD L.: Grounded theory in medical education research: AMEE guide no. 70. *Medical Teacher* 34, 10 (2012), 850–861. 2
- [Zim00] ZIMAN J.: Are debatable scientific questions debatable? *Social Epistemology* 14, 2-3 (2000), 187–199. 4
- [ZSN*06] ZUK T., SCHLESIER L., NEUMANN P., HANCOCK M. S., CARPENDALE S.: Heuristics for information visualization evaluation. In *Proc. AVI Workshop on BEyond Time and Errors: Novel Evaluation Methods for Information Visualization* (2006), BELIV '06, pp. 1–6. 2