MATTHEW BREHMER, PHD

RESEARCH STATEMENT, DEC. 2018

CONTACT

mabrehme@microsoft.com
mattbrehmer@gmail.com
+1-778-834-3016
mattbrehmer.github.io
@mattbrehmer
matthewbrehmer
matthewbrehmer
mattbrehmer

MAILING ADDRESS

Microsoft Building #99
Office #3442
14820 NE 36th Street
Redmond, WA USA 98052

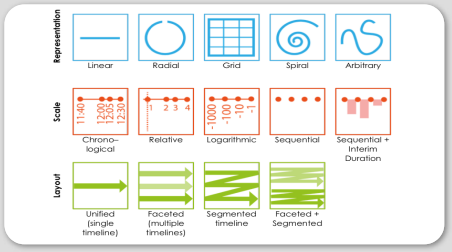
NOTE

The citations in brackets throughout this document refer to publications as indexed on my CV. PDF copies of these publications are available at mattbrehmer.github.io.

My research combines **information visualization** and **human-computer interaction** and is motivated by use cases in **data-driven storytelling** and **journalism**, as well as by a need to support **casual data analysis**. Specifically, I consider approaches to **expressive information design**, **visualization for mobile devices**, and **visualization for resource conservation**.

TIMELINES AND THEIR APPLICATIONS IN STORYTELLING

The visualization of time-oriented data has been a recurring theme in my research. In particular, I have been captivated by **timelines**, or visual representations of event sequences. In the **Timelines Revisited** project and journal paper (J6), my colleagues and I proposed a design space for timelines based on a survey of over 250 timelines and timeline visualization tools from a variety of domains. We also proposed considerations for presenting timelines in the context of **data-driven storytelling**, demonstrating these considerations with dozens of datasets and a prototype presentation tool.

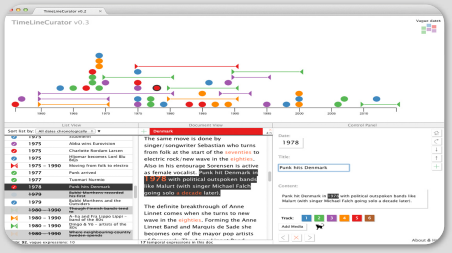


TIMELINES REVISITED

A design space for timelines, encompassing the dimensions of representation, scale, and layout, based on a survey of over 250 timelines from a variety of domains (with Lee, Bach, Riche, and Munzner).

timelinesrevisited.github.io

My fascination with timelines began while working with MSc student and former news graphics designer Johanna Fulda, whose newsroom experience of manually generating timelines with illustration software prompted us to consider approaches to semi-automating the timeline visualization process. The result was **TimeLineCurator** (J4), an interactive tool for extracting and curating timelines from unstructured text documents.

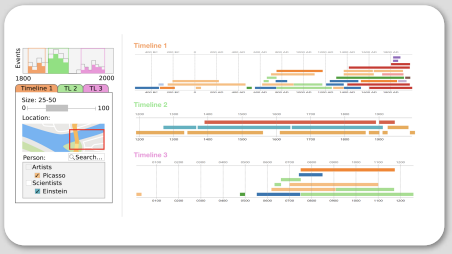


TIMELINECURATOR

An interactive web-based tool for extracting timelines from unstructured text (with Fulda and Munzner). Motivated by Fulda's experience working at the news graphics desk of *Süddeutsche Zeitung*.

timelinecurator.org

While a timeline is often used to present stories about event sequences in the domain of **journalism**, they are also central to analysis and communication in many other domains. In late 2016, I joined the **Timeline Consortium**, a Harvard University / Sloan Foundation initiative led by Dr. Alyssa Goodman of the Harvard-Smithsonian Center for Astrophysics, who is also an instructor for the HarvardX online education platform. The goal of this initiative was to assemble a network of scholars, educators, and software developers interested in applications of timelines in domains that include **journalism**, the **digital humanities**, and **cultural collection curation**, among others. Once assembled, the consortium would work toward establishing a standard for timeline data and metadata, so as to ensure the interoperability of software tools and to promote the sharing of data. A secondary goal of this initiative was to prototype and develop timeline software tools, particularly for the online education domain. We published a **draft standard** in early 2018, along with preliminary designs of a timeline tool for use in online education.



TIMELINE CONSORTIUM

A Harvard University / Sloan Foundation initiative to develop a timeline data standard, with immediate implications for the design of a timeline viewer in the HarvardX online education platform (with Goodman et al.).

timelineconsortium.org

Finally, with Christophe Hurter (ENAC: the French Civil Aviation University) and my colleagues at Microsoft Research (MSR), we are experimenting with the display of timelines in **augmented reality** as a novel and immersive way to navigate a collection of entities with temporal metadata, such as exhibits that one might encounter in a **museum or gallery**.

TOOLS FOR EXPRESSIVE INFORMATION DESIGN

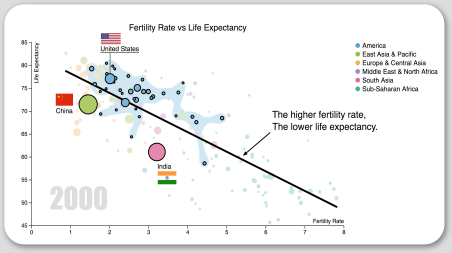
Timeline Storyteller (C7) is the realization of the timeline design space research described above and proposed in J6. I led the development of this interactive visualization presentation tool, and working with the Microsoft **Power BI** product group, the Microsoft **Data Journalism Program**, and my colleagues at MSR, we released and promoted this browser- and Power BI-based application in mid-2017. We demonstrated Timeline Storyteller at high-profile customer and practitioner events, and as of Fall 2018 the Power BI version of the application has been **downloaded over 36,000 times**.

TIMELINE STORYTELLER

An authoring tool for producing expressive visual narratives about timeline data; a web application and extension for Microsoft Power BI; exports images or iFrame presentations (with Lee, Riche, Tittsworth, Lytvynets, Edge, and White).

timelinestoryteller.com

In research led by Bongshin Lee (MSR) and Donghao Ren (University of California, Santa Barbara), we investigated approaches that allow people to be more expressive when visualizing data, without requiring them to write code. Two tools have emerged from this research. The first is **ChartAccent** (C5), which allows people to annotate standard chart types based on the design conventions of news graphics from leading newsrooms, supporting direct manipulation interaction surfacing attributes of the underlying data.

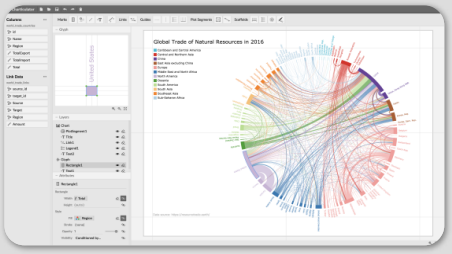


CHARTACCENT

An interactive web-based tool for annotating common chart types (with Ren, Lee, Höllerer, and Choe). Motivated by a survey of annotation in charts produced by leading newsrooms.

chartaccent.github.io

The second tool to emerge from research led by Lee and Ren is **Charticulator** (J7), a highly-expressive web-based environment for producing bespoke chart layouts comprised of customizable data glyphs. Charticulator also exports reusable chart templates, including those compatible with Microsoft **Power BI**. Our paper about Charticulator (J7) received an **Honorable Mention for Best Paper** at IEEE InfoVis 2018 and the tool was shortlisted for the 2018 Kantar ***Information Is Beautiful*** **Awards**.

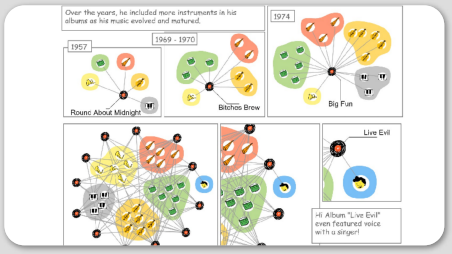


CHARTICULATOR

An interactive web-based tool for producing bespoke visualization layouts and representations (with Ren and Lee). Shortlisted for the 2018 Kantar *Information Is Beautiful Awards*.

charticulator.com

The most recent expressive information design tool to emerge from our group is **DataToon** (C8), a collaboration with intern Nam Wook Kim (Harvard University) and a team of researchers spanning three countries. Unlike the aforementioned tools, DataToon is unique in that it leverages pen and touch interactions in the production of comics about dynamic networks, a form of data that is poorly-served by existing tools.



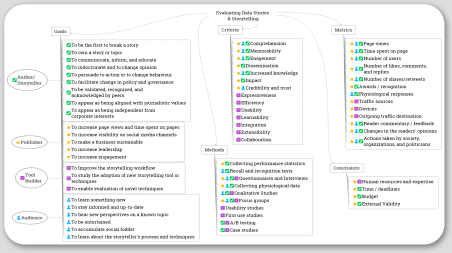
DATATOON

A pen + touch authoring environment for producing comics about dynamic networks, such as the evolution of a social media network over time (with Kim et al). The inset image to the left shows a comic about the network of musicians collaborating on Miles Davis records.

Finally, along with my colleagues at MSR, I continue to collaborate with former intern Sriram Karthik Badam (University of Maryland, College Park) and former visiting researcher Christopher Collins (University of Ontario Institute of Technology) on another expressive visualization design tool project, one focusing on geospatial data and responsiveness across display types, a critical aspect of design that is not addressed by existing tools or by the tools described earlier in this section.

EVALUATION OF DATA-DRIVEN STORIES AND STORYTELLING TOOLS

In 2016, I participated in a **Dagstuhl seminar on Data-Driven Storytelling**, whose attendees included journalists, designers, and freelancers, as well as a group of leading researchers in this area. Working with Fereshteh Amini (University of Manitoba, now with Microsoft), Christina Elmer (*Spiegel Online*), Gordon Bolduan (Universität des Saarlandes), and Benjamin Wiederkehr (Interactive Things), we pondered the question: "*What makes a particular instance of data-driven storytelling effective or compelling?*". We then set out to identify a set of evaluation criteria, metrics, and methods of interest to different stakeholder groups, such as authors, publishers, and story consumers.



EVALUATING DATA-DRIVEN STORIES

A book chapter in *Data-Driven Storytelling* (CRC Press 2018, with Amini, Elmer, Bolduan, and Wiederkehr) discussing evaluation methods and metrics from the perspective of an author, a publisher, a tool-builder, and a story consumer.

aka.ms/dds_book

The result of our discussion is a chapter in *Data-Driven Storytelling* (CRC Press, 2018) (BC1). Several of the methods discussed in this chapter pertain for assessing various forms of **engagement**, a construct that I would hope to investigate further in my future work, particularly in the context of data-driven stories that feature interactive visualization.

This chapter (BC1) also touches upon the **evaluation of tools** for producing such stories, which include information design tools such as those profiled in the previous section. Working again with Donghao Ren and my MSR colleagues Bongshin Lee and Nathalie Henry Riche, we recently probed deeper into methods for evaluating such tools. Unlike visualization tools for data analysis, where a person using the tool is asking questions of their data, visualization tools for communication and storytelling have a different set of evaluation metrics and thus require different evaluation methods. While the goal of the former class of tools is to enable people to perform analysis tasks quickly and accurately, goals of the latter class of tools include maximizing one's expressive potential and integrating with one's storytelling workflow. Our recent workshop paper (W5) catalogs the metrics and methods relevant to the evaluation of chart authoring tools and identifies several open challenges.

EVALUATING CHART AUTHORING TOOLS

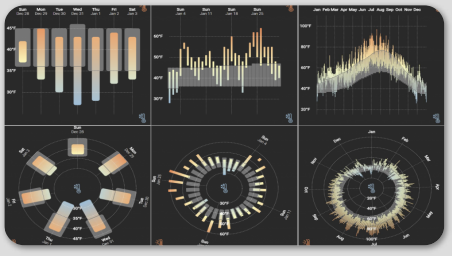
A discussion of methods and metrics for evaluating interactive tools that enable people to produce presentation-oriented data visualization (with Ren, Lee, and Riche), including lessons from developing 6 of these tools.

aka.ms/authoring-eval

Demonstrating the expressive power of information design tools such as Timeline Storyteller and Charticulator has proved to be a formidable research challenge. The evaluation of expressive potential is also a logistical challenge; people who opt to use a deployed visualization design tool with their own data have varied levels of design training, and they may not opt into sharing their data or results with researchers. Thus, I intend to continue collaborating with my colleagues at MSR and to initiate collaborations with the developers of other tools in an effort to **identify appropriate methods and/or benchmark datasets for evaluating visual expressiveness**.

INFORMATION VISUALIZATION FOR MOBILE DEVICES

Following a demonstration of Timeline Storyteller, a team at MSR reached out to me with a tantalizing question: "***which representations of time are best suited for mobile displays?***". This group was concerned with the visualization of **ranges over time**, where each time point has a high value and a low value. This form of data appears often in **personal health and activity** contexts (e.g., sleep and waking times, blood pressure, heart rate), as well as in finance and weather reporting. For this project, I enlisted the help of Bongshin Lee (MSR), Petra Isenberg (Inria), and self-tracking data expert Eun Kyoung Choe (University of Maryland, College Park). We conducted a crowdsourced experiment comprised of five tasks performed in the context of linear and radial representations of time, as well as weekly, monthly, and yearly temporal granularities. We found that while people were typically faster to complete tasks with linear representations, there were no differences in accuracy between the representations. This and other findings are reported in a recent journal paper (J8).



VISUALIZING RANGES ON MOBILE PHONES

Evaluating visual representations designed for mobile phones, motivated by the increasing prevalence of apps and online news reporting on data relating to personal health, climate, and finance (with Lee, Isenberg, and Choe).

aka.ms/ranges-tvcg

In recent years, mobile app developers and news graphics editors have increasingly been visualizing data for consumption from a mobile phone, and **responsive visualization design** has become an important skill for practitioners. In response to this trend, I co-organized a **CHI 2018 workshop** with my colleagues Lee, Isenberg, and Choe, as well as with Raimund Dachselt and Ricardo Langer (Technische Universität Dresden) (W4). Our intent was to identify a mobile visualization research agenda as well as opportunities for collaboration with researchers and practitioners who share this interest.

I am continuing to collaborate with Lee, Choe, and Isenberg on another mobile visualization experiment, albeit focusing on a different type of data appearing often in news graphics: scatterplots at multiple time points. Meanwhile, I am also exploring the **design space for interacting with representations of time-varying data on mobile phones**, a collaboration with Bongshin Lee (MSR), Ken Hinckley (MSR), and Christopher Collins (UOIT). I also plan to continue my investigation of methods for crowdsourcing the evaluation of visualization design alternatives on mobile phones; one such project will focus on the design of multi-attribute glyphs for display in "small multiple" calendar grids, a design pattern that is becoming common in activity tracking apps.

VISUALIZATION FOR RESOURCE CONSERVATION

The emergence of **instrumented buildings and cities** allow citizens, policymakers, and employees to monitor the use of resources such as energy and water over time and make **informed conservation decisions**. One of my PhD projects (J4) involved the iterative human-centred design of visual analysis tools for monitoring energy usage in large building portfolios, such as universities, municipal buildings, or hospital networks.

ENERGY MANAGEMENT AND CONSERVATION

An iterative human-centred design process resulted in a series of prototype visual analysis tools for monitoring the energy consumption of large building portfolios.

aka.ms/matches_mismatches

The effective monitoring of resource consumption requires an awareness of event sequences (i.e., **timelines**) to put **quantitative time-varying data** in context. Furthermore, those capable of making resource conservation decisions in real time are on often on site and thus require the ability to monitor resource consumption **from a mobile phone**. Finally, in order for policymakers, citizens, and users of instrumented buildings and cities to become more aware of issues pertaining to resource conservation, we could present them with **memorable and personally-relevant data-driven stories**.

SYNTHESIS AND FUTURE VISION

My research advances the state-of-the-art in terms of how people **visualize time-oriented data**; it increases the **expressive potential of data-driven storytelling**; and it reveals new ways in which people can perform **casual and glanceable data analysis from a mobile device**.

With respect to expressive information design, I have been inspired by the potential of **bimanual pen and touch input** on large surface displays following the success of the DataToon project (C8). The particular context of use for pen + touch information design tools that I currently find most interesting is that of **data-driven storytelling during live presentations**, such as in educational settings or in live news broadcasts.

With respect to visualization for mobile devices, a focus of my future work will aim to develop **methods for evaluating** mobile-first and mobile-only visual encoding and interaction design choices, and to propose a set of **mobile visualization design heuristics** that reflect different tasks, data types, and application contexts.

My long-term vision is to integrate the theories and frameworks of the visualization research community with the best practices established by those working in domains where visualization techniques are applied, such as in **journalism**, **education**, **personal health**, and **resource conservation**. Furthermore, I will identify and act upon visualization design opportunities for use cases involving people who do not self-identify as professional data analysts, but rather as news readers, students, and health- and resource-conscious citizens. In doing so, I will be addressing the larger challenge of increasing **visualization literacy** and, more broadly, **data literacy** among the general public, so that collectively, we may have a more informed data-driven discussion of our society's future.

REFERENCES

Timelines Revisited: A Design Space and Considerations for Expressive Storytelling — J6
M. Brehmer, B. Lee, B. Bach, N. H. Riche, T. Munzner (2017). In *IEEE TVCG*.

TimeLineCurator: Interactive Authoring of Visual Timelines from Unstructured Text — J4
J. Fulda, M. Brehmer, T. Munzner (2016). In *IEEE TVCG*.

Timeline Storyteller: The Design & Deployment of an Interactive Authoring Tool for Expressive Timeline Narratives — C7
M. Brehmer, B. Lee, N. H. Riche, D. Tittsworth, K. Lytvynets, D. Edge, C. White (2019). To appear in *Proc. Computation + Journalism Symp*.

ChartAccent: Annotation for Data-Driven Storytelling — C5
D. Ren, M. Brehmer, B. Lee, T. Höllerer, E. K. Choe (2017). In *Proc. 2017 IEEE PacificVis Symp*.

Charticulator: Interactive Construction of Bespoke Chart Layouts — J7
D. Ren, B. Lee, M. Brehmer (2019). In *IEEE TVCG*.

DataToon: Drawing Dynamic Network Comics With Pen + Touch Interaction — C8
N. W. Kim, N. H. Riche, B. Bach, G. A. Xu, M. Brehmer, K. Hinckley, M. Pahud, H. Xia, M. McGuffin, H. Pfister (2019). To appear in *Proc. ACM CHI*.

Evaluating Data-Driven Stories & Storytelling Tools — BC1
F. Amini*, M. Brehmer* (equal contribution), G. Bolduan, C. Elmer, B. Wiederkehr (2018). In *Data-Driven Storytelling* (CRC Press).

Reflecting on the Evaluation of Visualization Authoring Systems — W5
D. Ren, B. Lee, M. Brehmer, N. H. Riche (2018). In *Proc. 2018 BELIV Workshop*.

Visualizing Ranges over Time on Mobile Phones: A Task-Based Crowdsourced Evaluation — J8
M. Brehmer, B. Lee, P. Isenberg, E. K. Choe (2019). In *IEEE TVCG*.

Data Visualization on Mobile Devices — W4
B. Lee, M. Brehmer, E. K. Choe, P. Isenberg, R. Langer, R. Dachselt (2018). In *Proc. ACM CHI Extended Abstracts*.

Matches, Mismatches, and Methods: Multiple-View Workflows for Energy Portfolio Analysis — J5
M. Brehmer, J. Ng, K. Tate, T. Munzner (2016). In *IEEE TVCG*.