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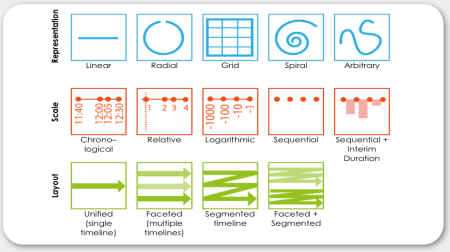
NOTE

The citations in brackets throughout this research statement 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 and glanceable data analysis. Specifically, I consider approaches to expressive information design and information visualization for mobile devices

EXPRESSIVE INFORMATION DESIGN

Expressive information design tools address use cases in data-driven storytelling, an activity that is increasingly prevalent in journalism, education, scientific communication, and business intelligence. However, to develop such tools one must first understand their respective design spaces. This process is exemplified by how my understanding of the timeline design space (J6) led to Timeline Storyteller (C7).



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.

timelinesrevisited.github.io

I led the development of Timeline Storyteller, and with the Microsoft Power BI product group, the Microsoft Data Journalism Program, and my colleagues at Microsoft Research (MSR), we released and promoted this browser- and Power BI-based application in mid-2017, demonstrating it at high-profile customer and practitioner events, such as during a keynote presentation at the Microsoft Data Insights Summit. As of Fall 2018 the Power BI version of the application has been downloaded over 36,000 times.

TIMELINE STORYTELLER

An interactive authoring tool for producing expressive visual narratives about timeline data; deployed as a web application and as an extension for Microsoft Power BI; exports images or iFrame presentations.

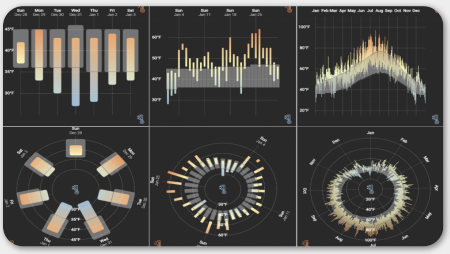
timelinestoryteller.com
github.com/Microsoft/timelinestoryteller

Other expressive information design tools to emerge from my collaborations with Bongshin Lee and Nathalie Henry Riche at MSR and their interns Donghao Ren (Univ of California, Santa Barbara) and Nam Wook Kim (Harvard University) include ChartAccent (C5), Charticulator (J7), and DataToon (C8). DataToon is particularly noteworthy for its incorporation of pen + touch interactions that allow the author to infuse their own personal illustrative style into data-driven comic strips.

While a goal of visualization tools for data analysis is to enable people to perform analytical tasks both quickly and accurately, a goal of visualization tools for communication and storytelling is that of maximizing one's expressive potential and integrating with one's storytelling workflow. Working again with Ren, Lee, and Riche, we recently catalogued the metrics and methods relevant to the evaluation of chart authoring tools and identified several open challenges, such as the development of expressiveness benchmarks (W5).

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).

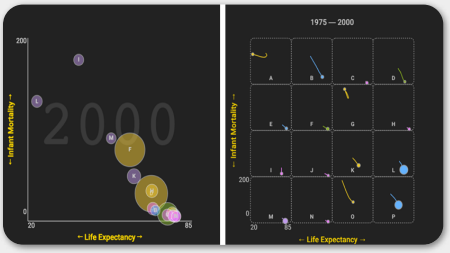


VISUALIZING RANGES ON MOBILE PHONES

Alternative visual representations of ranges designed for mobile phones, motivated by the increasing prevalence of apps and online news reporting on data relating to personal health, climate, and finance.

aka.ms/ranges-tvcg
github.com/Microsoft/RangesOnMobile

I am continuing to collaborate with Lee, Choe, and Isenberg on another crowdsourced mobile visualization experiment, albeit focusing on a different type of data appearing often in news graphics: scatterplots at multiple time points.



TREND VISUALIZATION ON MOBILE PHONES

An experimental application used to assess animation and small multiples for visualizing multivariate trends on mobile phones, motivated by the rise of looped animated news graphics.

github.com/Microsoft/MobileTrendVis

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 (University of Ontario Institute of Technology). This project is motivated in part by the observations of news graphics publishers that while many people view the content that they produce, few of them interact with it, which may be due to the fact that many people attempt to consume this content from their mobile phone.

Beyond my ongoing projects in this area, I intend to continue my **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.

In summary, 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.

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 (J5) 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 approaches for **casual and glanceable data analysis from a mobile device**.

With respect to expressive information design, I am inspired by the recent rise of **interactive visual essay** journals and online magazines that blend visualization and text, such as *Distill*, *The Pudding*, and the forthcoming *Parametric Press*. If more journalists, educators, and scientific communicators are to create these **scrollable, shareable, and responsive data-driven documents**, they will need expressive tools that support their creation, and I believe that I am well-suited to lead the design of such tools.

I am also 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 about 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*.

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... 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*.

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... 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*.