DataChopin – A Collaborative Interface for Data Visualisation and Composition on Large Interactive Screens

Abstract

DataChopin is a research prototype that explores the democratisation of data analytics and sensemaking capabilities. The collaborative interface is a major outcome of sustained research efforts at the Urban Informatics Research Lab, part of the QUT Design Lab, in citizen science and public engagement with urban data. It was developed over the course of multiple iterations spanning across three use cases. Its distinctive characteristics are the use of large, interactive displays as a shared desktop, as well as flexible composition mechanisms for incremental construction of visualisations. By studying interfaces for composing data and visual forms, this research contributes to the understanding of the fundamental components and structure of visualisations, resulting in a general and flexible compositional model. This lays the groundwork for data exploration tools that allow non-expert users to mix, match, and manipulate datasets to obtain visual representations requiring little to no programming knowledge.

Introduction

Ongoing technological advances have led to rapid growth in the availability of data, with potential impacts in many areas of society. However, currently there is often an asymmetric relationship between data collectors and data collection targets. While large public and private entities can rely on data scientists and experts to derive benefits from data, individuals or smaller businesses cannot afford to make such investments. As a result, when users are prompted relinquish control over their data, it is accompanied by a sense of powerlessness and resignation. To counter that, this research pursues the development of interfaces to support collaborative, community-led inquiry into data, which is referred to as *Participatory Data Analytics*.

The main practical outcome of this research is DataChopin, a collaborative interface for data visualisation and composition on large interactive screens. In order to obtain this result, the research employed a user-centred design approach, which included extensive study of user requirements and an iterative design process to develop a series of prototypes. The prospective user groups were involved at each step in the development process through established methods in Human-Computer Interaction. For purposes of understanding the challenges around sensed and reported data and defining requirements, focus groups, interviews, and field observations were conducted. Beginning in early design process, users were involved through activities such as sketching and paper prototyping. Finally, the resulting prototype was exhibited in laboratory and field trials.

Research Prototype

The interface design emerged gradually over the course of multiple prototyping stages. During the development, agility was prioritised over optimal implementations and robustness. Therefore, the resulting application should be understood as a research tool and a proof-of-concept, rather than a commercial quality product. Nonetheless, a number of custom user interface components had to be developed in order to address the unique requirements of collaboration in large-scale, shared-desktop environments. In particular, the interface exposes a flexible, general-purpose visualisation framework, specifically designed to support dynamic visualisation composition.

The prototype was implemented in *Python* with *Cython* bindings to a number of selected third party *C/C++* libraries. The choice of a dynamically typed programming language was mainly motivated by the need for agile and rapid prototyping. The user interface was realised with the *Qt* framework and makes heavy use of *QtQuick*, a modern library of touch-driven controls, based on a GPU-accelerated scene graph. The implementation makes heavy use of modern graphics programming techniques in order to generate its visual representations. With the aid of programmable shaders, it extends the capabilities of the conventional graphics pipeline to address the graphics needs of exploratory visualisation systems. A GPU-accelerated approach provides several benefits. First, by varying parameters at different stages a wide range of visual representations can be achieved. Second, the transformations at various stages can be dynamically updated to allow real-time interaction. Third, the changes can be interpolated to create fluid transitions and explore different types of visualizations in a continuous fashion.

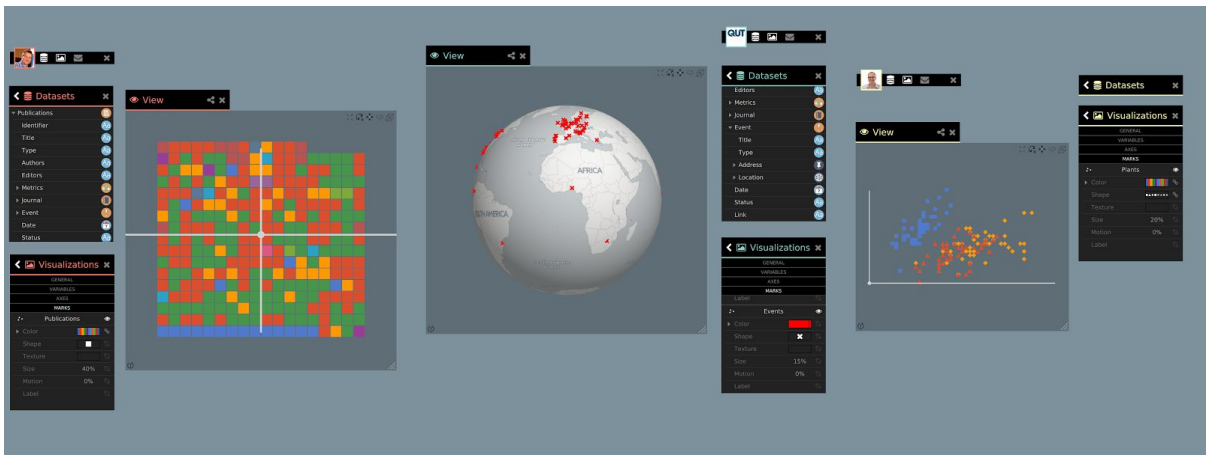

Figure 1: DataChopin shared workspace.

The interaction metaphors originated from low-fidelity paper prototypes, while their precise semantics were subsequently derived from the formal study of visualisation theories. These proposed interactions provide an initial design vocabulary that is open to extensions and variations. Ideally, future frameworks will converge around common best-practices and conventions, helping to address challenges with regard to learnability and overall adoption.

Research Venues

This non-traditional research output takes the form of an interactive application that was exhibited on several occasions in public venues.

Since early 2016, the research prototype has been continuously tested and exhibited on-demand at the IFE Viser lab, making use of QUT's large-screen visualisation facilities. The evaluation included two workshops, during which groups of participants engaged with the collaborative interface. Through a series of activities, the workshops explored applications of the interface based on real-world academic quality assessment schemes. The interface was used to visually represent bibliometric data in order to discover high-quality research outputs. The ability to rapidly tailor visualisations and take initiative during the investigation was well received. This use case served as an example of collaborative data analysis in academic settings.

Figure 2: DataChopin at the QUT ViseR Lab.

In late 2016, the research prototype was deployed at Wandering Cooks (http://wanderingcooks.com.au/), a Brisbane community hub providing commercial kitchen space to street food vendors and gourmet food truck operators. The purpose of this deployment was to explore the use of open data for supporting street food vendors. The real-world experience with food truck operators ensured the relevance of the available datasets and visualisations. The evaluation allowed for testing assumptions behind the design of DataChopin with local entrepreneurs, revealing practical challenges and providing inspiration for future improvements. This use case served as an example of the potential benefits from empowering small and medium enterprises to collaboratively analyse data.

Figure 3: DataChopin at Wandering Cooks.

Research Outputs

The development of DataChopin was central to the success of the study. Exhibiting and trialing the prototype in real-world settings has resulted in multiple academic publications, as well as other media communications, such as press releases. The main research publications originating from this work are listed below:

D. Filonik (2017). “Participatory Data Analytics – Designing Visualisation and Composition Interfaces for Collaborative Sensemaking on Large Interactive Screens”, PhD Thesis, Queensland University of Technology.
ePrints: Forthcoming.

D. Filonik, M. Rittenbruch, and M. Foth (2016). “DataChopin – Designing Interactions for Visualisation Composition in a Co-located, Cooperative Environment”. In: *CDVE’16. 13th International Conference on Cooperative Design, Visualization, and Engineering*. Ed. by L. Yuhua. Lecture Notes in Computer Science, Volume 9929. Springer International Publishing.
ePrints: http://eprints.qut.edu.au/100084/

D. Filonik, T. Bednarz, M. Rittenbruch, and M. Foth (2016). “Glance – Generalized Geometric Primitives and Transformations for Information Visualization in AR/VR Environments”. In: *VRCAI’16. 15th International Conference on Virtual-Reality Continuum and its Applications in Industry*. ACM SIGGRAPH.
ePrints: http://eprints.qut.edu.au/101553/

Summary

The research prototype constitutes a significant research effort that was undertaken to investigate the notion of smart citizens, which explores how everyday citizens can make use of datasets in personal and professional contexts. The deployments of DataChopin have demonstrated how data composition and visualisation can support academics and entrepreneurs in everyday work processes. Looking across these cases, it is reasonable to be optimistic about the impact that Participatory Data Analytics can have in the future. However, it will not be sufficient to merely develop better visualisation systems and wait for their adoption. Instead, it will be just as important to develop an understanding of the most effective ways to introduce these systems into communities.

Ultimately, the potential for data to be an empowering force is predicated on the level of accessibility through data exploration interfaces such as the one presented here. However, the development of these interfaces, which aim to support self-directed, open-ended investigations by non-expert users, presents a unique set of usability challenges. This work represents a step towards addressing these challenges and putting sensemaking and visualisation capabilities in the hands of a broader audience.

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