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Academic Statement

My research explores the design of new interactive systems and programming languages that help people better manage, author, understand, and reuse both code and data. My research combines techniques from human-computer interaction (HCI), visualization, and programming languages to first identify the types of challenges that users face, then to develop and evaluate novel application solutions. By focusing new programming languages and end user systems on the domain expertise and tasks most relevant to the user, we can improve how people interact with systems to better promote program understanding, and to proactively surface surprising or incorrect results.

Languages and Visualization Tools for Data-Centric End User Programming

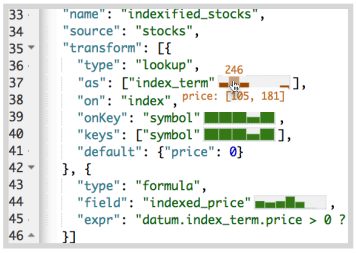


Figure 1: A Vega code snippet augmented with inline visualizations that show the distribution of data in array variables. For example, the "symbol" variable is an array containing five unique strings, one of which occurs less frequently than others.

Programmers often struggle to overcome the gap between high-level code and system output. Motivated by interviews with Vega [1] programmers, I developed new visualization tools [2,3] to automatically surface relevant details of the program behavior in real-time within the context of the code, thus enabling users to focus on their primary development task. The interactive timeline and a simplified data view are currently employed as part of the online Vega editor [4]. Evaluations of these techniques show that users can effectively understand the source code to identify bugs or crucial dependencies using the proposed visual debugging techniques [2]. I further show that users can more accurately answer program understanding questions with the aid of inline visualizations of the code behavior (Figure 1) [3].

Domain experts often lack the tools needed to produce custom, domain-specific graph layouts; therefore, domain experts must either use ill-fitting techniques that do not appropriately reflect their needs or develop new tools specifically designed for their particular use case. To better support domain experts in designing custom graph layouts, I developed SetCoLa [5]: a new programming language for specifying high-level constraints for graph layout based on existing domain-specific properties of the graph (e.g., node attributes and topology). SetCoLa supports custom layouts with an order of magnitude fewer user-authored constraints than previous approaches, and supports layout reuse across similar graphs (Figure 2). To demonstrate the utility of this approach, I reproduced three real-world examples. I then demonstrate the reuse of a custom layout for visualizing biological systems based on several graphs from InnateDB [6], as shown in Figure 2.

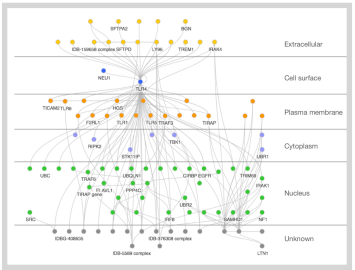


Figure 2: The layout for theTLR4 biological systems from InnateDB [6] produced using only four constraints in SetCoLa [5]. Layers in the graph correspond to the location of biomolecules in a cell. The SetCoLa layout can then be reapplied to other graphs from InnateDB, which include the same graph properties.

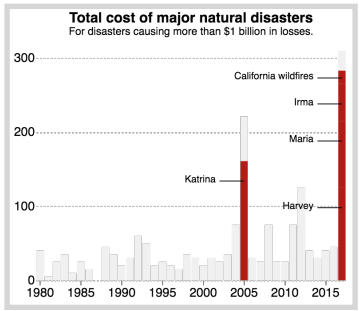


Figure 3: A bar chart visualization designed for small mobile devices using our responsive visualization system [7]. This design was reproduced based on an article from a New York Times [8].

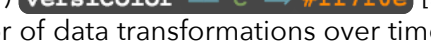
Readers more often consume media content on a phone than a desktop computer. However, journalists often utilize an inflexible design workflow for creating responsive visualizations. In formative interviews with five journalists, I found that responsive design was often forefront in their minds, yet most designers focused on desktop development first and customized designs for mobile as the last step in the development process. To enable more flexible design workflows with an emphasis on mobile devices, I developed a new visualization construction system that allows designers to simultaneously view, create, and modify multiple device-dependent visualizations via linked editing [7]. To evaluate this work, I describe the iterative processes for recreating four real-world responsive visualizations found in online news articles, an example of which is shown in Figure 3.

I presented my research on visualizing program behavior [2,3] and SetCoLa [5] as part of the 2019 CHI Doctoral Consortium [9]. Since then, my work on responsive visualization design has received a CHI 2020 Best Paper Award (Top 1%). I have further presented an overview of my research as part of the UW Allen School Women's Research Day; the talk is now available on YouTube [10].

Reflection and Future Research Agenda

My research aims to better understand people and to help people better understand systems. For each project, I sought to understand the pain points faced by individuals in their current development process, and then identify and develop ways in which to mitigate such challenges. I evaluated the proposed approaches via user studies or by reproducing real-world examples to demonstrate the benefits provided by the proposed techniques, as well as new areas for future work. In my future work, I would like to continue to explore how to ease the burden on people and empower them to focus on the applications and designs that matter most. Towards this goal, I seek to design novel methods and tools that offset the burden on users while adapting to their changing needs and available resources.

There are many areas of future work that I would like to pursue. My work on visualizations for code understanding [2,3] exemplifies how such techniques may be applied for a large class of *reactive* programming languages, but I would further like to explore how to effectively incorporate real-time program visualizations into *imperative* programming domains or other data-centric end users systems. For example, while SetCoLa [5] aims to simplify the process of creating customized graph layouts, the execution and invalidation of constraints can still be hard to comprehend. I would therefore like to develop new techniques to facilitate program understanding for constraints. Constraints may also prove useful for reflecting the expectations of the user for responsive visualization design [7], and similarly raises issues of program understanding and debugging as explored in my prior work. In this space, I would like to explore options for automatically adapting the visualization content based on device or user context. As the number of visualizations grows, I would like to explore new techniques for summarizing multiple designs and supporting designers in exploring the space of visualizations that they create.

To facilitate the process of interacting with complex end user systems, I would like to conduct research on how best to communicate the user's intent in the system and translate the system output into actionable information for the user. This future work could prove integral to the application and widespread use of constraints. Going further, I want to explore how communicating both user and system intent can positively impact a larger class of end users systems. One common assumption across my research projects is that the data will arrive in a clean, ready-to-use format. For Vega [1], many data transformations are possible, and my programming understanding systems aim to give insight into how those transformations behave or what happens when they fail [2,3]. For example, users can probe points in the output to see how data maps to the visual encodings (e.g., the color) 

[2] or to see the variation in a dataset  based on the behavior of data transformations over time [3]. These approaches surface details of the otherwise opaque data processing pipeline in Vega. In my future work, I would like to explore how these techniques or new approaches can better support users in developing and integrating data transformations into their design process for different end user systems and data analysis workflows.

Leadership and Volunteer Experience

My research aims to improve the user experience as does my volunteer work in the computer science community. I joined the Graduate, 5th-year Masters, and Postdoc Advisory Council (G5PAC) [11] to discuss and implement changes that improve the graduate student experience within the UW Allen School.

As part of this council I worked on communicating and analyzing results from past student-led surveys on happiness within the department and developed a set of guidelines to inform how future surveys are conducted. In an effort to improve communication in the Allen School, I also worked on new procedures for students planning to change advisors and for faculty to report on-leave status from the department. As part of the G5PAC, I enjoyed engaging with other students, faculty, and staff to learn about the challenges when running a large academic organization and to envision and implement opportunties for growth.

As a graduate student in the Allen School, I have also helped to organize the weekly HCI seminar (CSE590h) focused on reading and discussing papers. As part of this role, I collected feedback and implementing changes to the seminar to encourage participation and ensure that attendees felt included and welcome in class conversations. As the HCI group has grown in size, we needed to shift the structure of this seminar to include smaller group conversations that enable more students to actively participate by sharing their opinions and unique expertise with a subset of other students and faculty. This change has been a great way to hear from a wider range of people and expand the topics covered in discussion.

In two related roles, I acted as one of the HCI Visit Days Coordinators to organize group activities and schedule one-on-one meetings with prospective graduate students (Winter 2018) and as the New Graduate Orientation Leader to coordinate and host the two-day orientation for new graduate students in the Allen School (Fall 2015). In both cases, it was important to arrange activities in which new students could feel comfortable meeting and interacting with others. These positions were a wonderful opportunity to personally interact with and shape the experiences of new students in the department.

I have also acted as a Graduate Student Admissions Volunteer, in which I reviewed admissions applications for the Allen School (Fall 2016). This experience was an interesting way to learn about the admissions process and the values of our department. This role can be quite challenging however, and the G5PAC has recently begun discussing how best to prepare and support future volunteers, and better ways to communicate expectations to potential applicants. I also frequently act as a reviewer for conferences including CHI, VIS, UIST, and TVCG. Reviewing papers is another good way to learn about the inner-workings of the publication process, and to become familiar with cutting-edge research.

This April, I attended and prepared a talk for the 2020 Women's Research Day, which was released on the UW Allen School YouTube channel [10]. As an intern with Adobe Research (Summer 2019), I also gave a talk as part of the Girls Who Code program [12], which aims to empower young high school women by engaging them in technology and computer science fields. Finally, I received a Hopper x 1 Seattle 2019 Scholarship to attend the conference and meet with other award recipients. For me, these experiences have been a wonderful way to meet and engage with other incredible women in the computer science community. Attending these types of events provides unique insights into the computer science field and allow me to engage with a larger group of individuals outside my immediate research area. I also find it valuable to share my own expertise as a senior graduate student and to meet new aspiring researchers.

I believe that there are always opportunities to learn and grow. I find that it is important to be involved in leadership and volunteer roles in which I can contribute positively to the growth of my organization and the larger computer science community. In such roles, I appreciate having the opportunity to hear and learn from the experiences of others and to share my own opinions and expertise. I hope to continue being involved in positions that value service work and strive to create an inclusive and socially conscious environment both within the organization and as part of the organization's larger role and impact on society.

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