Title:

Bringing Real-World Data and Visualizations of Student-Implemented Data Structures into Sophomore CS courses Using BRIDGES

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Abstract. This workshop introduces participants to the concepts and use of BRIDGES, a software infrastructure for programming assignments in data structures and algorithms courses. BRIDGES provides two key capabilities, (1) *easy to use interface* to real world datasets spanning social networks, entertainment (IMDB, Song Lyrics), scientific data (real-time USGIS Earthquake Data) or social (crime data), literature (books), and (2) the acquired data can be used in assignments by students to populate their implemented data structures and *visualized*, including the capability to bring out attributes of the dataset. The visualizations are displayed on the BRIDGES website and are easily shared (with family, friends, peers, etc) via a weblink. Workshop attendees will engage in hands-on experience with BRIDGES and multiple datasets, and will have the opportunity to discuss how BRIDGES can be used in their own courses, as well as partner with the BRIDGES team.

Advertisement. *Do you teach a Data Structure course? Here is an opportunity for you. We will be running a BRIDGES training workshop at SIGCSE 19. BRIDGES provides an infrastructure for data structures/algorithms courses that let you easily bring in interesting real-world datasets into your course assignments and let your students visualize the data structures they build. See the examples at http://bridgesuncc.github.io/ Bring a laptop!*

Significance and Relevance of the Topic. Despite the huge explosion in CS enrollments in the past few years, retention of CS majors remains a major concern. Many researchers agree that showing relevance and connecting programming courses to the real world are key to increasing students' motivation and engagement in computing, and may help provide a path forward to retaining students in CS degree programs. While retention depends on multiple factors (many of which are institution dependent), our own experience on using BRIDGES over the past 3 years in our data structures courses have shown better student outcomes in follow-on courses, when compared to students from the remaining sections of the same course.

BRIDGES provides two key advantages that is readily applicable to data structures and algorithms courses: (1) Minimal effort in using interesting real-world datasets as part of homework assignments, typically, a single function call returning an array of objects (Java, C++ or Python objects) corresponding to the dataset, and (2) the ability to visualize the data structures that students create and easily share via a web link (multiple live examples of BRIDGES data structure visualizations can be seen at http://bridgesuncc.github.io/). BRIDGES has been used in data structures and algorithm analysis courses at UNC Charlotte for the past 4 years, and currently in use at 6 other institutions; student feedback has been very positive. BRIDGES supports both C++, Java and Python and is fully documented. Finally, BRIDGES is ready for use by educators and a SIGCSE workshop to disseminate the system will be attractive to attendees.

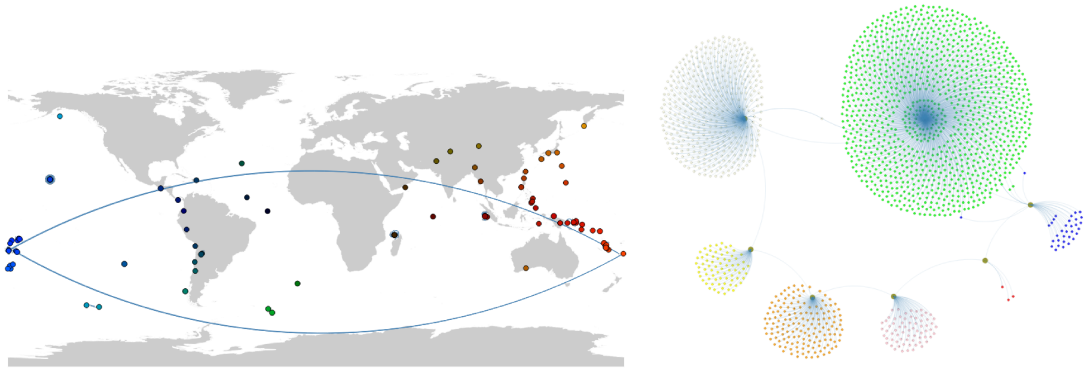

Figure 1: [Left] Illustrates a graph representing earthquake data from USGIS, mapped to their respective locations; there is an edge between two nodes if they are within 100km. [Right] A graph representation of the earthquake data, displayed as clusters of the nodes by quake magnitude range (magnitudes in the range 1.0-2.0, 2.0-3.0, 3.0-4.0, 4.0-5.0, 5.0-6.0)

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Expected Audience. Computer Science or ECE educators teaching algorithms or data structures courses who are interested in using real-world datasets and visualizations in course assignments. We expect broad interest in this workshop (25-30 participants). Our first BRIDGES workshop at ACM SIGCSE 2016 attracted about 22 participants.

Space and Enrollment Restrictions. There are no space and enrollment restrictions.

Expertise of Presenters:
Kalpathi Subramanian is an Associate Professor of Computer Science at the University of North Carolina at Charlotte. He is the PI on the NSF TUES award, *Building BRIDGES Within the Undergraduate Major in Computer Science*, along with Drs. Jamie Payton, as well as a more recent NSF IUSE Award, *Retaining and Engaging Computer Science majors by Solving and Visualizing Algorithmic Problems on Real-world Data Sets,* along with Drs. Payton and Erik Saule, which is the motivation for this workshop.
Jamie Payton is an Associate Professor of Computer Science at Temple University. She is the PI of the STARS Computing Corps, an NSF-funded alliance of 50 colleges and universities that aims to broaden participation of underrepresented groups in computing. She is the creator of the Mobile Application Development for Science program, which leverages her research in crowdsensing (i.e., engaging the general public in collecting data using sensors embedded on mobile phones for a civic or scientific purpose) to introduce middle school students to STEM concepts. She is a co-PI on the NSF-funded project, The Connected Learner, which aims to revolutionize CS education by connecting students to their peers, the profession, and a purpose, and is a co-PI on the BRIDGES and IUSE projects.
Erik Saule is an Assistant Professor of Computer Science at the University of North Carolina at Charlotte. His educational research interests include the education of parallel computing, data structures, and algorithms. He serves as the Program Chair of the 2018 Workshop on Education for High-Performance Computing (EduHPC-18). He is a co-PI of the above mentioned NSF IUSE award and a recipient of an NSF CAREER award. He received his PhD in 2008 from the Grenoble Institute of Technology, France
Workshop Agenda
Participants will have the needed BRIDGES software and Java, C++ or Python components prior to workshop through distributed materials.

- **BRIDGES project (overview, design, demo)** (15 minutes)
- **Hands-on Experience 1.** Participants will be led through a simple example (scaffolded example) BRIDGES program to ensure that they can build and generate a visualization of the data structure. For example, they will be provided a graph of a family tree, which they can customize to represent their own family. (30 min)
- Break (10 min.)
- **Hands-on Experience 2.** Participants will choose (vote) from a set of 3-4 example real-world data set/data structure combination (IMDB Actor/Movie data, USGIS quake data, Song Lyrics, Books); to ensure the attendees are able to complete this example, all attendees will work through the chosen example (extensions to the example will be provided for early finishers). Scaffolding/starter code will be provided for each example, which should help the participants complete the project. Some examples can be seen at http://bridgesuncc.github.io/)(75 min)
- **Results/Feedback/Discussion.** Participants will present their results from the BRIDGES exercise, discuss difficulties they faced with BRIDGES, and the issues they face in teaching data structures/algorithms courses, suggest improvements. They will also complete a survey. (45 min)

Audio/Visual and Computer Requirements Workshop attendees should bring their own laptops to work through exercises using the BRIDGES software infrastructure (else pairing up is also acceptable). Access to power outlets is needed as this is a hands-on workshop. WiFi access is needed to support interaction with the BRIDGES server. A projector is needed for presentation to the audience.

Other Critical Information This workshop will advance the goal of finding new and potential adopters of this software system, a principal and current goal of our NSF iUSE project.