Relevant Real-World Undergraduate Research Problems: Lessons from the NSF-REU Trenches

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SUMMARY

Projects funded by the National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program aim to (a) enhance participation of students who otherwise might not have research opportunities, and (b) increase the number of students interested in graduate programs, thus expanding the pool of a well-trained scientific workforce. To provide meaningful experiences for these students, REU projects make use of a set of interesting, appropriate research problems that can be tackled in 8 to 10 weeks in summer.

The panelists have all served as PIs or Co-PIs on NSF REU projects in computing. They will present their REU research problems, highlight challenges they encountered, and present their results. They will also discuss what they have done, or what can be done, to incorporate such research problems within the regular computing curriculum, for example, in capstone courses or senior projects. A significant amount of time will be set aside for audience participation and discussion.

Categories and Subject Descriptors

K.3.2 [**Computer and Information Science Education**]: Computer science education

General Terms

Design

Keywords

Undergraduate research, computing problems

1. BACKGROUND

The inclusion of meaningful research experiences for undergraduates has received increased attention in recent years at computing conferences including SIGCSE for a variety of reasons. Such experiences foster recruitment of undergraduate students, who otherwise might not have research opportunities including the underrepresented, into graduate programs via early research exposure [3]. Additionally, it has been shown that students benefit from exposure to highly interdisciplinary research problems [1, 8]. REU-style research problems can address the needs of many undergraduate computer science curricula that require some form of senior project or capstone experience [9]. Involvement in undegraduate research also helps with faculty professional development [6] and there is evidence that the early involvement in research helps with student retention [5, 7].

Attributes of successful undergraduate research projects have been previously discussed [2]. At SIGCSE 2006, a related panel focused on the benefits and challenges of providing research experience for undergraduates, and how faculty can fund and develop their own undergraduate research programs [4].

This panel focuses instead on specific REU research problems. The panelists are PIs or Co-PIs on NSF REU projects in computing. The NSF REU program provides support for undergraduate research through various channels including the establishment of summer research programs at academic institutions around the country. The students involved in these programs typically work on specific research problems for 8-10 weeks.

To provide meaningful research experience for students involved in these programs, the assigned research problems must be interesting and significant enough in scope to cover the duration of the program. The panelists will focus on how they developed relevant real-world research problems, what was achieved, and how these problems can be generalized in other undergraduate contexts. The focus on specific research problems makes this substantially different than previous SIGCSE panels. Finally, a higher number of panelists is justified for this session to ensure that a wider variety of research problems is presented.

2. THE PANELISTS

Dr. Reynold Bailey serves as a mentor for an REU site in computer science at Rochester Institute of Technology. He

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has also been involved in efforts to broaden participation in computing programs among underrepresented communities. He will function as the moderator for this panel.

Dr. Guy-Alain Amoussou has served as PI of two consecutive REU sites at Humboldt State University, a California State University campus. Since 2005, his REU programs have trained forty four students in an interdisciplinary environment including computer science, math modeling, geographic information systems and engineering. The overarching theme is related to the science of design (SoD) with a focus on creativity, design activities, and methodology for thinking about and solving problems. Examples of projects students investigated include: robotic systems for visual placement, study of fusion energy, design of multi-platform real-time collaborative sketching infrastructures, and computational coastal management.

Dr. Tiffany Barnes serves as co-PI of the Socially Relevant Computing REU Site at the University of North Carolina at Charlotte, where four labs have engaged students in 60 research experiences that advance technology to empower people to solve problems of personal interest, as well as problems that are important to society at large. Specific problems include developing: games to teach computing concepts, visualization tools and algorithms to help people develop mental maps for improved navigation, digital humans for more effective computer-based education of children, and sensor network protocols and systems to monitor environments for preserving historical and artistic artifacts.

Dr. Hans-Peter Bischof serves as PI of an REU site in computer science at Rochester Institute of Technology, where students work on different aspects of an interdisciplinary project to analyze and visualize the simulation of galactic events such as the formation of galactic nuclei and supermassive black hole mergers. Specific problems include the development of high performance distributed file systems based on commodity hardware, addition of sound to visualizations of galactic events using data-driven audio synthesis, and improved visualization of gravity waves and black hole mergers using various rendering techniques.

Dr. Thomas Naps serves as PI of an REU site in computer science at the University of Wisconsin Oshkosh, where students work on open source algorithm visualization projects. These projects are carried out using the JHAVÉ algorithm visualization environment (http://jhave.org), a large open source platform for staging instructional algorithm visualizations. JHAVÉ offers students the opportunity to be involved in all the components that contribute to successful algorithm visualization, including graphics, automated assessment strategies, and accompanying hypertextbooks. Student projects focus on developing a complete visualization-based instructional module on a topic of their choice.

3. SESSION OUTLINE

The moderator will provide the panel background and motivation, and introduce the other panelists. Panelists will speak for 10 minutes and discuss the research projects tackled by students at their REU sites. Each panelist will:

- Describe how their REU site is structured and the expectations of the students involved.
- Present an overview of the research problems including relevant background, challenges, and possible applications.
- Discuss the actual progress of student projects, focusing on student background, learning, and final achievements.
- Discuss the lessons learned and how their work can be generalized to other undergraduate contexts such as capstone courses or senior projects.

Finally, at least 30 minutes of the session are reserved for audience participation and discussion.

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