NSF Project Showcase

SIGCSE 2016

March 2-5, 2016

Memphis, TN

Schedule

CrowdGrader: Peer grading with incentives

Luca de Alfaro (UC Santa Cruz)

NSF award(s) 1432690

CrowdGrader is a peer grading tool in use in several universities and high schools. In CrowdGrader, the grade each student receives depends both on the quality of the students submitted work, and on the precision and helpfulness of the grades and reviews the student provides for the work she or he grades. This provides a powerful incentive for students to be accurate in their review work, and helpful in their feedback to others. We present in detail various alternatives for the incentive system, and we discuss the alternatives were received in the classroom and led to different student behavior. We also describe the lessons we learned by observing how CrowdGrader was used in classrooms for a variety of subjects in multiple institutions.

Project MLExAI: An Innovative Model for Teaching Core AI Concepts

Ingrid Russell, Zdravko Markov, and Susan Imberman (College of Staten Island)

NSF award(s) 0409497 and 0716338

The goal of Project MLeXAI is to develop a project-based framework for teaching core Artificial Intelligence (AI) topics through a unifying theme of machine learning. We build on the success of our smaller-scale NSF-funded Phase 1 work. A total of 26 adaptable, hands-on laboratory projects have been developed that can be closely integrated into introductory AI courses. This is a collaborative effort involving several faculty members working on the development of the material and also on its implementation and testing. Each project involves the development of a machine learning system in a specific application. The applications span a large area including network security, recommender systems, game playing, intelligent agents, computational chemistry, robotics, conversational systems, cryptography, web document classification, vision, data integration in databases, bioinformatics, pattern recognition, and data mining. The project will enhance the student learning experience in introductory AI courses by:

- Introducing machine learning elements into the AI course
- Increasing student interest and motivation to learn AI by providing a project-based framework for the presentation
- Developing, applying, and testing an adaptable framework for the presentation of core AI topics which emphasizes the important relationship between AI and computer science in general, and software development in particular

We present sample projects, our experiences using them, and results of assessment. Additional information is available at the project website at: `http://uhaweb.hartford.edu/compsci/ccli/`.

Computing in the Arts: Community Building and Curriculum Development

Jennifer Burg (Wake Forest Univ.)

NSF award(s) 1323593

This project – a collaboration of faculty at Wake Forest, College of Charleston, and UNC Asheville – is aimed at disseminating curriculum material and administrative structures that foster viable university-level computing in the arts programs. Computing in the arts programs have the challenge of integrating art, music, and computation by means of interdisciplinary courses and projects. Through three summer workshops, we provide faculty members from diverse fields an opportunity to discover and share ideas, experience, curriculum material, projects, and practical program-building skills that they can take back to their own institutions.

C5 - Catalyzing Computing and Cybersecurity in Community Colleges

Melissa Jane Dark (Purdue), Beth Hawthorne (Union County College), and Corrinne Sande (Whatcom Community College)

NSF award(s) 1548315

C5 project is an NSF funded project to Catalyze Cybersecurity and Computing in Community Colleges. The C5 project has two main goals: 1) increase the number of Centers of Academic Excellence-2 Year or CAE2Y institutions and create a nationwide network of community colleges that have met national standards in cybersecurity education, producing more and better prepared graduates, and ultimately leading to a more secure nation, and 2) develop a new CSP-Cyber course that will provide a different dimension to cybersecurity education at community colleges–as a key foundational computer science/cybersecurity course it will introduce a large number of students to the principles of computing and cybersecurity disciplines in an integrated format.

Bringing Real-World Data And Visualizations Into Data Structures Courses Using BRIDGES

Kalpathi Subramanian, Jamie Payton, David Burlinson, and Mihai Mehedint (UNC Charlotte)

NSF award(s) 1245841

This demo introduces participants to the concepts and application of BRIDGES, a software infrastructure designed to facilitate hands-on experience for solving traditional problems in introductory computer science courses using data from real-world systems that are of interest to students, such as Facebook, Twitter, and Google Maps. BRIDGES provides access to real-world data sets for use in traditional data structures programming assignments, without requiring students to work with complex and varied APIs to acquire such data. BRIDGES also helps the students to explore and understand the use of data structures by providing each student with a visualization of operations performed on the student's own implementation of a data structure. BRIDGES visualizations can be easily shared (via a weblink) with peers, friends, and family. Demo attendees will see (and possibly engage in) hands-on experience with BRIDGES and will have the opportunity to discuss how BRIDGES can be used to support various introductory computer science courses. Additionally, the demo will complement our oral presentation of our work at SIGCSE, by providing hands-on demonstrations of BRIDGES.

Software Tutors for Introductory Programming: Epplets, Codelets and Problets

Amruth N. Kumar (Ramapo College of New Jersey)

NSF award(s) 1502564, 1432190, and 0817187

Epplets, codelets and problets are three software tutoring suites developed to help students learn to program. They are meant to supplement classroom instruction and complement programming projects. They are available over the web and are free for educational use.

Epplets (`http://epplets.org`) present extended Parsons puzzles. In a Parsons puzzle, the student is presented a description of a problem, and a program to implement it, with the statements in the program scrambled. The student must reassemble the statements in their correct order and eliminate distractors. The student cannot submit the solution until it is correct, but feedback is provided to help the student solve the problem. Solving a Parsons puzzle is equivalent to reconstructing the underlying algorithm.

Codelets (codelets.org) present a problem and an algorithm to solve it. The student must write code for the problem as per the algorithm. Once again, the student cannot submit the solution until the code is complete and correct, but immediate feedback is provided after each statement describing not only whether the students code is correct, but also how to fix incorrect code. Codelets help the student learn to translate an algorithm into a program.

Problets (problets.org) present problems such as debugging programs, predicting their output, predicting their state, and evaluating expressions. They flag errors while the student is entering the answer to a problem. After the student submits the answer, they provide step-by-step explanation of the correct answer. Problets help students learn programming concepts by solving problems.

If you are interested in using these tutoring suites, please contact amruth@ramapo.edu.

Customizable Visualizations for Introducing Database Concepts to Many Majors

Suzanne W. Dietrich (Arizona State) and Don Goelman (Villanova Univ.)

NSF award(s) 1431848 and 1431661

Database concepts are typically taught only to upper-level computer science majors. However, databases are a tool used in many disciplines for the storage and retrieval of information. In fact, scientific research typically involves large observational data sets that must be stored in databases to support its analysis. To address this multidisciplinary need of diverse disciplines, the National Science Foundation funded the predecessor of the current grant, in order to develop animations that dynamically present relational database concepts. They include how a database differs from a spreadsheet and how to query a database using the industry standard SQL. The current project adds opportunities for formative self-assessment, called checkpoints, to each animation. Moreover, the examples and associated text used in the visualizations are customizable, providing instructors across disciplines with a tool to tailor the example to meet their pedagogical needs in the classes that they already teach. The animations with supporting curriculum materials are available online at `http://databasesmanymajors.faculty.asu.edu`. The presentation at the Showcase will highlight the customization tools for specializing the animations; the tool, now being beta tested, is not yet available on the project Web site. The goal of the presentation is thus two-fold: to recruit users of the animations to introduce databases in their non-major fluency courses, and to recruit colleagues with existing interdisciplinary collaborations to customize the animations for a specific domain. Existing customizations that are available on the Web site include geographic information systems and computational molecular biology.

Learning CS Education Empirical Research Methods

Jeffrey Carver (University of Alabama), Sarah Heckman (NC State Univ.), and Mark Sherriff (University of Virginia)

NSF award(s) 1525373

As the demand for computer science graduates increases, educators must effectively educate students at scale, which requires innovation in teaching and learning techniques. This project will help move the CSEd community from reflective teaching to the Scholarship of Teaching and Learning by increasing study rigor and replication frequency. The goal of this project is to transform empirical CSEd research by building and supporting a community of CSEd researchers through: (1) creation and curation of laboratory packages to facilitate empirical CSEd research, (2) facilitation of cohorts of 10-12 educators who are mentored in developing and executing an empirical CSEd research study and (3) development and presentation of tutorials on empirical research methods at CSEd conferences. Laboratory packages are aids that provide researchers with a driving research question, a methodology for designing and executing a study, tools and resources to replicate the study, and results of previous related studies. The cohorts will have a more-focused interaction during a summer session to develop a study with a follow-up workshop to report and discuss results. Finally, the tutorials allow for broader dissemination of the key concepts of empirical CSEd research to the larger community.

Integrating Mobile Computing and Security into a Computer Science Curriculum

Xiaohong Yuan, Kenneth Williams, Jinsheng Xu, and Kelvin Bryant (NC AT&T University)

NSF award(s) 1332504

This project integrates mobile computing and security into the Computer Science program at North Carolina A&T State University. Twelve (12) course modules in mobile computing and security are being developed and integrated into existing Computer Science courses such as computer programming, software development, operating systems, and information assurance courses. Each course module includes learning objectives, a tutorial, presentation slides, hands-on labs and/or case studies, test questions, etc. The course module material we develop and our teaching experiences will be beneficial to computer science educators who are considering including mobile computing and mobile security into their curricula.

CS1: Creative Computation in the Context of Art and Visual Media

Dianna Xu (Bryn Mawr College), Ira Greenberg (Southern Methodist Univ.), Deepak Kumar (Bryn Mawr College), Aaron Cadle (Fort Worth Country Day School) and Ursula Wolz (RiverSound Solutions)

NSF award(s) 1323463 and 1323305

We showcase a new approach to teaching CS1 using computational and generative art as a context. We design our courses to teach the core CS1 topics as we would in any average traditional Java-based CS1, but show applications of these principles with contemporary, diverse examples of computing in a modern context. We use the Processing programming language and environment, designed for the construction of 2D and 3D visual forms. Its IDE is lightweight, but well-suited for the kind of rapid prototyping needed for dynamic visual work. We hope to strengthen formative/introductory CS education by catalyzing excitement, creativity, and innovation. More than thirty pilot offerings in a variety of different institutions report overwhelmingly positive enrollment and retention trends, as well as strong evidences of attracting women and non-STEM or undecided majors to computer science. This multi-institutional project is testing and assessing course adoptions in computer science programs at a dozen participating colleges, universities and high schools nationwide.

Collaborative Education: Building a Skilled Software Verification and Validation User Community

Sushil Acharya, Priyadarshan Manohar, and Peter Wu (Robert Morris Univ.)

NSF award(s) 1245036

Software quality is a crucial issue in software development. As software has become ubiquitous, software products have become critical. Industrys general lack of appreciation of Verification and Validation (V&V) benefits and more importantly the shortage of V&V practitioners poses multitude of problems in the software industry. Imparting real world experiences in the academia as well as the industry is a challenge due to lack of effective active learning tools. This pedagogical requirement is important to the academia as graduates are expected to develop software that meets rigorous quality standards in functional and application domains.

Through a NSF grant the PIs have incorporated academic research and industry best practices through an academia-industry partnership and have developed eighteen (18) delivery hours of case studies, sixteen (16) delivery hours of exercises, and six (6) delivery hours of case study videos for use in courses that impart knowledge on S/W V&V topics viz. requirements engineering, reviews, configuration management, and testing. This project has: 1.Critically examined existing V&V course contents at the authors institute, 2. Identified areas where improvements can be made in the pedagogy, 3. Developed new active learning tools, 4. Developed course delivery strategies, 5.Integrated and delivered new pedagogical tools in the course, 6. Performed assessments and evaluations of the effectiveness of these tools, and finally 7. Disseminated course modules and assessment reports. The developed active learning tools have been disseminated to 12 universities and many of them are actively using the materials in their courses in the current academic year.

Supporting Student Learning in Humanitarian Free and Open Source Software (HFOSS) Projects

Heidi J. C. Ellis (Western New England Univ.), Darci Burdge (Nassau CC), and Gregory W. Hislop (Drexel Univ.)

NSF award(s) 1225708

Humanitarian Free and Open Source Software (HFOSS) projects are open source projects that somehow improve the human condition and may range from medical records to micro-finance to disaster management systems. Student participation in HFOSS projects allows students to gain real-world experience and learn about complex software within a community of professionals. In addition, the humanitarian aspect of HFOSS projects provides students with the motivation of doing good. However, many faculty members face barriers to such participation including identifying assignments, designing appropriate rubrics, mapping an academic schedule to the HFOSS release cycle, and eliciting engagement from the HFOSS community.

This presentation will have two main sections. The first section will present results of a multi-year, multi-institutional research study that indicates that student participation in HFOSS promotes student learning in the areas of tools and techniques and technical knowledge about the process and tools used to develop an HFOSS project. Results also suggest that women and underrepresented minorities find the social and altruistic aspects of computing attractive and that involving students in HFOSS projects may encourage students to persist in CS as a career. The second section of the presentation will address the challenges that faculty members face in supporting student participation in HFOSS including approaches for overcoming such challenges. Experience reports of faculty who have successful supported student participation in HFOSS will be presented.

Increasing Retention in Engineering and Computer Science with a Focus on At-Risk First Year and Sophomore Students

Tammy VanDeGrift (University of Portland)

NSF award(s) 1317238

At the University of Portland, the first to third semester retention rate for engineering and computer science students who start in pre-calculus is 53.8%, and the four-year graduation rate is 25.0% (compared to 80.7% and 51.9%, respectively for students who start in calculus I or higher). In addition, students who start their second year behind their cohort in terms of credits have a 17% lower third to fifth semester retention rate than those who are on track to graduate in four years. We focus on this "at-risk" group, defined as students who start in pre-calculus or fall behind toward degree progress during the first two years of college.

We implemented two summer interventions for our at-risk group: a two-day STEP UP summer program for pre-freshmen and an eight-week Summer Scholars program for rising sophomores. In addition, a year-long academic success program supports these at-risk students; an academic advisor works one-on-one with students to assist with goal-setting, effective academic success strategies, setting up plans to get back on track toward degree progress, and to help keep students accountable. In addition to one-on-one meetings, the academic advisor coordinates workshops and social events for students to build community. All three programs draw upon Tintos model of retention, which suggests that students need to be fulfilled both academically and socially to persist. We emphasize academic achievement and community building as key pieces to success in engineering. The overall program depends on cross-campus collaboration with other academic departments and student services.

Bolstering Security Education in Browser Security

Wenliang (Kevin) Du (Syracuse Univ.), Li Yang (UT Chattanooga), and Xiaohong Yuan (NC A&T Univ.)

NSF award(s) 1318439, 1318695, and 1318883

Web browser is one of the most frequently used software by users on daily basis because of its ubiquitous access. It is attractive for a number of applications, including email, online retail sales, banking, Wikis, health Information Technology (IT), content management systems (CMS), social networks and many other functions. We have transited important research topics in browser security into teaching objects in forms of hands-on labs, visualization tools, and case studies. We will show several hands-on labs including: (1) cross-site scripting attack lab, (2) cross-site request forgery attack lab, (3) SQL injection attack lab, (4) Clickjacking attack lab, and (5) cookie tracking lab. We will show visualization tools such as Cross Site Scripting (XSS), cross-site request forgery (CSRF), and cookie tracking. We will also use a case on Ad Fraud to show privacy violation, and another case on "How to shop for free online" to show security vulnerabilities in complex web applications.

On Beyond Sudoku: Pencil Puzzles as an Engaging Problem Domain for Intro CS

Zack Butler and Ivona Bezakova (Rochester Inst. of Tech.)

NSF award(s) 1245349

In the course of teaching typical programming concepts in an introductory computer science course, it is challenging to come up with appropriate assignments that are relevant, interesting, and easy to understand. Context-based learning, in which the students learn a technique by applying it to a real-world problem, has been applied in computer science using different domains, but it can be difficult to continually produce novel and engaging assignments. In this project, we aim to use the domain of pencil puzzles (think Sudoku, but across dozens of different – and nontraditional – styles) as context across the different topics of CS 1/2. These puzzles are designed to be solved by humans with pencil and paper, and naturally encourage algorithmic thinking in the solver. In addition, the wide variety of existing puzzle types makes it possible to continually develop novel and engaging assignments.

We have developed (and continue to expand) a repository of ideas for puzzle-based assignments at `http://www.cs.rit.edu/~pencilpuzzle`, and delivered several assignments in three different courses at RIT. The repository lists possible puzzles to use for most topics in CS 1/2, many of which are presented with complete assignments. The use of short standalone assignments makes it easy for educators to adopt as little or as much of our work as desired for their particular course. To date, we (and our colleagues) have delivered pencil puzzle assignments in three different courses to over 600 students.

Please stop by our NSF showcase booth to discuss the possibilities that puzzles can offer in the CS curriculum!

Computional Creativity to Improve CS Education

Leen-Kiat Soh and Duane Shell (Univ. of Nebraska)

NSF award(s) 1431874

Computational thinking and creative thinking are complementary skills that when blended together become computational creativity, enhancing learning and application of both. Our long-term vision is to address the growing need for computationally savvy, creative thinkers and problem solvers by incorporating computational creativity into the undergraduate CS curriculum to reach both CS majors and other students in STEM and non-STEM fields. A suite of Computational Creativity Exercises (CCEs) was created through a TUES grant (DUE-1122956). Evaluation found that students who completed the exercises had higher course grades and better learning of CS content. The goal of this project IUSE: Design, Development, and Implementation Projects: Computational Creativity to Improve CS Education for CS and non-CS Undergraduates is to build on the innovation and results from the previous TUES grant. Specific aims are to produce a final suite of validated, high quality CCEs and a Computational Creativity undergraduate course, and to conduct rigorous research to understand for whom and under what conditions the CCEs are most efficacious, why the CCEs are effective by studying students' collaborative interactions and learning processes, and how the CCEs impact students' enrollment and retention in CS and STEM courses.

Bringing a Rigorous CS Principles Course to the Largest School System in the U.S.

Dan Garcia (UC Berkeley), Brian Harvey (UC Berkeley), Tiffany Barnes (NC State), June Mark (EDC), and E. Paul Goldenberg (EDC)

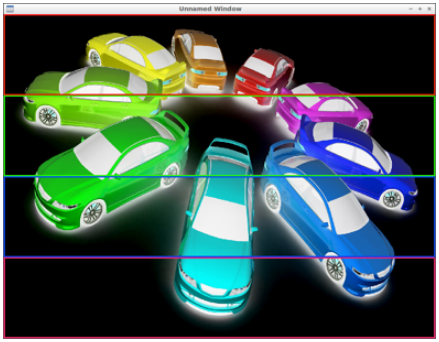
NSF award(s) 1138596

The Beauty and Joy of Computing (BJC) is an introductory computer science curriculum developed at the University of California, Berkeley, intended for non-CS majors at the high school junior through undergraduate freshman level. It was one of the five initial pilot programs for the AP CS Principles course being developed by the College Board and the National Science Foundation. Many things have changed since those early days, with more than two hundred high school teachers offered BJC professional development (PD) through four NSF grants, a transition to our blocks-based online software platform Snap! (based on Scratch) with cloud support, and a partnership with professional high school curriculum developers at EDC (Education Development Center), who are working with us to further refine our curriculum. Through partnerships with EDC, the New York City Department of Education, and CSNYC, our NSF-funded BJC4NYC project will bring BJC to 100 high school teachers in New York City, the largest and one of the most diverse school districts in the country. We have professional development opportunities for any interested high school teacher: `http://tinyurl.com/BJC2016`

Patternlets and TSGL: CSinParallel Tools for Visualizing Parallel Behavior

Joel C. Adams (Calvin College), Richard Brown (St. Olaf College), and Elizabeth Shoop (Mcalester College)

NSF award(s) 1225739, 1226172, and 1225796



Parallel and distributed computing (PDC) is now in the core CS curriculum, so every CS student needs to learn about PDC. CSinParallel is an NSF funded project to provide modular PDC pedagogical materials, tools, and faculty development workshops. One of our tools is patternlets, a collection of minimalist, self-paced, parallel programming exercises. Another of our tools is TSGL, a thread-safe graphics library that can be used with OpenMP, C++11, and/or POSIX threads. Using TSGL, an educator (or student) can annotate a multithreaded computation with graphics calls that show precisely what each thread is contributing to the computation as the program is running, in near real-time. This presentation will include an overview of the CSinParallel project, plus "live" demonstrations of patternlets and TSGL visualizations that illustrate different ways of visualizing parallel behavior.

Computing in the Arts: Multidisciplinary I

Susan Reiser and Rebecca Bruce (UNC Asheville)

NSF award(s) 1323610

We are makers and we are educators. In the tradition of Black Mountain College, we believe that "making something is a different learning experience from remembering something." Making is making choices. It is synthesis; it is creativity; it is experimentation; and it should be part of a technical education. For us, making is always informed by artistic concepts and methods. Equally important, we find that art theory and practice can be enriched by technical expertise. For example, computing theory and practice can be applied in art and, at the same time, be informed by atristic concepts and methods. Engineering design is not a balance of art skills and engineering skills: it is a synergy of these two such that each practice informs the other. We have worked to bring making to technical education across several disciplines. This presentation focus on our project-based CS0 course in which our students team with sculpture students to design and fabricate assistive devices. An assistive device can make its user feel conspicuous when its visual aesthetic is ignored. Our students are tasked with designing functional devices that change the perception of disability through aesthetics, craftsmanship, and social acceptance. The students - computer science, art, engineering, and new media majors - experiment with materials and design throughout the fabrication process, this semester including bronze or aluminum casts. The synergy of form and function in the devices they create is a manifestation of the larger synergy between art and technology.

Building Virtual Research, Interactive, Service, and Experiential Learning Modules for Cyber Security Education

Feng Li (Purdue)

NSF award(s) 1431330

This project will help address the critical need for more graduates who have a foundation in cybersecurity concepts and skills. It will utilize a cyberinfrastructure learning experience, through the use of a mobile cloud-based virtual laboratory (MCVE), to introduce cybersecurity material to computer science (CS), information technology (IT), and computer engineering (CE) students at Indiana University-Purdue University at Indianapolis (IUPUI), Rochester Institute of Technology (RIT), and Tennessee State University. Existing courses can be enhanced with the addition of relevant lab modules, and this approach will make it possible for students to see directly how computer science and engineering concepts can be used in real problem-solving. This project will promote recruitment and retention of CS, CE, and IT students for careers in cybersecurity. In addition, a number of professional development and outreach workshops will help increase the number of university faculty prepared to offer courses that utilize the same underlying system, and also prepare high school teachers to, at minimum, make students aware of cybersecurity issues and practices.


For more information on participating, please visit:
http://www.cs.virginia.edu/~sherriff/nsfshowcase