Schedule

Thursday, 10:00 a.m. – 11:30 a.m.
A New Tool for Guiding Faculty in Customizing Database Visualizations for Learners of Many Majors Suzanne W. Dietrich: Arizona State University
Don Goelman: Villanova University
Software Tutors for Introductory Programming: Epplets, Codelets and Problets Amruth N. Kumar: Ramapo College of New Jersey
Computing in the Arts: Community Building and Curriculum Development Jennifer Burg: Wake Forest University

Thursday, 3:00 p.m. – 4:30 p.m.
CyberPaths: Broadening the Path to STEM Professions through Cybersecurity Learning Xenia Mountrouidou: College of Charleston Xiangyang Li: Johns Hopkins University
CS Principles Ebooks for Teachers and Students building on Educational Psychology Principles Barbara Ericson, Mark Guzdial, Miranda Parker: Georgia Tech
Design Challenges and Stories: Integrating Reflective Design Learning in Computer Science John Georgas, Austin Sanders: Northern Arizona University
Activity-Based Logical Code Reasoning Michelle Cook: Clemson University Jason O. Hallstrom: Florida Atlantic University Joseph E. Hollingsworth: Indiana University Southeast Murali Sitaraman: Clemson University

Friday, 10:00 a.m. – 11:30 a.m.
Information Assurance and Security Education on Portable Labs Dan Lo: Kennesaw State University
Increasing Student Interest in Data Structures Courses with Real-World Data and Visualizations Using BRIDGES Kalpathi Subramanian, Jamie Payton, Michael Youngblood, Robert Kosara, Paula Golkasian, David Burlinson, Mihai Mehedint, Dakota Carmer, Lucas Estrella: UNC Charlotte
Automated Laboratory Generation for Yakama Nation Students Brent Lagesse: University of Washington
On Beyond Sudoku: Pencil Puzzles for Introductory Computer Science
Zack Butler, Ivona Bezakova: Rochester Institute of Technology

Friday, 3:00 p.m. – 4:30 p.m.

Collaborative Research: Capacity building in Cybersecurity-literacy:
An inter-disciplinary approach Shamik Sengupta: University of Nevada, Reno

Puzzle-Based Learning Approach to Teaching Cyber Security Concepts
Joshua Britt: Jackson State Community College

Authentic STEAM-based Computer Science Education for Non-Majors Brian Magerko, Tom McKlin, Lea Ikkache: Georgia Tech

Integration of Computing with Electronic Textiles to Improve Teaching and Learning of Electronics in Secondary Science Colby Tofel-Grehl: Utah State University

Saturday, 10:00 a.m. – 11:30 a.m.

Designing and Studying of Maker Oriented Learning to Transform Advanced Computer Science Zane Cochran, Betsy Disalvo: Georgia Tech

Transforming Computer Science Education Research Through Use of Appropriate Empirical Research Methods: Mentoring and Tutorials Jeffrey Carver, University of Alabama
Sarah Heckman, North Carolina State University
Mark Sherriff, University of Virginia

MyCS: Middle-years Computer Science Sam Andow, Kaitlyn Eng, Julia McCarthy, Olivia Palenscar, Adam Schulze, Tommy Schneider, Zachary Dodds: Harvey Mudd College
Bryan Twarek, San Francisco Unified School District

Collaborative Research: Developing Course Modules to Teach Service-Oriented Programming through Exemplification and Visualization Xumin Liu, Rajendra K. Raj: Rochester Institute of Technology
Chunmei Liu: Howard University
Alex Pantaleev: SUNY Oswego
A New Tool for Guiding Faculty in Customizing Database Visualizations for Learners of Many Majors

Suzanne W. Dietrich: Arizona State University
Don Goelman: Villanova University

NSF award(s) 1431661, 1431848

The database visualizations with which this project deals introduce fundamental database concepts for learners of many majors using a dynamic presentation. There are three animations: one introducing relational databases and how they differ from spreadsheets, another covering querying concepts and the SQL standard, and the third describing the conceptual design of relational databases using Entity Relationship diagrams. Each animation includes a checkpoint, which is a formative self-assessment component that quizzes the learner to reinforce the concepts. A unique aspect of the animations is that they are customizable, where the example data and the associated text can be revised for any domain. The animations are available on the projects Web site at [http://databasesmanymajors.faculty.asu.edu](http://databasesmanymajors.faculty.asu.edu), including several customizations to the following topics: astronomy, computational molecular biology, environmental science/ecology, forensics, geographic information systems, and statistics. A study on the customization of the animations illustrated a need for a tool to assist the domain experts in the design of the data instance, which must adhere to various constraints. This tool guides the user through the creation of the database and generates the files that support the customization of the three animations using the newly created database. The domain expert can then use the generated file to customize the associated text within each animation. The customized animations are being used in existing courses as well as Course-based Undergraduate Research Experiences (CURE) to introduce students of many majors to the fundamental concepts of databases, addressing the needs of diverse disciplines in the design and analysis of data.
Software Tutors for Introductory Programming: Epplets, Codelets and Problets

Amruth N. Kumar: Ramapo College of New Jersey

NSF award(s) 1432190, 1502564

Epplets, codelets and problets are three software tutoring suites designed to help students learn to program. They are meant to supplement classroom instruction and complement programming projects. They facilitate active, self-paced learning, and are available for C++, Java and C#. They are accessible over the web and are free for educational use.

Epplets (epplets.org) present a problem statement and a program to solve it, but with the statements in the program scrambled. The student must reassemble the statements in their correct order and eliminate distracters. The tutor provides feedback until the student arrives at the correct solution. Epplets help students construct the algorithm for a problem.

Codelets (codelets.org) present a problem statement and an algorithm to solve it. The student must write code for the problem according to the algorithm. The tutor provides immediate feedback to help the student fix errors in the code until the solution is complete and correct. Codelets help students learn to write code.

Problets (problets.org) present problems on debugging and tracing programs and evaluating expressions. They prompt the student to revise the solution by flagging errors. After the student submits the solution, 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.
EDURange: an easy-to-use framework for cybersecurity education

Jens Mache: Lewis and Clark College
Richard Weiss: Evergreen State College
Michael Locasto: University of Calgary

NSF award(s) 1516100, 156730

The unmet demand for cybersecurity professionals in the US has been growing for several years. This represents a security risk. The EDURange project has created innovative exercises designed to address this problem. The intellectual merit is that we have created exercises that emphasize analysis skills, and we have used these exercises in the EDURange framework to collect data to assess how students accomplish analysis-related tasks. We have tested the exercises in several colleges, and we have introduced them to many faculty through workshops at several conferences.

These exercises 1) teach important analytical skills and adversarial thinking to undergraduates, which will not become obsolete as technology changes; 2) are presented as games and have been tested in the classrooms, where students have found them to be fun; 3) use public cloud computing to host the infrastructure, which has made the exercises easy to access without the need for special hardware or software; and 4) use a scenario design language and graphical interface, which provide flexibility for instructors to modify and create their own exercises.
Computing in the Arts: Community Building and Curriculum Development

Jennifer Burg: Wake Forest University

NSF award(s) 1323593

The Computing in the Arts grant is a partnership of three institutions: Wake Forest University, UNC Asheville, and the College of Charleston. The goals of the grant are to disseminate the successes of the model Computing in the Arts Program developed at College of Charleston; synthesize this work with other complementary approaches at partner institutions; and continue to create and disseminate innovative instructional material in order to build a strong and diversified community of computer science educators interested in adopting computing in the arts programs at their own institutions. Over a period of three years, this community has been forged through annual faculty development workshops, meetings and special sessions at SIGCSE, and a shared website of course exemplars and instructional material.

One resource developed during the course of the grant is the textbook entitled Digital Sound and Music: Concepts, Applications, and Science. This book creates bridges between computer science, music, and sound design and is freely available online at digitalsoundandmusic.com (authors Jennifer Burg (Wake Forest), Jason Romney, and Eric Schwartz).

Another textbook produced during the course of the grant which relates computer programming and music is Making Music with Computers: Creative Programming in Python (author Bill Manaris, College of Charleston).

Another curricular and programmatic outgrowth of the grant is UNC Asheville’s STEAM Studio, where students create innovative hands-on projects combining Arduinos, computer programming, robotics, sculpture, and other art forms.
The goal of this project is the diversification and broadening of the STEM talent pipeline in cybersecurity in predominantly undergraduate and liberal arts schools. This is achieved by the creation of a curriculum that accommodates students of different levels of computer literacy with focus on experiential learning. This project mitigates the challenges undergraduate institutions currently face in the cybersecurity area, for example, a tight computer science curriculum and the inability to support the expensive infrastructure required for cybersecurity education. Integrated into this project is research that evaluates using this new learning paradigm, whether students will attain an increased interest in cybersecurity learning.

We address the above challenges by creating a range of cybersecurity learning opportunities that emphasize hands-on and realistic experimentation for students in primarily undergraduate institutions. First, we attract a diverse population of students by introducing cybersecurity topics through multiple paths of study and engagement. Students will be introduced to cybersecurity concepts through stand-alone course modules and laboratory exercises injected in general education liberal arts courses. Interested students can study further by taking two cybersecurity focused courses and cybersecurity capstone projects created by this project. Second, we use the Global Environment for Network Innovation (GENI) infrastructure in the development of hands-on labs and the capstone project assignments. GENI offers an affordable cloud solution to undergraduate institutions that lack the infrastructure to support high overhead computer labs. We demonstrate the experiential learning material on GENI, the general education modules, and offer insights after piloting these at the College of Charleston.
CS Principles Ebooks for Teachers and Students building on Educational Psychology Principles

*Barbara Ericson, Mark Guzdial, Miranda Parker: Georgia Tech*

NSF award(s) 1138378, 1432300

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We have developed a new model for online learning using a dynamic, web-based book (or *ebook*), informed by principles of educational psychology. We believe that ebooks can have higher completion rates than a MOOC, with learning comparable to face-to-face classes. We have developed an ebook for prospective teachers of the new AP CS Principles (CSP) course that incorporates findings from educational psychology: worked examples, dual modality presentations, low cognitive load exercises, social support from small groups, and frequent practice interleaved with examples. We have also developed an ebook for high school students studying for the AP CSP exam. We will demonstrate both of these books at the Showcase.
Design Challenges and Stories: Integrating Reflective Design Learning in Computer Science

John Georgas, Austin Sanders: Northern Arizona University

NSF award(s) 1245427

Design is a core activity in computer science and software engineering as it determines the function and quality of software systems. As a result, it is vitally important that computer science graduates possess strong design skills. Conventional curricula, however, do not adequately support design learning since they isolate the explicit study of design to only a few selected courses and subjects while not encouraging wide-ranging design space exploration.

This project is aiming at improving the strategies used to support design learning in computer science by developing a modular instructional approach that enables students to engage in design problem-solving followed by the use of reflective learning to create narratives called design stories. This work is addressing the shortcomings of current practice by infusing the study of design throughout the computer science curriculum and promoting reflection as a key element of the learning process.
Using a freely available, web-based automated reasoning tool, we will demonstrate a sequence of engaging reasoning activities that are suitable to introduce beginning programmers and software engineering students to reason logically about code. The activities expose the difficulties in trying to pinpoint fine-grain obstacles that beginning-level programming students face in reasoning correctly about basic sequential code fragments as well as code compositions using if-then-else and loop statements or recursion. Some of the later activities involve simple objects. The automated tool has an underlying verification engine that makes it possible for the tool to offer activities and directed logical feedback not possible with typical development environments. Instructors can create new activities and can fine-tune the existing activities to their specific needs. The reasoning tools are freely available at our web site and they have been used in undergraduate classrooms. This research is funded in part by IUSE-EHR grant 1611714.
The popularity and the large market share of mobile devices such as smart phones and tablets have had a significant impact on our daily lives. The full-fledged computing platforms render a ubiquitous means to deliver information and knowledge. This project aims to utilize such platforms to enhance computer science education, especially in curricula such as programming, mobile application development and information assurance and security. Meanwhile, there is an urgent need to produce more qualified computer professionals in mobile application development and information assurance and security to meet the workforce shortage. We describe the design and implementation of our hands-on pedagogical model for learning information assurance and security based on mobile devices. Not only is this model feasible, but also it is affordable. The labware consists of hands-on real-world relevant self-contained learning modules, and is designed to be ready for wide scale implementation.
Increasing Student Interest in Data Structures Courses with Real-World Data and Visualizations Using BRIDGES

Kalpathi Subramanian, Jamie Payton, Michael Youngblood, Robert Kosara, Paula Goolkasian, David Burlinson, Mihai Mehedint, Dakota Carmer, Lucas Estrella: UNC Charlotte

NSF award(s) 1245841

We present BRIDGES, a software infrastructure designed to facilitate hands-on experience for solving traditional problems in algorithms and data structures courses using real-world data, such as social networks (Twitter, Facebook), scientific or engineering datasets (USGIS Earthquake data), Google Maps, etc. BRIDGES provides easy interfaces to real-world data sets for use in routine data structures or algorithms related programming assignments, without requiring students to work with complex and varied APIs to acquire such data. BRIDGES also provides visualization capabilities, allowing students to visualize the data structure they have created as part of their assignment. BRIDGES visualizations can be easily exported and shared, via a weblink, with peers, friends, and family. Attendees will see example data structure and algorithms projects that have been used in course projects over the past 2 years.
Automated Laboratory Generation for Yakama Nation Students

Brent Lagesse: University of Washington

NSF award(s) 1419313

We are working with the Yakama Nation to provide hands-on computer security education in their school district. Our project is divided into two main directions, technical and social. In the technical direction, we are building a system that will automatically generate computer security laboratories in a variety of virtual/cloud environments. The goal of this system is to make it so that teachers who lack expertise in enabling technologies can easily and rapidly deploy realistic labs for hands-on teaching and organizations that lack the funding for a dedicated computer security lab can remotely utilize resources provided by well-furnished organizations. In the social direction, we are working with experts in the Yakama Nation to involve the family and community that surrounds the students to support and encourage them to pursue STEM fields.
On Beyond Sudoku: Pencil Puzzles for Introductory Computer Science

Zack Butler, Ivona Bezakova: Rochester Institute of Technology

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. In this project, we are using the domain of pencil puzzles (think Sudoku, but across dozens of different – and nontraditional – styles) as an engaging 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 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 stand-alone assignments makes it easy for educators to adopt as little or as much of our work as desired for their particular course. We have delivered the assignments nine times in seven different sections of courses at RIT, for a total of over 1000 students, and have collected data from student surveys and grades. Our analysis shows that these assignments are effective for students independent of their gender and prior computing experience.

Please stop by our NSF showcase booth to discuss the possibilities that puzzles can offer in the CS curriculum!
The demand for cybersecurity research and a trained cybersecurity workforce is significant and increasing daily. The goal of this collaborative project between the University of Nevada, Reno (UNR) and the Truckee Meadows Community College (TMCC) is to develop an interdisciplinary cybersecurity research and education platform. This effort is aimed towards the development of the next generation of cybersecurity scientists and professionals and to equip them with a solid grasp of different academic viewpoints, including Computer Science, Political Science, Social Psychology, Information Systems, Business, Public Policy, and Justice. The research team will have a significant impact on students through engaging interdisciplinary training and learning mechanisms. The project has both a direct and indirect impact on hands-on research, STEM education, training and career development of the graduate, undergraduate, and K-12 students and ultimately, the community.
Puzzle-Based Learning Approach to Teaching Cyber Security Concepts

Joshua Britt: Jackson State Community College

NSF award(s) 1406992

The idea behind puzzle-based learning is to stimulate the learning curve by providing interesting challenges. Solving puzzles is an interesting and effective way of learning complex logic and abstract concepts. Puzzles formulate a problem in a specific format that encourages the solver to use skills and expertise and to think out of the box. The objective of this project is to develop innovative puzzles to assist in the learning process for cyber-security education. This session will demonstrate puzzles that have been created using several computer gaming platforms such as RPG Maker and Unreal.
EarSketch combines a Python and JavaScript code editor, an API and user interface for making music, and an audio loop library with musical building blocks in a variety of popular styles. This integrated web-based learning environment has been used primarily in AP Computer Science Principles and other high-school level computing courses, with pilot studies showing significant gains in student content knowledge and engagement, with particularly strong gains for female students. This research project seeks to adapt the EarSketch curriculum for introductory programming courses for non-CS majors at the college level and to determine if the intervention has a similarly significant impact in this context. Through a collaboration between the original creators of EarSketch and IT faculty at an open-access public college, the project has 1) iteratively authored, piloted, and revised an EarSketch e-book for undergraduate non-majors; 2) identified barriers to effective implementation of authentic STEAM undergraduate courses and approaches to addressing those challenges; 3) developed auto-grading and peer-grading approaches that enable open-ended STEAM assignments to be assessed at scale; and 4) piloted the e-book and evaluated students’ engagement, content knowledge gains, and persistence in computing.
Integration of Computing with Electronic Textiles to Improve Teaching and Learning of Electronics in Secondary Science

Colby Tofel-Grehl: Utah State University

NSF award(s) 1542801

Project STITCH (STEM Teaching Integrating Textiles and Computing Holistically) is a curriculum and professional development project designed to facilitate the development of a curricular approach to STEM content that integrates computer science (both hardware and software applications and development) into STEM curricular content to solve a range of authentic problems across disciplines in grades 5-11. Using electronic textiles (e-textiles) as a medium, Project STITCH seeks to train science teachers to use computer programming in an integrated fashion in core science content projects. As a medium, e-textiles projects align very well with longstanding calls for more hands-on, project-based science and engineering learning activities in schools (National Research Council, 2012). Teachers participate in a four day professional development workshop during which time they are taught both how to do e-textile projects and how to use them to teach the content required of them as classroom teachers. In addition to providing the teachers with professional development in the form of the workshop, Project STITCH provides teachers ongoing PD support to facilitate their success in teaching with these projects. Thus far our work has focused on developing the professional development experience and paired curriculum for teachers as well as prototyping three novel e-textile projects including our temperature sensing lunchbox, a force detecting backpack, and an analog sensor texting t-shirt. Our research team is interested in finding collaborators interested in the integration of core k-12 education and maker space technology. Please contact the principal investigator, Colby Tofel-Grehl via email at Colby.tg@usu.edu for further information.
In a rapidly changing world, it is essential that students develop the ability to transfer and apply their learning in new contexts. This project, at Georgia Institute of Technology, will explore the incorporation of Maker activities into upper-level computer science courses. The project hypothesis is that maker activities will improve knowledge transfer, and lead to stronger undergraduate STEM communities who can better carry out interdisciplinary work. The PIs are concerned with the physical environment that is used for maker-oriented courses, and the development of a physical environment that will facilitate learning in addition to making. Project outcomes will include a model for the physical environment and artifacts that will support maker-oriented learning, as well as a framework for maker-oriented learning that builds upon previous work on problem-based learning and studio-learning environments. This project will be funded by the Division of Undergraduate Education through the IUSE and S-STEM programs.

The project will incorporate maker-oriented learning into two advanced computer science courses, Mobile and Ubiquitous Computing, and Human-Computer Interaction. The project team will utilize Design-based Research (DbR) methods to determine how maker-oriented learning environments facilitate skills transfer to new contexts, how maker-oriented learning activities encourage reflection in computer science learning environments, and how the structure of maker-oriented learning approaches impact the development of a community of learners. The project team will use observations, interviews, surveys, and data collected on tools and equipment to aid their iterative course design process. This data will also be provided to the project evaluator, SageFox Consulting Group. The evaluation team will use the ISE Informal Education and Outreach Framework, focusing on factors including understanding, engagement, attitudes, behavior, and skills, ultimately reporting on both the progress of the project team as well as the overall effect of the educational intervention on the students.
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. More information may be found at [http://empiricalcsed.org/](http://empiricalcsed.org/).
MyCS: Middle-years Computer Science

Sam Andow, Kaitlyn Eng, Julia McCarthy, Olivia Palenscar, Adam Schulze, Tommy Schneider, Zachary Dodds: Harvey Mudd College Bryan Twarek, San Francisco Unified School District

NSF award(s) 1240939

In 2015-16, San Francisco Unified School District (SF) piloted MyCS, a middle-years CS curriculum, in half of its middle schools. This unexpected launch led naturally to diverging curricula. The summer after the pilot, however, SF’s and MyCS’s stewards convened for a week of feedback, PD, and planning. This exhibit highlights the curricular refinements, assessment results, and institutional changes that came from this curricular divergence and subsequent reconciliation. The data analyzed include teacher- and district-feedback, along with an analysis of over 3000 surveys from SF’s pilot implementation. Though accidental, this experiment suggests that substantial benefits can come from independently co-evolving (branching) and then reconciling (merging) curricula. When merged, those otherwise independent branches create a community both stronger and more invested, in practice and in agency, for all of the contributors.
Collaborative Research: Developing Course Modules to Teach Service-Oriented Programming through Exemplification and Visualization

Xumin Liu, Rajendra K. Raj: Rochester Institute of Technology
Chunmei Liu: Howard University
Alex Pantaleev: SUNY Oswego

NSF award(s) 1140567, 1141112, 1141200

Service oriented programming (SOP) is a programming technique to build software applications using services provided on the web as the building blocks. With cloud computing and mobile devices becoming ubiquitous, SOP is becoming even more crucial, but has not made significant inroads into the U.S. undergraduate computing curricula. This project represents a well-conceived effort to address this shortcoming by developing course-work in SOP to ensure that U.S. students are prepared in this crucial technology, thus competitive in the global software development marketplace.

This project is being jointly conducted at three diverse participating institutions: Howard University in Washington, DC, the State University of New York at Oswego, and the Rochester Institute of Technology in Rochester, NY. Three reusable curricular modules in SOP are being designed for different undergraduate computing courses - a first year introductory programming course, a sophomore course, and a senior-level course. These curricular materials are being constructed on a carefully crafted platform that provides examples and visualization to help achieve effective learning. A modular approach is being used to ensure that the developed curricular materials will be useful for a variety of undergraduate institutions across the United States.
For more information on participating, please visit:

http://nsfshowcase.org