Happy New Year from all of us in the NC State Computer Science Department! It is my pleasure to share this issue of our Research newsletter, our annual synopsis of research activities in the Computer Science (CSC) Department.

The year 2017 marked a milestone in the Department as we celebrated our 50th Anniversary. We had many events to celebrate this milestone, but a highlight was the induction of the inaugural class of the Computer Science Alumni Hall of Fame. The CSC Alumni Hall of Fame was established to celebrate and recognize the exemplary contributions our outstanding graduates have made to their profession, their community, and to the world at large. I encourage you to visit our website (csc.ncsu.edu/news/2069) to learn more about the 2017 class of inductees.

Another highlight of our 50th Anniversary celebration was the 50th Year Technical Symposium and Reception held on October 13th in the James B. Hunt, Jr. Library. In addition to faculty and alumni panel discussions, our symposium featured talks by Fran Sullivan, General Manager of IBM/Wanda Cloud Company Partnership and IBM Senior Executive for North Carolina; Patrick McDaniel, a distinguished professor and renowned security expert from Penn State University; Alvy Ray Smith, a pioneer in the field of computer graphics and animation, and co-founder of Pixar Studios; and Brian David Johnson, renowned futurist, technologist and author, and currently the Futurist in Residence at Arizona State University.

Along with a wonderful 50th Anniversary celebration, we have experienced much success over the past year. Our students and faculty have received numerous awards and honors. However, there are a few highlights that deserve special notice:

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Research Highlights

• **Dr. Min Chi**, assistant professor in the NC State Computer Science Department, has received a Faculty Early Career Development (CAREER) Award from the National Science Foundation (NSF). She becomes the 28th NSF CAREER Award winner for the department of computer science at NC State (22nd currently on faculty), one of the highest concentrations of any department in the nation. Chi’s award, valued at $547,810, supports her proposal titled “Improving Adaptive Decision Making in Interactive Learning Environments.”

• **Dr. Donald Bitzer**, Distinguished University Research Professor of Computer Science, has been named a fellow of the National Academy of Inventors (NAI). Bitzer co-invented the flat plasma panel in 1964, and the technology was eventually applied to television screens. His work on the plasma display monitor earned him an Emmy Award in 2002. He also invented and co-developed Programmed Logic for Automated Teaching Operations, or PLATO, for the first computer system to combine graphics and touch-screen displays.

• It is only a year old, but already the Visual Narrative Cluster has come together as a team to find new ways of telling stories and to offer their resources to community members. Its members are physically spread across campus, hailing from four departments. The cluster includes **Todd Berreth**, assistant professor of design; **Frederico Freitas**, assistant professor of history; **Tianfu Wu**, assistant professor of electrical and computer engineering, and is coordinated by **Matthew Booker**, associate professor of history; **Helen Burgess**, associate professor of English; and **Arnav Jhala**, associate professor of computer science.

• Researchers from Boston University, George Mason University, and **Dr. Alessandra Scafuro** from NC State have developed a Bitcoin-compatible system, called TumbleBit, a computer protocol that runs on top of Bitcoin, that could make it significantly more difficult for observers to identify or track the parties involved in any given Bitcoin transaction.

• **Dr. Timothy Menzies**, professor of computer science, has been recognized for his major contributions in the field of mining software repositories with the inaugural Mining Software Repositories Foundational Contribution Award. Menzies is the curator of the PROMISE repository, which is storage for Software Engineering project data.

• The NC State Department of Computer Science is pleased to announce the approval and launch of a **Masters Track in Security** in the Computer Science Graduate Program curriculum. Topics include both an overview of computer and network security, and a variety of more in-depth topics, including systems security, software security, privacy, and cryptography. The track can be customized to be more practice-oriented or theoretically-oriented based on the interests of the student.

• **Drs. Christopher Healey and Robert St. Amant**, along with PhD student **Zeyuan Chen**, have developed a user-friendly, inexpensive controller for manipulating virtual objects in a computer program in three dimensions. The device allows users to manipulate objects more quickly – with less lag time – than existing technologies. The device, called CAPTIVE, offers six degrees of freedom for users – with applications ranging from video gaming to medical diagnostics to design tools. And CAPTIVE makes use of only three components: a simple cube, the webcam already found on most smartphones and laptops, and custom software.

• **Dr. Robert Rodman** (1940-2017), professor of computer science and author, passed away in January 2017. He taught thousands of students throughout his 38 years as an NC State professor, making an impact on the lives of many. A professor, author, researcher, and friend: Rodman’s legacy is one of incredible stature.
According to the latest data from the American Society for Engineering Education (ASEE), NC State continues to rank #1 in the nation in number of tenure-track/tenured faculty in Departments of Computer Science in Colleges of Engineering. The department currently has 20 female faculty and several other female adjuncts;

**Dr. Min Chi** is the department’s most recent recipient of an NSF CAREER Award. She becomes the 28th NSF CAREER Award winner in the NC State Computer Science Department (22nd currently on faculty), one of the highest concentrations of any department in the nation;

The Game Design Program at NC State has been recognized as one of the “Top 50 Undergraduate Schools to Study Game Design for 2017” on the Princeton Review’s annual list which salutes the best schools in the US and Canada. NC State ranked 7th on the list of public universities, and 38th overall.

NC State is a Tier 1 research institution, and with over 30 centers, labs and groups, research is key to our mission. Our research productivity stands at more than $62M in active research grants, and annual expenditures in the $10M range. This ranks us in the top ten departments for sponsored research funding among computer science departments in colleges of engineering in the United States. On page two you will see a list of some of our research highlights, and a list of representative projects appears on page four of this newsletter. We invite you to visit our website at csc.ncsu.edu to learn more about the department, our faculty and staff, and our game-changing research.

In addition, our faculty and students benefited from a record level of corporate collaboration and research support over the year. Industry research partners including Cisco, Google, IBM, Northrop Grumman, LexisNexis, Microsoft and SAS provided research support of approximately $1M to our faculty in 2016-17.

Also key to the CSC department’s mission is providing the best education possible to our students. Enrollments continue to increase – in fall 2016 we enrolled 1,628 students in our department (918 undergraduates and 710 graduate students), and in fall 2017 that number increased to 1,753 students (1,049 undergraduates and 704 graduate students (197 PhD students)). In 2016-2017 we awarded 195 undergraduate degrees and 276 graduate degrees.

Demand for our graduates continues to be extremely high with starting salaries for those graduating with a BS degree averaging over $70,000, while starting salaries for our master’s degree students is more than $108,000, and for PhD graduates, it’s even higher. The top employers of our most recent graduates include Amazon, VMware, EMC Dell, NetApp, SAS, Fidelity Investments, and LexisNexis.

We are very proud of the accomplishments of our faculty who have received numerous prestigious awards and professional recognitions: **Dr. Donald Bitzer** has been named a fellow by the National Academy of Inventors (NAI). Bitzer co-invented the flat plasma display panel in 1964; **Dr. Munindar Singh** was elected a Fellow of the Association for the Advancement of Artificial Intelligence (AAAI); the International Foundation for Autonomous Agents and Multiagent Systems (IFAAMAS) has selected a paper co-authored by **Dr. James Lester** as a recipient of the 2017 Influential Paper Award. The article, “Animated pedagogical agents: Face-to-face interaction in interactive learning environments,” laid the groundwork for a wide range of educational products incorporating animated agent technology; **Dr. Timothy Menzies** has been recognized for his major contributions in the field of mining software repositories with the inaugural Mining Software Repositories Foundational Contribution Award. Menzies is the curator of the PROMISE repository, storage for Software Engineering project data.

As we wrap up the celebrations of our first 50 years, it’s easy to see the tremendous impact the Computer Science Department has had. The Research Triangle Park was built on the talent produced by this department. About 70% of our 9,000 alumni have remained in the area. However, over 10% of our alumni base is in the Silicon Valley and Seattle areas, with mission critical software engineering jobs on products and services we use every day. From your iPhone to Google Maps, from an Amazon order to your Pinterest page, NC State computer science alumni are helping shape the experience. We look toward an exciting future!

**Laurie Williams**

*Professor and Interim Department Head*
Selected Research Projects

Consortium for Nonproliferation Enabling Capabilities, Nagiza Samatova (pictured below), Robin Gardner. $9,744,249 by US Department of Energy.

ENGAGE: A Game-based Curricular Strategy for Infusing Computational Thinking into Middle School Science, James Lester (pictured bottom right), Brad Mott, Eric Wiebe (Friday Institute). $2,498,862 by National Science Foundation.

DIP: Integrated Data-driven Technologies for Individualized Instruction in STEM Learning Environments, Min Chi, Tiffany Barnes. $1,999,438 by National Science Foundation.

Moore Foundation Data-Driven Discovery Investigator, Blair Sullivan. $1,500,000 by Gordon and Betty Moore Foundation.

CAREER: Improving Adaptive Decision Making in Interactive Learning Environments, Min Chi. $547,810 by National Science Foundation.


Holistic, Cross-Site, Hybrid System Anomaly Debugging for Large Scale Hosting Infrastructures, Xiaohui (Helen) Gu. $518,000 by National Science Foundation.

Scaling CS Principles Through STARS Community and Leadership Development, Tiffany Barnes. $500,000 by National Science Foundation.

Supporting Regular Expression Testing, Search, Repair, Comprehension, and Maintenance, Kathryn Stolee. $499,996 by National Science Foundation.

Direct Physical Grasping, Manipulation, and Tooling of Simulated Objects, Robert St. Amant, Christopher Healey. $496,858 by National Science Foundation.

CAREER: Expanding Developers’ Usage of Software Tools by Enabling Social Learning, Emerson Murphy-Hill. $495,721 by National Science Foundation.

SHF: Small: Improving Memory Performance on Fused Architectures Through Compiler and Runtime Innovations, Xipeng Shen, Frank Mueller. $470,000 by National Science Foundation.

SHF: Medium: Collaborative Transfer Learning in Software Engineering, Tim Menzies. $464,609 by National Science Foundation.

CAREER: Enable Robust Virtualized Hosting Infrastructures via Coordinated Learning, Recover, and Diagnosis, Xiaohui (Helen) Gu. $450,000 by National Science Foundation.

Fine-grained Measurement of Performance Metrics in the Internet of Things, Muhammad Shahzad. $449,999 by National Science Foundation.


Taming Web Content Through Automated Reduction in Browser Functionality, Alexandros Kapravelos. $406,609 by National Science Foundation.

Transforming Computer Science Education Research through Use of Appropriate Empirical Research Methods: Mentoring and Tutorials, Sarah Heckman. $406,557 by National Science Foundation.

CAREER: Secure OS Views for Modern Computing Platforms, William Enck. $400,000 by National Science Foundation.


Collaborative Research: Semi and Fully Automated Program Repair and Synthesis via Semantic Code Search, Kathryn Stolee. $387,661 by National Science Foundation.

Collaborative Research: Fostering Computational Thinking into Middle School Science, Edward Gehringer. $330,000 by National Science Foundation.

ENGAGE: A Game-based Curricular Strategy for Infusing Computational Thinking into Middle School Science, James Lester (pictured below), Brad Mott, Eric Wiebe (Friday Institute). $2,498,862 by National Science Foundation.

DIP: Integrated Data-driven Technologies for Individualized Instruction in STEM Learning Environments, Min Chi, Tiffany Barnes. $1,999,438 by National Science Foundation.

Moore Foundation Data-Driven Discovery Investigator, Blair Sullivan. $1,500,000 by Gordon and Betty Moore Foundation.

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CAREER: Secure OS Views for Modern Computing Platforms, William Enck. $400,000 by National Science Foundation.


Collaborative Research: Semi and Fully Automated Program Repair and Synthesis via Semantic Code Search, Kathryn Stolee. $387,661 by National Science Foundation.
Chris Martens joined the department in fall 2016 as an assistant professor. Her specialty is formal methods for creative media, game design, believable virtual agents, collaborative digital storytelling, and simulation modeling. She received her BS and PhD in Computer Science from Carnegie Mellon University.

Hung-Wei Tseng joined the department in fall 2016 as an assistant professor. His specialty is systems, and his current interests are in the area of heterogeneous computing. He received his BS and MS in computer science from National Taiwan University, and his PhD from the University of California, San Diego.

Collin Lynch joined the department in fall 2016 as an assistant professor. His research interests are in the area of graph-based educational data mining, and the development of robust intelligent tutoring systems. He received his BA in Artificial Intelligence from Hampshire College, and his MS and PhD in intelligent systems from the University of Pittsburgh.

Bradley Reaves joined the department in fall 2017 as an assistant professor. His research is dedicated to measuring and improving security and privacy of computer systems. He received his BS, and MS in computer engineering from Mississippi State, his MS in computer science from Georgia Tech, and his PhD from the University of Florida.

Aleksandra Scafuro joined the department in fall 2016 as an assistant professor. Her specialty is cryptography, and her current interests are in the area of secure computation. She received her MS and PhD in computer science from the University of Salerno.

New Faculty Profiles

Senior Faculty Spotlight

Dr. Tiffany Barnes
Professor of Computer Science

Barnes is a professor of computer science at NC State University. She received her BS and MS in computer science and mathematics, and her PhD in computer science from NC State. A member of Phi Beta Kappa and the NC State Golden Chain Society, she has served as Chair (2008) and Program Chair (2009) of the Educational Data Mining conference, Chair of the STARS Celebration conference (2011 and 2015), Program Chair (2014) for the Foundations of Digital Games conference, the ACM Special Interest Group on Computer Science Education Board (2010-2016), the Board of Directors for the International Educational Data Mining Society (2011-2016), Associate Editor for the Journal of Educational Data Mining (2008-2010), and Guest Editor for the IEEE Computer Graphics and Applications Special Issue on Serious Games (2009). Barnes received an NSF CAREER Award for her novel work in using data and educational data mining to add intelligence to STEM learning environments. Barnes is co-PI and current Executive Vice President for the STARS Computing, a consortium of universities that engage college students in outreach, research, and service to broaden participation in computing. Her research focuses on educational data mining, serious games for education, health, and energy, and broadening participation in computing education and research.
Researchers

Dennis R. Bahler, Associate Professor
PhD, University of Virginia, 1987
Artificial intelligence: constraint processing, machine learning, hybrid neural-symbolic computing

Tiffany Barnes, Professor
PhD, North Carolina State University, 2003
Educational data mining, serious games for education, health and energy, broadening computing participation

Donald Bitzer, Distinguished University Research Professor
PhD, University of Illinois, 1960
Convolutional codes, signal processing for biological systems, computer-based education

Franc Brglez, Visiting Research Professor
PhD, University of Colorado, 1970
Distributed and collaborative workflows, databases, and groupware for the Internet

Min Chi, Assistant Professor
PhD, University of Pittsburgh, 2009
Machine learning, artificial intelligence, cognitive science and learning science

Rada Y. Chirkova, Associate Professor
PhD, Stanford University, 2002
Database performance, query-processing efficiency, data sciences

Jon Doyle, SAS Professor of Computer Science
PhD, Massachusetts Institute of Technology, 1980
Artificial Intelligence, mathematical and philosophical foundations, rational agents, decision making

Patrick Dreher, Research Professor
PhD, University of Illinois, 1991
Cloud computing, scientific and high performance computing

Rudra Dutta, Professor
PhD, NC State University, 2001
Network design: optical, wireless sensor and mesh networks; future Internet design

William Enck, Associate Professor
PhD, The Pennsylvania State University, 2011
Systems security, mobile operating systems security

Vincent Freeh, Associate Professor
PhD, University of Arizona, 1996
Operating systems, compilers, programming languages, storage

Edward Gehringer, Associate Professor
PhD, Purdue University, 1979
Memory management, object-oriented software systems, computer-aided education

Xiaohui (Helen) Gu, Associate Professor
PhD, University of Illinois, 2004
Distributed systems, operating systems, computer networks

Khaled Harfoush, Associate Professor
PhD, Boston University, 2002
Computer networking, Internet measurements, peer-to-peer systems, routing protocols

Christopher G. Healey, Goodnight Distinguished Professor
PhD, University of British Columbia, Canada, 1996
Visualization and computer graphics: methods for rapidly, accurately, effectively visualizing large complex datasets

Steffen Heber, Associate Professor
PhD, Universität Heidelberg, Germany, 2001
Algorithms to compare and analyze gene order permutations, animation development for bioinformatics education

Arnav Jhala, Associate Professor
PhD, NC State University, 2009
Artificial intelligence, storytelling in games, intelligent machinima generation, smart graphics, and intelligent user interfaces

Guoliang Jin, Assistant Professor
PhD, University of Wisconsin-Madison, 2014
Architecture and operating systems, parallel and distributed systems, software engineering and programming languages

Alexandros Kapravelos, Assistant Professor
PhD, University of California-Santa Barbara, 2015
Systems and software security

Michael Kowolenko, Managing Director of ITng
PhD, Northeastern University, 1985
Data science

James C. Lester, Distinguished Computer Science Professor
PhD, University of Texas, 1994
Artificial intelligence, intelligent user interfaces, intelligent tutoring systems, computational linguistics

Collin Lynch, Assistant Professor
PhD, University of Pittsburgh, 2014
Graph-based educational data mining, development of robust intelligent tutoring systems, adaptive educational systems for ill-defined domains

Chris Martens, Assistant Professor
PhD, Carnegie Mellon University, 2015
Formal methods for creative media, game design, believable virtual agents, collaborative digital storytelling, simulation modeling

Tim Menzies, Professor
PhD, University of New South Wales, 1995
Artificial intelligence, game-based learning environments, computational models of interactive narrative

Frank Mueller, Professor
PhD, Florida State University, 1994
Compilers and code optimization, concurrent and distributed, real-time and embedded systems

Emerson Murphy-Hill, Associate Professor
PhD, Portland State University, 2009
Software engineering, especially the intersection of human-computer interaction and software engineering.

Kemafor Anyanwu Ogan, Associate Professor
PhD, University of Georgia, 2007
Semantic computing: semantic Web, databases, data mining, information retrieval, services computing

Chris Parnin, Assistant Professor
PhD, College of Computing, Georgia Tech, 2014
Graphics and computer interaction, software engineering, programming languages

Harry Perros, Alumni Distinguished Graduate Professor
PhD, Trinity College, Ireland, 1975
Performance analysis of optical networks, performance monitoring of grids, queuing networks

Michael Rappa, Distinguished University Professor
PhD, University of Minnesota, 1987
Analytics, e-commerce, open courseware, open educational content, technology management

*List includes 2016-17 faculty as well as faculty promotions, and faculty joining the department in August 2017.
Bradley Reaves, Assistant Professor
PhD, University of Florida, 2017
Measuring and improving the security and privacy of computer systems, with emphasis on telephony networks and software for mobile platforms

Douglas S. Reeves, Professor
PhD, The Pennsylvania State University, 1987
Internet protocols, multimedia computing and networking, information security, computer org.

David Roberts, Associate Professor
PhD, University of California, Los Angeles, 1973
Computational forensic linguistics, applying artificial intelligence to error recovery in speech recognition

George N. Rouskas, Professor
PhD, Georgia Institute of Technology, 1994
Network architectures and protocols, optical networks, grid computing

Nagiza Samatova, Professor (joint apt. w/ORNL)
PhD, Russian Academy of Science (CCAS), 1993
Graph theory and algorithms, bioinformatics, systems biology, data management, data integration, data science

Carla D. Savage, Professor
PhD, University of Illinois, 1977
Combinatorics, combinatorial algorithms, network algorithms, graph theory, discrete mathematics

Alessandra Scafuro, Assistant Professor
PhD, University of Salerno, 2013
Cryptography, secure computation

John Streck, Chief Technologist of ITng
MS, Rensselaer Polytechnic Institute, 1974
Networks, cloud computing

Blair Sullivan, Associate Professor (joint apt. w/ORNL)
PhD, Princeton University, 2008
Algorithms and theory of computation, scientific and high performance computing, and analytics

David Thuente, Professor
PhD, University of Kansas, 1974
Denial of service and security for wireless systems; media access control protocols

Hung-Wei Tseng, Assistant Professor
PhD, University of California-San Diego, 2014
Systems, heterogeneous computing

Ranga Vatsavai, Associate Professor (joint apt. w/ORNL)
PhD, University of Minnesota, 2008
Advanced data sciences, geospatial analytics

Teaching Professors

Suzanne Balik, Teaching Assistant Professor
PhD, NC State University, 2014
Graphics, human computer interaction

Lina Battestilli, Teaching Assistant Professor
PhD, NC State University, 2005
Computer science education, cloud computing and datacenter networks, networking architecture

Sarah Heckman, Teaching Associate Professor
PhD, NC State University, 2009
Computer science and software engineering education, open educational resources

Jason King, Teaching Assistant Professor
PhD, NC State University, 2016
Logging for user accountability, nonrepudiation and forensicability

Jessica Young Schmidt, Teaching Assistant Professor
PhD, NC State University, 2012
Scholarship of teaching and learning

David Sturgill, Teaching Associate Professor
PhD, Cornell University, 1996
Parallel computation and its application to computationally hard problems, parallelism, machine learning
Computer Science Research

Our key research areas are in:

- **Artificial Intelligence and Theory** (including Intelligent Agents, Machine Learning, Knowledge Representation, Planning, Natural Language Processing, Computational Economics and Management, Algorithms, Theory of Computation)
- **Computational Applications and Analytics** (including Data Intensive Computing, Scientific Computing, Bioinformatics, Data/Text Mining, Information Visualization, HealthCare Information Technology, Analytics Clouds, Data Science)
- **Games, Interaction, and Education Informatics** (including Games, Human-Computer Interaction, Graphics, Intelligent Tutoring, Undergraduate Education in Computing)

The department has a number of teaching and research laboratories, centers, institutes and other facilities that support its education, research and outreach missions.