

# RESEARCH



## Faster Downloads for Smartphones

Tired of waiting around for your smartphone to play that video? NC State computer scientists have good news: Faster downloads are coming soon. **Dr. Injong Rhee**, a professor of computer science, has helped develop a new algorithm that significantly reduces data retrieval time for the software programs that power smartphones and tablets.

These mobile devices use "transmission control protocol (TCP) stacks," programs that send and receive packets of data between the device and the network. With help from Dr. Kyunghan Lee, a former senior research associate at NC State who is now an assistant professor at the Ulsan National Institute of Science and Technology in South Korea, Rhee demonstrated that the new algorithm makes the stacks more efficient. That greatly improves the user experience.

The researchers plan to use support from the Chancellor's Innovation Fund (CIF) to quantify that improved efficiency on various network providers using several smartphone and tablet brands. They're also creating a business strategy for US markets. Eventually they want to expand to Asia.

"This technology will help make the smartphone and tablet experience much more enjoyable for users," Rhee said. "And the CIF funding will help convince network providers that it really works."



## Research Highlights

The NC State Department of Computer Science is one of the oldest and largest producers of computer science talent in the nation. With a curriculum and research portfolio focused on solving the grand challenges of the future, our graduates are highly valued and sought after by the most innovative and respected companies in the world. Our department is a national leader in gaming, educational informatics, healthcare IT, cybersecurity, cloud computing and analytics, and we benefit from being located on NC State's Centennial Campus within the shadows of the award-winning Hunt Library. With a strong focus on industry collaboration, our ePartners corporate relations program is a model revered nationwide. Whether it is identifying the latest security threats or improving the effectiveness of K-12 education or designing the future of the Internet, our faculty and students are making a real difference in the world, every day!

Research is central to the success of the department, and our research productivity continues to grow with annual research expenditures in the range of \$14M. We now have an all time high of over \$46M in active research grants, which ranks us well within the top departments for sponsored research funding among computer science departments in colleges of engineering. Faculty research interests range from theory and algorithms, bioinformatics, high-performance and power-aware systems, to advanced analytics research, to artificial intelligence, serious games, graphics and visualization, networks, security, software engineering, and educational informatics. A list of select representative research projects appears on page three of this newsletter.

Over the last year, our department has continued to experience exciting growth. We have received numerous accolades and professional recognitions, and we have welcomed two new faculty (assistant professors, Dr. Min Chi and Dr. Blair Sullivan). Our enrollments continue to increase (now over 1,400 students), as does our research productivity and funding (>\$46M in active research). We are particularly grateful for the generous financial support from our alumni, friends and corporate partners (~\$800K in total unrestricted cash contributions from all sources).

2012-2013

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[www.csc.ncsu.edu](http://www.csc.ncsu.edu)

## Research Faculty

**Randy Avent, Professor****PhD, University of North Carolina, 1986**

Defense analytics, dealing with unstructured and semi-structured data mining and exploitation

**Dennis R. Bahler, Associate Professor****PhD, University of Virginia, 1987**

Artificial intelligence: constraint processing, machine learning, hybrid neural-symbolic computing

**Tiffany Barnes, Associate Professor****PhD, North Carolina State University, 2003**

Educational data mining, serious games for education, health and energy, broadening computing participation

**Lina Battestilli, Teaching Assistant Professor****PhD, North Carolina State University, 2005**

Computer science education, cloud computing and datacenter networks, networking architecture

**Donald Bitzer, Distinguished University Research Professor, PhD, University of Illinois, 1960**

Convolutional codes, signal processing for biological systems, computer-based education

**Kristy Boyer, Assistant Professor****PhD, North Carolina State University, 2010**

Artificial intelligence, computational linguistics, intelligent tutoring systems, computer science education

**Franc Brglez, Research Professor****PhD, University of Colorado, 1970**

Distributed and collaborative workflows, databases, and groupware for the Internet

**Rada Y. Chirkova, Associate Professor****PhD, Stanford University, 2002**

Database performance, query-processing efficiency by designing and materializing views

**Jon Doyle, SAS Professor of Computer Science****PhD, Massachusetts Institute of Technology, 1980**

Artificial Intelligence, mathematical and philosophical foundations, rational agents, decision making

**Rudra Dutta, Professor****PhD, North Carolina State University, 2001**

Network design: optical, wireless sensor and mesh networks; future Internet design

**William Enck, Assistant Professor****PhD, Pennsylvania State University, 2011**

Systems security, mobile operating systems security

**Robert Fomaro, Professor****PhD, Pennsylvania State University, 1969**

Networks and applications of real-time embedded computer systems, wireless sensor systems

**Vincent Freeh, Associate Professor****PhD, University of Arizona, 1996**

Operating sys., compilers, programming languages—distributed &amp; parallel computing, embedded systems

**Edward Gehringer, Associate Professor****PhD, Purdue University, 1979**

Hardware support for memory management, object-oriented software systems—performance studies

**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, Professor****PhD, University of British Columbia, Canada, 1996**

Visualization &amp; computer graphics: methods for rapidly, accurately, effectively visualizing lg. complex datasets

**Steffen Heber, Associate Professor****PhD, Universität Heidelberg, Germany, 2001**

Algorithms to compare and analyze gene order permutations, animation dev. for bioinformatics education

## Highlights (cont.)

In the 2012-2013 academic year, faculty as a group produced about 300 publications, and faculty gave about 200 professional talks related to their research and educational activities. A number of our faculty serve as editors and on editorial boards of leading professional publications, and as members and officers in the most prestigious professional societies and organizations in their areas of specialty. Our faculty continued the tradition of being both organizers and participants in a number of prestigious professional events and flagship computer science conferences, as well as delivering services and functions to the university, the state, professional societies, and the nation.

In our undergraduate program, we awarded 170 BS degrees, an upward trend expected to continue for several more years. In the fall of 2013, we had 817 undergraduate students, including 58 who are double majors. Demand for our undergraduates has surged as the economy has improved. Many of our graduates received multiple employment offers, and average starting salaries were over \$65K, among the highest in the NC State College of Engineering. For a number of years, we have been one of the top suppliers of new graduates to IBM, Cisco, SAS, NetApp, and other industry giants. However, a large number of students have pursued careers with smaller companies or other entrepreneurial opportunities. Our Undergraduate Concentration in Game Development has been recognized as one of the top in the nation for three consecutive years by The Princeton Review.

Our graduate program continues to thrive! Applications for admission continue to increase year-over-year. We enrolled 612 graduate students; 179 of these were PhD students – both record highs for the department. Similarly, we awarded a record number of graduate degrees (224), including 24 PhDs. As with our undergrads, demand for our graduate students is extremely high, with starting salaries for our master's degree students averaging approximately \$93K, while starting salaries for our PhD students are starting around \$120K. Some of the top consumers of our graduate talent include Amazon, Cisco, IBM, Microsoft, EMC, SAS and NetApp.

In 2012-2013 our faculty received a number of prestigious awards and honors: Dr. Donald Bitzer, Distinguished University Research Professor in the NC State Computer Science Department, has been inducted into the National Inventors Hall of Fame. (Bitzer co-invented the flat plasma display panel in 1964.); Drs. William Enck and Emerson Murphy-Hill received NSF CAREER Awards (the department's 23rd and 24th NSF CAREER Award winners – 21 currently on faculty), one of the highest concentrations of any department in the nation; Dr. Robert Fornaro was selected to receive the IEEE Computer Society's 2013 Computer Science and Engineering Undergraduate Teaching Award; Dr. Carla Savage was named to the inaugural class of Fellows of the American Mathematical Society (AMS) and was later appointed to AMS Secretary; Dr. R. Michael Young was recently awarded senior member status of the Association for the Advancement of Artificial Intelligence (AAAI); Dr. Rada Chirkova was named a senior member of the ACM; and Dr. James Lester has been named Distinguished Professor in Computer Science at NC State.

Our students received numerous honors and awards as well: undergraduate students (Joseph Arthur and Neil Shah) and graduate students (Brittany Johnson and Fernando Rodriguez) have been chosen to receive NSF Graduate Research Fellowships; Zhe Zhang was recently awarded a prestigious IBM PhD Fellowship Award; Kamaria Hardy, Pamela Ocampo, Piyali Dey, and alumnae Andrea Villanes and Bushra Anjum were selected as mentors/role models in SHE++, a Stanford University initiative whose goal is to foster a community to inspire a new generation of female programmers; Denae Ford was one of 25 recipients worldwide of a 2012 Facebook Grace Hopper Scholarship to attend the Grace Hopper Celebration of Women in Computing Conference; Xusheng Xiao won the ICSE Student Research Competition Best Project Representing an Innovative Use of Microsoft Technology; recent graduate KaMar Galloway has been chosen to participate in the Google Computer Science Teaching Fellows Practicum. His area of focus is K-12 computer science education; and Stephen Cossa and Sean Mealin were awarded the Donald L. Bitzer Creativity Awards for 2012-2013.

**Mladen A. Vouk***Professor and Department Head*

## Selected Research Projects

Complete list with abstracts is at <http://www.csc.ncsu.edu/research/>

*Secure Open Systems Initiative*, Dennis Kekas, Peng Ning, Mladen Vouk, Rudra Dutta. \$3,336,000 by Army Research Office.

*NSA/North Carolina State University Science of Security Label: Analytics Supporting Security Science*, Laurie Williams, Michael Rappa. \$2,475,248 by National Security Agency via US Army Research Office.

*North Carolina Bio-Preparedness Collaboration (NCB-Prepared)*, Marc Hoit (OIT), Laurie Williams. \$1,760,486 by US Dept. of Homeland Security via UNC-CH.

*ENGAGE: Immersive Game-Based Learning for Middle Grade Computational Fluency*, James Lester, Kristy Boyer, Bradford Mott, Eric Wiebe. \$1,015,996 by National Science Foundation.

*Scalable Data Management, Analysis, and Visualization (SDAV) Institute*, Nagiza Samatova, Anatoli Melechko. \$750,000 by US Department of Energy.

*NetSE: Large: Collaborative Research: Platys: From Position to Place in Next Generation Networks*, Injong Rhee, Munindar Singh. \$706,167 by National Science Foundation.

*Quality of Information-Aware Networks for Tactical Applications (QUANTA)*, Munindar Singh. \$669,029 by Pennsylvania State University (Army Research Laboratory).

*Co-Design of Hardware/Software for Predicting MAV Aerodynamics*, Frank Mueller. \$666,666 by Virginia Polytechnic Institute and State University (US Air Force).

*NeTS: Large: Collaborative Research: Network Innovation Through Choice*, Rudra Dutta, George Rouskas. \$643,917 by National Science Foundation.

*Comprehension-Driven Program Analysis (CPA) for Malware Detection in Android Phones*, Xuxian Jiang. \$556,488 by Iowa State University/US Air Force-Research Laboratory.

*HCC: Small: Plan-Based Models of Narrative Structure for Virtual Environments*, R. Michael Young. \$513,860 by National Science Foundation.

*CAREER: Expanding Developers' Usage of Software Tools by Enabling Social Learning*, Emerson Murphy-Hill. \$498,681 by National Science Foundation.

*Detection and Transition Analysis of Engagement and Affect in a Simulation-Based Combat Medic Training Environment*, James Lester, Bradford Mott. \$478,592 by Columbia University/US Army Research Laboratory.

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

*CAREER: Trust and Privacy Management for Online Social Networks*, Ting Yu. \$450,000 by National Science Foundation.

*III: Small: Optimization Techniques for Scalable Semantic Web Data Processing in the Cloud*, Kemafor Anyanwu Ogan. \$446,942 by National Science Foundation.

*NeTS: Small: Computationally Scalable Optical Network Design*, George Rouskas. \$429,995 by National Science Foundation.

*SHF: Small: Towards Regulatory Compliance Software Engineering with UCONLEGAL*, Ana Antón, Jon Doyle. \$400,000 by National Science Foundation.

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

*Scalable and Power Efficient Data Analytics for Hybrid Exascale Systems*, Nagiza Samatova. \$364,944 by Oakridge National Laboratories – UT Battelle, LLC.

*REU Site: Interactive and Intelligent Media*, Tiffany Barnes. \$359,999 by National Science Foundation.

*SHF: Small: Expressive and Scalable Notifications from Program Analysis Tools*, Emerson Murphy-Hill, Sarah Heckman. \$250,000 by National Science Foundation.

*Collaborative Research: Dynamic Staging Architecture for Accelerating I/O Pipelines*, Xiaosong Ma, Scott Klacky. \$133,933 by National Science Foundation.

## Research Faculty (cont.)

**Sarah Heckman, Teaching Assistant Professor**  
PhD, North Carolina State University, 2009

Computer science and software engineering education, open educational resources

**Xuxian Jiang, Associate Professor**

PhD, Purdue University, 2006

Virtual machines and security

**James C. Lester, Distinguished Computer Science Professor, PhD, University of Texas, 1994**

Artificial intelligence, intelligent user interfaces, intelligent tutoring systems, computational linguistics

**Xiaosong Ma, Associate Professor (joint appointment with ORNL), PhD, University of Illinois, 2003**

High performance computing, parallel I/O, storage systems, scientific data management

**Brad Mott, Research Scientist**

PhD, NC State University, 2006

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, Assistant Professor**

PhD, Portland State University, 2009

Software engineering, esp. the intersection of human-computer interaction and software engineering.

**Peng Ning, Professor**

PhD, George Mason University, 2001

Computer and network security: new techniques for building trustworthy systems and wireless security

**Kemafor Anyanwu Ogan, Assistant Professor**

PhD, University of Georgia, 2007

Semantic computing: semantic Web, databases, data mining, information retrieval, services computing

**Harry Perros, Alumni Distinguished Graduate Professor, PhD, Trinity College, Ireland, 1975**

Performance analysis of optical networks, performance monitoring of grids, queueing networks

**Michael Rappa, Distinguished University Professor, PhD, Univ. of Minnesota, 1987**

Analytics, e-commerce, open courseware, open educational content, technology management

**Douglas S. Reeves, Professor**

PhD, The Pennsylvania State University, 1987

Internet protocols, multimedia computing and networking, information security, computer org.

**Injong Rhee, Professor**

PhD, UNC Chapel Hill, 1994

Computer/wireless/sensor networks, multimedia networking, distributed systems, operating systems

**David Roberts, Assistant Professor**

PhD, College of Computing, Georgia Tech, 2010

Machine learning and artificial intelligence and their application to interactive technological experiences

**Robert D. Rodman, Professor**

PhD, University of California, Los Angeles, 1973

Computational forensic linguistics, applying AI to error recovery in speech recognition

**George N. Rouskas, Professor**

PhD, Georgia Institute of Technology, 1994

Network architectures and protocols, optical networks, grid computing, scheduling

**Nagiza Samatova, Professor (joint apt. w/ORNL), PhD, Russian Acad. of Sci. (CCAS), 1993**

Graph theory & algorithms, bioinformatics, systems biology, data management, data integration

**Carla D. Savage, Professor**

PhD, University of Illinois, 1977

Combinatorics, combinatorial algorithms, network algorithms, graph theory, discrete mathematics

## Research Faculty (cont.)

**Munindar P. Singh, Professor**  
PhD, University of Texas, 1993

Multiagent systems, intelligent agents, service-oriented computing, agent languages and protocols

**Robert St. Amant, Associate Professor**  
PhD, University of Massachusetts, Amherst, 1996

Human-computer interaction, artificial intelligence, intelligent user interfaces, statistical expert systems

**Matthias Stallmann, Professor**  
PhD, University of Colorado, 1982

Algorithm design and analysis of both serial and parallel models of computation

**William J. Stewart, Professor**  
PhD, Queen's University, Northern Ireland, 1974

Performance evaluation of computer sys., numerical linear algebra, computer operating systems

**David Sturgill, Teaching Assistant Professor**  
PhD, Cornell University, 1996

Parallel computation and its application to computationally hard problems, parallelism, machine learning

**David Thuente, Professor**  
PhD, University of Kansas, 1974

Denial of service and security for wireless systems; media access control protocols

**Mladen Vouk, Professor**  
PhD, King's College, England, U.K., 1976

Software engineering, scientific computing, computer-based education, and cloud computing

**Benjamin Watson, Associate Professor**  
PhD, Georgia Institute of Technology, 1997

Relationships between computer graphics and design

**Laurie Williams, Professor**  
PhD, University of Utah, 2004

Agile software processes, software security, open software systems, healthcare information technology

**Tao Xie, Associate Professor**  
PhD, University of Washington, 2005

Automated software testing and verification, mining software engineering data

**R. Michael Young, Professor**  
PhD, University of Pittsburgh, 1997

AI: planning & plan recognition, natural language processing, dev. of human-computer interaction

**Ting Yu, Associate Professor**  
PhD, University of Illinois, 2003

Security, trust management and privacy protection in open systems, semi-structured databases

## Emeritus Faculty

**Wushow Chou, Professor Emeritus**  
PhD, University of California - Berkeley, 1968

**Edward W. Davis, Professor Emeritus**  
PhD, University of Illinois, 1972

**Thomas L. Honeycutt, Associate Professor Emeritus**  
PhD, NC State University, 1969

**David F. McAllister, Professor Emeritus**  
PhD, UNC Chapel Hill, 1972

**Woodrow Robbins, Professor Emeritus**  
PhD, Syracuse University, 1971

**Alan L. Tharp, Professor Emeritus**  
PhD, Northwestern University, 1969

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## Senior Faculty Profiles



**Dr. Laurie Williams**, a professor of Computer Science, is one of the foremost researchers in agile software development, the science of cybersecurity, and the security of healthcare applications. She is the co-director of the NSA-sponsored NC State Science of Security Labet. She leads the Software Engineering Research research group, and is the Senior Research Director of the Institute of Next Generation Systems (ITnG). Additionally, she is the software engineering area representative for the Secure Open Systems Initiative.

Her research focuses on software security, particularly in relation to healthcare IT; agile software development practices and processes; software reliability, software testing and analysis; open source software development; and broadening participation and increasing retention in computer science. Williams has more than 175 refereed publications. In January 2009, her 2000 IEEE Software paper titled, "Strengthening the Case for Pair Programming," was chosen as a IEEE Software 25th Anniversary Top Pick Paper and was on the list of the Most Cited IEEE Software articles for a 25-year period.

Williams has received many awards including an NSF CAREER Award (2003), and several IBM Faculty Awards. She was named an ACM Distinguished Scientist (2011), received the inaugural ACM SIGSOFT Influential Educator Award (2009), and was inducted into NC State's Academy of Outstanding Teachers (2006).

She received her PhD in Computer Science from the University of Utah in 2000, her MBA from Duke University Fuqua School of Business in 1990, and her BS in Industrial Engineering from Lehigh University in 1984. She worked for IBM for nine years before returning to academia.



**Dr. R. Michael Young**, a professor of Computer Science, is founder and executive director of the NC State Digital Games Research Initiative. He also directs the Liquid Narrative research group, and he developed and directs the department's undergraduate concentration in game development, which was recognized as one of the top 20 game design programs in the United States and Canada in 2011 and 2012 by The Princeton Review. He earned his PhD in Intelligent Systems from the University of Pittsburgh in 1997, his MS in Computer Science from Stanford University in 1987, and his BS in Computer Science from California State University, Sacramento in 1984.

His research interests include artificial intelligence; digital humanities; advanced learning technologies; graphics and human computer interaction; computer and video games; health care information technology; and cloud computing. Young and his students work to develop computational models of interactive narrative with applications to computer games, educational and training systems and virtual environments. His research group is internationally known as a leading center for work on games research, especially in the area of interactive storytelling and AI in games.

Young is a senior member of the Association for the Advancement of Artificial Intelligence, and serves as vice president and is a founding board member of the Society for the Advancement of the Science of Digital Games. He has won a number of awards including an NSF CAREER Award, an IBM Faculty Award and NC State Awards for outstanding teaching, extension and engagement. He was a GlaxoSmithKline Faculty Fellow in Public Policy and Public Engagement in 2010, and his work with North Carolina games companies and state policy makers to strengthen the state's games ecosystem has been widely recognized.

## New Faculty Profiles



**Dr. Min Chi** joined the faculty as assistant professor in the Digital Transformation of Education cluster (part of the Chancellor's Faculty Excellence Program) in August 2013. She received her MS and PhD degree from the Intelligent Systems Program at the University of Pittsburgh in 2006 and 2009, respectively. Her specialty is machine learning. Her research interests include artificial intelligence, applying computer science to learning, cognitive science and learning science, and math and science education.



**Dr. Blair Sullivan** joined the faculty as assistant professor in August, 2013. She received her BS degrees in Mathematics and Computer Science in 2003 from Georgia Tech. She received her MA and PhD degrees in Mathematics from Princeton University in 2005 and 2008, respectively. Her research interests include algorithm design, high performance graph analysis, parallel computing, combinatorial scientific computing, and graph theory. Recent work has focused on integrating tools and techniques from structural graph theory into tools for scalable network analysis.