NC STATE UNIVERSITY

computer science
RESEARCH

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Researchers Devise More Accurate Method for Predicting Hurricane Activity

Researchers from NC State University have developed a new method for forecasting seasonal hurricane activity that is 15 percent more accurate than previous techniques.

"This approach should give policymakers more reliable information than current state-of-the-art methods," says Dr. Nagiza Samatova, associate professor of computer science. "This will hopefully give them more confidence in planning for the hurricane season."

Conventional models used to predict seasonal hurricane activity rely on classical statistical methods using historical data. Hurricane predictions are challenging, in part, because there are an enormous number of variables in play – such as temperature and humidity – which need to be entered for different places and different times. This means there are hundreds of thousands of factors to be considered.

The trick is in determining which variables at which times in which places are most significant. This challenge is exacerbated by the fact that we only have approximately 60 years of historical data to plug into the models. But now researchers have developed a "network motif-based model" that evaluates historical data for all of the variables in all of the places at all of the times in order to identify those combinations of factors that are most predictive of seasonal hurricane activity.

The groups of important factors identified by the network motif-based model are then plugged into a program to create an ensemble of statistical models that present the hurricane activity for the forthcoming season on a probability scale. For example, it might say there is an 80 percent probability of high activity, a 15 percent probability of normal activity and a 5 percent probability of low activity. Read more at www.csc.ncsu.edu/news/1378.

Research Highlights

Established in 1967, the NC State University Department of Computer Science is one of the oldest and largest computer science departments in the nation. Our department is a national leader in gaming, educational informatics, healthcare IT, cybersecurity, cloud computing and analytics, and we play a key role in the multi-disciplinary efforts relating to NC State's strategic research areas: health & well-being, energy & environment, educational innovation, and safety & security. We are not only one of the largest producers of talent in the nation, our graduates are highly valued and sought after by the most innovative and respected companies in the world. Our corporate relations program is a model revered across the nation. And whether it is identifying the latest security threat to our smartphones or improving the speed and efficiency of our wireless networks 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 $12M. We now have an all time high of over $44M in active research grants, which ranks us well within the top 20 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 computer-based education. 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 (Dr. Tiffany Barnes, associate professor, and Dr. Lina Battestilli, teaching assistant professor). Our enrollments continue to increase (now over 1,400 students), as does our research productivity and funding (>$44M in active research). We are particularly grateful for the generous financial support from our alumni, friends and corporate partners (~$1M in total cash contributions from all sources).

(Continued on page 2)

2011–2012

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- Projects
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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, Associate 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 Fornaro, 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 & 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, Assistant 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, Associate Professor
PhD, University of British Columbia, Canada, 1996
Visualization & computer graphics: methods for rapidly, accurately, effectively visualizing lg. complex datasets

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

Highlights (cont.)

In the 2011-2012 academic year, faculty as a group published over 60 refereed journal papers, over three times as many conference and workshop papers, one book, 13 book chapters, and a number of other edited works. They also produced over 90 other publications, tutorials, editorials, news articles, or media appearances. Over the academic year, faculty gave over 150 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.

In our undergraduate program, we awarded 107 BS degrees, an upward trend expected to continue for several more years. In the fall of 2011, we had 695 undergraduate students including 40 who are double majors. Demand for our undergraduates has surged as the economy has improved. Many of our graduates received multiple offers, and average starting salaries were almost $60K, among the highest in the NC State College of Engineering. Large numbers of our undergraduates were hired by the likes of Cisco, Fidelity Investments, IBM, NetApp and SAS Institute. But a large number of students pursued careers with smaller companies or entrepreneurial opportunities. Our Game Development Concentration, recognized as one of the top in the nation for two consecutive years by The Printceton Review, continues to grow, now with an enrollment of 55 students.

Our graduate program continues to thrive! Applications for admission continue to increase year-over-year. We enrolled 576 graduate students; 175 of these were PhD students – both record highs for the department. Similarly, we awarded a record number of graduate degrees (215), including 15 PhDs. As with our undergrads, demand for our graduate students is extremely high, with starting salaries for our masters students averaging approximately $85K, while starting salaries for our PhD students are starting around $110K and some have exceeded $150K. Some of the top consumers of our graduate talent include Cisco, IBM, Microsoft and Amazon.com.

In 2011-2012 our faculty received a number of prestigious awards and honors: Dr. George Rouskas was named an IEEE Fellow (the department's 6th IEEE Fellow); Dr. Xiaohui (Helen) Gu received a NSF CAREER Award (the department's 21st NSF CAREER Award winner – 19th currently on faculty), one of the highest concentrations of any department in the nation; Dr. Frank Mueller was named a member of the IEEE Golden Core, and was named a 2011 Distinguished Scientist by the ACM; Dr. Laurie Williams was also named a 2011 Distinguished Scientist by the ACM; Drs. Rada Chirkova, Xiaohui (Helen) Gu, Christopher Healey and Mladen Vouk received IBM Faculty Awards; Dr. Peng Ning received a 2011 IBM Open Collaborative Faculty Award – the only one in IBM history to receive a fourth year renewal.

Our students received numerous honors and awards as well: Jennifer Sabourin received the prestigious NSF Graduate Research Fellowship for the third year; Ben Smith received a prestigious IBM PhD Fellowship Award for the third year; Bushra Anjum was selected to receive a 2011 Phi Kappa Phi "Love of Learning" Award; Anjum also was selected to attend the 2012 Google Graduate researchers in Academia of Diverse Backgrounds (GRAD) CS Forum, the Career Mentoring Workshop (co-located with SIGCSE 2012), the IEEE N2Women Workshop (co-located with INFOCOM 2012), and the CRA-W Graduate Cohort Workshop; Piyali Dey and Ramya Gopalan received travel support to attend the CRA-W Graduate Cohort Workshop; Dey was also selected to attend the Career Mentoring Workshop (co-located with SIGCSE 2012); Preethi Krishnaswamy was selected to receive the IEEE Student Travel Fellowship to attend the Global Humanitarian Technology Conference (GHTC); Alan Sheridan was named a 2011 NC State Leader of the Pack; and William Formyduval, Thomas Pensyl and Eric Whitmire were awarded the Donald L. Bitzer Creativity Awards for 2011-2012.

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**.

TC: Large: Collaborative Research: Trustworthy Virtual Cloud Computing, **Peng Ning, Xuxian Jiang, Mladen Vouk. $1,523,685 by National Science Foundation**.

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**.

Scientific Data Management Center for Enabling Technologies, **Mladen Vouk. $885,000 by the U.S. Department of Energy**.

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

Investigating an Intelligent Cyberlearning System for Interactive Museum-Based Sustainability Modeling, **James Lester, James Minogue, Bradford Mott, Patrick Fitzgerald. $713,384 by National Science Foundation**.

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)**.

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**.

II: NEW: ARC: A Root Cluster for Systems Research into Scalable Computing, **Frank Mueller, Vincent Freeh, Xiaohui (Helen) Gu, Xuxian Jiang, Xiaosong Ma. $549,999 by National Science Foundation**.

CAREER: Cooperative Developer Testing with Test Intentions, **Tao Xie. $525,727 by National Science Foundation.**

TC: Small: Defending against Insider Jammers in DSSS- and FH-Based Wireless Communication Systems, **Peng Ning, Huaiyu Dai, ECE. $499,064 by National Science Foundation**.

Promoting Literacy Education in Rural Schools with Intelligent Game-Based Learning Environments, **James Lester, Bradford Mott. $498,783 by EDUCAUSE**.

GENI IMF: Integrated Measurement Framework and Tools for Cross Layer Experimentation, **Rudra Dutta, George Rouskas. $479,259 by Global Environment for Network Innovations (National Science Foundation)**.

SHF: SMALL: Scalable Trace-Based Tools for In-Situ Data Analysis of HPC Application (Scala-Jack), **Frank Mueller. $457,395 by National Science Foundation**.

Ultrascale Computational Modeling of Phenotype-Specific Metabolic Processes in Microbial Communities, **Nagiza Samatova, Anatoli Melechko. $454,311 by Oak Ridge National Laboratories – UT Battelle (DOE)**.

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**.

CSR: Medium: Collaborative Research: Providing Predictable Timing for Task Migration in Embedded Multi-Core Environments (TIME-ME), **Frank Mueller. $390,000 by National Science Foundation.**

Scalable and Power Efficient Data Analytics for Hybrid Exascale Systems, **Nagiza Samatova. $364,944 by Oak Ridge National Laboratories.**

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, Assistant 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 artifical 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, Associate 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, 2000
Agile software processes, software security, open software systems, heathcare information technology

Tao Xie, Associate Professor
PhD, University of Washington, 2005
Automated software testing and verification, mining software engineering data

R. Michael Young, Associate 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

Computer Science
NC STATE UNIVERSITY

NC State Department of Computer Science
Box 8206, Raleigh, NC 27695–8206

Edited by Tammy Coates and Ken Tate.
2,200 copies of this document were printed at a cost of $0.33/ea.

Senior Faculty Profiles

Dr. Donald L. Bitzer, Distinguished University Research Professor of Computer Science at NC State, received his PhD in Electrical Engineering from the University of Illinois in 1960. Before joining NC State in 1989, he was a professor of Electrical and Computer Engineering at the University of Illinois from 1960-1989.

In 1964, Bitzer co-invented the flat Plasma display panel, and in October 2002, he was awarded an Emmy by the National Academy of Television Arts and Sciences for his efforts advancing television technology.

Largely regarded as the "father of PLATO", he has made a career of improving classroom productivity by using computer and telecommunications technologies. The creation of the PLATO computer system, the first system to combine graphics and touch-sensitive screens, is the hallmark of his efforts.

He is a member of the National Academy of Engineering (since 1974), a member of the American Society for Engineering Education (since 1974), a Fellow in the American Association for Advancement of Science (since 1983), a Fellow in the Institute of Electrical and Electronics Engineers (since (1976), a Fellow in the Association for Development of Computer Based Instructional systems (since 1986), and a Fellow of the International Engineering Consortium (since 1984).

In1967 he received the Industrial Research 100 Award, and in 1973 he received the prestigious Vladimir K. Zworkin Award of the National Academy of Engineering. Other awards include the Chester F. Carlson Award (1981) from the American Society for Engineering Education for "Innovation in Engineering Education", the Computer Science Man of the Year (1975) from the Data Processing Management Association, and the Education Award (1989) from the American Federation of Information Processing Societies. In 1982 he was named Laureate of the Lincoln Academy by the State of Illinois for contributions made "for the betterment of human endeavor". The College of Engineering at the University of Illinois awarded him with the Alumni Distinguished Service Award in 2004. In 2006 he was inducted into the Consumer Electronics Hall of Fame.

Dr. Peng Ning, professor of Computer Science and Technical Director for the Secure Open Systems Initiative (SOSI), joined NC State in 2001. He earned his PhD in Information Technology from George Mason University in 2001, his ME degree in Communication and Electronic Systems and a BS degree in Information Science in 1997 and 1994, respectively, both from the University of Science and Technology of China.

His research interests include developing systems and techniques that enhance the security of networks, distributed systems, and applications. His current research is focused on cloud computing security with an emphasis on compute cloud infrastructure security. He is also working on wireless security, particularly the security of emerging wireless networking technologies.

In 2011, Ning received an IBM Open Collaborative Faculty Award. His Open Collaboration Research (OCR) project is the only one in IBM history to receive a fourth year renewal. The total amount of the award is now $300,000.

Ning serves on the editorial board of ACM Transactions on Sensor Networks (since 2007), and the Journal of Computer Security (since 2006). He has served on the organizing committees or program committees for over 50 technical conferences or workshops related to computer and network security. He is a senior member of the ACM, the ACM SIGSAC, and a member of the IEEE and the IEEE Computer Society.

New Faculty Profiles

Dr. Tiffany Barnes joined the faculty as associate professor in August 2012. Barnes is a three-time graduate of NC State receiving her BS in Computer Science and Mathematics in 1995; her MS in Computer Science and Mathematics in 2000; and her PhD in Computer Science in 2003. Her research focuses on educational data mining, serious games for education, health, and energy, and broadening the participation in computing education and research. She is a member of Phi Beta Kappa, and the NC State Golden Chain Society.

Dr. Lina Battestilli joined the faculty as a teaching assistant professor in August, 2012. She received an MS degree in Computer Networking in 2002 and a PhD degree in Computer Science in 2005, both from NC State. Her research interests include computer science education, cloud computing and datacenter networks, networking architectures and protocols (high-speed, internet, wireless, optical), software defined networking and openflow, performance evaluation, simulation and queueing theory.