

RESEARCH

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Associate Professor, Dr. James Lester is pictured with *Crystal Island*, an adventure-style video game being developed at NC State. *Crystal Island* leverages artificial intelligence and commercial game technologies to create engaging interactive learning experiences. The game targets 8th graders studying microbiology, and features a science mystery in which the student plays a detective tracking down the source of a disease.

Lester has been awarded more than \$4M in National Science Foundation grants to study intelligent game-based learning environments for elementary and middle school students. *Crystal Island* is a collaborative project between NC State's Department of Computer Science and the College of Education.

Photo by Roger Winstead



Research Highlights

The NC State University Department of Computer Science, which celebrated its 40th year in the fall of 2007, is proud to be one of the oldest and largest computer science departments in the nation. Fueled by an expansive growth of our graduate program and research efforts, as well as our recent move to NC State's award-winning Centennial Campus, our department consistently ranks among the leading producers of the computer science talent and innovation that fuels an economic engine anchored in the Research Triangle Park and extending across the globe.

2007–08 was a truly historic year in the life of our department. During the fall of 2007, the department held a number of events in celebration of its 40th year, anchored by a Technical Symposium featuring Steve Wozniak, Al Aho, Dorothy Strickland and Larry Hodges. Work did not stop during this period of celebration, as our faculty and students excelled winning numerous prestigious awards and recognitions, our graduate program experienced continued growth, we added new academic concentrations and centers, and our research funding grew significantly.

Our research productivity reached a new level over the last year. Our research expenditures exceeded \$8M and we now have more than \$28M in active research grants. We also received over \$7.5M in in-kind donations during the year. Our research interests range from theory and algorithms, bioinformatics, high-performance and power-aware systems, to artificial intelligence, graphics and visualization, networks, security, software engineering, and computer-based education. A list of select representative research projects is provided within this document.

2007–2008

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www.csc.ncsu.edu

Research Faculty

Annie I. Antón, Professor**PhD, Georgia Institute of Technology, 1997**

Software engineering, requirements engineering, information privacy and security, policy

Kemafor Anyanwu, Assistant Professor**PhD, University of Georgia, 2007**

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

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

AI: constraint processing, machine learning, hybrid neural-symbolic computing

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

Convolutional decoding for high-speed networks; high-speed, error-free communication channels

Franz Brügler, 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

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

Computer architecture—emphasis on design and application of highly parallel computers

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

Robert Fornaro, Professor**PhD, The 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 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, Assistant Professor**PhD, Universität Heidelberg, Germany, 2001**

Algorithms to compare and analyze gene order permutations, EST assembly, analysis of alternative splicing

Highlights (cont.)

During the past year, our faculty published 56 refereed journal papers, 167 refereed conference and workshop papers, one book, and 22 book chapters and other edited works. They also produced over 110 other publications, tutorials, editorials, and news articles and made media appearances and gave about 200 professional talks related to their research and educational activities. We have 17 faculty serving as editors or 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 graduate program continues to grow. In 2007-2008, we awarded 101 masters (25 with thesis), and 15 PhD degrees, a rate comparable to that in top 30 computer science departments in the nation. We received 1,031 applications for admission to the graduate program for fall 2008 (up almost 10% from last year) and estimate that the PhD enrollment will approach 175 and the overall graduate program will grow to about 500 for Fall 2008. As a strong testament of value, our Masters in Computer Science degree was ranked #3 in the nation as a “Best Buy” in the category of “Online Degrees in Computer Science” by GetEducated.com.

Our facilities house more than 30 research groups, laboratories and centers. The notable addition during the 2007-08 academic year was the creation of the Secure Open Systems Initiative (SOSI), a research center that will make vital computer systems more secure. The center opened in April 2008 with the help of NC Congressman, David Price, after several years of close collaboration between representatives from the NC State Networking Technology Institute and several outside partners, particularly open-source giant Red Hat and the Army Research Office. Our faculty also play an integral role in the University’s new Institute for Advanced Analytics which opened in 2007. Finally, in 2008 we were one of the first in the country to receive NSA’s National Center of Academic Excellence in Information Assurance Research (CAE-R) designation.

In 2007–08, our faculty and students received a number of outstanding awards and accolades. Dr. Ting Yu became the department’s 18th NSF CAREER Award winner. Dr. Bob Fornaro became the department’s 9th member of the NC State Academy of Outstanding Teachers. Eight faculty including Drs. Annie Antón, Kemafor Anyanwu, Vince Freeh, Helen Gu, Christopher Healey, Steffen Heber, Laurie Williams, and Tao Xie received prestigious IBM Faculty Awards. Graduate students Travis Breaux and Sarah Heckman received prestigious IBM PhD Fellowship awards, Aaron Massey and Paul Otto won two of just 12 nationwide Google Policy Fellowships, Jennifer Robison received the very prestigious NSF Graduate Research Fellowship, and the work of David Cox, was featured on the cover of the May issue of *Notices of the American Mathematical Society*. Finally, a visualization model of Hurricane Katrina by Steve Chall and Theresa-Marie Rhyne of RENCI’s NC State engagement center won top honors at the annual meeting of the U.S. Department of Energy’s Scientific Discovery through Advanced Computing.

The department experienced some faculty changes during the year. We are very proud to announce the addition of Dr. Xuxian Jiang this fall. Dr. Purush Iyer, has taken a leave of absence to direct the US Army Research Office (ARO) Intelligent Systems program, and Dr. Richard Mayr joined the University of Edinburgh, U.K. We now have 43 faculty involved in research, 21 lecturers and adjuncts, and about 34 research, information technology and administrative support staff.

I would like to thank all who have contributed to our success during the last year, and during our first 40 years.

Mladen Vouk
Professor and Department Head

Selected Research Projects

Complete list with abstracts is at

<http://www.csc.ncsu.edu/research/>

R&D: Developing Science Problem Solving Skills and Engagement Through Intelligent Game-Based Learning Environments, **James Lester, Hiller Spires, John Nietfeld, James Minogue**. NSF (\$2,523,295, 8/1/2008–7/31/2011)

Secure Open Systems Initiative, **Dennis Kekas, Peng Ning, Mladen Vouk, Rudra Dutta**. Army Research Office (\$3,336,000, 4/3/2008–4/2/2010)

Comparative and Web-Enabled Virtual Screening, **Xiaosong Ma (Co-PI), Jacqueline Hughes-Oliver (PI), Moody Chu, Gary Howell, Morteza Khaledi**. NIH (\$1,111,110, 9/23/2005–7/31/2008)

NOAA Interdisciplinary Scientific Environmental Technology(ISET) Cooperative Research and Education Center, **Vince Freeh (Co-PI), Fredrick Semazzi (PI), Lian Xie, Jingpu Liu**. NC A&T University via National Oceanic & Atmospheric Administration (\$978,528, 9/1/2006–8/31/2011)

ITR: Encoding Rights, Permissions, and Obligations: Privacy Policy Specification and Compliance, **Annie Anton, Julie Earp, Lynda Aiman-Smith, David Baumer**. NSF (\$932,000, 9/15/2003–8/31/2008)

High-Performance Data Analytics with Demonstrations to DOE-Mission Applications, **Nagiza Samatova**. Oak Ridge Nat'l Labs & UT-Battelle, LLC (\$920,002, 10/4/2007–8/31/2009)

NeTS-NBD: Measurement-Based Mobility Modeling for MANETs, **Mihail Sichitiu (ECE), Injong Rhee**. NSF (\$484,827, 8/15/2006–7/31/2009)

CAREER: Trust and Privacy Management for Online Social Networks, **Ting Yu**. NSF (\$450,000, 8/1/2008–7/31/2013)

Toward Cognitive Habile Agents, **Robert St. Amant**. NSF (\$375,266, 1/1/2006–12/31/2008)

NeTS-NR: Traffic Quantization: A Formal Framework for Quality of Service (QoS) and Scalability in Packet-Switched Networks, **George Rouskas**. NSF (\$357,314, 9/1/2004–8/31/2009)

BPC-A: The STARS Alliance: A Southeastern Partnership for Diverse Participation in Computing, **Laurie Williams, Mladen Vouk, Sarah Berenson**. UNC-Charlotte (NSF) (\$303,219, 3/1/2006–2/28/2009)

Mining Program Source Code for Improving Software Quality, **Tao Xie**. Army Research Office (\$300,000, 9/8/2008–8/30/2011)

REU Site:Design Tech: Sparking Research in Interactive Visual Design, **Benjamin Watson, Christopher Healey, R. Michael Young, Patrick Fitzgerald**. NSF (\$268,763, 3/1/2006–2/28/2009)

CT-ISG: The Origin of the Code: Automated Identification of Common Characteristics in Malware, **Doug Reeves**. NSF, (\$268,510, 9/1/2008–8/31/2011).

Collaborative Research: Effective Detection and Alleviation of Scalability Problems, **Frank Mueller, Jerzy Bernholc**. NSF (\$231,652, 9/1/2004–8/31/2009).

IPA Agreement between NCSU and US Army Research Office for Dr. SP Iyer, **SP Iyer**. US Army Research Office (\$175,158, 2/11/2008–12/31/2008).

Policy-Based Governance for the OOI Cyberinfrastructure, **Munindar Singh**. University of California-San Diego (\$107,945, 5/3/2007–09/30/2008).

Enhancing Bioinformatics Education, **Steffen Heber**. NC Biotech Center (\$80,146, 5/16/2008–05/15/2009).

Enumeration and Structure in Combinatorial Families Defined By Linear Inequalities, **Carla Savage**. National Security Agency (DOD) (\$77,186, 4/21/2008–10/31/2009).

Process Coloring: An Information Flow-Preserving Approach to Malware Investigation, **Xuxian Jiang**. Purdue Univ. (\$50,000, 8/1/2008–12/6/2008..

Triangle Computer Science Distinguished Lecturer Series, **Franc Brglez**. Army Research Office (\$43,320, 9/1/2007–8/31/2010)

Research Faculty (cont.)

Thomas L. Honeycutt, Associate Professor
PhD, North Carolina State University, 1969
Management information systems, computer modeling and simulation, computer literacy

S. Purushothaman Iyer, Professor
PhD, University of Utah, 1986
Programming and specification languages; software model-checking, probabilistic models of concurrency

Xuxian Jiang, Assistant Professor
PhD, Purdue University, 2006
Virtual machines and security

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

Xiaosong Ma, Assistant Professor (joint appointment with ORNL), PhD, University of Illinois, 2003
High performance computing, parallel I/O, storage systems, scientific data management

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

Peng Ning, Associate Professor
PhD, George Mason University, 2001
Computer and network security: new techniques for building trustworthy systems and wireless security

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

Douglas S. Reeves, Professor
PhD, The Pennsylvania State University, 1987
Network security, peer-to-peer computing and overlay networks, real-time communication

Injong Rhee, Associate Professor
PhD, UNC Chapel Hill, 1994
Computer/wireless/sensor networks, multimedia networking, distributed systems, operating systems

Robert D. Rodman, Professor
PhD, University of California, Los Angeles, 1973
Spoken natural language dialogue and voice I/O sys., 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, sys. biology, data management, data integration

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

Munindar P. Singh, Professor
PhD, University of Texas, 1993
Multiagent systems, intelligent agents, agent communication 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

Research Faculty (cont.)

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., approximate and numerical solution techniques for analysis

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

File and data structures, man-machine interfaces, database management systems

David Thunte, Professor
PhD, University of Kansas, 1974

Communication system design, simulation, performance modeling; media access control protocol

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

Software engineering, scientific computing, computer-based education, high-perf. networks.

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

Relationships between computer graphics and design

Laurie Williams, Associate Professor
PhD, University of Utah, 2000

Agile software development methodologies and practices, collaborative/pair programming

Tao Xie, Assistant 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, development of computational models

Ting Yu, Assistant 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

Robert E. Funderlic, Professor Emeritus
PhD, University of Tennessee, 1970

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

Woodrow Robbins, Professor Emeritus
PhD, Syracuse University, 1971

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Senior Faculty Profiles



Dr. Douglas S. Reeves received his BA in Biology from Indiana University; his MS in Computer Science/Engineering from the University of Louisville; and his PhD in Computer Science from The Pennsylvania State University in 1987. He joined the department in 1987, and currently serves as Professor of Computer Science and Electrical & Computer Engineering. Dr. Reeves is a contributing faculty member of several high-profile centers and labs on campus including the Center for Advanced Computing and Communication, the Center for Open Software Engineering, and the Cyber Defense Lab. His research interests include computer and network security, peer-to-peer computing and overlay networks, real-time communication and quality of service in networks, and network services including voice. During his academic and professional career, he has received many honors including the General Electric Doctoral Fellowship in 1985, an Undergraduate Teaching Award for the Department of Computer Science in 1988, and the Professional Engineer of the Year Award by the Department of Computer Engineering and Computer Science from the Speed Scientific School at the University of Louisville in 2003. Dr. Reeves has served as a consultant for a number of companies, and has been a member of the editorial boards of the *International Journal of Information and Computer Security* and the *Telecommunications Systems Journal* since 2005. He currently serves as the chair of the University Library Committee, which is actively involved in planning for the addition of The James B. Hunt Library, scheduled to open in 2013 on the Centennial Campus. To date, Dr. Reeves is the author/co-author of over 40 research papers, and has received over \$4.7M in research funding. His most recent project, the "modus operandi project" is concerned with computing the similarity between two pieces of software. The major application is identification of metamorphic and polymorphic malware.



Dr. David J. Thunte received his PhD from the University of Kansas, and he currently serves as Director of Graduate Programs and Professor of Computer Science at NC State University. He is also Professor Emeritus, Purdue University and was a Director of Graduate Programs for the Purdue Graduate School. Dr. Thunte has extensive experience in both industrial and academic computing. He is the author/co-author of over 50 refereed journal and conference publications, another 20 workshop and professional publications (most refereed), over 30 industrial white papers and consulting reports, and has over 100 professional presentations at universities, industries and conferences nationally and internationally. Dr. Thunte has produced a seminal line-search algorithm that is the critical component of many optimization algorithms. He has also done benchmark research on protocols for low-bandwidth military communications and is currently working on protocol aware denial-of-service for wireless communications. He has held research positions at Argonne National Laboratory, Mitre Corporation, Magnavox Electronic Systems Company, Hughes Defense Communications Company, and Raytheon Systems Company. He has also been a consultant for Lockheed Corp., General Electric, OPNET and Northrop Grumman. Since 1985 Dr. Thunte has received over \$2M in research and development grants and an additional \$24M in other funding supporting teaching and research. Since Dr. Thunte became Director of Graduate Programs at NC State in 2003, the graduate program has grown by almost 60 percent to nearly 500 students. More impressive, the PhD enrollment has grown from 47 to 174 students, representing an astounding 270 percent growth. Under Dr. Thunte's leadership, the NC State graduate program now ranks in the top ten public universities in the country in terms of graduating both Master's and PhD students.

New Faculty Profiles



Dr. Xuxian Jiang joined the faculty in August, 2008. Dr. Jiang received his PhD from Purdue University in 2006, and was formerly an assistant professor at George Mason University in Fairfax, VA. His research interests are in virtual machines (VMs) and security.

Contributions from Fay Ward and Roger Winstead
Edited by Tammy Coates and Ken Tate
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