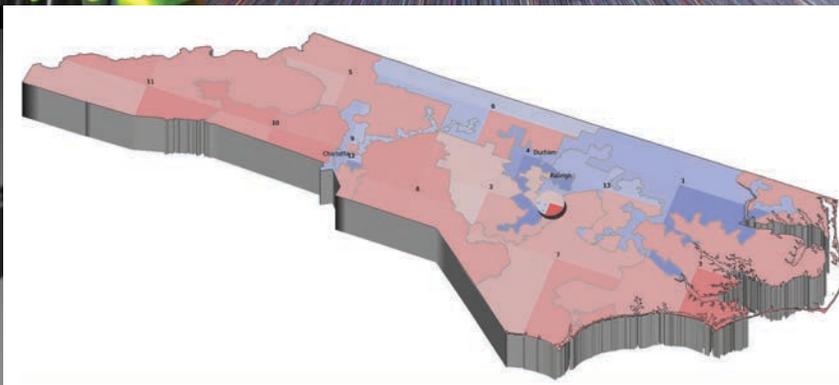
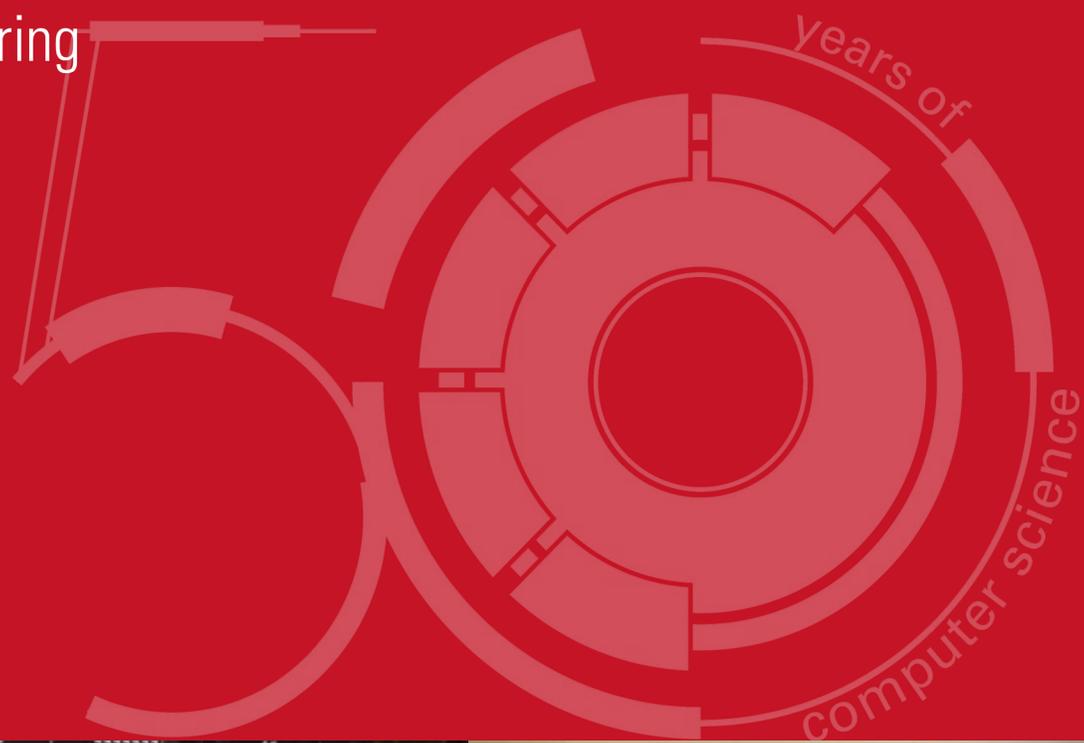


NC STATE Engineering



DEPARTMENT OF COMPUTER SCIENCE

1967–2017

50 YEARS OF EDUCATION AND RESEARCH

MESSAGE FROM THE HEAD



*Dr. Laurie Williams, Interim Head
Department of Computer Science*

Welcome

When the first computers were installed in Patterson Hall in 1957, there must have been great speculation about the impact of

computing. Ten years later, in the fall of 1967, the NC State Department of Computer Science was “officially” established. Over the next 50 years, we have emerged as one of the largest and most productive computer science departments in the nation. We now have 48 outstanding faculty, have produced 28 NSF CAREER award winners, and offer expertise that ranges from systems to theory, from artificial intelligence to networks, and from software engineering to bioinformatics.

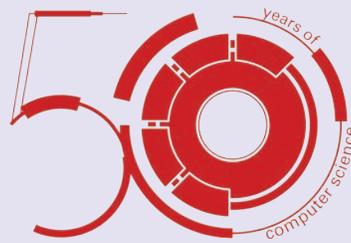
As part of a land-grant institution adjacent to the world-famous Research Triangle Park, we have held true to our mission—serving citizens of North Carolina by educating a strong talent pool to meet the growing technology needs of our state and beyond. Award winning programs like our Senior Design Center have helped to ensure that our students graduate with real-world skills to accompany a solid technical foundation. With over 9,000 alumni, we rank among the leading producers of computer science talent nationwide, and are proud to consistently act as a valued source of new

graduates for industry.

Since its launch in 1989, our graduate program has experienced steady growth and attained an outstanding reputation. Our researchers have been equally successful. New state-of-the-art facilities on NC State’s Centennial Campus house over 30 research groups, laboratories and centers. Strong industry and government ties have helped drive curriculum evolution and groundbreaking research results in areas such as Security and Privacy, Software Engineering, Data Science, Serious Games, and Learning Technologies.

Over the years I have had the privilege to know and work with many who have shaped the department. I am extremely proud of and thankful for all our past and present students, faculty and staff and our alumni and corporate friends. I would also like to thank the former computer science department heads and the NC State University, UNC, and State of North Carolina administrations for the vision, support, and effort that allowed this department to be founded and to grow and excel.

The pages that follow provide some insights into the paths the department has followed, its current education and research activities, and its future directions. While it is hard to give appropriate credit to all who have contributed to our success, I hope that these snapshots will whet your interest. Please join us in celebrating our 50th anniversary.



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About the cover (clockwise from top-left): NPCs modeled with AI social behavior models; ARC HPC cluster; fifteen of the twenty department female faculty members; election voting visualization map for North Carolina; high performance, high resolution shadow algorithms; wireless harness to facilitate canine-human communication

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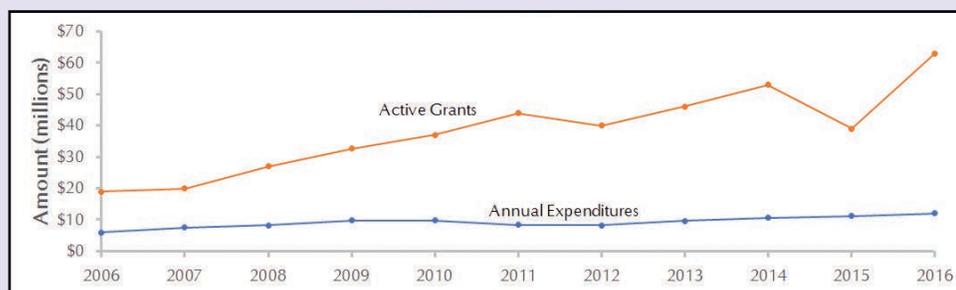
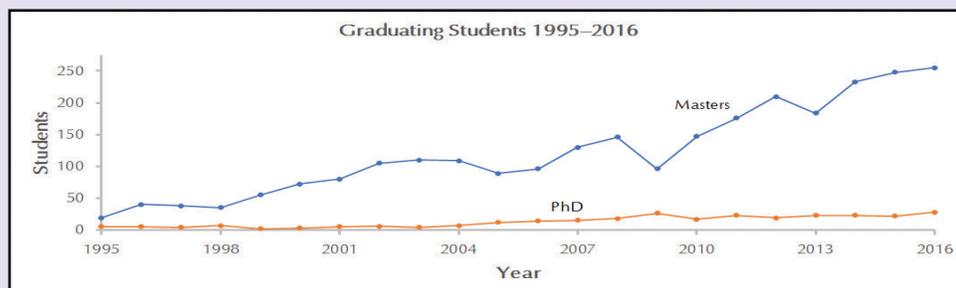
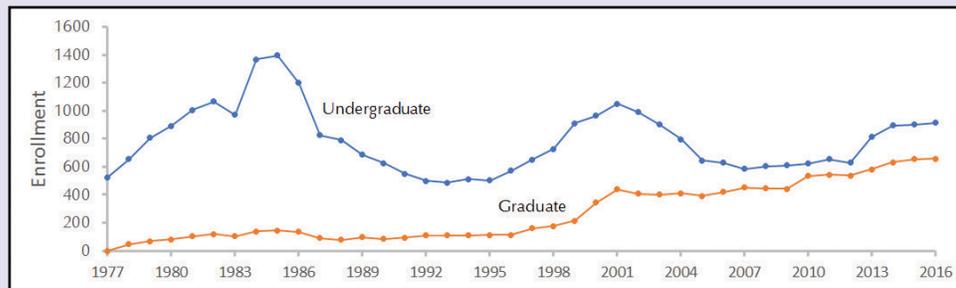
Peter Wurman presents at the Fidelity Investments lecture series

Facts and Figures

The Department of Computer Science matches or exceeds other top departments throughout the country. The ASEE ranks us among the top 20 departments in enrollments, graduate rates, and research

dergraduate, 101 MS, and 18 PhD students graduating. While our undergraduate totals follow national trends, overall our graduation numbers continue to strengthen. Our PhD rate matches the averages for depart-

DEPARTMENT ACHIEVEMENTS



funding. We were 48th in the nation in the 2014 US News & World Report ranking for graduate Computer Science programs.

In 2017 the department included 1,070 undergraduate, 510 MS, and 195 PhD students, with 105 un-

dergraduate, 101 MS, and 18 PhD students graduating. While our undergraduate totals follow national trends, overall our graduation numbers continue to strengthen. Our PhD rate matches the averages for depart-

ments ranked 13-24, and our MS rate for departments ranked 1-12. Faculty in the department secured \$63 million in research grant funds in 2016, with an annual expenditure of \$12 million. Overall research funds and expenditures continue to grow.



WELCOME
TO
COMPUTER
SCIENCE

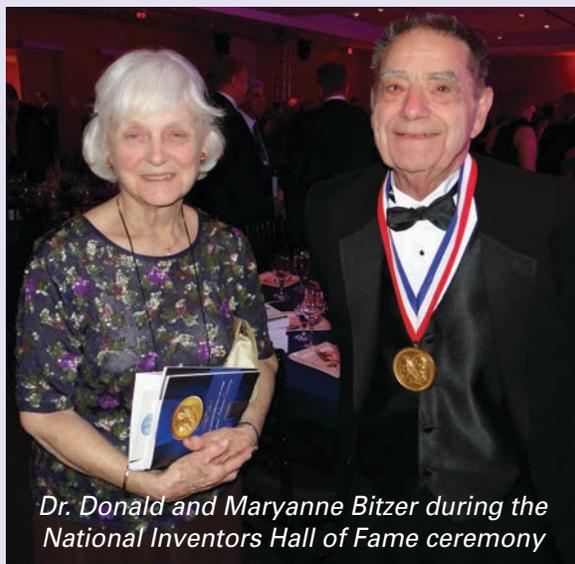


Awards



Select Faculty Awards

- **ACM SIGSOFT Influential Educator Award**, Laurie Williams
- **American Association for Artificial Intelligence Fellow (2)**, Jon Doyle, James Lester
- **Emmy Award, National Academy of Engineering Member, National Academy of Television Arts and Sciences Award**, Donald Bitzer
- **IEEE Fellows (7)**, Donald Bitzer, Wushow "Bill" Chou, Frank Mueller, Harry Perros, George Rouskas, Munindar Singh, Mladen Vouk
- **Moore Investigator Award**, Blair Sullivan
- **National Mathematical Society Fellow**, Carla Savage
- **NSF CAREER Award (28)**, Annie I. Antón, Tiffany Barnes, Kristy Boyer, Min Chi, Rada Y. Chirkova, William Enck, Vincent W. Freeh, Helen Gu, Khaled Harfoush, Christopher G. Healey, Xuxian Jiang, Vicki Jones, James C. Lester, Xiaosong Ma, Frank Mueller, Emerson Murphy-Hill, Peng Ning, Injong Rhee, Jonathan Rossie, George N. Rouskas, Xipeng Shen, Munindar P. Singh, Ben Watson, Laurie Williams, Peter Wurman, Tao Xie, R.

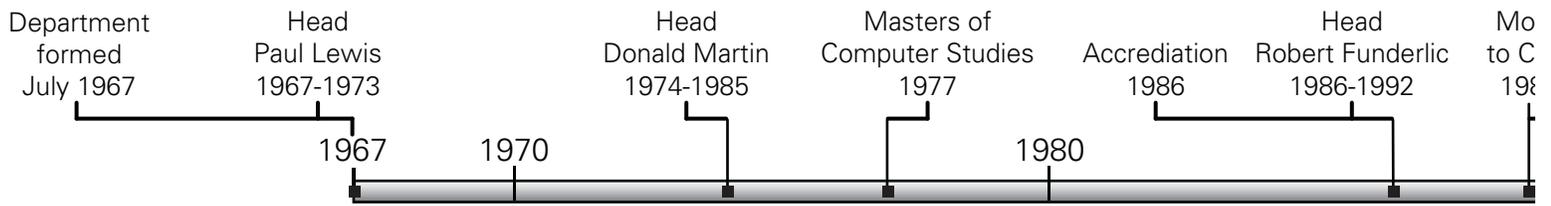


Dr. Donald and Maryanne Bitzer during the National Inventors Hall of Fame ceremony

- Michael Young, Ting Yu
- **NCSU Academy of Outstanding Teacher Award (11)**, Edward Davis, Robert Fornaro, Christopher G. Healey, Sarah Heckman, Margaret Heil, James Lester, Carolyn Miller, George Rouskas, Alan Tharp, Laurie Williams, R. Michael Young

Select Student Awards

- **COE Faculty Senior Scholar Nominee**, Melissa Novitsky
- **Equity for Women Award**, Veronica Catete
- **Microsoft Open Source Challenge — Grand Prize**, Akond Rahman
- **Microsoft PhD Research Fellowship**, Denae Ford
- **National Defense Science and Engineering Fellowship**, Timothy Godrich
- **NSF Graduate Research Fellowship**, Rachel Mary Chung, Denae Ford, Sean Mealin
- **Woman Enhancing Technology Scholarship**, Dana Christo, Megan O'Conner



ENIAC
1946



IBM/360
1964



Altair 8800
1975



Cray-1
1976



Apple II
1977



IBM PC
1981



Macintosh
1984

DEPARTMENT HISTORY

Computer science began at North Carolina State University in 1957, when the Department of Experimental Statistics installed the first computers in the basement of Patterson Hall. In 1966, a committee on computer science called for



*Dr. Paul Lewis
Head, 1967-1973*

a Computer Science Department (CSC) offering a Bachelor of Science degree. In 1967, Chancellor Caldwell formally proposed the Computer Science Department, which was approved in July.

Dr. Paul Lewis became the first Computer Science Department head. After beginning in Harrelson Hall, the department expanded to occupy 10 offices in the newly opened Dabney



*Dr. Donald Martin
Head, 1974-1985*

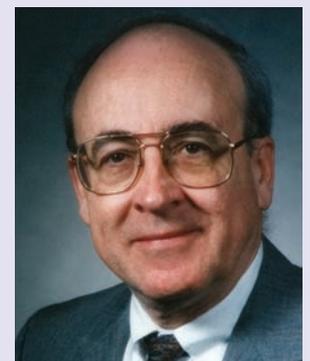
Hall in 1970. The department also recruited its first two computer science PhDs in 1969—Dr. Alan Tharp (Northwestern) and Dr. Robert Fornaro (Penn State).

In 1973 Dr. Lewis stepped down and Dr. Norm Williamson acted as interim head for over a year. In 1974, Dean Arthur Menius asked Dr. Donald Mar-

tin to become the new head of the Computer Science Department. In the first four years of Dr. Martin's leadership, the department averaged 350 majors and enrolled more than 2,000 students in all CSC courses.

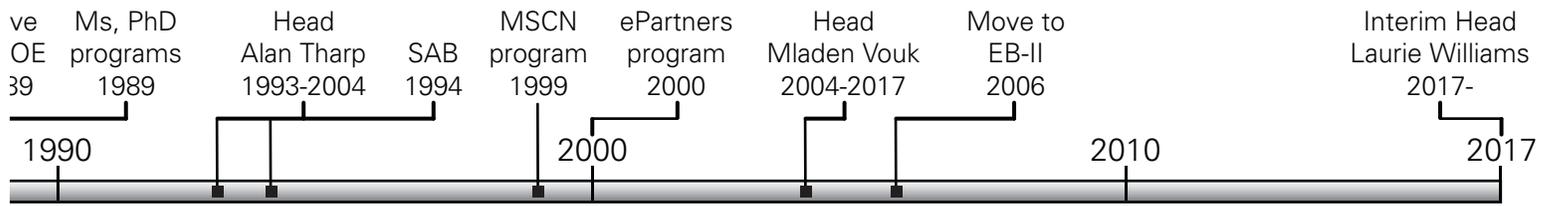
In 1979, CSC made a major move from Dabney Hall to the newly renovated Daniels Hall. In 1982, CSC dedicated a Data General MV 8000 to support its instructional program. In 1983, CSC installed a Sage microcomputer system to serve 2,000 students in the basement of Leazer Hall.

Dr. Robert Funderlic took over as head of the Computer Science Department in 1986. In 1989, Dr. Donald Bitzer, member of the National Academy of Engineering and co-inventor of the plasma display and the Plato educational system, moved from the University of Illinois to join the department.



*Dr. Robert Funderlic
Head, 1986-1992*

Through the strong efforts of Dr. Funderlic, with support from the Dean of Engineering Dr. Larry Monteith and Electrical Engineering Head Dr. Nino Masnari, independent Computer Science MS and PhD graduate program was approved in 1989 when



IBM SSD
1992



Netscape
1994



NVIDIA GPU
1999



iPod
2001



NASA Spirit
2004



iPhone
2007



Raspberry Pi
2012



Windows 10
2015

the department moved from the College of Physical and Mathematical Sciences (PAMS) to the College of Engineering (COE).

Dr. Alan Tharp was named interim head in 1992, and department head in 1993.



*Dr. Alan Tharp
Head, 1993–2004*

Dr. Tharp pursued a vigorous program of growth, resulting in numerous new faculty hires in areas such as e-commerce, network security, object technologies,

visualization, optical networks, human-computer interaction, and virtual worlds.

The department's rapid expansion spread faculty members over nine separate buildings. October 2003 saw the ground-breaking ceremony for the new Engineering Building II (EB-II), designed to combine the department's academic and research units into one space.

Dr. Mladen Vouk was named interim head in 2004, and department head in 2006. This coincided with the department's move into 210,000 ft² in the newly completed EB-II.

The department shifted from undergraduate to world-renowned research facility, including a move towards interdisciplinary research, a common

focus on many top Computer Science Departments. A professional teaching faculty was hired and is now responsible for designing and delivering quality education to the undergraduate students.

The department forged and cultivated relationships with partners outside the university in business, industry, and governmental agencies. Combined with NC State's proximity to Research Triangle Park, this allows students and faculty the opportunity for internships, research collaborations, and interaction with potential employees, setting us apart from schools that can only provide a classroom experience.

Following a significant expansion of the department's faculty and expertise, Dr. Vouk accepted a position as Associate Vice Chancellor for Research and Development.

Dr. Laurie Williams was named interim department head while a search is initiated for a new, permanent department head.



*Dr. Mladen Vouk
Head, 2004–2017*



*Dr. Laurie Williams
Interim Head, 2017–*

Undergraduate Programs



Student Ambassadors

The Department of Computer Science at NC State University offers a state-of-the-art curriculum emphasizing fundamental scientific and engineering principles. We expose students to leading-edge technology while working on a wide range of exciting problems with real-world impact.

From an initial undergraduate student body of 49 majors in 1968, we currently enroll 1,022 undergraduates pursuing a Bachelor of Science in Computer Science, an Accelerated Bachelor's/Master's Degree, or an Undergraduate Minor in Computer Programming. We also offer a concentration in game development, designed to explore computer games for entertainment and serious applications.

Our Bachelor of Science program is accredited by the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology, Inc. The department has also been named a Center for Academic Excellence in Information Assurance by the National Security Agency from 2008 through 2019.

The department includes seven core research focus areas: (1) theory; (2) systems; (3) artificial intelligence; (4)

networks; (5) security; (6) software engineering; and (7) computer-based education, as well as numerous interdisciplinary areas like data analytics, visualization, databases, and user experience.

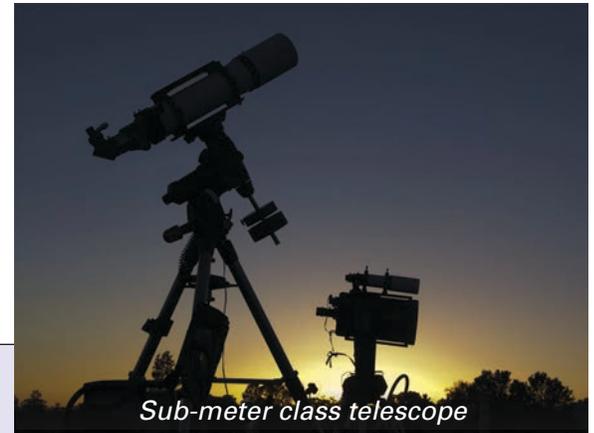
The job market for Computer Science graduates has exploded in recent years. Indications are that this trend will continue. Prior to graduation, our students have the opportunity to participate in the university's Cooperative Education Program, allowing them to alternate between semesters of full-time study and full-time paid



Dereck Whittenburg, speaker at the Fall 2016 Diploma Ceremony

work experience at companies like Cisco, Red Hat, and SAS Institute. Informal exit interviews suggest that approximately 60% of our more recent graduates had secured positions in industry, with this number approaching 100% within three months. Another 12–15% elected to continue on to graduate school.

Senior Design Center



The Senior Design Center (SDC) was created in 1994 to provide upper classmen a value-added capstone learning experience. By 2017, more than 2,100 students and 180 companies have benefited from senior design projects.

The *added value* for students comes through the supportive environment provided by the center's faculty and staff. They develop the writing, speaking, interpersonal and project management skills needed to make a difference in today's technology industry.



The *added value* for company sponsors comes from the opportunity to meet and work with graduating seniors—a great recruitment opportunity—as well as project results that the teams provide.

This year, twenty-one companies including Cisco, Merck, Capital One, IBM, American Red Cross, LexisNexis, and SAS Institute, are sponsoring SDC projects.

IBM – Cognitive Telescope Project.

Telescopic follow-up of transient astronomical events is one of the most desirable and scientifically useful activities in modern observational astronomy.

Sub-meter class telescopes can be now be controlled remotely. The Cognitive Telescope Network (CTN) is a framework that takes notifications of transient events and instructs a network of sub-meter telescopes to observe the region of the sky that likely contains the transient. The CTN collects data from the network, evaluates and classifies it to identify likely transient candidates, and deliver results to astronomers for further analysis by larger telescopes.

Merck – NC Collaborative for Children, Youth & Families. The NC Collaborative is working to improve its website and use of social media to promote understanding of children's issues.



Social workers across the State come to the website to train and certify to serve as mental health consultants. The Collaborative would like to allow for assessment of a person who is trained, and then monitoring and assessment of how participants use their training.

Science of Security

North Carolina State University's Science of Security Lablet (SoSL) has helped build a foundation for the National Security Agency's vision of the Science of Security (SoS) and an SoS community. We emphasize data-driven discovery and analytics to formulate, validate, evolve, and solidify the theory and practice of security. Efforts in our lablet have provided a deeper understanding of users' susceptibility to deception, developers' adoption of security tools, and how trust relates to commitments.

Motivated by NSA's overarching vision for SoS, we will continue (1) developing a science-based foundation for five hard problems we previously formulated; and (2) fostering a SoS community with high standards for reproducible research. Our approach will involve a comprehensive, rigorous, integrated treatment of technical artifacts, humans and relationships and processes relevant to the hard problems.

Leveraging the Effects of Cognitive Function on Input Device Analytics to Improve Security. What features of mouse or keyboard usage analytics

are reflective of the cognitive processes users are performing? What processes distinguish normal, benevolent use from potentially insecure (such as distracted or confused) use?

Smart Isolation in Large-Scale Production Computing. What isolation granularity is best given system requirements? When should isolation occur uniformly, differentially, passively, or proactively?



Formal Specification and Analysis of Security—Critical Norms and Policies. How can we verify whether a set of norms (1) is consistent and realizable through the policies and

preferences of the collaborators, and (2) achieve specified security properties? How can we predict the difficulty of the reasoned, modular creation and maintenance of sets of norms, policies, and preferences?

Attack Surface and Defense-in-Depth Metrics. What methods of composition can be employed to provide defense in depth protections? How can a value-based economic analysis of attack surface metrics and defense-in-depth metrics be used to predict vulnerabilities in systems?

Graduate Programs



Software Engineering laboratory

Graduate degrees in the Department of Computer Science offer education and research opportunities to outstanding students from across the United States and throughout the world. The department boasts nationally ranked PhD, Master of Science, Master of Computer Science, and Master of Science in Computer Networking programs.

We currently enroll 705 students (195 PhD, 510 Masters candidates). This includes 146 U.S. students and 144 female students. Enrollment has been at a record high for several years, with our PhD numbers growing by 21% over the last five years.

Dr. George Rouskas, Director of Graduate Programs, attributes this growth to a recognition

of the quality of our faculty, to the reputation of the program, to active recruiting of our best U.S. applicants, and to the success of our graduates in obtaining excellent positions in the world's top research laboratories and companies. Our students have consistently lead the College and university in terms of Dean's and Alumni Fellowships and have received many prestigious IBM and NSF fellowships.

Masters candidates can specialize in a number of research *tracks*: focus areas that currently include software engineering, security, and data science. Students in each track are required to enroll in courses that provide theoretical and practical skills in the given research area.

Our graduate students also have an opportunity to participate in the university's Cooperative Education Program. During the summer of 2016, 84 Computer Science graduate students held co-op positions, the most of any NC State department. Participating

companies included IBM, Intel, Network Appliance, and Goldman

Sachs. Informal exit interviews suggest nearly all of our students are employed following graduation at companies that include Google, Microsoft, Cisco, Apple, Amazon, Intel, SAS Institute, and others. Our PhD graduates also hold academic positions at many institutions including UNC Charlotte, UC Irvine, UT Arlington, the University of Nebraska, and Arkansas State University.



Climate data being studied on the iPearl Immersion Theater

Visual Narrative

The Digital Games Research Center is a multi-disciplinary center whose focus investigates the scientific, engineering, social and educational challenges of digital games technology. Housed in the Department of Computer Science, the center's faculty include seven computer scientists working on a wide range of research and educational initiatives that study new modes of entertainment and interaction in digital media. Colleagues from the Colleges of Education, Design and Humanities and Social Sciences also join in the center's efforts, some of which are listed here.

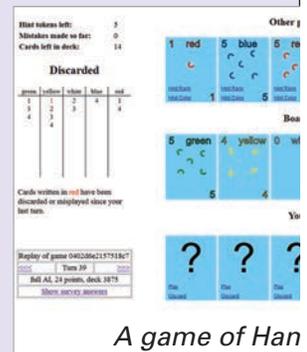
Social NPCs. Dr. Arnav Jhala and his colleagues at the Universidade de Lisboa in Lisbon, Portugal developed CiF-CK, a social agent architecture that models reasoning about persistent social interactions between non-playable character (NPC) and human players. This allows the system to automatically manage and keep up with the complexity of social interactions, reducing the number of experiences that need to be explicitly authored by a developer, and increasing the credibility and believability of NPCs by providing them with basic human traits like emotions and the ability to make decisions on their own.

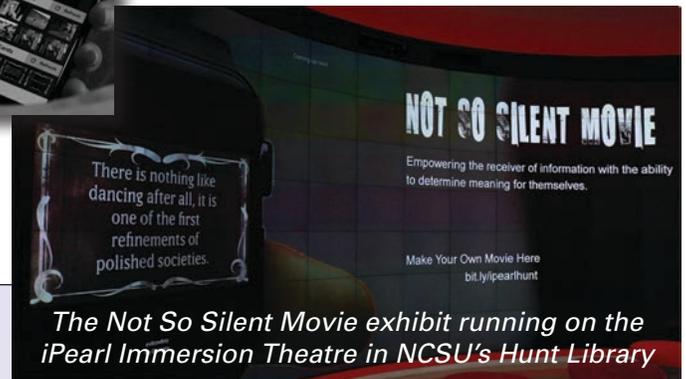
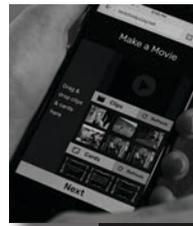
CiF-CK is inspired by McCoy et al's *Comme il-Faut* (CiF, correct in behavior or etiquette) architecture that

represented rich social interactions between NPCs and players that included feelings, social and relationship contexts, and longer term mood. The key contribution of the work is in adapting the richness of CiF to a first-person interaction experience, implemented in the role playing game (RPG) Skyrim's commercial video game engine. Results have been positive, with the released modification finding success in the player community for this popular game.

Hanabi AI. Hanabi is a popular two-player cooperative card game, with cards in five colors, and with ranks from one to five. Each player receives five cards, which they hold facing the other player. The goal is to build fireworks of each color, represented by a stack of cards with a common color, placed in ascending order. On a player's turn, they must choose from three options:

1. Play a card from their hand, which is placed on a firework stack if it matches in color and ascending order, otherwise it is discarded.
2. Give a hint to the other player, by telling them all the cards of either a particular rank or a particular color that they have.
3. Discard a card.





The Not So Silent Movie exhibit running on the iPearl Immersion Theatre in NCSU's Hunt Library

After a turn, players draw a card from the deck to return to five cards. Play ends when three mistakes are made, or when the draw pile is empty. The final score is equal to the number of cards successfully built as fireworks.

“If an AI systems behaves rationally, humans view it as working towards some goal”

Hanabi is technically classified as a cooperative game with partial observability. These types of games are particularly challenging when building a computer-based AI player. Dr. Chris Martens and her students developed an AI agent to better play with a human partner by harnessing communication theory and psychology research.

Critically, intentional AI is used to model the agents. This means that the agent is designed to be intentionally working towards a goal, in this case, maximizing the

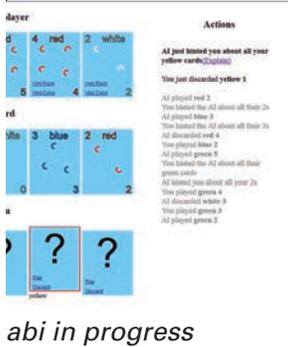
score the agent and the human achieve during a game of Hanabi. It does this by following a basic strategy of: (1) playing a card it knows is playable, otherwise (2) discarding a useless card, otherwise (3) giving a hint to its partner, otherwise (4) dis-

carding a card with the lowest expected point value.

The agent was tested in an experiment where 224 participants played one or more games of Hanabi with different AIs. The Hanabi AI scored higher than previously published agents in this setting.

Silent Movie Authoring. The *Not So Silent Movie* project allowed the general public to author their own movies using a mobile phone to combine clips from silent westerns and title cards from “Pride and Prejudice.” The exhibit was run on the iPearl Immersion Theatre, a 21x7 ft curved display wall of 112 Christie Microtiles arranged in a 16x7 array, with a total resolution of 6816x2240 pixels.

The exhibit was also used to investigate the *Kuleshov* effect, where viewers infer meaning between two sequential shots that they would not infer from a single shot in isolation. Kuleshov showed an expressionless face of Ivan Mosjoukine, followed by either a plate of soup, a girl in a coffin, or a woman on a divan. Although Mosjoukine’s face was always identical, the audience believe his expression was different depending on the follow-on scene: hunger for the plate of soup, grief for the girl in the coffin, and desire for the woman on the divan. Results from the experiment confirmed a similar Kuleshov effect during the exhibit.



hanabi in progress

WSPR Laboratory

The WSPR (*whisper*) laboratory models, designs, builds, and validates technology to protect users, systems, and networks from malicious and privacy-infringing acts. The group's six faculty members and students work on all areas of computer security, from designing new cryptography constructs to ensuring protected execution of code to empirical studies on how software is secured; from finding flaws in existing operating systems to building systems resilient to known attacks; from detecting malicious activity such as malware and denial of service to building networks and mechanisms to prevent abuse. The WSPR Lab works to secure all types of computer systems, from legacy telephone networks to emerging technologies like smartphones and Internet of Things devices.

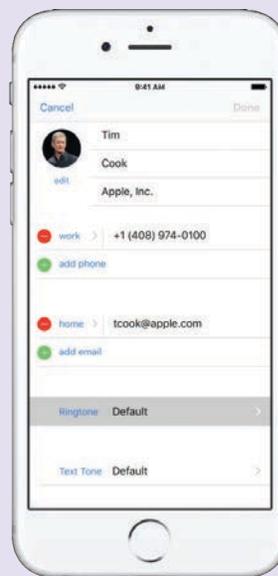
SandScout. Dr. William Enck and his team identified serious security vulnerabilities in Apple's iPhone and iPad devices. iOS uses a *sandbox* to communicate with an app. A *profile* controls information the app can access, and what it is allowed to do.

Enck and his student, along with colleagues from Bucharest and Darmstadt, extracted, revised, and formally modeled iOS sandbox profiles and used automated tests to

search for potential security vulnerabilities. This allowed them to identify vulnerabilities that would allow an app to launch different types of attacks, for example:

“Enck identified vulnerabilities in Apple’s iOS that allowed apps to bypass privacy and security settings”

- bypassing iOS’s privacy settings for contacts
- learning the user’s location search history
- obtaining the user’s name and media library
 - allowing apps to share information without permission



Enck relayed the full list of vulnerabilities to Apple, who began work to fix the issues and identify any apps that were already taking advantage of the security vulnerabilities.

TumbleBit. Bitcoin is a way for people to exchange money anonymously. Unfortunately, it was discovered that one could track a Bitcoin transaction and often identify the parties involved.

Dr. Alessandra Scafuro and colleagues from Boston University and George Mason University developed



a Bitcoin-compatible system that makes it much more difficult to identify parties involved in a Bitcoin transaction using “mixed servicing.” Instead of person A paying person B directly, person A pays an intermediary “tumbler,” which then pays person B. The more people who use the tumbler, the more difficult it is to determine when a specific person (person A) pays another person B. The mixed service algorithm follows three steps.

1. During *escrow*, A notifies the tumbler they want to make a payment, and B that they want to be paid.
2. Cryptographic tools allow the tumbler to pay B without actually knowing who A and B are.
3. *Cashout* occurs when all transactions are conducted simultaneously, making it more difficult to identify individual parties or specific transaction.

Scafuro and her colleagues published their work at the Network and Distributed System Security Symposium in San Diego in February, 2017.

Web Cloaking. Malicious web sites often try to attract users through web search engines like Google Search or well known advertisement services. For example, if a user were searching for an iPhone, a malicious site might

pretend to be a legitimate iPhone reseller, while its true purpose could be to deliver malware to a user’s computer.

Web crawlers attempt to vet the content of each web site they index, forcing malicious sites to use a variety of techniques to mask their true intent. This is known as *web cloaking*. For example, many legitimate sites vary their content based on information about the visitor, geolocation, or the type of device being used to browse the site. Malicious sites take advantage of these *split-views* to present search engine crawlers with enticing, legitimate content, then serve malicious material to real users when they visit the site.

“Malicious web sites use *web cloaking* techniques to mask their true intent”

Dr. Alex Kapravelos and his colleagues at Google investigated how ten services being sold in the underground perform web cloaking. Based on this, they built an anti-cloaking system that detects the vast majority of split-view attempts. Using this system, they searched with high-risk keywords (*e.g.*, luxury products, weight loss supplements). This highlighted the prevalence of web cloaking threats, and exposed how cloaking techniques vary their responses to try to avoid detection.

Center for Educational Informatics

The Center for Educational Informatics (CEI) was established to design, develop, and investigate next-generation learning technologies. A distinguishing characteristic of CEI is its unique capabilities in

“The Center for Educational Informatics develops and investigates next-generation learning technologies”

advanced learning technology innovation. Because creating effective learning technologies requires a deeply interdisciplinary perspective, CEI initiatives draw on collaborations between computer scientists, learning scientists, educational psychologists, and STEM educators.

The mission of CEI is to design, develop, and investigate next-generation learning technologies. With a focus on personalized learning for K-12 STEM education, CEI creates adaptive learning technologies for classrooms, homes, and museums.



Crystal Island. In Crystal Island, students are motivated to acquire competencies in both science and language arts through participation in highly engaging problem-solving activities. The environment features an immersive 3D story world with an expansive cast of characters in which the student plays the role of a science detective. Students interact with virtual characters, virtual lab equipment, and read science texts to construct and apply context-specific knowledge to interpret complex events.

Students develop central ideas, find themes, and craft potential solutions by gathering supporting details, information, and evidence necessary for solving the ill-structured problem

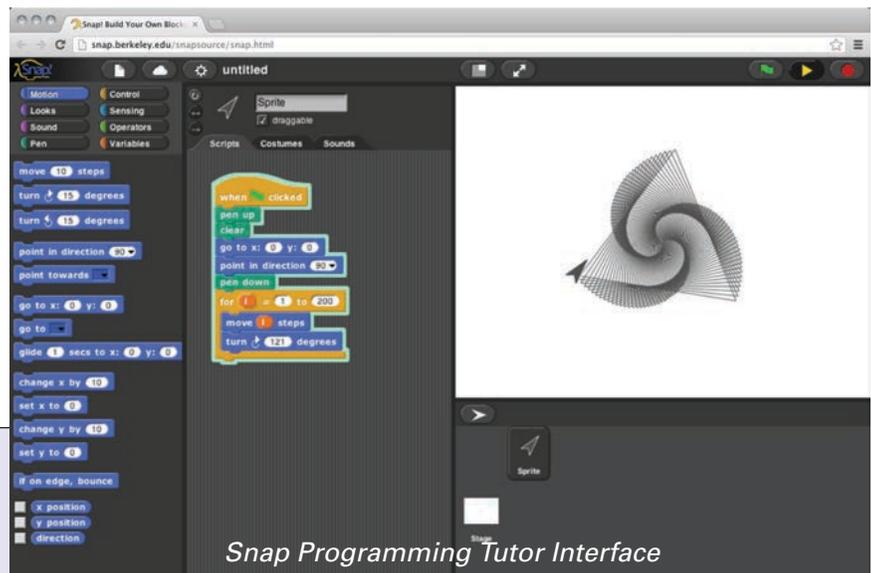
presented in the game’s narrative. Through interactions with virtual characters, students are able to assess how point-of-view can impact decisions

and solutions. The game-based learning environment is an ideal vehicle to meet Common Core Standards for integration and evaluation of content presented in diverse formats and media.

ENGAGE. ENGAGE is a game-based learning environment for middle grade students designed to develop computational thinking skills and broaden interest in computer science. The game is set in an undersea research station, where players must regain control after it is captured by a nemesis, Dr. Murdock, who wishes to thwart the research being conducted there. Students play in pairs, taking on the role of a field agent charged with retaking control of the research station and figuring out Dr. Murdock's plans. They are challenged to work together to manipulate objects and program devices in a real-time environment to solve puzzles in order to advance through the game.

The ENGAGE project combines game-based and classroom-based learning and problem-solving that integrate a computer science and an ocean science curriculum. Classroom activities support and extend the Computer Science Principles covered within the game, introduce students to key oceanography concepts and problems, and encourage students to think computationally about solving real-world oceanography problems.

Integrated Data-Driven Technologies for Individualized Instruction in STEM Learning Environments. Creating intelligent learning technologies from data has significant potential to transform the American educational system by providing a low-cost way



to adapt learning environments to individual students' needs and by informing advanced research on human learning. This project creates the technology for a new generation of data-driven Intelligent Tutoring Systems. The result is a modular framework of educational data mining that offer students adaptive, individualized support, and that have been implemented and empirically validated for learning impact and robustness across three STEM domains: logic, probability, and programming.

This project develops hierarchical data-driven, interpretable, and robust models that optimize student learning. It investigates whether integrating agent decision-making with user-initiated decisions can help students learn to make better decisions. This can fundamentally transform how we assess students' learning: the emphasis should not be just on what students have learned, but on whether students can adapt in future situations. This project can make individualized learning support accessible to a broad audience, including students that are traditionally underrepresented in STEM fields. Ultimately, this project is about using data-driven policies to support student decision-making and eventually to improve their long-term problem-solving abilities.

... if ~~engineering~~ ^{software} then NC State ...

Software Engineering

Software Engineering is the process of the design, construction and maintenance of good enough software, given the available resources. Good software engineers know the space of options for building software. And the best software engineers know where to find the best options. Researchers in SE look at all those options, decide which are best, and (sometimes) even create new options.

This is an ideal time to research software engineering. Software has now become a dominant force in the world, driving innovation and productivity. Graduates from our program are well placed for high-profile careers in industry and academia and other industries as well.

“Software engineering has now become a dominant force in the world, driving innovation and productivity”

This is also a very good time to conduct research at NC State. With seven SE faculty and dozens of graduate students, we have one of the most innovative and inclusive research environments. NC State Computer Science has the largest number of female faculty in the country, many of whom work in software engineering.

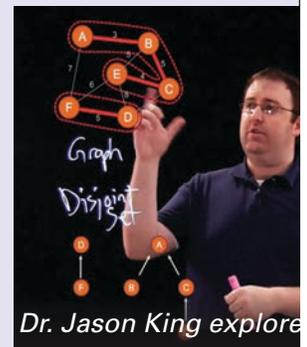
The Research Triangle Park (RTP) is a preeminent software engineering de-

velopment center. With our extensive contacts to local and international industry and academia, NC State researchers are ideally situated to study the reality and future possibilities of software engineering.

Yet another reason to study software engineering is that we now know software engineering is much, much stranger than we ever thought. Many of the truisms, tools and techniques of last century are being replaced with new insights from new data. In this age of the Internet, open source tools (Github), and crowdsourced development (TopCoder, AliBaba, etc), we can access project data from decades of development of hundreds of thousands of projects. How to handle all that information? What novel insights can we learn from that data? That is the challenge of SE research at NC State.

From this data we have learned many things. One lesson is that many security problems in modern software actually arise from less-than-good programmer practice. Dr. Laurie Williams explores software security, developing better ways for programmers to build more secure systems.

Another important finding is just how important humans are in the process of developing software. People have

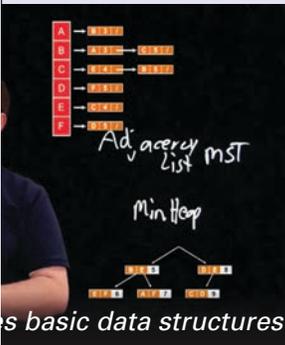




certain cognitive skills and limitations.

Dr. Christopher Parnin instruments the human that build the software. Using eye-tracking software and numerous other bio-feedback devices, we are now learning how to more effectively design development tools to better support humans.

Dr. Kathryn Stolee explores the same task of removing standard classes of errors. Her work ranges from automatic algorithms that synthesize and repair source code to studies of which language design choices lead to what kinds of errors in programming.



Teams turn out to be much more important than we ever realized. For one thing, there are patterns of good and bad behavior within teams. Dr. Sarah Heckman explores how processes and practices can help novice developers write higher quality software individually and on teams.

Teams often reactively consider efficiency and security after implementing a piece of software. Dr. Jason King explores tools and educational practices for helping novice developers connect data structure and algorithm theory with software engineering practice, as well as tools

and practices for proactively building security into software from the beginning of the development lifecycle.

and practices for proactively building security into software from the beginning of the development lifecycle.

“Programmers often know about only a small subset of tools, even when others may be valuable to them”

The Developer Liberation Front, directed by Dr. Emerson Murphy-Hill, studies software developers and development tools. For example, programmers interact with a variety of tools, from “undo” to FindBugs’s security warnings to entire development environments. However, programmers typically know about only a small subset of tools, even when other tools might be valuable to them. In one project, Dr. Murphy-Hill investigates how and why software developers find out about—and don’t find out about—useful programming tools. The goal is to help developers find more relevant tools, more often.

The RAISE lab (Real World AI for SE), directed by Dr. Tim Menzies, applies artificial intelligence (AI) to SE applications and vice-versa. As SE is asked to answer dynamic automated, adaptive, large scale demands, other disciplines come into play. AI is one that may bring SE to further heights. Conversely, SE can also play a role to alleviate development costs efforts associated with AI tools.

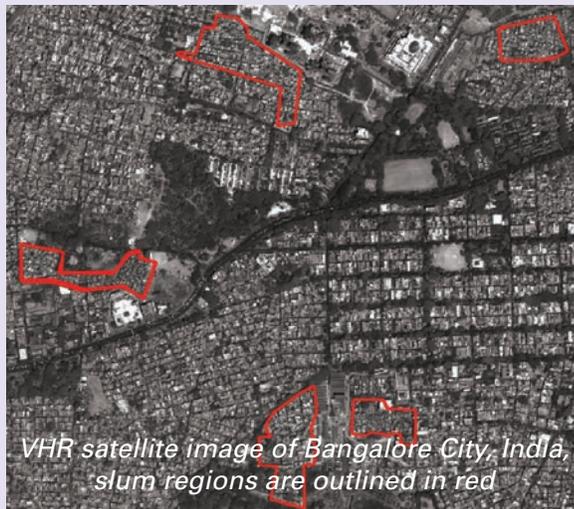


NC State's Software Engineering Faculty

Interdisciplinary Research

Faculty engage in interdisciplinary research throughout the university and the world. Computers impact our daily lives, so interdisciplinary research is critical to solving real-world problems.

Property Rights and Land Tenure in the Slums of Bangalore. Mapping informal settlements (slums) is an important humanitarian and national security task. High rates of urbanization, political conflicts, and poverty have rapidly increased informal

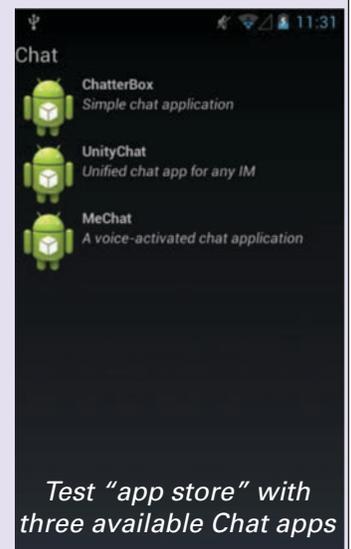


settlements. The number of people living in slums is close to one billion and rising. These unplanned, unauthorized, and/or unstructured homes are often located in the most hazardous regions and lack basic services. Mapping slums of the world is a daunting and challenging task, since official data about slums are weak. Many countries have ignored slums (e.g., Favelas in Brazil). Even in situ-

ations where slums were notified or recognized by a municipal authority (e.g., India) the spatial boundaries of these settlements are rarely, if ever, plotted on city maps.

“The number of people living in slums is close to one billion and rising”

With availability of very high resolution (VHR) satellite imagery, it is possible to identify distinct spatial patterns between the formal and informal settlements. However, well-known machine learning approaches deal with pixels, which often cannot capture larger spatial patterns. Research on patch-based approaches have accurately mapped slums for sites across the world. Together with social scientists at Duke University, Sanford School of Public Policy, and UNC Department of City & Regional Planning, we are investigating identification of slums using VHR satellite images, and studying patterns of progress in individual settlements and households.





Improving Mobile Security With a Deeper Understanding of Human Experience.

An important challenge in security is human behavior. A poor decision can bypass even the most secure encryption. This is particularly true for mobile devices, which are now integrated into human activity. Our project seeks to discover the conditions under which mobile users are most likely to make security errors, so that we may offer timely encouragement toward safe mobile behavior.

Earlier work indicated that conditions causing stress may increase insecure behavior, with the cause being relatively unimportant. We therefore

focused on multitasking, asking participants to choose applications to install on a phone, an important security decision. Participants experienced more stress and made more security errors when multi-tasking. This suggests that when mobile

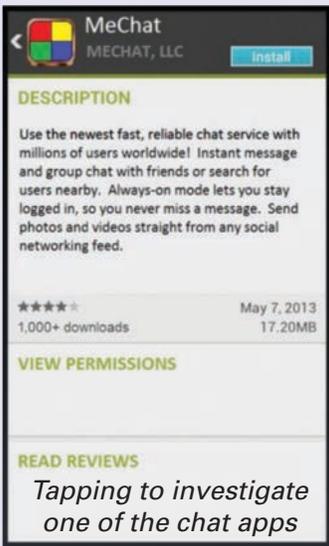
users are multi-tasking, designers should create especially effective warnings and guards against error.

Data Analytics. The Institute for Advanced Analytics (IAA) prepares data

savvy professionals for leadership in a digital world. The goal of analytics is to derive and effectively communicate insights from vast quantities and varieties of data. There is a pressing need for professionals with strong quantitative skills and an understanding of how to apply analytics to challenges facing organizations. The IAA's mission is to produce the world's finest analytics practitioners, through theoretical training, teamwork, and a passion for intellectual curiosity, honest, integrity, professionalism, and continuous self-improvement.

“Analytics derives and effectively communicates insights from vast quantities of data”

Founded at NC State University, the Institute serves as the focal point for a university-wide, interdisciplinary collaboration among numerous faculty. The IAA's flagship program is the nation's first Master of Science in Analytics (MSA) degree, a full-time, 10-month learning experience with an innovative curriculum developed exclusively for students in the program. It is NC State's leading master's degree in terms of student outcomes and its graduates are among the university's most sought-after and highly compensated. Benchmark studies place the MSA in the ranks of comparable master's degrees at the nation's most prestigious universities.





Faculty

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

Artificial intelligence, machine learning, data mining, bioinformatics

Suzanne Balik, Teaching Assistant Professor
PhD, North Carolina State University, 2014

Tiffany Barnes, Professor
PhD, North Carolina State University, 2003
 Intelligent tutoring systems, educational games, data mining, participation in CS

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

Donald Bitzer
Distinguished University Research Professor
PhD, University of Illinois, 1960
 High-speed networks, communications, bioinformatics, computer-based education

Franc Brglez, Research Professor
PhD, Pennsylvania State University, 2011
 Design, optimization, and measurement for security, mobile security

Min Chi, Assistant Professor
PhD, University of Pittsburgh, 2009
 Applied machine learning, data mining, human-computer interaction

Rada Y. Chirkova, Associate Professor
PhD, Stanford University, 2002
 Databases, computational logic

Jon Doyle, SAS Professor of Computer Science
PhD, MIT, 1980
 Artificial intelligence, mathematical foundations, rationality, knowledge discovery

Rudra Dutta, Professor
PhD, North Carolina State University, 2001
 Traffic grooming, fault tolerance, optical networks, ad-hoc wireless networking

William Enck, Associate Professor
PhD, University of Illinois, 1977
 Enumeration, algorithms, combinatorics, discrete mathematics

Vincent Freeh, Associate Professor
PhD, University of Arizona, 1996
 Operating systems, compilers, programming languages, distributed and parallel computing

Edward Gehringer, Associate Professor
PhD, Purdue University, 1979
 Object-oriented software, parallel processing

Xiaohui (Helen) Gu, Associate Professor
PhD, University of Illinois, 2004
 Distributed and operating systems, networks, autonomic computing, system mining

Khaled Harfoush, Associate Professor
PhD, Boston University, 2002
 End-to-end network diagnosis, topologies, routing, ad-hoc and peer-to-peer networks

Christopher G. Healey
Goodnight Distinguished Professor
PhD, U. British Columbia, Canada, 1996
 Visualization, computer graphics, perception

Steffen Heber, Associate Professor
PhD, Universität Heidleberg, Germany, 2001
 Computational biology, bioinformatics

Sarah Heckman, Associate Teaching Professor
PhD, North Carolina State University, 2005

Arnav Jhala, Associate Professor
PhD, North Carolina State University, 2009
 Narrative, visual discourse, visual narrative

Guoliang Jin, Assistant Professor
PhD, University of Wisconsin, 2014
 Software system reliability

Alexandros Kapravelos, Assistant Professor
PhD, UC Santa Barbara, 2015
 Systems, software security

Jason King, Assistant Teaching Professor
PhD, North Carolina State University, 2016

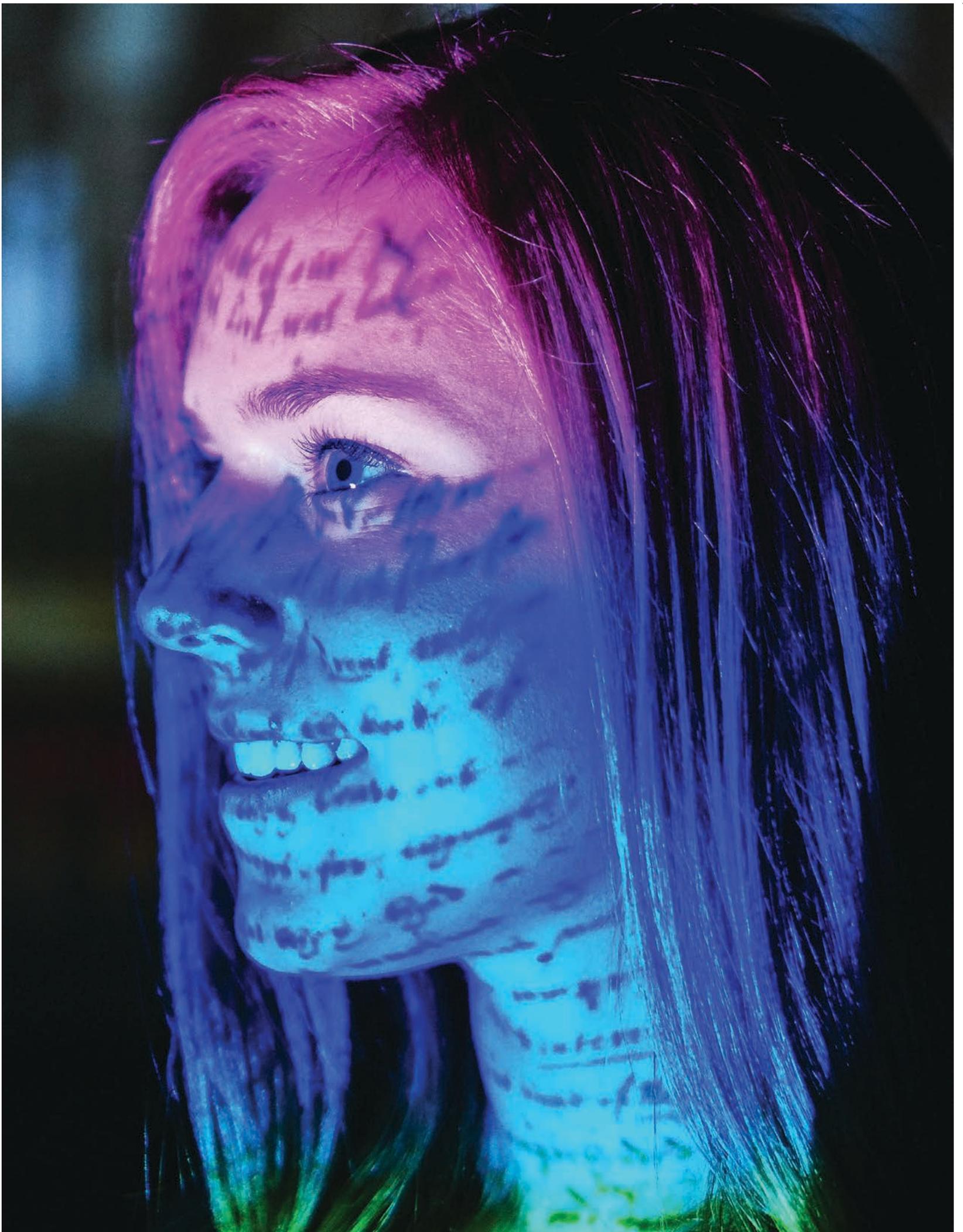
James C. Lester, Distinguished Professor
PhD, University of Texas, 1994
 Artificial intelligence, intelligent tutoring systems, natural language processing

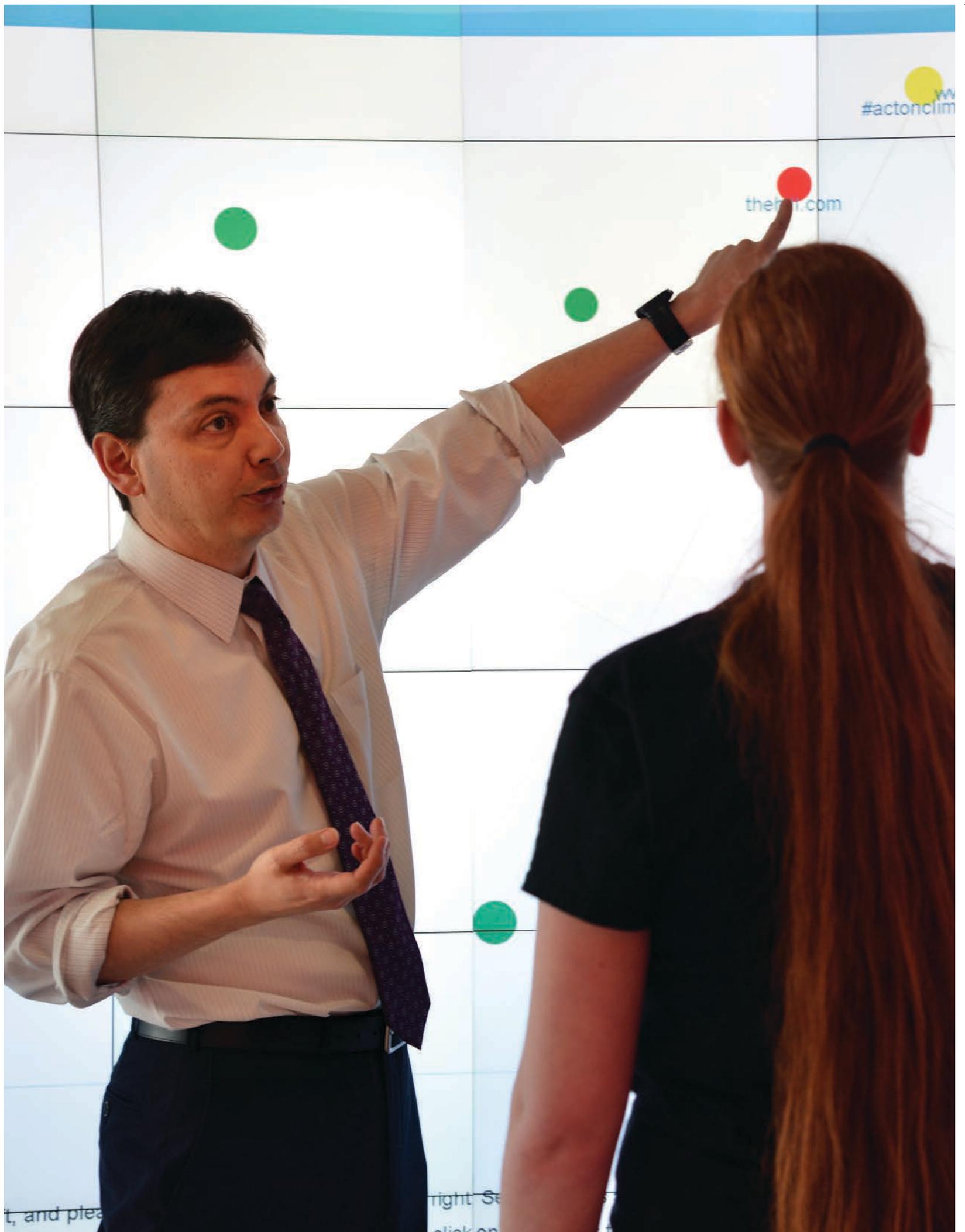
Collin Lynch, Assistant Professor
PhD, University of Pittsburgh, 2014
 Intelligent tutoring systems

Chris Martens, Assistant Professor
PhD, Carnegie Mellon University, 2015
 Artificial intelligence, programming languages, formal methods

Timothy J. Menzies, Professor
PhD, University of New South Wales, 1995
 Software engineering, data mining, AI optimization, search-based software engineering

Frank Mueller, Professor
PhD, Florida State University, 1994
 Parallel and distributed systems, compilers, real-time and embedded systems





Faculty

Emerson Murphy-Hill, Associate Professor
PhD, Portland State University, 2009

HCI, software engineering

Kemafor Anyanwu Ogan, Associate Professor
PhD, University of Georgia, 2007

Semantic and services computing, bioinformatics, data and knowledge systems, data mining

Christopher Parnin, Assistant Professor
PhD, Georgia Institute of Technology, 2014

Social ecosystems, automated software engineering, future programming environments

Harry Perros

Alumni Distinguished Graduate Professor
PhD, Trinity College, Ireland, 1975

Networking, performance modeling, queueing theory, service science mgmt and engineering

Michael Rappa, Distinguished Professor
Goodnight Director, Institute for Adv. Analytics
PhD, University of Minnesota, 1987

Analytics, business management

Bradley Reaves, Assistant Professor
PhD, University of Florida, 2017

Security, mobile security

Douglas S. Reeves, Professor
PhD, Pennsylvania State University, 1987

Network and software security, peer-to-peer computing

David L. Roberts, Associate Professor
PhD, Georgia Institute of Technology, 2010

Serious games, computer-canine interaction and communication

George N. Rouskas, Professor
PhD, Georgia Institute of Technology, 1994

Network architectures and protocols, optical networks, performance evaluation

Nagiza Samatova, Professor
PhD, CCAS, Russia, 1993

Computational biology, graph theory, scalable data analytics, data management

Carla D. Savage, Professor
PhD, University of Illinois, 1977

Enumeration, algorithms, combinatorics, discrete mathematics

Robert St. Amant, Professor
PhD, University of Massachusetts, 1996

HCI, cognitive systems, intelligent user interfaces

Alessandra Scafuro, Assistant Professor

PhD, University of Salerno, 2013

Cryptography

Jessica Schmidt, Assistant Teaching Professor
PhD, North Carolina State University, 2012

Muhammad Shahzad, Assistant Professor
PhD, Michigan State University, 2015

Networking, Internet of Things, security

Xipeng Shen, Associate Professor
PhD, University of Rochester, 2006

Enumeration, algorithms, combinatorics, discrete mathematics

Munindar P. Singh

Alumni Distinguished Graduate Professor
PhD, University of Texas, 1993

Multiagent systems, trust, service-oriented computing, business protocols and processes

Matthias Stallmann, Professor
PhD, University of Colorado, 1982

Experimental algorithmics, combinatorial optimization, NP-hard problems

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

Performance modeling, Markov chains, queueing theory and numerical linear algebra

Kathryn T. Stolee, Assistant Professor
PhD, University of Nebraska, 2013

Program analysis, code search, crowdsourcing, software engineering, empirical studies

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

Blair Sullivan, Associate Professor
PhD, Princeton University, 2008

Graph theory, algorithms, scalable analysis of complex networks

David Thuente, Professor
PhD, University of Kansas, 1974

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

Hung-Wei Tseng, Assistant Professor
PhD, UC San Diego, 2014

Architecture, storage and runtime systems

Ranga Vatsavai, Associate Professor
PhD, University of Minnesota, 2008

Spatial-temporal big data, high performance computing

Department Personnel



Leslie Rand-Pickett, Director
of Graduate Career Services

**Mladen Vouk, Distinguished Professor
Associate Vice Chancellor for R&D
PhD, King's College, UK, 1976**
Software engineering, scientific/network
computing, computer-assisted education

**Benjamin Watson, Associate Professor
PhD, Georgia Institute of Technology, 1997**
Computer graphics, design, interaction

**Laurie Williams, Professor
Interim Department Head
PhD, University of Utah, 2000**
Pair programming, software security, agile soft-
ware development, testing and reliability

Administration

- **Dr. Barbara Adams**, Director of Advising
- **Dr. Dennis Bahler**, Director of Undergraduate Programs
- **Carlos Benavente**, IT Manager
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- **Dennis H. Kekas**, PE, ITng Executive Director; Associate Vice Chancellor
- **Dana Lasher**, Scheduling Officer
- **Leslie Rand-Pickett**, Director of Graduate Career Services
- **Ken Tate**, Director of Engagement and External Relations
- **Dr. George Rouskas**, Director of Graduate Programs
- **Dr. Matthias Stallmann**, Associate Director of Graduate Programs
- **Dr. Laurie Williams**, Interim Dept. Head

Staff

- **Carol Allen**, Administrative Support Associate
- **John Bass**, Director of ITng Services
- **Jami Boylan**, Accounting Technician
- **Andrew Brown**, Research Associate
- **Marcus Bullett**, Accounting Technician
- **Tammy Coates**, Public Communication Specialist
- **Camille Cox**, Accounting Technician
- **Dr. Jeanette Discala**, Program Manager

- **Marhn Fullmer**, Networking Lab Manager
- **Christopher Gurley**, Linux Administrator
- **Oriana Johnson**, Project Coordinator
- **Ryan Kilby**, Business and Technology Applications Analyst
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- **Kathy Luca**, Graduate Program Manager
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- **Terri Martin-Moss**, Finance Officer
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- **Trey Murdoch**, Systems Programmer Analyst
- **Tyler Puckett**, Desktop Support Admin
- **Donna J. Richards**, Accounting Technician
- **P. Andrew Sleeth**, Graduate Admissions Specialist
- **Zelda Tuazama**, Advising Specialist
- **Dr. Gary Weinberg**, Academic Advisor
- **Lauren Williamson**, Accounting Technician

Adjunct Faculty

- **Dr. Stanley Ahalt**, Adj. Professor
- **Dr. Annie I. Antón**, Adj. Professor
- **Dr. Kristy Boyer**, Adj. Asst. Professor
- **Dr. Ram Chillarege**, Adj. Faculty
- **Dr. Aldo Dagnino**, Adj. Asst. Professor
- **Dr. Nadia Diakun-Thibault**, Adj. Faculty
- **Dr. Paula Hennon**, Adj. Faculty
- **Dr. Gary Howell**, Adj. Asst. Professor
- **Dr. Steven Hunter**, Adj. Faculty
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- **Dr. Lucas Layman**, Adj. Assoc. Professor
- **Dr. Peng Ning**, Adj. Professor
- **Dr. Injong Rhee**, Adj. Professor
- **Dr. Andrew Rindos**, Adj. Assoc. Professor
- **Dr. Anthony Rivers**, Adj. Asst. Professor
- **Dr. Jessica Staddon**, Adj. Professor
- **Dr. David Wright**, Adj. Asst. Professor
- **Dr. Hong Yi**, Adj. Asst. Professor
- **Dr. R. Michael Young**, Adj. Professor

Partners



Keith V. Collins (BS '82), CIO and Executive Vice President, SAS Institute

Emeritus Faculty

- **Dr. Wu-Show Chu**, Professor Emeritus
- **Dr. Edward Davis**, Professor Emeritus
- **Dr. Robert Fornaro**, Professor Emeritus
- **Dr. Thomas L. Honeycutt**, Assoc. Professor Emeritus
- **Dr. David F. McAllister**, Professor Emeritus
- **Dr. Woody Robins**, Professor Emeritus
- **Dr. Alan Tharp**, Professor Emeritus

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- **David H. Whitley**¹, Applied Systems, Inc.
- **Steve Worth**¹ (Emeritus)

Computer Science Alumni Hall of Fame

- **Alen D. Baker** (BS '73), Duke Energy; President Emeritus, NC Wildlife Federation
- **Marshall Brain** (MS '89), Founder of HowStuffWorks
- **David Burke** (PhD '04), Director of Cyber Warfare for Naval Aviation

- **Keith Collins** (BS '82), EVP & CIO, SAS Institute; NC State DEA
- **Jeff Crume** (BS '84), Distinguished Engineer & Executive IT Security Architect, IBM
- **Chris Crump** (BS '78), Retired Silicon Valley Executive
- **Brenda Crutchfield** (MS '89), Deputy Director of Future Operations, US ARCYBER
- **Nirmit Desai** (MS '03, PhD '08), Research Staff Member, IBM and creator of Mesh Network Alerts
- **Suzanne Gordon** (BS '75), retired CIO, SAS Institute
- **Dr. Larry Hodges** (MS '82, PhD '88), VR expert and Professor of Human-Centered Computing, Clemson University
- **Richard Holcomb** (MS '89), Serial Entrepreneur
- **Bobby Johnson** (BS '77), co-founder and former CEO, Foundry Networks
- **Martin Loy** (BS '87), Senior Director, Security Trust Engineering, Cisco Systems
- **Dr. Elizabeth Mynatt** (BS '88), Distinguished Professor; Exec. Director, Georgia Tech Institute for People and Technology
- **Raif Onvural** (MS '85, PhD '87), President and CEO, Telehealth & Telemedicine, Inc.
- **Gerhard Pilcher** (BS '85, MSA '11), President and CEO, Elder Research
- **Rudy Puryear** (BS '74), Partner and Director, Bain & Company IT practice
- **Troy Tolle** (BS '98, MS '00), Co-founder and CTO, DigitalChalk, Inc.
- **Erik Troan** (BS '89), Serial Entrepreneur
- **Donna Troy** (BS '78), retired EVP and General Manager, Epicor Software
- **Bill Weiss** (BS '76), Chairman and CEO, The Promar Group
- **Ed Whitehorne** (BS '72), Chairman of the Board, FHI 360
- **Josh Whiton** (BS '04), Founder and former CEO, TransLoc, Inc.
- **Gary Williams** (BS '74), former executive with Milliken & Company
- **Dr. Pinar Yolum** (MS '00, PhD '03), Entrepreneur & Professor, Bogazici University

¹ Computer Science Department Alumnus

Corporate Partnerships



Ken Tate, Director of Engagement and External Relations

Since its launch in 2000, the ePartners Program has served as the

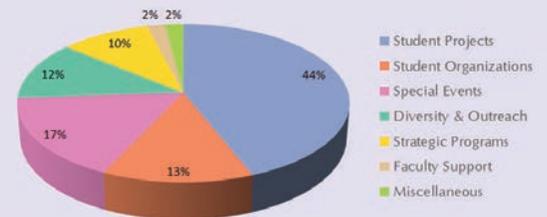
department's cornerstone corporate relations program, providing a framework for developing and nurturing strong collaborative partnerships with the global business community.

Under the guidance of Ken Tate, Director of Engagement and External Relations, the ePartners Program has grown to more than 100 companies engaged with the department. In addition to providing transformational financial support, the program fosters ongoing communications and engagement with students and faculty, allowing our corporate partners to play a meaningful role in shaping the department's future direction.

Over the last decade, corporate support has increased over 300%. In 2006–07, total funding provided by ePartners and Super ePartners totaled approximately \$300K, with almost \$110K being unrestricted cash support. Fast forward 10 years, and our corporate support for the 2016–17 academic year has grown to over \$1.25M with more than \$350K in unrestricted support. Over the last ten years alone, support from ePartners has totaled over \$9.15M with almost \$2.3M being completely unrestricted.

Funding and support are allocated across a wide range of strategic

needs and initiatives including student projects, broadening participation and outreach, student organizations and special events, department publications and communications, and learning and research technologies and supplies. In aggregate, our ePartners Program provides financial support, which is a critical component to our overall funding model, assuring our position as one of the world's top computer science research and educational departments.



Typical ePartners program funding allocation

One of the most meaningful ways corporations support our students is through ongoing sponsorship in our award-winning Senior Design Center (SDC). Since the center's launch in 1994, approximately 2,500 students have participated on well over 500 project teams, and corporate project sponsorships have topped \$2.8M. During the last decade, the SDC prioritized student-defined entrepreneurial projects, and thanks to corporate support, was able to provide a project slot for entrepreneurial-minded students almost every semester.

Corporations and professional associ-

EPARTNERS

The department enjoys strong and active partnerships with more than 100 companies, organizations, and agencies including super ePartners BB&T, BCBSNC, Capital One, Cisco Systems, Dell EMC, Eastman, Fidelity Investments, IBM, KPIT, LabCorp, LexisNexis, Merck, NetApp, Oracle, Premier, RedHat, and SAS Institute.



Vivek Wadhwa presents at the Fidelity Leadership Speakers Series

ations have led the way in providing much needed scholarships over the years. Several awards come from endowments created by Progress Energy, SAS Institute, Oracle, NetApp, NC-SIM, and the Raleigh Chapter of ISSA, while several companies like Cisco, Eastman, LexisNexis, Merck and others have donated cash awards to fund annual scholarships. With corporate support, the department launched a new Aspirations Awards, given annually to any student who has won a regional or national NCWIT Aspirations Awards and who comes to NC State to study computer science. The program is a cornerstone of our diversity initiative to attract and retain more females to the discipline.

The department benefits greatly from industry-specific guidance it receives from its Strategic Advisory Board (SAB), a dynamic group of executives and leaders representing our corporate partners. Over the last decade, the SAB has played an influential role in guiding department leaders to create new graduate tracks and certificate programs, and to launch a highly effective outreach campaign and student ambassadors program. The SAB also created a Diversity Endowment that provides significant scholarship awards annually.

As corporate partnerships mature, they reach far beyond scholarships and student projects, as evidenced by Fidelity Investments' sponsorship of

the "Leadership in Technology"

Speakers Series. The series, now in its 11th year, has hosted renowned authors, futurists, technology innovators, CEOs, entrepreneurs, TV personalities, and even an astronaut.

NC State has historically been a top provider of graduate talent for IBM, but we have also benefited as one of the top recipients of prestigious student fellowships and faculty research awards from IBM. The recent addition of a dedicated IBM lab on Centennial Campus has provided faculty and students an ideal collaboration space.

Championed by Chancellor Randy Woodson, a strong University focus on innovation has led to a variety of significant Master Research Agreements with SAS Institute and Eastman. These have generated faculty awards for department researchers, as well as numerous multi-disciplinary initiatives in cyber-security, user experience, and data sciences. These have also led to collaboration with a industry. Among the success stories—a data sciences certificate for Cisco Systems engineers and the launch of a multi-disciplinary Experience Innovation Studio at LexisNexis.

To all of our corporate partners who have supported our department through your gifts, your time, your insight, and ongoing engagement, we extend our most sincere appreciation.



50th Anniversary Sponsors



"Bolts of Innovation", by alumnus Mark DeMaria

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