



2016-2017
COMPUTER SCIENCE
ANNUAL REPORT

PURDUE
UNIVERSITY®



MESSAGE FROM THE HEAD



GREETINGS!

It is the start of another school year here in West Lafayette. This year, 360 students are embarking on their journey as freshmen in the Department of Computer Science. Many moved to campus at the end of July for Bridge, an immersion program developed for incoming CS majors who lack strong coding experience. In the footsteps of Bridge's success, we have created a second program, CS 180 Black and Gold, also designed to increase retention in computer science. This initiative divides students' first programming course into two sections according to coding experience.

We take pride in preparing excellent graduates, and employers are well aware of the quality of our students. After graduation, our students enjoy not only a near-100 percent placement rate, but also the highest undergraduate starting salaries here at Purdue.

We continue to witness a robust demand for computer science, and we are doing very well in meeting that demand. We continue to grow, especially in terms of student population. But a growing student population means that we must also expand our faculty. We have hired 18 new faculty members in the last five years, including five this year (four of them women).

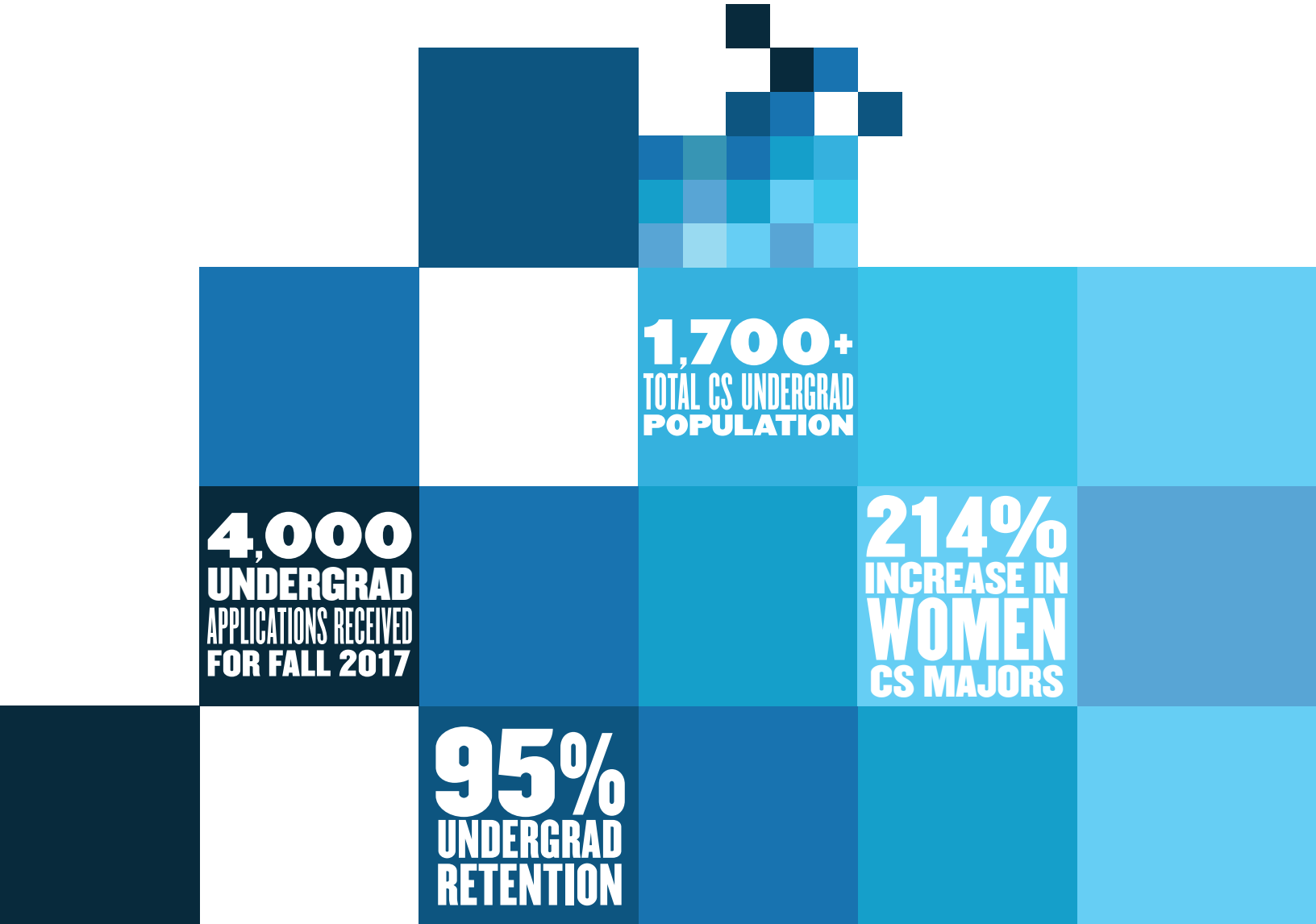
We are placing the highest priority on continuing to attract and retain top-caliber faculty members. Success in this arena hinges on our ability to be competitive. Three recent gifts to the department have resulted in the creation of new professorships that will greatly increase our ability to hire and keep faculty members. They include:

- The Jyoti and Aditya Mathur Rising Star Professorship, a gift from former department head Aditya Mathur and his wife, Jyoti
- The Bea Yormark Rising Star Professorship, a gift from Justin Walker in memory of his late wife, Bea (MS '68), former COO of Echelon and College of Science distinguished alumna
- The QCRI Distinguished Professorship in Computer Science, established by the Qatar Computing Research Institute

A department is only as strong as its faculty members. These gifts, and the faculty members that they attract, will enable us to further our mission of advancing the state of computing and preparing top-caliber computer scientists.

Boiler up!

Sunil Prabhakar
Head, Department of Computer Science



by the NUMBERS

Since being declared one of 10 Purdue Moves by Purdue President Mitch Daniels in 2013, the Department of Computer Science has grown and expanded beyond all expectation.

- *The number of undergraduate computer science majors has doubled, increasing by 117 percent since Fall 2012.*
- *21 percent of incoming students are women, compared to 15.2 percent in Fall 2012.*



Aditya and Jyoti Mathur (third and fourth from left) pose with students and Purdue staff members on Purdue's Annual Day of Giving.



FORMER DEPARTMENT HEAD'S GIFT HONORS **RISEING STAR** FACULTY MEMBER

Aditya and Jyoti Mathur know how important faculty members are to a university. Part of the Purdue faculty since 1987, Aditya served as head of the Department of Computer Science from 2007-2010. His wife, Jyoti, coordinated Purdue's interdisciplinary graduate programs in Computational Science and Engineering (CS&E) and Computational Life Sciences (CLS). The Mathurs have a first-hand appreciation for the importance of recruiting and retaining top-quality professors.

This knowledge, as well as a deep loyalty to Purdue and the Department of Computer Science, led them to create the Jyoti and Aditya Mathur Rising Star Professorship. This gift will help the Department of Computer Science recruit and retain outstanding faculty members.

Sunil Prabhakar, head of the Department of Computer Science, said, "At a time where demand for computer science faculty is at an all-time high, our ability to attract and retain top-caliber faculty at Purdue hinges upon the ability to be competitive. Being able to offer this rising star professorship to a new or existing faculty member is an important piece of making competitive offers and attracting faculty members to come or stay here."

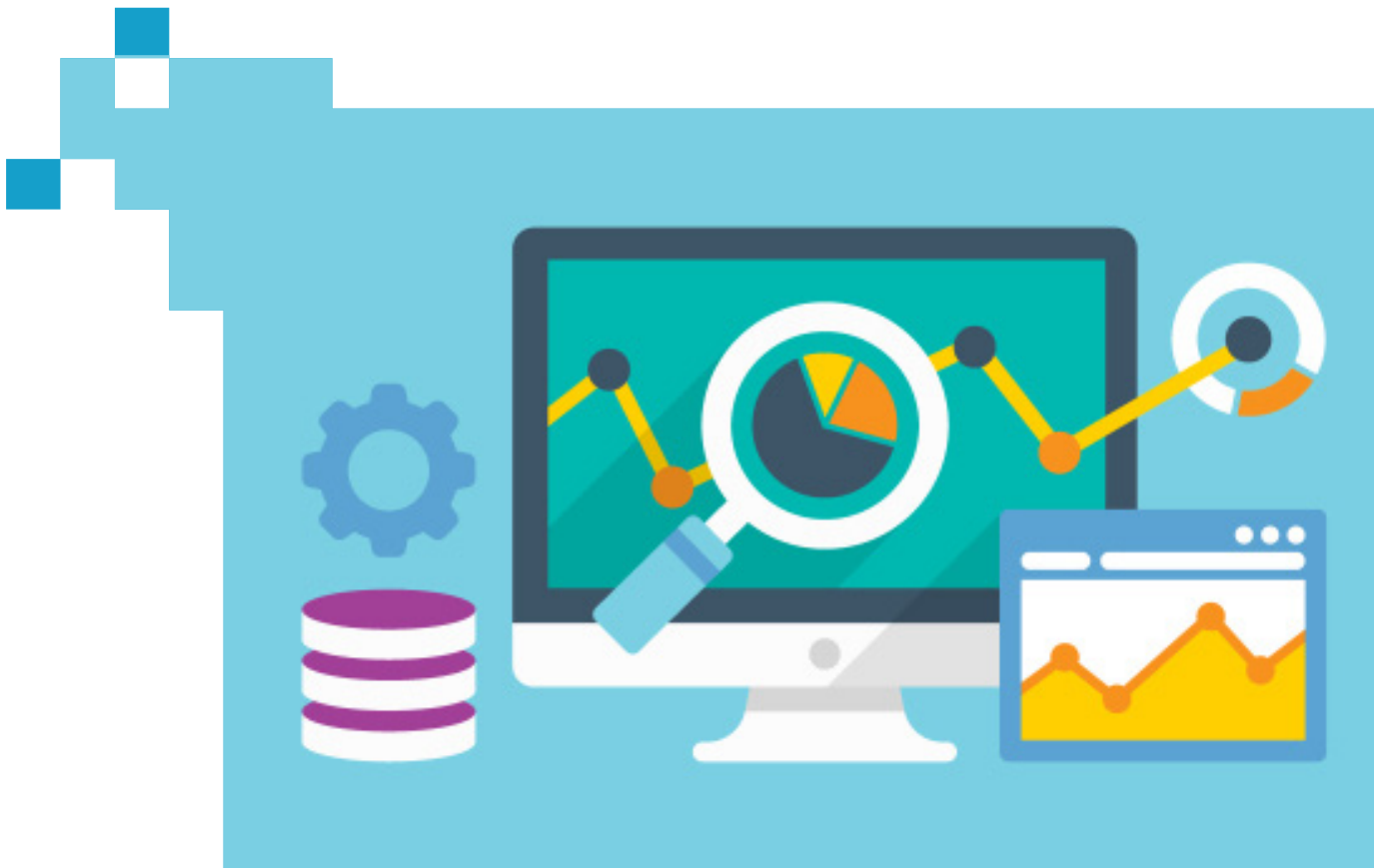
Throughout their respective forty-year careers, Aditya and Jyoti have been affiliated with four different universities in three countries. Prior to joining the

Purdue faculty, Aditya served as head of the first degree-awarding computer science department in India, which he also helped to launch. Today, he is founding head of the Information Systems Technology and Design pillar at Singapore University of Technology, where he also serves as director of the iTrust Center for Research in Cybersecurity.

Aditya said, "Each workplace turned out to be highly enjoyable and offered an enviable learning experience. Purdue University and the city of West Lafayette have been our home for the past 30 years and remain a significant part of our academic journey. We have enjoyed and continue to value the loving and friendly company of many students, staff and faculty at Purdue."

Aditya and Jyoti Mathur's gift stems from a deep appreciation for Purdue and the Department of Computer Science, as well as first-hand knowledge of the importance of recruiting and retaining talented faculty members.

Aditya said, "We understand and believe in the importance of honoring bright and productive members of our faculty and are happy and thankful to be able to contribute to this cause. We hope that this Rising Star gift will enable the Department of Computer Science to attract and retain young and bright minds."



NEW **DATA SCIENCE** MAJOR FOR UNDERGRADS

The Department of Computer Science announced a new undergraduate major in data science, a collaboration with the Department of Statistics. Students entering Purdue University in Fall 2017 and beyond will have the opportunity to enter the data science major.

“This new major will place students at the forefront of an emerging field and prepare them for an exciting career at the intersection of computer science and statistics,” said Kevin Jones, academic advisor for the data science major.

Advances in technology have generated heaping quantities of data from sources in all areas of society. As the prevalence of data has increased, businesses in all sectors have realized that they need scientists with the technical knowledge and statistical abilities to analyze, manipulate and act on the available data, then communicate their findings to the world. Glassdoor named the data scientist the #1 occupation on a recent “Best Jobs in America” list.

Data science majors will learn about key computational methods and statistical techniques as they develop the deep analytical thinking skills needed to reason reliably, intelligently and creatively from data.

The data science major will open pathways to careers in virtually every area of society, from healthcare, security and sustainability to education, business and economics.

Kevin Jones
Academic Advisor

Established as part of a Purdue Move by Purdue President Mitch Daniels, the new major is a response to industry trends and student demand.

Tiark Rompf is creating new capabilities in programming, combining concepts from different fields to increase the performance and reliability of software. Rompf's main research area is generative programming – building programs that have the ability to generate other programs on demand, at runtime, allowing the computer scientist to load data and then specialize the rest of the program based on the knowledge the data brings.

The goal of his research is to make high-level programming techniques more useful for performance-critical software, capitalizing on the ease of programming in a high-level language while also benefiting from the performance gains that come from working in a low-level language.

By definition, low-level languages are harder to code because their syntax is closer to how the machine works, whereas high-level languages are easier because they are closer to how humans intuitively think about the program. High-level languages can be translated to the machine, but not always efficiently, leading to slow software, battery drainage, and excess energy costs.

“Normally, if you write a piece of software and you want it to run efficiently, you have to write it in a very low-level language,” Rompf said. “It’s very difficult and very painful, because you need to manually optimize every line of the program.”

Rompf aims to bridge this performance gap using generative techniques. He has developed programming models that allow a user to write high-level code, but in a generative style that produces low-level code at runtime.



RESEARCH SPOTLIGHT: **TIARK ROMPF**

His recent work shows that you can build a whole database system in a high-level language. “The database community still thinks that this is a very radical thought,” Rompf said. “Commercial database systems

- **2017 Department of Energy Early Career Research Award**
- **2017 Google Faculty Research Award**
- **2015 NSF CAREER Award**

have millions of lines of manually optimized C code, but we’ve shown that that’s not necessary. You can write something that is 5,000 lines of code in a high-level language and it performs the same as the manually optimized code.”

A recent paper shows that generative techniques can be used to build the core parts of a web server. Rompf said, “Our code is just 10

percent as long as the handwritten code that exists in other systems. It gets the same performance, and it’s much more readable. What is more, the code is simple enough that we can give it to a program verification tool and obtain proof that it is free from certain classes of security vulnerabilities.”

Rompf is currently most excited by two new projects that have strong potential to impact industry. His group is optimizing the performance of Google TensorFlow, an open-source software library for machine intelligence, and Apache Spark, currently the most popular framework for cluster computation and big data.

Rompf recently received the Department of Energy’s 2017 Early Career Research award. His proposal was one of 59 selected from around 700 submissions. He joined the Purdue faculty in 2014, drawn in by Purdue’s strong faculty research in programming languages, databases, and machine learning.

CS 180 BLACK AND GOLD



Students enter the computer science major with vastly different levels of programming experience. Here's what we're doing about that.

Some computer science majors begin their freshman year at Purdue with extensive programming experience. They've taken AP Computer Science or taught themselves to program games or apps. Other incoming students may have never coded before, but their strong SAT Math scores show that they will succeed at programming once they are exposed to it.

All incoming computer science majors take the same introductory programming class, CS 180, regardless of programming experience. "Learning programming with students who seem to have a lot of prior knowledge can be daunting for new CS majors who haven't programmed before. These students, particularly women, sometimes report feeling like they've fallen behind, or like they don't belong. Often, they change majors before ever giving themselves the chance to succeed," said Randy Bond, assistant department head. "That's why we created CS 180 Black and Gold."

Launched in 2016 to increase retention in the CS major, CS 180 Black and Gold divides students into two sections: those who have programming experience and those who don't. Students learn with peers who have the same level of programming experience, so that they don't feel lost or bored. Students choose which section to enroll in and are allowed to switch sections during the semester. Both sections have the same course objectives and outcomes.

"Analysis of students' grades from CS 180 and CS 240, the subsequent programming class, shows that the students are doing very well," said Diversity Specialist Adrian Thomas. "Early results show that when we provide this type of intervention, students without programming experience do just as well at programming as their peers who had previous programming experience."

Students who lack programming experience also have the opportunity to come to Bridge, a two-week intensive that takes place the summer before freshman year. Designed to introduce them to coding and the computer science major, Bridge covers half of CS 180. Accepted students are also invited to an online course that covers the material from CS 180.



STUDENTS TEACH COMPUTER SKILLS IN TANZANIA

In May, five students from the Department of Computer Science traveled to Dar es Salaam, Tanzania, for a service learning and study abroad experience. Accompanied by Department Head Sunil Prabhakar and Diversity Specialist Adrian Thomas, the students worked with children at Matumaini Primary School, which serves nearly 200 children with disabilities and other socially at-risk youth.

Purdue students introduced the children to computers with the goal of nurturing a desire to continue to work with technology, especially computers. Children learned about basic technology, including spreadsheets, searching the web, word processing and cell phones.

Prabhakar said, “The Tanzania program is a point of pride for the Department of Computer Science. It is such an important experience for our students. It broadens their cultural competence and teaches them so much about the world and its people.”

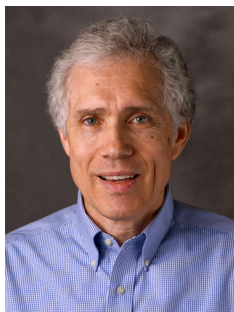
Austin Reed, a senior, said it was hard to pinpoint which aspect of the trip was the best. “From seeing our favorite animals on safari, to riding a horse on the beach, to staying up late trying to make the best lesson plan in existence, to watching the students grow and practice the skills we taught them, to crying when they threw a party with us, there is no way to place value of any of these things over another. Every aspect of this trip was amazing.”

“Many computer science students have a hard time explaining our ideas to others. This program is not only a thrilling adventure, but also an opportunity to work on the communication skills that are vital in our field.”

Austin Reed
Senior, Computer Science

RETIREMENTS

In 2017, the department celebrated the distinguished careers of four outstanding professors: Greg Frederickson, Bradley Lucier, Ahmed Sameh and Robert Skeel. Together, they have served Purdue for more than 100 years.



GREG FREDERICKSON joined the Department of Computer Science in 1982. His areas of interest include the analysis of algorithms, with special emphasis on data structures, and graph and network algorithms. He published three books: *Dissections Plane & Fancy*; *Hinged Dissections: Swinging & Twisting*; and *Piano-Hinged Dissections: Time to Fold*. He was inducted into Purdue's Book of Great Teachers in 2008. He won a George Pólya Award from the Mathematical Association of America in 2004, and again in 2009.



BRAD LUCIER joined Purdue University in 1981 and holds a joint appointment in mathematics and computer science. He is a fellow of the AMS. His work focuses on wavelet and multiresolution methods for image processing and other applications, especially applications in medical imaging.



AHMED SAMEH is the Samuel D. Conte Professor of Computer Science. He joined the Purdue faculty in 1997 as head of Computer Science after serving on the faculty of the University of Illinois and the University of Minnesota, where he was head of Computer Science and the holder of the William Norris Chair for Large-Scale Computing. He is a fellow of ACM, IEEE and AAAS, and a member of SIAM. He has also received the IEEE's 1999 Harry Goode Award for influential work in parallel numerical algorithms.



ROBERT SKEEL joined the Purdue faculty in 2004. His research seeks to aid in the discovery of the structures and mechanisms that are basic to life. Such simulations are very demanding computationally, running for days, weeks, and even months on parallel computers. His recent research explores the problems of doing dynamic simulations on biological time scales and of calculating free energy differences and transition paths in very high-dimensional configuration space. Skeel co-authored a textbook, *Elementary Numerical Computing with Mathematica*. Prior to coming to Purdue, he initiated the development of the scalable parallel molecular dynamics program NAMD at the University of Illinois.



THREE CS FACULTY MEMBERS WIN 10-YEAR BEST PAPER AWARDS

This year, three papers by Purdue researchers received 10-year best paper awards that honored the long-standing impact and legacy of their work. Sunil Prabhakar, head of the Department of Computer Science, said, “A ten-year best paper award is an amazing recognition. To have three faculty members win these test-of-time awards in the space of one year speaks volumes to the quality of work going on in the department.”



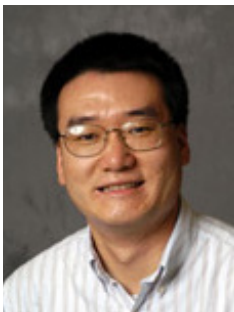
WALID AREF: VLDB 10-YEAR BEST PAPER AWARD

Professor Walid Aref won the Very Large Data Bases (VLDB) 10-Year Best Paper Award for the enduring legacy of his 2006 paper, “The new Casper: query processing for location services without compromising privacy.” Co-authored with Mohamed Mokbel of the University of Minnesota and Chi-Yin Chow of City University of Hong Kong, the paper tackled a major privacy concern by introducing a framework that lets both mobile and desktop users use location-based services without revealing their location information.



TONY HOSKING: OOPSLA 2016 MOST INFLUENTIAL PAPER

Co-authored by Associate Professor Tony Hosking, “The DaCapo benchmarks: Java benchmarking development and analysis” was named the Most Influential Paper of OOPSLA 2006 (the 21st annual ACM SIGPLAN Conference on Object-Oriented Programming Systems, Languages and Applications). According to the SIGPLAN committee, “The DaCapo benchmarks have become the de facto standard Java benchmarking suite, quickly replacing older suites, such as the SPEC JVM benchmarks. The DaCapo paper has set a standard that substantially raised the level of Java experiments in the overall literature of the past decade.”



NINGHUI LI: ICDE 2017 TEST OF TIME AWARD

Professor Ninghui Li won the IEEE International Conference on Data Engineering (ICDE) 2017 Test of Time (10-Year Award) for his 2007 paper “t-Closeness: Privacy Beyond k-Anonymity and ℓ -Diversity,” written with Tiancheng Li (Ph.D. '10) and Suresh Venkatasubramanian. In this paper, the authors proposed a new privacy notion called t-closeness, which requires that in a table of records, the distribution of a sensitive attribute in any equivalence class is close to the distribution of the attribute in the overall table.

NEW FACULTY

The Department of Computer Science has added 18 new faculty members in the past five years, reinforcing our dedication to preparing excellent computer scientists and conducting research that furthers the field. Meet this year's hires.



Simina Branzei



Christina Garman



Chunyi Peng



Yexiang Xue



Ming Yin



2016-2017 FACULTY

COMPUTATIONAL SCIENCE & ENGINEERING



Petros Drineas



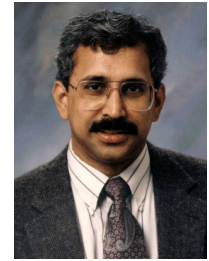
David Gleich



Ananth Grama



Alex Pothen



Vernon Rego

DATABASES & DATA MINING



Walid Aref



Bharat Bhargava



Chris Clifton



Sunil Prabhakar



Ahmed Elmagarmid



Mohammad Sadoghi

THEORY OF COMPUTING & ALGORITHMS



Saugata Basu



Elena Grigorescu



Susanne Hambruch



Wojciech Szpankowski

BIOINFORMATICS & COMPUTATIONAL BIOLOGY



Daisuke Kihara



Majid Kazemian



Buster Dunsmore



Aditya Mathur

DISTRIBUTED SYSTEMS

SOFTWARE ENGINEERING



2016-2017 FACULTY

INFORMATION SECURITY & ASSURANCE



Mikhail Atallah



Elisa Bertino



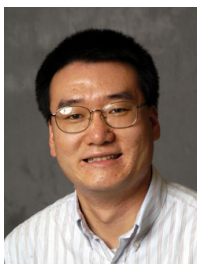
Jeremiah Blocki



Aniket Kate



Byoungyoung Lee



Ninghui Li



Hemanta Maji



Eugene Spafford

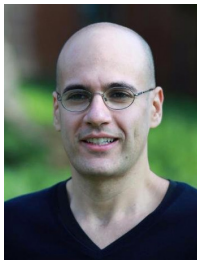


Samuel Wagstaff



Dongyan Xu

MACHINE LEARNING & ARTIFICIAL INTELLIGENCE



Elias Bareinboim



Dan Goldwasser



Jean Honorio



Jennifer Neville



Bruno Ribeiro

NETWORKING & OPERATING SYSTEMS



Doug Comer



Sonia Fahmy



Kihong Park



Mathias Payer



He Wang



2016-2017 FACULTY

PROGRAMMING LANGUAGES & COMPILERS



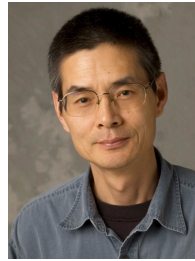
Ben Delaware



Antony Hosking



Suresh Jagannathan



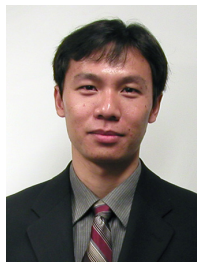
Zhiyuan Li



Tiark Rompf



Roopsha Samanta



Xiangyu Zhang

GRAPHICS & VISUALIZATION



Daniel Aliaga



Christoph
Hoffmann



Elisha Sacks



Xavier Tricoche



Voicu Popescu

PROFESSORS OF PRACTICE



Gustavo
Rodriguez-Rivera



Jeff Turkstra

This year, the department welcomed its first two professors of practice. Their primary focus is on teaching and promoting the integration of academic scholarship with industrial experience. These hires illustrate the department's continued commitment toward meeting teaching needs and to the high quality of our educational program. Gustavo Rodriguez-Rivera, previously a continuing lecturer, switched roles to become an associate professor of practice, and Jeff Turkstra joined the department as an assistant professor of practice. He received his Ph.D. from Purdue in Electrical and Computer Engineering and most recently worked for Purdue's Rosen Center for Advanced Computing.



Craig Pfeifer, Vicki Capadona and Ko-Yang Wang (pictured with Department Head Sunil Prabhakar and Distinguished Professor Emeritus John Rice) are Computer Science's Outstanding Alumni for 2016.

2016 OUTSTANDING ALUMNI



Three exceptional computer science graduates were recognized as the department's 2016 Outstanding Alumni. This award recognizes extraordinary professional achievements, distinctive innovations and diligence in advancing the field of computing.

VICKI CAPADONA

Vicki Capadona graduated in 1972 with one of the inaugural computer science undergraduate degrees earned at Purdue. She began her career in Chicago at Continental Illinois National Bank as an application programmer working on IBM's largest computer at the time. She went on to work with Allstate Insurance Company and Blue Cross. Vicki served her school board technology committee and church council, and served as a board member for a local museum and for her community foundation.

CRAIG PFEIFER

Craig Pfeifer has served the Dynamic Research Corporation as the technical architect for projects with the Department of Veteran's Affairs and the Department of the Navy's Bureau of Medicine and Surgery. He joined the MITRE Corporation, where he served as Principal Artificial Intelligence Engineer and published on the topics of author attribution, native language identification and minimally supervised multilingual relation extraction. Craig is currently pursuing a Ph.D. in natural language processing.

KO-YANG WANG

Ko-Yang Wang has held various technical and business leadership roles at IBM during his career. He was elected IBM Distinguished Engineer in 2000 and is a member of the IBM Academy of Technology. He is the founder and CEO of Fusions360.com and has extensive experience in IT consulting and strategic business management, including serving as executive vice president and CTO at the Institute for Information Industry of Taiwan and leading the Cloud System Software Research Institute. Ko-Yang has co-authored eight patents and more than 50 publications.



BRAD SURAK, 2017 DISTINGUISHED ALUMNI

Brad Surak (BS '95) is an “intra-preneur” with a proven ability for building a successful “business within a business” for large multi-national companies. He has led teams from startup mode to driving global-scale digital transformations that deliver outstanding growth and productivity.

Most recently the Chief Operating Officer (COO) of GE Digital and a founding member of the GE Digital executive team, Brad joined GE in 2012 to oversee GE’s digital transformation, focusing on the creation of GE Digital, which brought together 28,000 employees and hundreds of software offerings across many business units. As COO, he orchestrated GE Digital’s strategy and the integration of all software acquisitions.

Surak got his first taste of industry while still taking classes at Purdue. Off campus, he worked in the IT department of the Whirlpool Corporation where he was able to apply the concepts of what he was learning in the classroom to meaningful manufacturing challenges. One of his favorite classes was the Ubiquitous Computing course, which introduced him to the early applications of the Internet.

RECENT CAREER HIGHLIGHTS

2016

Helped GE Digital eclipse \$6 billion in revenue

2015

Received General Electric’s Chairman Award for collaboration with GE Aviation, which resulted in more than \$500 million in two years for the company



“Purdue grounded me in computer science theory and provided me opportunities to apply the theory in practice through various labs and student employment programs.”

Brad Surak, BS '95



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