RESEARCH PROVES THE IMPROBABLE CAN BE MADE POSSIBLE

OPTIMIZING DATA STORAGE

REACHING NEW HEIGHTS IN CYBERSECURITY
Our exceptional faculty members are known throughout the international academic community and the global industry for their research in computer science and computer engineering. All serve on conference committees, editorial boards and in professional societies. They are committed to the department’s mission of developing the human and intellectual resources needed to meet the future technological challenges in the field of computing.

Our faculty members are continually acknowledged for their research through grants and awards. Twenty-one faculty members have been presented with principal young investigator, NSF young investigator and faculty early development CAREER awards by the National Science Foundation in recognition of their potential as young stars in science and engineering. We have six IEEE Fellows, one AAAS Fellow, two ACM Fellows, one SIAM Fellow, nine ACM Distinguished Scientists, and one ACM Distinguished Engineer. Six of our faculty members hold endowed professorships, five of whom are women.
HIGH IMPACT

Devoted to the advancement of computing through innovative research and dedication to the field, our renowned faculty members and outstanding students are making strides to create a better tomorrow in their respective research areas. Their research activities in our department have resulted in best paper awards in top conferences, collaboration with industry and national labs, and several patents.

STUDENT SPOTLIGHT

The department is committed to developing computer scientists and computer engineers for positions of leadership in industry, government and academia. Graduates of the department’s undergraduate and graduate programs leave well-prepared for careers that encompass the full spectrum of the computer science and engineering discipline. They proceed to have an influence in research, industry, and our communities.
Message from the Department Head

It has been two years since I joined Texas A&M University as head of the Department of Computer Science and Engineering. As I expected, I found high-quality research and education activities carried out by outstanding faculty and students in our department. I also encountered an atmosphere of passion for innovation and the zeal to attempt challenging ideas. There is strong momentum for increasing our impact, fueled by the many accomplishments of our faculty and students.

Since fall 2014, our department has hired eight tenure-track faculty and five teaching faculty, increasing our strength in areas that include big data, cybersecurity, natural language processing, health, systems and software. We are still expanding our research portfolio and expect to continue to grow our faculty in the coming years. With computing at the epicenter of problem solving in all fields, most of our researchers work in multi-disciplinary teams tackling challenging problems directly impacting our society. Our graduate program aims to prepare the next generation of researchers for the fast-paced world of computing, where transformation within a sub-field quickly percolates into other domains. In the last two years, we have graduated 34 Ph.D. students who have moved on to positions in academia and industry.

Our undergraduate students are energized by the exciting times we are living in and by the way computing permeates every aspect of our world. They embrace new opportunities to learn outside of the classroom and make a difference. We pursue novel ways of engaging students in active learning without compromising the nurturing environment that is built around our university’s traditions. As computing professionals, we are at the forefront of exploring what technology can do to advance our educational mission.

We continue to make great strides in improving the diversity in our department. We have many initiatives to recruit a diverse population of students and enable their success. I feel very fortunate to work in a department where 37 percent of our full professors are women or underrepresented minorities. Additionally, the dean of the college of engineering and the provost of the university are also women.

It is a fantastic time to be in the computing field. As the articles showcased in this magazine indicate, our faculty, students and alumni are taking full advantage of this exciting time.

Dilma Da Silva, Ph.D.
Department Head, Professor and Holder of the Ford Motor Company Design Professorship II
Department of Computer Science and Engineering | Texas A&M University
New Faculty Additions

Dr. Xia “Ben” Hu is currently a tenure-track assistant professor at Texas A&M University in the Department of Computer Science and Engineering. He received his Ph.D. in computer science and engineering from Arizona State University, and Master of Science and Bachelor of Science in computer science from Beihang University, China. At Texas A&M, Hu directs the Data Analytics at Texas A&M (DATA) Lab and is also affiliated with the Texas A&M Experiment Station’s (TEES) Center for Remote Health Technologies and Systems and the Center for the Study of Digital Libraries. The DATA Lab currently consists of five Ph.D. students, four Master of Science students and two undergraduate students. Research focus of the DATA Lab is to develop data mining and machine learning algorithms with understanding of theoretical properties to better discover actionable patterns from large-scale, networked, dynamic and sparse data. Existing research projects are directly motivated by, and contribute to, applications in social informatics, health informatics and information security. As a result, Hu has published nearly 60 papers in several major academic venues, including WWW, SIGIR, NIPS, KDD, ICDM, SDM, WSDM, IJCAI, AAAI, CIKM, and ICWSM. One of his papers was selected in the Best Paper Shortlist in WSDM 2013. He is the recipient of the 2014 ASU President Award for Innovation, and Faculty Emeriti Fellowship. His work has been featured by several news media, including ACM TechNews, New Scientist and Defense One.

Dr. Ruihong Huang joined the Texas A&M computer science and engineering faculty as an assistant professor in fall 2015 after she completed a postdoc at Stanford University. Huang received her Ph.D. in computer science from the University of Utah. Before that, she received a master’s degree and a bachelor’s degree in computer science from the Chinese Academy of Sciences and Shandong University, respectively. Huang’s research lies in natural language processing and machine learning. She is particularly interested in information extraction and knowledge mining from large amounts of text by developing weakly supervised learning algorithms. Her other research interests include artificial intelligence and applications of natural language processing to social sciences, literature and biomedical domains.

Dr. Roozbeh Jafari is an associate professor in biomedical engineering, computer science and engineering and electrical and computer engineering at Texas A&M University. He received his Ph.D. in computer science from the University of California, Los Angeles and completed a postdoctoral fellowship at the University of California, Berkeley. His research interest lies in the area of wearable computer design and signal processing. His research has been funded by the NSF, NIH, DoD (TATRC), AFRL, AFOSR, DARPA, SRC and industry (Texas Instruments, Tektronix, Samsung & Telecom Italia). He has published over 100 papers in refereed journals and conferences. He has served as the general chair and technical program committee chair for several flagship conferences in the area of Wearable Computers including the ACM Wireless Health 2012 and 2013, International Conference on Body Sensor Networks 2011 and International Conference on Body Area Networks 2011. He is the recipient of the NSF CAREER award in 2012, IEEE Real-Time & Embedded Technology & Applications Symposium (RTAS) best paper award in 2011 and Andrew P. Sage best transactions paper award from IEEE Systems, Man and Cybernetics Society in 2014. He is an associate editor for the IEEE Transactions on Biomedical Circuits and Systems, IEEE Sensors Journal, IEEE Internet of Things Journal and IEEE Journal of Biomedical and Health Informatics. He has served as an expert witness on a number of interesting industry litigation cases.

Dr. Shinjiro Sueda is an assistant professor of computer science and engineering at Texas A&M University. Prior to this appointment, he was an assistant professor at California Polytechnic State University, after completing a postdoctoral fellowship at Disney Research Boston and Massachusetts Institute of Technology. He received his Ph.D. from the University of British Columbia. His main research area is computer graphics and animation, specializing in physically based animation, biomechanical simulations and computational fabrication.
Robotic Lifeguard Aids in First Response Around the World

A robot assistant lifeguard called EMILY is making waves by helping migrants cross the Mediterranean Sea safely. In the wake of unrest, over 500 refugees have drowned attempting to cross the Mediterranean from Turkey to Greece. Members from the Texas A&M Engineering Experiment Station’s (TEES) Center for Robot-Assisted Search and Rescue (CRASAR) and Roboticists Without Borders gathered at the Greek island of Lesvos to assist the local Coast Guard and lifeguard organizations to prevent this from happening in the future.

Dr. Robin Murphy, Raytheon Professor in the Department of Computer Science and Engineering at Texas A&M University, aided authorities in Lesvos alongside CRASAR, of which she is the director. She is working with students to continually improve the lifesaving device, which can carry up to eight people at once. Several undergraduate seniors are working on senior design projects that would help humanitarian efforts and five graduate students are working on an autonomous version of EMILY in Murphy’s graduate level robotics class.

Team Tanks, comprised of seniors Timothy Foster, Andy Tran, Natalie Rawle, Karrie Cheng and Shane Scott, chose to work on an app called “Draw Me a Picture” as their senior capstone project. The idea is that EMILY can display an animated GIF illustrating what the responders want the refugees to do, for example how to tie a rope to their boat so it can be pulled away from the rocks. The app was presented at Texas A&M Student Research Week, where the team placed first over all the undergraduate teams for the Sigma Xi Symposium Theme Award, as well as taking first place in the Undergraduate Oral division.

EMILY’s creator, Tony Mulligan, is the CEO of Hydronalix, a company dedicated to the innovation of robotics, and an active member in Roboticists Without Borders. The original EMILY, built in 2010, was designed to assist swimmers caught in rip currents and bring them safely back to shore. Since 2010, these have been distributed to first responders around the world.

Designed to speed out to those who require immediate relief, EMILY gives the Coast Guard crucial time needed to save others in need. EMILY can be thought of as a combination of a large life preserver with a battery powered miniature jet ski that a lifeguard can control remotely.

Murphy began working with this type of robot and the manufacturer as part of the 2014 and 2015 Summer Institutes on Flooding and the Computing for Disasters NSF Research Experience for Undergraduates site grant. This summer, the institute was focused on mass marine casualties such as refugees’ drownings, what would happen if a cruise ship went down in Galveston Bay or a repeat of the Cuban boat flotillas.

Looking to the future, EMILY can be effective in first response situations such as these.

Murphy’s research was recently covered on NPR All Things Considered and WIRED.
Amato Named One of the 25 Women in Robotics Everyone Should Know

Dr. Nancy M. Amato, Unocal and Regents Professor in the Department of Computer Science and Engineering at Texas A&M University, was named to Robohub’s list of “25 Women in Robotics You Need to Know About.”

Amato was selected because of the impact she has made on robotics and computer science for numerous years. Among those contributions, her paper on probabilistic roadmap methods is seen as one of the most important papers in the field. For these contributions, she has been named a Fellow of the American Association for the Advancement of Science (AAAS) and Institute of Electrical and Electronics Engineers (IEEE). She was also named a 2015 Fellow by the Association for Computing Machinery for her contributions to robotics and leadership in broadening participation in computing.

Amato serves as a member of the board of directors for the Computing Research Association where she is also co-chair of the Committee on the Status of Women in Computing Research.

Davis named IEEE Fellow

Dr. Tim Davis, professor in the Department of Computer Science and Engineering at Texas A&M University, was named an IEEE Fellow. Davis is recognized as a world leader in algorithmic research for sparse matrix computations. His work combines graph-theoretic methods and numerical techniques to create algorithms for solving problems in computational science that arise across a wide range of applications. He incorporates his novel theory and algorithms into robust library-quality open-source software that is widely used in industry, academia and government labs.

Davis’ graph and sparse matrix algorithms are important to scientific and engineering simulations, social network analysis, computer vision, computer graphics, robotics and many other domains. The MathWorks relies on his sparse solvers in MATLAB, a widely-used language and application for technical computing. Every photo in Google StreetView, PhotoTours, and 3-D Earth is placed in proper position using his software via Google’s Ceres nonlinear least squares solver.

The US Geological Survey (USGS) uses his sparse solvers to process images of the Earth, moon, Mercury and other planetary bodies, cutting its time-to-solution from hours/days down to minutes. Davis’ open-source software has been adopted by all major Linux distributions and is widely used in open-source packages such as Sandia’s Xyce circuit simulator, GIMP, R, Octave, FEniCS, ROS, OpenSLAM.org, Boost, Julia and Scilab, to name just a few.

Davis joined the faculty at Texas A&M in 2014 after 23 years at the University of Florida. He holds doctoral and master’s degrees in electrical engineering from the University of Illinois, Urbana-Champaign, and graduated with distinction with a bachelor’s degree in electrical engineering from Purdue University.
Dr. Robin Murphy, Raytheon Professor in the Department of Computer Science and Engineering at Texas A&M University, has been named one of the 30 Most Innovative Women Professors Alive Today by The Best Master’s Degrees, a website that provides reviews and rankings to help narrow down the field when it comes to selecting which programs to pursue in higher education.

Each woman on the list embodies the term “innovative” as defined as something “featuring new methods”. Among the 30 women honored with this recognition, three are involved in researching and developing robotics. Murphy is the only woman recognized from Texas A&M.

Murphy is director of the Texas A&M Engineering Experiment Station’s Center for Emergency Informatics, which includes the Center for Robot-Assisted Search and Rescue (CRASAR) at Texas A&M. CRASAR is one of only two centers in the world specializing in disaster robotics. She established the field of disaster robotics in 1995 alongside Dr. Satoshi Tadokoro of the International Rescue Systems Institute at Tohoku University.

Along with directing CRASAR, Murphy also founded Roboticists Without Borders, a program designed to bring together groups of professionals in ground, aerial, or marine robots or emergency response to aid in the recovery after an incident occurs at no cost to responders and agencies.

Among her numerous awards, Murphy recently received the Association for Computing Machinery Eugene Lawler Award for Humanitarian Contributions within Computer Science and Informatics.

Beyond innovative research, Murphy has employed innovative means of engaging students and the public. She created robot petting zoos, which have been held at South by Southwest and other venues, introducing robots to over 5,000 participants. She has a blog and a new book, Robotics Through Science Fiction, which uses classic science fiction stories to explain robotics.

Her research interests include human-robot interaction, heterogeneous teams, victim management, perceptual directed behavior-based control and artificial intelligence as applied to emergency informatics and research, especially with tactical land, sea and air vehicles.

Huang Receives Prestigious NSF CAREER Award

Dr. Jeff Huang, assistant professor in the Department of Computer Science and Engineering at Texas A&M University, has received a five-year National Science Foundation (NSF) Faculty Early Career Development (CAREER) award for his research in debugging concurrency related software defects.

The NSF awards the prestigious CAREER grants to outstanding junior faculty members to help them advance their research and teaching activities. Huang’s project, “Scalable and Maximal Concurrency Debugging,” will continue through January 2021.

“Concurrency related software defects, or bugs, are among the most expensive and dangerous in practice, and have become a major threat to the reliability and security of safety-critical systems and the nation’s critical infrastructure,” said Huang. “However, detecting and fixing these defects are very challenging. I aim to develop new theoretical and algorithmic advances and build practical automated tools to help developers detect and understand concurrency bugs earlier, and fix them safer and faster.”

Huang’s CAREER research will investigate solutions to four major research questions on concurrency debugging: how to reproduce failures in long running concurrent programs with minimal runtime perturbation and overhead; how to detect concurrency bugs at the maximum ability and with no false alarms, even under limited observation; how to accurately identify the failure’s root cause and how to effectively simplify concurrency bugs and speed up their reproduction; and how to fix concurrency bugs without introducing deadlocks or unnecessary performance degradation and how to effectively validate the correctness of fixes.

The broader significance and importance of this project is to help produce more reliable, secure and economical software systems and infrastructure, remove concurrency related vulnerabilities and strengthen science, technology, education and mathematics (STEM) education on software debugging, which is a critical, but lacking aspect of today’s software engineering education.

Among Huang’s many honors are a 2015 Google Faculty Research Award, a 2013 Distinguished Paper Award from ACM SIGPLAN conference on Programming Language Design and Implementation (PLDI), which was selected as one of the nine ACM SIGPLAN Research Highlights papers in 2013, and the 2013 ACM SIGSOFT Outstanding Dissertation Award, which recognizes the author of one outstanding doctoral dissertation in the area of Software Engineering annually.

The NSF established the CAREER program to support junior faculty within the context of their overall career development, combining in a single program the support of research and education of the highest quality in the broadest sense. Through this program, the NSF emphasizes the importance of the early development of academic careers dedicated to simulating the discovery process in which the excitement of research is enhanced by inspired teaching and enthusiastic learning.
Research Proves the Improbable Can be Made Possible

Microprocessors are at the heart of devices such as computers, smartphones and iPads. In the Texas Architecture and Compiler Optimization (TACO) lab at Texas A&M University, Dr. Daniel Jiménez, professor in the Department of Computer Science and Engineering, has revolutionized the way research on this technology is conducted.

Microprocessors execute programs by reading instructions written in machine language, decoding them, carrying out their objective and storing the results. Similar to an assembly line, they process instructions through a channel called a pipeline where many instructions are processed at the same time in different stages.

Some commands, such as branch instructions, cause the pipeline to temporarily stop until the instruction can complete. Branch instructions can change the source of subsequent instructions, creating the potential for a type of problem known as a control hazard; when a control hazard occurs, no other work can be performed. Jiménez works to address these hazards with microarchitectural prediction.

Some instructions load values from the computer’s main memory, which is usually made from a high-capacity, but slow technology called Dynamic random-access memory (DRAM). When a load instruction has to access the main memory, it can take up to 300 times longer than an instruction that does not use the main memory.

A delay caused by the slow memory is called a data hazard and can also reduce performance. Microprocessors rely on a cache to avoid the cost of accessing the slow memory. However, most processors’ caches have a limited capacity to keep the right data.

Jiménez has developed many algorithms for performing branch prediction, which allows the processor to predict whether a branch instruction will cause a change in the flow of control in a program.

Most of his algorithms are based on neural learning – the same form of information processing method neural networks such as the biological nervous system use.

Jiménez’s branch predictors are among the most accurate in the literature and industry and are used in a range of computing platforms such as high-performance computers, desktop and laptop, as well as mobile computing. Recent microprocessors from Advance Micro Devices (AMD), Oracle, and others feature branch predictors based on those designs. He was awarded the NSF CAREER grant for his work in this area.

Jiménez and his team in the TACO lab have developed several dead block prediction algorithms as well as improved cache replacement policies for data hazards. Dead block predictors give a prediction as to whether a block of data will be used again in the near future. With this information, the cache controller can decide whether to keep a block or remove it in favor of a block that is more likely to be used soon; this improves the storage capacity of the cache and in turn, efficiency.

“When I first started working on the idea of using neural learning in branch prediction, I didn’t realize that the idea was totally impractical,” Jiménez said. “Once I proposed it, I learned that the tight timing constraints in a microprocessor make neural learning almost impossible to implement for branch prediction. I spent several years as an assistant and associate professor at Rutgers turning ‘totally impractical’ and ‘almost impossible’ into reality by inventing various techniques to solve the timing problem as well as improve accuracy.”

Jiménez and his students have introduced several improved dead block predictors and cache replacement policies, including their most recent paper which was presented at the 2016 HPCA conference.

That paper, “Minimal Disturbance Placement and Promotion,” introduced a policy that uses very little hardware overhead to do cache replacement that results in performance competitive with state-of-the-art policies with higher overheads.

They recently submitted another paper that merges neural learning with dead block prediction to outperform all other state-of-the-art policies. Several microprocessor manufacturers have expressed interest in using these cache replacement algorithms.

Jiménez first began studying microarchitectural prediction while completing his doctorate at the University of Texas at Austin in 1999; his first neural branch prediction paper was a collaboration with graduate adviser, Dr. Calvin Lin.

Jiménez’s research on branch prediction was featured in the 2009 issue of IEEE Micro’s “Top Picks from Computer Architecture Conferences”; this research was conducted in collaboration with Dr. Doug Burger and Dr. Renée St. Amant from the University of Texas at Austin. He has also collaborated with Dr. Gabriel Loh of AMD Research on branch prediction and other microarchitectural prediction.
Adult learners of a second-language (L2) often continue to speak with the accent associated with their first language. This can subject them to discrimination and make them less confident when interacting with others.

L2 learners rarely receive formal training in pronunciation, a primary reason being that effective training must be customized to meet each learner’s individual needs. To address this problem, Dr. Ricardo Gutierrez-Osuna, professor in the Department of Computer Science and Engineering and director of the Perception Sensing and Instrumentation Lab at Texas A&M University, is working with linguists at Iowa State University to develop the technology to provide better pronunciation practice.

“Paraphrasing my colleague John Levis, pronunciation is viewed as the Cinderella of language learning, which typically emphasizes grammar and vocabulary, whereas pronunciation is expected to just happen,” Gutierrez said.

One of the primary difficulties with pronunciation is that it cannot be taught on a large scale, such as in a classroom of 300 students. Traditional classroom instruction cannot easily meet the needs of diverse learners because each individual has their own needs based on their first language.

Gutierrez and his collaborators are working to develop algorithms that synthesize a personalized “golden speaker” for each learner. The golden speaker will be his or her own voice, but without the non-native inflection usually present. The idea is that learners can more easily perceive differences between their actual and ideal pronunciations when hearing their own voice, thus improving their pronunciation.

The National Science Foundation recently awarded Gutierrez and his team two grants to develop and evaluate golden speakers. The first grant, from the NSF Robust Intelligence program, will develop the underlying technology for golden speakers, the speech representations and speech processing algorithms to produce high-quality golden speaker voices.

Similar to RGB color coordinates, the teacher’s voice and the L2 learner’s voice each have their own weighted sum of base sounds that comprise their individual way of speaking. The golden speaker program will record the teacher’s and the learner’s voices while speaking a sentence or phrase. It will then assess the fragments and make the learner’s voice comparable to that of the teacher’s voice by recombining the base sounds.

The second grant, from the NSF Cyberlearning program, will create a web-based learning environment that allows L2 learners to build their golden speakers by selecting among different regional U.S. accents or voices that they identify themselves with, such as actors, world leaders, or inspirational figures. The investigators will use this learning environment to study how golden speakers facilitate pronunciation training.

“The goal is to create these engaging pronunciation exercises in a computer format so that students can practice on their own time, at their own pace, and in the comfort of their own home, with their alter ego: their own voices but with a native accent,” Gutierrez said.

To bring these projects to fruition, Gutierrez is collaborating with professors John Levis and Evgeny Chukharev-Hudilainen of the Applied Linguistics program at Iowa State University, and current Ph.D. students, Chris Liberatore and Guanlong Zhao. Former Ph.D. students, Dr. Daniel Felps and Dr. Sandesh Aryal also helped with this research.

These two projects have the potential to impact society in a significant way by enhancing communication in critical sectors such as higher education, technology and healthcare, which attract a large number of non-native speakers of English.
Eight computer science and engineering students received recognition for their research during Texas A&M University’s 2016 Student Research Week (SRW).

Zachary Varnadore placed first in the undergraduate math, statistics, computer science division for his poster, which was based on a portion of the work he is executing for a GPS receiver network project in the Real Time Distributed Systems (RTDS) lab under Dr. Steve Liu, computer science professor.

“The work I presented was about how we were able to implement evaluation models for data availability and reliability of GPS data from hundreds to thousands of GPS receivers using software that I developed,” Varnadore said. “The purpose of doing this is to evaluate a large GPS receiver network called the CORS network to identify quality issues in the data provided by GPS receivers in the network.”

The data received by the CORS network GPS is used by many different research groups and organizations for positioning data applications.

“I am most delighted to see his hard work recognized,” Liu said. “His work helps my team to validate our model based on this large-scale experiment, and it will help us to elevate our research to the next level of investigation.”

Sampath Jayarathna, a Ph.D. candidate and teaching fellow, placed first in the graduate poster competition in the math, statistics, computer science division for his research poster, which explored new models of relevance feedback. The idea is to learn consumer preferences more accurately by accounting for their behaviors in web search environments. Jayarathna works under faculty advisor, Dr. Frank Shipman, who is the associate director for the TEES Center for the Study of Digital Libraries.

“I believe that analyzing user behavior and capturing user preferences is of great importance for the design of many personalized recommendations and other relevant applications such as behavioral targeting, computational advertising and information retrieval,” Jayarathna said.

Raniero Lara-Garduno, a Ph.D student in the Sketch Recognition Lab (SRL) under Dr. Tracy Hammond, associate professor, received second place in the graduate poster competition in the math, statistics, computer science division. His poster was centered on his dissertation project, which focuses on the digitization and automation of digitized sketch data in neuropsychological tests.

Lara-Garduno’s research focuses on a universal Windows app written specifically to adapt paper-and-pencil exams from the field of clinical neuropsychology. SRL is currently in the process of collecting data from the general population to develop a computational model of sketching behavior. This model would be applied to pre-diagnosis, which would prove invaluable in early detection of cognitive illnesses such as Alzheimer’s and dementia.

“I feel very fortunate in working with this exciting project, as it merges the field of sketch recognition with a novel approach in neuropsychology that can have significant impact in the field,” Lara-Garduno said. “I always enjoy participating in Student Research Week, which gives me and similar Ph.D. students the invaluable opportunity to present our research and hear feedback from experts from STEM fields.”

Graduating seniors Timothy Foster, Andy Tran, Shane Scott, Karrie Cheng and Natalie Rawle made up Team Tanks, which placed first overall the undergraduate teams for the Sigma Xi Symposium Theme Award and in the Undergraduate Oral Presentation division.

Recently, Dr. Robin Murphy, director of the Center for Robotic-Assisted Search and Rescue (CRASAR) and founder of the Roboticists Without Borders program, was sent to Greece to assist the local Coast Guard and lifeguard organizations in rescuing refugees from drowning. To further aid in this effort, Murphy proposed several different capstone projects her students could choose from, all of which would be used to help with the refugee crisis.

Of the projects proposed, Team Tanks chose to work on the Draw Me a Picture app, which was presented by the team at SRW. The app is designed to help refugees make it back to safety as efficiently as possible by displaying a GIF with easy-to-understand instructions. Rawle created a majority of the graphics found in Draw Me a Picture’s documentation.

“I am excited about the opportunity to work on a real-world problem going on right now,” said Foster, team leader. “As we speak, refugees are risking their lives to escape turmoil, and what we are doing may save lives that would have otherwise been lost. It was a pleasure to share our work with Student Research Week and the other competitors.”
Terry Leeper, a former student of the Department of Computer Science and Engineering at Texas A&M University, was selected to lead the new Amazon corporate office in Austin, Texas.

The office currently employs more than 165 full-time people with plans for expansion in the near future. In addition to leading the new office, Leeper also serves as the chief technology officer for Business-to-Business at Amazon.

“I’m excited to be back in Texas leading the Austin office,” Leeper said. “There is a great deal of potential for growth in the Texas market. Through this office, we are able to offer Amazon services such as PrimeNow and AWS and create a development center in Texas for full-time developers and interns.”

Leeper graduated from Texas A&M in 1986 with degrees in computer science and electrical engineering. Prior to his current role, he was in charge of Amazon’s vendor facing software and business software for MyHabit.com.

Before moving to Amazon, Leeper worked at Microsoft for 12 years in Visual Studio. While at Microsoft, Leeper moved to England where he led developer tool sales and marketing in Europe, the Middle East and Africa.

Leeper currently serves as a member of the Computer Science and Engineering Advisory Council. He and the other council members work with Dr. Dilma Da Silva, department head and holder of the Ford Motor Company Design Professorship II.

“Terry brings our council extensive understanding of opportunities for our students in e-commerce,” Da Silva said. “It’s great to hear about the demand for our students and real-world challenges they can tackle through internships and software development jobs at Amazon.”

In 2014, Leeper and his wife established the Jana and Terry Leeper ’86 Scholarship for freshmen in the Department of Computer Science and Engineering.

“Establishing the scholarship was incredibly easy,” Leeper said. “Helping a student pay for school is our way to give back to the program that helped me so much. It’s about Aggies helping Aggies.”

Dr. Lydia Tapia, former student from the Department of Computer Science and Engineering at Texas A&M University, was awarded the Denise Denton Emerging Leader ABIE Award at the 2015 Grace Hopper Conference in Houston.

The Denise Denton Emerging Leader ABIE Award is presented by the Anita Borg Institute for Women in Technology to a junior faculty member at an academic or research institution who pursues high-quality research in engineering or physical sciences, demonstrates leadership capabilities and contributes to promoting diversity in his/her environment.

Tapia, assistant professor of computer science and director of the Adaptive Motion Planning Research Group at the University of New Mexico (UNM), received the award because of her research accomplishments, ability to overcome great personal challenges and her work with minority students.

While in graduate school at Texas A&M, Tapia suffered from two strokes causing her to lose the use of one arm, her sight and her ability to walk. One year later, after regaining her ability to walk, write and type, she returned to finish her doctorate degree in computer science.

In addition to leading a very successful research group, Tapia volunteers to introduce underprivileged youth to technology and robotics. She brings her research to the students with an interactive exhibit that allows the students to learn about robotics in an engaging environment.

At UNM, Tapia serves as a research mentor to both undergraduate and graduate students. Her research in methodologies for the simulation and analysis of motions has been published in numerous conference and journal publications. She is working to advance the fields of molecular binding and robotic obstacle avoidance. Through her research and mentorship, her goal is to give back to her students.

Tapia has started a women-in-computing group at UNM to help boost female involvement in computer science. While at Texas A&M, Tapia was a research and teaching assistant and served in numerous clubs and organizations.

At Texas A&M, Tapia was a doctoral student under Dr. Nancy Amato, Unocal professor in the Department of Computer Science and Engineering. Her graduate thesis was titled “Intelligent Motion Planning and Analysis with Probabilistic Roadmap Methods for the Study of Complex and High-Dimensional Motions.”

Tapia received several awards while at Texas A&M for her impact in women’s progress, leadership, mentoring, and more. She graduated from the university in 2009 with her Ph.D. in computer science.
Department of Computer Science and Engineering

Dr. Xia Hu, assistant professor in the Department of Computer Science and Engineering at Texas A&M University, is collaborating with Arizona State University and Yahoo! to understand user behavior on social media platforms by developing novel data mining algorithms.

These predictions are not based solely on a user’s personal social media presence, but rather based on the interaction with their friends and their friends’ opinions. This is motivated by two fundamental social theories, homophily and social influence, which state that people befriend others who are similar to them, or they become more similar to their friends over time.

Understanding and processing data produced by social media services is necessary to improve the quality of user experience, and to positively impact the overall value of the social systems going forward.

In the collaborative project with Arizona State and Yahoo!, Hu’s team at the Data Analytics at Texas A&M Lab (DATA) focuses on social spamming detection and understanding user behavior by analyzing people’s online posts and social interactions.

Social spamming occurs when unwanted spam content appears on social networks or any website with user-generated content to targeted users and it is often intended to boost a user’s social influence, legitimacy and credibility.

“Successful spammer detection in social media is important to improve the quality of user experience, and to promote the healthy use and development of a social networking system,” Hu said. “Since social media provides a platform for people to share thoughts on various events, we have done work on identifying rhetorical questions, online protest participation, advocates of political campaigns, health discussions, et cetera.”

Hu co-authored “Predicting Online Protest Participation of Social Media Users,” a paper to predict if social media debate will turn into violent protests, which was recently presented at the 2016 AAAI Conference on Artificial Intelligence (AAAI).

Brownian Motion, which notes the interaction between fluid particles in motion over time, was applied to this research. By looking at the interaction between users the team was able to employ this theory to model the probability of a user declaring protest.
Most of us have seen the “Not Enough Storage” message on our smartphone or tablet. Cloud computing services provide a way to alleviate this overwhelming need for space, by letting programs store their data on remote servers instead of locally. Cloud computing is just one example of distributed storage, a general concept that captures the idea of providing a shared data service for geographically dispersed computer systems.

Distributed storage, or shared data, is a vital mechanism for communication among processors in distributed systems. The use of shared memory allows for better structured and easier-to-verify distributed applications. This shared service facilitates the development of higher-level applications including collaborative editing systems, multiplayer games, and scientific data repositories.

Although having shared data has quickly become a necessity, it is not provided off the shelf in large-scale distributed systems. Instead, processors must keep individual copies of the data. These processors communicate by sending messages to keep the replicas consistent.

Dr. Jennifer Welch, Regents Professor and Chevron Professor II in the Department of Computer Science and Engineering at Texas A&M University studies consistency conditions for shared data in distributed systems, including those supporting cloud computing. She is currently exploring how relaxing the specifications of the shared data can improve the performance of distributed systems.

As an example, consider the classic queue data structure which supports two operations — one which adds an element to the queue and one which removes and returns the oldest element in the queue. This definition assumes that the queue is accessed sequentially, with only one operation taking place at a time. When considering distributed systems, it is possible that several users can be trying to access a shared queue at the same time.

“When this occurs it is important to define what kind of behavior we want when there are simultaneous, overlapping operations,” said Welch, co-director of the computer science and engineering track of engineering honors. “This is called a consistency condition.”

Linearizability, the most common consistency condition, requires that the return values of operations be the same as if the operations occurred one after the other on the classic queue in an order that is consistent with the order of non-overlapping operations.

There are two ways to relax this set-up. One way is to have a more relaxed consistency condition, which allows more flexibility in the return values by not requiring the return values to be consistent with a sequential execution. Another way is to continue with the linearizability consistency condition but define it with respect to a more relaxed sequential data structure than a classic queue. For example, the queue can be defined so that even in the sequential case the remove operation returns one of the oldest elements, not necessarily the absolute oldest element. Dr. Welch and her group are developing algorithms to implement relaxed data structures with provably optimal time performance.

With the growing reliance on distributed computing systems, establishing correct and optimally efficient algorithms for implementing shared data will significantly benefit society through improved software that has the ability to run on multiple processors; these distributed applications will be able to utilize greater storage space using cloud computing. Additionally, understanding the inherent limits of these systems allows for better exploration of the design space.

Welch’s interest in distributed storage began in 1989 when she and colleague Dr. Hagit Attiya, professor at the Technion in Israel, noticed that the computer architecture papers written at the time neglected to present a clear distinction between two different consistency conditions. They wanted to understand if there were any inherent efficiency gaps between different conditions.

“I have returned to the topic recently, motivated by the growth of cloud computing and interest in relaxing conditions and/or specifications to improve performance,” Welch said.
Texas A&M named National Center for Academic Excellence for Cyber Defense

The National Security Agency (NSA) and the Department of Homeland Security (DHS) recently designated Texas A&M University as a National Center of Academic Excellence, both in education and in research. This well-regarded designation places Texas A&M among a select group of only 30 universities that have earned both distinctions.

Texas A&M has been dedicated to the advancement of cyber defense since the 1990s, when the very first academic course utilizing an active attack-defense laboratory was created. Since that time, the university has continued to build a robust body of cybersecurity research under the direction of a strong faculty, and has graduated an impressive number of cybersecurity students.

This coveted distinction aligns with the cybersecurity center’s vision to collaborate with strategic partners, and in doing so, move to the forefront of cybersecurity research. The center’s mission in education and research is to develop novel and innovative methods for cybersecurity education and to facilitate the conduct of ground-breaking, basic and applied cybersecurity research.

As stated in the NSA designation letters, “[Texas A&M University’s] ability to meet the increasing demands of the program criteria will serve the nation well in contributing to the protection of the National Information Infrastructure.”

The Texas A&M Cybersecurity Center is jointly run by the university and the Texas A&M Engineering Experiment Station (TEES). Director, Dr. Daniel Ragsdale, was chosen to lead the center in 2015. Ragsdale along with Deputy Director Lynn Schlemeyer, and many faculty and staff have since galvanized the effort for cyber defense within The Texas A&M University System.

The center was formally recognized by the NSA and DHS at the National Cyber Security Summit in Huntsville, Alabama, on June 8.

Tyagi Awarded Instructional Grant

Dr. Aakash Tyagi has been awarded an instructional grant to develop a one-of-a-kind course in the Department of Computer Science and Engineering at Texas A&M University.

Tyagi, a professor of practice, was awarded $5,000 to complete his project “Bringing Chip Design Verification to Academia.” The goal is to establish a foundational course in chip design verification at Texas A&M.

The funding is being used to host experts from the industry for a weeklong engagement. The expert-in-residence engagements are occurring throughout the fall 2015 semester. Additional funding will be used to attend a flagship verification conference to facilitate building the course and curriculum.

Dr. Flemming Anderson, principal engineer at Intel Corporation, was the first engineer-in-residence. During his week-long visit at the end of September, Anderson gave three lectures, collaborated with researchers and provided insight to students and faculty about course development and emerging technologies in computer science.

The completion of this project reaffirms Texas A&M’s position as a leader in computer science and engineering. Once the full vision for this course is complete, it will be the first of its kind in the nation.

“Since its first offering in spring 2015, this course has attracted talented and committed students,” Tyagi said. “Industry leaders—Cadence, Mentor Graphics, Intel and Qualcomm—have expressed excitement and continued assistance in the development of this course.

Tyagi joined the Department of Computer Science and Engineering in 2015 after 20 years of service at Intel. While working at Intel, he was the senior director of the Server Development Group. He worked on eight generations of CPUs, most recently managing the design and execution of Knights Landing, a second generation Xeon Phi product.

As a professor of practice, his academic track position focuses on educating undergraduate students in the department. His research interests center around high performance computing architectures and applications.

“In his short time in the department, Dr. Tyagi has already improved the material for several of our course offerings,” said computer science and engineering department head, professor and holder of the Ford Motor Company Design Professorship II, Dr. Dilma Da Silva. “I am very impressed with his novel approaches to refining the content of our courses. Besides this grant to involve key technical leaders from industry, he has also acquired funding to involve the students who took his courses in the process of improving project and assignments.”
Cybersecurity Center Tackles Security Challenges in a Rapidly Changing World

With more devices connected to the internet, homes have become smarter. It's possible for a refrigerator to send shopping reminders, and to control the lights or thermostat while away from home. But as the things around us become smarter, there is a growing need to ensure that they also become safer.

Texas A&M University has long been a leader in cybersecurity, but with the formation of the Texas A&M Cybersecurity Center, the university looks to take on a larger role in tackling some of the biggest challenges of the 21st century.

Dr. Daniel Ragsdale, a retired Army colonel and distinguished Texas A&M alumni who received his Ph.D. in computer science from Texas A&M in 2001, is leading those efforts as the director of the center, which is a joint endeavor between the university and the Texas A&M Engineering Experiment Station (TEES). Ragsdale joined Texas A&M in 2015 as a professor of practice after working for the Defense Advanced Research Projects Agency (DARPA), where he was awarded the Secretary of Defense Medal for Exceptional Civilian Service, the highest decoration for non-career federal employees.

“We believe that Texas A&M can contribute not only to national and economic security but also to the social good. And that’s the really inspiring vision for our center,” Ragsdale said.

Cybersecurity is a subject that covers a vast array of disciplines, with a definition so technical that Ragsdale believes the subject has been hard for people to grasp. Most people understand the data and information aspect of cybersecurity, but he believes many don’t fully understand what the industry calls the “internet of things.”

“As more and more components are connected, they can have an influence on the physical world,” he said. “Most people don’t fully appreciate what that means. Through hacking into any one of these systems, they can change something in the physical world. That’s very different from traditional information technology (IT). IT systems focus almost exclusively on processing, transmitting and storing data. If the information stored on these systems were stolen, modified or deleted, that could be highly disruptive. But with the internet of things and industrial controls systems, we’ve integrated components that don’t just manipulate data, they change the physical world around us, potentially in scary, life-threatening ways.”

To help explain what has become a quickly expanding field, Ragsdale defines cybersecurity as a study of the conflict and competition. The conflict takes place in code and in systems that people work with on a daily basis, but it’s more than just, as he puts it, bits and bytes.

“We need to bring academic disciplines that aren’t only technically oriented into the cybersecurity community,” he said. “You can think of computer science, information technology, computer engineering and information management. Those are the people that address the software part. But to address the conflict and competition aspect of cybersecurity, we need to engage with folks that are involved in psychology, behavioral science, sociology, ethics, law and business. All of them, at least in part, address inherent conflict or competition that is a part of our human nature.”

That need for an interdisciplinary approach is why he believes TEES and Texas A&M are perfectly positioned to be at the forefront of cybersecurity research.

“Texas A&M has an internationally renowned group of faculty who are already engaged in groundbreaking cybersecurity research,” he said. “Additionally, the university benefits from having great facilities which enable much of this impressive research portfolio. And finally, it is a well-known fact that Texas A&M, a premier land-grant institution, has absolutely fantastic students. The combination of great faculty, great facilities and great students give me tremendous confidence that A&M will soon move to the very forefront of cybersecurity research and education.”

With 16 colleges, more than 3,500 faculty members and almost $900 million in research annually, Texas A&M can bring cybersecurity into many disciplines.

“We have always had pockets of excellence in a variety of places around the campus for folks doing cybersecurity research,” he said. “Now, because we have a center, we can connect the dots. As we have interactions with sponsoring agencies for example, they’re seeing there’s more of a holistic program in place now.”

The added focus on this field also brings benefits to Texas A&M students. Ragsdale said the cybersecurity industry is expecting tens of thousands of jobs in the near future that it currently doesn’t have a workforce to fill. He describes bringing a focus on cybersecurity to the students of Texas A&M almost a “moral obligation.” Going beyond students who may enter the actual cybersecurity field though, Ragsdale emphasizes that more and more fields require knowledge of cybersecurity.

Last spring, Texas A&M announced a minor in cybersecurity starting next academic year with a curriculum that involves courses from six different colleges. Ragsdale said there has already been off-the-charts interest from students.

“We have students that are interested in this,” he said. “They are captivated and they know the significance of it. They get it. They look to us for curriculum offerings that will allow them to pursue something they’re interested in and at the same time prepare them for important work.”

Working with those students is why Ragsdale decided to give up what he described as a great job that he loved at DARPA to come back to College Station.

“We were doing important work, hanging out with all the cool kids, making the world a better place,” he said. “But I had very little interaction with students. And I missed that so much. When this opportunity at Texas A&M presented itself, I said I could continue to do important work, but at the same time I can be engaged with young men and women in classroom settings, in lab settings and in club settings. Much as I expected, it has already been a tremendously rewarding and fulfilling experience for me.”

College of Engineering • Texas A&M University 17
Gu, Liu Reach New Heights in Cybersecurity Research

Dr. Guofei Gu and Dr. Jyh-Charn Liu in the Department of Computer Science and Engineering at Texas A&M University are developing game-changing defense approaches to beat cyber attackers in two very different, but important aspects of cybersecurity.

**Proactive Cyber Defense**

Gu, associate professor and director of the Secure Communication and Computer Systems (SUCCESS) lab at Texas A&M, has developed techniques to automatically uncover unknown vulnerabilities in existing software so that defenders can detect the problems ahead of cyber attackers. This technique has identified more than two dozen serious vulnerabilities in widely used software from vendors such as Google, Adobe and Microsoft.

“Most current cybersecurity solutions are passive and reactive, focusing on known attacks,” Gu said. “The situation is becoming worse because the economic engine of profit-driven cyberattacks is quickly transforming the threat and defense landscape to favor more on attackers, as they enjoy many fundamental advantages over defenders.”

To combat this issue, Gu and his team developed PeerPress, a prototype system with new analysis techniques that automatically extract intrinsic and harmful behaviors from malware, and then use them for active, robust and scalable malware detection.

The team has also developed CyberProbe and AutoProbe, two new techniques that can automatically learn and extract malware’s control logic so that defenders can perform accurate and active detection of global malicious cyber infrastructures in the whole Internet IPv4 space in just a few hours.

Gu is also heavily involved in the investigation of potential security implications of software-defined networks (SDN), which are being proposed by researchers and vendors alike as a way to serve the demand for highly flexible network infrastructures to support dynamic services on the internet or for cloud computing. One of the fundamental advantages of SDN is its centralized control plane which provides visibility of the entire network.

He and his team have designed the first security constraint enforcement kernel for SDN controllers, FortNOX; FRESCO, the first security application development framework for SDN; and AvantGuard, the first scalable and vigilant switch flow management solution in SDN to defend against control plane saturation attacks.

SDN controllers are designed to provide a centralized management system for the network. Gu’s research in this area also revealed and helped fix several previously unknown serious topology poisoning vulnerabilities in almost all widely used SDN controllers.

**Protecting GPS Signals**

Liu, professor and director of the Real Time Distributed Systems Lab, is currently working on developing algorithms to detect incorrect signals of the Global Navigation Satellite Systems (GNSS). Not only recognizing them, but finding a way to combat these errors due to spoofing or natural interference is a central focus in the efforts he and his collaborators are pursuing. To achieve cohesiveness in GNSS signals, Liu and his team are working to create an experimental environment which supports the development of computing algorithms that are able to detect spoofing that occurs in the real world. In turn, this will allow for more reliable information to be provided by location-based applications, such as Google Maps on smartphones, that we use daily.

Liu began studying the subject when GPS spoofing emerged as a cyber physical security issue. He works alongside his students in the RTDS lab, as well as Dr. Mladen Kezunovic, Eugene E. Webb Professor, and Alex Sprintson, associate professor from the Department of Electrical and Computer Engineering at Texas A&M.

The most challenging aspect of this topic is figuring out a way to guard the unprotected data at the unknown place and time.

“We formulated the problem into an integrity checking problem, and we aim to develop distributed computing algorithms on the basis of the well-established theories in distributed computing,” Liu said. “We also aim to develop software based solutions, so that they can be more easily disseminated to the massive consumer market in defending against various data errors, man-made or natural causes.”

In order to validate the defense algorithm designs, Liu and his team have replicated the GPS spoofing in a Faraday cage, where a radio frequency software defined radio coupled with open source GPS simulator manipulates a smartphone GPS receiver.

This research has a large scope of impact including consumer general navigation such as GPS mapping, industry control, power grid sensing and control, and autonomous vehicles.

**Award and Honors**

The research conducted by Liu and his colleagues on campus and in industry has led to an award from the Department of Energy for the Development of Next Generation Cybersecurity Technologies and Tools. This award is given to projects that will enhance the reliability and resilience of the nation’s energy critical infrastructure through innovative, scalable, and cost-effective research, development and demonstration of cybersecurity solutions.

Gu and his team in the SUCCESS lab have published their results in top computer security conferences such as the IEEE Symposium on Security & Privacy, the ACM Conference on Computer and Communications Security, and the Annual Network & Distributed System Security Symposium. Their vulnerability detection work won the best student paper award at the 2010 IEEE Symposium on Security & Privacy. FRESCO won the finalist for 2013 AT&T Best Applied Security Paper award and their research has also won the 2013 AFOSR Young Investigator award. Additional research done by the team won the Best Paper Award at the 2015 International Conference on Distributed Computing Systems, which also resulted in a U.S. patent and technology transfer to a commercial partner.
Andrew Nemec, a recent graduate from the Department of Computer Science and Engineering at Texas A&M University, held several prestigious distinctions during his undergraduate career including participation in Engineering Honors, Honors in Science, Honors in Mathematics, Honors Fellows and Undergraduate Research Scholars.

His participation in these programs is a credit to his dedication and willingness to surpass the expectations for his education. In summer 2015, Nemec began working alongside Dr. Andreas Klappenecker, a professor in the department, on quantum error-correcting codes over finite Frobenius rings. Frobenius rings are arithmetic structures that allow one to perform addition and multiplication.

Quantum computing is significant because it allows one to have the ability to solve problems much more quickly than traditional computing. This is because classical computing simply uses ones and zeroes for construction; instead of being restrained into using one number or the other, quantum computing sanctions the addition of those zeroes and ones together. This superposition of ones and zeroes allows for more efficient computing previously unavailable.

In quantum computing, the information is stored in the state of quantum mechanical systems. Since these systems interact with their environment, it is unavoidable that the stored information will be altered over time. Quantum error-correcting codes allow one to correct such errors. Nemec made rapid progress in this area, despite the fact that quantum error-correcting codes in this generality were largely unexplored territory.

The following semester, Nemec delved deeper into this research. “Among other things, he generalized the famous Gleason-Prange theorem,” Klappenecker said.

Nemec’s theorem allows him to deduce that the quantum code has the same minimum distance as the classical code.

“This result is very impressive, as even the simpler original theorem of Gleason and Prange is considered difficult and rather inaccessible,” Klappenecker said.

Nemec plans to pursue a graduate degree from the department and credits much of his success to his professors and mentors in the department.

“My time at Texas A&M has helped me shape a path towards my career goals,” Nemec said. “Along the way I have been given a lot of support from the faculty, who through classes, research, and advising showed me the wide range of what I could do with computer science. This helped me find a field of research I was interested in — quantum error correcting codes — and spurred me to pursue a graduate degree.”
Devoted to the advancement of computing through innovative research and dedication to the field, our renowned faculty members and outstanding students are making strides to create a better tomorrow in their respective research areas. Their research activities in our department have resulted in best paper awards in top conferences, collaboration with industry and national labs, and several patents.