This year, headlines about the lack of diversity at such tech industry giants as Microsoft and Google shed light on a number of systemic challenges confronting society at large and university computer science programs in particular. The percentage of minority students graduating with degrees in computer science is lower than their representation in the population — and the number of women entering the workforce with computer science degrees has dropped sharply in recent years.

The second challenge facing computer science can be summed up by the term “big data.” Although the Silicon Valley is still a major destination for graduates with computer science degrees, the discipline is now fundamental to progress in virtually every field of endeavor. This expansion makes it hard to estimate the future need for computer scientists, but projections from the Bureau of Labor Statistics indicate that the supply falls short of demand.

To address these deep-seated challenges, computer science programs must go beyond making the most of the applications they receive. They must make an effort to shape the applicant pool, collaborating with high school and community college teachers to encourage more students — and more diverse students — to consider the field.

**Workshops for Community College Faculty**

Since 2008, Engineering and Society Associate Professor Joanne McGrath Cohoon and her husband, Computer Science Associate Professor Jim Cohoon, have presented their National Science Foundation (NSF)-funded Tapestry workshops to hundreds of high school computer science teachers. Their goal: to help these teachers attract a more diverse group of students, including young women and minorities, to their classes. The Cohoons have now received a $1.5 million NSF grant to adapt these workshops for community college educators.

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When Thomas Jefferson conceived of the University of Virginia, he thought of it, not as an ivory tower distinct from society, but as an Academical Village in the midst of it. His goal was to create an institution that would serve society by encouraging advances in knowledge and by equipping its most promising young people (white males) with the skills they need to be productive members of society.

At a moment in history in which computer science has become the enabling technology for innovation across a broad range of human activity, this department’s determination to support — and redefine — this vision is more important than ever.

This edition of our department newsletter highlights a sampling of our efforts, which range from making search engines more responsive to refining smart-home technology. It also details steps our faculty has taken to increase the representation of women and minorities in our field and to ensure that more students are exposed at a younger age to the excitement of computer science. And finally, it highlights the recognition that two of our senior faculty members have earned for their exemplary efforts to advance the field and make it more inclusive.

Planning this issue was difficult because there was so much to choose from. Computer science finds its place naturally at the heart of the Academical Village, at the intersection of the practical and theoretical. As a department, we are always, as Professor Jack Stankovic says, “looking for real applications that drive fundamental research.”

Kevin Skadron
Professor and Chair, Department of Computer Science
HONORED FOR THEIR LEADERSHIP
A Number of Our Faculty Members Were Recognized by International Organizations This Year for Their Contributions to the Profession.

JACK STANKOVIC
Receives Honorary Doctorate

When he received his honorary doctorate from the University of York in July, Jack Stankovic, the BP America Professor, joined distinguished company. Last year’s recipients included Nobel Prize-winning physicists and economists, professors of medieval literature and software engineering, and trumpeter Hugh Masekela.

Although Jack had no inkling that he was about to be singled out by the U.K. university, the connection is understandable. The University of York has one of the world’s foremost groups in real-time computing — his specialty — and he has lectured there twice.

“I know quite a few of the faculty,” he says, “but had no idea that they had nominated me.”

In addition to real-time and cyber-physical computing, Jack’s current research includes wireless sensor networks, wireless energy and wireless health applications. “As sensors became more prevalent, I became interested in home health care, in helping the elderly live at home as long as possible,” he said in an interview published by his alma mater, Brown University. “I’m always looking for real applications that drive fundamental research.”

In addition to receiving his honorary doctorate during the university’s July graduation ceremony, he lunched with its chancellor, attended a black-tie dinner and gave a talk to graduate students. “It was a wonderful experience” he says. “Throughout my career, I’ve tried to use computing to understand and interact with the real world — and this honorary degree recognizes that. I’m quite gratified.”

Mary Lou Soffa, the Owens R. Cheatham Professor, has demonstrated not only that women can find in computer science an intellectually stimulating career, but also that they can help shape the direction of research in the field.

Mary Lou is highly regarded for her research on compilers, program optimization, system software and system engineering. At the same time, she has also worked tirelessly to encourage more women to take advantage of this opportunity, both as a member and former co-chair of the Computing Research Association - Women (CRA-W) board and as a teacher and mentor. Women wrote half of the 32 dissertations completed under her direction.

In recent years, Mary Lou has been recognized for her advocacy. This year, she received the 2015 IEEE Technical Committee on Software Engineering Distinguished Women in Science and Engineering Leadership Award. It is presented annually to an individual for outstanding and/or sustained leadership in the software engineering community to encourage women to explore career paths in science and engineering. In 2014 she was named the ACM SIGSOFT (Special Interest Group on Software Engineering) Influential Educator Award for her teaching and mentoring.

“Women’s perspectives,” she says. “We need people who are using technology to help design and create it.”

“Mary Lou Soffa
Recognized for Mentoring Women

As a profession, computer science can seem like an all-boys club. Through her example, Mary Lou Soffa, the Owens R. Cheatham Professor, has demonstrated not only that women can find in computer science an intellectually stimulating career, but also that they can help shape the direction of research in the field. An ACM and IEEE Fellow, Mary Lou is highly regarded for her research on compilers, program optimization, system software and system engineering.

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“We need women’s perspectives. We need people who are using technology to help design and create it.”
MAKING A PRACTICAL DIFFERENCE

Our Faculty and Graduate Students Devote Themselves to Addressing Practical Problems as Well as to Advancing Knowledge.

HONGNING WANG
Better Searches

Just 25 years ago, people researching a topic typically started with a visit to their library and a chat with the reference librarian. Today, with the help of an Internet search engine, they can answer almost any question whenever it occurs to them — but only if they can find the right keyword. As any search engine user knows, finding that keyword can occasionally be frustrating.

“Oftentimes a keyword is strongly associated with a topic that the user is not interested in,” says Hongning Wang, one of the department’s new assistant professors. “At other times, it’s simply difficult to reduce an abstract query to a meaningful keyword.”

The fundamental problem, Hongning points out, is the constrained nature of human-computer interactions, which leaves users’ intentions latent, or unexpressed. He is devising mathematical models that computers can use to make appropriate suggestions or ask relevant questions, based on individual user data and the activities of similar users.

Hongning doesn’t rely on data alone, however. He also draws on knowledge about human behavior from the social sciences to improve the predictive ability of his models. To do so, he takes behavioral rules from sociology and psychology and translates them into mathematical formulas.

“My work is grounded in the behavioral as well as the combinative sciences,” he says.

DAVID EVANS AND YUCHEN ZHOU
More-Secure Websites

Most Internet users know that practicing good online hygiene — never clicking on spam, choosing strong passwords and setting up two-factor authentication — is essential for protecting their personal information. They typically don’t know, however, that unless the developers of the websites they visit take similar precautions, they could still be at risk. That’s because Web developers increasingly embed third-party scripts, some reputable and others less so, in an effort to make website design more efficient.

These scripts serve a variety of purposes. Some, like single sign-on scripts, make browsing the Web more convenient. Others inject ads that enable the site to earn revenue or track users. Professor David Evans and graduate student Yuchen Zhou are developing tools that can help busy developers deploy these services safely.

In the case of single sign-on services, there are at least two causes for the vulnerabilities. The first is flaws in the software development kits that these organizations distribute to developers. Dave and Yuchen and collaborators at Microsoft took an exhaustive look at three such kits, identifying bugs that could produce vulnerabilities. Facebook awarded them with three $1,500 “bug bounties” for their work.

The second and more common cause is developers who lack the knowledge to securely integrate the services. “Either the documentation is not clear or the developers fail to follow it correctly,” Yuchen says.

Dave and Yuchen’s response was to build a tool — SSOScan — that can automatically review a site for vulnerabilities caused by using Facebook’s single sign-on. A developer simply enters the website URL and receives an analysis within a short period of time.

These vulnerabilities are common. Yuchen ran SSOScan on the top 20,000 U.S. websites. Of the sites that used Facebook’s single sign-on, 20 percent had at least one type of security vulnerability.
People spend roughly half their lives at home. Technology that graduate student Erin Griffiths is developing with Associate Professor Kamin Whitehouse has the potential to help people not only make their homes more energy efficient, but also make better use of their time there.

“Most often, people think of smart-home technology as a way to help residents cut heating and cooling bills,” she says. “It could also generate lifestyle information—for instance, documenting how much time they spend alone or with their family.”

Erin and Kamin detect occupancy by placing inexpensive ultrasound and infrared sensors at the threshold of each room. These sensors provide information about the height—and ideally the identity—of individuals passing through a room, as well as their direction of movement. Their challenge is to link patterns in the sensor data with human behavior. “A lot of what I do is signal processing,” Erin says. “You need to know how a pattern maps in the real world if you are going to provide actionable feedback.”

They have found that as long as sensors record movement at doorways and not in rooms, most subjects don’t object to using them to evaluate their use for mapping.

One of the impediments to large-scale adoption of smart-house technology is the complex setup it typically requires. Erin and Kamin are also experimenting with self-organizing systems. “We would like to get to the point where an entire system configures itself,” Erin says.

AARON BLOOMFIELD
Strengthening Local Nonprofits

As a board member of Madison House, Associate Professor Aaron Bloomfield became aware that cash-strapped local nonprofits often faced challenges in areas that a good software program could solve, like scheduling. As a faculty member, he understood that growing enrollment was making it increasingly difficult for the department to find worthwhile senior thesis projects for its students, and to supervise them. He devised an elegant solution to both problems: the Service Learning Practicum (SLP).

This two-semester sequence for fourth-year computer science majors gives students the experience of seeing a large, real-world software engineering project from specification to deployment while having the satisfaction of applying their skills to make a difference. Assigned to nonprofits in need of software solutions, students work in groups of six or seven, progressing through a series of two-week deadlines designed to keep their project on track. Students complete an initial version of the project by the end of the first semester. During the spring semester, they take the project through a series of iterations that leads to a six-week period devoted to testing, tweaking and deploying as the academic year ends.

Last year, 100 students in the Service Learning Practicum took on 15 projects, contributing more than 10,000 hours to local nonprofits. For instance, students created a web portal for The Haven, that enables its more than 800 volunteers to schedule shifts on their own. Eleis Lester, the organization’s volunteer coordinator, noted that the new system saved her hours of work each week, time better devoted to serving the homeless.

Jennifer Walker, director of programs for Madison House, had similar praise for the online scheduling system that SLP students created for the organization, and, like Eleis, she praised the professionalism of the students. “The students paired with us were extremely hard-working and…professional,” she says. “I could not believe they were college students!”

ERIN GRIFFITHS
Smart Homes

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As an undergraduate at the University of Puget Sound, Erin was told that U.Va. was a good place for women computer scientists. When she arrived, she found that there was indeed a support network that she could access. Erin has herself become part of this network, as a teacher and mentor. For her work, she was named the department’s 2015 Outstanding Teaching Graduate Student.
Last December, Jacob Steele (CS ’14) got a call from the provost of Alderson Broaddus University, a small, 144-year-old Baptist institution in Philippi, West Virginia. Its computer science program was in disarray. Would Jacob come and help turn it around?

Having just completed his master’s degree program, Jacob had intended to spend the next few years in industry — in fact, he was waiting to hear from employers when the Alderson Broaddus call came — but he jumped at the opportunity. Ever since he’d volunteered as a tutor in his third year at West Virginia University, Jacob has enjoyed working with students. While at U.Va., he developed his teaching skills as an assistant for courses led by such master teachers as Associate Professor Tom Horton and Lecturer Mark Floryan.

Arriving in Philippi a month later, Jacob jumped into the fray. It was daunting at first. He soon found himself the only full-time faculty member in the computer science department, assigned to teach five different classes. The only silver lining for him was that falling enrollments meant that some of his classes had only eight students.

Jacob stepped up to meet the challenge, focusing initially on increasing the rigor of the curriculum so that his students could compete successfully for programming jobs after graduation. “There was a lot of catch-up involved,” Jacob says. “I spent a lot of time working with students to provide the foundation they were missing. I had to teach them to think like programmers.”

The insight he gained at U.Va. into computer science theory proved valuable in helping him reach his Alderson Broaddus students. “I could point out a solution to a problem and explain why it was the right solution,” he says.

Although he still has a great deal of work to do to help the program reach its potential, Jacob has experienced a number of early successes. His dean praised the quality of the presentations the three graduating seniors made at the university’s annual research symposium — and the two introductory classes he will be teaching in the fall will have an enrollment of 20 students each. Clearly, word has gotten out that the Alderson Broaddus computer science program is on its way back.
Summer

innovation experience, students have returned home and founded high school groups to experience real-world group programming. Motivated by the competition because it gives their students the opportunity to work together to solve 10 programming problems in an allotted 3.5 to 4.5 hours. Each problem is associated with a different colored helium balloon — and as groups solve problems, their area becomes festooned with balloons. "Students can use the balloons strategically," Aaron says. "They can see which problems other teams find easiest to solve and devote their energies accordingly." To make the competition more interesting, the student-organizers set the stage for an even more successful event the next year," Aaron says. "Each year, the student-organizers learn something new that sets the stage for an even more successful event the next year," Aaron says.

Judging by the growth of the program since its inception five years ago, HSPC’s student-organizers, most of whom have competed for the department’s world-class college-level programming team, have been remarkably successful in both areas. In 2011, three teams attended the high school competition. This year, there were 52 teams. "Each year, the student-organizers learn something new that sets the stage for an even more successful event the next year," Aaron says.

During the competition, teams of four high school students work together to solve 10 programming problems in an allotted time, which has ranged from 3.5 to 4.5 hours over the years. The team that correctly completes the most problems in the least amount of time wins. Each problem is associated with a different colored helium balloon — and as groups solve problems, their area becomes festooned with balloons. "Students can use the balloons strategically," Aaron says. "They can see which problems other teams find easiest to solve and devote their energies accordingly." To make the competition more interesting, the student-organizers set the questions in the context of a blockbuster movie like "The Avengers" or "Lord of the Rings."

The competition has had an impact on the individual participants as well as their high schools. High school teachers like the competition because it gives their students the opportunity to experience real-world group programming. Motivated by the experience, students have returned home and founded high school chapters of the ACM or held practice contests.

High School Programming Competition

When Associate Professor Aaron Bloomfield talks about the High School Programming Competition (HSPC) held at U.Va. each year, the words he uses most often are fun and excitement. Fun because he and the competition's student-organizers do everything they can to make the meet enjoyable for high school teams who, in some cases, come from hundreds of miles away to participate. Excitement because that's what he would like the students to feel about programming and computer science when they return home. Judging by the growth of the program since its inception five years ago, HSPC’s student-organizers, most of whom have competed for the department’s world-class college-level programming team, have been remarkably successful in both areas. In 2011, three teams attended the high school competition. This year, there were 52 teams. "Each year, the student-organizers learn something new that sets the stage for an even more successful event the next year," Aaron says.

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Chenyang Lu's (CS '01) experience as a graduate student with Professor Jack Stankovic positioned him to become an active participant in some of the most important developments in computer science over the subsequent years. Chenyang wrote a thesis on feedback control for real-time scheduling and spent a year on Jack's sensor-network team at a time when the phrase "Internet of Things" had only recently been coined.

But Chenyang's achievements after graduation have been entirely the products of his creativity and energy. This spring, Chenyang was honored for his contributions to the field, when Washington University, where he has taught since beginning his professional career, named him the Fullgraf Professor. He directs the university's Cyber-Physical Systems Laboratory; is editor-in-chief of ACM Transactions on Sensor Networks, one of the leading publications in the field; and has chaired top conferences in his field, including the IEEE Real-Time Systems Symposium, ACM/IEEE International Conference of Cyber-Physical Systems and ACM Conference on Embedded Networked Sensor Systems.

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Chenyang's research has widespread applications. With support from the National Institutes of Health and the Barnes-Jewish Hospital Foundation, he developed and piloted one of the world's first large-scale clinical monitoring systems to use wireless sensor networks to collect real-time vital signs from hospital patients. He has also made important contributions to deploying wireless monitoring and control systems for civil infrastructure. With National Science Foundation funding, he devised a system to help buildings and bridges respond to earthquakes.

Chenyang's research has also had important applications in computing systems with stringent real-time performance requirements, such as those controlling automobiles and industrial automation. His contributions span adaptive real-time middleware, industrial wireless sensor-actuator networks and real-time virtualization technology that has been incorporated into mainstream system software used worldwide.

"I learned a lot at U.Va.,” Chenyang says. "Jack was a great role model who cared about growing the careers of his students. I learned from him how to pick intellectually stimulating research projects. Equally important, he set the standard for mentoring graduate students that I try to follow today."
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