In its new strategic plan, the University comes to grips with its unusual size. Ranked consistently for the past 20 years as one of the best public universities in the country, it is much smaller than its competitors — and when it comes to research, critical mass makes a difference.

The University is addressing this issue in a number of ways. Under an agreement with the Commonwealth of Virginia that gave it increased autonomy, it agreed to expand its enrollment. The University is allocating much of that growth to the sciences and engineering. As a result, the department expects to field more than 30 tenure-track faculty members by 2020, an all-time high. This means that, over the next six years, we will be hiring additional faculty members as well as replacing those that retire — providing an exceptional opportunity to strengthen existing research groups and build new ones.

The new assistant professors we hired this year illustrate this process. Connelly Barnes contributes to our expertise in computer graphics and sets the stage for collaborations with other departments on computer vision. Mohammad Mahmoody joins Associate Professor Abhi Shelat, distinguishing the department by giving us two faculty members in theoretical cryptography. And Yanjun “Jane” Qi helps us create a presence in machine learning, widely recognized as critical to society’s ability to benefit from big data.

The second way the University is addressing the issue of critical mass is by encouraging interdisciplinary collaboration. Over the next three years, it will establish up to four pan-University institutes that will bring faculty together from around the University to identify and solve critical problems that transcend the boundaries of a specific field.

The department played an important role in envisioning and launching the first of these, the Data Science Institute. The challenges of big data for society as well as for research are immense, and the department has expertise in a host of areas — from privacy and security to high-performance computing and networking — that are critical for addressing them. The Data Science Institute will help us identify research issues that will require advances in computer science even as it enables us to direct our expertise to areas where they are most needed.

In short, the University’s strategic plan creates a road map for translating its unique size into a strength. The department has an opportunity to take a leading role in this transformation — and in the process achieve new prominence.
Fifteen years ago, when I came to the department, we were in the final stages of the dot.com bubble, driven by premature claims about the power of the Internet to transform commerce. With the passage of time, computer scientists have in fact realized many of these expectations, employing computation to transform virtually every human endeavor. As a result, there is a renewed appreciation of its potential.

This new appreciation has driven a resurgence of enrollment in our undergraduate programs, in both the bachelor of science degree and the interdisciplinary bachelor of arts degree. Whatever their interests, today’s students see the major in computer science as the key to a satisfying career. Our challenge as a department is to find ways to accommodate this growth while maintaining the close faculty-student relationships that are our hallmark. In practical terms, this means finding ways to keep our class sizes small, ensure one-on-one interaction and offer exceptional research experiences for students.

We’ve addressed this challenge in a number of ways. First, we have hired three talented lecturers, Nada Basit, Mark Floryan and Luther Tychonievich. While each of them has conducted significant research for their doctorates, they share a commitment to focusing their careers on education. They began teaching this fall, and the response of our undergraduates has been overwhelmingly positive. We have also added three new tenure-track faculty: Connelly Barnes, Mohammad Mahmoody and Yanjun “Jane” Qi. This infusion of faculty members is enabling the department to offer popular courses more often as well as more graduate courses. The addition of these tenure-track faculty members also expands the research opportunities for undergraduates.

And, with support from the department’s industrial advisory board, we have increased the number of undergraduate teaching assistants available for our larger courses. They are among our very best students and bring to this assignment their enthusiasm for the course content and insight into the material most likely to prove challenging to their contemporaries.

The ongoing growth in our tenure-track faculty also boosts our externally funded research and doctoral education, helping keep our department at the forefront of scholarship in computer science, to the benefit of all of our students, the region and the Commonwealth of Virginia.

I invite you to learn more about our new faculty members, whom we profile in this issue of the newsletter. Their presence testifies to our conviction at U.Va. that education, even in the most technical of fields, is a human enterprise.

Kevin Skadron
Professor and Chair
If there is one thing more compelling for Assistant Professor Yanjun “Jane” Qi than the opportunity to learn new things, it’s the chance to use that new knowledge to have an impact. This journey of discovery and self-discovery has shaped her research and her professional development.

Certainly, machine learning, her specialty, has given Qi a platform to explore a wide range of areas. She has developed new machine learning techniques to mine information from biological data, text, video and images. Among other projects, she has developed algorithms to help researchers use blood samples to diagnose cancer and identify biomarkers of disease, devised a method to help physicians identify electronic medical records that fit specific criteria and created a technique to identify the kinds of sentiments expressed in online reviews.

But over time, she has become more interested in medical and health care applications. “One of the reasons that I chose to come to U.Va. is the proximity of the School of Medicine and the opportunity to work with researchers here, both to advance scientific research and to help make the health care system more efficient. I really want to make a difference,” she says. Qi was also attracted by the department’s research strengths in privacy and security as well as in sensors; she feels both are critical to helping people enjoy healthier lives.

Her decision to join NEC Labs American after earning her doctorate from Carnegie Mellon University and her subsequent decision to return to academia are illustrations of her intellectual adventurousness. A powerful inducement for Qi to join the Machine Learning Department at NEC Labs America was the opportunity to work with such giants in her field as Vladimir Vapnik. At the same time, she was also hoping to gain insight into how research is practiced in a corporate setting. “Computer science has such a pervasive influence on our world,” she says. “I wanted to better understand how advances in knowledge move into everyday life, and I wanted to be a part of the process.”

But after working with summer interns, Qi discovered that she loved teaching students — and this realization led her back to academia. “I found I really enjoyed helping young computer scientists grow,” she says. “It’s another way I can have an impact on real life.”

Accordingly, another important reason that led Qi to choose U.Va. is the quality of the University’s students. “I want to work with excellent, self-motivated young people,” she says. “And that’s who I’m finding here.”
A pivotal moment for Assistant Professor Mohammad Mahmoody came when he won the gold medal in the ninth Iran National Olympiad in Informatics. There were practical advantages. The gold medal exempted him from studying for the national college entrance exam and meant that he could choose to attend the university of his choice. But more importantly, it confirmed for him his love for computation and mathematics and set him on a course that has brought him to U.Va.

Initially, Mahmoody was interested in algorithm design, but in his first semester as a graduate student at Princeton, he took a cryptography course to fulfill a requirement and was captivated. “The beauty of mathematical arguments in the course impressed me more than I thought they would,” he says. “By the end of the semester, I was doing research on cryptography.” After completing his dissertation, he continued his investigations as a postdoctoral research associate at Cornell.

Mahmoody’s specialty is the foundations of cryptography. As he explains, “Initially, cryptography focused on encryption, but now it’s a much broader field with wide applications. It entails a formal examination of the notion of security in any system in which there is some notion of an adversary.” Mahmoody studies how to define security, how to prove a system to be secure and how to identify the assumptions necessary or sufficient for a system to be secure. “Some assumptions about security are implicit in the design of cryptographic systems,” he says. “We study them formally to see if they make sense or not.”

Mahmoody’s interest in cryptography brought him to his second area of interest: computational complexity. One way that cryptographers make the challenge for adversaries as hard as possible is to borrow problems from computational complexity that are hard or impossible to solve efficiently.

Although Mahmoody’s research is about theoretical aspects of cryptography, it has immediate applications to fundamental notions of security that could or could not be achieved for medical records, financial transactions and a host of other areas. “I love theoretical computer science and computational complexity, but I prefer to work on something that connects to real life,” he says.
Assistant Professor Connelly Barnes’ interest in the arts and video games has shaped his approach to computer graphics. He focuses on creating algorithms that enable artists or nontechnical users to better create or manipulate images or video. “I like making new creative tools that are inspired by the way artists work,” he says. His interest in making tools for artists to use is one reason why, between the completion of his doctorate at Princeton in 2010 and joining the department, he went to Adobe Technology Lab in Cambridge, Mass., as a postdoctoral research scientist.

“People are increasingly posting content online on Facebook or Instagram, but it is virtually impossible for the average person to remix, modify and change it as they might like,” he says. “In my opinion, we need more tools that enable everyday users to specify their goals and intentions at a high level and have their computers do the low-level manipulation.”

For his dissertation, Barnes developed a fast, randomized matching algorithm, PatchMatch, that can be used to remove unwanted objects in an image, move objects and change image aspect ratios. It operates quickly, silently and without leaving a trace, using lighting, tone and noise from examples in surrounding areas so the altered image looks original. This algorithm is behind the “content-aware fill” and “content-aware move” features in Adobe Photoshop CS5 and CS6.

Barnes is interested in extending these “by-example” tools to three dimensions, enabling users to alter a 3-D model or combine it with parts of other models with a few keystrokes. “The challenge is to ensure the physical integrity of the new object as you are modifying it,” he says. Barnes is teaching a graduate seminar that includes 3-D shape manipulation and 3-D printing.

Barnes was attracted to an academic position because of the opportunity to be more forward-looking in his thinking. “I’m interested in inspiring people to work on things that I believe will be useful in the future,” he says. “I would like to push the state of the art and, at the same time, make it accessible and relevant to people who are nontechnical.”
New Faculty

NADA BASIT

“I was fortunate for my doctorate to combine biology and computer science, two areas that I really enjoy,” says Nada Basit, one of the department’s recently appointed lecturers. One of the challenges to individualized, molecular medicine is determining the way mutations in the amino acids that constitute a protein alter its function. Determining these relationships through traditional wet-lab experimentation is tedious, time consuming and costly.

As a graduate student at George Mason University, Basit combined tools from machine learning and bioinformatics to create computational analogs that mimic these experiments. Her goal was to enable researchers to manage large amounts of data much more cheaply and efficiently. “Using this technique, a researcher could narrow the range of choices for biological study,” she says. “This can accelerate the identification of drug targets, among other uses.”

Another motivation for pursuing a doctorate was to create an opportunity to teach. “I just love the teaching experience,” she says. “It gives me the chance to have an impact on people’s lives. I feel very happy to be teaching at U.Va.”

MARK FLORYAN

For Mark Floryan (CS ’08), his return to U.Va. as a lecturer feels like he’s come full circle. He discovered his love of teaching while serving as a teaching assistant in the department. “I really loved holding office hours and sitting down and talking with students,” he says.

Floryan’s interest in education then took him to the University of Massachusetts, Amherst, where he studied with Beverly Woolf, who is widely recognized for designing software tutors that respond to a student’s mood and personal learning pace. He completed a doctorate in artificial intelligence in 2013.

Among the courses he is currently teaching is CS 4102, Algorithms, long considered a rite of passage for the major. “It was fun challenging my students — and at the same time really helping them get through,” Floryan says. From his perspective, one of the nicest things has been the way he’s been embraced as a colleague by his former professors. “It’s all felt very natural and easy coming back,” he says.

LUTHER TYCHONIEVICH

Having completed his doctorate at U.Va. in 2013, Luther Tychonievich was uncertain whether he wanted to pursue an academic career emphasizing research or one that stressed teaching. “After accepting a lectureship here, I found that I absolutely love teaching,” he says. “I’d like to go on and make that a more permanent thing.”

As a graduate student at U.Va., Tychonievich devoted a considerable amount of time to educational initiatives that encourage greater diversity among computer scientists. With Associate Professor James Cohoon, he co-taught an NSF-funded programming course for students who had no experience with software. He helped train high school teachers to attract a greater number of diverse students to computing and taught programming concepts at summer camps for underrepresented minority students.

He is also interested in research. For his doctoral dissertation, he developed proofs about what it is possible for swarms of mobile agents to do. “I like the certainty that comes with a proof,” he says. “I’ve always liked the mathematical side of things.”
Michael Douglas has always been interested in computer graphics and a fan of digital art, so it was no surprise that he enjoyed Associate Professor Jason Lawrence’s Introduction to Computer Graphics. He asked Lawrence if there was a chance he could help out with his research program, and two years later, he’s compiling a database of information about the way light reflects off opaque surfaces.

Researchers use a formula called a bidirectional reflectance distribution function to describe this information. In the past, researchers developed complex analytical models for BRDFs that approximate what real-world materials look like. But for surfaces coated with materials like pearlescent paints, which produce wavelength-dependent effects, a better approach is to record a series of the real-world BRDFs and then interpolate the results.

Working with Lawrence, Douglas is using a gantry to move a light source around a sphere covered with a material he wants to capture. They photograph it using a black-and-white camera with a tunable lens filter, which enables them to observe the light being reflected off the material at very specific ranges of wavelengths.

“One of the things I like about the research is that we are not just collecting information for our use alone,” he says. “We are building a database that other people can use to do cool projects.”
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