SPRING 2017

COMPUTING NEWS

A publication of the George Mason University Department of Computer Science

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GEORGE MASON UNIVERSITY | Volgenau School of Engineering

Message From THE CHAIR

Welcome to the Spring 2017 issue of the CS Department's newsletter.

GENERATION CS – that's the title of a recent report from the Computing Research Association (CRA) highlighting the phenomenal growth in Computer Science enrollments in North American universities over the last decade. Generation CS is well represented at Mason – the number of incoming freshmen in the CS undergraduate programs has more than tripled between Fall 2011 and Fall 2016. Indeed, CS is now the most popular major among incoming freshmen (348 students in Fall 2016) at Mason, having overtaken perennially popular majors such as Biology and Psychology over the last couple of years.

While the popularity of CS among students is gratifying, it does pose significant challenges. The department has responded to the enrollment surge by hiring additional faculty and by redirecting resources to the undergraduate programs. In Fall 2011, for example, the department offered nine sections at the senior undergraduate (400) level with an average class size of thirty-three students whereas in Fall 2016 this number had more than doubled to twenty-two sections with an average class size of thirty-nine students.

In comparison to most of our peer universities (where senior CS classes of 100 or more students are increasingly commonplace), we have managed to keep class sizes at roughly the same levels. Ironically one of the reasons for the relatively stable average class size for senior level courses is that there is a severe shortage of large classrooms with capacity above eighty at Mason. We have resisted the urge to schedule classes at 7:30 AM (or on Friday evenings) when there is greater availability of large classrooms, but I am afraid that if the enrollments keep growing at their current rate, CS students – and faculty – may need to get used to early mornings!

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A CYBER SLEIGHT-OF-HAND

Reconnaissance, weaponization, and payloads are not terms often associated with computer programs. They are the vocabulary of conflict and military engagements. But it is appropriate when considering how to counter the actions of state-sponsored cybersecurity attacks, rogue cyber terrorists, and organized crime. The growing sophistication of cyber attacks and the ease of hackers to plumb the depths of seemingly secure systems, is a threat to national security, financial institutions, commerce, and infrastructure.

Mason CS researchers, Angelos Stavrou, Dan Fleck, and Constantinos Kolias are fighting back against one of the most common cyber attacks, the distributed denial-of-service, DDOS attack. This happens when a bad actor attempts to disrupt a server to either slow it down or render it useless by overloading the server with bogus requests.

The team's solution is to shuffle the servers and through their MOTAG tool, identify and segregate the attackers. "Legitimate users are minimally affected," says Angelos Stavrou, the project's PI, "and the bad actors don't realize what is happening either. We don't block them from the server as that would show our hand." Part of the project is to then determine a way to trace the attackers on the segregated server.

The project, called SR2, which stands for Shuffle, Redirect, Replicate, is meant to work on cloud-based systems where there is large server capacity. Think Amazon web services. Amazon is also a partner in the project and the team will be testing the tool in the Amazon cloud. Stavrou says, "The cloud has an elasticity of resources and can expand and contract making this type of counter attack affordable and easy."

The main funder of this project is DARPA, the agency awarded the team, which also includes researchers from Columbia University, Penn State, and BAE Systems, a four million-dollar grant. The project is now in its second eighteen-month period. The agency is interested in defenses for its federal cloud services.

This type of research has broad government and private benefit. Stavrou explained the idea and initial research for this tool came from one of his students, Quan Jia, who has since graduated from Mason. They were able to turn it into a working research project. Having transition partners to support these ideas is essential. The federal government helps with the costs associated with the time intensive research. Partners such as Amazon, however, are key because they help develop these tools into viable commercial applications. The project can move from an academic or government specific solution to a wider audience. This could be a tool that Amazon offers to its customers, an affordable solution to a growing problem. ■

ALUMNI PROFILE

MEET MEGHAN CLARK, SAM GELMAN, AND NATHAN LAPIERRE.
THREE NEWLY MINTED CS ALUMS WHO PROVE THAT SUCCESS CAN SPARK EARLY.

MEGHAN CLARK

Year Graduated: 2012

Path to CS: Began her Mason studies in conflict resolution, switched to economics and had her ah-ha moment when she took an intro to programming class.

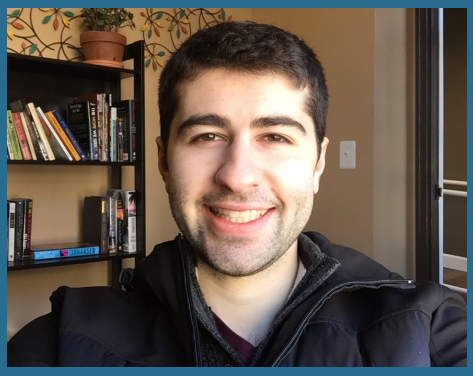
Bravo! 2012 Volgenau School of Engineering Outstanding Undergraduate Student Award winner and 2014 NSF Graduate Research Fellow

GPS: PhD student at the University of Michigan in computer science and engineering studying smart building infrastructure.

Paying it Forward: "I started the CS KickStart program at the University of Michigan to address the problem of too-few women in computer science. During a one-week summer program we taught incoming freshman women how to program and exposed them to the impactful research and jobs available to those with computer science degrees."

What's Next? Finishing the NSF Graduate Fellow Program and transferring to Berkeley to work with her advisor.

Then? "I want to become a professor. Mason was a great role model for female faculty members."



SAM GELMAN

Year Graduated: BS CS 2014 and MS CS 2016

Path to CS: Enrolled as a biology student with plans to enter medicine. CS was a hobby in high school. Took a class and realized there were applications to both CS and biology. It was a great mix.

Bravo! 2014 OSCAR Student Excellence Award for outstanding research in creative activities. "Mason was a great place to study. My sister is a graduate and my brother is there now. It's our school."

GPS: PhD student at the University of Wisconsin, Madison studying artificial intelligence and machine learning

Paying it Forward: Mentors students and works as a teaching assistant.

What's Next? "Several more years of research."

Then? As much as I like Madison, I plan to return home to the Baltimore area when I graduate. I want to work in industry and make a difference in people's lives."

NATHAN LAPIERRE

Year Graduated: 2015

Path to CS: "It was a foregone conclusion: Thomas Jefferson High School graduate, father is a computer programmer." Planned to become a software engineer then became interested in bioinformatics and data mining. Knocked on Professor Huzefa Rangwala's door one day and asked about research opportunities.

Bravo! As an undergrad, co-authored and published a paper with Professor, Huzefa Rangwala. Just returned from China where he and Rangwala presented another paper, "CAMIL: Clustering and Assembly with Multiple Instance Learning for Phenotype Prediction," for the IEEE International Conference on Bioinformatics and Biomedicine (IEEE BIBM '16).

GPS: UCLA – "The weather is a bonus."

Paying it Forward: Just ran a city 5K to raise money for Special Olympics

What's Next? Working on an NIH training grant. Researching ways to sequence bacteria and build models and reference databases for research.

Then? Teaching – maybe ■

Kinga Dobolyi

Mark Snyder

CS Faculty Win University **TEACHING AWARDS**

Teaching is at the heart of what we do at George Mason University. The CS Department is fortunate to have some of the best instructional faculty in the Commonwealth, from tenured faculty researchers, dedicated assistant professors, and adjunct staff who provide a vital link from the classroom to careers in CS. Since 2000, seven faculty members have received the prestigious Teaching Excellence Award.

This past year, two more of our outstanding teaching faculty members, **Kinga Dobolyi** and **Mark Snyder** were awarded the 2016 University Teaching Excellence Award from the Center for Teaching and Faculty Excellence. This University award "acknowledges the significant work that faculty members devote to course planning and preparation; curriculum development, and innovative teaching, advising, and undergraduate and graduate mentoring." It is unusual for two faculty members in the same department to win the award in the same cycle. For both Kinga and Mark, this award puts an exclamation mark on their work.

The process begins with an anonymous nomination. Each candidate puts together a portfolio of his or her work and completes a lengthy application.

Kinga won the award with the additional distinction of the general education category. She says, "It's gratifying to see all my hard work come together. This award is a better way to measure my teaching effectiveness." Part of Kinga's portfolio is her teaching, design, and mentoring work on a three-year Google Grant to find a way to teach more CS students and change how CS material is taught. She along with several Mason faculty members, with advice from co-winner Mark Snyder, developed SPARC. This is a self-paced flipped classroom model. Now in its second year, SPARC data is still coming in with students progressing through the program. Kinga was responsible for overseeing the development of the coursework, writing new software to establish the testing model, and teaching. In addition to teaching the SPARC model, she is also teaching a traditional class as a control. "George Mason University is a great place to teach," says Kinga. She's excited about her future.

"It's great to be rewarded for something that is so important to me."

Mark comes from a family of teachers. "My mother is a teacher and my father, a physician, also teaches." He says this award is a huge thumbs-up approval of all the work that he does adding, "It's great to be rewarded for something that is so important to me."

Mark is now in his sixth year of teaching in the CS department. He says one of his biggest challenges was that when he was hired, he had to take over another class and there wasn't a lot of material. "I had a blank slate," he says, explaining that it was exciting to develop his own material but also daunting in the amount of time it took. Over the years, he has revised and improved the material and is always looking for ways to engage with students. One of the best parts of his job is that he teaches intro to programming and then higher level CS classes. He sees students when they first start in the program and then sees the same students in their junior and senior years. "I like seeing how they have changed and advanced since they started in the program. They are often surprised," he says with a laugh, "that the coursework is so much more challenging." Mark has prepared them well. ■

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COMPUTING **RECREATIONS**

DANA RICHARDS

This puzzle concerns a algorithm devised by the legendary mathematician John Horton Conway, which he calls TopSwops. This problem appears in Knuth's newest volume of the Art of Computer Programming (Volume 4A, Part 1).

This is the way Martin Gardner described it:

A deck of cards is numbered 1 to n in random order. Perform the following operations on the deck. Whatever the number on the top card is, count down that many in the deck and turn the whole block over on top of the remaining cards. Then, whatever the number of the (new) top card, count down that many cards in the deck and turn this whole block over on top of the remaining cards. Repeat the process.

Show that the number 1 will eventually reach the top.

Find the answer on page 7.

Message from the Chair... continued from page 2

The department has added several new faculty members over the last couple of years. Eight of the new faculty are profiled in this newsletter. Each and every one of them has a strong track record and I am delighted that we were able to recruit them. Indeed, it is a testament to the steady improvement in our reputation (and that of Mason in general) that we were able to hire such outstanding faculty in the face of severe competition from other universities.

Since the last edition of this newsletter, the CS department has continued its recent tradition of having at least one of its faculty win a Mason Teaching Excellence award every year. In 2016 both Kinga Dobolyi and Mark Snyder received this award; they are profiled in this newsletter. Six CS faculty have won this award over the last five years demonstrating both the department's good fortune in being able to recruit outstanding faculty as well as a department-wide commitment to teaching excellence.

The department is equally committed to excellence in research. Last year, Angelos Stavrou received over $6.5M from DARPA for research on network security, and Gheorghe Tecuci received a $7.5M grant from IARPA for his research in artificial intelligence. The newsletter includes articles on both these research projects.

Many of our top undergraduates go on to receive PhDs from some of the most prestigious programs in the nation. This issue profiles three of our recent alumni who are now working on their PhDs in highly ranked programs. Last, but not least, this issue contains a puzzler from our resident puzzle master Dana Richards.

Enjoy!

FAST FACTS ABOUT **CS@GMU**

FACULTY

49

(41 Tenure Track)

Research EXPENDITURES FY16

$5.9M

Grants with PI in CS department

$2.3M

Grants with PI in other units at Mason

Student Enrollment

(Fall 2016)

Undergraduates **1139** Masters **409** PhD **102**

Degrees Conferred (2015-16)

B.S: 142 **M.S.:** 143 **Ph.D:** 16

ARTIFICIAL INTELLIGENCE MEETS REAL WORLD INTELLIGENCE NEEDS

One of the most pressing needs in today's data-flooded world is for accurate data interpretation. This is especially true in the intelligence community. The US government works diligently to build barriers against cyber-attacks that can take down our financial systems and wreak havoc on our nation's infrastructure; terrorism both domestic and international; chemical, nuclear, and conventional weapon strikes, and even threats against our democracy and election processes.

Professors Gheorghe Tecuci, Mihai Boicu, and Dorin Marcu, researchers from George Mason University's, Learning Agents Center are on to something big. A creative, technical solution that combines their research in artificial intelligence and learning agents with crowdsourcing. The goal is to develop a reliable, flexible technical assistant that can help intelligence analysts evaluate evidence, determine what is credible versus a red herring, and to share that information with other analysts, who working together, can quickly assess critical situations.

The system is called **Co-Arg (Cogent Argumentation System with Crowd Elicitation).** The Learning Agents Center team's research has just been published in two books, Knowledge Engineering: Building Cognitive Assistants for Evidence-Based Reasoning and Intelligence Analysis as Discovery of Evidence, Hypotheses, and Arguments: Connecting the Dots. They've also taken their work into the classroom and out into the field."

This past January, the LAC team, which is also supported by several researchers from Mason and five other universities, was awarded a $7.4-million-dollar contract from the Intelligence Advanced Research Project Activity (IARPA). The aptly named CREATE program: Crowdsourcing Evidence, Argumentation, Thinking and Evaluation is charged with finding technical solutions to assist intelligence analysts with data analysis, to dramatically improve analytic reasoning and the resulting analytic products.

Gheorghe Tecuci, the project PI speaks for his team when he says how eager and excited they all are to expand their work and ideas. They are confident they can develop a novel working solution and point to the fact that they are well on their way with the research.

The Co-Arg system has two main components, Cogent and Argupedia. Cogent is a cognitive assistant with advanced analytic and learning capabilities that directly supports a lead analyst in answering intelligence questions. Boicu explains that Argupedia is an innovative wiki for crowd problem solving allowing multiple crowd analysts to work through specific intelligence requests from the lead analyst, regardless of their physical location, and determining the most likely solution. Argupedia is also an encyclopedia of arguments. The stored information can be used over and over for multiple tasks and it will become more comprehensive and accurate as intelligence problems are solved and incorporated into the wiki.

The Co-Arg system evaluates scenarios using an original Wigmorean probabilistic inference network. Tecuci explains that the idea emerged from an integration of previous LAC research on problem solving through analysis and synthesis, with the Wigmorean graphical method used in the legal profession to analyze legal evidence in trials. This part of the project was influenced by LAC's David Schum, a founder of the science of evidence. One of the biggest hurdles is how to design a system that will be easily used by non-technical analysts. Tecuci says that the team fortunately has years of experience teaching the use of their AI systems at the U. S. Army War College and understands the population of people likely to use Co-Arg.

The Learning Agents Center is working on several projects related to the Co-Arg AI research including, sInvestigator, an education program to teach undergraduate students critical thinking skills in science, funding through NSF's IUE Program; cognitive assistants that capture and automatically apply the expertise employed by cybersecurity analysts when they investigate Advanced Persistent Threat alerts, funded through the AFRL ADCO program; and a Mitre/ NRO program, Towards Persistent Intelligence Processing.

Learn more online at: http://lac.gmu.edu

WELCOME NEW FACULTY

The CS Department's newest faculty members join the department with a variety of research interests and a love of teaching.

FOTEINI BALDIMTSI

Foteini Baldimtsi came to Mason as a post -doctoral researcher at Boston University. She earned her PhD from Brown University. Her research specialty is cryptography with an emphasis on the bitcoin economy, blockchain technologies, and private authentication. Mason interested as a place to teach because of its excellent research reputation and its proximity to Washington, DC where says there are a lot of scientists who are working in her field.

She appreciates that there are so many other women faculty members at Mason and is working to organize CS events on campus to speak to women and minorities about CS fields.

Currently she is teaching a graduate class on network security where she says she is working with students to get them to "think as an attacker," as she teaches them how to spot vulnerabilities. She will also be teaching a new class on bitcoin and blockchain where she will introduce her research interests and issues of electronic payments and anonymity.

SHVETHA SOUNDARARAJAN

Shvetha Soundararajan came to Mason after completing her Master's and PhD degrees at Virginia Tech. Her research specialty is software engineering, with an emphasis on agile transformation and assessment. The CS department's software engineering reputation was a huge draw for her. "This department values both teaching and research and that excited me," she says.

She is teaching object oriented programming and an undergraduate software engineering class for juniors and seniors. She will also be teaching a Python programming class as part of the SPARC project – a three-year Google Grant research initiative to find innovative ways to teach programming to large numbers of students.

Shvetha says that coming from Virginia Tech, she was surprised at the number of part-time students and students who come with strong industry backgrounds. She likes the mix and the experience they bring to the classes.

Shvetha is a classically trained Indian music singer but admits these days when she's not working she's only singing lullabies to her son.

SONG MIN KIM

Song Min Kim came to Mason from the University of Minnesota where he earned his PhD. He was interested in teaching at Mason because, "it's location is great, right outside of Washington, DC and close to core national agencies and the high tech industry." He's enjoying the diverse faculty and how the entire campus interacts.

He is teaching CS 367, computer systems and programming. This is his first time lecturing and he's enjoying the challenging he feels it's essential for students to understand how computers operate.

Song Min's own research is on wireless systems and how to make them more efficient as well as mobile, and low power embedded sensor networking. He is looking forward to teaching a graduate level class on the Internet of Things and pulling in his larger interests.

Song Min first became interested in computers through gaming and he worked for an online gaming company. He's interested in all uses of computers including art and digital painting.

JONATHAN BELL

Jonathan Bell came to Mason after completed his PhD in Computer Science from Columbia University. He is interested in software engineering and software systems. He says, "I was the nerdy kid who went to computer camp." He's interested in how computers can be used to build something with a huge impact.

He is teaching software engineering for the web. He says that the way Mason teaches this subject is unique because it encourages students to look at problems from multiple angles. He will also be teaching a distributed software engineering class.

This is his first-time teaching and he is enjoying the small class sizes and how he is able to interact with students. Jonathan lives in Washington, DC, and notably bikes to campus in Fairfax.

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DOV GORDON

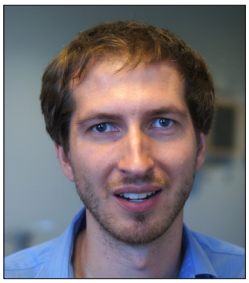
Dov Gordon joined the CS faculty in 2015 after working in industry for several years for Applied Communication Science (ACS). While there, he worked on issues of cryptography and cyber security. Prior to ACS, he did post-doc research at Columbia University and was a recipient of the Computing Innovation Fellowship. He earned is PhD in CS from the University of Maryland.

Dov's area of research is computing and encryption. He is currently teaching Intro to Cryptography and Formal Methods and Models.

He says he's enjoys teaching at Mason because of its mix of traditional students and those coming in from industry. It has allowed him to develop his courses to address both CS foundations and current technology trends.

In addition to teaching, Parth is an active researcher and is currently recruiting students who are interested in wireless and mobile computing research. He says that he has two goals, "to stay engaged with students via teaching and mentoring, and to continue with his research."

Mason is a great location to be working as he has family on the East Coast. He looks forward to the connections he can build on campus and the ability to stay connected to his family.



THOMAS LATOZA

Thomas LaToza came to Mason in 2015, after completing his post-doc research at the University of California at Irvine. Thomas is most interested in studying how humans interact with code and ways to design new methods to build software. He says he "works at the intersection of software engineering and human-computer interaction."

Thomas has a PhD in Software Engineering from Carnegie Mellon University, as well as a BS in CS and BS in psychology from the University of Illinois at Urbana.

He co-chairs several software engineering industry workshops and participates in a variety of research programs. He is currently teaching Design and Implementation of Software for the Web and Software Engineering Environments.

PARTH PATHAK

Parth Pathak came to Mason from his post-doctoral research at the University of California at Davis. He earned his PhD in Computer Science from North Carolina State University where his research interests focused on wireless networks, mobile and pervasive computing, and network analytics.

KATHERINE "RAVEN" RUSSELL

Katherine "Raven" Russell came to Mason from the University of Maryland University College to pursue her PhD in Computer Science. She is currently a doctoral candidate and has been involved in the CS department both as a TA and as part of the robotics lab throughout her studies. Katherine grew up in Maryland and likes being close to friends and family. The role reversal from PhD student to teacher has "been a lot of fun" she says. She enjoys the feedback she gets from students and developing new materials for classes based on that feedback.

Katherine is teaching a variety of courses including CS 112, CS 321, and INFS 519, which she explains is a foundation course for graduate students with a non-CS background. This course more than others speaks to her interest as a teacher. She says, "Students often come to INFS 519 for professional reasons," which mirrors her own experience working in industry before getting a formal education. Her own CS story began doing website development with a friend, after which her interest grew into a full CS degree path.

Katherine is making steady progress on her dissertation but will be mixing up her summer research with teaching. ■

Computing Recreations Answer

There are many possible solutions, this one is due to the combinatorial algorithm expert H. S. Wilf. At any given point in time, let p(i)=1 if the ith card is i, and 0 otherwise. Let S be the summation of 2^i p(i) for all i from 1 to n. (In other words, p describes S written in binary.) The observation is that every swap increases S (since if k is the top card then S increases 2^k while it can decrease by no more that 2^1+2^2+...+2^(k-1) < 2^k). Since when S is maximized the first card is a 1 it follows the procedure will terminate.

Another way to say the same thing: prove by induction that (n-k) can only come to the top 2^k times.

For an additional challenge (from Knuth) show that it will never take more than F_(n+1) swaps (i.e., the (n+1)st Fibonacci number).