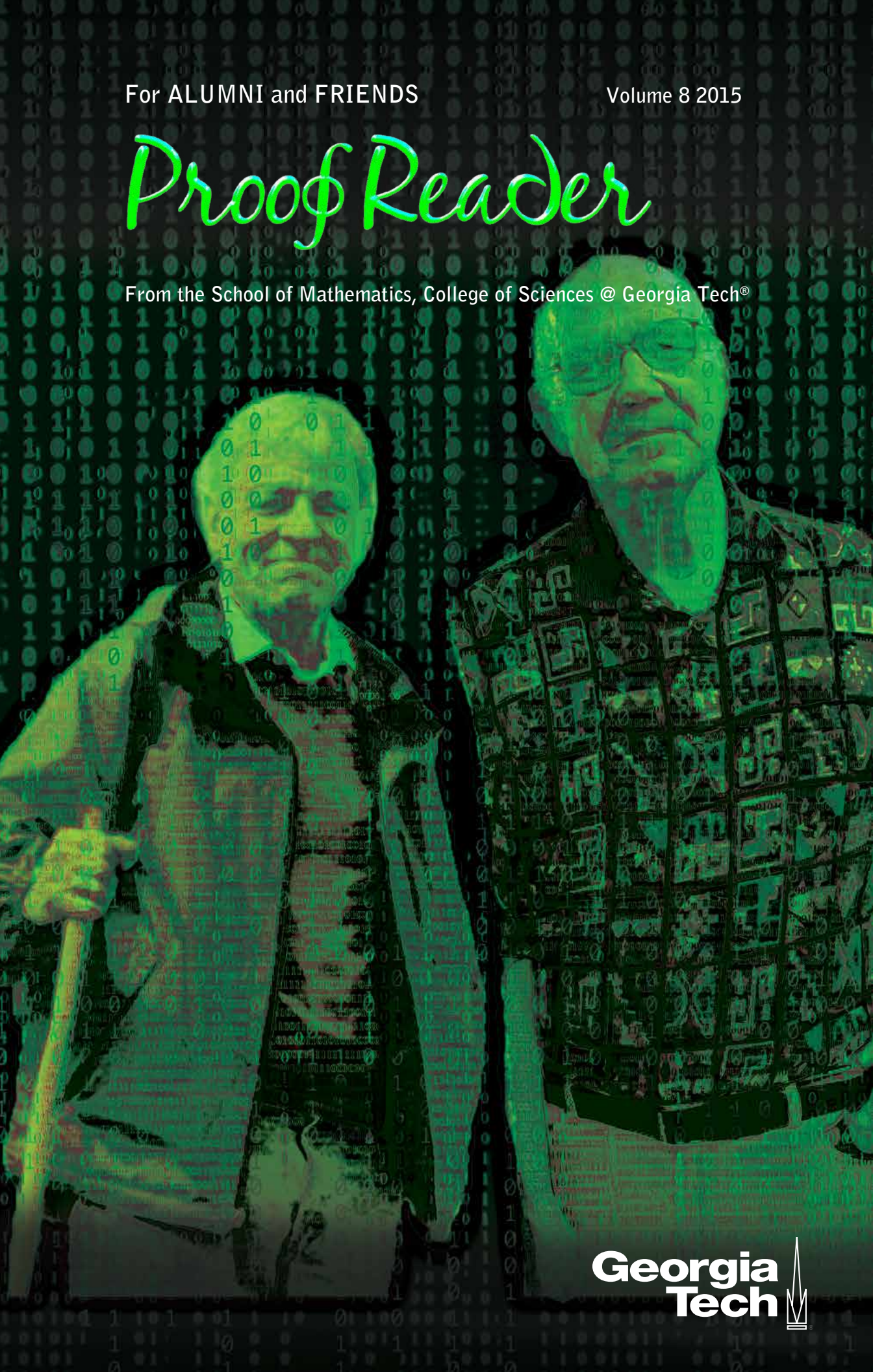
For ALUMNI and FRIENDS

Volume 8 2015

Proof Reader

From the School of Mathematics, College of Sciences @ Georgia Tech®



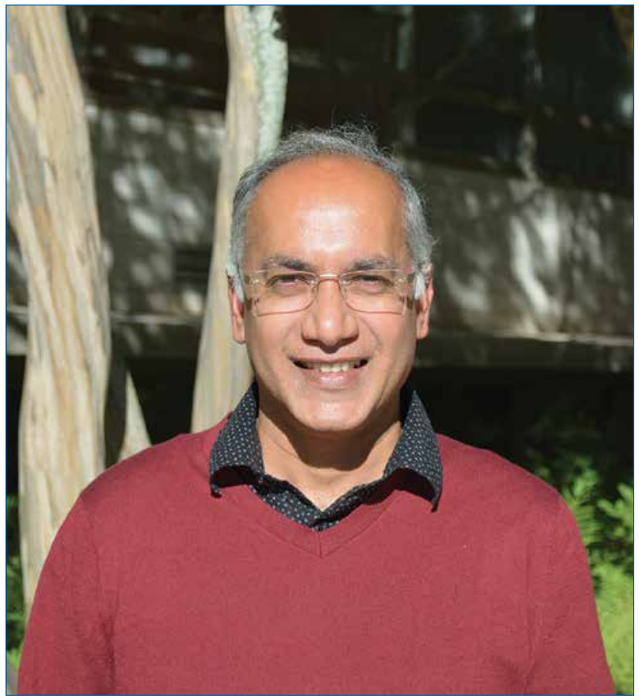
Georgia Tech

Notes from the Chair

The 2014-2015 academic year has been one of many transitions! Since mid-April 2015, I have had the honor of serving as the Interim Chair while a national search is conducted to identify the next Chair for the School.

After serving splendidly as the Chair of the School of Mathematics for six years and having accomplished a great deal on multiple fronts, Doug Ulmer stepped down to resume a faculty position in the School. Working with the School's hiring committees over these years, Doug helped us hire fifteen tenure-track faculty and an additional four academic professional faculty. These include world-class mathematicians in areas such as algebra, analysis, applied & computational math, combinatorics, dynamical systems, geometry, number theory, PDE, and probability and statistics. Thank you, Doug!

In January 2015, my colleague Matt Baker was appointed as the Director of Undergraduate Studies, following Doron Lubinsky's term in the position. In recognition of Doron's dedication to teaching and outstanding service to students, he was awarded the inaugural Herman K. Fulmer prize. Kudos to Doron!



Our Director of Graduate Studies, John Etnyre, completed his term of three years on a commendable note, having further strengthened the graduate program by helping recruit top-notch students and engaging in efforts to reach out to minority students from colleges in the metro Atlanta area. Mohammad Ghomi kindly stepped up to receive the baton in July 2015, assuming the role for a five-year term.

You can learn more about both our under-graduate program on pages 33-37 and our graduate program on pages 26-32.

About the Cover
This cover is a tribute to the young and old, the present and past, the exciting mathematics of today that wouldn't have come to fruition without the foundational mathematics of yesterday.

During all of these transitions, the School has been grateful to the staff's support of faculty and students. In particular, the fine leadership being provided by Kimberly Stanley Jones, our Assistant Director for Business Operations, resulted in a successful staff reorganization. Our staff feature, on pages 24-25, highlights Kimberly's contributions.

In this issue we are recognizing fellow faculty who were or are extraordinary teachers. We lost two such individuals this year, Professor George Cain and Professor Richard Duke. *ProofReader* is featuring them on the cover and with articles and tributes that have come pouring in. See pages 8-11 as well as a particularly heartfelt memory from Friends of the School of Mathematics (FoSoM) member Ben Elkins on page 42.

Alumni have reached out to Georgia Tech and created named awards and prizes in honor of SoM professors who positively impacted their lives. See pages 40-41. On behalf of the School, I would particularly like to thank FoSoM member Charles Crawford and the family of the late Howard Woodham for their support and generosity.

Another master teacher, Professor Tom Morley, our Distance Calculus guru, has singlehandily created and led, for more than ten years, a very strong distance learning program that provides opportunities for Georgia's talented high school students. Tom's story begins on page 14.

"The devil is in the data" seems to be the new mantra as the national demand for a new generation of data scientists, trained in data analytics, machine learning, and (high-dimensional) probability and statistics, grows at a tremendous rate. See pages 6-7 for an elementary yet informative narrative by my probability colleague Henry Matzinger. The subject is principal component analysis, a classic technique being refined by mathematicians with applied interest in data mining and clustering.

The School of Mathematics and the Division of Student Life were notified that both have been selected to receive the ***Georgia Tech 2015 Diversity Champion unit award!*** The award recognizes efforts toward diversity, equity and inclusion within the Georgia Tech campus community, and highlights the vast improvements in the gender makeup of the School's faculty community. We now have ten female faculty members, four of whom were recruited in the year 2014-2015, and four female academic professionals. This is a marvelous leap from even a few years ago: back in 2006, we had only one female tenured faculty member (on leave)!

Also, through our National Science Foundation (NSF) Interdisciplinary Mathematics Preparation and Career Training (IMPACT) grant for mentoring and promoting postdocs, we have hired six IMPACT postdocs in the past two years, four of whom are women. You will read more about this recognition in the next issue, as the award is to be presented in September 2015.

Finally, I am very grateful to Cathy Jacobson and Janet Ziebell for having come back from retirement to help the School put this issue together, along with our newly hired academic professional, Dr. Sneha Subramanian.

Best regards,
Prasad Tetali
Professor and Interim Chair

SoM Statistics Spring 2015

Faculty	61 (tenured or tenure track)
Emeritus Faculty	13
Academic Professionals	8
Visitors	11
Postdocs	16
Staff	13
Graduate Students	75
Undergraduate Students	
Math	136
Discrete Math	15

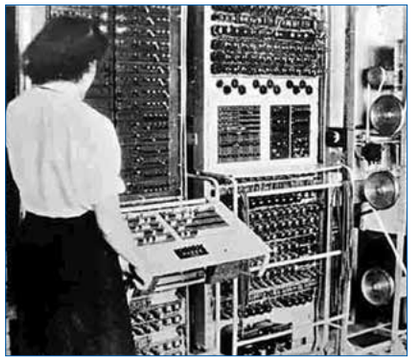
The Rise of the Machines

by Tom Morley

In the summer of 1973, I was clacking away on a teletype, writing code for a NASA grant to the University of Maryland (probably an implementation of Edmonds matching algorithm), when a friend walked in the room and showed me the most amazing thing I had ever seen—a Hewlett Packard HP-35.

This had been out for months, but was hard to get and very expensive—$395.

But it was the most amazing thing I'd ever seen. A calculator held in your hand with transcendental functions: sine, cosine, tangent, log, exponentials and many more. Wow.



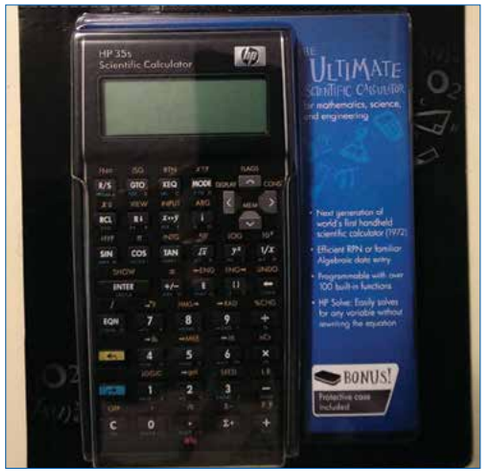
Calculators had been around a long, long time. Before the electronic kind, there was the mechanical kind based on gears. It's easy to see how gears can multiply. With a set of gears for each digit, they easily did addition and multiplication with high accuracy,

powered either by handles that you turned or, later, electric motors. These were the adding machines (as they were called then) that were used by large rooms full of "computers" (a job title, not a machine) during World War II.

But slide rules still ruled. They had at least three advantages over the older calculators. One, you could carry them around in your hand. Two, they could compute with numbers in scientific notation, like 7.6×10^{23}, and three, they could do trig functions, square roots and, depending on the model, other transcendental functions.

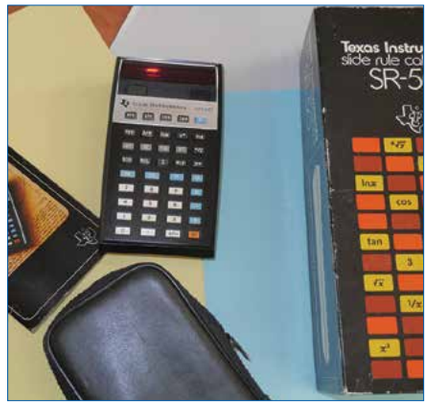
There were gear-based adding machines that you could hold in your hand, but they were expensive and slow, and never caught on. Then in 1972 Texas Instruments introduced the SR-10, the first electronic, hand-held calculator with scientific notation. It had no trig functions and such, and was $149.95. But it could tell you that 5×10^{3} times 4×10^{12} was 2×10^{16}. However, there were no logarithms or exponentials yet.

The HP-35 was different. It had sine, cosine, tangent, y^x, log, e^x—all that good stuff, together with silky-smooth buttons (the TI SR-10 always



seemed to have cheap mechanics) and Reverse Polish Notation—Just like FORTH (or PostScript), if you get the reference. It's not a + b = but rather a b +.

The HP-35 displayed 10 significant digits, with a two-digit exponent. Internally there were 14 digits. When the HP was being debugged, there were no big mainframe computer codes for transcendental functions that had as many significant digits as the HP-35, so they tested it against well-documented transcendental function tables. But a bug snuck through, $e^{\log(2.02)}$, or in Reverse Polish, 2.02 log e^x, that turned out to be 2, and not 2.02. This was a subtle bug caused by the interaction of iterative refinement (take and answer, and iterate to make it more accurate) for the logarithm, and by inconsistent internal truncation of significant digits. While this was quickly fixed, to this day HP-35s with the "2.02 error" are worth significantly more ($100 or so) on the collectors market and, in good condition with boxes, much more than they originally cost.



So what happened then? The Texas Instruments SR-10 came down to $89.95, and was soon owned by most every collegiate engineer. The HP-35 fixed the 2.02 bug and dropped in price to $295, but these were still expensive. For a short period, most engineers had a "slide rule" (scientific notation) calculator, but trig functions and other tables were necessary for work on tests, quizzes and homework. The descendants of the HP-35 became more powerful, cheaper and more common among college students.

Later in 1973, Texas Instruments introduced the SR-50 for $170. This had the standard transcendental functions, including trig functions, logs and exponentials.

And the great Hewlett-Packard–Texas Instruments war was on.

Of course nowadays, the calculator in my phone is better than any of these—and yes, I've used it with a document camera in class when the podium computer wasn't working.

Tom Morley

Extracting Hidden Information from Matrices: Data Science Progress at the SoM

by Heinrich Matzinger

Imagine that you are working for Interpol. In a small Italian village where the Mafia is believed to be present, data is collected on how often people call each other and for how long they speak. You put that data into matrix form. By analyzing your matrix, you try to find the groups of individuals within which there might be an abnormally high amount of communication. Hopefully one such group will be the Mafia!

Below we show three toy examples with seven people. We are going to work from the simple case of matrix A to more complicated ones. The matrix-entry of row i and column j represents how many hours the i-th and the j-th persons talked together during the sample recording time.

In matrix A, the first five people talked a lot to each other; each spoke for five hours to every other person in the group. The last two people talked together for four hours. There was no calling time recorded between these two groups. This would lead us to infer that the five people in the first group form a sub-community in the village and so do the two in the second group. When you look at the eigenvectors of matrix A with non-zero eigenvalues given below, you see that each eigenvector corresponds to such a sub-community.

Now, we need a slightly more realistic situation than the example just mentioned. For this we must make sure that the people also call each other outside of their small sub-community, but with less frequency or time than within their sub-community. This gives us matrix B below, where between the sub-communities, people speak with each other for two hours on the phone. However, matrix B still has too much regularity to be realistic.

In reality, not all the people within the same sub-community call every other person in that sub-community for the exact same number of hours. We don't call each of our friends for exactly the same amount of time every month just to make sure they won't get jealous.

This means that in a first approximation we could simulate a more realistic matrix by taking B and adding a random noise matrix $NOISE$. That is, we will add a random alteration to each entry. We did so by taking a die with five equiprobable sides and marked the sides as −2, −1, 0, 1 and 2. Then, for each entry of the matrix above the diagonal, we threw the die and added its value to the entry. In other words, we added independent entries above the diagonal.

Finally, since we needed a matrix that is symmetric, we recopied the value ij into the cell ji and obtained $B + NOISE$. Now, when we first glance at that matrix, sub-communities no longer appear so clearly. However, to find the sub-communities, we can again take the two eigenvectors with the biggest eigenvalues (given below) and round up the entries to the next closest integer. Vavoom! We find that we are back to the original eigenvectors that reveal the sub-communities! Isn't that magic?

And with more people, it would work even better. We could add way more noise, so that from the matrix $B + NOISE$ nothing would be visible to the eye anymore, but the eigenvector method would still work for finding the hidden sub-communities. This forms the basis of a method called Principal Component Analysis (PCA).

EXAMPLE:

$$A = \begin{pmatrix} 5&5&5&5&5&0&0\\ 5&5&5&5&5&0&0\\ 5&5&5&5&5&0&0\\ 5&5&5&5&5&0&0\\ 5&5&5&5&5&0&0\\ 0&0&0&0&0&4&4\\ 0&0&0&0&0&4&4 \end{pmatrix}, \quad B = \begin{pmatrix} 5&5&5&5&5&2&2\\ 5&5&5&5&5&2&2\\ 5&5&5&5&5&2&2\\ 5&5&5&5&5&2&2\\ 5&5&5&5&5&2&2\\ 2&2&2&2&2&4&4\\ 2&2&2&2&2&4&4 \end{pmatrix}, \quad B + NOISE = \begin{pmatrix} 7&5&4&3&6&2&2\\ 5&5&6&5&6&2&0\\ 4&6&5&5&7&1&4\\ 3&5&5&7&5&0&2\\ 6&6&7&5&7&0&1\\ 2&2&1&0&0&4&6\\ 2&0&4&2&1&6&4 \end{pmatrix}$$

The only two eigenvectors with non-zero eigenvalues for the matrix A are

$$\vec{\mu}_1^{\,A} = (1,1,1,1,1,0,0), \qquad \vec{\mu}_2^{\,A} = (0,0,0,0,0,1,1).$$

The eigenvectors with the two largest eigenvalues for matrix $B + NOISE$ are

$$\vec{\mu}_1^{\,B+NOISE} = (.8,.8,.9,.8,.9,.2,.3), \qquad \vec{\mu}_2^{\,B+NOISE} = (0,.2,0,.3,.4,1.35,1.35).$$

As mentioned, in reality we work with giant matrices. (Note that with 100,000 people, the matrix already has 10 billion entries.) When does the PCA technique work? There is a classical result from matrix perturbation theory that tells us that the biggest eigenvalue (in absolute value) of the noise matrix needs to be less than the spectral gap. (The spectral gap here is the difference between the two largest eigenvalues.)

Practitioners from Silicon Valley regularly come to us with theoretical questions about PCA and related machine learning problems. After they have computed the eigenvectors with the largest eigenvalues for an enormous matrix, they need to know whether the result is reliable or just noise. Therefore, a formula is needed for the typical order of magnitude of the biggest eigenvalue for some model of random noise matrices and for models where the entries above the diagonal of the noise matrix are only approximately, not exactly, independent of each other.

Large random matrices have been studied by some of the greatest statisticians in history, such as Karl Pearson, the inventor of PCA. Furthermore, large random matrices play a key role in quantum theory; hence, some of the greatest physicists of modern times have worked on them.

Until recently, there was no general formula for noise matrices generated by using different dice with different numbers of faces. SoM Professors Vladimir Koltchinskii and Karim Lounici, along with PhD student, Dong Xia, studied problems of this nature for some classes of random noise matrices, and they determined the magnitude of the spectral norm of the noise matrix by using concentration of measure and other mathematical tools.

Additionally, SoM Professor Ionel Popescu has made significant contributions to free probability theory. This theory describes the limiting structure of joint large random matrices and has an incredible number of applications ranging from mathematical physics to engineering and even finance.

The matrix problem we presented in this article arises in the topic of *Detection of Communities in Large Networks*, and a large interdisciplinary community of scientists has been working on the problem for a few decades. It is related to the algorithmic problem of finding sparse cuts in large graphs, which Professors Prasad Tetali and Santosh Vempala together with collaborators Anand Louis and Prasad Raghavendra had actively worked on.

In particular, these colleagues established rigorous connections between higher eigenvalues and graph cuts involving many pieces, thereby generalizing the so-called Cheeger inequality concerning the spectral gap and cutting a graph into two pieces.

There are also many other areas of machine learning that use PCA. For example, PCA is often used to classify texts or words according to topic. In this case, the ji entry in the matrix we consider will have the number of words that are shared between document i and document j. Here are a few other application examples:

Heinrich Matzinger

I) Imagine a firm's website that matches job postings with job applicants. From the millions of CVs available, the firm may wish to determine which skills increase the likelihood of finding a job. The first step in building such a recommender system is to cluster similar skills using PCA.

II) Consider a website that tries to match people for marriage. First, one would apply PCA to determine different categories among people, and those could then be used for matching.

III) The *Netflix* recommendation system is based in part on PCA-related algorithms.

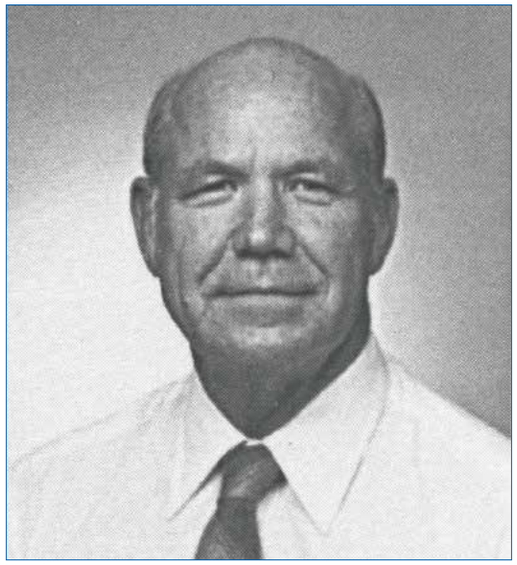
IV) *Sentiment-analysis* refers to algorithms that automatically assess customer satisfaction with certain products based on online comments. Because each product has several aspects (a car can be safe, have a beautiful design, etc.), you first need to determine which words belong to the same or similar aspects, and you can use PCA for this.

PCA is only one of the methods of classical mathematical statistics that has started a new life in high-dimensional statistics, an area of statistical (data) science that deals with learning the underlying structures of complex, high-dimensional data sets. This area has deep connections with probability and geometry in high-dimensional spaces, with random matrix theory, and with such areas as machine learning and compressed sensing. The research on high-dimensional statistics is being actively pursued at the SoM and other schools on campus.

Faculty Tribute

George Cain 1934-2015

by Bill Green



George Lee Cain Jr. was born on January 13, 1934, in Wilmington, North Carolina. In 1952 he graduated from New Hanover High School and enrolled at the Massachusetts Institute of Technology, receiving a Bachelor of Science in 1956. On occasion in later life he was known to refer to his alma mater as "the other Institute."

From 1956 until 1960, George worked in Marietta for the Scientific Computing Department at Lockheed Aircraft, although he served briefly (91 days) in 1958 in the US Army, until released to do defense-related work back at Lockheed. He was later amused to point out that his brief army career qualified him for a Georgia Veteran's Driver's License.

There was a momentary hitch in George's entry into the US military when, in response to a loyalty oath question, he declared that a relative had advocated the violent overthrow of the US government: his great-great-grandfather was a private in the Confederate Army. He was told not to be a wise guy and was drafted anyway.

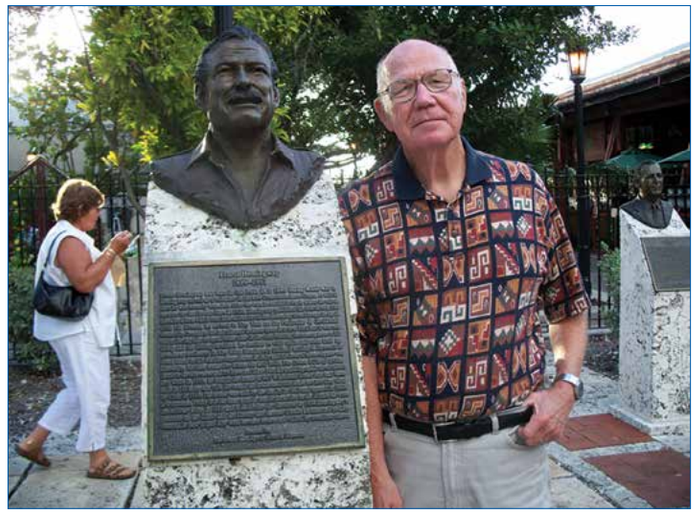
George Cain became the first-ever recipient of a Georgia Tech Mathematics PhD (one of two that year, Cain being first in alphabetical order). He had entered the doctoral program in 1960 and completed his doctoral studies in 1965. His dissertation work, done under the supervision of Robert Kasriel, won him a Sigma Xi Research Prize in 1963. He was also an NSF Faculty Fellow for the 1964-1965 academic year.

George became an associate professor in 1968, served the School as Assistant Director from 1973 to 1978 and was promoted to professor in 1980. His many services to the Institute included membership on the Executive Board and a chairmanship of the Faculty Status and Grievance Committee. He supervised two master's theses (L. E. Elder and Benjamin Elkins) and four doctoral dissertations: Stanley Wertheimer (1970), Gary Lewellen (1989), Franklin Mendivil (1996) and Luis Gonzalez (2001). He retired in May 2001.

Tributes to Professor George Cain

"I first met George in 1974 when I interviewed for a position at Tech. He was very helpful to me then and has been a kind friend for more than forty years since. I will miss his wit ("I have two questions, and I will ask the second one first") and his wisdom ("Never do anything for the first time"), and of course his company. I also taught out of his topology book, for which I have a great deal of admiration. We are poorer today for the loss of him." —Bill Green

"He taught me so much, and his passing drives me to commit myself more to perform better and be a better mathematician. George's spirit, attitude, strong voice, and approach to mathematics live on as I tutor my sons and others. There's no doubt about it: I respected, admired and looked up to him in many ways." To this day, one of Ben's prized possessions is a copy of Wittgenstein's *Bemerkungen über die Grundlagen der Mathematik,* in which Professor Cain autographed the inside cover with Proverbs 8:33 in his distinctive calligraphy: "Heed instruction and be wise, and do not neglect it." —Ben Elkins, VP Consulting Services, EBB Nielsen Marketing Analytics (see FoSoM news, page 42)



Professor Cain did research in fixed-point theory and in compactifications of sets and mappings. He authored the much-respected textbook in general topology *An Introduction to General Topology* (1994), and in 2005 coauthored the book *Separation of Variables for Partial Differential Equations: An Eigenfunction Approach* with Gunter Meyer. He contributed chapters to a number of handbooks in engineering and contributed to many research papers in topology. While on the Tech faculty, George continued to consult for Lockheed, and he also consulted for General Electric, for Atlantic Steel and, on occasion, for legal and chiropractic offices.

The Washington Star April 15, 1970 issue pointed out that a Georgia Tech mathematics professor computed the length of Henry Aaron's longest home run to that date (503 feet); all available evidence suggests that the professor in question was George. In fact, in 1969, he had served the Braves officially in this capacity, computing the lengths with a stopwatch and a slide rule from a seat in the broadcast booth.

Professor Cain enjoyed playing clarinet with the East Cobb New Horizons Band after he retired from Georgia Tech. His vita reports that George's favorite book was *Moby Dick* and his favorite movie, *The Treasure of the Sierra Madre*. George was a master storyteller who was fond of quoting Shakespeare. He will be sorely missed by colleagues and friends who looked forward to exchanging tales, trials and tribulations with him. After battling pancreatic cancer for about a year, George passed away on June 19, 2015. He is survived by his immediate family: Marilyn Cain (spouse), Carolyn Naser (daughter), Charles Naser (son-in-law) and Alex Naser (grandson). Contributions in his honor may be made to the Friends of the School of Mathematics fund (contact the School of Mathematics, 686 Cherry Street, Atlanta, GA 30332-0160, 404-894-2701, for details), the Georgia Tech Foundation General Fund for Scholarships or the Lustgarten Foundation (1111 Stewart Avenue, Bethpage, NY 11714).

"In my years as a graduate student at Georgia Tech, George was like a father to me. He was the very finest teacher I ever had, and I still treasure all of the 'war stories' he shared with me in his office. He always added a good dose of humor to the most serious of subjects and offered me a richer perspective on the world. He remains a tremendously positive influence on me in so many ways." —Mark LaDue, Georgia Tech alum and George Cain's bowling buddy.

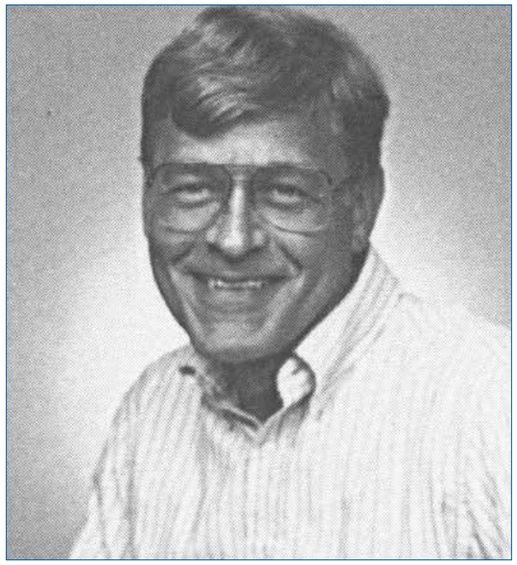
"George was an excellent but tough teacher and was known as 'Killer Cain' to his students. He was always friendly and had a way of disarming his critics with his wonderful Southern drawl and booming laugh. He definitely was one of the people who made it fun to work in the department. I will miss his wit and humor." —Jeff Geronimo

"Several people in the School of Mathematics now use versions of what I recall as being an original George Cain's joke: he'd walk by my office around 5:00 p.m. on a Friday and say, 'Dr. Tetali, please take the rest of the week off!'"—Prasad Tetali

Faculty Tribute

Richard Duke 1927-2015

by Lew Lefton



Most readers of the *ProofReader* will be familiar with Paul Erdős, who is one of the best-known and most prolific mathematicians of the 20th century. When Erdős visited Atlanta, he would stay in a beautiful home in Ansley Park, with his friend and colleague Professor Richard Duke. Richard's longtime friend, Zar Rochelle, recalls, "I would sometimes take Erdős to get haircuts and spend the afternoon with him while Richard was occupied at Georgia Tech. I felt a little guilty, when so many people with more mathematical interest would have loved the opportunity to spend an afternoon with Erdős!" Of course, Richard himself had an Erdős number of one, as many of Richard's 28 mathematical papers in graph theory and combinatorics were published jointly with Vojtech Rodi and Paul Erdős.

Professor Richard Duke passed away early in the morning on February 19, 2015, after an 18-month battle with cancer. Born in Geneva, Ohio, in 1937, Richard earned a bachelor's degree at Kenyon College, a master's degree at Dartmouth and, in 1965, a doctorate at the University of Virginia. After a seven-year stint at the University of Washington, he came to Georgia Tech in 1972 as Assistant Director of the School of Mathematics and later served as Interim Director of the School from 1998 to 2002. Richard was active in national and state organizations supporting the teaching of mathematics, and he consulted for the College Board and academic publishers. He lectured widely in the US and Europe and held a visiting position in Bielefeld, Germany, in 1991.

Although Richard moved away from Seattle, the Pacific Northwest remained an important part of his life. He maintained a collection of Native American artwork from that area, and he also kept a houseboat there. Whenever he headed back to Seattle for a several-week visit, Richard had a knack for picking dates when there was no rain.

Professor Duke led the School of Mathematics during an important period of growth, hiring strong research faculty and improving the already strong academic programs. One of Richard's most important and lasting contributions to mathematics research and education was his founding of the Institute's interdisciplinary doctoral program in Algorithms, Combinatorics and Optimization (ACO) in 1992. He served as the chair of its coordinating committee until 2006. Another important contribution he made was to compile a history of the first 100 years of mathematics at Georgia Tech, 1888-1987, which is available on the School website.

In general Richard was a rather private man, but he was not a homebody. He liked to dance (Greek, folk, Morris) and he especially loved the great outdoors. Even at work, he would frequently step outside onto one of the small balconies in Skiles and enjoy his pipe (obviously this was before Georgia Tech was the nonsmoking campus it is today). He cultivated an impressive collection of houseplants, making his home feel like an outdoor space. Duke's love for hiking wasn't always appreciated by visitors. Zar recalls that "Richard was a fast walker, and when he would pick up visitors at the airport, he might skip the train and walk all the way back to baggage claim from Concourse D."

Here's something you probably didn't know about Dr. Richard Duke: he was an excellent stonemason. His house has many examples of beautiful walls, paths and hardscaping, all carefully, patiently and expertly constructed by him. Some were projects done in secret. Once Zar was banned from Duke's basement for three days. When finally allowed to take a look, he found that Richard had hand-stained the entire floor to give the appearance of stone tiles, but in fact it was a regular concrete floor. The project shows the patience and persistence of a man who had a deep appreciation and connection to the natural world.

Professor Duke's pipe smoke may be gone, but his legacy is as solid as a rock. Before he passed away, he arranged for a final lasting impact on the School of Mathematics. *The Richard A. Duke Faculty Endowment* was established in November 2014 by a generous donation from Richard with the purpose of supporting faculty chairs in the SoM, especially for midcareer faculty members. Those wishing to make a gift in Richard's honor are invited to add to the endowment. Please contact the School of Mathematics (686 Cherry Street, Atlanta, GA 30332-0160, 404-894-2701) for details.

Tributes to Professor Richard Duke

"Richard was a wonderful colleague who made lasting contributions to the School of Mathematics and Georgia Tech, but never sought any recognition for himself. We will always remember him as one of the founding fathers and a longtime director of the ACO program. I think that it is fair to say that without Richard's vision and leadership, the ACO program would not have come into existence." —Robin Thomas, Regents' Professor of Mathematics and Director of the ACO program

"I will always be grateful to Richard for his wise and thoughtful counsel during my years as School Chair. We have lost a friend, a colleague and a stalwart member of our community." —Tom Trotter

"Richard (Dick to many of us in the early days) was quiet and unassuming, and didn't seek the spotlight. Yet were it not for his leadership and focused drive, the ACO program might not have gotten the traction needed to evolve into the elite program it became." —Robert Gary Parker, Professor, School of ISyE

"Richard was an all-around wonderful human being, besides being one of the founding fathers (and the heart and soul) of the ACO program, and serving SoM and Georgia Tech in the utmost selfless, inspiring manner." —Prasad Tetali

"Welcoming and engaging, and eager to talk about Atlanta history and life, Richard had a characteristic modesty that forbade him from bringing up his many contributions to mathematics and to Georgia Tech...Later, I would learn much about them from others, who spoke of Richard as a central colleague, the kind who brings a school together as a community. Through his leadership and presence on campus, and through his extraordinary generosity in establishing permanent endowments for program and faculty support, Richard Duke has done much to enhance the stature of Georgia Tech and the opportunities enjoyed by its community of mathematicians. We offer our sincere gratitude." —Paul Goldbart, Dean, College of Sciences

Ice Bucket Challenge

by Howie Weiss

In August 2014, about a dozen School of Mathematics faculty members made pledges and took the ice bucket challenge to support research into finding a cure for Lou Gehrig's disease (ALS). Students and staff also made donations for the privilege of dumping coolers of ice water (and ice cubes!) over a Skiles balcony railing and onto math faculty lined up like ducks below.

For the School of Mathematics, ALS is more than just a hashtag or meme. Our friend and colleague Robin Thomas suffers from this debilitating and incurable disease. We took the challenge out of solidarity with Robin and to support ALS research. Robin was there to cheer us on.

Worldwide, about 17 million people participated in the challenge, and the ALS Association raised $115 million in six weeks for the cause. But do such campaigns lead to scientific breakthroughs? This summer, researchers at Johns Hopkins University published (in the journal *Science*) a potential breakthrough therapy for ALS, which they claim was facilitated by the additional funding made available by the ice bucket challenge. Their research centers on a protein that forms clumps inside the brain cells of ALS patients. Without the functioning protein, brain cells die. The researchers created a protein to perform the function of the defective protein. Hopefully this is a substantial step toward developing an effective gene therapy to combat ALS.

Distance Calculus Guru Professor Tom Morley

by Tom Trotter/Prasad Tetali

The School of Mathematics wishes to recognize and celebrate the extraordinary service of Professor Tom Morley in Distance Education, particularly his outreach to talented high school math students in the state of Georgia. Here's the background.

All across the nation, local high schools wrestle with the challenge of meeting the needs of talented students whose studies carry them to academic content that cannot be addressed at the secondary school level. Traditionally, high schools have offered advanced placement (AP) courses to prepare students to take an exam that can lead to college-level credit. The drawback is that it requires the participating high school to have advanced-level teachers capable of teaching the course, together with sufficient numbers of students qualified to enroll. Often smaller high schools are unable to meet one or both of these requirements.

Public and private universities have wrestled with the challenge of helping area high schools meet these needs, and a second approach has been to arrange for high school students to travel to nearby college or university campuses. Again, this approach has clear transportation and scheduling limitations.

Starting in the 1990s, Georgia Tech began to take a different approach, with Professor Tom Morley serving in a key leadership position. In conjunction with the Georgia Statewide Academic and Medical System (GSAMS), Tom taught calculus here at Georgia Tech, delivering the course live via videoconferencing to a limited number of area high schools. This approach was highly successful, but it too had its limitations, especially the scheduling constraints inherent in the fact that the high school students had to be free at a fixed hour in the day. As the demand for service grew, it became increasingly clear that a truly asynchronous model was needed, and the Distance Calculus Program (DCP) was established.

Continuing his leadership role from earlier years, Tom Morley has been the driving force for the DCP, which has grown from an initial class of 34 students in 2005 to its current status of 450 students for the fall semester of 2015. He has served as instructor, counselor and course coordinator while developing the curricular, organizational and management components of the two-course calculus sequence offered via the DCP.

Professor Morley's energy levels as an instructor are remarkable. In a typical semester, he may carry an instructional load in excess of 200 Georgia Tech students on the campus and some 400-plus high school students through the Distance Calculus Program. Tom also supports the program through numerous live presentations and Q&A sessions that provide information and orientation for both prospective and enrolled students and their families, the Georgia School District Math Coordinators, and the high school faculty involved.

He responds to calls and messages on his personal cellphone or email from individual high school students who have questions about course content because they are unable to attend extra study sessions on campus. Tom makes sure that every high school student is welcome to attend his on-campus class when their schedule allows.

When the calculus sequence is completed, Tom is still not done supporting his high school students. Each year a number of the students seek additional advanced mathematics courses from Georgia Tech because they haven't yet graduated from high school and wish to advance in their study of math. So Tom is willing to work with this small group of students, offering them an independent study (or a reading course) of more advanced topics.

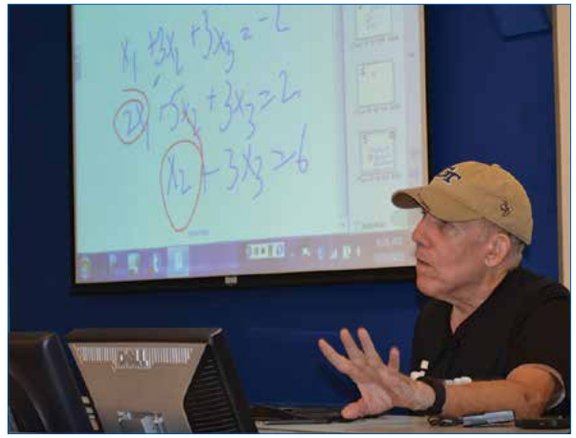
Enrollment and admission statistics for the Distance Calculus Program are striking. The data clearly shows the extraordinary value of the DCP both to Georgia Tech and to the state of Georgia:

1. In the fall of 2014, our entering class consisted of 2,843 new students. Of these, 185 were DCP participants. This cohort represents 6.5 percent of the entire class and 12.4 percent of the in-state students.

2. Of the 355 Georgia high school students who participated in the DCP in 2013-2014, 333 applied for freshman admission at Georgia Tech, and of this group, 331 were accepted. This represents a 99.4 percent admit rate, while Georgia Tech's overall admit rate is 32 percent.

3. Of the 438 former and current DCP students who are 2015 high school graduates, 418 (93 percent) applied for freshman admission at Georgia Tech. Of this group, 375 (89.7 percent) were accepted, and from the accepted group, a total of 237 (73.3 percent) entered Georgia Tech in the fall of 2015.

This last statistic is particularly significant, as the referenced group of students represents Georgia's best and most qualified high school graduates. Typically, these students apply to and are accepted by the nation's best universities, and when we make comparisons on acceptance/enrollment figures for talented Georgia students who have not participated in the Distance Calculus Program, our success rates are dramatically lower. Recently, as part of the ongoing evaluation of our programs and in planning for the future, the School of Mathematics paused to assess the current status of the Distance Calculus Program. The outcomes were uniformly strong and appreciative statements of support for Tom from Georgia Tech administrators and his student evaluations. Here are two student comments followed by other excerpts:



Tom Morley in the distance learning classroom

"I took Distance Calculus in my senior year of high school, and I can honestly say it was an absolute lifesaver...Dr. Morley is incredibly passionate about the subject and never failed to keep us engaged, even when we were just watching the class online."

"I was always in awe of Dr. Morley...he related every concept to real-world applications such as how curl functions could be used in fluid dynamic predictions or how gradients could be visualized in the topography of Peachtree Street."

George Wright, Director of Georgia Tech Online and Professional Education, wrote, "Tom has readily adapted to our newest innovations in online instruction technology without complaint or reservation. He welcomes the opportunity to learn how to use the technology and in many cases adopts it for his other non-online courses as well. As I have stated often, without Tom Morley's willingness to adapt and innovate I have no doubt whatsoever that the current Distance Calculus Program would not be as large and successful as it is. In fact, I have serious doubts that it would even exist."

Rick Clark, Director and Undergraduate Admission Chair, reported that "Dr. Morley's format, teaching style and personalized exchange have drawn many students into the high school program and then led them to Georgia Tech for their undergraduate career. In particular, I have talked to a sizable number of young women who have taken this course and say that participating in the DCP has given them the confidence and exposure they needed to continue to pursue advanced math and STEM fields more broadly. This is a tremendous testament to the passion and dedication that Tom Morley has shown."

So the faculty, administration and students of Georgia Tech would like to take this opportunity to express to Professor Tom Morley our deep and lasting appreciation for his dedicated and highly effective service throughout his career and his extraordinary leadership in conjunction with the Distance Calculus Program.

Another Distance Learning Course for High School Students: Number Theory and Cryptography

by Matt Baker

Editor's note: The following is excerpted from a post that was originally published on the American Mathematical Society (AMS) blog On Teaching and Learning Mathematics. The complete blog article can be found at https://mattbakerblog.wordpress.com/2015/07/01/number-theory-and-cryptography-a-distance-learning-course-for-high-school-students/.

Starting in the fall of 2014, I began offering an online Number Theory and Cryptography course for gifted high school students through Georgia Tech. Fourteen high school seniors from metro Atlanta took the course in fall 2014. (Another fourteen are taking it in fall 2015.)

Matt Baker

I was motivated to create this course because I benefited tremendously from a Saturday course on linear algebra and differential equations when I was a senior in high school—this was one of the key formative experiences that eventually turned me into a successful mathematician. However, I know that most public high school students don't have that kind of opportunity available through their school systems, and I wanted to teach a course, comparable to the one I had attended, using modern technology so that students would not have to show up in person once a week.

Students qualified for the course by successfully completing Georgia Tech's Distance Calculus Program (which covers integral calculus, linear algebra and multivariable calculus) by the end of their junior year in high school. Students received Georgia Tech credit for the course, and their tuition was fully paid through a state-funded financial aid program (originally ACCEL, now MOWR: Move On When Ready).

My course covered basic number theory and applications to cryptography, plus some fun applications to such topics as calendar calculations, music theory and card tricks. A detailed syllabus can be found here: *http://www.math2803.gatech.edu/wp-content/uploads/Math2803Syllabus2015.pdf*.

Students also learned to write proofs and to program in SAGE, and many of them learned LaTeX as well (all homework solutions had to be typed). Final projects included a calendar calculation quizzer for Android phones, a PowerPoint presentation on Furstenberg's "topological" proof of the infinitude of primes and a video on elliptic curve cryptography.

The course followed an asynchronous distance learning model, meaning that students watched videos on their own time rather than attending live lectures remotely. In addition to the usual assignments and exams, they had to present final projects at an end-of-the-semester, daylong "mini-conference" in which the students and I got to meet one another in person. I held weekly video office hours, and there were extensive discussions on the course page in Piazza, which is an integrated online discussion platform designed specifically for academic courses.

These Piazza discussions were productive, as students asked a lot of questions and often answered each other's questions before I had a chance to respond myself, which was great! In addition, there were some Piazza-facilitated interactive homework assignments that worked very well, such as an activity where students posted RSA public keys to Piazza and then encrypted and decrypted messages to one another. Students got extra credit for learning how to calculate (in their heads) the day of the week given a date, and I tested them by video chat.

Most of the videos for the course were filmed during a "pilot" offering of a similar course on campus in fall 2013, and Georgia Tech postdoc **Greg Mayer** helped me edit all the video footage. We broke up the material into roughly five-minute chunks, uploaded the resulting videos to VideoPress and added descriptive captions below each video.

For sample videos from the course, go to *https://vimeo.com/131127032* or *https://vimeo.com/131128434*.

I received a lot of assistance with this course, including help from Greg Mayer, who built the WordPress site in addition to editing the videos; from Nick Culpepper, an undergraduate student who graded all the homework assignments; from Georgia Tech's Professional Education department, which handled the proctoring and mailing of exams as well as the videotaping of the pilot course; and from the Admission Office, which handled accreditation, registration and tuition payment.

I also had help from Georgia Tech's School of Mathematics and College of Sciences, as well as from our CEISMC (Center for Education Integrating Science, Mathematics and Computing) program. I would not recommend embarking on a project like this without a helpful and professional team like I had—they really made the whole experience quite enjoyable and (relatively) painless.

Note: This article is also posted at *http://blogs.ams.org/matheducation/2015/07/01/number-theory-and-cryptography-a-distance-learning-course-for-high-schoolstudents/#sthash.ldpxBIsW.dpbs*.

High School Math Competition

by Robert Rahm

The 2015 Georgia Tech High School Mathematics Competition (HSMC) took place in February. Over three hundred students from more than fifty schools and several states competed. As the name suggests, the competition is meant for high school students, but every year there are several bright middle school students who also compete.

Prizes are awarded to the top five teams and to the top ten individuals. The top four 11th- and 12th-grade scorers receive scholarships to Georgia Tech in the amounts of $4,000, $3,000, $2,000 and $1,000. This year, the top four individual scorers were Benjamin Chen, Henrik Boecker, Jae Woo Pyo and Rickie Jang.

To get a taste of the type of problems that the competitors must solve, consider the following question (taken from this year's exam):

The 20-digit decimal number 60028022015X28022015 is divisible by 11.

What is the missing digit, X? And remember, you only have three minutes to find it!

The competition is organized and administered by SoM student volunteers and staff members. Several improvements to the already fantastic competition were made this year. For example, we offered more money in scholarships than we have in any prior year. The first prize this year was $4,000 compared with $1,500 for the 2014 competition.

The student organizers were Philip Benge, Chairman, who oversaw the financial improvements; Peter Woolfitt, Eric Sabo and Yoan Delchev, Assistant Co-chairs, who were in charge of preparing the exams; and George Kerchev, who oversaw registration. The HSMC T-shirt was designed by Shane Scott.

Annette Rohrs, Sharon McDowell and Kimberly Stanley Jones were our excellent support staff. Finally, there were more than sixty undergraduate, graduate and faculty volunteers who helped on the day of the competition. Thanks to everyone who contributed to a very successful day!

Atlanta Science Festival: Are YOU Curious?

by Evans Harrell

The third annual Atlanta Science Festival will occur during Tech's Spring Break, March 19-26, 2016. This is a weeklong event taking place all over Atlanta, with the aim of engaging the public and showcasing science and its connection to all parts of our lives through hands-on activities.

For the first several days there will be events for all ages throughout Atlanta, including facility tours, presentations and performances. At the end there will be a free EXPLORATION EXPO at Centennial Olympic Park with interactive events, demos and stage shows in small tents, particularly aimed at families. You can find out about schedules and how to get involved at *http://atlantasciencefestival.org/*.

Past festival events included robotic music, science-themed movies, theatrical performances connected with evolution and the chemistry of chocolate, and science-themed stand-up comedy. Tech's School of Mathematics has been represented by Evans Harrell and Lew Lefton since Day One in March 2014. In addition, Matt Baker has performed magic tricks at the variety show. However, there have been a only few events with mathematical themes. Think of a creative way to share with the public what is beautiful and inspiring about our field!

Atlanta Science Tavern
Magic

by Marc Merlin

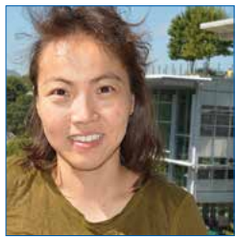
On a Saturday evening in late June this past summer, Atlanta's landmark watering hole, Manuel's Tavern, became a showcase for performance magic as School of Mathematics Professor Matt Baker brought his "Mathemagical Mystery Tour" to over 100 members of the Atlanta Science Tavern, a local grassroots public science forum organized on Meetup.com. See *<http://www.meetup.com/AtlantaScienceTavern/>*. Matt's show explored the boundaries between science and magic, drawing on topics that included quantum physics, knot theory, Charles Darwin (young and old) and, for the neuroscientists on hand, mind reading. All this to the amusement and bemusement of his skeptically inclined audience. Of course, numbers—lots of them—made a special appearance in Matt's finale.

Faculty Awards
July 2014–June 2015

Professor Greg Blekherman was promoted to Associate Professor with tenure in 2014. He was also awarded the Center for the Enhancement of Teaching and Learning (CETL)/ BP 2015 Junior Faculty Teaching Award for his dedication to undergraduate education.

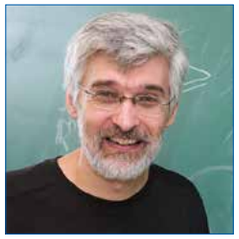
Professor Shui-Nee Chow won the College of Sciences Faculty Mentoring Award for his continuous efforts to support the development of junior faculty members.

Professor John Etnyre received the Simons Fellowship, which will allow him to spend one month in fall 2015 at the Mittag-Leffler Institute of Stockholm, and spring 2016 at the Institute for Advanced Study in Princeton.



Professor Sung Ha Kang was awarded the Cullen-Peck Fellowship in April 2014. This fellowship allows her to support undergraduate and graduate students, and boost her research activities.

Professor Wing Suet Li, Georgia Tech ADVANCE Professor, received the Ralph and Jewel Gretzinger Moving Forward School Award in recognition of her achievements in encouraging diversity in faculty composition, creating a family-friendly work environment and providing a supportive environment for junior faculty.



Professor Michael Loss is the recipient of the Humboldt Research Award, which allows him to work on joint research projects with a group at the University of Tubingen in Germany in fall 2015. Professor Loss will visit other universities while on leave: Paris Dauphine, Rutgers, and the Catholic University of Santiago, Chile. His leave is also supported by a Faculty Development Grant.

Professor Doron Lubinsky was awarded the inaugural Herman Fulmer award for his outstanding service as Director of Undergraduate Studies, his sustained record of excellent teaching and his manifest dedication to all our students.

Dr. Enid Steinbart was awarded the 2015 NACADA Outstanding Academic Advisor Award from the National Academy Advising Association for her commitment to our undergraduate math students. She also received the Georgia Tech Outstanding Undergraduate Faculty-Academic Advisor Award with stipend at the annual spring Center for Academic Success luncheon. Her insight, expertise and experience have guided the undergraduate program of the School of Mathematics for nearly fifteen years, during which time the number of majors has more than doubled.

New Faculty 2015

Michael Damron received his PhD from New York University in 2009 and continued with an NSF postdoc in probability theory at Princeton until 2013, when he joined the faculty at Indiana University. Since grad school, his main mathematical interests have been in probability, specifically models from statistical mechanics like percolation and spin glasses. Recently he has become more interested in ergodic theory.

Last year, the Damrons welcomed a daughter. They enjoy visiting their families, who are now considerably closer. Prior to grad school, Michael played classical piano, so he is excited to hear some of the live music Atlanta has to offer.

Esther Ezra earned a PhD from Tel-Aviv University (Israel) in 2008, working with Micha Sharir and focusing primarily on discrete geometry and geometric arrangements. She was then awarded an IBM PhD fellowship and the Minerva and PIMS postdoctoral fellowships.

During her postdoctoral research at Duke University and later at New York University, Esther expanded her research to approximation algorithms on geometric settings such as the Epsilon-Nets. In 2012, Esther was awarded an NSF grant for her research on geometric optimization. Her current research is focused on discrepancy theory and related probabilistic combinatorics. She is on the editorial board of *Discrete and Computational Geometry*.

During her free time Esther and her husband support their little daughter's gymnastics and swim activities. The family enjoys music together and jazz in particular.

Jennifer Hom earned a PhD from the University of Pennsylvania in 2011 under the supervision of Paul Melvin. Following graduate school, she returned to Columbia University, her undergraduate alma mater, as a Ritt Assistant Professor.

Before joining the faculty at Georgia Tech she will spend the 2015-2016 academic year at the Institute for Advanced Study, an independent postdoctoral research center located in Princeton, New Jersey. Jen was also recently awarded a Sloan Research Fellowship for her work in low-dimensional topology.

Jen enjoys running and playing board games when not at work. She recently ran her third marathon and looks forward to exploring new running routes in Atlanta. Her favorite board games are Settlers of Catan and Carcassonne.

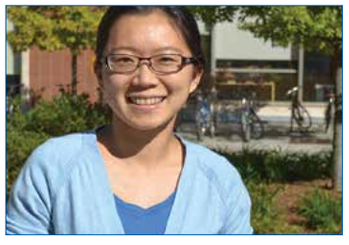
Galyna Livshyts was born in Kharkiv, Ukraine, in 1988. She got her undergraduate and master's degrees from Kharkiv State University in 2010. While pursuing her master's degree, Galyna worked as a math teacher at a high school in Kharkiv.

She received her PhD from Kent State University in 2015 under the supervision of Artem Zvavitch. Galyna works in probability, convex geometry and asymptotic analysis, and specializes in the geometry of log-concave measures and related functional inequalities.

In her spare time, Galyna enjoys jogging, hiking and playing tennis. She also is a big fan of technology, sci-fi novels and classic rock music.

Shahaf Nitzan received her PhD from Tel-Aviv University (Israel) in 2009 for work done under the supervision of Alexander Olevskii. After that she spent a few years at the Norwegian University of Science and Technology, at the Weizmann Institute of Science (Israel) and at Kent State University. Her work to date has been in harmonic analysis, focusing on systems of vectors in function Hilbert spaces.

Shahaf enjoys reading, visiting art and history museums, and attending live theater. In her spare time, she also continues to try to improve her Russian language skills.



Yao Yao received her PhD in Mathematics from UCLA in 2012, working with Inwon Kim. After that, she was a Van Vleck visiting assistant professor at University of Wisconsin-Madison for three years. Yao's research centers on nonlinear partial differential equations. She is especially interested in the equations with a nonlocal structure, which arise naturally in many models in fluid dynamics and math biology.

Yao has been active in mentoring undergraduate research, and she won two teaching awards at UW-Madison.

When she is not doing math, Yao enjoys reading mystery novels, playing accordion and especially exploring local food when traveling.

New Academic Professionals

Gregory Mayer received a PhD in applied mathematics in Canada from the University of Waterloo in 2008. He was a postdoctoral fellow in the Center for Education Integrating Science, Mathematics and Computing (CEISMC) at Georgia Tech, where he developed online courses and programs for high school mathematics teachers and students.

Recently Greg has been supporting and conducting research on courses in our Distance Calculus Program for advanced high school students, and is teaching alongside Professor Tom Morley. Greg is also supporting Professor Matt Baker's online "Number Theory and Cryptography course" for high school and honors program students.

In his spare time, Greg is working on a masters' in education with an emphasis on distance education, and enjoys camping and kayaking in Georgia and Florida.

Sneha Subramanian received her PhD in Mathematics from the University of Pennsylvania under the supervision of Robin Pemantle in 2014, and was a postdoc under Michael Cranston at the University of California, Irvine. Her research is in probability—in particular, random polynomials and random analytic functions.

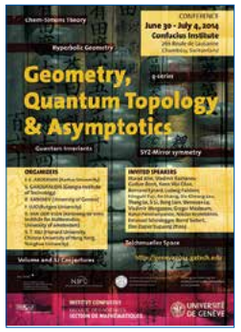
During graduate school at U Penn, Sneha served as a master TA who trained new TAs and supported them during their first semester of teaching. She also received two Good Teaching awards and the 2013 Herb Wilf Memorial Prize for teaching and research.

She was born in Calcutta (India) and raised in Dubai (U.A.E.), which means Sneha has lived in three completely different countries so far! In her free time, she enjoys oil painting, hiking and traveling.

Conferences and Events, July 2014–August 2015

June 30-July 4, 2014
Geometry, Quantum Topology and Asymptotics Conference

Professor **Stavros Garoufalidis** was a member of the organizing committee for the Geometry, Quantum Topology and Asymptotics Conference held at the Confucius Institute of the University of Geneva, Switzerland. Professor **Thang Le** was an invited speaker. The goal of the conference was to bring together world-class experts and young researchers in the field to discuss recent advances.

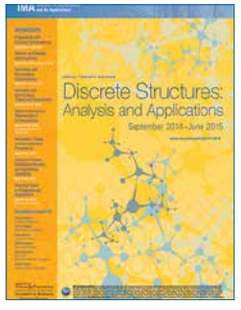


August 4-8, 2014
Internet Analysis Seminar

The Internet Analysis Seminar organized by Professor **Brett Wick** held its fourth conference at Georgia Tech. The focus was on projects related to Hausdorff geometry and singular integral operators. Professor Alexander Volberg was the guest lecturer.

September 2014-June 2015
IMA Special Year on Discrete Structures

Professor **Prasad Tetali** was an organizer of the Institute of Mathematics and its Applications (IMA) Special Year on Discrete Structures. The annual thematic program "Discrete Structures: Analysis and Applications" focused on discrete mathematics, its applications and the overlapping areas of probability and analysis.



Program workshops spanned frontier topics of research in discrete mathematics (including combinatorics and optimization) and probability throughout the year. In the fall term, the program focused on probabilistic, extremal, geometric and enumerative aspects of combinatorics and convex and other nonlinear programming aspects of optimization. During the spring term, the focus shifted to theoretic, geometric, functional and analytical aspects of probability and analysis.

As part of this Special Year event, the March 16-20, 2015, workshop on the Power of Randomness in Computation was held at Georgia Tech. It was also organized by Professor Tetali.

October 31-November 2, 2014
Fourth Abel Conference: A Celebration of Yakov G. Sinai

Professor **Leonid Bunimovich** was an organizer of the Fourth Abel Conference: A Celebration of Yakov G. Sinai, hosted by the Institute for Mathematics and its Applications (IMA). The Abel Conference is an annual conference series that honors the Abel Prize Laureates. It is a collaboration between the Norwegian Academy of Science and Letters and the IMA.

December 5-7, 2014
Tech Topology Conference 2014

Organized by **John Etnyre** and **Dan Margalit**, the fourth annual Tech Topology Conference was held at Georgia Tech. It brought together established and young researchers from around the country for a weekend of mathematics, and among the featured speakers was SoM PhD candidate **James (Jamie) Conway**.

February 9-20, 2015
X Americas Conference on Differential Equations and Nonlinear Analysis

Professor **Rafael de la Llave** was an organizer of the Dynamical Systems Focus Session at the X Americas Conference on Differential Equations and Nonlinear Analysis that was held in Buenos Aires, Argentina. Rafael was also an invited speaker and served on the conference scientific committee.

This conference was a sequel to the Americas Conference on Differential Equations and Nonlinear Analysis series that started in 1994 with a meeting in Taxco, Mexico, and has held regular international meetings ever since. This is the first time the meeting took place in Argentina.

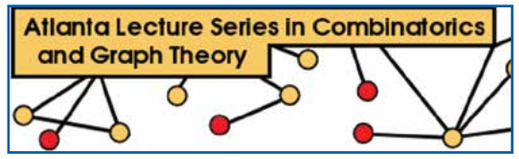
February 26, 2015 2015
STEM Education Research Expo

Klara Grodzinsky presented a poster in the 2015 STEM Education Research Expo at Georgia Tech, titled "Flipping the Class in Calculus I." Students, postdocs and faculty displayed posters and discussed their research at the event, which was an excellent opportunity to find new collaborators or new research questions.

March 8-10, 2015
SEAM 2015—The 31st Southeastern Analysis Meeting

Professor **Brett Wick** was one of the plenary speakers at the 31st Southeastern Analysis Meeting (SEAM) held at the University of Georgia. Brett's graduate student, **Ishwari Kunwar**, gave a 20-minute contributed talk.

April 11-12, 2015
Atlanta Lecture Series



Emory University, Georgia Tech and Georgia State University, with support from the NSF and the National Security Agency, continued the series of mini-conferences and will host a series of nine new mini-conferences between 2014 and 2017. The fifteenth of these was held at Georgia Tech and hosted by Professor **Xingxing Yu**. The conferences address a variety of topics and feature lectures by one prominent researcher, four or five outstanding researchers, and several young researchers or graduate students. This year's featured speaker was Professor David Conlon, Royal Society University Research Fellow at Wadham College, Oxford, United Kingdom.

April 11, 2015
Meeting on Algebraic Geometry for Applications

Professors **Greg Blekherman**, **Anton Leykin** and **Josephine Yu** organized the Meeting on Algebraic Geometry for Applications, where speakers from nearby universities presented their research in the area. Former Georgia Tech graduate student and current Queen's University postdoc **Robert Krone** and SoM postdoc **Rainer Sinn** each contributed talks at the meeting.

May 26-30, 2015
p-adic Methods in Number Theory

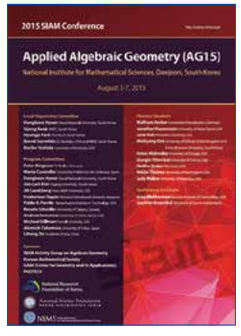
Professor **Matt Baker** was one of the organizers of the conference inspired by the mathematics of Robert Coleman (pictured here). Professor Coleman, who passed away in spring 2014, was Professor Baker's PhD advisor. The conference, held at the University of California, Berkeley, was both a tribute to the memory of Professor Coleman, and a vehicle for surveying recent developments in p-adic analytic geometry and p-adic modular forms and inspiring future breakthroughs. Professor Baker was also an invited speaker at the conference.

July 6-11, 2015
Internet Analysis Seminar

The Internet Analysis Seminar, organized by Professor **Brett Wick**, held its fifth and final conference at Georgia Tech. The topic was related to harmonic analysis associated with second-order elliptic operators.

August 3-7, 2015
SIAM Conference on Applied Algebraic Geometry

Professor **Greg Blekherman** co-organized the SIAM conference on applied algebraic geometry held at the National Institute for Mathematical Sciences in Daejeon, South Korea. He was also an invited speaker for a mini-symposium at the conference, as was postdoc **Rainer Sinn**. Professors **Anton Leykin** and **Josephine Yu** presented at various other mini-symposia at the same conference.



Staff Profile

Kimberly Stanley Jones

by Cathy Jacobson

During her time on campus so far, Kimberly Stanley Jones has had a large impact on the School of Mathematics.

After earning a BA in Finance and an MPA (Master's of Public Administration) with a concentration in budgeting and financial management, both from Georgia State University, Kimberly held several human resource and finance positions in state government. Just prior to coming to Georgia Tech, she was the Division Administrator of the Pulmonary, Allergy and Critical Care Medicine Division at the Emory School of Medicine.

Kimberly joined us in August 2013 as an Administrative Manager. She had some very large shoes to fill after the departures of Christy Dalton and Jan Lewis, but she stepped up and quickly mastered all aspects of the School's human resources, finance and operational functions. In fact, for her first three months, she was completing her obligation at Emory and assuming her new responsibilities with us concurrently.

By late spring 2014, Kimberly had overseen the development of a staff reorganization plan that would bring a higher level of service to the School's faculty and students. This included new faculty support coordinator positions, promotions for several of our long-serving staff, and a thorough redistribution of our operations. In recognition of her excellent work to date, Kimberly was promoted to Assistant Director for Business Operations on July 1, 2014.

Unfortunately, during the late-summer implementation of the new plan, her mother-in-law became quite ill and died, so Kimberly found herself in the intensive care waiting room in LaGrange tending to School issues on her laptop. She is still grateful for the tremendous support given to her by Dr. Ulmer and the staff that collectively saw her through that stressful period.

Kimberly, who was born and raised in Atlanta, has a daughter, Madison, and a stepson, Javante, with her husband Mike, a local police captain. Away from the office, Kimberly loves spending time with her family, taking beach vacations, baking and running. From a family that was involved in and enjoyed sports (her father was the ultimate Little League coach for his children's teams, and one of her brothers played football for Georgia Tech!), Kimberly grew up playing softball and cheerleading. Then, in ninth grade, while watching a track meet, she was tapped to replace a sprinter who had dropped out at the last minute, and soon she found herself drafted onto the varsity track team; she continued to run throughout high school.

Now that she is an adult, running has again become a favorite activity, and in 2013 she and a group of women friends began running 5K races for their getaway days. She completed her first half-marathon this year and is headed to another one in Puerto Rico in November 2015. She trains by running whenever she can squeeze it in, often in the parking lot or on nearby streets while her daughter is at an event or a lesson.

Describing herself as a "Clark Howard type" traveler, Kimberly began visiting different parts of the US, Mexico and Canada after college, and she continues to enjoy travel with her family. In fact, for many years, drawing on her famous management skills, she and her brothers organized an annual family reunion week for 15 people at the beach or in the mountains.

Joanne Cook, a longtime staff member, has been impressed with Kim's efficiency and her willingness to help. She writes, "Soon after her arrival Kim began to familiarize herself with my job so that she could step in for me, if necessary. I have never had a supervisor do that before! She has a very calm and confident manner, is a good listener, and is quick to give credit where it is due. Finally, she has an awesome ability to mentor and cultivate talent. It's a pleasure to work with Kim!"

When asked about the challenges and rewards she has experienced at Tech, Kimberly noted that running out of office and classroom space has been and continues to be a major challenge, while the rewards have been the people—a staff team that works very well together for a faculty that is intelligent, laid-back and appreciative. Plus, she gets to work with what she really loves—the numbers of finance! With so many accomplishments to her credit already, we look forward to many more great things to come from Kimberly!

Graduate

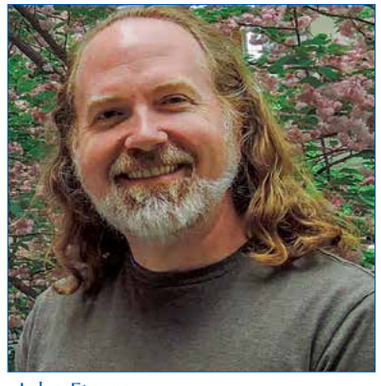
Program News 2014

by John Etnyre, former Director of Graduate Studies

After three years in the making, new guidelines for PhD students in mathematics finally went into effect in the fall of 2015. These changes affect the course requirements and the written comprehensive exams. By providing more program flexibility, the revisions were designed to help students start research sooner and hopefully reduce the time it takes to complete their degree. At the same time, the guidelines ensure that students still receive rigorous training in core fields of mathematics.

The first change is to the course requirements. Previously a student had to complete 51 hours of coursework, but with essentially no guidance or restrictions on what those courses were. In fact, students in the past could obtain a PhD in mathematics without meeting the requirements for a master's in mathematics! Now students need to take only 30 of coursework together with nine hours for their minor; however, the required 30 must satisfy certain breadth requirements spelled out on the department's website. Thus, despite the reduction of total hours required, we expect that students will have a broader understanding of mathematics when completing the program and should easily qualify for a master's degree along the way if they wish to apply for it.

The second change to the program is a new set of written comprehensive exams that a students must pass within their first two years in the program. Previously there were only two exams offered (analysis and algebra), and all students had to pass both exams. In addition, the amount of material on the two exams was not the same; the analysis exam contained more material than the algebra exam. Now we are offering exams in seven subjects—with a uniform amount of material on each exam—but a student still needs to pass only two of these exams. More details on these exams can be found on the graduate programs website.



John Etnyre

To further enhance our graduate students' experience we have created a new course for first-semester PhD students. This course provides Responsible Conduct of Research training that is now mandated for all PhD students at Georgia Tech to comply with regulations from federal funding agencies. More specifically, the course discusses various ethical issues surrounding a career as a research mathematician, such as the peer review process, conflicts of interest, research misconduct, responsibilities of mentors and trainees, and many other essential matters.

In addition the course will help new students make the most of their graduate experience by discussing things like how to choose an advisor, how to get the most out of seminars and conferences, how to build a strong CV while in school and other such essential skills. The course also covers grant writing and information about the academic job market and other job opportunities after graduation. Much of the course is taught in a lively and interactive panel discussion format where faculty members and more senior students present their experiences and take questions from the students. The course was first taught in the fall of 2014, and we are looking forward to continuing and improving this important course.

The final big change for our program is that Mohammad Ghomi took over as the graduate director during the summer of 2015. The graduate program will be in good hands with Mohammad, who will continue to grow the PhD program and increase the diversity of our student body.

Graduate

Program News 2015

by Mohammad Ghomi, Director of Graduate Studies

It is exciting, not to mention an honor, to be entrusted with the responsibility of guiding the graduate program in the School of Mathematics. While the job is certainly time-consuming, I am enjoying more frequent interactions with students and faculty, and have found satisfaction in fulfilling an important function for the school. My predecessor, John Etnyre, worked tirelessly to improve various aspects of the program, and has been very helpful with my transition into this new position. I am grateful to him for his invaluable service to the school during the past three years and for his continued help and advice.

Mohammad Ghomi

As one of my earliest duties, it was my pleasure to meet and welcome our new 2015-2016 class of graduate students in August, and to participate in the orientation activities that were so well organized by Dr. Mo Burke, with help from Klara Grodzinsky and Kenya Payton. This young and energetic class, which consists of 15 PhD and nine Master of Science (MS) students, is quite diverse: five PhD students are in the ACO program, one is in bioinformatics, and the rest are in math; half of the MS students are in the statistics program, and half are in math; five of the PhD and six of the MS students are female; and five of the PhD and six of the MS students are domestic, while the rest come from China, South Korea and Italy. Furthermore, we have three exchange students from Germany plus six visiting students from China, France and Italy.

Certainly, one of the most important duties of the graduate director is overseeing the recruitment of students who are most likely to succeed in our program, while trying to balance their distribution with regard to nationality, ethnicity and gender, working closely with the Graduate Committee. In particular, ensuring that more domestic students study mathematics has been declared a national priority. To this end the School's STEM Grant, which was secured by Professor Luca Dieci, has been a useful tool in maintaining and increasing the proportion and diversity of domestic students.

Another important and related goal is to increase the overall size of the program, given that the School's number of permanent faculty members now stands at 60, while currently we have only 75 PhD students. Since the School engages in a broad range of research specialties and multidisciplinary programs, I believe that we can well afford to grow and achieve a higher student-to-faculty ratio that would be more in line with that of our peer math departments around the country.

In other news, the professional development class begun last year for new PhD students, coordinated by Dr. Marty Engman, has been approved by the Institute's Graduate Committee and will now appear in the official catalogue. Many thanks to all faculty members who participated on different panels in this class to advise the students on various topics.

I look forward to continuing to work closely with our students and faculty members to ensure that things run as smoothly as possible, while exploring various ways we can strengthen our graduate program.

Graduate Profile

JD Walsh

by Alan Diaz

JD Walsh is a third-year PhD student in the School of Mathematics. He won an NSF Graduate Research Fellowship in 2014 and studies numerical approaches to optimal transport with his advisor, Professor Luca Dieci. He is making contributions to the SoM's undergraduate curriculum and has led a regional outreach program as president of Georgia Tech's graduate student AMS chapter. The SoM recently awarded JD a Festa Fellowship in recognition of his academic accomplishments and leadership. He spoke with ProofReader at the end of spring 2015.

Q. So what is optimal transport?

Put simply, we want to move stuff from point A to point B, and we want to know the most efficient way to do it. In mathematical terms it becomes much more complex than that. It has all sorts of applications, from as obvious as "How do we move these shipping containers?" to as subtle as "How do we resolve economic conflicts?"

Q. How did you become interested in this area?

Professor Dieci and I started off two years ago looking at an algorithm of Michael Muskulus of the Norwegian University of Science and Technology, and Sjoerd Verdyun-Lunel of Utrecht University. They were using optimal transport to compare time series data from two dynamical systems, to see if the systems have similar structures. Verdyun-Lunel had visited Georgia Tech in the spring of 2012 and had given a couple of lectures. Professor Dieci said, "Let's look at this paper and see what's interesting."

We thought it could be used for other things besides time series data. What if we applied the same approach to image comparisons? We were trying to compare fingerprint images, because it's pretty clear if you look at the whorls that there's some kind of dynamical system in those lines.

Q. One theme of your recent work is to try to utilize information that is usually disregarded. Can you talk about that?

When you compute optimal transport, you end up with a number, a cost. But in the process of getting that cost, you have to construct a transportation network that then gets thrown away. However, it's important because it has geometric properties: it tells you not just how two systems differ, but where they differ and where they don't.

We began looking at pairs of brain scans from a research paper by a group at Los Alamos: one scan before a brain tumor has developed, and the other one afterward. I was able to replicate the results, and to pull out of it a gradient vector that shows you how it has changed.

Q. You were awarded an NSF Graduate Research Fellowship last year, which gave you the freedom to work full time on research. Yet you have also opted to teach during this time. Can you talk about that decision?

Teaching is what I love doing, and if I can end up in an academic position, I will. Even though we are a research institution, people here care about teaching, and I do too.

Q. Tell us about some of your teaching efforts.

Last semester I was a lead instructor for Survey of Calculus, a course for business and liberal arts majors. By the end of the term I felt that I should have done it completely differently, and I volunteered to write down ideas on how to change the course. Most of the textbooks include a lot of theory that these students likely won't need, and are light on applications that they might find much more useful.

Over the summer I'm scheduled to help Professor Dan Margalit with writing online homework for some of our courses. We're exploring an open source online homework system called WebWork. We want to see if it scales well to large groups, and whether we can make it user-friendly for the faculty.

Q. What do you like to do when you're not working on math?

I volunteer with my wife for Lost and Found Youth, a local homeless shelter. We teach financial management to 18-25-year-olds: how to budget, how to find an apartment, how to grocery shop and how to further their education.

A lot of people aren't aware of how many homeless kids there are in Atlanta; there are 700-800 in that age group. This particular shelter focuses on LGBT youth, who are the fastest growing and largest group of homeless youth. Somewhere between 45 and 50 percent of them have been kicked out of their homes.

Q. This year you were president of our AMS graduate student chapter. Tell us about the outreach program you started.

It is geared toward female and minority math majors in colleges that are located within a day's ride from us. We felt those students didn't hear enough about how great math is and all the things you're able to do with math. Rarely were they told, "Hey, going to grad school and going into an advanced career in math is a great opportunity! It's something you're qualified for. It's something that would be great for you and great for mathematics."

So we got funding from the Provost's fund for Excellence in Graduate Studies (PEGS) to take trips to these colleges and speak about these issues. Math is all about looking at problems from a different perspective. When we have a lot of people with different backgrounds coming into math, we're solving more problems and learning more about the structure of the universe, and that helps everybody.

Alan Diaz

Graduate Profile

Chun-Hung Liu

by Alan Diaz

Chun-Hung Liu earned his PhD from Georgia Tech's ACO program in 2014, writing a thesis in graph theory under the direction of Professor Robin Thomas. Previously he had earned his BS and MS at National Taiwan University. He recently finished his first year as a postdoc at Princeton University. He corresponded with ProofReader by email.

Q. In mathematics and related fields, graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. Please tell us a bit more about graph theory for those who are not familiar with it.

Graph theory is one of the central topics in discrete mathematics and combinatorics. It addresses problems on graphs and offers systematic and efficient ways to solve them. Every graph consists of vertices and edges. Each edge is a link between a pair of vertices, in which case we would say that these two vertices are adjacent. Numerous practical problems can be modeled as graphs.

For example, in a computer network, computers are vertices and the edges represent whether two computers can transmit data directly; in scheduling, tasks are vertices and two vertices are adjacent if the corresponding tasks conflict with each other; in chemistry, atoms are vertices and the edges are bonds between pairs of atoms. Due to this generality, graph theory not only has mathematical merit but also has wide application in other sciences and engineering.

Q. You recently won the School of Mathematics award for Best PhD Thesis. What was your thesis work about?

Let's first consider a natural question: what kinds of graphs can be drawn in the plane without any edges crossing each other? Such graphs are called planar. One important non-planar graph is K_5, the graph on five vertices with all pairs of vertices adjacent. Another is $K_{3,3}$, the graph on six vertices, where the first three vertices are adjacent to all the other three vertices.

On the other hand, deleting vertices or edges from a planar graph preserves the planarity. There is another operation preserving planarity, called contraction, which involves identifying two adjacent vertices as a single vertex. So a graph is not planar if K_5 or $K_{3,3}$ can be obtained from it by vertex/edge-deletions and contractions.

Furthermore, there is another operation that also preserves planarity, called suppression, which involves removing a vertex only incident with two edges and adding a new edge to link the two vertices adjacent to the deleted vertex. In fact, it is not hard to see that suppression is a special case of contraction.

One classical theorem states that a graph is planar if and only if neither K_5 nor $K_{3,3}$ can be obtained from it by vertex/edge-deletions and suppressions. This suggests that contraction and suppression are closely related, and maybe the former can be replaced by the latter. One of the deepest theorems in graph theory is the graph minor theorem: given infinitely many graphs, we can find two graphs such that one of them can be obtained from another by vertex/edge-deletions and contractions. It was proven by Neil Robertson and Paul Seymour in a series of around 20 papers. One might want to replace contractions with suppressions in this theorem.

It is not true in general, but the graphs in all known counterexamples involve a specific structure. Robertson conjectured that contractions can be replaced by suppressions in the graph minor theorem if we restrict the problem to graphs without this structure.

My thesis is dedicated to a proof of this conjecture. In turn, it leads to the existence of polynomial-time algorithms for some problems.

Q. What was it like working with your advisor, Professor Robin Thomas?

Robin is an extremely supportive advisor. Though I knew some graph theory before I came to Georgia Tech, I was completely new to the field of my thesis work. Robin patiently led me into this area and helped me initiate my work. I really appreciated his inspiring ideas and encouragement during my periods of frustration. It would have been difficult to achieve this without his kind help.

Q. What are you working on these days?

I am working on problems in structural and extremal graph theory. One of them involves following two closely related questions in combinatorial optimization: How many disjoint substructures with certain properties in a graph can you find? And how many vertices/edges do you have to delete to destroy all such substructures?

A classic problem is to determine when the solution of these two questions is bounded by functions of each other. The answer is known for the substructures related with vertex/edge-deletions and contractions. I am interested in the case when the substructures are related with vertex/edge-deletions and suppressions, and also in other graph operations.

Q. Princeton is such a famous place, both for math and in general. What is it like to live there?

Princeton is a suburban area. It is quieter and closer to nature compared with Atlanta. I have seen deer twice on campus! But it is still full of energy and convenience. People are friendly, and semesters are shorter and more compact.

Q. When did you know that you wanted to be a mathematician? Tell us a bit about how you decided to come to Georgia Tech.

I have liked math since I was a kid, but I didn't intend to be a mathematician because I was also interested in computer science. During my undergraduate studies, I realized that what I really like is discrete math, which serves as a connection between math and theoretical computer science. The ACO program at Georgia Tech provided me with exactly what I wanted, and I was very fortunate to be able to study there.

Alan Diaz

Graduate Awards

July 2014–August 2015

The School of Mathematics swept the prestigious CETL/BP Campus-wide Teaching Awards last year. Graduate students **Philip Benge** and **JD Walsh** won CETL/BP teaching awards. Philip won the Graduate Student Instructor award, given to an outstanding graduate student instructor who taught his own class. JD won the only Institute-wide award for graduate student TAs. Both awards symbolize Georgia Tech's commitment to promoting exemplary teaching.

The School of Mathematics Graduate Student Awards: Spring 2015

Festa Fellowship: **JD Walsh**
Award includes a cash stipend to the student who shows superior academic and leadership skills.

SoM Best PhD Thesis: ***Graph structures and well-quasi-ordering***. **Chun-Hung Liu**

SoM Top Graduate Students: **Fabio DiFonzo** and **Robert Krone** (not pictured)
Awarded for evidence of superior academics and achievement.

SoM Outstanding Graduate Teaching Assistant: **Elizabeth Bolduc**

Outstanding Student Evaluations: **Victor Bailey** and **Rohan Ghanta** (not pictured), **Alex Hoyer** and **Donald Sampson**
The graduate TAs received certificates of commendation because of the positive student survey feedback on their recitation classes.

Outstanding Math Lab Tutor: **Joseph Moravitz**
Given to a teaching assistant with the most positive student feedback from students who attended the Math Lab the previous spring.

SoM Best S-STEM (Scholarship in Science, Technology, Engineering and Mathematics) Fellow: **Scott Spencer**
Awarded to a student exhibiting superior academic skills who is contributing significantly to the STEM program and the SoM.

Undergraduate

Program News—Fall 2015

by Matt Baker, Director of Undergraduate Studies

There have been many changes in the School of Mathematics undergraduate program in the past year. First of all, there was a leadership transition as I took over the job of Director of Undergraduate Studies from Doron Lubinsky in January 2015. Doron did an excellent job during his time at the helm, and the entire School thanks him for his service.

The biggest change to the program was our revamp of the core undergraduate math sequence in calculus and linear algebra—see the accompanying article by Dan Margalit (page 36) for an overview of what was done and why. The new course sequence was implemented in fall 2015. Each of the new courses has a course coordinator to make sure that the new courses are run in a consistent fashion, and there has been an intensive advising effort to make sure that students and their advisors understand the new system. Many people in the SoM contributed to this successful effort, but I would particularly like to thank Dan Margalit, Christine Heitsch and Doug Ulmer for their strong leadership, and Luz Vela-Arevalo for successfully managing the highly complex details of the transition.

Matt Baker

In addition to the revamp of our core course offerings, we have also created two new courses: Foundations of Mathematical Proof (Math 2106) and a second course in Linear Algebra (Math 3406). Together these courses will replace the old Abstract Vector Spaces (Math 2406), which is being phased out. Math majors will now get a much more detailed introduction to abstract mathematical thinking and methods of proof, which we believe will increase performance and understanding in difficult but essential classes such as Algebra I and Analysis I. In addition, the students will now learn linear algebra in much more depth than ever before. Over a roughly five-year period, Christine Heitsch led the effort to design and implement Math 2106, and the School of Mathematics owes her a debt of gratitude for her hard work.

The School of Mathematics continues to provide important outreach through its undergraduate course offerings as well. We ran a very successful REU (Research Experience for Undergraduates) program in summer 2015. We continue to teach hundreds of talented Georgia high school students every semester through the Distance Calculus Program (see pages 14-15) and have now begun to offer a post-Distance Calculus program (see pages 16-17). We also continue to sponsor the annual Georgia Tech High School Math Competition, which once again attracted several hundred participating students in February 2015.

Our undergraduate math majors are constantly achieving impressively; for example, see the profile of Dylan McKay and the section on undergraduate awards. We have a very active Club Math that meets weekly to discuss puzzles and fun math facts, and an enthusiastic group of around 40 students per year who take the grueling and challenging six-hour Putnam exam. I have been coaching the Putnam team for many years now and we have a crop of new participants this year who are the most talented I've ever seen—you will be hearing more from and about them!

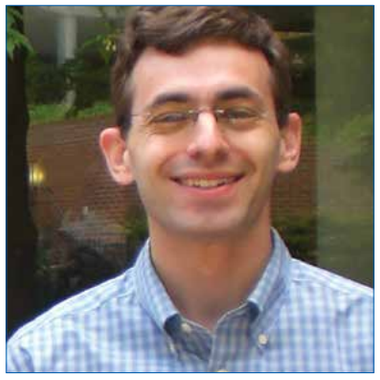
Undergraduate
Calculus Revamped

by Dan Margalit

Over the past few years, the Undergraduate Committee in the School of Mathematics has made an effort to restructure our first-year calculus and linear algebra sequence, which had not changed for a number of years. In the end, this project—known in the School as the Calculus Revamp—resulted in several new courses, as well as a simple but innovative restructuring of some existing material. The old first-year calculus sequence looked like this:

Math 1501: Calculus I, 4 credit hours
Math 1502: Calculus II, 4 credit hours

While this system was effective for many years, it also had its drawbacks. Most obviously, Math 1502 was listed as Calculus II but in fact was a hybrid of calculus and linear algebra. More important, the resulting cutoff points for incoming students were not compatible with their preparation. For instance, students with credit for AP Calculus AB would naturally fall somewhere in the middle of Math 1501, and so they would be forced to either repeat material they already knew or jump ahead. This mismatch had an adverse effect on student morale and student performance.


Dan Margalit

In fall 2015 the School unveiled our new calculus sequence. The first-year sequence now consists of three courses:

Math 1551: Differential Calculus, 2 credit hours
Math 1552: Integral Calculus, 4 credit hours
Math 1553: Introduction to Linear Algebra, 2 credit hours

The content (and the total number of credit hours) in the new system is unchanged, but now each topic has its own course and the cutoff points are consistent with the advanced placement exams. We hope that very few students will be taking Math 1551, thus allowing us to keep the class sizes small for this course.

While Math 1553 fulfills the requirements for much of the Institute, a two-credit course in linear algebra is insufficient for many majors, including our own (anyone familiar with the Google Page Rank algorithm should agree!). As a result, the School created two additional courses in linear algebra:

Math 1554: Linear Algebra, 4 credit hours
Math 1564: Linear Algebra with Abstract Vector Spaces, 4 credit hours

Math 1554 is an expanded version of Math 1553, basically at the same level but with more material. This course will be required for computer science majors, but can be taken by other students who have room in their schedule. It will also be used in our Distance Calculus Program. Math 1564 is an intensive course, with an emphasis on proofs, intended for the strongest students.

The design and implementation of the Calculus Revamp has occupied the attention of the Undergraduate Committee for the past several years. A number of people worked very hard on various aspects of this, most notably Matt Baker, Igor Belegradek, Klara Grodzinsky, Chris Heil, Christine Heitsch, Doron Lubinsky, Tom Morley, Enid Steinbart, Doug Ulmer, Luz Vela-Arevalo, Josephine Yu and myself. Our efforts have been widely recognized and applauded by the Institute.

More important, this change in courses gives us a chance to evaluate other aspects of our teaching at the lower levels. In the coming years, we will continue to experiment with active learning, online homework, clickers, and other technological and pedagogical tools. One particular point of emphasis is to build bridges between calculus and other subjects, by explaining more applications of calculus during our lectures. We hope to be reporting more about these efforts in the near future!

Undergraduate Profile
Dylan McKay

One of this year's Outstanding Undergraduate awardees, Dylan McKay, had an unusual mathematical journey. He writes "During my first year at Georgia Tech, I still didn't really know what I wanted to do with my life, but I fell in love with combinatorics, taking Alan Diaz's Applied Combinatorics class my first semester and Dr. Svetlana Poznanovik's Combinatorial Analysis class my second semester. At least, I thought I did. It was an extremely intuitive field for me at the time, and I had a huge knack for it. But in the middle of my second semester, I stumbled upon *Logicomix*, a graphic novel. Exploring the stories of Bertrand Russell and the people he meets—particularly Kurt Godel—and their mathematical works caused me to really fall in love with logic."

After transferring from Southern Polytechnic State University, Dylan McKay attended Georgia Tech from 2011 to 2015. On finding himself intrigued by the field of logic, he traveled to Budapest, Hungary, for a semester to take logic courses there, and later took graduate-level courses in logic at UCLA's Logic Center Summer School. In addition to his classes, Dylan worked as a research assistant for computer science professors Lance Fortnow and Dick Lipton on computational complexity theory, and was a teaching assistant for five SoM course sections. He also developed android applications used to test the performance of new mobile devices as a summer intern at Intel Corporation.


Dylan McKay

While at Tech, Dylan took the Putnam exam twice, and both times he scored among the top 500. He founded and chaired The Big O: Theory Club, for students and faculty interested in theoretical computer science. He was a regular participant in Club Math, organizing and giving talks, and frequently providing math puzzles.

Dylan is grateful to the School of Mathematics community and wishes to express his thanks. He writes, "Alan Diaz really pushed me when I first met him, Klara Grodzinsky gave me so many opportunities to work as a TA and was very forgiving of my mistakes, Professor Michael Lacey and Dr. Enid Steinbart were great advisors during my graduate school application process, Professor Michael Loss and Professor Thang Le supported me in my journey to Hungary, and instructors Dr. Salvador Barone, Alan Diaz and Shane Scott were all great to work for, as they made me feel like I was really making a difference." And finally, agreeing with his classmate and peer, Gautam Goel, Dylan says that Professor Loss's Analysis class was the best mathematics class he has ever taken.

Always a stellar student, Dylan graduated in May 2015, with bachelor's degrees in discrete mathematics and computer science, both with highest honors. After receiving offers from MIT, Stanford, Princeton, University of Chicago and a host of other universities for his PhD studies, Dylan has decided to pursue his PhD in computer science, starting fall 2015, at Stanford University.

Undergraduate Awards

July 2014–June 2015

Rose McCarty won the ***2015 Mehta Phingbodhipakkiya Memorial Scholarship***. Every year, a junior or senior in the College of Sciences is given this award, which consists of $1,500 and a certificate. This scholarship was established by Maranee Phing to honor her father, his love for physics and the great sacrifices he made to ensure that she would have the very finest education.

Timothy Kierzkowski was the recipient of the ***2015 College of Sciences Undergraduate Research Prize***. This consists of a $250 award and a certificate.

Forrest Kieffer, who is a double major in mathematics and physics, won the ***2015 A. Joyce Nickelson and John C. Sutherland Undergraduate Research Award***, which includes a $3,000 scholarship and a certificate. The award was created by a donation by Joyce E. Nickelson and John C. Sutherland to honor

Joyce's late mother, A. Joyce Nickelson (Mathematics 1962), and the Nickelsons' longtime friend, John C. Sutherland (Physicm BS 1962, MS 1964, PhD 1967). The Scholarship recognizes excellence at the interface of mathematics and physics. It is awarded to an undergraduate student who has jointly studied both and who has engaged in scientific research.

Every year, the SoM Undergraduate Committee recognizes the achievements of our exceptional undergraduate math majors.

Dylan McKay and **Bhanu Kumar** each won a ***2015 Outstanding Undergraduate Award*** with stipend, in recognition of their outstanding academic accomplishments as math majors. Bhanu, who was a double major in mathematics and aerospace engineering, graduated in spring 2015 with a GPA of 3.95, and will be a PhD student at the SoM starting fall 2015. Dylan also graduated last spring, with a BS in mathematics and a BS in computer science, and will pursue his PhD studies in computer science at Stanford University (see page 37).

The ***2015 SoM Outstanding Junior Award*** with stipend was given to undergraduate

Stephen Gillen, who is a mathematics and computer science double major. Stephen has an impeccable GPA of 4.0 and has already been taking many graduate-level classes.

Alex Lind was nominated for the prestigious ***CETL/BP award for Outstanding Undergraduate TA***.

The ***2015 Outstanding Undergraduate TAs*** were **Allyson Rogers** and **Timothy Kierzkowski**. This award, which comes with a stipend, goes to graduating seniors who have excellent evaluations from students and faculty and have been good departmental citizens.

Based on the 2014-2015 student survey responses about their recitations, the following undergraduate TAs received certificates honoring them as having ***Outstanding Student Evaluations***: **Stephen Wang**, **Natchaphon Ruengsakulrach**, **Mihier Gore**, **Derek Kielty**.

FoSoM Giving Back

Eric R. Immel

College of Sciences Eric R. Immel Memorial Award

Georgia Tech alumnus Charles Crawford (Mathematics, 1971) has established the ***Eric R. Immel Memorial Award for Excellence in Teaching***. The award was created to honor the passion and talents of the late Professor Eric R. Immel. A member of the School of Mathematics faculty from 1956 through 1984, Dr. Immel is remembered for his fine teaching abilities in the introductory math courses. In Mr. Crawford's words, "[Dr. Immel] was quiet, often wore the same suit and appeared physically frail, but after a few classes, I knew he was a wonderful teacher. His ability to explain concepts was exceptional, and he never sought to embarrass students who were unprepared or gave incorrect answers. I had him for three quarters of freshman calculus. As a math major, I had many math teachers over my four years at Tech, and many were very good, yet I chose to honor him."

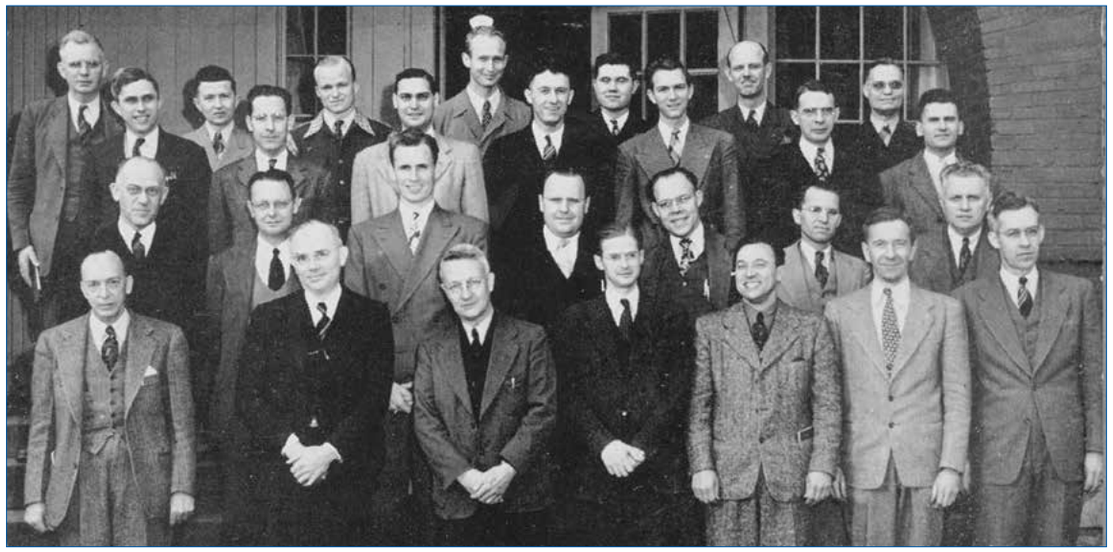
Each fall a College of Sciences junior faculty member will be recognized for exemplary teaching in lower division core foundational courses during the prior academic year. The award includes a $5,000 stipend.

The recipient of the inaugural Immel Award is Assistant Professor **John Wise** from the School of Physics. John is recognized for his exceptional teaching in Intro to Physics II, a course taken by some 90 percent of Tech undergraduates.

Charles Crawford

John Wise

Former Mathematics Professors Honored



The 1948 School of Mathematics faculty

Herman Fulmer

School of Mathematics Herman Fulmer Prize

Georgia Tech alumnus the late Howard Woodham (Engineering, 1948) established the ***Herman K. Fulmer Faculty Teaching Fund Endowment*** for the School of Mathematics. He created the Fulmer Prize in memory of Professor Herman Fulmer, his former mathematics professor, who had a strong influence on Howard as a young student. Professor Fulmer was known to have genuine regard for students struggling with coursework, especially at the freshmen and sophomore levels, and Howard believed that he never would have been successful at Tech and in his later career had it not been for Professor Fulmer's guidance and tutelage.

Born in Como, Mississippi, Professor Fulmer received his BS degree from the University of Mississippi in 1921 and his master's degree from Columbia University in mathematics in 1922. Subsequently, he joined the Georgia Tech faculty as an instructor in mathematics and served as acting head of the School of Mathematics in 1952. The prize honors Professor Fulmer's legacy and devotion to teaching, to students and to the discipline of mathematics.

Howard Woodham

The inaugural 2014-2015 Herman Fulmer Prize was awarded to SoM Professor **Doron S. Lubinsky** in recognition of his outstanding service as Director of Undergraduate Studies, his excellent teaching and his dedication to our students (see page 21).

Alumni News

Welcome to new FoSoM member Ben Elkins, who holds his BSAM (1988) and MSAM (1992) from Georgia Tech.

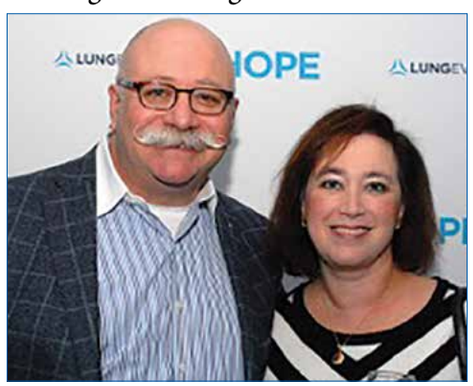
Ben largely credits SoM Professor George Cain for his success in both his academic and his professional life. The two had been in touch regularly since Ben's undergraduate days, and the news of Professor Cain's illness came as a shock to Ben and intensified their communication to daily emails and phone calls. On Father's Day, Ben received a message from Professor Cain's daughter that he had passed from this world peacefully and painlessly.

When Ben was a senior undergraduate, his interest in topology was sparked by Professor Cain and they enjoyed many reading classes together. After graduation, Ben spent a few years working on the least-squares fitting of ellipses and circles problem, pertaining to defense applications in Huntsville, Alabama. He returned for graduate studies in 1991 and ultimately wrote a thesis under Professor Cain's direction in the area of ultra-metric topological spaces.

Ben and Professor Cain's reading classes continued through graduate school, and afterword their joint passion for the mathematical work of Felix Hausdorff, whose more philosophical work under his pseudonym, Paul Mongré, continued to prompt sessions for close to the next quarter century! Together, they tracked down a copy of *Das Chaos in kosmischer Auslese* to read and discussed its ideas at length in the original German. Also, they read together the "Hausdorff Recursion for Aleph Exponentiation," which was one of the first lecture courses in transfinite set theory, and Hausdorff's seminal work, *Grundzüge der Mengenlehre.*

After graduate school, Ben's career transitioned from defense to target marketing applications to the Bayesian linear hierarchical modeling applications utilized in marketing mix analyses. He's now approaching his 10th anniversary with the Nielsen Company, where he has spent time in the Buenos Aires, Oxford and Indian offices. He spent a decade jumping back and forth between Chicago and Vadodara, Gujarat, India, where he taught statistical modeling techniques; he now considers that his second home. "I think my Hindi is almost as good as my Yiddish but not as good as my Esperanto," he recently wrote to a friend. Ben's new role in the company is VP, Client Consultant, located in the Evanston, Illinois offices near the Northwestern University campus. There, he manages the marketing mix engagements of several major companies with a team of analysts.

Ben is married to Ivy Elkins, Princeton (AB 1988), Wharton (MBA 1992), and has two boys, Adam (15) and Jared (13). They live in the northwestern suburbs of Chicago in the village of Buffalo Grove. He is a proud Yellow Jacket alum, having worked for Bobby Cremins tutoring basketball players as an undergraduate, and maintains contact with a few of his classmates from graduate school. He spends his spare time enjoying his family and pursuing his fascination with Hausdorff's work and philosophical ideas. He also enjoys tutoring accelerated high school students who take advanced mathematical coursework and has a large international Esperanto pen-pal letter-writing network that spans the globe. He is an amateur chef and an avid reader and is addicted to *The Notices of the AMS.*



Ben and Ivy Elkins

David Lowry-Duda (BS Applied Mathematics, 2011)

David is a graduate student at Brown University studying analytic number theory under Professor Jeff Hoffstein. He writes, "This has been a remarkable year for me, as my first paper was published and I've submitted three more. Last year, I helped create a new conference for graduate students in the Northeast, and we're planning the third annual rendering for this coming March. Non-mathematically, since graduating from Georgia Tech, I married a wonderful woman named Joanna, and I've become David Lowry-Duda."

Melanie Dunn (BS Discrete Mathematics, 2012)

Melanie Dunn is working as an actuarial consultant at Oliver Wyman. Last year, she became an Associate of the Society of Actuaries and she plans to become a Fellow of the Society of Actuaries (FSA). She says that studying for her FSA exams involves a lot of theoretical mathematical studies as well as practical applications of financial theory. She writes, "I love my job and working with clients, although the large amount of business travel is a challenge. I also like to use my vacation time to the max." She is planning to embark on an exciting two-and-a-half-week-long hiking and biking trip in Cambodia and Laos in December.

Shelby Schuller (BS Applied Mathematics and BS Applied Languages & Intercultural Studies, 2014)

Shelby won the prestigious Woodrow Wilson Teaching Fellowship awarded by the Woodrow Wilson National Fellowship Foundation. The Fellowship focuses on preparing top-quality STEM educators for our nation's most underserved schools. She will receive $30,000 for a specially designed master's program based on a yearlong classroom experience, and three years of support and mentoring while teaching in urban and rural schools. Shelby is part of the first cohort in Georgia.

Gautam Goel (BS Applied Mathematics, 2015)

Gautam won an NSF Fellowship for his graduate studies. He is currently pursuing a PhD at Caltech's brand-new PhD program called Computing and Mathematical Sciences (CMS). He reports that this program exposes him to many different topics, including theoretical computer science, mathematical biology, quantum computing, optimization and machine learning. As for his new life in California, in Gautam's words, "The people are nice and the heat is awful."

Notes from the ProofWriters

Dear Reader,

Transitions indeed! In addition to the ones enumerated by Interim Chair Prasad Tetali in his Notes, the original ProofWriters recently had scattered to the winds. Editor Cathy Jacobson and graphic designer Janet Ziebell had both retired; editor Michael Loss was off to Europe to work on research. So the 2014-2015 academic year slipped by although the Communication, Development and Outreach (CDO) Committee continued to collect stories for the next issue.

About the time Volume 8 was due to appear—October 2015—Prasad put out a plea for help, and the retirees agreed to return for "one more issue." Thanks to the tireless gathering and organization of material by Professor Matt Baker and the CDO Committee during our absence, we had lots of wonderful stories to work with when we began again in October. A big thank-you also goes to Dr. Sneha Subramanian, who joined the team for this issue and became our in-house photographer par excellence! We'd also like to thank Dr. Mo Burke who supported us with back-up editing. This Volume 8 will reach you belatedly in the spring of 2016, and pending funding, we hope to be back on track with Volume 9. Thank you all!

The renovation of Tech tower caused another kink in our process, as all the graphic design hardware and software Janet uses had been located in the College of Sciences Dean's office. That office has temporarily moved across campus to very cramped quarters in the Cherry Emerson building. We are incredibly grateful to Lew Lefton, now CoS Assistant Dean for Information Technology, who graciously shared his office space there with us during the layout and proofing stage, allowing us to print preview copies in color. His consolation when finding no room in his office, was being able to commiserate with Einstein (see page 47).

Given the consummate skills of Professor Michael Loss, founder, and Professor/Past Chair Doug Ulmer, contributor and primary supporter, the *ProofReader* legacy set a very high standard that we have attempted to meet. Although both of them have moved on to other duties, we would like to take this opportunity to thank them for their enormous support of *ProofReader*. Without their leadership and input, we would have found ourselves hard-pressed to produce a little journal that would reflect the heartbeat of the School of Mathematics.

We hope you will find this volume up to the standard that you have come to expect, and we look forward to your feedback. So please let us hear from you, about you and any stories you would like to share related to the SoM. Just write to ***editors@math.gatech.edu***. —Cathy Jacobson, for the Editorial Team

Why Make a Gift?

The short answer is this: your gift can have a large impact on the education and research efforts of the School of Mathematics. Below are some of the many ways this can happen.

A long-standing goal of the School is to have a program of named postdoctoral fellows. These positions are the route to a permanent appointment at a top institution (such as Georgia Tech). Securing sufficient funds to sponsor a permanent postdoc program is a long-term project requiring significant effort, but it promises to contribute greatly to the School's progress into the top ranks worldwide.

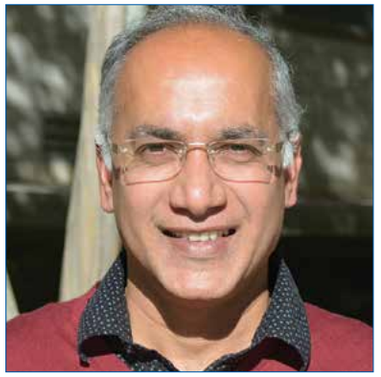
A central part of the mission of the School of Mathematics is teaching, and we have a very talented and dedicated teaching faculty. Recognizing the best of them through awards for excellent teaching and mentoring underlines the importance of these efforts and encourages even more excellence. A named award would be a great way to remember an alumnus or former faculty member who had a big impact on your life.

Our graduate students are integral to all of the efforts of the School—from teaching to research to outreach. They are also the future of the discipline. Supporting them with scholarships, thesis prizes, travel-and-professional-expense funds or other small gifts has a large impact on the School and the discipline.

Everyone knows that college affordability is a serious issue for many families. Funds for undergraduate scholarships help support deserving students as they work toward a very valuable degree.

The High School Mathematics Competition is an inspiring event where students gather with others interested in mathematics and compete for scholarships. It is run entirely by undergraduate and graduate student volunteers, with scholarships supported by corporate and private donations as well as a federal grant. Contributions toward prize money or operating expenses help insure that this event continues and inspires the next generation. (See ***http://hsmc.gatech.edu***.)

We're very grateful for the help of our friends in all its forms, both large and small. If you would like to contribute to any of the efforts mentioned above or discuss other possibilities, please get in touch.



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Share Your Story with *ProofReader*!

Dear Alumni,

We need your news!

What's going on in your professional or personal life?

Please go to ***www.math.gatech.edu/shareyourstory*** and send the following updated contact information along with your news.

Name:

Degree and Class:

Email Address:

Snail Mail Address (new?):

Your News:

Or you can email the same to ***editors@math.gatech.edu***.

We need your photos too.

You can upload a recent high-resolution (300 dpi minimum) photo of yourself at the website or attach it to your email. If the photo was taken on a cellphone, send the "full" size or largest size available.

When your submission is accepted, we reserve the right to edit it for length and style. Be sure to check the box on the website giving us permission to use the material in the next issue of *ProofReader*.

We hope to hear from you soon!

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