# MATHS AND STATS

Mathematics and Statistics | Missouri S&T | Winter 2019

## SHARPENING OUR FOCUS page 4

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## Training native speakers in

# THE LANGUAGE OF THE UNIVERSE

From linear equations to calculus to probability, mathematics is the foundation of every scientific and engineering discipline. It's the training ground where problem-solvers become fluent in the language of the universe.

Your annual support of the mathematics and statistics department is helping build the fluency that will shape our future — because every dollar supports scholarships for mathematicians.

So when you receive your phonathon call in the next few weeks, please take time to talk to your student caller. It's a great way to learn what's happening in our department and across campus. And it's also a great time to give back — because your gift will support the native speakers essential to our future.

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### DEAR ALUMNI, Colleagues and Friends,

Since our last newsletter, the department has experienced many new developments. We bid farewell to several esteemed, long-serving faculty with the passing of Dr. Roman Dwilewicz and the retirements of Drs. Leon Hall, Ilene Morgan and Robert Roe. We have also welcomed Kelley Koob and Drs. Daozhi Han, Wenqing Hu, Nan Jiang and Jason Murphy. We are now a department of 19 tenured, or tenure-track, research-active faculty and four non-tenure-track teaching faculty.

Our classroom effort generates over 26,000 student credit hours annually, the largest for any department on campus, and we mentor up to 70 undergraduate majors and 35 graduate students. Through our long-established program for proper placement of incoming students to our recent redesign of the calculus sequence, our faculty continue a longstanding tradition of promoting student success. Recognition of our teaching faculty has come through multiple teaching awards as well as the promotion of Dr. **V.A. Samaranayake** to the rank of Curators' Distinguished Teaching Professor.



Annually, faculty scholarship has generated over 50 archived publications and 60 conference presentations, up to \$400,000 of externally funded support, and the graduation of at least four Ph.D. students. Five of our faculty are currently either sole principal investigators or co-principal investigators for projects funded by the National Science Foundation, National Institutes of Health and the Missouri Department of Higher Education. Recognition of our faculty has come through research awards, the promotion of Dr. Martin Bohner to the rank of Curators' Distinguished Professor of mathematics and statistics and the election of Dr. Samaranayake to a Fellowship in the American Statistical Association.

Often quietly, our department has been a dynamic part of the Missouri S&T campus and is central to its core mission of educating tomorrow's leaders in science, technology, engineering and mathematics.

As always, we are thankful for your continued support.

Warm Regards,

#### **Stephen L. Clark, Ph.D.** Professor and Chair, Mathematics and Statistics



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- Q&A: Gayla Olbricht
- Olbricht uses statistical methods to help solve biological mysteries.
- A Sharpening our focus

Chair Stephen L. Clark shares how the department has evolved over the past two decades.

### Improving math and science teaching in Missouri

S&T faculty teach Missouri's K–12 teachers how to make math and science more fun for their students.

Sharing a passion for mathematics

> Math junior Tyler Glidden started out an engineering student, but his Calc III class fostered a love of mathematics that inspired a change in majors.

## FACULTY UPDATES

### 👉 ACCOMPLISHMENTS

- Wenqing Hu, assistant professor of mathematics and statistics, was awarded the Miner Alumni Association's Class of '42 Excellence in Teaching Award during Homecoming in October 2018.
- V.A. Samaranayake was named Curators' Distinguished Teaching Professor of mathematics and statistics in 2013. Samaranayake, the first mathematics and statistics faculty member to earn this distinction, was also designated a fellow of the American Statistical Association in 2017.
- Martin Bohner was named Curators' Distinguished Professor of mathematics and statistics in 2013, the first in the department to receive this designation. Bohner is internationally recognized in the field of time scales calculus.
- Xiaoming He, associate professor of mathematics and statistics, spent his sabbatical leave from December 2017 through August 2018 visiting eight universities and centers in China and as a Humboldt Research Fellow visiting the Friedrich-Alexander University Erlangen-Nürnberg in Germany.
- Gayla Olbricht, associate professor of mathematics and statistics, was accepted into the Statistical and Applied Mathematical Sciences Institute program on Statistical, Mathematical, and Computational Methods for Precision Medicine (PMED) for the 2018–19 academic year. She is using the time to expand her research in integrating various genomic data for clinical uses.

## TEACHING AWARDS

Our department continues to excel in teaching, with multiple faculty members receiving the campus Outstanding Teaching Award. The campus has recognized Elvan Akin, Vy Le, Gayla Olbricht and John Singler for their excellence in teaching over the past three years.

### **RETIREMENTS**

- Leon Hall, a professor emeritus, retired in 2013 after 26 years of service to S&T, including several years as department chair.
- Ilene Morgan, an associate professor, retired in 2017 after 23 years at S&T.
- Robert Roe, an associate professor emeritus, retired in September 2018 after nearly 30 years of service.

### (\$) GRANT AWARDS

- > Nan Jiang received \$150,000 from the National Science Foundation for "Efficient Ensemble Methods for Predictive Fluid Flow Simulations Subject to Uncertainty."
- Jason Murphy received \$42,000 from the Simons Foundation in 2018 for a Collaboration Grant. Primarily a travel grant, it provides support from fall 2018 through the end of summer 2023. It provides \$6,000 per year for travel and research expenses and can be used both to fund personal travel as well as to invite visitors.
- Xiaoming He, a member of the computational and applied mathematics group, received \$160,000 from NSF for "Modeling, a decoupled final element method, and analysis for two-phase ferrofluid flows." Cheng Wang, assistant professor of mechanical and aerospace engineering is co-principal investigator.
- Yanzhi Zhang, a member of the computational and applied mathematics group, received \$180,000 from NSF for "Numerical and Analytical Investigations on Nonlocal Dispersive Wave Equations." She hopes to build mathematical and numerical treatments for nonlocal Schrödinger wave equations with long-range interactions.

) MATH NEWSLETTER





## If mathematics is the language of the universe, associate professor **Gayla Olbricht** translates math into biology.

An expert in statistical modeling of biological data, she uses statistical methods to help solve a variety of biological mysteries. We asked her to share a bit about her work.

#### Q: Can you tell us about your current research?

**A:** I have worked on three externally funded projects: mathematical modeling of sleep, Science Education and Quantitative Literacy (SEQL) and a project funded by the Center for Undergraduate Research in Mathematics (CURM).

#### Q: What is the SEQL project?

**A:** It is a professional development program for 3rd- through 5th-grade teachers that focuses on inquiry-based methods for integrating math and science in the K–12 curriculum. The project, led by **V.A. Samaranayake**, was funded for many years by the Missouri Department of Higher Education.

#### Q: I understand the CURM project involved mentoring undergraduates.

**A**: CURM's goal is to help undergraduate students in mathematics develop research skills. For this project, I paired four students up into two teams. One team conducted statistical analysis to determine the locations of the genome that exhibited significant differences in DNA methylation between individuals with and without cervical cancer. The other team used statistical methods to investigate white-matter structural differences in brain regions and the presence of a genetic risk allele for Alzheimer's disease. The idea behind both projects was to use statistical methodology to better understand the

relationship between genetic and epigenetic risk factors and different aspects of human health.

#### Q: Human health is a theme in your third project as well, right?

A: Along with Dr. Samaranayake, I am a co-primary investigator on a National Institutes of Health-funded grant through the National Institute of General Medical Sciences led by Matthew Thimgan, associate professor of biological sciences. This work involves using mathematical and statistical modeling techniques to better understand sleep and its impact on health in Drosophila melanogaster, the fruit fly. Adequate sleep is important to many performance and health outcomes, from cognition to cardiovascular health. Quantity and quality of sleep matter to health, yet many aspects of sleep-wake dynamics are not understood. Fruit flies are ideal for studying sleep since they exhibit molecular, behavioral, and genetic similarities to human sleep. They also have a short enough lifespan to allow us to monitor their sleep and wake activity over their entire life so we can study how sleep features change over time. With the power of mathematical and statistical modeling, we can better understand how sleep-wake transition dynamics relates to the aging process and identify sleep features that could help predict health problems at earlier stages.

Gayla Olbricht joined the S&T faculty in 2011. She holds a master of science degree in applied statistics and a Ph.D. in statistics from Purdue University and a bachelor's degree in mathematics from Missouri State University. In addition to these projects, Olbricht conducts interdisciplinary research with colleagues in biology, psychology, and electrical and computer engineering.

## 

&T's mathematics and statistics department may keep a low profile on campus, but don't let that fool you — there is strength in numbers. Teaching an average of 26,000 credit hours a year, the department has evolved into one that distinctly aligns with Missouri S&T's vision to become a leading public technological university.

Steve Clark, chair since 2013 and a professor of mathematics and statistics, says he's seen the department undergo a "healthy evolution" since joining the faculty in 1987.

"The department's investment in applied mathematics and statistics that began in 2007 is the most obvious transformation," says Clark. "We now have a computational and applied mathematics group, comprising five of our 23 faculty, who solve real-world problems by collaborating with researchers from other fields at S&T, like aerospace engineering and geosciences. Together with our five statisticians, they form the core of an applied emphasis in our undergraduate and graduate programs.

"The group also distinguishes S&T's mathematics program from others in the state," says Clark. "It fits very well on campus by promoting interdisciplinary applied research and development, as well as basic science."

From this group, three faculty members are working with National Science Foundation grants and two have received support from the National Institutes of Health.

"Across the board, we have become more research active with a steady increase in published and funded research," Clark says. "We've never before had so much funded research going on at one time. And with the research, we're graduating more Ph.D. candidates than in the past — up from three or four a year to as many as seven in one recent year."

With funding from the University of Missouri System, S&T's calculus course sequence was redesigned to give students a greater chance of success, and Clark is pleased with the changes.

"Across the board, we have become more research active with a steady increase in published and funded research."

"What were basic calculus recitation classes before are now interactive labs where faculty and graduate students act as guides to answer questions and encourage students to work with each other," says Clark.

The department also incorporated a "fall back" program for calculus students needing extra help to preserve their credit hours and financial aid. "We've been very successful in moving students forward by giving them the time and attention to master the material," he says.

"We've sharpened our focus," says Clark. "With this evolution, our department is fitting well with S&T's mission to integrate education, research and application to create knowledge that serves the state and solves the world's great challenges — we're right where we need to be."

## WELCOME NEW FACULTY



DAOZHI HAN Assistant professor of mathematics and statistics **Daozhi Han** joined S&T in 2017 as an assistant professor after a Zorn Postdoctoral Fellowship at Indiana University. He holds a Ph.D. in applied and computational mathematics from Florida State University and master's and bachelor's degrees in applied mathematics from Central

South University, China. Han's research interests include analysis of partial differential equations in fluid dynamics modeling. He teaches courses in ordinary and partial differential equations.



WENQING HU Assistant professor of mathematics and statistics Wenqing Hu joined S&T in 2016 as an assistant professor after three years as a postdoctoral associate in the School of Mathematics at the University of Minnesota, Twin Cities. He holds a Ph.D. from the University of Maryland, College Park and a bachelor's degree from Peking University,

both in mathematics. Hu studies stochastic analysis applied to stochastic processes, differential equations, dynamical systems and mathematical physics, and teaches courses in advanced calculus, differential equations, complex analysis, linear algebra and stochastic processes.



NAN JIANG Assistant professor of mathematics and statistics Nan Jiang joined S&T in 2016 as an assistant professor after working as a postdoctoral associate researcher in scientific computing at Florida State University. She holds a Ph.D. in mathematics from the University of Pittsburg and a bachelor's degree in computing and information science from

Xi'an Jiaotong University in Xi'an, Shanxi, China. Jiang studies computational fluid dynamics, particularly the numerical methods and analysis for modeling turbulent flow, anomalous diffusion and flow ensemble simulation. She teaches courses in ordinary and partial differential equations.



KELLEY KOOB Assistant teaching professor of mathematics and statistics Kelley Koob, Math'97, MS Math'99, joined S&T as an assistant teaching professor in 2017. She holds an educational specialist degree in information science and technology from the University of Missouri-Columbia. Koob was a lecturer in our department and in business and

information technology from 1999 to 2017. Her teaching interests include incorporating technology in the classroom and improving learning assessment methods, as well as collaborative, blended, flipped and distance learning.



Jason Murphy joined us in 2017 as an assistant professor after a three-year NSF postdoctoral fellowship at the University of California, Berkeley. His mathematics degrees include master of arts and Ph.D. from the University of California, Los Angeles and a bachelor's degree with honors from

the University of Texas at Austin. Murphy's research focus is harmonic analysis and nonlinear dispersive partial differential equations. He teaches courses in linear algebra and harmonic analysis.



## **ALUMNI UPDATES**

- Julie Davenport, MS Math'02, joined William Woods University as an instructor of mathematics. She had taught eighth-grade math and algebra at Lewis and Clark Middle School in her hometown of Jefferson City, Mo., since 2011.
- Edward W. "Woody" Dorrell Jr., Math'68, returned to campus this past May for the Miner Alumni Association's Golden Alumni Reunion.
- Henry Pat Duvall, Math'62, volunteers as a math and physics tutor at South Seattle Community College and recently completed his 13th year as a volunteer for the Boeing Classic Champions Golf Tournament in Snoqualmie, Wa. Duvall received S&T's Award of Professional Distinction in 2004.
- Nicole Galloway, Econ'04, Math'04, was elected Missouri State Auditor in November 2018 after her 2015 appointment to the office following the death of former auditor Tom Schweich. Galloway holds a master's degree in public administration from the University of Missouri-Columbia and is a Certified Public Accountant and a Certified Fraud Examiner.
- Cheryl Tefft, AMth'89, a professional calligrapher based in St. Louis, was featured in the Spring 2018 issue of *Missouri S&T Magazine*. Her work has been featured in *Martha Stewart Weddings, Brides,* and *Bound and Lettered*.



he mathematics and statistics department began redesigning the way it taught calculus in spring 2015 with hopes of improving student success in Calculus I that would translate to subsequent courses.

Approximately 90 percent of S&T undergraduates are enrolled in degree programs that require a calculus course. With that many students passing through the department, it is hard to ensure they are all actually understanding the course material and learning.

Now in full swing, the new course structure allows faculty to identify students who are struggling in Calculus I and give them an opportunity to enroll in a pass-or-fail review course to prepare them for success in Calculus I the following semester.

"Students who are doing poorly tend to stay in the class and simply fail it," says **Paul Runnion**, Math'05, MS Math'07, faculty coordinator for the calculus redesign. "With faculty intervention, they can maintain full-time status while preparing to retake the course at a later date."

Success in lower-level calculus classes has proven to lead to success in advanced math classes and beyond. Students reported grade improvement in physics and other STEM courses, as well. By setting a good foundation early in a student's career, the department hopes to eliminate as many undergraduate struggles as possible.

"The students know the required math — the algebra and trigonometry," says Runnion, an associate teaching professor. "A lot of times, there are other reasons they are failing the class, like a lack of self- or time-management, or simply not knowing how to really study for a math course."

The calculus redesign also included a comprehensive overhaul of the university's online Calculus III course and the introduction of online course options for Calculus I and II. The online courses make it easier for students to complete their mathematics requirements while they are away from campus.



Over 40 elementary and middle school teachers attend the two-week workshop on math and science integration. The program is called Science Education and Quantitative Literacy (SEQL). Carolyn Bereska, a Presidential Award-winning teacher from Maryland, leads the session.

#### IMPROVING MATH AND SCIENCE TEACHING IN MISSOURI

For many years, S&T faculty have been working with Missouri K–12 teachers to make math and science instruction more engaging for students. The Science Education and Quantitative Literacy (SEQL) workshop is a professional development program for math and science teachers, focused on grades 3-5 in the last several years.

**V.A. Samaranayake**, Curators' Distinguished Teaching Professor of mathematics and statistics, says in addition to some stand-alone math activities, faculty use hands-on science experiments and then use the resulting data to add math skills to the program. This approach shows teachers how math and science instruction could be integrated at the elementary level.

"Those teachers who came consistently for three years, we could see improvement in their level of confidence and content knowledge," says Samaranayake. "We also visited schools, and we could see that the way they engaged their students has improved."

Samaranayake says external evaluators also found improvement in student test scores. Faculty say the teachers expand their classroom activities when they better understand the content.

"As they gain knowledge of the topics and concepts, they are more willing to ask questions and modify activities," says **Dave Westenberg**, associate professor of biological sciences. "This is reflected in better preparation for the activities and a greater willingness to let the students explore activities beyond what was planned."

The SEQL program was supported through federal grants, but the latest version of the federal education law eliminated the funding. S&T is working to find other sources of federal and private funds to continue helping Missouri teachers.

Samaranayake says S&T hopes to continue SEQL because it helped teachers reach struggling students.

"We got the teachers to better understand math and science concepts and do a better job of teaching," he says.

Other S&T faculty assisting the SEQL program include **Gayla Olbricht**, associate professor of mathematics and statistics; **Kelley Koob**, Math'97, MS Math'99, assistant teaching professor of mathematics and statistics; and **Michelle Schwartze**, assistant teaching professor of teacher education and certification.



## LEON HALL WINS STATE SERVICE AWARD

Leon Hall received the Missouri Section of the Mathematical Association of America's (MAA) Meritorious Service Award during MathFest in Denver in August 2018. Hall, Math'69, MS Math'71,

PhD Math'74, a professor emeritus of mathematics and statistics, joined the faculty in 1985 and served as department chair for 15 years before retiring in 2013.

Nominators say Hall was a section pioneer in the use of computational tools in mathematics. He organized Derive and Mathematica Workshops, and ran a Mathematica session at the 1991 Missouri Section meeting.

More recently, he was part of the Missouri group involved in discussing and planning the historic joint meeting of the Iowa, Kansas, Missouri and Nebraska/SE South Dakota Sections held in Maryville, Mo., in 2013. He has contributed or refereed several articles for The American Mathematical Monthly, The College Mathematics Journal, and Mathematics Magazine over the years.

"My thirty-plus-year professional association with the people in the Missouri Section has been one of the most rewarding parts of my mathematics career," Hall wrote in his remarks.

Hall has held several positions in Missouri's MAA section, including vice chair, chair and governor. He also helped coordinate exams for American Mathematics Competitions in the state.



Professor emeritus of mathematics and statistics



## DESIGNING A NEW WAY TO LEARN

Courses have a "best-by" date, and once it passes, the classes become less engaging. Materials need updates, technology changes and grows, and teaching styles evolve. Along with the Calculus I redesign, our faculty have changed the way online courses are presented.

Students in the Success for Calculus course work through guided activities in groups and present their solutions to their classmates.

"While we redesigned the class, we had to ask ourselves, 'How do students learn, and how can we convince them to learn what they need in order to → succeed?'," says **Barbara Wilkins**, Hist'94, MST Math'06, a lecturer in mathematics and statistics and an instructional designer in educational technology.

"For example, students are now being assigned reading in their math classes. They must learn to read their math books and other technical manuals so they can see that they are tools and guides for the class."



#### BARBARA WILKINS Lecturer in mathematics

and statistics and an instructional designer in educational technology



#### SHARING A PASSION FOR MATHEMATICS

When St. James, Mo., native **Tyler Glidden** graduated from high school, he wanted to be a chemical engineer like his uncle. And he wanted to earn his degree from Missouri S&T because he knew S&T had a great reputation for engineering.

But it only took one mathematics course to change his mind — Calculus III with **Reginald Brigham** (Math'04, MS Math'06, PhD Math'17).

"No one loves math more than I do," says Glidden, who is now a junior in applied mathematics.

Despite the change in major, Glidden says leaving S&T was never an option.

"I stayed at S&T when I changed my major because I loved the atmosphere and the people I met during my freshman and sophomore year," he says.

Today, Glidden works in the new student programs office as a Preview Registration and Orientation (PRO) leader.

"Being a PRO leader is one thing that made a huge impact on my college career," Glidden says. "As a team, we put together orientation for all freshman and transfer students. I'm so much better at introducing myself and talking to people. Being a PRO leader teaches all those soft skills that I never thought I would develop."

When he isn't studying or guiding new Miners, the former high school football player and pole vaulter enjoys spending time outdoors, and gets back to the track whenever he can.

"I am a volunteer coach for the track and field team at the St. James high school," Glidden says. "I get to work with the pole vaulters and guide them to success."

That experience will come in handy in the future. After pursuing a master's degree in his field, Glidden wants to teach math and coach track and field.

"Hopefully I am able to share my passion for mathematics with a wide variety of people," he says. "There just aren't enough people who appreciate math, and I want to change that."



Missouri S&T researcher Xiaoming He tracks the flow of water and waterborne pollutants as they wash through soil and rocks. He develops and analyzes a mathematical model to simulate the subsurface ground water systems before developing a numerical method for the simulation.

## **APPLYING MATH**

esearchers in the Missouri Institute for Computational and Applied Mathematics Sciences at Missouri S&T are using mathematical modeling in projects from potential drug delivery improvement to better earthquake preparedness.

Associate professor **Xiaoming He** is working on projects funded by two National Science Foundation (NSF) grants. One project focuses on data-enabled modeling, data assimilation, and analysis for coupled dual-porosity flow and free flow. The research could apply to groundwater systems, petroleum extraction and biochemical transport. He's team will study the mathematical side of the research with Craig Douglas at the University of Wyoming and compare the results to lab experiments performed by **Baojun Bai** and **Mingzhen Wei** at Missouri S&T.

He's other project examines two-phase ferrofluid flows to better understand this magnetic liquid material and its potential applications. Ferrofluids are liquids with dispersed ferromagnetic particles suspended in a carrier fluid. They could be used in applications like better drug delivery systems in the body. He's team will look at the mathematics with a collaborator at the University of South Carolina and his Missouri S&T co-PI **Cheng Wang** in mechanical engineering will perform laboratory experiments to validate the proposed models and numerical schemes.

Yanzhi Zhang, an associate professor of mathematics and statistics, studies fundamental issues related to mathematical modeling and numerical simulations of nonlocal dispersive wave equations, as well as the properties of their solutions. For example, experiments in low-temperature physics, including Bose-Einstein condensation and superconductors, can be cost prohibitive. Mathematical modeling of these experiments helps researchers better understand the physics behind the experiments.

Zhang is also researching the applications of seismic imaging. Understanding the structure of the earth can help with earthquake preparedness and finding oil. Large amounts of data are gathered from seismic exploration, and Zhang's research touches on the predictive 3-D modeling capabilities of these fields and the structure of the Earth's subsurface. Her work could help communities understand the shockwave effects of an earthquake.

### PREMIER POST-DOCTORAL FELLOWSHIPS AWARDED TO PH.D. GRADUATES

Two S&T mathematics Ph.D. graduates are the department's first to obtain postdoctoral appointments in Ph.D.-granting mathematics departments. The appointments are additional research opportunities from senior academic mentors that are awarded through a competitive application process.

Siwei Duo, PhD Math'17, is a postdoctoral fellow in the University of South Carolina's Interdisciplinary Mathematics Institute. Her mentor there is mathematics professor Hong Wang, an expert in numerical approximation to differential and integral equations and scientific computations.

At S&T, Duo was a doctoral student of associate professor **Yanzhi Zhang**. Duo's thesis, titled "Numerical Investigation on Nonlocal Problems with the Fractional Laplacian," focused on developing efficient and accurate methods to solve problems arising in ultra-lowtemperature physics. Her research interest is mathematical and numerical issues of anomalous diffusion, phase field problems and wave propagation.

Yangwen Zhang, PhD Math'18, started a postdoctoral fellowship this past fall in the University of Delaware mathematics department. Zhang and his mentor, Peter Monk, UNIDEL Professor of Mathematical Sciences, worked on a project titled "Integrated Simulation of Non-Homogenous Thin Film Photovoltaic Devices."

Zhang, who received three postdoctoral offers, studies control theory, model order reduction, scientific computing and numerical analysis. He was a doctoral student of S&T associate professor **John Singler**.

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## GRADUATION Doesn't mean Goodbye

Tell us how you're doing. We'd love to hear about new appointments, degrees earned, job promotions, family news or other professional news.

Get in touch with us by emailing **math@mst.edu**. Tell us what you're doing with a degree in mathematics and statistics so we can feature your accomplishments among our alumni achievement stories.