Newsletter of the Department of Mathematical Sciences @ University of Delaware

RECKONINGS

SUMMER **2017** AND **2018**

Message from the Chair

LOUIS F. ROSSI

Dear Friends and Alumni,

This has been a key time of renewal and growth in the Department of Mathematical Sciences, and I am excited that we can share some recent developments with you in this issue of *Reckonings*.

Our faculty, students and alumni are the engine that moves the department forward. Just this week, as the Development Committee was putting the finishing touches on this `double issue', I received a happy email from one of our students who was admitted to a top graduate program and a note from one of our PhDs who had to choose between a faculty position and a staff scientist position at NIST. These two examples remind me of the power and reach of our initiatives and our programs.

Mathematics as a discipline evolves like anything else, and as a department, we evolve with it. There is no more profound way of bringing change than through careful and strategic hiring. We were excited to welcome seven new faculty to our department in the fall of 2017. They bring a wealth of expertise to us and their contributions are already being felt. They add to a department of top scholars and educators. In these pages, you will read about the incredible achievements of our faculty and students. I know you will find it informative. The latest news is always posted to our website at www.mathsci.udel.edu. We always welcome updates or a visit from our alumni. When you have a chance, send us a note at math-contactus@udel.edu or Tweet at #UDmath.

Louis Rossi
March 2018

Inside

2017: A Successful Year for UD's Math Major

BY PROFESSOR MAHYA GHANDEHARI

Over the past year, undergraduate students in the Department of Mathematical Sciences have earned national and international honors in fellowships and competitions alike.

Two secondary mathematics education alumni won a prestigious **Knowles Science Teaching Foundation (KSTF) Fellowship.** Amy Fligor (Class of '17), and Anthony Reid (Class of '16), have been awarded teaching fellowships that will provide them with over $40,000 of resources over the next five years. Amy Fligor is

Amy Fligor

teaching at Germantown Friends School in Philadelphia. Antony Reid is teaching at Howard High School of Technology in Delaware and currently attends Wilmington University as a M.Ed student with a concentration in Instruction: Teaching and Learning. As a Blue Hen, Reid realized his true calling was in mathematics education. Dr. Cirillo and Dr. Flores inspired Reid, "both showing a passion for instruction and for their students." Anthony aims to cultivate a learning environment where students "feel confident in class and have teachers who love the

Anthony Reid

content, just as much as the teacher loves working with the students. I want students to learn to persevere, and become advocates for themselves and become active participants in their own education." (Reid)

KSTF is a non-profit organization dedicated to providing beginning math and science teachers with professional development, resources, and support to improve STEM education in U.S. schools. The organization seeks "dedicated, passionate individuals who are committed to teaching, who demonstrate the potential to develop exemplary teaching practices, and who have the potential to lead and drive change in education." Because only about 35 students are chosen nationally each year, it is truly remarkable to have two of these 35 come from UD's Secondary Education Program.

UD Students also competed in the **Mathematical Contest in Modeling (MCM),** an international contest for high school students and college undergraduates. Three teams of three UD students competed, earning titles "finalist" (Yongduo Liu, Dehu Kong, and Yunyao Li), "successful" (Jon Clifford, Jerome Troy, Rob Jaquette), and "honorable mention" (Barry Moe, Scott Fones, and Cory Nunn.) Of the 8,843 teams that competed, only the top 98th percentile of teams received the "finalist" title. MCM challenges teams of students to clarify, analyze, and propose solutions to open-ended problems. The contest attracts diverse students and faculty advisors from over 900 institutions around the world." (Consortium for Mathematics and Its Applications).

Jennifer Fanelle, Quentin Dubroff, Chunxu Ji, Joseph Buxton, Zachary Moseder, and Jiaru Wu represented UD's Mathematical Sciences Department in the **Putnam competition,** a "preeminent mathematics competition for undergraduate college students in the United States and Canada [... where] participants work individually on 6 challenging mathematical problems. Although participants work independently on the problems, there is a team aspect to the competition as well." (Mathematical Association of America)

Of the six mathematics majors, Quentin Dubroff (class of '17) scored highest in the competition. Dubroff intends on pursuing a Ph.D. after conducting research this year in Switzerland. While "participating in the competition did not impact my future plans, it was humbling to see clever solutions from other students across the country. I believe that participating in the competition allowed me to develop perseverance for solving problems." Quentin, originally a Chemical Engineering major, thanks "Professor Rakesh, who not only gave fun problems in honors calculus, but was also very helpful in my switch into the math department, as well as Professor Lazebnik who has consistently given great lectures that continue to energize and enkindle my love for math." He aims to "emulate the helpfulness of many professors," whose love of math greatly influenced his future desire to teach. (Dubroff)

Undergraduate Research in Quantitative Biology

BY PROFESSOR PAK-WING FOK

Four of our Quantitative Biology undergraduates had success in 2017 when their MATH512 ("Contemporary Applications of Mathematics") capstone project was published in the *American Journal of Undergraduate Research*. Rachel Austin, Scott Fones, Dominic Santoleri and Kaitlyn Thomesen explored a model of platelet activation and signaling using ordinary differential equations (ODEs) when they took MATH512 in Fall 2016. By non-dimensionalizing the ODEs of an existing model from Dunster et al., PLoS Computational Biology (2015), they identified several large parameters which allowed them to find some explicit analytic approximations using classical ODE theory. In the spring semester of 2017, they voluntarily put in the extra time and effort to bring their report up to publication standard. After several rewrites and making some modifications in response to a reviewer's suggestions, their work was officially accepted for the November issue of AJUR. The journal is competitive and has an acceptance rate of about 22% and we are very pleased for Rachel, Scott, Dominic and Kaitlyn. We wish them all the best for their future careers.

The full citation for their work is: R. Austin, S. Fones, D. Santoleri, K. Thomesen and P.-W. Fok, *Derivation of Explicit Solutions Describing Early Stages of Platelet Activation,* American Journal of Undergraduate Research 14 (3) pp 101 - 117 (2017).

At the time of writing, Rachel is serving as an AmeriCorps member with City Year Philadelphia. Scott Fones is on his way to graduating with his BSc in Quantitative Biology (minoring in Computer Science), Dominic Santoleri is in the Biochemistry and Molecular Biophysics PhD program at the University of Pennsylvania and Kaitlyn Thomesen is pursuing her MBA with a concentration in Healthcare Management at the University of Delaware.

Practice AP Statistics Test

BY BRYAN CRISSINGER

On Saturday April 29, 2017, 93 high school students from 11 area high schools and 5 high school teachers participated in the fourth annual Practice AP Statistics Exam hosted by the Department of Mathematical Sciences. Held about a week and a half before the actual AP Statistics exam, the event gave local high school students the chance to practice taking the exam in a realistic setting and to get feedback from experienced AP statistics teachers. The practice exam is written by a team of statistics teachers from several high schools and universities across the country including the University of Delaware and Clemson University. Most members of the team are also long-time AP Statistics Readers.

High school teachers were also encouraged to participate and those who did were trained on the scoring rubrics for the free-response questions and then graded the students' responses. After the exam, students had a break for lunch and then were debriefed on the exam where they were provided feedback on the scoring rubrics and common mistakes to avoid. They were also given a way to estimate what their AP score would have been had the exam been the actual AP Statistics exam. The goal of the AP program in general and this practice exam project in particular is to improve college readiness among high school students by exposing them to university-level expectations.

This partnership with the local high school statistics community has been very well-received. In a survey of participants, many students mentioned that they liked the realistic setting of the exam and the immediate feedback they received. Several teachers mentioned that the training on the rubrics and then using the rubrics to score students' responses was very helpful.

Students commented favorably about the event. For example, one said "It gave me a good sense of the time and feel of the test, and it showed me easily corrected mistakes that will help me on the actual test." Another said "This was a really helpful event, and I wish other AP exams had events like this :) Thank you so much for hosting this practice exam!!!". Teachers were also positive commenting that "I especially enjoyed working with other AP Stat teachers from the area — we had great content and process discussions." as well as "Students really benefit from the practice. Really like the fact they see the types of free response including the big analysis one because they don't see many of them."

Planning has begun for the 2018 Practice Exam event. If you have any questions or would like to participate, please feel free to contact Bryan Crissinger (crissing@udel.edu).

Annual Winter Research Symposium Puts Our Best Foot Forward

BY PROFESSORS L. PAMELA COOK AND RICHARD J. BRAUN

The ninth annual Department of Mathematical Sciences Winter Research Symposium (WRS) was held Friday February 9th in Gore Hall. Dr. Rakesh, Acting Associate Chair of the Department, opened the event by noting the important contributions of the graduate students to the event. About 100 attended the event, including faculty, graduate students, family, friends and potential recruits for the coming year.

Back row: Richard Braun, Michael Bush, Tom Brown
Front row: Emily Bergman, Constanze Liaw, Lan Zhong

A number of departmental prizes were given at the start of the event. The winners of the AWM travel awards were announced by Assistant Professor Dr. Constanze Liaw: Emily Bergman and Michael Bush each were awarded travel reimbursements. Dr. Richard Braun, Professor and Director of Graduate studies, awarded the Wenbo Li Scholarship. The award is in memory of Dr. Wenbo Li, a Professor in the department who passed suddenly five years ago. This cash prize recognizes an outstanding paper that is primarily authored by a graduate student. This year, the prize was awarded to two students. Mr. Thomas Brown won for the paper "Evolution of semidiscrete system modeling the scattering of acoustic waves by a piezoelectric solid" and Ms Lan Zhong won for the paper "Mathematical modelling of glob-driven tear film breakup."

There were eight talks given by graduate students: of these, six were senior students (K. Alton, Z. Bailey, S. Cowall, A. Hungria, M. McGinnis, Yinxiang Zhou) and as well as the two prize recipients (T. Brown and L. Zhong). There were also 12 posters presented; this large number indicates the health and growth of the program.

Finally, there was also an invited alumni talk. The speaker this year was Dr. Kara Maki. Dr. Maki, currently an associate professor at Rochester Institute of Technology (RIT), received her Ph.D. in applied mathematics from the Department of Mathematical Sciences under the direction of Dr. Braun in 2009. Her thesis topic was computational models for tear film dynamics. After completing her Ph.D., Dr Maki spent two-years as a postdoctoral fellow at the Institute for Mathematics and its Applications at the University of Minnesota before joining the faculty at RIT. Dr. Maki spoke on the topic of her current research: A Mathematical Study of the Influence of a Blink. Most of the talk described a model for the interaction of the tear film with a contact lens; with support from Bausch and Lomb, she has developed what may be the most successful model explaining how a contact lens centers itself.

At the end of the WRS, awards for best posters were given; these awards consisted of travel reimbursement. The posters were judged by visiting faculty in the Department using a detailed rubric. The Two Best Poster awardees were: Mr. Kristopher Hollingsworth and Mr. Hua Chen. Honorable mention went to Mr. Samuel Cogar and Ms. Emma Pollard.

The event made a good impression on the recruits. One recruit commented to Dr. Braun about how professional the talks were; he couldn't believe that students were giving them. The faculty is proud to have helped these students make the journey to completing their theses and starting their professional careers.

Dr Kara Maki, speaker at
the Winter Research Symposium

The University Graduate Scholar Awards

BY PROFESSOR RICHARD J. BRAUN

Left to Right: Richard Braun, Michael Bush, Lucas Quintero, and Melissa Fuentes, with Carl J. Rees' portrait (former chair of math and provost of the university) in the background

The Department of Mathematical Sciences is very happy to have three students who have won University Graduate Scholar Awards this Spring. Michael Bush received his renewal for a second year of this award. Melissa Fuentes and Lucas Quintero won the award for the first time this spring.

MICHAEL BUSH

Michael Bush is a 2016 graduate of The College of Wooster, with a Bachelor of Arts in Mathematics and Physics. He has passed his preliminary and candidacy exams, and he is being supervised by Constanze Liaw, Assistant Professor of Mathematics. His research is in finite rank perturbations using tools in complex and functional analysis. Michael describes his roots as humble and that he was taught the value of education from an early age. He also learned compassion from his parents, and he won a campus-wide award at Wooster for his volunteering to help the homeless. He is also active in the Graduate Student Association on campus.

MELISSA FUENTES

Melissa Fuentes graduated with Bachelor and Master degrees in Mathematics from Montclair State University. She has passed her preliminary and candidacy exams, and is currently investigating an extremal graph theory problem which involves maximizing the number of proper 5-coloring of graphs with a fixed number of vertices and edges. Her advisor is Felix Lazebnik, Professor of Mathematics. Aside from doing mathematics, Melissa trained in classical and modern dance for 20 years, and is also a skilled classical and contemporary pianist. She is currently a voluntary instructor for the UD Zumba Club.

LUCAS QUINTERO

Lucas Quintero graduated from the Colorado School of Mines with Bachelor and Master degrees in applied mathematics. He has passed his preliminary exams, and his research is on dynamics and flow of polymer solutions. His PhD advisor is Pamela Cook, Unidel Professor of Mathematical Sciences, Professor of Chemical Engineering, and Associate Dean of Engineering. Lucas was raised in Colorado, and found that Mines had a strong effect on him because it fostered his love of applied mathematics. He is also an avid hiker and tennis player.

The awards will support each of them for twelve months starting July 1, 2018. Awards are competitive and are based on academic achievement as well as membership in historically underrepresented groups. University Graduate Scholar awards are for one academic year, though students may be nominated for a second year.

FEATURED GRADUATE STUDENTS

OUR FEATURED GRADUATE STUDENTS IN THIS ISSUE WERE JOINT WINNERS OF THE "BEST POSTER" PRIZE AT THIS YEAR'S "WINTER RESEARCH SYMPOSIUM"

THOMAS BROWN

I grew up in Bedford, Virginia, a small town in the shadow of the Appalachian mountains. In 2007, I graduated from Lynchburg College in Lynchburg, Virginia with a double degree in music performance and mathematics. At the time, I fancied myself a musician and this misconception led me to briefly pursue a Master's degree in music theory at the University of North Carolina in Greensboro. Though I didn't finish the degree, the experience had a profound impact on me in the sense that I realized that my future would be tied to mathematics. Due to this epiphany I abandoned my music education and spent five years as a high school math teacher in Pittsylvania County, Virginia. During this time, I earned my Master's in Science Education with an emphasis in Mathematics (because Lynchburg College did not offer a math education Master's degree at the time), and with the encouragement of my professors decided to pursue a Ph.D. in math.

I began my studies at the University of Delaware in the Fall of 2013. After quickly discovering that teaching high school mathematics does not adequately prepare one for graduate school, I worked very hard to begin filling in the gaps in my knowledge. During my first summer, I worked with Constantin Bacuta on stable pairings of spaces used to solve the Stokes equations using Finite Elements. This research highlighted to me the joys of working in numerical analysis where the interactions between theory and practice lead to interesting and rewarding research. I joined the research team of Francisco-Javier Sayas in February 2015 and have enjoyed the many challenging projects tackled both one on one with my advisor and together with the other members of Team Pancho.

I have been fortunate to have the opportunity to present my research at such conferences as the 2017 SIAM Conference on Computational Science and Engineering in Atlanta, the 2017 SIAM Conference on Analysis of Partial Differential Equations in Baltimore, the 13th International Conference on Mathematical and Numerical Aspects of Wave Propagation (WAVES) 2017 in Minneapolis, various incarnations of the Finite Element Circus, and most recently at the 2018 Joint Math Meetings in San Diego. I am the recipient of the 2016 Baxter-Sloyer award for excellence in teaching and the 2018 Wenbo Li award for excellence in research. I have also attended summer schools in Ciudad Real, Spain and Houghton, Michigan.

I am happily married to the most wonderful and supportive wife anyone could ask for, Katie. Together we enjoy going on hikes in the surrounding area, adding to our every expanding collection of vinyl records, or just staying home and playing old Nintendo games. I am extremely grateful for the help and encouragement I have received from Professor Sayas and the other members of Team Pancho past and present, as well as the larger community in the Department of Mathematical Sciences at UD. While I do not yet know what new adventures await me, I am very happy that I have had the opportunity to be a part of this department.

LAN ZHONG

Lan Zhong grew up in Chengdu, Sichuan, which is known as the "Land of Abundance". Chengdu is very famous for Pandas, Sichuan Cuisine, Shu Brocade and many other things. Lan did her undergraduate study in mathematics at University of Science and Technology of China. After getting her Bachelor degree, she decided to pursue a Doctorate degree in mathematics.

Lan's doctoral research is being supervised by Professor Richard Braun, focusing on developing and solving PDEs-based models to simulate rapid tear thinning. This problem aims at revealing mechanisms of rapid thinning where the tear film thins dramatically in under a second. The tear film is a multi-layered thin film over the cornea, and is comprised of an oil layer, aqueous layer and glycocalyx. When the tear film thins abnormally, it may cause pain and ocular inflammation. The model is based on a physical hypothesis that the non-uniform lipid layer, which coats the aqueous layer, will result in a strong tangential flow by the Marangoni effect and drives the water away rapidly. The model successfully captures the short time scale in in-vivo experiments and its predictions match well with experimental observations. With this model, Lan is also studying how ophthalmologists can improve the imaging of subjects' eyes with rapid tear thinning. This study has generated three publications covering the development of the model for simulation, extending the model for the imaging of subjects' eye and validating the model by comparing the model results with the experimental results.

During her time at UD, Lan actively attended summer schools and workshops at different institutes such as the Mathematical Sciences Research Institute, Institute for Mathematics and Its Application, and the Mathematical Biosciences Institute. She also presented her research results in many conferences across different disciplines such as physics, vision science and mathematics. These experiences broadened her view of cutting-edge research in many fields and also enabled her to build connections. After graduation, Lan will start her career as a mathematician in industry.

During her stay at UD, Lan has been positively influenced by graduate students, faculty members and staff in the math department. Among all of them, she specially thanks her advisor Prof. Braun for his patient guidance and support.

AWM's Year of Community Building

BY EMILY BERGMAN, VICE PRESIDENT

> "True community requires commitment and openness. It is a willingness to extend yourself to encounter and know the other."
>
> - Davis Spangler

In 2017, our Association for Women in Mathematics (AWM) chapter focused on the mathematical community at the University of Delaware. One of the purposes of AWM is "to promote equal opportunity and the equal treatment of women and girls in the mathematical sciences." We believe that the best way to do this is to foster conversations, both mathematical and personal, among the members of our department.

We added social hours to our recurring events in addition to our usual brown bag lunches to help create a space for discussion. Our brown bag lunch topics have ranged from the mathematical strategies of 'rock, paper, scissors' to the differences in letters of recommendation among all genders. Our social hours after colloquiums offered an encouraging environment for graduate students, post-docs, and faculty alike to talk about the mathematics we just learned. We believe having a diverse chapter whose participants are comprised of all genders gives us an advantage. While it is important to support the minority it is at least equally important to inform the majority of challenges caused by communication, societal expectation, and financial differences.

Our chapter of AWM is also interested in the professional development of our graduate students. We partnered with SIAM to host an academic advising panel in the fall and plan to bring a careers panel to the department in the spring semester. Our advising panel was able to spark questions and ideas among the first and second year students as they search for a future advisor. In the spring, we will bring in alumni as well as professors to discuss after graduation plans with the graduate students. Our second professional development project is called LAAMP (Linear Algebra and Analysis Mathematical Practice), and offers review sessions in linear algebra and real analysis for the first- year students during the fall semester. Our goal was to relieve some of the typical stresses of the semester and ensure that students did not get tunnel vision when studying the material, and to help them discuss preliminary exam problems. These sessions also created an environment where we could encourage timid students to speak up while simultaneously ensuring that everyone could be heard and contributed to the activity.

Other events sponsored by AWM were: the beginning of the semester rocket launch, and the AWM and SIAM New Faculty Speaker Series. The rocket launch was a fun event inspired by the release of the movie Hidden Figures. The New Faculty Speaker Series welcome the new faculty members, and introduced their research to graduate students and fellow faculty.

Our intention is to continue to build our community and to encourage professional growth. We are excited to keep working with members of our department to cultivate an inclusive environment.

University of Delaware Chapter of SIAM

BY SAMUEL COGAR, CHAPTER PRESIDENT

The University of Delaware Chapter of SIAM has enjoyed an active year of both professional development and social events in the department. A highlight of the year was the continuation of our Alumni Talk series by two graduates of our department who are now postdoctoral researchers at the National Institute of Standards and Technology (NIST). The Spring talk featured Ryan Evans, a National Research Council postdoctoral fellow in the Applied and Computational Mathematics Division in Gaithersburg, MD, and the Fall talk was given by Jacob Rezac, a postdoctoral researcher at the Communications Technology Lab in Boulder, CO.

The chapter after the Alumni Talk by Jacob Rezac in December 2017.

In an effort to introduce chapter members to places beyond their office walls, we enjoyed two outings in 2017: one professional and one social. Our Spring outing was a visit to Constellation Energy in Baltimore, MD, which included a tour of Constellation's new energy commodity trading floor and a session with a quantitative analyst on the applications of diverse areas of mathematics to energy trading. With the Fall semester came a trip to Longwood Gardens in Chester County, PA, and despite the seemingly non-mathematical nature of the Gardens, fruitful discussion ensued on modeling of water fountains, engineering of water pumps, and the expected lifetime of apples arranged in an artful pond design.

In addition to the big events of the year, the chapter also enjoyed an Open House in September and multiple breakfasts throughout the Fall semester, and we co-sponsored an advising panel and a New Faculty Speaker series with the UD Chapter of the Association of Women in Mathematics. We look forward to an equally productive and enjoyable year in 2018!

New Masters of Science Degree Expected to Begin in Fall 2018

BY PROFESSOR RICHARD J. BRAUN

In early March, the University Faculty Senate approved the new Master of Science with a major in Data Science to begin in the Fall of 2018. This interdisciplinary degree is offered jointly by the Departments of Mathematical Sciences (DMS), Computer and Information Systems, and Applied Economics and Statistics. Besides these three departments, electives may initially come from a number of other departments, including: Urban Affairs and Public Policy; Economics; Civil and Environmental Engineering; Geography; and Bioinformatics.

The participating departments are expected to increase significantly in the coming few years. DMS faculty member Richard Braun will be the founding director of the program.

This is the first new major for a graduate degree in DMS for many years. The interdisciplinary effort was inspired by the data science planning committee, which included faculty and administrators from all over UD; DMS was represented by department chair Louis Rossi and College of Arts and Science associate dean John Pelesko. In particular, a data science symposium was held in May 2017; the symposium hosted several speakers from exemplary programs and held crucial discussion groups among UD faculty. An influential white paper on data science at UD was written by the planning committee as well.

The cooperation between departments and colleges is an exciting opportunity for both the faculty and the students. The opportunities for graduates in this field are manifold. A web page will appear in the near future; for further information, contact Dr Braun at rjbraun@udel.edu.

Being a Graduate Director

BY PROFESSOR FRANCISCO-JAVIER SAYAS

From September 2014 to August 2017 I had the privilege of being the Director of Graduate Studies of the Department of Mathematical Sciences at UD. In the next paragraphs I want to share my impressions on what's going on in the graduate program, what's new, what's old, etc.

Let me first state that I'm an "if it ain't broke, don't fix it" kind of person. My two predecessors, John Pelesko and Tobin Driscoll, started many activities in the program that worked excellently and just needed the energy to keep them up and going, and that's what I tried to do.

We also continued the long established tradition of witty acronyms for some of our activities. The summer program for incoming domestic students was remodeled to adapt to the new preliminary exam structure and changed its name from GRIPS to The RAMP (Review of Advanced Mathematical Programs). In the Fall of 2015 and 2016 we ran a workshop for undergraduates which we whimsically named WHIMS (What's Hot In Mathematical Sciences) and which attracted students not only from distant corners of the US, but also from Chile and South Korea.

I want to emphasize some of what I think are our most successful and appealing activities. The annual Winter Research Symposium has been running in its current format for quite a while. Friday afternoon of the first week of the spring semester (which we could rephrase as the First Friday after Super Bowl Sunday) our most senior students give a talk in one of the classy first floor lecture rooms in Gore Hall and most of the remaining post-candidacy exam graduates present a poster in the adjoining rotunda. The cherry on top is an invited address by a graduate alum of the department and the activities are complemented with a couple of poster awards (with a not-that-secret jury made up of visitors and postdocs) and tasty hors d'oeuvres. The WRS seems to combine in well balanced quantities the seriousness of presenting student's research in front of professors and peers, with a fun and relaxed side, and we know very well that this is our most successful recruitment event. Among the many goals of the WRS (in the Kinder egg spirit, we think that if it's nutritious and has chocolate, why shouldn't it include a toy inside?) are getting the first year students to see closely what research is done in the department, as well as presenting ourselves as a serious but not self-important research unit in front of colleagues and prospective students.

For three years, we prepared a very easygoing graduate program newsletter, which, in the spirit of the times where any symbol can be part of a word, we called #GraduateMath@UD. This diptych showcased activities carried out by our graduate students and current information about the program and had the unwritten rule that no photograph of a faculty member would appear on it! Several senior graduate students were responsible for the data collection, writing of the news pieces, browsing over photos, and (the most difficult task of all) finding clickbait quality headings for the sections. Taking advantage of the departmental website reconstruction, we did a lot of spring cleaning in the graduate program pages, and added updated information about the program, our students, the side activities, etc.

In the academic part of the program, the most recent APR report motivated a change in the Preliminary Exam structure. We have thus recently moved to a two-tier system which, for good or for bad, involves more faculty every year, but aims at balancing the length and difficulty of the exams and at reorganizing the second year of the masters degree for those students who will only stay in the program for two years.

At this time, the Math and Applied Math graduate programs seem to be thriving. We have had steady numbers of PhD graduates for several years and it seems like our graduates (PhD and MS) are doing very well in the job market, both in industry and academia. The future brings new challenges though. We are experiencing lower numbers of applicants (the job market for MS and BS students in the US seems to be stronger these days and there is more competition) and the international panorama is changing as well. We now have frequent applications from international students with US undergraduate degrees, and the flow of students from abroad is also changing. The pool of domestic students from the Eastern Seaboard is still strong and the effort to keep on bringing to good old Newark motivated students with a strong potential to be professional mathematicians is work-in-progress.

All of this could not have been done without the help of colleagues in the very time-consuming graduate committee, of our engaged students, and, of course, of our staff assistant Ms. Deb See.

An Information-Theoretical Framework for Phylogenetic Inference

BY PROFESSOR VU DINH

Evolution is a unifying theme in biological research. Therefore, phylogenetics, the reconstruction of evolutionary trees from molecular sequence data such as DNA, is an important enterprise enabling an evolutionary understanding of biological systems. Through phylogenetics, researchers can test models of viral transmission, infer gene function, compare genetic diversity, and perform many other applications. In addition, the evolutionary history itself is of continuing interest.

Phylogenetic inference is a difficult mathematical problem. In part, this is due to the fact that the set of phylogenetic trees forms a space with discrete (graph topology) and continuous (branch lengths) components. This space is usually modeled by a cubical complex, where many Euclidean spaces are glued together by some topological rules. The resulting space is a metric space with geodesics, but is not a manifold, and most mathematical and statistical methods are not developed with such structures in mind. The problem is much compounded by the large number of trees, which grows super-exponentially in the number of leaves.

In the recent years, high-throughput sequencing is making large collections of sequences available to researchers at low cost. These technologies have opened a completely new window of understanding the biology of small evolving units: a single deep sequencing run from these environments can return millions of unique sequences. With the availability of large biological datasets, the field of computational phylogenetics is transforming and the next generation of phylogenetic methods are emerging. Understanding of the mechanism of those methods, their advantages/disadvantages in different contexts, and their interaction with each other plays a central role in the future of phylogenetics.

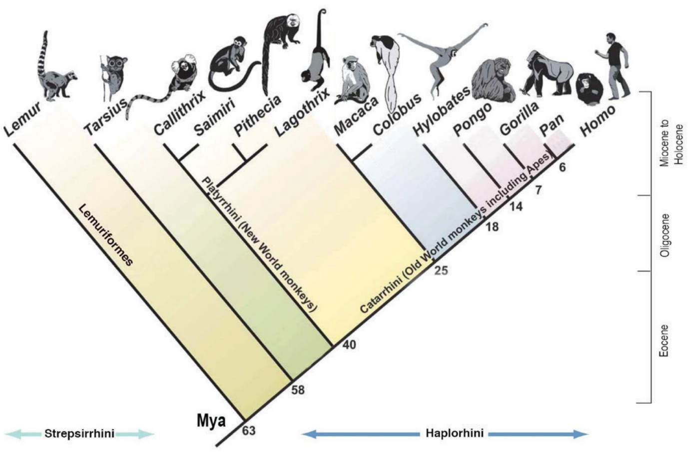


Figure 1: A phylogenetic tree of mammals

AN INFORMATION-THEORETICAL VIEW ON STATISTICAL PHYLOGENETICS

Some of my research involves understanding of the relationship between two major approaches in phylogenetic inference: statistical phylogenetics and local methods.

Statistical phylogenetics is a popular means of reconstructing evolutionary trees, for which the tree is viewed as an unknown parameter in a likelihood-based statistical inference problem. These approaches are very popular and are usually considered as the ``correct ways'' to do inference. However, little is known about their theoretical properties, and such results are often confounded by technicalities. In practice, the super-exponential complexity of statistical phylogenetics has also created a computational limit that cannot be overcome easily.

On the other hand, it has been known that there are various local structures of the tree that can be explored for phylogenetic reconstruction and inference. Many heuristic ``local'' methods of this type have been introduced for phylogenetic inference. For example, in tree reconstruction, one popular class of methods are ``distance methods'', which relies on computing the genetic distances between pairs of species/individuals and use such information to reconstruct the tree. In a similar manner, ``quartet methods'' relies on the reconstructions of subtrees of four leaves (quartets) and build up the global tree from such subtrees. For parameter inference and ancestral reconstruction, the method of ``phylogenetic contrast'' can be used to extract independent information for parameter estimation.

From an information-theoretical view, likelihood-based approaches operate on the joint probability of leaf data and retain full information. "Local methods" can be regarded as dimension reduction techniques, whereas some statistics are extracted from the ``raw data'' for reconstruction/estimation. During these ``data processing'' phases, information are lost, but the dimension of the problems are reduced and some noises in data are also filtered. Therefore, both theoretical analyses and practical implementation of local methods are more straightforward: many of the local methods have excellent theoretical properties, and their implementations run much faster than the likelihood-based counterparts. On the other hands, as for other feature selection problems, local methods are more prone to (even minor) model misspecification and usually do not perform well on real data.

PHYLOGENETICS: INFORMATION, UNCERTAINTY, AND GEOMETRY

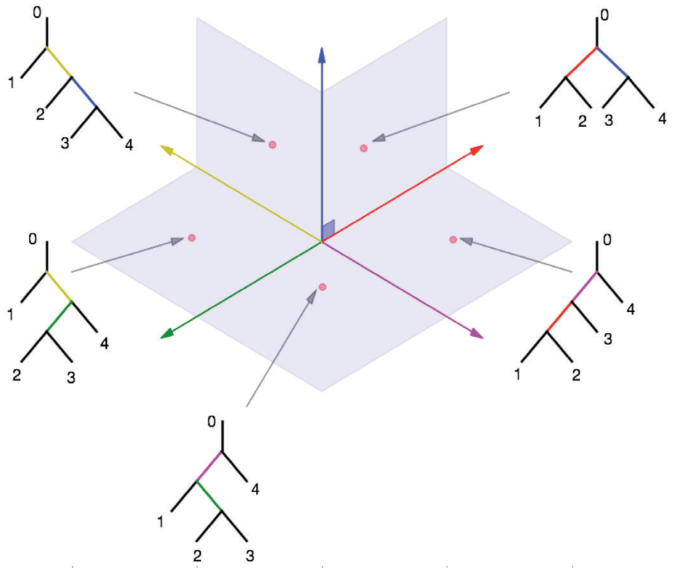


Figure 2: The tree space is a cubical complex, where each orthant corresponds uniquely to a tree topology and the coordinates in each orthant parameterize its branch lengths

To further understand this narrative, we can take a step back and investigate an easier but similar problem. Consider a standard 1D problem, where the maximum likelihood estimator is constructed from an i.i.d. sample of size n to estimate a parameter of interest θ*. Denoting the log-likelihood function by ln, from the definition of the maximum likelihood estimator, we obtain

$$E[\ell_n(\theta^*)] - E[\ell_n(\hat{\theta}_n)] \leqslant \left(\ell_n(\hat{\theta}_n) - E[\ell_n(\hat{\theta}_n)]\right) - (\ell_n(\theta^*) - E[\ell_n(\theta^*)])$$

If the statistical model is identifiable, the log-likelihood function is smooth, and the Fisher information matrix at θ* is regular, then we have a local lower bound on the information to distinguish the estimator and the true parameter of interest, where the constant depends on the local geometry of the log-likelihood surface

$$E[\ell_n(\theta^*)] - E[\ell_n(\hat{\theta}_n)] \geqslant C_1(\hat{\theta}_n - \theta^*)^2.$$

On the other hand, analytical tools from information and learning theories enable one to bound the deviation of the log-likelihoods from their expected values (usually referred to as ``uncertainty'' or ``noise''), uniformly with high probability, where the constant depends on some measure of effective dimension of the space of all possible log-likelihoods associated with the model

$$|\ell_n(\theta) - E[\ell_n(\theta)]| \leqslant \frac{C_2}{\sqrt{n}}.$$

The combination of the two bounds provides a simple way to assess the accuracy of the maximum likelihood estimator, and the convergence analysis can be regarded as an assessment of the ``signal/noise'' duality from information theory and signal processing.

Generalization of such an approach to phylogenetic analyses, especially in non-asymptotic setting, is difficult. The first issue comes from the fact that there has been a lack of analytical tools to construct and analyze phylogenetic estimates. In general, the lack of manifold structure of cubical complexes poses a significant problem. Similarly, the phylogenetic likelihood is known to be non-differentiable across different tree topologies, and analytical tools (such as Taylor expansion) are just not available. Finally, there has been little work on information and uncertainty of phylogenetic signals, and such work require a deep understanding of the geometry of phylogenetic statistical models which have not been available in the field.

One underlying idea from this part of my research is to extend understanding about the relationship between local methods and statistical phylogenetics in several contexts. The main focus is to provide insights about which type of information are lost and which type of noises are filtered in various local methods. Along with the newly-derived geometric and analytical tools (local-to-global phylogenetic expansion, concentration inequalities) and other classical results in information theory (such as the Data Processing inequality), one can construct a framework to use local methods as bridges to analyze likelihood-based phylogenetic methods. Such insights will also provide a systematic way to stabilize uncertainties while retaining maximal information.

This idea is simple, but its executions require a deep understanding of phylogenetics from the viewpoints of biology, information theory, topology, geometry, discrete and computational mathematics. While mathematical phylogenetics is new to the Department of Mathematical Sciences at University of Delaware, many faculty from the department are experts in those fields. I expect that this is an area where the department will have many important impacts to pure and applied sciences in the future.

Inverse Problems at Delaware 1985-2015

BY UNIDEL PROFESSOR DAVID COLTON

For roughly 30 years from 1985 to 2015 the Department of Mathematical Sciences at the University of Delaware was one of the leading centers in the world for the study of inverse problems and in particular inverse scattering theory. The benefits to the Department were many, among them international recognition for the Department, generous funding from government agencies (in particular AFOSR), a multitude of postdoctoral students coming to Delaware who were paid for by their governments and, in a related direction, numerous visits by faculty and graduate students between Delaware and the University of Goettingen in Germany and the Ecole Polytechnique in France. In what follows I will first explain why scattering theory has been a central field of applied mathematics throughout the twentieth century and into the present and why during the period from 1985 to 2015 the area of inverse scattering theory experienced a renaissance in its development. My story will then continue with a description of how Delaware became a leading player in this renaissance.

Scattering theory has played a central role in twentieth century mathematical physics and applied mathematics. Indeed, from Rayleigh's explanation of why the sky is blue, to Rutherford's discovery of the atomic nucleus, through the recent developments in medical imaging, scattering phenomena have attracted, perplexed and challenged scientists and mathematicians for well over a hundred years. Broadly speaking, scattering theory is concerned with the effect an inhomogeneous medium has on an incident particle or wave. In particular, if the total field is viewed as the sum of an incident field and a scattered field, then the direct scattering problem is to determine the scattered field from a knowledge of the incident field and the differential equations governing the wave motion. Of probably even more interest is the inverse scattering problem of determining the nature of the inhomogeneity from a knowledge of the asymptotic behavior of the scattered field, i.e. to reconstruct the differential equations and/or its domain of definition from the behavior of (many of) its solutions.

David Colton is Unidel Professor of Mathematical Sciences at the University of Delaware. He came to the University of Delaware in 1978 from the University of Strathclyde in Glasgow, Scotland.

During the period from 1985 to 2015 the field of inverse scattering theory experienced a renaissance in its development. This renaissance was characterized by the realization that the inverse scattering problem was not only nonlinear but also ill-posed in the sense that the solution (if it exists at all!) does not depend continuously on the measured data, thus presenting severe problems in the development of practical inversion algorithms. Although linearized models continued to be relevant in many applications, the increased need to focus on problems in which multiple scattering effects could no longer be ignored led to the nonlinearity of the inverse scattering problem playing an ever more important role. In addition, the possibility of collecting large amounts of data over limited regions of space led to the situation where the ill-posed nature of the inverse scattering problem became of central importance.

Initial efforts to deal with the nonlinear and ill-posed nature of the inverse scattering problem focused on the use of nonlinear optimization methods. Although efficient in many situations, the use of such methods suffers from the need to have strong a priori information in order to implement such an approach. Unfortunately, in many situations of practical importance such information is simply not available. Hence, in order to circumvent this difficulty, during the period from 1985 to 2015 attention was focused on the development of a qualitative approach in which the amount of a priori information needed was drastically reduced but at the expense of obtaining only limited information about the scattering object such as connectivity, support and an estimate of the values of the constitutive parameters of the scattering object. The development of this qualitative approach to inverse scattering theory was initiated at the University of Delaware and further developed at Delaware during the period from 1985 to 2015 leading to Delaware becoming a world center for inverse scattering theory.

How was Delaware able to assume such a leadership role in inverse scattering theory? It was a combination of luck, funding by AFOSR and strong leadership by the Administration. The luck was that there were already three people in the Mathematics Department at Delaware, Ralph Kleinman, George Hsiao and Tom Angell, who were already actively involved in scattering theory and closely related areas. The role of leadership came from a new Provost, Leon Campbell, who had arrived at Delaware with the belief that a university that wanted to be strong in engineering had to also have a strong mathematics department. Hence when Campbell became Provost one of his first steps was to appoint Ivar Stakgold as Chair of the Mathematics Department and to present him with the task of strengthening the research mission of the Department in the general area of applied mathematics. In order to build up the research reputation of the Department, Stakgold was given the authority to appoint three new full professors. This was to be in addition to Bob Gilbert who had just recently been appointed as Unidel Professor in the Department. The three professors that Stakgold appointed were Adi Ben-Israel, Zuhair Nashed and myself. All three of us had an interest in inverse problems to some degree or another and, with the appointments of Peter Monk and Rakesh as new assistant professors in the 1980's, the inverse problems group at Delaware reached critical mass. In particular, Peter Monk's expertise in numerical analysis proved to be an indispensable component of the further development of inverse scattering theory at the University of Delaware.

At this point luck re-entered the picture by the fact that before arriving at Delaware I had developed a close friendship and professional relationship with Rainer Kress who was Professor of Numerical Analysis and Applied Mathematics at the University of Goettingen. At the same time that the inverse problems group was being developed at Delaware, Rainer Kress was building up the field of inverse problems at Goettingen through his seminars and supervision of students. As part of these efforts Rainer would send some of his most promising students to Delaware for a year, supported by the German government. As a result, Joachem Blobaum, Peter Hahner, Andreas Kirsch and Roland Potthast spent a year at Delaware. At the same time, Rainer and I visited back and forth from Goettingen to Delaware (funded by AFOSR and the German government) during which time we wrote two books on inverse scattering theory, one of which has been republished in the SIAM "Classics in Applied Mathematics" series, whereas the other book is now in its third edition in the Springer Applied Mathematical Sciences Series. The popularity of these two books attracted many new people into the field of inverse scattering theory and in addition sparked their interest in coming to Delaware to study.

Not all of the PhD and postdoctoral students who came to Delaware came from Goettingen. In particular, Christophe Labreuche and Michele Piana came from France and Italy respectively. However, the most important "non-Goettingen" postdoctoral students who came to Delaware were undoubtedly Houssem Haddar from France and Fioralba Cakoni from Albania. These two mathematicians, together with Andreas Kirsch, have played a decisive role in the development of the qualitative approach to inverse scattering theory and are among the outstanding examples of what the Department of Mathematical Sciences at the University of Delaware has produced in the past thirty years. Houssem Haddar is now a professor at the Ecole Polytechnique in Paris and through his efforts and those of Fioralba Cakoni (who since 2015 is a professor at Rutgers University) an active exchange program between the University of Delaware and the Ecole Polytechnique has been established which has benefited numerous graduate students in both Newark and Paris for many years.

The development of the field of inverse problems at Delaware, and in particular inverse scattering theory, is a textbook example of how a small department of mathematics can achieve international recognition in a relatively short period of time provided a little luck is available and the university administration has both a vision and the courage to pursue that vision.

Recent graduates in inverse problems at UD include:

Dr. Irene de Teresa Trueba: now a postdoctoral researcher at the University of Heidelberg, Germany (Mentors: Drs. Cakoni and Monk).

Dr Shixu Meng: now a postdoctoral researcher at the University of Michigan (Mentors: Drs. Cakoni and Colton).

Dr. Jake Rezac: now a postdoctoral researcher with NIST in Boulder, Colorado (Mentor: Dr. Cakoni).

Highly Accurate, Efficient and Robust Solvers in Computational Fluid Dynamics

BY PROFESSOR JINGMEI QIU

For centuries, researchers have been obsessed by characterizing natural phenomena in our world, from astrophysical phenomena such as solar flares, to dynamics of weather and climate change, to biological behaviors and phenomena, and to the dynamic of human blood flow. Better understanding and characterization of these phenomena can lead to prediction of future events for better planning, design of interventions, among many others. In the past, researchers have been striving to characterize these phenomena by mathematical equations, which usually are partial differential equations (PDEs). These PDEs, arising from real work applications, are often complicated by high dimensionality, multi-scale and multi-physics features, complicated boundary conditions, interactions of fluids and structures, and propagation of uncertainties. These challenges push the frontier of advancement in computational science and stimulate development of computational algorithms with high accuracy, efficiency, robustness and scalability for large scale supercomputing.

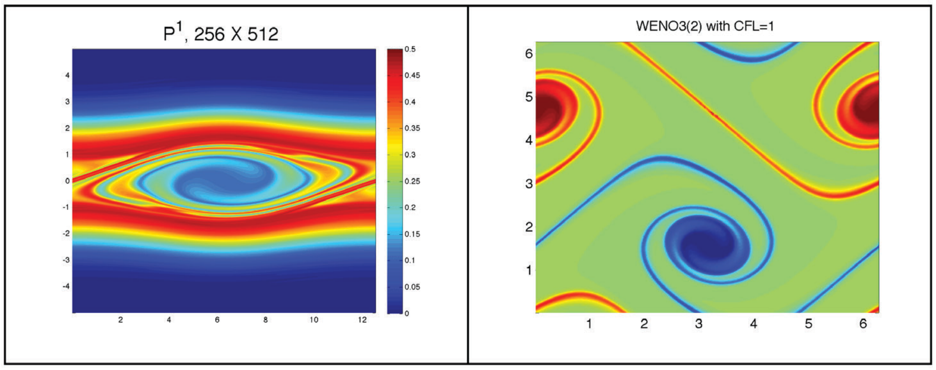
My research interest focuses on the design of efficient and high order numerical algorithms that can effectively leverage physical laws, e.g. conservation laws, and underlying mathematical properties in solving complex PDEs systems. In particular, my research background has been focused on using non-oscillatory reconstruction techniques and discontinuous Galerkin methods for capturing shock phenomena that naturally arise in many areas of applications, e.g. aerodynamics, gas dynamics and fluid dynamics.

One of my recent research interests is on the development of highly efficient and robust semi-Lagrangian methods for kinetic equations with plasma applications, for fluid dynamics, as well as for global transport problems with meteorology applications.

The semi-Lagrangian (SL) methodology has been under great development for more than three decades. It has been shown in many applications to be advantageous, compared with traditional Eulerian and Lagrangian approaches. In fact, it is designed to take advantage of both approaches. An Eulerian scheme, based on a fixed set of numerical mesh, is formulated by directly discretizing the PDE at a fixed spatial location. Such schemes, due to the CFL condition (i.e. numerical domain of dependence should include the physical domain of dependence), often have quite restrictive time step constraint. A Lagrangian scheme is designed by following macro-particle trajectories. The scheme has no CFL time step constraint. However, the initially regularly spaced macro-particles often got distorted after a few time steps, leading to either an over-clustering or sparsely-spaced grid that could no longer support important features of the solution.

The SL method inherits the high-spatial-resolution from an Eulerian method based on a fixed set of computational grid and avoids the particle re-meshing procedure in a Lagrangian method. It traces characteristics to propagate information as in a Lagrangian method in order to avoid the CFL time step constraint in an Eulerian method. The method has been very popular in various applications such as passive-advection in weather forecasting, Navier-Stokes simulations of fluid dynamics, kinetic Vlasov-Poisson and Boltzmann simulations, and interface front tracking, among many others areas. The SL methodologies developed by my research group couple the characteristics tracing mechanism with high order polynomial reconstructions in a finite volume or finite difference framework, or high order polynomial evolution in the context of the discontinuous Galerkin method. These methods maintain the advantage of the SL scheme in allowing for large time stepping sizes, and incorporating cutting edge CFD high order techniques in capturing solutions with discontinuities or sharp gradients using under-resolved computational mesh with robustness and stability.

The figure below shows contour plots of numerical solutions of the two-stream instability for the Vlasov-Poisson system when modeling plasma dynamics (left) and that of the incompressible Euler system for fluid dynamics applications (rights). High resolutions of solutions with non-oscillatory capture of sharp gradients are remarkable.



Left: the two-stream instability for the Vlasov-Poisson system when modeling plasma dynamics; right: incompressible Euler system for fluid dynamics applications

NEW FACULTY

VU DINH

Vu Dinh received his PhD in 2014 from Purdue University (Indiana). Before joining University of Delaware in 2017, he was a post-doctoral research fellow at Fred Hutchinson Cancer Research Center (Seattle, WA). Vu's research focuses on applied probability/ statistics and phylogenetics, with an emphasis on the development of next-generation Markov chain Monte Carlo (MCMC) methods for phylogenetic inference. He is also interested in computational methods for experimental design and control of biological systems, as well as machine learning algorithms and their applications in applied sciences.

CHAD GIUSTI

Chad Giusti received his PhD in 2010 at the University of Oregon, followed by a sequence of postdoctoral positions at Willamette University, the University of Nebraska -- Lincoln, and the University of Pennsylvania. His research interests broadly lie in pure and applied algebraic topology. His recent theoretical work includes computations in group cohomology, including the mod-two cohomology of the alternating groups, and investigations into the homological (in)stability of simplicial complexes derived from geometric data under subsampling. Applications include work on the relationship between coding properties and connectivity in biological and artificial neural networks, methods for detecting organizing principles for the activity of in vivo neural systems, and development of new analytic tools for clinical and laboratory human brain imaging data.

GAIL HEADLEY

Gail Headley received a PhD in Educational Studies with a concentration in Quantitative and Mixed Methods Research Methodologies from the University of Cincinnati in 2016. Her interest in understanding how students develop symbolic mathematics language literacy (SMaLL), or the ability to read and write mathematical text such as x^2 or √(x), emerged from experiences teaching mathematics in elementary, secondary, and post-secondary settings. For her dissertation, she crafted an innovative multilevel mixed methods research design to develop an empirically driven model of SMaLL that accounts for students' cognition, metacognition, and classroom culture. The dissertation offers research methodologists a new approach for exploring academic development. In addition, it offers educational researchers a new theoretical framework to explore mathematical development among adolescents and adults.

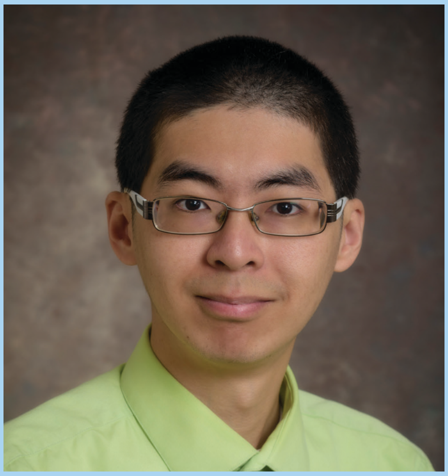
VIRGINIA EIRINI KILIKIAN

Virginia Eirini Kilikian received her PhD in Applied Mathematics from Brown University in May 2017. Her research focuses on mathematical models to describe biological phenomena and their simulation using mathematical software. Her dissertation was a comprehensive study of chemotactic models, aiming to shed light on the mobility mechanisms of bacteria that change characteristics of their moving patterns in response to external stimuli. She is also involved in a project by a group of women in STEM fields, who study the fast firing mechanism of nematocysts, special organelles employed by jellyfish and other organisms to shoot their prey.

Before coming to University of Delaware, she was a Visiting Assistant Professor at Brown University, where she taught a course on Scientific Computing. She loves teaching and implements active learning methods in her classroom. In her free time, Eirini likes spending time with her family, cooking and playing tabletop games.

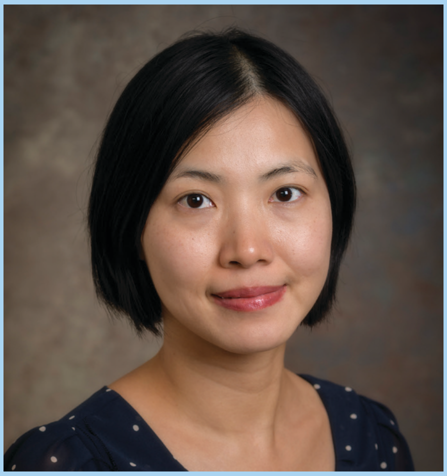
CONSTANZE LIAW

Constanze Liaw received her Ph.D. in 2009 from Brown University. Prior to UD, she was an Assistant Professor at Baylor University and a Visiting Assistant Professor at Texas A&M University. Her current mathematical interests revolve around topics in harmonic and complex analysis and the theory of self-adjoint extensions, mostly in connection with the spectral and Clark theory of finite rank perturbations and their applications. To understand some of the applications, recall that many physical systems are modeled by differential operators. One way of describing a system's long-term behavior is through spectral theory, which includes the finding of frequencies naturally exhibited by the system. Imagine a vibrating string or beam of fixed length. Clearly, its frequency (think "sound") depends on how its ends (aka boundaries) are clamped down or otherwise restricted. In general, the spectrum of a differential operator and with it the properties of a physical system can change drastically when the conditions imposed on the boundary are changed. In many cases, we know the complete spectrum for one set of boundary conditions. From there, we can gain knowledge about the system under other conditions via the theory of so-called finite rank perturbations. The primary goal of Constanze's current research is to systematically study spectral theory of finite rank unitary perturbations by tightening the relationship to corresponding functional models. The rank one setting is reasonably well-understood, while a general treatment of the finite rank problem presents several difficulties. Non-cyclic unitary unperturbed operators pose an issue, which can be resolved by investigating general matrix-valued Herglotz and Cauchy transforms. The study of these transforms are expected to provide insight into finite rank perturbation theory.



ANTHONY MAK

Anthony Mak received his PhD in Mathematics in 2017 from the University of Virginia, with a dissertation on geometric topology, specifically invariants of smooth 4-dimensional manifolds. He joined the Department as a core member of MSLL and is dedicated to advance the Department's teaching mission through active learning and continuous improvement of teaching model. In addition to teaching, he endeavors to gain insights into how cultural and behavioral factors impact the performance of UD students in math classes.



JINGMEI QIU

Jingmei Qiu received her Ph.D. from Division of Applied Mathematics at Brown University in 2007. Her thesis was on high order numerical methods for hyperbolic conservation laws with Astrophysics applications. During 2007 - 2008, she was a postdoc associate at Michigan State University. She was a tenure-track assistant professor at the Colorado School of Mines from 2008-2011. After that, she moved to University of Houston, where she was promoted to Associate Professor in 2014. She joined University of Delaware in 2017 as an Associate Professor. Dr. Qiu's research interests are in highly accurate, efficient, stable and robust numerical methods for hydrodynamics, kinetics and multi-scale models. Relevant applications areas include fluid dynamics, plasma physics, astrophysics, atmospheric sciences, travel flow engineering, etc.

JAMIE SUTHERLAND

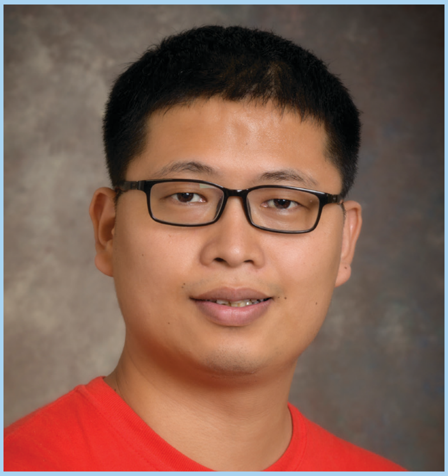
Jamie Sutherland received his PhD. in

2004 from the University of Wisconsin. Before moving to Delaware, he was an assistant professor at Texas A&M University. He joined the Department of Mathematical Sciences in 2008 as a temporary faculty member and in 2012 became the curricular advisor for all undergraduate mathematics majors in the department. He was hired as a permanent CT faculty member in 2016. In addition to advising undergraduate majors and teaching a wide variety of courses, Dr. Sutherland does research in mathematics education at both the high school and college level. He is particularly interested in the teaching and learning of proof, and student transitions from high school to university level mathematics as well as the transition math majors make to more advanced math classes.

POST DOCS

TOM ANDERSON

Tom Anderson received his PhD in Applied and Computational Mathematics from the University of Edinburgh, UK, in November 2017. His thesis focused on the optoelectronic simulation of nonhomogeneous, thin film solar cells. He joined University of Delaware as a post-doctoral researcher in December 2016, hosted by Peter Monk. Tom's current research continues to investigate the effect of material non-homogeneities in thin film solar cells. His current projects involve developing various simulation tools, from a Maxwell solver using the rigorous coupled wave algorithm, to a hybridized discrete Galerkin model for the carrier drift diffusion equations. These will be used in conjunction with optimization methods, such as the differential evolution algorithm, to optimize the solar cell design parameters for maximum efficiency.



XIAOFENG CAI

Xiaofeng Cai joined the University of Delaware in September 2017 as a postdoctoral researcher working with Dr. Jingmei Qiu. He received his PhD from Xiamen University in 2016 under the supervision of Dr. Jianxian Qiu. His thesis focused on the development of high order numerical methods for hyperbolic conservation laws. Xiaofeng's current research interests lie in high order semi-Lagrangian method for kinetic and transport equations with applications plasma physics. Currently, Xiaofeng, Wei Guo (Texas Tech University) and their advisor Dr. Jingmei Qiu develop a conservative high order semi-Lagrangian discontinuous Galerkin method without operator splitting. This method is free of operator splitting error and allows for extra large time stepping size. It can be applied to the problems in plasma physics. Their work has been published in the Journal of Computational Physics.

MARKO PETROVIC

Marko Petrovic received his PhD in 2017 from University of Antwerp in Belgium, under supervision of Prof. Dr. Francois Peeters. His PhD work focused mainly on electronic transport in nanostructured graphene. He joined University of Delaware in August 2017 as a postdoctoral fellow working with Prof. Petr Plechac. Dr. Petrovic is working on problems involving dc and time-dependent transport in van der Waals heterostructures. Under supervision of Prof. Plechac, Marko is developing and implementing a time-dependent non-equilibrium Green function code for the evolution of electronic density matrix. The code will be used to study domain-wall dynamics initiated by the injection of ultrashort dc current pulses.

Professor Pam Cook is the 2018 SIAM Julian Cole Lecturer

Congratulations to Professor Pam Cook from the Department of Mathematical Sciences for being awarded the 2018 SIAM Julian Cole lectureship. The prize includes both a monetary award, and the honor to present the Julian Cole Lecture. Dr. Cook's lecture will take place at the 2018 SIAM Annual meeting in Portland, Oregon, July 9-13, 2018.

The Julian Cole lectureship is awarded in memory of Professor Julian Cole from RPI. This is especially significant for Professor Cook because she is co-author, with Prof. Cole, of the classic book "Transonic Aerodynamics" published in 1986, as well as joint author on several research papers, with Professor Cole.

The Julian Cole Lectureship is awarded every four years to an individual for an outstanding contribution to the mathematical characterization and solution of a challenging problem in the physical or biological sciences, or in engineering, or for the development of mathematical methods for the solution of such problems. A distinguished selections committee composed of Michael J. Shelley (Chair), Anette Hosoi, and John R. King awarded the prize to Professor Cook, citing her "comprehensive mathematical modelling of the structure and dynamics of worm-like micellar solutions." Their appreciation continues; "Developed in close collaboration with experiment, this work has had broad influence and application in both industry and the academy, and sets a standard for modelling such multi-component systems."

We congratulate Dr. Cook on this prestigious award!

Professor Jinfa Cai Named a Changjiang Scholar

Professor Jinfa Cai from the Department of Mathematical Sciences has been named a Changjiang (Yangtze River) Scholar by the Ministry of Education in China. The prestigious award is the highest award issued to an individual in higher education by the country's Ministry of Education.

Changjiang Scholars are in the top tier of the country's "High-level Creative Talents Plan" aimed to recruit talented academics, establishing research programs in their respective academic disciplines in order to promote the development of those disciplines to the highest international level. The selection of Changjiang Scholars is based on very stringent criteria, such as academic accomplishment, publications, grants, international leadership and recognitions. Since the implementation of the plan, the country has assembled a large number of scholars with such academic talent. Currently, the number of Changjiang Scholars in a university has become an important indicator of the academic strength in the university.

Besides Chinese scholars, a limited number of international recipients are also chosen every year. Most scholars appointed in the past were in the fields of Medicine, Mathematics, Science and Engineering, and few were in the humanities and education. This year, Dr. Cai is the only person selected in Mathematics Education.

We congratulate Dr. Cai on this prestigious award!

Conference Corner

BY PROFESSORS SEBASTIAN CIOABA AND CONSTANTIN BACUTA

THE *ALGEBRAIC AND EXTERNAL GRAPH THEORY* CONFERENCE

IN HONOR OF PROFESSORS WILLEM HAEMERS, FELIX LAZEBNIK AND ANDRE WOLDAR

Algebraic and extremal graph theory are important areas of combinatorics with a great symbiotic relationship. To celebrate this fact and to honor the research of Willem Haemers (Tilburg University, The Netherlands), Felix Lazebnik (University of Delaware, USA) and Andrew Woldar (Villanova University, USA), the *Algebraic and Extremal Graph Theory* Conference (www.mathsci.udel.edu/aegt) took place between August 7 and 10, 2017 at the Newark campus of the University of Delaware.

The conference covered topics related to spectral graph theory, quantum computing, strongly regular graphs, distance-regular graphs, association schemes, Turan-type problems, Moore graphs, cages, algebraic and extremal properties of graphs/digraphs defined by systems of equations, finite groups, expanders, and designs.

The conference consisted of 14 plenary talks by: Aida Abiad (Maastricht University), Camino Balbuena (Universitat Polytecnica de Catalunyia), Edwin van Dam (Tilburg University), Zoltan Furedi Renyi Institute-Univ. of Illinois Urbana-Champaign), Chris Godsil (University of Waterloo), Willem Haemers (Tilburg University), Bill Kantor (University of Oregon), Felix Lazebnik (University of Delaware), Misha Muzychuk (Netanya Academic College), Ron Solomon (Ohio State University), Andrew Thomason (Cambridge University), Andrew Woldar (Villanova University), Jason Williford (University of Wyoming) and Qing Xiang (University of Delaware), and 27 contributed talks. There were over 90 participants coming from USA, Canada, China, India, Singapore, Thailand, Australia, Ukraine, Hungary, The Netherlands, Israel, Germany, Brazil, with over half of the participants being young researchers (undergraduate students, graduate students, postdocs or junior faculty).

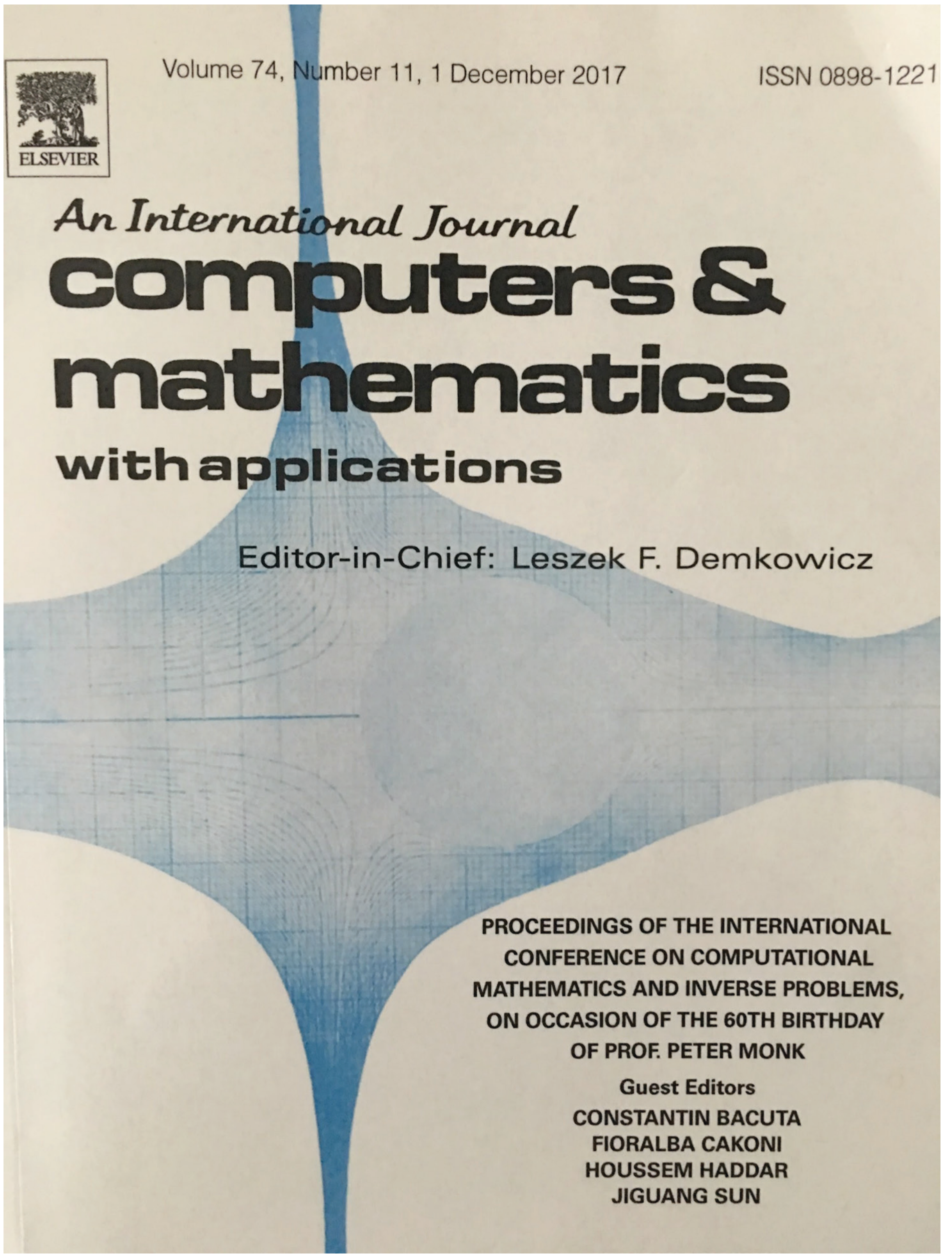
The conference was organized by Sebastian Cioaba, Robert Coulter and Qing Xiang (all University of Delaware) and Gene Fiorini (Muhlenberg College), with the generous support of the National Science Foundation, University of Delaware, Villanova University, DIMACS, Muhlenberg College, IMA and ILAS.

To further disseminate the knowledge presented and obtained during the conference, the slides of the presentations have been posted on the webpage and a special issue of the journal *Discrete Mathematics*, dedicated to the conference, is under preparation.

THE INTERNATIONAL CONFERENCE ON *COMPUTATIONAL MATHEMATICS AND INVERSE PROBLEMS*

ON THE OCCASION OF THE 60TH BIRTHDAY OF PROFESSOR PETER MONK

An international conference on "Computational Mathematics and Inverse Problems" honoring Professor Peter Monk was held at Michigan Technological University in Houghton, Michigan, August 15-19, 2016. Professor Peter Monk is an internationally recognized leader in the areas of inverse scattering theory



and the finite element analysis of partial differential equations (PDEs). He has been on the faculty of the Department of Mathematical Sciences at the University of Delaware since 1982, and an UNIDEL Professor since 2000. Prof. Monk is the author of more than 160 papers, and a book on "Finite Element Methods for Maxwell's Equations" that have been cited more than 3000 times so far. He has also published a research monograph entitled "The Linear Sampling Methods in Inverse Electromagnetic Scattering" co-authored with F. Cakoni and D. Colton, following a series of lectures sponsored by CBMS-NSF.

The meeting at Michigan Tech brought together colleagues, collaborators, and former students of Professor Monk, and facilitated a great exchange of ideas among internationally recognized experts and junior researchers in the field. The conference topics focused on recent developments on numerical analysis for PDEs in multiple space dimensions, scientific computing, and computational inverse problems. Specific topics included finite element methods for eigenvalue problems, finite element methods for Maxwell's equation, computational inverse problems, and applications of finite element methods to the simulation of solar-voltaic structures.

In 2017, a special issue of the Computers and Mathematics with Applications (CAMWA) Journal was dedicated to Professor Peter Monk in honor of his long lasting contribution and leadership in the areas of direct and inverse scattering theory and the numerical analysis of PDEs and integral equations. This special issue of CAMWA is a collection of original research papers on topics on numerical methods for PDEs and computational inverse problems. Much of the work presented in the special issue offers the reader a glimpse at the significant impact Peter Monk's work has on many mathematicians' research.

Constantin Bacuta (University of Delaware), Fioralba Cakoni, (Rutgers University), Houssem Haddar (Ecole Polytechnique, France) and Jiguang Sun (Michigan Tech) organized the conference, and edited the special journal issue. The National Science Foundation, Michigan Technological University, and University of Delaware sponsored the conference. Many thanks go to Leszek F. Demkowicz, the editor-in-chief of CAMWA.

For more information, please visit the conference website at https://www.math.mtu.edu/~jiguangs/NAIP2016/

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