Mathematics at UMW

Welcome from the Chair

The beginning of the fall semester is always my favorite time of the year. It's a time to start fresh with new courses and opportunities and to begin thinking about what we're all going to accomplish this year. There's no better sign of rejuvenation than the missing trailers on campus! Last year was a successful and productive one for our majors and faculty, with new course offerings, tons of undergraduate research projects, and the largest graduating class in mathematics in my time here at UMW. This year holds much the same promise.

For our current students, we have some unique course offerings planned for this year. In the fall we are running a special topics course in Cryptology, a recent mathematical interest of mine. In the spring semester we are planning on giving two topics courses. Dr. Hydorn is going to run her own version of MATH 361: Problems in Industry, the agency-partnership class exploring mathematics problems of real interest to scientists first offered by Dr. Denhere last year. On the theoretical side, Dr. Lehman is teaching a section of MATH 461 on the subject of Algebraic Number Theory, perfect as a sequel to his popular Number Theory course. We are also offering two courses that run on a more sporadic rotation, namely MATH 372: Modern Geometry and MATH 481: Theory of Interest. If you have any "interest" (see what I did there?) in these courses, now is the time to jump on board.

We are currently planning our extra-curricular programming for the year and are open to any ideas you may have. We will have some external speakers visit for colloquium talks and we are planning to move our Alumni and Career Panel event to the fall semester, thanks to student feedback. If you are an alum of our program and would like to contribute, please reach out as we'd love to have you. We are also conducting a search for a new tenure-track professorship, so you may see candidates around the department in the spring. We always involve our students in the search process, so keep an eye out for invitations from me for opportunities to meet our job candidates.

As you can see, we have lots planned for this year, all with plenty of moving parts. If there is any programming you'd like to see from the department, please let us know. With enough warning, we may be able to make it happen. As a department, we'd like to make sure we're providing what you need to stay involved and be successful. Always keep in touch!

Randall Helmstutler
Chair, Department of Mathematics

10th Annual Calculus Tournament

On April 30th, nearly forty students and faculty from local high schools met in Trinkle Hall to participate in the department's 10th Annual Calculus Tournament. Eight teams competed, representing five schools from the Fredericksburg and northern Virginia region. Each team competed in four round-robin matches during the morning, after which the top four teams moved on to the semifinal matches held in the afternoon. In the exciting final match, Paul VI edged out Fredericksburg Academy for the victory. The afternoon's activities also included an individual challenge test for all participants. The winning team was presented with a trophy and first and second place teams and individuals were awarded cash prizes during the prize session which concluded the day. All participants received t-shirts compliments of the Office of the President and breakfast and lunch were provided by the math department. Many thanks to Professors Lehman and Magee for organizing the tournament, Professors Helmstutler, Konieczny, Lee, and Perkins for moderating the matches, and the student volunteers who helped make the tournament a success.

UNIVERSITY OF MARY WASHINGTON
where great minds get to work

Jepson SSI

Nora Benedetto and **Kelley Swenson** worked on statistical projects with Dr. Melody Denhere, analyzing UMW's historic data provided by the Office of Institutional Analysis and Effectiveness.

Kelley's project, *Predicting Enrollment using Time Series Models*, was motivated by the PIC Math course that Dr. Denhere taught in the spring. The purpose of the project was to find a statistical model that could accurately predict enrollment for UMW. Four statistical models were considered, including the Holt-Winters and AR(1) models. By way of cross-validation, Kelley determined that the Holt-Winters model was the most accurate for short-term enrollment projections. She received a first place award for her poster presentation at the SSI symposium.

Nora analyzed course evaluation completion rates at UMW using different statistical tools. This work continued work she had started in the spring and the resulting project was titled *Cluster Analysis of Course Evaluation Response Rates*. The goal of the project was to determine if significant trends existed in the response rates at UMW. ANOVA tests and hierarchical and k-means cluster analysis methods were used to determine these trends. She concluded that in the fall semesters, upper level students and the College of Education were the different groupings with the highest response rates.

Rachelle Dambrose and **Aaron Thomas** worked together to solve Poisson's equation analytically and computationally under the direction of Dr. Leo Lee. In particular, their projects focused on heat flow through a two-dimensional square domain. Their projects were titled *Numerical Approximation of Poisson's Equation* and *Mathematical*

Solution to Poisson's Equation, respectively. In his project, Aaron found the mathematical solution of the equation using the method of eigenfunction expansion and wrote computer programs to graph/simulate his solutions. On the other hand, Rachelle derived several numerical models of Poisson's equation with the Taylor series expansions of functions. She also developed a computer code based on her algorithm to solve numerical model problems using various input parameters. Then Aaron and Rachelle performed an experiment to find the temperatures through a heated piece of aluminum foil. Their experimental data was compared to both analytical and computational solutions of Poisson's equation, demonstrating that their models and computer programs could be used to predict real world phenomenon. Both presented their work at the SSI symposium, where Rachelle won first place for her oral presentation.

Dahlgren Research Projects

In the fall **James Branton** and **Kelly McGrady** worked with **Jeff Solka** and **Dan Parks** from the Dahlgren Naval Surface Warfare Center on analyzing *Sleeping Beauties in Science*. *Sleeping Beauties* are papers that don't receive many citations at first but are eventually cited by many other articles. Following the analysis described in *Sleeping Beauties May be Sleeping Innovations* by Anthony F.J. van Raan, James and Kelly wrote programs to reproduce van Raan's results concerning the pattern of citations of "sleeping beauty" papers until "being awakened by a prince" – starting to receive a lot of citations – and also considered alternate ways to identify a "sleeping beauty" paper. Drs. Solka and Parks provided James and Kelly with a database of the citation history of science articles which they used to analyze with their programs written in R. Dr. Hydorn served as the UMW mentor for this project, which was conducted as part of the department's continuing collaborative research with the Dahlgren base.

William Wilkinson worked with **Al Dean** from the Dahlgren base to analyze the workforce dynamics at the base. Also part of our department's collaborative research with Dahlgren, this project was mentored by **Chris Garcia** (COB). Mr. Dean provided William with a large database of employee demographic and employment data which William analyzed using "big data" methods to model relationships between employee characteristics. The long term goal of this project is to determine employee characteristics associated with long term employment in order to help maintain the workforce at the base.

Lloyd Wins Darden Award

Chris Lloyd was one of three recipients of the 2016 Colgate W. Darden Award, given to the graduating senior(s) with the highest GPA. Chris completed his major in mathematics and minor in computer science with a perfect 4.0 GPA, in addition to graduating with honors in mathematics. The last mathematics major to win the Darden Award was Christine Exley '09, now a professor in the Harvard Business School. Chris is currently a first-year Ph.D. student in the Department of Mathematics at the University of Virginia.

Honors Projects

Amy Bowden completed her Honors Program requirements by writing the thesis *The Anthropogenic Allee Effect in Whale Population Models* under the supervision of Dr. Sumner. Amy developed mathematical models based on the premise that species rarity and value are positively correlated where increasing demand for a declining species exceeds the growing costs of harvesting the species.

For his honors thesis, **Chris Lloyd** worked under Dr. Helmstutler on a research project in non-commutative cryptology. His thesis, titled *The Ko-Lee Key Exchange Protocol with Generalized Dihedral Groups*, examines how this new non-commutative protocol behaves under a certain infinite family of finite non-abelian groups. The Ko-Lee protocol is known to be very difficult to analyze with respect to its complexity and security, with few definitive and conclusive results in the literature. Chris was able to prove that generalized dihedral groups have an algebraic structure amenable to analysis under the Ko-Lee protocol. Chris showed that the protocol can be successfully attacked in polynomial time by using specially-constructed conjugate elements in the platform group, writing algorithms to implement his attack. Chris and Dr. H are currently writing an article based on his research.

Victoria Moore worked with Dr. Hydorn to investigate methods to fit models to a collection of simultaneous time series. Victoria started this project in the fall semester in an independent study to learn about time series modeling and how to use R to generate time series and conduct time series modeling. Victoria continued the work for her honors project in the spring by researching methods to fit one model to a collection of simultaneous time series, as opposed to fitting separate models to each series in the collection. She wrote programs in R to generate the collection of time series and to compare several methods for fitting a single model to the collection. She compared the observed prediction error of her methods with the prediction error observed from fitting separate models to each series. Victoria found that there is always greater error from fitting a single model to simultaneous time series, compared to fitting separate models. However, she discovered that in some cases the error is not substantially greater, and thus the greater efficiency of fitting a single model could be useful in those cases.

Pengcheng Zhang completed his honors thesis, titled *Homogeneous, Isotropic Cosmology, Schwarzschild Solution and Applications*, under the direction of Dr. Chiang. In his thesis, he studied the Einstein equation and homogeneous and isotropic cosmology. He then derived the Schwarzschild solution of the vacuum Einstein's equation, and discussed its applications. Zhang is a Mathematics and Physics major and expects to graduate in May 2017.

Are you a member of our Facebook group? Look up UMW Mathematics and join today!

Math in Industry

In the spring, Dr. Melody Denhere offered a special topics course as part of an MAA grant that she received for the Preparation for Industrial Careers in Mathematical Sciences (PIC Math) program. This NSF-funded program aims to prepare students for industrial careers by engaging them in research problems that come directly from business, industry, and government. She mentored four student groups on projects from the Naval Surface Warfare Center Dahlgren Division (NSWCDD) and from UMW's Office of Institutional Analysis and Effectiveness (OIAE).

Steven Hartzell and **Lolita Jojic** worked on a *Language Recognition with N-grams* project with Dr. David Marchette from NSWCDD. They explored how n-grams could be used on a new document to determine in which language the document is written. **John Robie**, **Joseph Dolan**, and **Brittany Armbright** worked with Drs. Jeff Solka and Dan Parks from NSWCDD on a project titled *Industrial Applications of Hidden Symmetries of Graphs*. Their project involved working with the normalizer subgroup to determine hidden symmetries in simple graphs with an application to word adjacency networks.

Dr. Taiwo Ande (OIAE) sponsored two projects that involved analyzing historic data from UMW. **Arfa Vasim**, **Ian Granger**, and **Ricky Martin** tackled the *Enrollment Projection* project by looking at UMW's historic enrollment data for the past 10 years so as to propose efficient methods of projecting the enrollment numbers into the next five years. **Nora Benedetto**, **Magdalen Osei Brantuo**, and **Alison Loughry** worked on a project on *Course Evaluation Completions*. They examined completions of end of course evaluations for the past 5 years by college, department and undergraduate/graduate level with the ultimate goal of looking at the completion trends.

All the students presented their work to the industrial sponsors and at the Research and Creativity Symposium in April. Steven also traveled to Boston to present the work he did with Lolita at a PIC Math session held at the SIAM Annual Meeting in July.

Esunge Fulbright

Julius Esunge spent the spring and summer of 2016 as a Fulbright Scholar in Cameroon. During this time, he presented lectures on Probability, Statistics, and Actuarial Science. He taught courses to undergraduate and graduate students at the University of Buea. He also co-taught a course on Applied Statistics at the prestigious African Institute for Mathematical Sciences and supervised the Masters theses of three students.

Faculty Notes

Yuan-Jen Chiang is a recipient of a Waple Professorship in 2016-2018. She had three research articles published including "Exponentially Harmonic Maps, Exponential Stress Energy and Stability" in the journal *Communications in Contemporary Mathematics*. She also gave four presentations including "Some Properties of f-Biharmonic Maps" at the International Congress on Mathematical Physics in Santiago, Chile.

Melody Denhere attended workshops and conferences in Atlanta, Seattle, Boston, Birmingham (AL) and at the University of Buea in Cameroon where she held multiple workshop sessions on *Predictive Modeling*. Her co-authored article *Rank Estimation for the Functional Linear Model* was published in the *Journal of Applied Statistics*.

Randall Helmstutler gave the joint talk "First-year Seminar in Mathematics: Cryptology" with Keith Mellinger at the MD-DC-VA section meeting of the Mathematical Association of America at Saint Mary's College of Maryland last November. Dr. Helmstutler also served as the four-year institution consultant for the Virginia Community College System's New Mathways Project, working over the year to redesign the mathematics curriculum in the state's community college system.

Debra Hydorn was elected to a three-year term to serve as a Councilor for the Mathematics and Computer Science Division of the Council on Undergraduate Research. She was also selected to participate in the MAA PIC Math program to offer a course to prepare students for data analysis and statistics careers in business, industry, and government. In addition, she was invited to serve as an Associate Editor for the *Journal of Statistics Education*.

Leo Lee saw the publication of an article in the *Journal of the Korean Society for Industrial and Applied Mathematics* and travelled to Seattle and Atlanta to give presentations on his research.

Larry Lehman was on sabbatical leave for the Fall 2015 semester, during which he completed writing a book, *Quadratic Number Theory*. He plans to use this text for a topics course in algebraic number theory during the Spring 2017 semester. He also attended MathFest, the national meeting of the Mathematical Association of America, in Columbus, OH in August 2016. He gave a presentation entitled "Seeding polynomials for congruences modulo prime powers" at the number theory session.

Gallery

Janusz Konieczny had two research articles accepted for publication. He also presented a talk on his research on transformation semigroups at the third annual Conference for the Exchange of Mathematical Ideas held on our campus in June.

Jennifer Magee attended the fall and spring section meetings of the Mathematical Association of America and presented "Calculus: something fun for high school students to do on a Saturday" at the spring meeting at Montgomery College.

Last year, **Keith Mellinger** published the article *Graphs Embedded into Finite Projective Planes* in the journal *Contributions to Discrete Mathematics*. The article was co-authored with one of Dr. Mellinger's collaborators in California and UMW mathematics alumnus Ryan Vaughn.

Suzanne Sumner was invited by the Association for Women in Mathematics to write the book chapter *Communicating Mathematics through Writing and Speaking Assignments* for the Springer-Verlag publication *Mathematics Education: A Spectrum of Work in Mathematical Sciences Departments*. The chapter features UMW mathematics students through their work and interviews. The volume will be published in time for the 2017 Joint Mathematics Meeting.

This past year **Debra Hydorn**, **George Meadows**, **Marie Sheckels**, and **Suzanne Sumner** partnered on a Virginia Department of Education Mathematics and Science Partnership grant "Integrated Professional Learning Communities (K-8) centered Applied Math & Applied Science to support Vertical Best Practices." They worked with teachers at Smith Station Elementary School and Freedom Middle School on mathematics content and the pedagogy of design briefs.

Check out our website

– cas.umw.edu/math –

view our page devoted to our alumni and,

better yet, email Dr. Helmstutler at

rhelmstu@umw.edu to get yourself included!