

Mathematics at UMW

Fall 2015

a newsletter of the Department of Mathematics at the University of Mary Washington

Welcome from the Chair

Welcome back for another year of engaging work in mathematics at UMW. The contents of this newsletter show that last year was a busy and fruitful one, and this year promises the same. We have a lot planned for 2015-2016, including special course offerings, external speakers and visitors, and the largest graduating class in mathematics in my 10 years here at UMW.

If you had noticed our campus' slightly disheveled look the last time you were here, things have progressed nicely. The new University Center opened in August and it is quite a leap forward from Woodard. Now all student services are centrally located in the University Center, complete with new dining facilities. Moreover, the new addition to Woodard (to house the College of Business) and the complete renovation of Mercer (for Psychological Science) are nearly complete. I can't believe it, but we may see those trailers disappear in the next few years...

Around the department, I am excited to announce that we have a brand new faculty member on board: Kelly Perkins joins us as a lecturer specializing in our lower-level offerings. You can read more about Kelly in his profile in this newsletter. For our current students, keep your eye out for a new offering this spring, Math 361: Problems in Industry. This course will have students formally partnered with regional firms and contractors to work on math problems of relevance to their particular industry. In this course you will learn the mathematics necessary to understand these problems and gain valuable real-world experience along the way. Those interested should contact Dr. Melody Denhere for more details.

In other department news, we have several faculty with sabbatical leaves for the next few semesters. Their absences could possibly affect course offerings and rotations. If you have any questions, you should contact your major advisor (that's why you have them!) or reach out to me directly. This year the department is also undergoing our 10-year program review, an assessment exercise that will require us to take a thorough look at what we're doing and how we can change for the better. As part of this we will have two visitors in October and November, chairs of notable programs that will be here to learn more about us and give helpful advice on how we can further enhance our offerings. To our current students, I may ask you to meet with these visitors to share your views on the department since your opinion matters most.

Speaking to our current students, we've always tried hard to offer exceptional opportunities for advanced study in mathematics. This year is no different, possibly with even more options than before. When you see an opportunity to further develop your studies or career preparation, be sure to speak up and take advantage. You have an entire network of faculty and staff here to assist you; all you have to do is let us know what you need. To our alumni, I've had a lot of contact with you the past few months and I sincerely appreciate your staying in touch. Your success after UMW is the best proof there is that what we're doing matters. To everyone—former, current, or prospective students—please keep in touch and reach out if you ever need anything.

Randall Helmstutler
Chair, Department of Mathematics

Departmental Updates



The Department of Mathematics is pleased to welcome Mr. Kelly Perkins, who joins our department as a full-time lecturer. Kelly earned a Master's degree in Applied Mathematics with a concentration in statistics in May of 2015 from Virginia Commonwealth University. Prior to his studies at VCU, Kelly graduated from Rice University, worked in the actuarial department of American General, and earned a Juris Doctorate from the University of Houston Law School. Outside of the classroom, Kelly enjoys attending live music events, following college sports, and relaxing in the Outer Banks.

Congratulations should be given to Julius Esunge, who earned tenure and was promoted to Associate Professor. Two faculty will be taking sabbatical this academic year: Larry Lehman will be away in the fall, and Julius Esunge will be away in the spring semester.



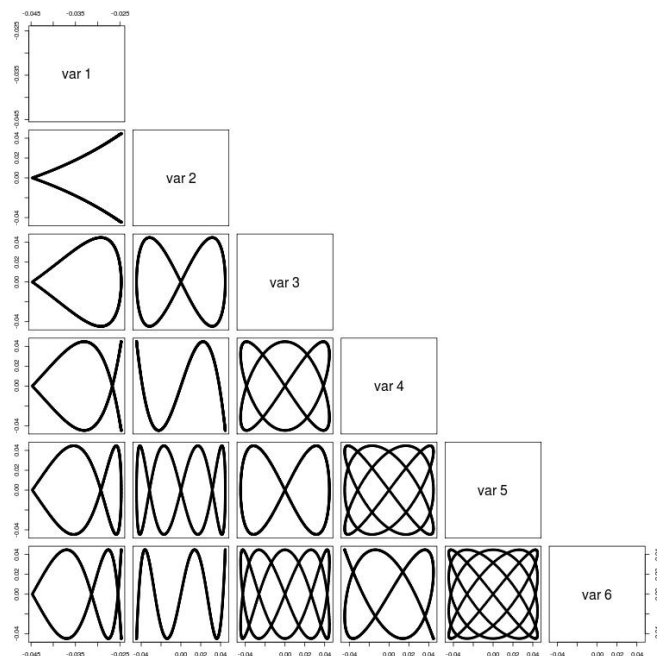
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where great minds get to work

Student Research

Junior **Alaina Morello** worked with Professor Mellinger on a project titled *Clifford embeddings: a problem in quantum coding theory*. Working with scientist and UMW alumnus Jake Farinholt, the team researched a problem in error correcting codes which allow information to be transmitted over noisy channels in a way that the original message can be recovered if the data is corrupted. Quantum computers in existence are limited to a small amount of operations, but large scale quantum computers promise to provide computational capabilities believed to be infeasible under our current classical systems. This work focused on a particular technique for performing quantum coding theory which reduces to a problem in abstract algebra. Alaina presented her findings at the Dahlgren Research symposium in the fall semester and also at UMW's Undergraduate Research and Creativity Day in April.

In the fall **Michelle Craft** investigated interesting patterns that can be observed in the pairwise plots of the eigenvectors of the inter-point distance matrix of evenly distributed points in one dimension. She worked with David Marchette and Elizabeth Hohman from the Dahlgren Naval Surface Warfare Center; Dr. Hydorn served as the UMW mentor for the project. The inter-point distance matrix is an example of a Toeplitz matrix and Michelle compared the inverse of this matrix to a discrete cosine transform matrix and its eigenvectors. Michelle used R to produce the pairwise plots and to investigate symmetric and skew-symmetric eigenvectors. A pairwise plot of the eigenvectors for $N=6$ points is shown below:



Lauren Falkenstein and **Heather Coleman** also worked with Drs. Marchette and Hohman from Dahlgren to investigate the relationship between multidimensional scaling and principal components analysis in the spring semester. Dr. Hydorn also served as the UMW mentor for this project. Lauren and Heather used R to produce the principal components and multidimensional scaling vectors for the same data and then showed that the two are equivalent when Euclidean distance is used to find the principal components. The equivalence of the two sets of results was shown using the Procrustes function in R. They also demonstrated how the solutions from the two methods differ from each other as the distance measure used for the principal components analysis deviates from Euclidean distance.

Dr. Denhere mentored two different groups of students on a project on citation prediction and analysis. The project's objective was to understand and reproduce the work of Wang, Song, and Barabasi on "Quantifying Long-Term Scientific Impact" published in *Science* (2013). The students worked on this with Drs. Solka and Parks from Dahlgren. In the fall, **Travis Whitehead** and **Jonathan Blauvelt** explored the initial values that worked with the predictive model. They produced useful convergence heat maps that helped to determine the optimal values for the model. **Steven Hartzell** and **Victoria Nguyen** worked on determining the error bounds for the predictive model in the spring semester. Both projects culminated in both oral and poster presentations at the end of the semester, as well as the submission of a report with recommendations for the Dahlgren researchers.

With funding from the Jepson Summer Science Institute, Julius Esunge led a research project working with UMW undergraduates **Rebecca Revercomb** and **William Scheid**. Both students worked on projects in computational actuarial science. Their efforts culminated in presentations at the Summer Science Symposium, where Rebecca gave an oral presentation and William gave a poster presentation.

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!

Honors Projects

Two students defended the work in their honors theses last year, both working with Dr. Debra Hydorn. In the fall semester, **Kimberly Hildebrand** investigated the use of Bernoulli random variables to model the number of female hires in a fixed number of open positions. She used the moment generating function and probability generating function for the sum of independent but non-identically distributed Bernoulli random variables to show that it is unlikely that less than two women would be hired for seven open positions. She then investigated the use of the binomial distribution to approximate the sum of independent but non-identically distributed Bernoulli random variables and found that, in most cases, the binomial distribution provides a good approximation. She conducted her analyses and simulations using R.



Hydorn and Craft

As a continuation of the project she began for her Dahlgren Undergraduate Research project, **Michelle Craft** found that every odd eigenvector of the discrete cosine transform matrix (DCTM-2) corresponds to an eigenvector in the inter-point distance matrix for evenly distributed points in one dimension. Using R, she also identified recurring patterns in the pairwise plots of the eigenvectors of the inter-point distance matrix. These include plots that have linear, circular, crossed ovals, and knot patterns. Michelle is currently working towards her Master's of Education in Secondary Education.

Lauren Turner completed her capstone research project for the Honors Program with Dr. Sumner. She used Mathematica to modify a differential equations model that studied the effect of vaccines on the spread of disease.

Calculus Tournament

The Department of Mathematics sponsored its ninth annual Calculus Tournament for regional high school students on April 18, 2015. This year's tournament, organized by Larry Lehman and Jennifer Magee, featured a record level of participation, with twelve teams representing eight high schools--two teams each from Bishop O'Connell (Arlington), Paul VI (Fairfax), Mountain View (Stafford County), and Spotsylvania County, and one team each from Riverbend (Spotsylvania County), Fredericksburg Academy, James Monroe, and Commonwealth Governor's School (Fredericksburg). After four round-robin matches in the morning, six teams advanced to the afternoon competition. Bishop O'Connell's second team and James Monroe were eliminated in the quarter-finals, and Fredericksburg Academy and Paul VI's second team were eliminated in the semi-finals. In the final match, Paul VI defeated Bishop O'Connell to claim the team competition.

Members of the first and second place teams were awarded cash prizes. Participants also had the opportunity to compete in an individual written exam, with cash prizes for first and second places. The cash prizes totaled \$750. All participants were given t-shirts and enjoyed breakfast and lunch at the tournament. This year's tournament was funded by the math department with a generous contribution from President Hurley.

Special thanks to the UMW student volunteers and faculty moderators Drs. Helmstutler, Konieczny, and Lehman, and Christopher Gray who helped the tournament run smoothly.



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

NSF Grant Update- Peer Assisted Study Sessions

Funded by the NSF STEM Talent Expansion Program grant awarded to the university in 2011, the department continues to offer peer mentoring in some of our calculus and statistics courses through Peer Assisted Study Sessions (PASS). Students who serve as PASS leaders attend class and offer two to three PASS sessions each week. Our PASS leaders last year were **Amy Bowden** and **Emma Tennant** for Calculus and **Aaron Kalman** for Introduction to Statistics. Amy is again serving as a PASS leader this year and explains that “The idea of PASS is for students to work together and develop studying techniques that they are able to utilize in all classes they take at UMW. I encourage them to work together on activities instead of me teaching them the whole lesson again.” Dr. Venitta McCall in the College of Education is the Director for PASS and provides training and support to the PASS leaders. About PASS Dr. McCall states “I wish more students took advantage of this wonderful opportunity to improve their performance and confidence to be academically successful in Calculus and Statistics. PASS participation also benefits students in developing study skills, test-taking tips, and learning strategies that carry over into all subjects.”

Magee wins teaching award

In April 2015, Professor Jennifer Magee was awarded the 3rd annual Chi Beta Phi Faculty Award. Chi Beta Phi is an interdisciplinary math and science honor society for undergraduates, which seeks to promote STEM disciplines and recognize academic achievements. The Faculty Award is a student-nominated award given to a professor in the STEM disciplines who demonstrates outstanding teaching and outreach to students. Students commented that Magee is enthusiastic in the classroom and always willing to help students understand. Suzanne Sumner was the 2014 winner of the award and presented the award to Professor Magee.



Esunge awarded Fulbright Fellowship



Professor Julius Esunge was recently selected to receive a prestigious 2015-2016 Fulbright U.S. Scholar grant. As part of his Fulbright grant, Esunge will travel to Cameroon to conduct research and lecture at the African Institute for Mathematical Sciences as well as his undergraduate alma mater, the University of Buea, beginning in the spring of

2016. While abroad he will teach two semesters of probability and actuarial mathematics, lead a weekly graduate seminar in stochastic analysis, and work on predictive models for healthcare costs.

The Fulbright Program, sponsored by the U.S. Department of State's Bureau of Educational and Cultural Affairs, is the U.S. government's flagship international exchange program. The scholarship program gives professors a unique opportunity as ambassadors of American higher education, pursuing research and teaching opportunities around the world. “The opportunity to return to the University of Buea and actively mentor a new generation of students is priceless,” said Esunge, who joined the UMW mathematics department in 2009. “I have the opportunity to map a path for the current students and motivate them through passionate teaching.”

Faculty notes

Yuan-Jen Chiang had three research articles published including “Paying Tribute to James Eells and Joseph H. Sampson: In Commemoration of the 50th Anniversary of Their Pioneering Work on Harmonic Maps” in the *Notices of American Mathematical Society*, 2015. She also presented two papers at conferences including the 2014 International Congress of Mathematicians in Seoul, South Korea.

Melody Denhere was selected to participate in the MAA program PIC Math to offer a course that helps students prepare for work in the real world. In addition to presenting at conferences in Texas, California, and Minnesota, her paper “Robust Principal Component Functional Logistic Regression” was published in the journal *Communication in Statistics - Simulation and Computation*.

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Debra Hydorn participated in the 10-week Office of Naval Research Summer Faculty Research Program at the Naval Surface Warfare Center Dahlgren Division, between June 1 and August 7, 2015. She investigated the use of the R BACCO package to implement Bayesian calibration of computer code output.

Janusz Konieczny has been awarded a Waple Professorship for the 2015-16 and 2016-17 academic years.

During his sabbatical in the fall of 2014, **Leo Lee** served as visiting professor at Sogang University in Seoul, South Korea where he taught the Computational Mathematics and Application course for undergraduate students and the Applied Mathematics course for graduate students. In addition, he published the paper “An Optimization Based Domain Decomposition Method for PDEs with Random Inputs” in the journal of *Computers & Mathematics with Applications*. He also gave several research talks on stochastic partial differential equations at Yonsei University and Sogang University in Seoul and served as the mathematics and statistics symposium chair for the US-Korea Conference 2015.

Larry Lehman was awarded a sabbatical leave for the Fall 2015 semester. He plans to complete writing a book, *Quadratic Number Theory*, intended as a textbook for a second course in number theory.

Jennifer Magee participated in workshops and discussions in the Fall 2014 and Spring 2015 section meetings of the MAA as part of her participation in Section NEXt.

Keith Mellinger delivered several invited presentations this year including the keynote address at the annual honors and awards banquet for the Mathematics Department at Millersville University in Pennsylvania. His co-authored article “Small Kakeya sets in non-prime order planes” was published last spring in the *European Journal of Combinatorics*.

Suzanne Sumner was invited to give a public media interview on “The Mathematics of Omar Khayyam” for an Iranian documentary titled *Broken Grail*. The *Broken Grail* documentary will reproduce scenes from Khayyam’s life and feature his accomplishments in mathematics, science, and philosophy. Sumner was also invited to give the Keynote Presentation for the National Chi Beta Phi meeting held at UMW in October 2014. Her interdisciplinary presentation was titled “Mathematical Modeling of Honey Bee Populations and Behavior.”

Gallery



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