Mathematics at UMW

Fall 2017

Welcome from the Chair

Welcome back for another great year of classes and programming in the Department of Mathematics. We are continuing to see a great many positive changes in the department and around the university, so I wanted to give you a quick overview of what we have planned for this year.

First, we've had some staffing changes since our last newsletter hit the stands. Gary Collier retired in December of last year, leaving big shoes to fill in our Calculus classrooms. In his place (though he is not replaceable) we were able to hire Jeb Collins, now affectionately known as "the new guy." Jeb comes to us from West Texas A&M University outside Amarillo, where he worked for a few years as an assistant professor. Jeb is known for his innovative teaching techniques and is a strong advocate for inquiry-based learning. You can read more about Jeb in this newsletter. In other news, Keith Mellinger will be serving as Interim Dean of the College of Arts and Sciences this year. So, if you need to find him, start your search on the third floor of GW Hall.

Campus looks a bit different now, in a good way: the trailers are now completely gone! Most were taken out last year, but one or two remained. If you're in Trinkle and you feel the building shaking, you don't (necessarily) need to take cover: work on the amphitheater renovations is well underway. Next up is the planned addition to Jepson Hall, scheduled to begin any day now.

For our current students, take careful notice of your degree requirements and our course prerequisites. In response to a complete program assessment and feedback from external evaluators, we're making multiple gradual changes to our curriculum over the next couple of years. The requirements for the math major have changed for new 2017-18 majors, and we'll be making more small changes in the coming years. Most importantly, MATH 330 (Foundations) is being phased in as a required course, eventually serving as a prerequisite to Abstract Algebra, Real Analysis, and Topology. Work with your advisor to make sure you have a good plan, and ask me whenever you have questions.

We are planning all of our usual programming for the year, including our popular Alumni & Career Panel in the fall. We will also have several special guests for colloquium speakers, including our special Alumni Colloquium talk in the spring, and the return of our High School Calculus Tournament. Our student chapter of the MAA is also planning for this year to be a revitalization period, so look for club meetings and student-centered events sponsored by our MAA group. To stay informed of all of these opportunities, be sure to join our UMW Mathematics Facebook group, where events and career opportunities are frequently posted.

If you ever have any questions or ideas for new programming, please stop by my office in Trinkle 128 and let me know. Whether you are a current student or an alum, we'd love to hear from you. Best wishes for a great year.

Randall Helmstutler
Chair, UMW Department of Mathematics

Transitions

The Department of Mathematics is happy to welcome Dr. Jeb Collins to our department as our new tenure-track assistant professor. Jeb completed his Ph.D. in numerical analysis in 2010 at NC State, after which he spent four years as a postdoctoral fellow at Colorado State University. After working for three years at West Texas A&M University, Jeb and his wife Deb are happy to be back on the east coast, closer to family. Having family close by will be helpful, as they are expecting their first child in October. If you see Jeb around the department, be sure to welcome him!

If you hadn't already heard, Dr. Gary Collier retired from UMW in December after more than 30 years of devoted service to UMW and our department. It is not the same around Trinkle without him, and scores of Calculus students are still recovering from the loss…

If you're looking for Dr. Keith Mellinger in Trinkle this year, you're in the wrong place. Dr. Mellinger is serving as the Interim Dean of the College of Arts and Sciences for the 2017-18 academic year.

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where great minds get to work
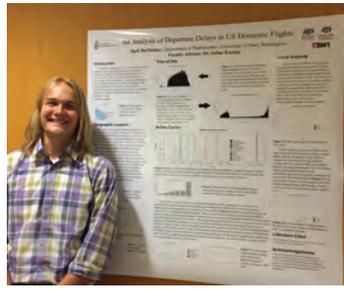
Jepson SSI

Once again, the Department of Mathematics was well-represented in the Jepson SSI program, with four students working with three faculty on research projects. **Ekta Kapoor** and **Gail Crunkhorn** worked with Dr. Debra Hydorn on developing several measures for assessing interrater reliability (IRR) for a situation with more than one rating criteria. Evaluating is important for assessing the rating criteria and how well raters understand and consistently apply those criteria, but the traditional measures for IRR are useful for situations where only one rating is made by two or more raters. Gail and Ekta focused their work on Fleiss's kappa, which "corrects" overall agreement between raters based on the probability of agreement just due to chance. They wrote several programs in R to conduct simulations to study the distribution of their kappa modifications assuming uninformed raters (ratings produced at random). They used the results of their simulations to evaluate the use of their modified kappa criteria on an example set of ratings which had four raters rating 17 "objects" using nine different criteria. This project was a continuation of the work Gail and Ekta had done as part of the spring PIC Math course (MATH 361).

Shannon Haley worked with Dr. Randall Helmstutler on the project "A Massey-Omura Cryptosystem with Disjoint Permutations." The original encryption scheme was patented by Massey and Omura in the 1980s, its algorithm being based on the well-understood algebraic properties of modular arithmetic. Shannon's project was an attempt to modify their scheme in a non-commutative setting, wherein the algebra would hopefully be sufficiently more complicated to better conceal information. Shannon worked on finding ways to adapt the original Massey-Omura system so that it could be implemented over permutation groups. These groups are known to be non-commutative and very large, two desirable properties in cryptography. However, this move to a non-commutative setting requires an entire rebuilding of the

system. Shannon worked out one way to accomplish all of this, replacing modular exponentiation with an action by conjugates in a symmetric group, even developing measures of security for the resulting system. Shannon is continuing her research in this area over the next academic year, looking at different ways of building non-commutative Massey-Omura schemes in her honors thesis research.

Under the direction of Dr. Julius Esunge, **Jack McMinimy** undertook a statistical analysis project on a massive dataset with over six million entries of airline travel information. (Yes, that's right, six million.) Using the statistical analysis program R, Jack focused his attention on analyzing departure delays based on airline, geographic location, month, and time of day. His culminating poster was presented at the SSI symposium in July.

Dahlgren Research and PIC Math

This past year a robust group of students applied their mathematics skills to tackle real-world problems with industrial and government partner agencies. Amazingly, all of these projects were directed by **Dr. Debra Hydorn**. **Brittany Armbright** worked with Dahlgren researchers Jeff Solka and Dave Marchetti to evaluate how Fitbits and other fitness tracking devices can be used to analyze sleep patterns. After applying methods to clean the data (e.g., identifying and accounting for missing data) Brittany used the changepoint package in R to identify sleep cycles in data provided by individual Fitbit users.

A number of students took Dr. Hydorn's Problems in Industry class (MATH 361) in the spring term, working on five different projects as part of the MAA's PIC Math program. **Amy Brennan**, **Danielle Niepokoj**, and **Margaux Tucker** analyzed survey data provided by the American Academy of Pediatric Dentists. Survey respondents answered questions regarding their beliefs and practices concerning childhood obesity and sugar consumption. Amy, Danielle, and Margaux used R to conduct principal components analysis to reduce the number of variables to be analyzed and then used canonical correlation analysis to find associations between groups of variables.

Creigh Brigman, **Shane Cramblett**, **John Hogan**, **Mark Quigley**, **Andrew Robinson**, and **Caitlin Ward** conducted time series analyses on data provided by the National Estuarine Research Reserve System. The students began the project working as a single group, learning how to upload the data from the NERRS website and work with time series data in R. They later divided into two teams, one analyzing data from the west coast and the other working with data from sites on the Chesapeake Bay.

Gail Crunkhorn, **Ekta Kapoor**, and **Stephanie Loftus** analyzed data consisting of ratings for nine criteria from four raters on 17 different "objects." (As a condition for working with this project they were not told about the source of the data.) The students used R to organize the data set and then produced a variety of different measures to evaluate the interrater reliability of the raters on each of the nine criteria. Gail and Ekta used this project as a springboard to the 2017 Jepson Summer Science Institute.

Kirstyn Howard, **Michael McKenna**, and **Alex Van Stippen** worked with Jeff Solka and Dave Marchetti from the Naval Surface Warfare Center Dahlgren Division to analyze network data. The goal of the project was to investigate ways to identify "nodes of interest" within a network, based on known information about some of the nodes. The students wrote programs in R to code algorithms they wrote to select a node and monitor neighboring nodes. With support from the PIC Math program, Kirstyn attended the 2017 MAA Math Fest in Chicago in July to present a poster on their project.

Dambrose Wins Darden Award

For the second year in a row, a mathematics major won the prestigious Colgate W. Darden award. The sole 2017 recipient of the Darden award was **Rachelle Dambrose**, an honors graduate in the Department of Mathematics. The Darden award is bestowed upon the graduating senior with the highest GPA. Previous Darden award winners from our department are Christopher Lloyd '16 and Christine Exley '09.

Honors Defenses

Two seniors defended their honors theses in April, graduating in May 2017.

After solving the 2-D Poisson's equation analytically and computationally in SSI 2016, **Rachelle Dambrose** expanded her research into the three-dimensional problem, again working under Dr. Leo Lee. In her honors thesis, Rachelle obtained approximate solutions of both the 2-D and 3-D Poisson's equation by hand and investigated solution patterns. With these patterns, she developed a numerical method to find approximate solutions of the equation for any number of unknowns, writing a computer program to approximate these solutions confirming the accuracy of her work. Rachelle delivered a presentation on her work at the undergraduate mathematics and statistics conference at James Madison University in the fall. Also, her three-dimensional results were rewritten as a research article for publication and submitted to a mathematics journal.

Nicholas Gabriel completed his honors thesis in the mathematics of space-time under Dr. Jen Chiang. Nicholas, a double major in math and physics, wrote a thesis titled "Maxwell's Equations, Gauge Fields, and Yang-Mills Theory." Nicholas' work starts with Maxwell's theory of electromagnetism in a Minkowski space-time, then generalizing this to arbitrary space-times and gauge groups. He is currently a first-year Ph.D. student in physics at George Washington University.

Faculty Notes

Yuan-Jen Chiang had two research articles published, including "Leaf-wise Harmonic Maps of Manifolds with 2-dimensional Foliations" in the *Bulletin of the Institute of Mathematics, Academia Sinica*. She also delivered two presentations including one at the International Congress of Chinese Mathematicians in Beijing.

Melody Denhere presented her research at the Women in Data Science and Statistics Conference (Charlotte, NC) and the 5th Workshop on Biostatistics and Bioinformatics (Atlanta, GA).

After a very fruitful Fulbright experience, **Julius Esunge** returned to his duties at UMW in the fall. He recently presented his research at the 52nd Actuarial Research Conference in Atlanta, GA, and will be co-hosting a special session on stochastic analysis at the January 2018 Joint Mathematics Meetings in California.

Randall Helmstutler attended the 2017 Joint Mathematics Meetings in Atlanta, where he participated in an intensive day-long workshop for chairs of mathematics departments. He also gave a research talk titled "Generalized Dihedral Groups in Non-commutative Cryptographic Protocols."

Faculty Notes (continued)

Debra Hydorn had two artworks selected for the Mathematical Art Exhibition at the Joint Mathematics Meetings in Atlanta. She also gave a presentation at the conference on using "small teaching" methods in her MATH 201 classes in the fall. In addition, she is the co-PI with Marie Sheckels and faculty from the College of Education on a grant from SCHEV to conduct a STEM professional development program for teachers from the Northern Neck of Virginia.

Janusz Konieczny published three research articles and submitted two additional articles for publication. He also gave a research talk in the special session on semigroup theory at the regional meeting of the AMS in Denver, CO.

Leo Lee presented his work on numerical solutions of stochastic partial differential equations at the Joint Mathematics Meetings in Atlanta, GA. He also served as a referee for mathematics journals.

Larry Lehman had the article "Seeding polynomials for congruences modulo prime powers" accepted for publication. Larry also gave three talks this year, including two presentations at the Joint Mathematics Meetings in Atlanta, GA.

Jennifer Magee attended the MD-DC-VA section meeting of the MAA hosted by Johns Hopkins University in November. In January she presented the talk "Cryptology for First-year Students" at the Joint Mathematics Meetings in Atlanta.

Keith Mellinger gave the invited workshop at the fall sectional meeting of the MAA and delivered a presentation on our quantitative reasoning course at the Joint Mathematics Meetings in Atlanta.

In addition to her involvement in multiple education grants, **Marie Sheckels** gave the talk "Enhancing Quantitative Reasoning and Skills through Exploring Scientific Applications" at the Joint Mathematics Meeting in Atlanta.

Suzanne Sumner saw the publication of her chapter in the AWM book *Mathematics Education: A Spectrum of Work in Mathematical Sciences Departments*, published by Springer. In addition to giving a presentation at the Joint Mathematics Meetings in Atlanta, Suzanne was involved in several educational grant initiatives with **Debra Hydorn**, **Keith Mellinger**, **Marie Sheckels**, and faculty from other disciplines.

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

Gallery

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!