2022 Intermountain MAA Section Meeting

March 25 – 26, 2022

Utah Valley University (UVU), Orem, UT

Hybrid Meeting

Sponsors:

2022 Intermountain MAA Section Meeting
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Utah Valley university, Orem, UT
Hybrid Meeting

Intermountain MAA Section Officers:

Brunja Kohler (USU), Congress Representative

Vinodh Chellamuthu (DSU), Chair

Derek Hein (SUU), Past Chair

Violeta Vasilevska (UVU), First Vice Chair

Md Sazib Hasan (DSU), Second Vice Chair

Emma Turner (SUU), Secretary/Treasurer

Ben Woodruff (BYU-I), Webmaster

Carolyn Connell (Westminster College), Historian

Planning Committee
Local Organizers

Violeta Vasilevska (UVU), Chair
Violeta.Vasilevska@uvu.edu

Alan Parry (UVU)
Alan.Parry@uvu.edu

Bob Palais (UVU)
Bob.Palais@uvu.edu

Michael Dorff (BYU)
MDdorff@math.byu.edu

Remarks:

The Friday Banquet dinner and Invited Talk will be held in the Fulton Library (FL). (Map of Fulton Library)

All other events will be held in the Science Building (SB). Map of the Science Building.

P - In-person Presentation

V - Virtual (LiveStreamed) Presentation

GS - Graduate Student

Welcome Message

Greetings, fellow mathematicians!

Due to continued impacts from the covid-19 pandemic, the Intermountain Section's executive committee decided to hold our annual Spring section meeting in a hybrid format to provide both in-person and virtual presentations. The meeting will be hosted by Utah Valley University (UVU) in Orem, UT, on March 25 and 26. This two-day event will include contributed talks, presentations from our distinguished invited speakers, and student presentations and activities (such as the Calculus Bee). Presentations cover topics across the field of mathematics with the goal to stir discussion and interest.

The program this year includes guest speakers:

Liz Copene (Sr. Director, Software Development, bioMérieux [formerly BioFire Diagnostics])

Catherine Hsu (Swathmore College)

Emille Davie Lawrence (University of San Francisco)

Ellen Veomett (Saint Mary's College of California)

We are excited that these guests have accepted our invitation! They are excellent speakers and experts in their individual fields. We will also have a workshop by Ellen Veomett on the theme: "Mathematics of Gerrymandering."

We will have a banquet on Friday night, a Section Business Meeting, Roots of Knowledge tours, and a hiking excursion on Saturday afternoon. We also want to thank the host - UVU, especially the College of Science and the Department of Mathematics, for hosting and supporting the meeting.

Sincerely,

Vinodh Kumar Chellamuthu

Chair, Intermountain Section

Associate Professor of Mathematics

Dixie State University

Friday, March 25, 2022 Schedule (**Mountain Daylight Time**)

12:30 - 5:00 pm	**Registration (SB Atrium)**
12:45 - 1:45 pm	**Roots of Knowledge Tour** *Contact: Alan Parry (Alan.Parry@uvu.edu)* **Brigham Gallery, Library**
2:00 - 2:10 pm	**Welcome Remarks** *Dean Daniel Horns (UVU College of Science)* *Chair Alan Parry (UVU Department of Mathematics)* *Chair Vinodh Chellamuthu (Intermountain MAA Section)* **SB 134**
2:10 - 3:00 pm	**Invited AWM Speaker:** Catherine Hsu (V) *Introduced by Vinodh Chellamuthu* **SB 134**

Moderators *Virtual* **Room**	**Math Ed** *R. Snellman* *W. Mogilski* **SB 073**	**Applied Math** *H. Bhatt* *S. Simmons* **SB 260**	**Undergraduate** *X. Xie* *Y. Li* **SB 139**	**Undergraduate** *D. Hein* *S. Lewis* **SB 134**
3:15 - 3:30 pm	K. Sharp (P)	B. Palais (P)	G. Schmidt (P)	A. Scanlon (V)
3:35 - 3:50 pm	Z. Coverstone (P)	A. Jenkins (P)	B. Price (P)	A. Frazier (V)
3:55 - 4:10 pm	M. S. Hasan (P)	H. Bhatt (P)	Z. Wang (V)	B. Carlson (V)
		Pure Math		
4:15 - 4:30 pm	W. Mogilski (P)	S. Simmons (P)	G. Schmidt (V)	J. E. Marrow (V)
4:35 - 4:50 pm	B. Sambandham (V)	L. Nelsen (V)		

5:00 - 6:00 pm	**Roots of Knowledge Tour** *Contact: Alan Parry (Alan.Parry@uvu.edu)* **Brigham Gallery, Library**
6:00 - 7:00 pm	**Banquet Dinner (UVU Catering)** **FL 421 (Timpanogos Room)**
7:00 - 7:10 pm	**Intermountain MAA Section Teaching Award** *Presented by Vinodh Chellamuthu* **FL 421 (Timpanogos Room)**
7:10 - 8:00 pm	**Invited BIG* Speaker:** Liz Copene (P) *Introduced by Bob Palais* **FL 421 (Timpanogos Room)** * *Business, Industry, Government*

Friday, March 25, 2022 Contributed Talks
Mountain Daylight Time

Time/ Room	Presenter/Title of the Talk
3:15 - 3:30 pm	
SB 073	K. Sharp (Hawkes Learning) *Elements for Successful Courses in the Digital Age*
SB 260	B. Palais (UVU) *Math Matters in Rapid PCR Diagnostic Assays*
SB 139	G. Schmidt (DSU) / B. Whipple (ISU) *A Dynamical Systems Model of Dengue Transmission for Rio De Janeiro, Brazil*
SB 134	A. Scanlon (Westminster College) *Analyzing Biases in the Salt Lake City Police Department*
3:35 - 3:50 pm	
SB 073	Z. Coverstone (USU) *An Problem-Based Approach to Geometric Series Convergence*
SB 260	A. Jenkins (BYU) *Topological Community Detection in Networks Using Persistent Homology*
SB 139	B. Price (DSU) / N. Garrett (ISU) *A Mathematical Model for the Transmission of Dengue Fever with Multiple Serotypes*
SB 134	A. Frazier (WSU) *Decomposing Treatment Effect Estimates Using a Bracketing Approach: Application to COVID-19*
3:55 - 4:10 pm	
SB 073	M. S. Hasan (DSU) / V. Chellamuthu (DSU) *Feasibility of Customized OERs?*
SB 260	H. Bhatt (UVU) *L-Stable Scheme to Damp Spurious Oscillations*
SB 139	Z. Wang (ISU) *The Effects of Supervised Modeling and Unsupervised Hierarchical Clustering for Topic Clustering as They Apply to Educational Videos on Mathematics*
SB 134	B. Carlson (SUU) *Numerical Analysis of Crowding Effects in Competing Species*

Friday, March 25, 2022 Contributed Talks (continue)
Mountain Daylight Time

Time/ Room	Presenter/Title of the Talk
4:15 - 4:30 pm	
SB 073	W. Mogilski (UVU) *The Impact of Prerequisites for Calculus I Performance*
SB 260	S. Simmons (UVU) *Periodic Orbits in the Co-Sitnikov Problem*
SB 139	G. Schmidt / R. Morgan (DSU) *Statistical Modeling to Predict the Trend in Lung Cancer Data in Utah Using Joinpoint Regression Analysis*
SB 134	J. E. Marrow (SUU) *The Schur Rings of Monogenic Semigroups*
4:35 - 4:50 pm	
SB 073	B. Sambandham (DSU) *Connecting Classroom to the Community - Active Learning Calculus*
SB 260	L. Nelsen (Colorado College) *Graph Theory at The Office*

Saturday, March 26, 2022 Schedule
Mountain Daylight Time

8:00 - 1:00 pm	**Registration (SB Atrium)**			
8:30 - 9:20 am	**Invited Speaker:** Emille Davie Lawrence (P) *Introduced by Violeta Vasilevska* **SB 134**			
Moderators *Virtual* **Room**	**Math Ed I** *V. Vasilevska/A. Parry* *A. Parry* **SB 073**	**Math Ed II** *V. Chellamuthu* *J. Fagan* **SB 139**	**Applied Math** *S. Armstrong* *M. A. Abramson* **SB 260**	**Calc. Bee**** **SB 134**
9:45 - 10:00 am	M. Dorff (P)	J. Fagan (P)	M. A. Abramson (P)	
10:05 - 10:20 am	R. Snellman (P)	V. Chellamuthu (P)	Z. Zhang (P)	
10:25 - 10:40 am	N. Anderson (P)	J. Beck (P)	S. Armstrong (V)	
10:45 - 11:00 am	J. Wittwer (V)	J. Contreras (P)	J. Han (V)	
11:05 - 11:20 am	J. Wittwer (V)			
11:30 - 1:00 pm	**Business Meeting** **Lunch - Subway** **SB 139**			
1:00 - 3:00 pm	**Workshop Speaker:** Ellen Veomett (P) *Introduced by Md Sazib Hasan* **SB 139**			
3:00 - ?? pm	**Social Activity (Hike)** *Contact: Adam Frederickson (10322904@uvu.edu) or* *Wiktor Mogilski (Wiktor.Mogilski@uvu.ed)*			

** *Organizers:*

Md Sazib Hasan (MdSazib.Hasan@dixie.edu)

Buna Sambandham (Buna.Sambandham@dixie.edu)

Emma Turner (EmmaTurner@suu.edu)

Saturday, March 26, 2022 Contributed Talks
Mountain Daylight Time

Time/ Room	Presenter/Title of the Talk
9:45 - 10:00 am	
SB 073	M. Dorff (BYU) *Programs of TPSE Math – Leadership, Data Science, and DEI*
SB 139	J. Fagan (UVU) *Discrete Mathematics: A Terminal Introduction to Proof Course for Computer Scientists*
SB 260	M. A. Abramson (UVU) *An Efficient Global Optimization Approach for Computing Penetration Depth between Two Convex Polytopes*
10:05 - 10:20 am	
SB 073	R. Snellman (BYU) *Classroom Community Using Cohorts*
SB 139	V. Chellamuthu (DSU) *Designing Authentic Learning Environment through Interdisciplinary Collaboration*
SB 260	Z. Zhang (USU) *A revisit of the Invariant Energy Quadratization (IEQ) Method for Preserving the Original Energy Dissipation Laws*
10:25 - 10:40 am	
SB 073	N. Anderson (USU) *The Influence of a Course on Assessment for Inservice Secondary Mathematics Teachers*
SB 139	J. Beck (USU) *Developing Confidence and Interest in Teaching Relevant Mathematical Modeling Lessons*
SB 260	S. Armstrong (SUU) *Convergence of a Nonstandard Numerical Scheme for a System of DEs with Crowing Effects*

Saturday, March 26, 2022 Contributed Talks (continue)
Mountain Daylight Time

Time/ Room	Presenter/Title of the Talk
10:45 - 11:00 am	
SB 073	J. Wittwer (Westminster College) *Lessons Learned from Westminster's S-STEM Scholarship Program*
SB 139	J. Contreras (BSU) *Using the Power of GeoGebra to Model Viviani's Problem*
SB 260	J. Han (SUU) *Numerical Scheme for a Gray-Scott Model*
11:05 - 11:20 am	
SB 073	J. Wittwer (Westminster College) *Using the Coaching Approach in Teaching*

1. Invited Addresses

BioFire by bioMérieux; The Product, Problems, and People

Liz Copene, Senior Director of Software Development at bioMérieux

Throughout my 14-year career at bioMérieux (formerly BioFire Diagnostics) I have been regularly asked the question "Why are you still working there?" and "What is your favorite part of the job?". Depending on the day, I may answer the question slightly differently, but the answer is always basically the same; It's all about the product, the problems, and the people. I began work on the product (a suite of multi-target PCR tests for rapid and accurate diagnosis of respiratory, blood, gastrointestinal and other infectious disease syndromes) in its early stages of development, and helped to grow the R&D teams to meet the market demand, especially during the current pandemic. Throughout this journey, there has been a never-ending supply of problems that we must solve as a team. In this talk, I will expand on these topics and provide you with examples where mathematics has played a role in enabling success.

Projective and Non-Abelian SET

Catherine Hsu, Assistant Professor, Swarthmore College

Mathematicians love SET. On the surface, this classic game is a contest of pattern recognition, but it also presents an interesting way to visualize the geometry of a torus over a finite field. In this talk, we will discuss some of the mathematics connected to SET and then explore several new versions of the game, including one arising from projective geometry and one arising from non-abelian groups. In particular, we will see how these non-abelian variations on SET can give intuitive visualizations of abstract group structures.

Exploring Mathematics Across Civilizations

Emille Davie Lawrence, Term Associate Professor and Chair, University of San Francisco

Close your eyes and ask yourself, "Who are the greatest contributors to modern mathematics?" Do you have your answer? There is a good chance that one of Newton, Gauss, Euler, Galois, Cauchy, Cantor, or Noether appeared on your list. While these are indeed important figures in today's mathematical landscape, what is largely absent from our mathematics education are the contributions of African, Indigenous, Oceanic, and people from other non-European cultures. The aim of this talk will be to provide thought-provoking insight into the mathematics of cultures that are often overlooked in American schools and universities. We will also highlight how these ideas can be presented in our own teaching as we work towards culturally responsive ways to engage students and towards presenting mathematics as a diverse human experience.

2. Workshop

Mathematical Metrics and Computational Techniques to Detect Partisan Gerrymandering

Ellen Veomett, Professor and Chair, Saint Mary's College of California

When you think about Gerrymandering, you likely think about bizarrely-shaped districts like the "Goofy Kicking Donald Duck" district, the "Praying Mantis" district, or the "Upside Down Elephant" district. Perhaps this suggests that looking at the geometry of district shapes is the best way to determine whether or not gerrymandering has occurred. But with modern technology, partisan cartographers can draw maps without irregularly shaped districts that still exhibit irregular partisan bias. In this presentation, we'll explore the evolution of metrics intended to detect gerrymandering. We'll start with shape metrics, move to metrics that use partisan data (like the Mean-Median Difference and Efficiency Gap), and then on to metrics and techniques that combine both district data and partisan data (like the GEO metric and outlier analysis). We'll work together to mathematically evaluate these metrics, as well as computationally evaluate real maps. You'll leave with ideas, examples, and python code that you can bring to your classroom.

3. Contributed Talks

Presenter: Mark A. Abramson, Utah Valley University

Title: *An Efficient Global Optimization Approach for Computing Penetration Depth between Two Convex Polytopes*

Abstract: During the detailed design phase of an aerospace program, one of the most important consistency checks is to ensure that no two distinct objects occupy the same physical space. Since exact geometrical modeling is usually intractable, geometry models are discretized, which often introduces small interferences not present in the fully detailed model. In this paper, we focus on computing the depth of the interference, so that these false positive interferences can be removed, and attention can be properly focused on the actual design. Specifically, we focus on efficiently computing the penetration depth between two polyhedra, which is a well-studied problem in the computer graphics community. We formulate the problem as a constrained five-variable global optimization problem, and then derive an equivalent unconstrained, two-variable nonsmooth problem. To solve the optimization problem, we apply a popular stochastic multistart optimization algorithm in a novel way, which exploits the advantages of each problem formulation simultaneously. Numerical results for the algorithm, applied to 14 randomly generated pairs of overlapping polytopes, illustrate both the effectiveness and efficiency of the method.

Presenter: Seth Armstrong, Southern Utah University

Title: *Convergence of a Nonstandard Numerical Scheme for a System of DEs with Crowing Effect*

Abstract: In 2018, a Lotka Volterra-type system of DEs was presented as accurately reflecting populations of competing species where crowding occurs. To approximate solutions to this system, a nonstandard discretization scheme is proposed that ensures positivity of approximate solutions. The scheme is unconditionally stable and the order of convergence to the true solution can be shown. We discuss how partial fraction decomposition can be applied to make a technical convergence proof more tractable. The same partial fraction decomposition leads to a sensible condition for convergence of the numerical approximation to the positive steady state of the competition-crowding system of DEs.

Presenter: Natalie Anderson (GS), Utah State University

Title: *The Influence of a Course on Assessment for Inservice Secondary Mathematics Teachers*

Abstract: Many mathematics teachers are not prepared to design valid and usable measurements of their students' mathematical achievements. In the 1980s-1990s, researchers conducted studies to help improve teachers' assessment literacy. In the 2000s, the focus shifted to teachers' feelings and attitudes towards assessment. This change in direction resulted in virtually no courses in assessment for today's inservice mathematics teachers. The purpose of this study is to (1) design a course on assessment for inservice mathematics teachers and (2) evaluate the effectiveness of the course. This paper recounts the development of the course and its influence on 16 teachers. Teachers who completed the course submitted a unit outline with learning objectives, a test blueprint, and a unit test. These artifacts influenced my evaluation on the effectiveness of the course. All 16 participants identified new assessment practices they will implement in their classrooms. The results suggest that this course on assessment influences the measurement design skills of inservice mathematics teachers.

Presenter: Jacy Beck (GS), Utah State University

Title: *Developing Confidence and Interest in Teaching Relevant Mathematical Modeling Lessons*

Abstract: Mathematical modeling is "the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions" (CSSM, 2010, p. 72). By providing students with an opportunity to engage in relevant mathematical modeling prompts, we provide them with transferable skills and knowledge. In addition, integrating mathematical modeling tasks that address current socio-political events into a high school curriculum can help teachers (1) connect students with mathematics, (2) understand student thinking and provide support, (3) raise quantitative literacy among all students, and (4) raise civic awareness in the classroom. The aim of this talk will be to provide insight into the relevance of teaching mathematical modeling, provide resources for integrating modeling tasks into a high school classroom, and to assist in developing higher confidence and interest in teaching relevant mathematical modeling lessons.

Presenter: Harish Bhatt, Utah Valley University

Title: *L-Stable Scheme to Damp Spurious Oscillations*

Abstract: Numerical schemes based on diagonal Padé approximations for the numerical solution of Reaction–Diffusion systems containing nonsmooth data have the disadvantage of producing poor numerical results (oscillations) when the time steps are too large relative to the spatial steps. On the other hand, schemes based on sub-diagonal Padé approximations do not suffer from this bottleneck. In this talk, we present a L-stable scheme for direct integration of reaction-diffusion problems with nonsmooth data. To investigate the accuracy, computational efficiency, and reliability of the scheme, we will discuss some numerical results and compare them with the results obtained via the existing schemes.

Presenter: Braden Carlson, Southern Utah University

Advisor: Jianlong Han, Southern Utah University

Title: *Numerical Analysis of Crowding Effects in Competing Species*

Abstract: In recent decades, scientists have observed that mortality rate of some competing species increases superlinearly as populations grow to unsustainable levels. This is modeled by terms representing *crowding effects* in the following system of nonlinear differential equations that describes population growth of two species competing for resources under the effects of crowding.

$$\begin{cases} x' = b_1 x(1 - x - \alpha_{12} y) - (m_{10} + d_1 x^{\delta})x \\ y' = b_2 y(1 - y - \alpha_{21} x) - (m_{20} + d_2 y^{\delta})y \end{cases}$$

In this system, x and y represent population density of each species, $' = d/dt$, b_1 and b_2 are birth rates, α_{12} and α_{21} measure the trauma of interacting with each other, m_{10} and m_{20} are mortality factors in absence of crowding, while d_1 and d_2 represent the density-dependent factor of each species, where $\delta > 0$ gives rise to the superlinear terms $x^{\delta+1}$ and $y^{\delta+1}$ that represent crowding.

After applying nondimensionalization to reduce parameters in the system, the stability of the four steady-state solutions is examined. A semi-implicit numerical scheme is proposed and studied that guarantees positivity of the approximate solutions to the system.

Presenter: Vinodh Chellamuthu, Dixie State University

Title: *Designing Authentic Learning Environment through Interdisciplinary Collaboration*

Abstract: Interdisciplinary collaboration provides students with an authentic experience solving a real-world problem from business, industry, or government agencies. The presenter will share benefits, successes, and challenges mentoring student teams on interdisciplinary projects. Participants will see the wide range of industrial projects that students in an undergraduate mathematics class can tackle. Participants will learn how interdisciplinary collaborative projects help students take ownership of a challenging problem, develop skillsets, and prepare for the demanding job market.

Presenter: Jose Contreras, Ball State University

Title: *Using the Power of GeoGebra to Model Viviani's Problem*

Abstract: In this presentation I will illustrate how learners can use GeoGebra as a tool to facilitate modeling geometric problems. In particular, I will explore Viviani's problem using a real-world context: Three towns are the vertices of an equilateral triangle. The sides of the triangle are the roads that connect the towns. A picnic area will be constructed such that the sum of its distances to the roads is as small as possible.

(a) What are all the possible locations for the picnic area?

(b) For practical reasons, what is the best location for the picnic area?

Justify your response.

Presenter: Zachary Coverstone (GS), Utah State University

Title: *An Problem-Based Approach to Geometric Series Convergence*

Abstract: When engaging with calculus, students often struggle with what it means for an infinite series to converge. The statement, for example, that $\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$, has lots of meaning that requires careful attention to unpack and is often abstract.

As part of a Calculus II class I recently taught, I developed inquiry-based curricular materials for a three-week unit to help students engage with infinite series convergence through models and problems, rather than through direct instruction. The in-class tasks were patterned after the Park City Mathematics Institute Teacher Leadership Program's inquiry-based problem sets used during the first part of each day of the workshop.

I will discuss the design of the first week of the unit (specifically relating to geometric series) and how this first week unit fits into the whole three-week unit designed. Additionally, I will share some preliminary results of how students thought about infinite geometric series convergence when they interacted with the assessments and in-class tasks.

Presenter: Michael Dorff, Brigham Young University

Title: *Programs of TPSE Math – Leadership, Data Science, and DEI*

Abstract: TPSE Math is a professional organization to strengthen and transform mathematics at the university and college level. Three focuses of TPSE are leadership, data science, and DEI. In this talk I will discuss some specific TPSE programs for faculty members including a year-long leadership institute for mid-career faculty who want learn how to be leaders at their own institution and in the mathematics community, twice a semester discussion webinars for department chairs, a 4-day summer interdisciplinary data science in-person workshop at BYU, and a set of DEI resources for math/stat departments to use so they can better assess and improve their efforts in creating a more diverse, equitable, and inclusive department.

Presenter: Joshua Fagan, Utah Valley University

Title: *Discrete Mathematics: A Terminal Introduction to Proof Course for Computer Scientists*

Abstract: While many upper division university mathematics courses are means and ends all their own – where the mathematical content itself is important outside the context of other areas of study â€“ there are other mathematics courses outside of remedial mathematics that exist as service courses to other non-mathematics classes and degrees. Discrete mathematics is a course that most R1/R2 universities require their computer science majors to take as a sophomore level course. It represents an interesting crossroad of introduction to proof and terminal mathematics class for these students. The goal of this study was to characterize this course by collecting and analyzing syllabi and other course data from 243 Carnegie classified R1 and R2 universities in the United States.

Presenter: Anthony Frazier, Weber State University

Advisor: Gavin Roberts, Weber State University

Title: *Decomposing Treatment Effect Estimates Using a Bracketing Approach: Application to COVID-19*

Abstract: Difference-in-Difference (DiD) estimation is a commonly used method to estimate the effect of a treatment to a population. In 2019, Hasegawa et al. described bracketed Difference-in-Difference estimation, used when a time and space variant confounding variable is suspected to bias the regular DiD estimate. This approach was originally proposed to be used under the circumstance that a singular treatment group was to be compared to multiple control groups. In this paper, we prove the bracketed DiD approach can be used in a two-way fixed-effects model in which every group operates as both a control and treatment state. We apply this methodology to COVID-19 data on deaths & Stay-At-Home orders.

Presenter: Jianlong Han, Southern Utah University

Title: *Numerical Scheme for a Gray-Scott Model*

Abstract: A stable semi-implicit difference scheme to solve numerically a reaction diffusion Gray-Scott system is proposed. The numerical scheme is uniquely solvable and some properties of the scheme are presented and analyzed.

Presenter: Md Sazib Hasan, Dixie State University

Co-Presenter: Vinodh Chellamuthu, Dixie State University

Title: *Feasibility of Customized OERs?*

Abstract: The purpose of this presentation is to discuss the strategy to foster active learners through the creation of "customized" OERs (C-OERs) curriculum that provide deeper conceptual understanding. In this presentation, we will share how we are developing C-OERs in collaboration with our students and a sample of student experiences in developing the C-OERs, along with sample artifacts. We will also discuss the rationale, challenges, and benefits of C-OERs and how it impacted their learning process through this authentic learning environment.

Presenter: Abigail Jenkins (GS), Brigham Young University

Title: *Topological Community Detection in Networks Using Persistent Homology*

Abstract: We present a new method for topological community detection in networks and explore its use in various genealogical, social, and infrastructure networks. We introduce the notion of a persistent surface which allows us to identify communities which are often different from those identified by other detection algorithms. Our findings indicate that it groups nodes that play a similar role in the structure of the network even when the nodes are distantly connected or even in distinct components.

Presenter: Joseph E. Marrow, Southern Utah University

Advisor: Andrew Misseldine, Southern Utah University

Title: *The Schur Rings of Monogenic Semigroups*

Abstract: There are ways to cluster items in various algebras that respect the operations of the structure. Algebraic partitions of groups, in particular Schur rings, have been studied since the 1930's. In this talk we consider these constructions over other structures, such as semigroups.

Presenter: Wiktor Mogilski, Utah Valley University

Title: *The Impact of Prerequisites for Calculus I Performance*

Abstract: We conducted a quantitative analysis to determine how the prerequisite path of students taking Calculus I impacts their grade performance. We began by investigating the performance of students that took College Algebra and Trigonometry versus those that took Pre-Calculus ahead of their credit-bearing Calculus I attempt. We concluded that there was a significant difference between the two prerequisite routes. We then performed regression analysis to view the number of credit prerequisite credit hours, including multiple attempts, as a predictor of Calculus I GPA and A-proportion. We found a strong negative correlation between these variables. We hope this study can be replicated at other institutions and in other fields to help university policymakers with decision-making regarding course listings. This is joint work with Zachariah Hurdle.

Presenter: Lauren Nelsen, Colorado College

Title: *Graph Theory at The Office*

Abstract: Networks, or graphs, are useful for studying many things in today's world. Graphs can be used to represent connections on social media, transportation networks, or even the internet. Because of this, it's helpful to study graphs and learn what we can say about the structure of a given graph or what properties it might have. It turns out that there are matrices that we can associate with graphs and these matrices can give us valuable information about the structure of graphs. In this talk, we will introduce a way of using graphs and matrices to understand interactions between characters on the popular TV show, *The Office*.

Presenter: Bob Palais, Utah Valley University

Title: *Math Matters in Rapid PCR Diagnostic Assays*

Abstract: A 2014 paper on a modification of PCR (a key technique used in rapid diagnostics for Covid and other diseases) claims that an additional pair of 'primers' could increase analyte yield exponentially. We derive the correct mathematical model involving a 9 by 9 lower triangular integer matrix, then calculate its powers in closed form. Our results indicate that additional primer pairs actually only increase the yield quadratically, not exponentially. We conclude by describing other ways math is being used in rapid PCR diagnostics.

Presenter: Brooklyn Price, Dixie State University

Co-Presenter: Nicholas Garrett, Idaho State University

Advisors: Vinodh Chellamuthu, Dixie State University

Xiaoxia Xie, Idaho State University

Title: *A Mathematical Model for the Transmission of Dengue Fever with Multiple Serotypes*

Abstract: Over the last several decades Dengue Fever has become a prevalent disease with almost 100 million cases on average per year (CDC, 2021). The primary vector for transmission of dengue fever is the Aedes aegypti mosquito. We have developed a hybrid, temperature-driven, multi-compartmental model that demonstrates the connection between temperatu re, and the Aedes aegypti mosquito population. This model takes into account how the different serotypes of dengue fever spread throughout the human population via mosquito transmission. The model also considers how individuals gain immunity through recovery from a serotype, but they may still remain susceptible to other dengue serotypes. Furthermore, this model has the potential to be used to assist in designing strategies to reduce infections through the control of the mosquito population.

Presenter: Bhuvaneswari Sambandham (Buna), Dixie State University

Title: *Connecting Classroom to the Community - Active Learning Calculus*

Abstract: This presentation will focus on strategies to promote active learners and problem solvers through hands-on activities in a Calculus class. The primary objective is to foster student reflection by creating an experience, choosing a real world problem in the community, and solving the concepts learned in the classroom.

Presenter: Addison Scanlon, Westminster College

Advisor: Kenan Ince, Westminster College

Title: *Analyzing Biases in the Salt Lake City Police Department*

Abstract: Using information collected and provided by the Salt Lake City Police Department we analyzed statistical datasets to identify underlying biases in policing. This is an independent analysis of data surrounding police interactions with individuals from between 2014 and 2017. In our pursuit to better understand the data, we utilized an online computing platform, R Studio, breaking substantial amounts of data into digestible, understandable, and shareable sets and visuals. Visuals include heat-maps demonstrating police interactions in Salt Lake City alongside statistically significant examples of police uses of force against communities of color.

Nuances of communicating with external departments became known through continuous attempts to understand the initial datasets. Through learning about communication with justice systems, building competency in online computing platforms and diving into Salt Lake City Police Department, our team increased individual competencies in statistical analyses.

Presenter: Gregory Schmidt, Dixie State University

Co-Presenter: Benjamin Whipple, Idaho State University

Advisors: Vinodh Chellamuthu, Dixie State University

Xiaoxia Xie, Idaho State University

Title: *A Dynamical Systems Model of Dengue Transmission for Rio De Janeiro, Brazil*

Abstract: The Dengue virus is a serious concern in many parts of the world, including Brazil. As data indicates, a prominent vector for Dengue is the Aedes Aegypti mosquito. By using the dengue incidence records from the Brazilian SINAN database, we estimate the population of Aedes aegypti within the city of Rio de Janeiro. Using historical climate data for Rio de Janeiro and the computed population estimates, we extend an existing model for the population dynamics of mosquitos to incorporate precipitation in aquatic stages of development for the Aedes aegypti mosquito.

Presenter: Gregory Schmidt, Dixie State University

Co-Presenter: Riley Morgan, Dixie State University

Advisor: Md Sazib Hasan, Dixie State University

Title: *Statistical Modeling to Predict the Trend in Lung Cancer Data in Utah using Joinpoint Regression Analysis*

Abstract: Lung cancer is one of the deadliest cancers in the state of Utah. According to the National Cancer Society's estimates in the United States, there were about 228,820 new cases of lung cancer and about 135,720 deaths from lung cancer in the United States in 2020. We obtained data from the Surveillance Epidemiology and End Results (SEER) database of the National Cancer Institute (NCI) and utilized JoinPoint Regression to predict the future trend. We developed a hybrid joinpoint regression model to describe incidence and mortality trends in Utah, assuming that the observed counts are probabilistically characterized by the Poisson distribution. We will compare our results with the other traditional statistical techniques. Using these methods, we can identify common trends that will allow us to come to a conclusion about lung cancer mortality in Utah. Our simulation results predict the rise of new deaths per year and future implications to help the policymakers in decision making.

Presenter: Kate Sharp, Hawkes Learning

Title: *Elements for Successful Courses in the Digital Age*

Abstract: With an increasing mix of online, hybrid & in-person course offerings, students are learning differently than ever before. As a result, they require a unique set of resources that not only meet their general course needs but also give them the necessary support to thrive in the array of new learning environments that they may encounter.

Join us as we break down the nine elements that instructors can implement to help meet students' needs in modern classroom setups. We will explore how factors such as equity, scalability and engagement play a role in supporting students as they learn, ensuring positive outcomes in any course structure. Learn new ways to connect with your students, facilitate active participation, prioritize accessibility, and more. Attend and be entered to win one of three $25 Amazon Gift Cards!

Presenter: Skyler Simmons, Utah Valley University

Title: *Periodic Orbits in the Co-Sitnikov Problem*

Abstract: The Sitnikov configuration is a special case of the restricted Newtonian 3-body problem. Specifically, two equal mass bodies (called primaries) orbit each other in a standard Keplerian 2-body orbit. A third massless particle is placed in an axis perpendicular to the plane containing the orbits of the primaries and passing through their joint center of mass. This configuration is noteworthy for showing oscillatory motion, in which the trajectory of the massless particle is unbounded, but it passes through the center of mass infinitely often. I will present some numerical results about a related orbit, which in some sense could be considered a geometric dual of the Sitnikov configuration.

Presenter: Robert Snellman, Brigham Young University

Title: *Classroom Community Using Cohorts*

Abstract: There's no denying that the post-COVID pandemic classroom has changed. The challenge of having to transition to remote delivery brought about significant changes, both good and bad, to our classrooms. As we recover from these challenges, some of the after effects are becoming clear. Isolation from peers and instructors has a significant impact on overall student success, and begs the question, how can we foster a sense of community in our classrooms? This talk will provide examples of the benefits of developing a course where the students work as a cohort. I will pull from experiences I have witnessed while teaching in the ACME program at BYU, wherein the cohort model plays center stage. I will also discuss some of the difficulties faced by departments when trying to mimic the ACME cohort model for undergraduate mathematics majors. Once the difficulties are discussed, potential solutions will be put forward.

Presenter: Ziming Wang, Idaho State University

Advisor: Xiaoxia Xie, Idaho State University

Title: *The Effects of Supervised Modeling and Unsupervised Hierarchical Clustering for Topic Clustering as They Apply to Educational Videos on Mathematics*

Abstract: The purpose of our project was to cluster a set of scripts from educational mathematical videos. These scripts had to be partitioned into the teaching style and subjects then each of these partitions was further separated into clusters. To achieve this we used a supervised model to create the two separate sets of partitions, then an unsupervised model was applied to each set of partitions to further cluster the scripts. During the unsupervised model clustering phase, each script was assigned keywords based on their cluster. This was to ensure connectivity between the scripts and allow for further applications to ascertain the connection between the scripts. The final step was to run a standalone unsupervised model on each script to distill the most important keywords from each script. Our end product was a set of related scripts with specific script tags and classification tags.

Presenter: Janine Wittwer, Westminster College

Title 1: *Lessons Learned from Westminster's S-STEM Scholarship Program*

Abstract 1: We are in the last year of a $600 000 NSF S-STEM scholarship and support grant for Mathematics, Physics and Computer Science students. In this talk I will describe our successes and challenges. My goal is to support those who may wish to apply for such a grant in the future.

Title 2: *Using the Coaching Approach in Teaching*

Abstract 2: In a recent sabbatical I completed formal life coach training. Many aspects of life coaching also apply to teaching. I have since incorporated life coaching techniques into my classes in the hope of reducing student anxiety, cultivating a more positive attitude towards mathematics, and enabling students to learn/retain the material in spite the difficult circumstances Covid 19 brought. I will talk about how it worked. This was not a formal study, just a particular approach in my teaching.

Presenter: Zengyan Zhang (GS), Utah State University

Title: *A Revisit of the Invariant Energy Quadratization (IEQ) Method for Preserving the Original Energy Dissipation Laws*

Abstract: The invariant energy quadratization (IEQ) method has been widely used to design energy-stable numerical schemes for phase-field or gradient flow models. Meanwhile, by combing it with the Runge-Kutta method, arbitrarily high-order schemes could be developed. However, there is one limitation of the IEQ method which is that the IEQ method usually respects a modified energy law. Therefore, here we revisit the IEQ method and provide a new perspective on its ability to preserve the original energy dissipation laws. By using the widely-used Cahn-Hilliard equation as an example, we demonstrate that the Runge-Kutta IEQ method can preserve the original energy dissipation laws for certain situations up to arbitrary high-order accuracy.