2021 Intermountain MAA Section Meeting
March 26 – 27, 2021
Virtual Meeting

Intermountain MAA Section Officers:

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March 26 – 27, 2021
Virtual Meeting
Mountain Daylight Time (MDT)

Friday, March 26, 2021 Schedule
Mountain Daylight Time

1:30 - 2:00 pm	**Social - Gather.Town**		
2:00 - 2:10 pm	**Welcome**: Derek Hein		
2:10 - 3:00 pm	**Invited Speaker:** Michael Dorff *Introduced by Derek Hein*		
Moderator	**Math Ed Session** *Chellamuthu*	**Pure Math Session** *Turner*	**Undergraduate Session** *Rose*
3:10 - 3:25 pm	K. MacArthur	S. Simmons	D. Maxwell
3:30 - 3:45 pm	S. Bagley	S. Lewis	A. Eubanks
3:50 - 4:05 pm	S. Bagley	G. Lawlor	J. Slone
4:10 - 4:25 pm	A. Parry	J. Gardiner	T. Osburn
Moderator	**Math Ed Session** *Bagley*	**Applied Math Session** *D'Andrea*	**Undergraduate Session** *Hein*
4:30 - 4:45 pm	N. Anderson	B. Sambandham	A. C. Monthomery
4:50 - 5:05 pm	K. Hadfield	J. Zhao	N. Rose
		Undergraduate Session	
5:10 - 5:25 pm	J. Hardy	A. Marshall	B. Payne
5:30 - 5:45 pm	B. Schoonmaker	I. Monk	W. Clark
5:45 - 6:00 pm	**Social - Gather.Town**		
6:00 - 7:00 pm	**Invited Speaker:** Angie Hodge-Zickerman *Introduced by Derek Hein*		
7:10 - 8:00 pm	**Reverse Panel** for new 4C COMMIT *Organizers: Spencer Bagley & Jonas D'Andrea*		

Saturday, March 27, 2021 Schedule
Mountain Daylight Time

8:00 - 9:00 am	**Department Chair/Liaison Meeting** *Emma Turner - moderator*		**Social - Gather.Town**	
9:00 - 9:50 am	**Invited Speaker:** Tom Edgar *Introduced by Brynja Kohler*			
Moderator	**Math Ed Session** *Kohler*	**Pure Math Session** *Vasilevska*	**Applied Math Session** *Chellamuthu*	**Calc. Bee***
10:00 - 10:15 am	M. Whittlesey	D. Fearnley	J. Han	
10:20 - 10:35 am	J. N. Contreras	B. Thomson	S. Armstrong	
10:40 - 10:55 am	M. Hughes	J. Sinkovic	M. S. Hasan	
11:00 - 11:15 am	E. Evans	V. Vasilevska	M. I. Hossain	
11:30 am - noon	**Get-together:** Section Project NExT Fellows			
12:00 - 1:00 pm	**Business Meeting**			

* *Organizers: Emma Turner & Buna Sambandham*

1. Invited Addresses

BIG jobs in math

Michael Dorff, Past President of MAA & Professor, Brigham Young University

CareerCast.com, a job search website, ranks the top jobs each year. One occupation is almost always in the top 5 and some years is the #1 job – that occupation is mathematician! Unfortunately, many students and people don't know this. They think that the main (or only) career option for someone who studies mathematics is teaching. While teaching is a great career, there are hundreds of companies in business, industry, and government (BIG) hiring math majors. To get hired by one of these companies, students need to do more than just major in math. In this talk, we will talk about some of the exciting things mathematicians in BIG are doing in their careers, and we will reveal the four things that recruiters say every math student should do to get a job.

A Mathematician's Groundhog Day: Prove, reflect, and repeat

Tom Edgar, Editor of Math Horizons (MAA undergraduate magazine) & Associate Professor, Pacific Lutheran University in Tacoma, Washington

What might a mathematician do if they were forced to relive the same day over and over, much like Bill Murray in the classic movie Groundhog Day? Wouldn't boredom set in after proving the same theorem over and over? Not if they use different techniques each time! In this talk, we will discuss why mathematicians might be interested in proving one result in many ways. We'll explore multiple proofs for a variety of theorems that are typically encountered by undergraduate mathematics students. In particular, we will encounter several visually-inspired proofs that encourage alternate ways of thinking about pure mathematical ideas.

Living Proof: Finding success, against all odds

Angie Hodge-Zickerman, Associate Professor, Northern Arizona University

In this talk, I will share my mathematical journal and how I overcame many obstacles along the way. I will share stories that are both personal and professional with the audience in hopes that everyone in attendance will leave with strategies for being successful in mathematics (and helping others be successful in mathematics).

2. Contributed Talks

Presenter: Natalie Anderson[1], Utah State University

Title: *Relevant Summative Assessments: A Case Study*

Abstract: A summative assessment is used to determine the success of a teaching cycle. During a teaching cycle, teachers encourage students to discover mathematical relationships, make connections, create proofs and arguments, comprehend, communicate, and apply mathematical concepts. If summative assessments do not measure these reasoning skills, then the assessment is not relevant nor useful. Most summative assessments, including the ACT and SAT, measure the memory level of students: their simple knowledge (memorization) and algorithmic skills.

In this talk, we will examine the case of one secondary mathematics teacher. Initially, she did not enjoy writing summative assessments because she felt she was not qualified to write test items. After learning how to design relevant test items, her perspective on the purpose of assessment shifted: instead of being a tool used to assign grades, assessments are now an instrument she can use to measure what her students understand. We will analyze items from a unit test she used in previous years and compare those items to the new items designed to match the learning levels of the lessons taught in class. Although we consider a single case study, we will consider the possible impact of a professional development offered to in-service secondary mathematics teachers online.

Presenter: Seth Armstrong, Southern Utah University

Title: *Numerical analysis of a nonlocal Lotka-Volterra system for competing species*

Abstract: A nonstandard finite difference scheme is proposed for numerical approximation of the Lotka-Volterra competition model

$$\begin{cases} u_t = J * u - \left(\int_\Omega J\right) u + u(K_1 - u - av), \\ v_t = J * v - \left(\int_\Omega J\right) v + v(K_2 - v - bu), \\ u(0,\mathbf{x}) = u_0(\mathbf{x}),\ v(0,\mathbf{x}) = v_0(\mathbf{x}),\ \mathbf{x} \in \mathbf{\Omega} \subset \mathbb{R}^{\mathbf{2}}, \end{cases}$$

with nonlocal interaction between species. We show that the scheme is uniquely solvable, stable, and that the numerical solution approaches the true solution $(u(t,\mathbf{x}), v(t,\mathbf{x}))$ with rate $\mathcal{O}(\Delta t + |\Delta \mathbf{x}|^{\mathbf{2}})$ as $\Delta t, |\Delta \mathbf{x}| \to 0$, uniformly on a finite interval $[0,T]$. This is joint work with Jianlong Han and Sarah Duffin.

Presenter: Spencer Bagley, Westminster College

Co-presenter: Anil Venkatesh, Adelphi University

Title: *Using Primary Sources to Improve Classroom Climate and Promote Shared Responsibility*

Abstract: To address a deteriorating classroom climate at the midpoint of a two-semester upper-division mathematics course sequence, we employed a novel instructor-led intervention: reading a mathematics education manuscript together with students as an invitation to legitimate peripheral participation in scholarly reflection on teaching and learning. This intervention resolved many student complaints about the structure and level of the course, and the manuscript's discussion of the didactical contract promoted the idea of shared responsibility. We propose that reading mathematics education literature with students can be an effective tool for improving the climate of the classroom, and that using the didactical contract in this way can particularly help students claim their share of responsibility for their own learning.

[1]Graduate Student

Presenter: Spencer Bagley, Westminster College

Title: *Ungrading as resistance*

Abstract: The pandemic has shined a spotlight on inequities, flaws, and ruptures that already existed in our educational system. Instead of adapting old systems, we can use the disruption of the pandemic as an opportunity to imagine new ones that are more just, more equitable, and do a better job promoting student learning. In this talk, I discuss how grades are detrimental to quality student thinking, and how we can use ungrading to disrupt existing systems from within.

Presenter: William Clark, Dixie State University

Advisor: Vinodh Chellamuthu, Dixie State University

Title: *Effects of Temperature on Population Mobility and Spread of Covid-19*

Abstract: The Covid-19 outbreak has caused a global pandemic and compelled many to search for a deeper understanding of how ecological and sociological factors influence the disease's spread. Many governmental leaders have mandated social distancing and other regulations on everyday activity to stop the spread of the disease. Many studies have developed models and shown the effects of social distancing, the efficacy of masks, and the impact the ambient temperature has on the number of cases reported. Yet numbers continue to rise despite the regulations being imposed, which has led researchers to ask why, and what other factors contribute to the spread of infections? We propose that a significant cause of the recent spikes in positive cases has been the mobility of the population, most notably the returning of students in school and the drop in temperature occurring near the end of the year. This study aims to identify the effect that temperature has on the mobility of a population and the spread of Covid-19. We developed a mathematical model presenting the dynamics of positive Covid-19 cases in the state of Utah with the incorporation of social distancing, mask efficiency, and the relationship between temperature and the rate of infection. A non-linear least-squares (lsqnonlin) scheme and Equler's method are used for the numerical solution of our proposed model. Our results suggest that the temperature effect has on a population's mobility plays a significant role in the Covid-19 disease dynamics and the attempt to mitigate the spread of the disease.

Presenter: José N. Contreras, Ball State University

Title: *Learning to Pose and Solve Problems with GeoGebra*

Abstract: In this presentation, I will illustrate how my students and I have used a problem-posing framework and GeoGebra to pose and solve Varignon problems using four main strategies: Specializing, generalizing, extending, and reversing. To enrich the students' experience, I start the investigation with the following version of the Varignon's problem: Let E, F, G, and H be the midpoints of the consecutive sides of a parallelogram ABCD. What type of quadrilateral is EFGH?

Presenter: Amy Eubanks, Brigham Young University

Advisor: Mark Hughes, Brigham Young University

Title: *Using Transformers to Turn Jones polynomials into Knots*

Abstract: Transformers are a powerful deep learning model, and an effective tool for sequence-to-sequence operations. In this talk I will discuss the potential of using transformers to translate a Jones polynomial into a knot permutation, why transformers are well suited for this problem, and the potential applications of the results of this work in progress.

Presenter: Emily Evans, Brigham Young University

Title: *Python Labs for Multivariate Calculus Understanding*

Abstract: At Brigham Young University we have designed a Python lab sequence to accompany one of our sections of multivariable calculus classes. Students who are enrolled in this section have self identified as being interested in computational mathematics. The labs accompanying the course are designed and chosen to increase understanding of challenging topics (for example Green's and Stokes' theorems) and also to excite the students about future numerical analysis topics (for example gradient descent). We discuss the labs designed and student's success in future mathematics courses.

Presenter: David Fearnley, Utah Valley University

Title: *Moore Space Baireability and Dense Metric Subspaces*

Abstract: We will discuss conditions under which a Moore space may be densely embedded into a Moore space with the Baire property (which we refer to as being Baireable), and present some recently developed tools for determining when a space is Baireable. We will also include an example of a space which is not Baireable, every subset of which can be shown to be Baireable if and only if it has a σ-discrete π-base using the aforementioned strategies, and use this to highlight the motivation behind two unresolved questions.

Presenter: Jason Gardiner[2], Brigham Young University

Title: *Seifert Surfaces of Petal Knots*

Abstract: A petal knot is a type of knot projection that allows us to represent a knot as a permutation. A Seifert surface of a knot K is an oriented surface with boundary equal to K. In this talk I discuss how petal knots can be used to represent incompressible Seifert Surfaces.

Presenter: KimberLeigh Hadfield, Utah State University

Title: *Providing ability to probability: Reducing cognitive load through worked-out examples*

Abstract: Undergraduate students tend to struggle with probability in their introductory statistics course. Probability problem solving requires several steps. First, students must make sense of the probability scenario, then determine the appropriate probability rules, and finally, execute the procedures to solve the problem. With no previous exposure to probability, this presents too great a cognitive load for many students. Using worked-out problems then transitioning to partially worked-out problems in an introductory statistics course at a large university helped students succeed at solving probability problems. The worked-out problems included writing prompts to encourage self-explanation of students' thinking through studying the worked-out examples. This presentation will expound upon the use of these instructional principles and their implementation in an introductory statistics course for non-STEM majors, published in "Teaching Statistics" (Hadfield, 2021).

Presenter: Jianlong Han, Southern Utah University

Title: *Numerical analysis for a reaction diffusion Lengyel-Epstein system*

Abstract: A finite difference scheme is proposed for a reaction diffusion Lengyel-Epstein system. The numerical scheme inherits the characteristic properties of the original system. The long term behavior of the numerical solution is analyzed.

[2] Graduate Student

Presenter: Jameson Hardy, Dixie State University

Co-presenter: McKay Sullivan, Dixie State University

Title: *Puzzling Teaching Methods: Crossing Disciplines with the Rubik's Cube*

Abstract: Aside from being a rewarding and challenging puzzle, the Rubik's Cube has interesting and deep connections to several disciplines. We show how to utilize some of these connections to build low threshold high ceiling activities for students of a wide variety of ages from elementary school to upper-division college students. In particular, we provide an example of an activity which relates Rubik's cubes to color choice in art and computer science as well as chameleon color changing in biology. Other examples involving chemistry and mathematics will also be provided.

Presenter: Md Sazib Hasan, Dixie State University

Title: *Improved Confidence Intervals for the Ratio of Coefficients of Variation of Two Lognormal Distributions*

Abstract: There are practical situations where one encounters data that are skewed and contain a relatively high proportion of zeros. These type of data can be modeled with lognormal distribution. The problem of estimating the ratio of coefficients of variation of two independent lognormal populations is considered. We proposed two closed-form approximate confidence intervals (CIs), one is based on the method of variance estimate recovery (MOVER), and another is based on the fiducial approach. The proposed CIs are compared with another CI available in the literature. Our new confidence intervals are very satisfactory in terms of coverage properties even for small samples, and better than other CIs for small to moderate samples. The methods are illustrated using an example.

Presenter: Md Istiaq Hossain, Southern Utah University

Title: *Effects of stage-structure on the dynamical output of a predator-prey model*

Abstract: In [A.S. Ackleh, M.I. Hossain, A. Veprauskas, and A. Zhang, Persistence and stability analysis of discrete-time predator-prey models: A study of population and evolutionary dynamics, J. Differ. Equ. Appl. 25 (2019), pp. 1568–1603.], we developed a discrete-time predator-prey model. The prey was assumed to grow according to a Beverton–Holt nonlinearity in the absence of the predator. The growth of the predator population having density-independent survival probability was assumed to be dependent on prey consumption, which is limited by the number of prey a predator can consume per unit of time. This model was later extended to a model that includes a stage-structured predator population in which the predator is classified according to two developmental stages: juveniles and adults and only the adult predators are capable of attacking and consuming the prey population. In addition, it is also assumed that the maturation period is such that all juvenile predators become adults after a one-time unit. In addition, the initial model is also extended to include the stage-structured for the prey population and unstructured predator population. This current model has a similar stage-structured form to the prey population as considered for the predator population in the second model where only juvenile prey is consumed by the predator population. We thoroughly investigate the various dynamical behaviors of all these discrete-time predator-prey models such as the existence and uniqueness of the extinction, predator-free, and interior equilibria as well as the local and global stability of the equilibria and the persistence of the systems. We provide numerical examples showing the various dynamical scenarios in support of the theoretical results. These numerical simulations show that introducing stage-structure into the predator population allows for complicated rich dynamics that are not possible when the predator is unstructured.

Presenter: Mark Hughes, Brigham Young University

Title: *Designing a computational linear algebra lab course using Google Colab.*

Abstract: In this talk I will discuss the design and implementation of a lab course which introduces students to computational algorithms in linear algebra using Python. This course does not assume students have any prior programming experience. Students work through weekly labs, programming their solutions using Google Colab online notebooks before submitting them to a website for automated grading. I will discuss the results of implementing a similar course at Brigham Young University, as well as some of the issues we encountered.

Presenter: Gary Lawlor, Brigham Young University

Title: *The triple bubble*

Abstract: The standard shape of triple bubble with equal volumes in three-space has least surface area needed to separately enclose those volumes.

Presenter: Scott Lewis, Utah Valley University,

Title: *Aspects of the* $3x + 1$ *Problem*

Abstract: The $3x + 1$ problem, also known as the Collatz problem, the Syracuse problem, Kakutani's problem, Hasse's algorithm, and Ulam's problem, concerns the behavior of the iterates of the function which takes odd integers n to $3n + 1$ and even integers n to $\frac{n}{2}$. The $3x + 1$ Conjecture asserts that, starting from any positive integer n, repeated iteration of this function eventually produces the value 1. The $3x + 1$ Conjecture is simple to state and apparently intractably hard to solve. It shares these properties with other iteration problems, for example that of aliquot sequences and with celebrated Diophantine equations such as Fermat's last theorem. Paul Erdos commented concerning the intractability of the $3x + 1$ problem: "Mathematics is not yet ready for such problems." Despite this doleful pronouncement, study of the $3x + 1$ problem has not been without reward. It has interesting relations with questions of ergodic theory on the 2-adic integers, and with computability theory. I'll share some of its rich history, some approaches and results of serious researchers, and mention some modest results in studying this delightfully, intricate problem.

Presenter: Kelly MacArthur, University of Utah

Co-presenter: Tracy Dobie, University of Utah

Title: *Exploring Shifts in Student Attitudes Toward Group Exams in College Calculus: The Case of Dane*

Abstract: Recent approaches to rehumanizing mathematics education have called for a range of changes to be made in mathematics classes, including shifting how students participate and are positioned in relation to mathematics, the instructor, and each other. This talk will focus on a university Calculus 2 class in which the instructor sought to rehumanize students' mathematics experience through the inclusion of group exams. Here we first briefly explore students' views of the group exams and their impact on the classroom learning environment - with particular focus on Black, Latinx, and Indigenous students. Then we dive in to examine the case of one student (Dane) whose perspective shifted dramatically over the course of the semester from adamant opposition to fervent support for the group exams. Part of this shift included a change in Dane's view of his relation to others, as he began to see how working with others benefited himself, consider others' experiences, and recognize how group exams can be helpful to everyone. Subsequently, we unpack four contributors to Dane's shift: positive group experiences, increased learning and performance, progress towards social goals, and trust in his instructor. Additionally, we consider how Dane's experience and attitudes are likely influenced

by the racialized and gendered nature of mathematics. Dane's story raises questions about instructors' role in not only seeking student buy-in to new teaching and learning practices, but interrogating deeper beliefs about what it means to do mathematics and the role of others in students' mathematics engagement. This research also highlights the importance of exploring students' experiences and attitudes in relation to the larger sociopolitical context of mathematics. While we only delve into a single case here, we consider implications for group exams more broadly, as well as other attempts to rehumanize students' mathematics experiences.

Presenter: Addesyn Marshall, Dixie State University

Co-presenters: Rosa Flores, Dixie State University, Brooklyn Price, Dixie State University

Advisor: Vinodh Chellamuthu, Dixie State University

Title: *Interconnecting a Network of Musical Influence by Four Degrees*

Abstract: A sense of belonging is one of the five basic needs for human survival. Thus, networks and interactions between individuals play a crucial role in humanity. Because there is such a high importance on interconnectivity within society, there are many different ways to connect people. One way that humans create networks is through music. Being able to categorize music and artists by their level of influence allows our society to see the connections and influence music has on people. We created a model to help us understand what makes music influential and while showing the relationships between musicians. Our model consists of multiple networks that allow us 1) to obtain the percentage of direct influence from our data using a matrix and submatrices of decades and genres. 2) illustrate and implement the Kevin Bacon Law to find the degree of separation between Influencers and Followers referred to as the RAB number. 3) uses conditional formatting to determine the proximity of musical characteristics by genre and by the artist to each character's average over the last century. Our network obtained the Average RAB number of 3.625, meaning that most Influencers are connected to their followers by 4 Degrees. It determined that danceability, liveness, loudness, and speechiness were the traits that contributed most to influenceability. Also, it created a definition for genres and showed how those genres have evolved.

Presenter: Dahlia Maxwell, Brigham Young University

Advisor: Mark Hughes, Brigham Young University

Title: *Finding Invariants from Petal Permutations*

Abstract: Petal knot diagrams are projections of a knot consisting of a single multicrossing and no nested loops. Any knot projection can be changed to a petal projection through a stem diagram. Any two petal projections of the same knot type may be related to one another through a series of petal moves. In this talk I will discuss petal projections, petal permutation of a knot, and attempts to define knot invariants solely in terms of petal permutations. This is a work in progress.

Presenter: Ian Monk, Brigham Young University

Advisor: Gary Lawlor, Brigham Young University

Title: *Subdividing an equilateral triangle into isosceles triangles*

Abstract: It is known that an equilateral triangle can be partitioned into twelve acute isosceles non-equilateral triangles. Can we prove that is the fewest?

Presenter: Alexander Craig Montgomery, Southern Utah University

Co-presenter: Braden Carlson, Southern Utah University

Advisor: : Jianlong Han, Seth Armstrong, Sarah Duffin, Southern Utah University

Title: *Numerical Analysis of a Model for the Growth of Microorganisms*

Abstract: A system that arises in a model for the growth of microorganisms in a chemostat is studied. A new semi-implicit numerical scheme is proposed. It is proven that the scheme is uniquely solvable and unconditionally stable. The convergence rate of the numerical solution to the true solution of the system is also given.

Presenter: Tanner Osburn, Brigham Young University

Advisor: Mark Hughes, Brigham Young University

Title: *Performing Band Surgeries on Knots Using C++*

Abstract: In this talk I will describe software that iteratively performs band surgeries on a knot to find an upper bound of a knot's slice genus. This presentation will be given in two parts: representing a knot effectively in code, and having the computer perform band surgeries on the knot. The programming language we use to accomplish this task is C++. This is a work in Progress.

Presenter: Alan Parry, Utah Valley University

Title: *Given Any Two Statements, One of Them Implies the Other*

Abstract: The statement of the title may come as a surprise. The proof is almost trivial as it is a tautology, but the mathematical and pedagogical consequences are important. In this talk, we will briefly prove this result and then discuss how we use the word "implies" as mathematicians and mathematics educators. We finally present an easy change to how one might present the idea of implication to the undergraduate student that may alleviate a lot of the common confusion about it.

Presenter: Brandon Payne, Dixie State University

Advisor: Vinodh Chellamuthu, Dixie State University

Title: *A Mathematical Model of COVID-19: Efficacy of Vaccination with Heterogeneous Populations*

Abstract: Infections from the novel coronavirus disease 2019 (COVID-19) remain superfluous as it continues to spread profusely across the world. Currently, there is no available vaccine to protect against COVID-19. As scientists work to develop a vaccine, our goal is to explore scenarios for different levels of vaccine-effectiveness and varying proportions of vaccinated-populations in order to mitigate the spread of COVID-19. We develop a mathematical model to analyze the disease dynamics of COVID-19 in relation to vaccine-effectiveness. Furthermore, we performed a data fitting algorithm to estimate parameters within the model to best resemble current infection trends using data from the CDC. Our simulation results determine possible best-case scenarios at varying degrees of vaccine-effectiveness and proportions of vaccinated-populations. Moreover, to account for the disease's varying infection and mortality rates based on an individual's age, we further partition the population by age groups to determine which groups are most vital to vaccinate. Our simulation also identifies the minimal required vaccine-efficiency for a given proportion of vaccinated individuals.

Presenter: Noah Rose, Brigham Young University - Idaho

Advisor: Jason Rose, Brigham Young University - Idaho

Title: *Using an SIR Model to find the transmission rate of COVID-19*

Abstract: An examination of how an SIR model can be used to estimate the transmission rate of a disease from reported deaths, infection fatality rate, and average duration of the infectious period, and an examination of how this estimated transmission rate has changed over the course of the COVID-19 pandemic, especially as related to the use of non-pharmaceutical interventions such as lockdowns.

Presenter: Bhuvaneswari (Buna) Sambandham, Dixie State University

Title: *Numerical Results for Linear Sequential Caputo Fractional Boundary Value Problems with Mixed Nonhomogeneous Boundary Conditions*

Abstract: The numerical results for linear sequential Caputo fractional boundary value problems with mixed homogeneous boundary conditions have developed in our recent work. We used Green's function representation to compute the solutions for linear sequential Caputo fractional boundary value problems. In this work, we have developed the numerical solution for the Caputo fractional boundary value problems with general nonhomogeneous terms with mixed non-homogeneous boundary conditions. This will be useful in solving the nonlinear Caputo fractional boundary value problem with Caputo mixed boundary conditions by the monotone method.

Presenter: Ben Schoonmaker, Southern Utah University

Title: *Using a Student Response System teaching Intermediate Algebra*

Abstract: In Fall of 2019 and Fall of 2020, I used a subscription based student response system called TopHat in my Intermediate Algebra classes. This talk will highlight how the system was used, What lessons I learned in its implementation, and what student responses were to the program.

Presenter: Skyler Simmons, Utah Valley University

Title: *A Collision-Based Periodic Orbit in Three Dimensions*

Abstract: I will present a collision-based periodic orbit of eight bodies in three dimensions in the Newtonian n-body problem. In this orbit, each body collides in turn with its nearest three neighbors. A construction of the orbit, its regularization, symmetries, and determination of the initial conditions will be given. Results relating to stability in multiple settings will also be discussed.

Presenter: John Sinkovic, Brigham Young University - Idaho

Title: *The smallest graphs for which the inertia bound is not tight*

Abstract: Given a simple graph G, a weight matrix W of G is a symmetric matrix such that the ij-th entry of W is zero whenever ij is not an edge of G. The independence number of a graph is the maximum size of a set of pairwise non-adjacent vertices. The inertia bound, or Cvetkovic bound, states that the independence number of a graph is bounded above by the minimum of the number of nonpositive eigenvalues and the number of nonnegative eigenvalues of any weight matrix W of G. The inertia bound is known to be tight for perfect graphs and graphs on 10 or fewer vertices. We will exhibit two graphs on 11 vertices for which the bound is not tight.

Presenter: Jared Slone, Brigham Young University

Advisor: Mark Hughes, Brigham Young University

Title: *Generative Adversarial Networks vs. The Jones Unknotting Conjecture*

Abstract: The Jones polynomial is a mathematical invariant of an oriented knot. The Jones conjecture states that no non-trivial knot has the same Jones polynomial as the unknot. In March of 2020, this conjecture was verified for all knots up to 24 crossings. In this talk, we will discuss the application of a modified GAN to define a sub-space of higher crossing knots where any potential counterexample to the conjecture would likely be, and to explore this proposed space.

Presenter: Bianca Thompson, Westminster College

Title: *The connection between Diophantine equations and binary trees*

Abstract: Binary trees are used to encode a lot of different types of information and can be used to make decisions by following different paths along the tree. It turns out you can also use these trees to represent the different possible 2-adic valuations for sequences like $x^2 + D$. Further, these valuation trees allow us to look at Diophantine equations of the form $x^2 + D = 2^c y$, y odd, and determine the possible solutions. The goal of this talk is to share how to use binary trees to create valuation trees and then use those trees to determine the possible integer solutions of specific Diophantine equations.

Presenter: Violeta Vasilevska, Utah Valley University

Title: *Nordhaus-Gaddum Problems for Power Domination*

Abstract: Power domination is a process on a graph that consists of finding a minimum set of vertices by following certain rules. At the end of this process, all vertices in the graph are 'observed' ('colored' with the same color).

In this talk we show how this process works and then discuss the Nordhaus-Gaddum problem for power domination. Then a few upper Nordhaus-Gaddum bounds for particular graphs will be discussed.

This is a joint work with several co-authors (REUF research group 2015 - the paper containing these results can be found on the arXiv).

Presenter: Marshall Whittlesey, California State University San Marcos

Title: *Using quaternions to prove theorems in spherical geometry*

Abstract: It is well known that the complex numbers can be used to do transformation geometry in the plane. In particular, rotation by angle θ about the origin is accomplished via multiplication by the complex number $e^{i\theta} = \cos(\theta) + i\sin(\theta)$. It is less well known that the quaternion algebra (consisting of expressions of the form $a+bi+cj+dk$ with $i^2 = j^2 = k^2 = -1$) can be used to do similar transformations in three dimensional space. In this talk we show how to use quaternions to prove an interesting classical theorem in spherical geometry. These methods are featured in the speaker's new book with CRC Press, "Spherical Geometry and its Applications", which the author hopes will be attractive for use in topics courses in geometry.

Presenter: Jia Zhao, Utah State University

Title: *Solving and learning phase field models using the modified Physics Informed Neural Networks*

Abstract: In this talk, I will introduce some recent results on solving and learning phase field models using deep neural networks. In the first part, I will focus on using the deep neural network to design an automatic numerical solver for the Allen-Cahn and Cahn-Hilliard equations by proposing an adaptive physics informed neural network (PINN). In particular, we propose to embrace the adaptive idea in both space and time and introduce various sampling strategies, such that we are able to improve the efficiency and accuracy of the PINN on solving phase field equations. In the second part, I will introduce a new deep learning framework for discovering the phase field models from existing image data. The new framework embraces the approximation power of physics informed neural networks (PINN), and the computational efficiency of the pseudo-spectral methods, which we named pseudo-spectral PINN. In the end, I will illustrate its approximation power by some interesting examples.

3. Panel Discussion

Reverse Panel for new 4C COMMIT

Abstrac:t The Four Corners COMMIT (COMmunity for Mathematics Inquiry in Teaching) is a newly formed group serving the geographical region encompassing parts of the Four Corners states plus other institutions in affiliated MAA sections, AMATYC sections, etc. In order for this organization to be as useful as possible to the people who will eventually make it up (YOU), we are organizing this panel to tell you a little about our purpose in forming and to collect ideas from you.

Are you interested in getting started with IBL? Or, perhaps you want to sharpen your IBL skills or help others to get started. Our community of inquiry-based learning practitioners may be perfect for you! What kind of support, workshops, and activities would be most useful for you? Do you have ideas on how we can productively collaborate across the long distances between institutions in the West? Please join us for this session to learn more about us and to tell us what we can do to help you!

Read more about our organization at https://fourcornerscommit.github.io/ and about the COMMIT Network at https://www.comathinquiry.org/home.