Book of Abstracts

Pi Mu Epsilon, Friday, September 20, 2019

Room 110

Margaret McGuire, The College of Wooster, email: mmcguire20@wooster.edu

Title: Reaction-Diffusion Models of 2D surfaces embedded in 3D Space and a Model of Geographic Tongue.

Abstract: Geographic tongue is a condition of unknown cause characterized by chronic inflammatory lesions migrating over the surface of the tongue. The condition's appearance of white, serpiginous propagating wave fronts suggests the condition can be modeled as a reaction-diffusion system. Here we construct a model of geographic tongue using reaction-diffusion equations and Objective C to suggest that geographic tongue's underlying cause may be a reaction diffusion system. We adapted a form of the Tyson Fife model of the Belousov-Zhabotinsky reaction to propagate waves on 2D curved surfaces. We demonstrate and explain the model's behavior on a sinusoidal surface and on a hemisphere of varying radius. We show our final model of reaction diffusion waves propagating on the tongue and compare it to patients who have geographic tongue.

Sylvia Yu, College of Wooster, yyu21@wooster.edu

Title: Reaction-Diffusion Wavefronts with Concave, Spiral, Fractals and Soft Obstacles

Abstract: We study the behavior of wavefronts colliding with different concave fractals, spirals, and perils noise simulations in two-dimensional channels using finite-differences numerical integration based on Tyson-Fife reduction of the Oregonator model of the Belousov-Zhabotinsky reaction. We study the influence of obstacles' shapes on the wavefronts' behaviors by plotting wavefront time versus left most point and delay versus time with obstacles on different angles and generations. We find that wavefronts behave the same when it goes through symmetric obstacles (for example, Hilbert curve and Sierpinski carpet). Due to the maximum left most versus generation of the obstacles, we predict that the maximum left most will go to infinite. By changing the diffusion equation, we make the diffusion constant as a function of space and the reaction constant as a function of light sensitive parameter phi. We build animations that a piece of wave is trapped in the obstacle, which generates periodic motion.

Phuong Ho, Miami University hopu@miamioh.edu

Title: Fixed Rings of Quantum Generalized Weyl Algebras

Abstract: Quantum generalized Weyl Algebra (GWAs) are generalizations of the classical Weyl algebra, which appears in diverse areas of mathematics including mathematical physics, noncommutative algebra, and representation theory. We study the invariants of quantum GWAs under finite automorphisms. We extend a theorem of Jordan and Wells to the case where the restricted map on the base ring is not necessarily the identity. This is then applied to determine the fixed ring of quantum GWAs under diagonal automorphisms. We furthermore study properties of the fixed rings, including global dimension and simplicity.

Melita Wiles, College of Wooster, mwiles22@wooster.edu

Title: Energy Stability of Gravitationally Interacting Rods and Dumbbells

Abstract: We extend classic results for two or three gravitationally interacting point masses to

ideal rods and dumbbells. We derive equilibrium configurations by demanding that the vector of first derivatives of energy at constant angular momentum vanish. We investigate their stability by checking if the spectrum of the Hessian matrix of second derivatives is positive. The additional degrees of freedom allow the objects to store and exchange angular momentum and enable us to elucidate the behavior of non-spherical celestial bodies like asteroids and comet nuclei.

Chloe Makdad, Butler University, cmakdad@butler.edu

Title: An Extension Theorem For Bicomplex Functions

Abstract: This talk looks at functions on the four (real) dimensional bicomplex numbers as an extension of functions on complex numbers, specifically through the lens of power series. It briefly describes some basic algebra of the bicomplex numbers z1 + j z2, where j2 = -1 and z1 and z2 are complex, as well as the requisite knowledge of complex power series and related theorems. It then discusses the convergence of bicomplex series and ultimately describes a new so-called Extension Theorem, providing a bridge from complex analytic functions to bicomplex analytic functions.

Sara Helwig, Ohio Northern University, s-helwig@onu.edu

Title: Statistical Consulting for the DoD: The Importance of Effective and Efficient Experimental Designs

Abstract: Statistical consulting can have a breadth of positive impact on the validity and efficiency of research across the board. Providing tools, briefs, and statistically optimized test designing techniques are crucial to ensure accurate and resource-efficient findings from research of all kinds. In this talk I will share my experiences as an intern for the Statistical Test and Analysis Techniques Center of Excellence and provide information about the process of designing an experiment in a Department of Defense environment.

Room 112

Benjamin Rempfer, Butler University, brempfer@butler.edu

Title: Geometric Limits of Julia Sets for a Non-Hyperbolic Siegel Disk Map

Abstract: The limiting behavior for sequences of filled Julia sets has been studied in several recent publications. When a non-hyperbolic degree polynomial map with a Siegel disk Δ is varied in the set of degree polynomials, the limit of the filled Julia sets always exists. It has also been shown that for all hyperbolic polynomial maps , if is defined as the sum of with a power map , then the same limit of the filled Julia sets exists and can be described explicitly. We attempt to extend this convergence for the maps to non-hyperbolic maps with a Siegel disk Δ and expect the theorems proved for hyperbolic polynomial maps to hold.

Kendra Herweck, Northern Kentucky University, Herweckk1@nku.edu

Title: Star Formation: Modeling the Loss of Magnetic Support for Dense Cores

Abstract: Most stars in our galaxy are formed in giant molecular clouds when dense cores collapse to form protostars. A typical collapse is observed to take approximately 1 million years. Considering only the forces of gravity and thermal pressure, theory predicts that the collapse happens in the span of 100,000 years. We consider a nonlinear diffusion model that includes magnetic support for the core under various equations of state and numerically investigate the resulting timelines for the core's collapse.

Chase Fuller, College of Wooster, chasef925@gmail.com

Title: Chemical Diode Behavior in the Belousov-Zhabotinsky Reaction due to Inhomogeneous Diffusion

Abstract: Excitable Reaction-Diffusion systems profuse nature, including in critical functions in the human body. It is of interest, then, to study laboratory examples to inform investigations of other systems. In this study, we numerically integrated the Tyson-Fife model of the Belousov-Zhabotinsky reaction using a finite difference method. We constructed simulations of two dimensional channels bounded by Carl Neumann no-flux boundary conditions and introduced soft obstacles in the form of activator and inhibitor diffusion coefficient inhomogeneities. We describe the mechanism by which excitation waves die due to fast inhibitor diffusion and show that, under particular configurations of soft obstacles, excitation waves exhibit unidirectional propagation behavior.

Alex Hwang, College of Wooster, hhwang20@wooster.edu

Title: Dynamic Market Equilibrium: Price Behind the Scenes

Abstract: As consumers, we tend to think of price as a static value. After all, we do not usually witness, let alone record the small and big fluctuations in the prices of commodities. In a similar vein, students of economics are taught that market equilibrium price occurs instantaneously when the graphs of supply and demand functions intersect. However, in reality, the price of a good may change at different velocities and accelerations. To capture this notion of 'rate of change in price', we treat supply and demand functions as second-order differential equations. As a result, we will see that equilibrium price is reached through a dynamic process.

Troy Wiegand, Butler University, tmwiegan@butler.edu

Title: Discerning Complex Hadamard Submatrices of the Fourier Matrices via Primitive Sets

Abstract: For a given selection of rows and columns from a Fourier matrix, we give a number of tests for whether the resulting submatrix is Hadamard based on the primitive sets of those rows and columns. In particular, we demonstrate that whether a given selection of rows and columns of a Fourier matrix forms a Hadamard submatrix is exactly determined by whether the primitive sets of those rows and columns are compatible with respect to the size of the Fourier matrix. This motivates the creation of compatibility graphs for the Fourier matrix, which represent which primitive sets are compatible. We conclude with some results that enable the construction of these graphs for submatrix sizes 2 and 3.

Steven Collar, Miami University, collarsr@MiamiOH.edu

Title: Fronts in a model for competitive exothermic combustion

Abstract: ???????????New talk???????????????????????

<u>**Room 114**</u>

Jonathan Ford and Jacob Fryman, Northern Kentucky University, fordj8@nku.edu, frymanj4@nku.edu

Title: Exploring Neural Networks with Mathematica

Abstract: We will report on our summer research project where we learned to create and train neural networks using Mathematica. In this talk we will introduce you to the Mathematica Neural

Network Repository, a collection of already-created neural network models, suitable for evaluation, training, visualization, and transfer learning. We will explain how we took one of these models, edited it, and then trained for a new task. This new neural network was able to identify trees from all 185 species from the Northeastern United States from a photo of their leaves with about 5% error.

Michael Pavelites, Fairmont State University, mpavelites@gmail.com

Title: Discrete Analogues of Chebyshev Polynomials

Abstract: The Chebyshev polynomials are polynomials which solve the Chebyshev Differential Equation. This talk will explore discrete analogues of Chebyshev polynomials. Additionally, it will provide examples of their properties such as difference equations and an analogue of the three-term recurrence.

Dejuan Winters, Butler University, dlwinter@butler.edu

Title: Geometric Limits of Julia Sets with a Parabolic Implosion

Abstract: The filled Julia set for a map is the set of points that have a bounded sequence of iterates by . We conjecture that the limit of the filled Julia sets for , the sum of a power map and a polynomial mapping with a parabolic fixed point, does not exist. This mimics the classical parabolic implosion, in which the failure of the limit is the result of the continuous "eggbeater" motion of periodic points. We present evidence that the family of maps also exhibits this behavior as the degree of our power map increases without limit

Marzie Bakhshi Miami University, email: bakhshm2@miamioh.edu

Title: A calculus for first and second order epiderivative
Abstract: Metric subregularity is used to establish a chain rule for epi-derivative. The key ingredient is the calculus for tangent cones.

Yangxinyu Xie, University of Texas at Austin, yx4247@utexas.edu

Title: On 2×2 Tropical Commuting Matrices

Abstract: In this talk, we investigate the geometric properties of a special case of the two sided system given by 2×2 tropical commuting constraints. Specifically, given a matrix $A \in \mathbb{R}^{2\times 2}$ with finite entries, we study the extreme vertices of the tropical polyhedral cone spanned by the vectors of entries of B such that $A \otimes B = B \otimes A$.

Thong Ngo, Centre College, email: thong.ngo@centre.edu

Title: The Jones polynomial of Montesinos link

Abstract: Jones polynomial is an extremely important invariant of knots and links, which assigns a Laurent polynomial to every knot and link. In this talk, we will discuss our attempt at finding a closed form formula for the Jones polynomial of a special family of knots and links, called the Montesinos link, and see how the Jones polynomial can be related to an extended Fibonacci form.

Room 102

Ryan Oostland, Bluffton University, oosrda@bluffton.edu

Title: Mathematics and algorithms to detect crystalline defects in Molecular Dynamics (MD) simulations

Abstract: This talk will give a mathematician's perspective on my summer XSEDE EMPOWER project in computational science: MD Simulation and Visualization of Acoustically-Controlled Defect Dynamics in FCC and Si Lattices. This will include a look at calculating the locations of defects in 3D lattices, but will have a focus on the use of mathematical morphology operations in detecting vacancies in 2D hexagonal lattices.

Jacob Charboneau and David Gregory, Butler University, jdcharbo@butler.edu, djgregor@butler.edu

Title: Finding Small Sizes of Modulo Difference Covers

Abstract: Let . Let be a modulo difference cover when is generated by differences in mod . Finding an of minimum size takes exponential time. In this talk we describe algorithms that find sizes of that are close to the minimum size in polynomial time. This talk requires no prior knowledge of computer science or discrete mathematics.

Corey Thrush, Ohio Northern University, c-thrush@onu.edu

Title: Zero Sum Two Player Games

Abstract: Zero sum two player games are specific kinds of games within Game Theory. Using zero sum games will uncover what the minimax principle is and how to guarantee payoffs. Then be able to determine the differences between pure and mixed strategies. After learning the differences, we will use them to solve for the value of games. Understanding these concepts will allow its' users to play games optimally.

Andrew Lowe, Ohio Northern University, a-loewe@onu.edu

Title: Sabermetrics - what, why, and is it good for the game?

Abstract: Reliability on data analytics in baseball has reached unprecedented levels. Sabermetrics has been credited with helping to build championship teams, but some continue to ignore it. This talk will explore the benefits and drawbacks of sabermetrics including an in-depth analysis on how some of the game's most popular stars don't actually meet the hype surrounding them.

Amanda Liddle, University of Colorado Boulder, Amanda.Liddle@colorado.edu

Title: Agent-Based Models to Simulate the Spread of Violent Crime

Abstract: In recent years, reaction-advection-diffusion models for urban-crime have been introduced in the literature with much interest. This framework makes the assumption agents react the same way. This assumption can be questioned when dealing with violent crimes as it has been proposed that violence should be treated as a public health issue and epidemiological modeling and techniques are suitable. Our study focused on understanding how individual differences can play a role in violent crime patterns. We compare the results from two different agent-based models simulating the spread of violent crimes. The Eulerian approach models the spread of violence under the assumption that locations in which crime occurs during one time-step will see increasing probabilities of future crime, as well as increased probabilities of crime in neighboring locations. The Lagrangian approach models the spread of violence under the assumption that the occurrence of crimes depends strictly on the individual, meaning that each agent has their own threshold for violence that will increase or decrease depending on their involvement in crime. In this talk we present the models and some preliminary results.