Southern Georgia Mathematics Conference

Abstract Booklet

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Keynote Speakers

Hao-Min Zhou, Georgia Institute of Technology
email: hmzhou@math.gatech.edu

Title: Optimal Transport on Graphs with Some Applications

Abstract: Optimal transport theory in continuous space has been extensively studied in the past few decades. In this talk, I will present the optimal transport theory on discrete spaces, including various developments related to free energy, Fokker-Planck equations, as well as Wasserstein distance on graphs. Some of them are rather surprising in the discrete case. Applications in robotics as well as Schrodinger equation on graphs will be demonstrated.

Bio: Prof. Hao Zhou graduated from UCLA and then obtained postdoc training from Caltech. He joined Georgia Tech in 2003 and became full professor in 2012. His main research interests lie in the areas of wavelets and PDE techniques in digital image and video processing, and analysis and computations of stochastic differential equations. His research is mainly supported by ONR (Navy) and NSF grants. Prof. Zhou has won various awards including NSF CAREER award and the 2019 Feng Kang Prize.

Marta Civil, University of Arizona
email: martac@email.arizona.edu

Title: Listening to students: A path to a more inclusive participation in mathematics

Abstract: In this talk I present a framework for participation in the mathematics classroom informed by a focus on equity. Drawing on both my own experience as instructor and researcher, as well as a broader view of research into practice, I will illustrate the different components of the framework. My plan is to engage the audience through a mathematics task to promote an interactive discussion of principles to consider, to support the participation of students, in particular students whose mathematical voices and ideas often go unnoticed.

Bio: https://profiles.arizona.edu/person/martac

Suzanne Lenhart, University of Tennessee-Knoxville
webpage: https://www.math.utk.edu/people/bio/Suzanne/Lenhart

Title: One Health: Connecting Humans, Animals and the Environment

Abstract: 'One Health' is a multidisciplinary approach to improving the health of people, animals and the environment. Environmental, wildlife, domestic animal, and human health fall under the One Health concept. Mathematical models of infectious diseases involving animals, environmental features, and humans will be presented. These models can suggest management policies and predict disease spread. Examples including La Crosse virus and Zika virus will be discussed.

Bio: Suzanne Lenhart is a Chancellor's professor in the Mathematics Department at the University of Tennessee. She was a part-time research staff member at Oak Ridge National Laboratory from 1987-2009. Her research involves partial differential equations, ordinary differential equations and optimal control of biological and physical models

She was the President of the Association for Women in Mathematics in 2001-2002. She received fellow awards from SIAM, AMS, AWM, and AAAS. She was the Associate Director for Education and Outreach of the National Institute for Mathematical and Biological Synthesis for the last 12 years. Lenhart has been the director of Research Experiences for Undergraduates summer programs at UT for 27 years.

Frank Morgan, Atwell Professor of Mathematics, Emeritus, Williams College
email: fmorgan@williams.edu

Title: Optimal Tiles

Abstract: In 2001 Hales proved that regular hexagons provide a least-perimeter tiling of the plane by unit areas, better than squares for example. (A unit-area square has perimeter 4, while the "rounder" unit-area regular hexagon has perimeter about 3.72.) What is the best pentagonal tile? How much better than the cube can you do in 3D? What about hyperbolic space? The talk will include open questions and recent results, some by undergraduates.

Bio: Frank Morgan received his bachelor's degree from M.I.T. and his Ph.D. from Princeton in 1977, under the direction of Fred Almgren, who introduced him to the study of minimal surfaces. After teaching at M.I.T for ten years, Frank joined the faculty of Williams College, where he served as chair of the Department of Mathematics and Statistics and Atwell Professor of Mathematics, and was the founding director of the NSF-sponsored SMALL undergraduate research project. His proof, along with colleagues and students, of the Double Bubble Conjecture, is featured at the NSF Discoveries site. He received the Baker Teaching award at M.I.T. and in 1992 was one of the inaugural winners of the MAA national Distinguished Teaching Award. He has published six books, and has served as vice president of the AMS, second vice president of the MAA, and editor-in-chief of the Notices of the AMS.

Special Session On Math Education

Jennifer Ruef, University of Oregon
email: jruef@uoregon.edu

Title: Reframing and Reclaiming "Good at Math"

Abstract: What does it mean to be "good at math?" Mathematics, historically, has been a gated space. Now, more than ever, it is important to frame mathematical competence in terms of curiosity, compassion, and connections with other ways of thinking. This presentation will share findings research from projects interwoven by re-humanizing the learning of mathematics, including the Mathematics Identity project, the Good at Math project, and the Ichishkíin Mathematics project.

Kay Howell, Indrani Singh, Frances Harper, Tabatha Rainwater, University of Tennessee, Knoxville
email: kadlhowe@vols.utk.edu

Title: Cross-disciplinary Connections as a Bridge to Community and Cultural Funds of Knowledge in Elementary Mathematics Lessons

Abstract: Mathematics lessons that leverage cultural and community funds of knowledge provide one way of integrating equitable teaching practices to enhance mathematical proficiency among children from diverse backgrounds. Learning to plan such mathematics lessons, however, proves challenging for prospective teachers. In this session we report on initial findings from our analysis of prospective elementary teachers of mathematics' lesson plans, in which they were asked to leverage children's mathematical thinking, cultural and community funds of knowledge, and cross-disciplinary connections. We explore the possibility for cross-disciplinary connections to ease the challenge of learning to integrate mathematics and community and cultural knowledge and experiences.

Basil Conway IV, Columbus State University, Brian Lawler, Kennesaw State University
email: conway_basil@columbusstate.edu

Title: Teaching Mathematics for Social Justice

Abstract: Why teach mathematics for social justice? How do you teach mathematics for social justice? Experience a snapshot of a lesson from Mathematics Lessons to Explore, Understand and Respond to Social Injustice.

Michael Owens, Natasha Ramsay-Jordan, University of West Georgia
email: mowens13@my.westga.edu

Title: A Call to Action: Improving Diversity and Inclusion in STEM

Abstract: This presentation highlights the disparity of Black and Latinx students' participation within high school STEM courses. Teacher impact and systemic influences are examined as primary determinants of these historically marginalized students' STEM experiences. Specif-

ically, the presentation identifies teacher-student relationships, student recruitment methods, teachers' perceptions about STEM, lack of teacher preparation, and lack of resources as stimuli that inhibit student participation within STEM courses and programs. The presentation then culminates with implications for school leaders and educators who seek to increase the number of Black and Latinx students' participation and readiness for STEM.

Natasha Ramsay-Jordan, Alexandria Carter, Savannah Garrison, Zhakira Sainsbury, University of West Georgia
email: nrjordan@westga.edu

Title: Pre-service Teachers' Approaches to Effective Virtual Instruction for the P-5 Mathematics Classroom

Abstract: The Covid-19 pandemic has caused many teacher education programs to alter traditional approaches to pre-service teachers' preparation. For example, as an added safety measure the number of days and length of time non-interned students are placed in the schools has decreased. Even more, a response to the pandemic has called for the continued preparation of high-quality teachers who can deliver effective instruction using different modalities, particularly virtual. In this presentation, three preservice teachers share their burgeoning understanding of and approach to effective online mathematics instruction. Specifically, they discuss their understanding of how to support P-5 students' mathematics learning using virtual manipulatives and other internet-based activities.

Erica Miller, Virginia Commonwealth University; Mary Pilgrim, San Diego State University
email: ermiller2@vcu.edu

Title: Measuring Mathematics Tutor/TA Beliefs

Abstract: There is a wealth of research on student and teacher beliefs and instruments that have been developed to measure them. However the same is not true for tutors and graduate students, who are both students and teachers. Our project aims to develop a survey that can be useful for faculty and staff who direct undergraduate mathematics tutoring centers or mathematics graduate teaching assistant professional development programs. In particular, a tutor beliefs survey would be useful in that it would allow faculty and staff to gain insight into tutor's current beliefs and measure whether or not those beliefs change over time.

Indrani Singh, University of Tennessee, Knoxville
email: isingh3@vols.utk.edu

Title: Mathematics Anxiety: Secondary Students' Avoidance of Elective Mathematics

Abstract: Students with high levels of mathematics anxiety tend to avoid leveraging opportunities to hone their mathematics skills. This avoidance undercuts their competence in mathematical skills essential for advanced mathematics coursework. However, it has been observed that highly anxious secondary mathematics students either tend to transfer to non-STEM pathways or avoid selecting mathematics as an elective subject at secondary level. In this session, I discuss how theories of mathematics anxiety and its nature translate to secondary students' avoidance of elective mathematics courses, and how it affects enrollment of secondary students in secondary mathematics need a more systematic approach.

Zareen Rahman, James Madison University
email: rahmanzx@jmu.edu

Title: Pre-service Mathematics Teachers' Experience with Productive Struggle

Abstract: Mathematics pre-service teachers (PSTs) need opportunities to learn best practices in teaching mathematics, e.g., productive struggle. Productive struggle happens when students work through challenging problems that are not straight forward (Hiebert & Grouws, 2007). This presentation will describe mathematics PSTs' engagement with productive struggle in a mathematics methods course. PSTs critiqued high cognitive demand tasks, planned and implemented them, and reflected on their experience focusing on productive struggle. Findings have implications for mathematics teacher preparation.

Debbian Campbell-James, University of West Georgia; Natasha Ramsay-Jordan, University of West Georgia
email: dcampbe6@my.westga.edu

Title: The Expansion of Online Learning and the Mathematics Classroom

Abstract: Given the new normal of teaching in the age of Covid-19, this presentation examines the expansion of online learning for mathematics education in grades K-12. The integration of varying technologies that advance online learning is discussed to foster a deeper understanding of how to support mathematics teachers and students. Additional discussions about the challenges and benefits these technologies offer for mathematics teaching and learning are also shared. Themes within this presentation include approaches for familiarizing teachers with technology, increasing technology self-efficacy, and delineating how to support student use of technology during the online environment.

John Gruver, Elizabeth Keysor, Michigan Technological University
email: jgruver@mtu.edu

Title: Exploring Learning from Online Dialogic Instructional Mathematics Videos

Abstract: With the COVID-19 pandemic, many educators have turned their attention to online learning, thinking about the affordances and constraints of various approaches. Our project seeks to develop and study students' use of an innovative form of instructional mathematics videos—ones that feature the authentic dialogue of pairs of high-school students as they grapple with cognitively demanding math tasks (see mathtalk.org for examples). In the session, we will explore how educators might use these videos during the pandemic and beyond.

AnnaMarie Conner, University of Georgia; Hyejin Park, James Madison University; Yuling Zhuang, University of Georgia; Laura Singletary, Lee University
email: aconner@uga.edu

Title: How Teachers Support Students in Argumentation: Verbal and Nonverbal Actions

Abstract: When we think about teaching mathematics by engaging students in discussions or in argumentation, we often think about the verbal aspects involved in the classroom – what teachers say, how they position students by their words, whether students are talking to each other in small groups or to the whole class. In this presentation, we explore why teachers might also engage in displaying actions such as writing on the board, asking students to write on the

board, or projecting images in the classroom. We discuss preliminary findings about how and why a teacher uses displaying actions to support collective argumentation.

James Janakat, Montclair State University
email: JanakatJ1@Montclair.edu

Title: Probability in Middle School Mathematics Textbooks

Abstract: Three distinct series of middle-school mathematics textbooks (Holt, Singapore Math, and Connected Math) were selected and analyzed vis-à-vis their treatment of probability. More specifically, the terms defined and the length of their definitions in comparison with the CCCS, the type and quantity of textbook exercises included, and the alignment of said exercises with the CCCS were analyzed. Since all three series have a distinct philosophy, the hypothesis was that their treatment of probability would be distinct as well. Chi-square tests of independence and a one-way ANOVA were conducted and statistically significant differences were found at a 99.5 percent confidence level.

John Sevier, Appalachian State University
email: sevierjn@appstate.edu

Title: Engaging Developmental Mathematics Students in Problem Posing

Abstract: This study examines the impact of problem posing on developmental mathematics students. Problem posing has been shown to engage students at all levels by allowing the students to build on their personal interests and experiences. Based on a quasi-experimental design, this study investigated the impact of problem posing and the effect it had on developmental mathematics students' engagement, attitudes and beliefs, and mathematical proficiency. This study illustrates that problem posing can be a promising avenue for developmental mathematics students, especially those who find mathematics as a gatekeeper to their degree and career aspirations.

Julie Nurnberger-Haag, Kent State University
email: jnurnber@kent.edu

Title: Towards a Theoretically-Grounded Classification of Integer Instructional Models

Abstract: Secondary students have difficulty with negative number arithmetic, so multiple methods and models have been developed using the classification system of cancellation, number line, or abstract. A revised classification system is needed. This long-standing classification is obsolete because some models do not fit these mutually exclusive categories. Moreover, a theoretical perspective should be used as the basis for classification. Most integer instructional models encourage students to physically move or imagine motions, consequently, embodied cognition is a promising theoretical perspective to characterize students' opportunities to learn integers with models and provide a theoretically-based classification system as a foundation for subsequent research.

Jeremy Zelkowski, Tye Campbell, University of Alabama
email: jzelkowski@ua.edu

Title: The Relationship of Program Design, Coursework, and Sequencing on Certification Licensure Exams

Abstract: Using NCTM SPA key assessments, we employed an SEM path analysis for program completes from 2012 through 2018, six years, five cohorts, to understand the impact of program design and effects on licensure content and pedagogy exams. This work was done to explore the veracity of the CBMS MET II and AMTE recommendations of three content advanced perspective and three pedagogy methods courses on licensure exams. We will report results.

Angel Abney, Doris Santarone, Brandon Samples, Georgia College
email: angel.abney@gcsu.edu

Title: Heading toward Equality: Preservice Teachers' Interventions to Change Students' Conceptions of the Equal Sign

Abstract: In this session, we will revisit the CGI Project (Carpenter et al, 2003) and contrast results of a similar study conducted by our pre-service teachers. Our investigation highlights the different conceptions that students have of the equal sign, the ways in which our elementary and middle grades PST assessed their students' conceptions, and outline the different interventions used to foster a more relational understanding. Ultimately, we will provide a qualitative analysis of our findings and their connections to the positive shift in algebraic reasoning over the past two decades.

Brianna Kurtz, Piedmont Virginia Community College
email: bkurtz@pvcc.edu

Title: Mathematics, Interrupted: Challenges in the Return to Formal Schooling for Displaced Learners

Abstract: In the times of Covid-19, mathematics students globally are facing the challenge of return to various styles of formal schooling after disruption due to the onset of the pandemic. However, this current situation is far from the first time students have faced educational interruptions. This presentation will explore lessons on specifically returning to mathematics education following hiatuses caused by natural disasters, political upheavals, medical events, and athletic conflicts.

Ander Erickson, University of Washington Tacoma
email: awerick@uw.edu

Title: Help or Hindrance? Students' Use of Online Resources for Learning Mathematics

Abstract: Undergraduate students make extensive use of online resources in their mathematics classes. This presentation will share actual case studies of students' use of online resources in order to explore the extent to which these resources may help or hinder student learning of mathematics. These cases are part of a larger mixed-methods study and I will also share information about which online resources students are using, how they are using them and why. These findings reveal undergraduate students as thoughtful and deliberate users of online resources who use them strategically to navigate challenges inherent to college mathematics.

Anita Sundrani, Travis Weiland, University of Houston
email: asundrani@uh.edu

Title: Opportunities for K-8 Students to Learn Statistics Created by Official Curriculum in the United States

Abstract: In this era of fake news, statistical literacy is the key to creating an informed and critical citizenry. To that aim, we investigate K-8 students' opportunities to learn statistics through state mathematics standards. We summarize the concept themes that emerge and analyze the standards for alignment to the Guidelines for the Assessment and Instruction in Statistics Education (GAISE II). We found that K-8 standards related to data do not offer appropriate and consistent opportunities to engage in formulating questions and collecting/considering data. We discuss the implications of the findings and provide recommendations for policy makers, standards writers, and researchers.

Matthew Dalzell, Montclair State University
email: dalzellm1@montclair.edu

Title: Comparing Cognitive Demand in Popular and Specialized Textbooks

Abstract: Some math textbooks challenge students with differentiated questions while others focus on procedures. In this study, I compare the cognitive demand of questions between two textbooks: Glencoe Prealgebra- a popular text and Beast Academy- a specialized textbook. I used a modified version of Stein and Smith's (1998) cognitive demand framework, allowing for low cognitive demand questions written with potential high cognitive demand approaches. Comparing analogous questions in them, Beast Academy focuses more on high cognitive demand questions and contains more questions with potential high cognitive demand approaches than Glencoe Prealgebra. This contributes to discussions on math textbook question design.

Jia He, Augusta University
email: hejia08@gmail.com

Title: Preservice Teachers' Evaluation and Interpretation of a Student Invented Decimal Division Algorithm

Abstract: This study investigated preservice middle school teachers' evaluation and interpretation of a student-invented decimal division algorithm. Most participants failed to correctly evaluate and interpret the invented method. They were unable to take into account different cases of decimal division problems. Preservice teachers also experienced difficulty in connecting the invented method to the standard decimal division algorithm. Instead of relying on their reasoning to make a judgment, they tended to rely on the authority and attempted to recall if they learned the invented method before. No preservice teachers were able to provide an idea that could improve the invented method.

Camden Bock, University of Maine
email: camden.bock@maine.edu

Title: Arguing Within and Beside a Pyramid: Continuous Geometric Transformations in Space

Abstract: Immersive virtual-reality environments offer the dynamic potential of digital renderings in a three-dimensional space. When used to render diagrams, these environments allow learners to use their bodies to interact with three-dimensional representations of geometric objects in ways that would be impossible with two-dimensional renderings: walking through, looking around, grasping, dragging, and throwing. I will report on a case-study where learners explored the shearing of a pyramid in a virtual-reality environment and used perspectives within and outside the pyramid to make arguments about the properties of the shearing transformation that would not be practicable with rigid three-dimensional or digital two-dimensional representations.

Brooke Armesto, Georgia Southern University
email: ba02907@georgiasouthern.edu

Title: Perceptions of Newly Qualified General Education Teachers on their Preparedness for Teaching in Inclusive Settings

Abstract: This study will focus on how newly qualified general elementary education teachers (NQTs) perceive their preparedness to teach in inclusive settings. The goal of this study is to discover what areas NQTs felt like they needed to build more proficiency in to successfully teach inclusion. The results of this study indicated that NQTs felt they would be better prepared to teach in inclusive settings had they had more special education coursework and hands-on experiences in placements. The results from this research can be used to reform curriculum or requirements for bachelors of elementary education candidates in the coming years.

Judy Benjamin, Kent State University (CANCELLED)

Title: Sense of Belonging and Task Difficulty as Moderators of Stereotype Threat

Abstract: Findings of a pilot investigation into the potential roles of stereotype threat, sense of belonging, and women's mindset on their performance on a calculus assessment revealed that the performances of women in this study were not depressed by the effects of stereotype threat as expected, but rather, may have been enhanced by its effects. Moreover, results of regression analysis showed that sense of belonging predicted performance in this case. Implications of these results and possible moderators of stereotype threat will be discussed.

Malack Amenya, Matthew Dalzell, Rachael Cane, Montclair State University
email: amenyam1@montclair.edu

Title: Investigating Students Understanding of Infinity Using GeoGebra

Abstract: Understanding infinity is critical for mathematics education because infinity conceptualization supports ideas within many branches of mathematics. Investigating infinity using Dynamic Geometric Environments (DGE) such as GeoGebra may help students grasp this essential concept. Therefore, this study investigates how high school students conceive infinity when engaging in GeoGebra activities. Ninety-five students from 5 math classes in a suburban New Jersey community participated in the GeoGebra tasks. Despite using GeoGebra, many students struggled to transition from finite reasoning, clinging to finite progression, reliance

on properties/definitions, and task-related restrictions. Future studies may benefit from DGE design activities sensitive to these tendencies.

Special Session In Data Science

Alex Dekhtyar, California Polytechnic State University
email: dekhtyar@calpoly.edu

Title: The Data Science Capstone Sequence at Cal Poly, San Luis Obispo

Abstract: Since Fall of 2016 Cal Poly, San Luis Obispo is running a unique program in Data Science, an 80-quarter unit Cross-Disciplinary Studies Minor in Data Science. The pinnacle of this program is a year-long capstone sequence that consists of a a Fall-quarter data science course and a two-quarter project-based capstone course sequence. In this talk we describe the organization of the capstone sequence, discuss the challenges we faced when running it, our approaches to solving them, and the lessons learned.

Scott Kersey, Georgia Southern University
email: skersey@georgiasouthern.edu

Title: Interpolation and Approximation to Functions Defined by Data on Sparse Grids

Abstract: Applied and computational mathematics problems, such as numerical approximation, differentiation, integration, and optimization, typically involve the values and derivatives of underlying functions at discrete gridded points. For high-dimensional problems with many grid points, the size of these data sets is easily beyond the performance and storage limitations of computers. Therefore, to circumvent these limitations, it is important to develop strategies which reduce the size of the data sets without affecting accuracy too much. In this study, we develop algorithms for the approximation of functions f on $\Omega := [0,1]^d \subset \mathbb{R}^d$ for dimension $d > 1$. Rather than choosing the usual *uniform (regular) grids* with n^d grid points, we choose certain *sparse grids* which have far fewer grid points, on the order of

$$\mathcal{O}(n\,(\log n)^{d-1}).$$

On the other hand, while the approximation of smooth functions on full grids is of the order $\mathcal{O}(h^{2m})$ for $h = 1/(n-1)$, the rate of approximation on sparse grids is of the order

$$\mathcal{O}(h^{2m}\,(\log h^{-1})^{d-1}).$$

Hence, while the number of grid points is dramatically less for sparse grids, the rate of approximation only slightly lags that of the full grid. In this talk, we describe a *combination technique* used to define these sparse grids and new sparse operators, which are based on spline and quasi interpolants, and we present our theoretical and numerical results.

Anna Oganyan, National Center for Health Statistics, CDC
email: annaoganyan7@gmail.com

Title: Association Rule Mining based method for Statistical Disclosure Limitation

Abstract: Government statistical agencies have an obligation by law to protect the privacy and confidentiality of data subjects who can be individuals or enterprises. This is usually done by altering—we use the term masking— the original data before release, for example, by aggregating categorical values, swapping data values for selected records, adding noise to numerical values, or synthesizing some or all of the responses. One of the most challenging problems is how to release to the public individual records, also called microdata, with a large number of attributes while keeping the disclosure risk of sensitive information of data subjects under control. When statistical agencies alter microdata in order to limit the disclosure risk, they need to take into account relationships between the variables to produce a good quality public data set. Hence, masking methods should not be univariate (treating each variable independently of others), but preferably multivariate, that is, handling several variables at the same time. In this talk, we present a novel multivariate top-coding method. Statistical agencies are often concerned about disclosure risk associated with the extreme values of numerical variables. Thus, such observations are often top or bottom-coded in the public use files. Top-coding consists of the substitution of extreme observations of the numerical variable by a threshold value, for example, by the 99th percentile of the corresponding variable. Bottom coding is defined similarly but applies to the values in the lower tail of the distribution. Our multivariate top-coding method is based on clustering the variables in the data and then running an association rule mining on vertical partitions of the data obtained on the clustering phase of the method in order to find the multivariate rules for top-coding.

Susanna Lange, University of Kentucky
email: susanna.lange@uky.edu

Title: Batch Normalization Preconditioning for Neural Network Training

Abstract: Batch normalization is a popular method in deep learning that has been shown to decrease training times and improve generalization performance of neural networks. In this talk, we introduce a new method of normalization that serves to improve the conditioning of the Hessian matrix of the loss function. We call this method Batch Normalization Preconditioning, as we apply a preconditioning transformation to the gradients of our network during training. Additionally, we will discuss the connection between Batch normalization and our proposed preconditioning method that provides insight into how Batch normalization improves training.

Vasily Zadorozhnyy, University of Kentucky
email: vasily.zadorozhnyy@uky.edu

Title: Adaptive Weighted Discriminator for Training Generative Adversarial Networks

Abstract: Generative adversarial network (GAN) has become one of the most important neural network models for classical unsupervised machine learning. A variety of discriminator loss functions have been developed to train GAN's discriminators with a common structure: a sum of real and fake losses that only depends on the actual and generated data, respectively. One challenge associated with an equally weighted sum of two losses is that the training may benefit one loss but harm the other, causing instability and mode collapse. We introduce a new family of discriminator loss functions that adopts a weighted sum of real and fake parts, which we call

adaptive weighted loss functions or aw-loss functions. Using the gradients of the real and fake parts of the loss, we can adaptively choose weights to train a discriminator in the direction that benefits the GAN's stability. Experiments validated the effectiveness of our loss functions on both unconditional and conditional image generation tasks.

Special Session In Math Physics I

Haitian Yue, University of Southern California
email: haitiany@usc.edu

Title: Random tensors and propagation of randomness under the dispersive flow

Abstract: Random tensors and propagation of randomness under the dispersive flow Abstract: In this talk, we will discuss recent developments on the propagation of randomness, in the setting of random data problems for nonlinear Schrödinger equations and Hartree equations. In particular, I will present a new framework called the theory of random tensors (which is a natural extension of the method of random averaging operators in our earlier work) that proves almost-sure local well-posedness in the optimal ("probabilistic subcritical") range of regularity. This is work with Yu Deng (USC) and Andrea Nahmod (UMass Amherst).

Wen Feng, Niagara University
email: wfeng@niagara.edu

Title: Large-time behavior of 2D incompressible MHD system with partial dissipation

Abstract: In this talk, we will discuss the decay results on a 2D magnetohydrodynamic (MHD) system with only vertical dissipation. Without the magnetic field, the fluid velocity obeys a 2D anisotropic Navier-Stokes equation and is not known to be stable in the Sobolev setting H^2 due to the potential double exponential growth of its H^2-norm in time. However, when coupled with the magnetic field in the MHD system, we show that the H^2-norm of any perturbation near a background magnetic field actually decays algebraically in time. This result demonstrates that the magnetic field indeed stabilizes and damps the electrically conducting fluids. Mathematically this result along with its proof offers a new and effective approach to the large-time behavior on partially dissipated systems of partial differential equations (PDEs). Existing methods are mostly designed for systems with full dissipation and do not apply when the dissipation is anisotropic. This is the joint work with Farzana Hafeez and Jiahong Wu.

Mihai Tohaneanu, University of Kentucky
email: mihaitohy@googlemail.com

Title: The wave equation on a manifold with boundary

Abstract: Local energy estimates are a robust way to measure the dispersion of waves. For a variety of spacetimes, including black hole solutions to Einstein's Equations, such estimates are known to hold (allowing for a derivative loss). The main difficulty in proving local energy estimates is the presence of trapped null geodesics, which accounts for the loss in derivatives. In this talk we will show that on certain types of manifolds with boundary, such estimates never hold, no matter how many derivatives one is prepared to lose. This is joint work with K. Datchev, J. Metcalfe, and J. Shapiro.

Ebru Toprak, Rutgers University
email: et400@math.rutgers.edu

Title: Dispersive estimates for massive Dirac Operators

Abstract: In this talk, I will present a study on the $L^1 \to L^\infty$ dispersive estimates for the two and three dimensional massive Dirac equation with a potential. In two dimension, we show that the t^{-1} decay rate holds if the threshold energies are regular or if there are s-wave resonances at the threshold. We further show that, if the threshold energies are regular then a faster decay rate of $t^{-1}(\log \log t)^{-2}$ is attained for large t, at the cost of logarithmic spatial weights, which is not the case for the free Dirac equation. In three dimension, we show that the solution operator is composed of a finite rank operator that decays at the rate $t^{-1/2}$ plus a term that decays at the rate $t^{-3/2}$. This is a joint work with M.Burak Erdoğan and William Green.

Gong Chen, University of Toronto
email: gc@math.toronto.edu

Title: Long-time dynamics of the sine-Gordon equation

Abstract: I will discuss the soliton resolution and asymptotic stability for the sine-Gordon equation. It is known that the obstruction to the asymptotic stability for the sine-Gordon equation in the energy space is the existence of small breathers which is also closely related to the emergence of wobbling kinks. Our stability analysis gives a criterion for the weight which is sharp up to the endpoint so that the asymptotic stability holds. This is joint work with Jiaqi Liu and Bingying Lu.

Special Session In Harmonic Analysis

Svetlana Roudenko, Florida International University
email: sroudenko@fiu.edu

Title: Nonlinear wave-type models: tools from Harmonic Analysis

Abstract: The nonlinear wave-type (or dispersive) models include such equations as the nonlinear Schrodinger (NLS), Hartree, Korteweg-de Vries (KdV), Benjamin-Ono equations, which have been given a great amount of attention in recent years, as they appear in fluid dynamics, turbulence, nonlinear optics, general relativity, fiber communication, etc. A lot of methods to study these models, their descriptions, solutions, dynamics, come from Harmonic analysis. In this talk I will show some examples of tools and methods from Harmonic analysis, which advanced our understanding of time evolution in the above models and can predict long term behavior or singularity formations in their solutions.

Sze-Man Ngai, Georgia Southern University
email: smngai@georgiasouthern.edu

Title: Sub-Gaussian heat kernel estimates for a class of one-dimensional self-similar measures

Abstract: We study the geometric properties of self-similar measures on intervals generated by iterated function systems that do not satisfy the so-called open set condition. Examples include the infinite Bernoulli convolution associated with the golden ratio, and a family of convolutions of Cantor-type measures. We obtain sub-Gaussian heat kernel estimates for the corresponding measure-theoretic Laplacian. This work is joint with Qingsong Gu (Memorial University, Canada) and Jiaxin Hu (Tsinghua University, China).

Oleksandr Vlasiuk, Florida State University
email: ovlasiuk@fsu.edu

Title: Short-range interactions in nature, geometry, and information theory

Abstract: Some popular models in different branches of science consist in predicting the behavior of a large number of independent agents, which interact in a way where the neighboring agents have much bigger influence than the more distant ones. Say, a territorial animal aggressively defends its habitat against the next-door rivals, but does not really interact with those separated from it by distance or natural obstacles.

In this talk, we will overview the mathematical principles underlying such short-range behavior, explain how they arise in different contexts, and show how to use them in order to predict the long-term behavior of the interacting system as a whole.

Aleh Asipchuk, Florida International University
email: aasip001@fiu.edu

Title: Harmonic Analysis and Stability in Discrete Dynamical Systems

Abstract: I will discuss the problems of stability of equilibriums in discrete dynamical systems. Harmonic Analysis will be an important practical tool. Numeric examples will be considered as well.

Special Session In Symbolic Computation

Moa Apagodu, Virginia Commonwealth University (CANCELLED)
email: mapagodu@vcu.edu

Title: Zeilberger's algorithm and its applications in different areas

Abstract: Zeilberger's Algorithm finds difference equations (recurrence equations) for summations involving hypergeometric sequences. It is a "go-to" technique to prove hypergeometric identities in combinatorial mathematics. It is also used to discover new hypergeometric identities. In this talk, we will discuss the method and demonstrate several applications. This talk is expository to audiences from different areas of Mathematics.

Frank Garvan, University of Florida
email: fgarvan@ufl.edu

Title: Congruences for weight 3/2 eta-quotients and their connection with mod 4 conjectures for the spt function and unimodal sequences

Abstract: Recently the speaker and Rong Chen (Tongji University, Shanghai) proved Bryson, Ono, Pitman and Rhoades's mod 4 conjectures for strongly unimodal sequences and Lim, Kim and Lovejoy's mod 4 conjectures for odd-balanced unimodal sequences as well as some mod 4 conjectures for the Andrews spt function.

In this talk we show how we found a similar mod 4 behaviour for certain weight 3/2 eta-quotients. This led to a connection with the Hurwitz class number and eventually gave us the clue for solving the mod 4 unimodal sequence conjectures. This is joint work with Rong Chen (Tongji University, Shanghai).

Shashank Kanade, University of Denver
email: shashank.kanade@du.edu

Title: Some recent explorations on Rogers-Ramanujan-type identities

Abstract: Rogers-Ramanujan identities are a pair of identities regarding integer partitions. These identities arise in many places, but importantly for us, they are related to the affine Lie algebra $A_1^{(1)}$. A recent computer experimentation led my collaborator Matthew C. Russell and myself to an infinite family of similar identities related to the affine Lie algebra $A_2^{(2)}$. These identities can be proved using Bailey-theoretic techniques. Further, this infinite family breaks very naturally into six infinite sub-families. All of this confirms a conjecture of McLaughlin and Sills from 2008. The talk will be based on these explorations and results.

Co-author: Matthew Russell (Rutgers University).

Nicolas Smoot, Research Institute for Symbolic Computation, Johannes Kepler University Linz, Austria
email: Nicolas.Smoot@risc.jku.at

Title: p-adic Convergence Over Surfaces of Genus 1: A New Method for Studying Partition Congruence Families

Abstract: A major topic of interest in the theory of partitions is the study of infinite families of congruences—regular patterns of divisibility of a given partition function by arbitrarily large powers of a given prime. In the century since Ramanujan's groundbreaking work, our understanding of this subject has grown substantially. Possible complications in the proofs of such congruences include the genus of the underlying modular curve, issues in the representation of the associated family of modular functions, and more subtle matters involving piecewise p-adic convergence. In this talk we will discuss how to overcome these complications using some recently developed techniques.

Special Session In Math Biology

Jemal Mohammed-Awel, Valdosta State University
email: jmohammedawel@valdosta.edu

Title: Mathematics of an Epidemiology-genetics Model for Assessing the Role of Insecticides Resistance on Malaria Transmission Dynamics

Abstract: The widespread use of indoors residual spraying (IRS) and insecticides-treated bednets (ITNs) has led to a dramatic reduction of malaria burden in endemic areas. Unfortunately, such usage has also resulted in the challenging problem associated with the evolution of insecticide resistance in the mosquito population in those areas. Thus, it is imperative to design malaria control strategies, based on using these (IRS- and ITNs-based) interventions that reduce malaria burden while effectively managing insecticide resistance in the mosquito population. This talk describes the use of a model that couples malaria epidemiology with mosquito population genetics to explore control scenarios.

Buddhi Pantha, Abraham Baldwin Agricultural College
email: bpantha@abac.edu

Title: Modeling Transmission Dynamics of Rabies in Nepal

Abstract: Even though vaccines against rabies are available, rabies remains a burden killing a significant number of humans as well as domestic and wild animals in many parts of the world, including Nepal. In this study, we develop a mathematical model to describe transmission dynamics of rabies in Nepal. In particular, an indirect interspecies transmission from jackals to humans through dogs, which is relevant to the context of Nepal, is one of the novel features of our model. Our model utilizes annual dog-bites data collected from Nepal for a decade long period, allowing us to reasonably estimate parameters related to rabies transmission in Nepal. Using our model, we calculated the basic reproduction number $R_0 = 1.16$) as well as intraspecies basic reproduction numbers of dogs ($R_0^D = 1.14$) and jackals ($R_0^J = 0.07$) for Nepal, and identified that the dog-related parameters are primary contributors to R_0. Our results show that, along with dogs, jackals may also play an important role, albeit lesser extent, in the persistence of rabies in Nepal. Our model also suggests that control strategies may help reduce the prevalence significantly but the jackal vaccination may not be as effective as dog-related preventive strategies. These results may be useful to design effective prevention and control strategies for mitigating rabies burden in Nepal and other parts of the world.

This is joint work with Sunil Giri (Florida Atlantic University), Hem Joshi (Xavier University), and Naveen Vaidya (San Diego State University).

Eric Che, Howard University
email: ericngangche@yahoo.com

Title: Risk Structured Model of Cholera Infections in Cameroon

Abstract: In this talk, we introduce a risk-structured ODE cholera model of Cameroon with no spatial structure. We use a “fitted” demographic equation (disease-free equation) to capture the total population of Cameroon, and then use a fitted low-high risk structured cholera differential equation model to study reported cholera cases in Cameroon from 1987-2004. The basic reproduction number of our fitted cholera model, R0, is bigger than one and our model predicted cholera endemicity in Cameroon. In addition, the fitted risk structured model predicted a decreasing trend from 1987 to 1994 and an increasing trend from 1995 to 2004 in the pre-intervention reported number of cholera cases in Cameroon from 1987 to 2004. Using the fitted risk structured cholera model, we study the impact of vaccination, treatment and improved sanitation on the number of cholera infections in Cameroon from 2004 to 2022. Furthermore, we use our fitted model to predict future cholera cases.

Nourridine Siewe, Rochester Institute of Technology
email: nxssma@rit.edu

Title: The Potential Role of Asymptomatic Infection in Outbreaks of Emerging Pathogens

Abstract: Preparation for outbreaks of emerging infectious diseases is often predicated on beliefs that we will be able to understand the epidemiological nature of an outbreak early into its inception. However, since many rare emerging diseases exhibit different epidemiological behaviors from outbreak to outbreak, early and accurate estimation of the epidemiological situation may not be straightforward in all cases. Previous studies have proposed considering the role of active asymptomatic infections co-emerging and co-circulating as part of the process of emergence of a novel pathogen. Thus far, consideration of the role of asymptomatic infections in emerging disease dynamics have usually avoided considering some important sets of influences. In this talk, we present and analyze a mathematical model to explore the hypothetical scenario that some (re)emerging diseases may actually be able to maintain stable, endemic circulation successfully in an entirely asymptomatic state. We argue that an understanding of this potential mechanism for diversity in observed epidemiological dynamics may be of considerable importance in understanding and preparing for outbreaks of novel and/or emerging diseases.

Special Session In Data Analysis

Fastel Chipepa, Botswana International University of Science and Technology
email: chipepaf@biust.ac.bw

Title: The Gompertz-G Power Series Family of Distributions with Applications

Abstract: In this article, we develop the Gompertz-G power series distribution and derive some structural properties of the new family of distributions including quantile function, linear representation, distribution of order statistics, Rényi entropy, moments, generating function, probability weighted moments, and maximum likelihood estimates. A simulation study also conducted to examine the consistency of the maximum likelihood estimates. We use two real data examples to demonstrate the usefulness of the Gompertz-G power series distribution.

This is joint work with Broderick Oluyede (Botswana International University of Science and Technology), Morad Alizadeh (Persian Gulf University), and Simbarashe Chamunorwa (Botswana International University of Science and Technology).

Chipo Zidana, Botswana International University of Science and Technology
email: zidanac@biust.ac.bw

Title: Poisson Mixture Models for Early COVID-19 spread in Age segmented data: A Zimbabwean case

Abstract: Unique COVID-19 prevention measures to different locations and age groups can only be effectively and efficiently implemented when there is a clear understanding of the dynamics of the disease at different levels, major risk factors and groups involved. This paper aims at determining the major COVID-19 spread risk factors in Zimbabwe. We intend to identify the different individual, age and location risk levels given the complex heterogeneous population of Zimbabwe. COVID-19 data for 37 individuals as provided by the Ministry of Health and Child Care (MoHCC) for the period from 20 March - 14 May 2020 is used. Generalised Poisson finite mixture models were implemented to achieve the objectives. Results show that COVID-19 spread is determined by gender, age, mode of infection and history of travel. However, these were distributed different across two clusters. Children (0-14) years, females and travellers were among those who had high spread risk. Thus we recommend that Zimbabwean government give priority to children, females, and non-travellers when implementing prevention measures.

This is joint work with Maslin Gudoshava (National University of Science and Technology, Zimbabwe) and Sarudzai Portia Showa (National University of Science and Technology, Zimbabwe).

Peter O. Peter, Botswana International University of Science and Technology
email: pp19100029@studentmail.biust.ac.bw

Title: The Topp-Leone Exponentiated Half-Logistic Marshall-Olkin-G Family of Distributions

Abstract: We develop a new generalized family of generalized distributions called the Topp-Leone exponentiated half-logistic Marshall-Olkin-G (TL-EHL-MO-G) family. Furthermore, we establish some useful mathematical and statistical properties for this family of distributions such as the hazard function, quantile function, moments and moment generating functions, Rényi entropy and order statistics. We apply the method of maximum likelihood estimation to

estimate the model parameters. To demonstrate the applicability, flexibility and consistency of these family of distributions we run some simulation experiments and finally apply its special case to real life data sets.

This is joint work with Broderick Oluyede (Botswana International University of Science and Technology) and Nkumbuludzi Ndwapi (Botswana International University of Science and Technology).

Whatmore Sengweni, Botswana International University of Science and Technology
email: whatmore.sengweni@studentmail.biust.ac.bw

Title: The Exponentiated Half-Logistic-Weibull Topp-Leone-G Family of Distributions with Applications

Abstract: A new family of distributions called the Exponentiated Half-LogisticWeibull Topp-Leone-G (EHL-WTL-G) distribution is proposed and studied. Some structural properties of the new family of distributions including moments, conditional moments, probability weighted moments, distribution of the order statistics and Rényi entropy are derived. Maximum likelihood estimation technique is used to estimate the model parameters. A simulation study to examine the bias and mean square error of the maximum likelihood estimators is presented and applications to real dataset to illustrates the usefulness of the model are given.

This is joint work with Broderick Oluyede (Botswana International University of Science and Technology).

Special Session In Math Physics II

Maksym Pryporov, Occidental Petroleum Corporation
email: Maksym_Pryporov@oxy.com

Title: Fractional Flow Parameter Optimization

Abstract: Objectives/Scope: The goal of this presentation is to introduce the basic concepts in oil and gas production, such as fractional flow, relative permeability, and water saturation. The fractional flow curve is describing the fraction of oil and water flowing from the oil well and it is depending on multiple parameters. The objective of the project is to develop fractional flow at surface parameter optimization to match the water cut values for New Mexico wells. The algorithm uses production water cut as a target and estimates any combination of the five relative permeability variables as required inputs into the fractional flow at surface method. The optimization method minimizes the non-uniqueness and potential bias associated with a manual solution.

Methods, Procedures, Process: The parameters are initialized within certain ranges by petrophysicists. The rate of change of the fractional flow depends on the parameter values which makes it possible to apply the gradient method. The dependencies between the parameters and fractional flow enable fast convergence to the optimal solution. Different constrains are applied to the optimization process depending on which parameters are optimized. Randomizing initial guess shows consistency in the optimization results. This is used to generate relative permeability curves and the fractional flow at surface curve.

Results, Observations, Conclusions: The user interactive application developed for this algorithm is widely used in petrophysics. The results are consistent across different areas. The fractional flow optimization tool became a part of a larger objective of tying petrophysics to production. A simultaneous optimization for multiple wells is also feasible. The optimization results can be used for water cut projections in other areas.

Novel/Additive Information: The cross-disciplinary approach for this project produced results that exceeded the expectations. Applying gradient method to the real data helped to reduce uncertainties in the reservoir characterization. The designed product is practical for both petrophysicists and reservoir engineers.

Jeffery A. Secrest, Georgia Southern University
email: jsecrest@georgiasouthern.edu

Title: Application of the Maximum Entropy Principle to Transport Phenomena

Abstract: In this presentation, the concept of entropy will be reviewed. The maximum entropy principle is discussed and the applied to a number of transport phenomena described by partial differential equations such as the advection equation, the diffusion equation, and the Fokker-Planck equation. These equations are solved by finding the equations of constraint which can be related to the low- lying moments of the probability distribution functions and the scalar potential if the system is acted upon by external conservative forces. In the end, if these low-lying moments and the potentials can be experimentally measured then the solutions to these equations are known. The gaussian dispersion model of aerosols will be examined within this context.

Manas Bhatnagar, Iowa State University
email: manasb@iastate.edu

Title: Critical thresholds in a nonlocal Euler system with relaxation

Abstract: We propose and study a nonlocal Euler system with relaxation, which tends to a strictly hyperbolic system under the hyperbolic scaling limit. An independent proof of the local existence and uniqueness of this system is presented in any spatial dimension. We further derive a precise critical threshold for this system in one dimensional setting. Our result reveals that such nonlocal system admits global smooth solutions for a large class of initial data. Thus, the nonlocal velocity regularizes the generic finite-time breakdown in the pressureless Euler system. We will also study a one-dimensional 2×2 hyperbolic Eulerian system with local relaxation from critical threshold phenomena perspective. The system features dynamic transition between strictly and weakly hyperbolic.

Yi Hu, Georgia Southern University
email: yihu@georgiasouthern.edu

Title: Sharp estimates on nonlinear Schrödinger equations with rotation

Abstract: In this talk, we aim to introduce some results on the nonlinear Schrödinger equation with rotation. We will provide a sharp threshold result on the global well-posedness, as well as a sharp blowup rate. We may also introduce some blowup results of other types.

Shijun Zheng, Georgia Southern University
email: szheng@georgiasouthern.edu

Title: Construction of Stable Ground States Solutions to NLS Type Equations

Abstract: I shall present a review over recent progress on the existence and stability for nonlinear Schrödinger type equations. Results will be reported concerning the regularity, symmetry and decay properties for the associated ground states solutions.

Solomon Manukure, Florida A&M University
email: solomon.manukure@famu.edu

Title: Solitons, lump and line rogue waves of Nonlinear PDEs in (2+1)-dimensions

Abstract: Nonlinear PDEs have many applications in mathematical physics. They possess many exact solutions such as solitons, rogue waves, lump and breather solutions, which are ubiquitous in fluid mechanics, gas dynamics, optics, plasma physics, atomic physics and many other areas. In this talk, we will discuss some of these exact solutions. We will particularly focus on lump and line-rogue wave solutions of nonlinear PDEs in (2+1)-dimensions which are solvable by the Hirota direct method. Necessary and sufficient conditions for analyticity and rational localization of these solutions will be discussed.

Special Session On Trends In Biomedical Math

Ephraim Agyingi, Rochester Institute of Technology
email: eoasma@rit.edu

Title: Modeling the immune system response to a pathogen infection

Abstract: The immune system response to pathogens is a very complex and well-orchestrated process whose main goal is to keep the host safe and healthy. It is made up two major lines of defense, namely; the innate response and the adaptive response, that are ready to counter any threat. As sophisticated as the immune response is, several pathogens successfully overcome the afforded defenses and infect the host. This paper models the collective response of the immune response to an invading pathogen using a system of two ordinary differential equations. The pathogen density is model using logistic growth while the immune response is modeled as a combination of two components, activation by parasite density and an autocatalytic reinforcement process. Analysis of the equilibriums points of the model for a chosen set of parameter values exhibits different bifurcations, leading to states that are associated with clinical diseases such as leishmaniasis.

Lucia Carichino, Rochester Institute of Technology
email: lcsma1@rit.edu

Title: Modeling Biochemical and Hydrodynamic Interactions in Sperm Motility

Abstract: Sperm are navigating in a complex three-dimensional (3D) fluid environment in order to achieve fertilization. Sperm trajectories vary from planar to helical depending on species, on external fluid properties and on proximity to walls. Biochemical signaling along the sperm flagellum, such as changes in calcium, regulates sperm trajectories and flagellar beat patterns. We present a fluid-structure interaction model of the sperm flagellum 3D motion that accounts for calcium signaling in the flagellum, interactions with a planar wall, and sperm-sperm interactions. The fluid is modeled as a Newtonian viscous fluid and the flagellum is modeled as an elastic rod with preferred curvature and twist, using the Kirchhoff rod model. The fluid-structure interaction problem is solved using the regularized Stokeslets method, and the effect of a planar wall is implemented via the method of images. The calcium dynamics, represented as a reaction-diffusion model on the moving flagellum, is coupled to the sperm motility via the flagellum curvature. Model results of 3D emergent waveforms and trajectories are compared to the planar case, and to experimental data.

Blessing Emerenini, Rochester Institute of Technology
email: boesma@rit.edu

Title: Epidemic patterns associated with superspreading events in stochastic models

Abstract: The importance of host transmissibility in disease emergence has been demonstrated in historical and recent pandemics that involve infectious individuals, known as superspreaders, that are capable of transmitting the infection to a large number of susceptible individuals. To investigate the impact of superspreaders on epidemic dynamics, we formulate deterministic and stochastic models that incorporate differences in superspreaders versus nonsuperspreaders. In particular, continuous-time Markov chain models are used to investigate epidemic features associated with the presence of superspreaders in a population. We parameterize the models for two case studies, Middle East respiratory syndrome (MERS) and Ebola. Through mathematical analysis and numerical simulations, we find that the probability of outbreaks increases and time to outbreaks decreases as the prevalence of superspreaders increases in the population. In particular, as disease outbreaks occur more rapidly and more frequently when initiated by superspreaders, our results emphasize the need for expeditious public health interventions.

Kimberly Dautel, Rochester Institute of Technology
email: kad1338@rit.edu

Title: Modeling education campaign impact during an Ebola outbreak

Abstract: Public health education has an important role in the prevention and control of emerging infectious diseases. During an Ebola outbreak within a community, it is imperative that the population is informed about the modes of transmission and is compliant with efforts to limit the intensity and duration of the outbreak. In this talk, we present a compartmental model that includes an education campaign and incorporates direct transmission from infectious, hospitalized, and deceased individuals with Ebola to susceptible individuals. We analyze the impact that the education campaign has on the community during an Ebola outbreak. Additionally, we compare our model to the results of the 2014-2016 Ebola outbreak in West Africa as well as the 2018-2020 Ebola outbreak in the Democratic Republic of Congo.

Miranda I. Teboh-Ewungkem, Lehigh University
email: mit703@lehigh.edu

Title: Mathematics and the Malaria Problem: Understanding the Within-Mosquito Parasite Dynamics and Possible Exploitation for Transmission Blocking Vaccines

Abstract: Malaria is a complex disease involving three interacting populations: The Plasmodium parasites, the agents that cause the disease; the female Anopheles mosquitoes, the agents responsible for spreading the parasite and hence malaria from human to human; and the humans, trying to stay healthy!!!! Part of the parasite's life cycle, the asexual part, is spent in humans while the sexual part is spent in mosquitoes. Successful transmission of the parasite to humans requires that a susceptible female mosquito feed on two distinct humans – one infected with the parasite and the other susceptible, at two distinct sequential time points. In addition, the parasite must be in its transmissible form in the mosquito at the latter feeding. The bottlenecks involved in the process illuminates how the parasite, driven by the need to survive, has captured the evolutionary and reproductive needs of the mosquito to ensure the parasite's survivability. Mathematics has been used to understand this transmission dynamics especially in situations where it might be challenging biologically. In this talk, I will present the first ever mathematical model of the within-mosquito life-cycle component of P. falciparum parasites which accounts for the developmental stage transformations of the parasites from ingested gametocytes (forms of the parasite transmitted from humans to mosquitoes) to the formation of sporozoites, parasite forms transmitted from mosquitoes to humans. The model will consider the action and effect of blood resident human-antibodies ingested by mosquitoes during a blood meal, in inhibiting gamete fertilization. Model analysis and simulations will be used to explore the question of whether it is possible to control and limit the development of oocysts, precursors of the sporozoites, and hence sporozoite development within a mosquito by boosting the efficiency of antibodies that can be ingested during a blood meal, as a pathway to the development of transmission-blocking vaccines.

Dawit Denu, Georgia Southern University
email: ddenu@georgiasouthern.edu

Title: Existence of traveling wave solutions of a deterministic vector-host epidemic model with direct transmission

Abstract: Vector-borne diseases have continued to be one of the most challenging threats to human health. As a result, health officials and the World Health Organizations have devoted several resources to educate populations on safety measures which prevent the spread of infectious diseases. In this talk, we will consider an epidemic model with direct transmission given by a system of nonlinear partial differential equations and study the existence and non-existence of traveling wave solutions. In particular, we will introduce the basic reproduction number R_0 of the epidemic model and show that if $R_0 < 1$, then there is no nontrivial traveling wave solution. On the other hand, when $R_0 > 1$; we will prove that there is a minimum wave speed c^* such that the system has a traveling wave solution with speed c connecting both equilibrium points for any $c \geq c^*$. Finally, the biological interpretations of c^* will also be discussed and some numerical simulations will be presented to support the theoretical findings.

This is joint work with Sedar Ngoma (State University of New York at Geneseo) and Rachidi B. Salako (Ohio State University).

Omotomilola Jegede, Old Dominion University
email: ojege001@odu.edu

Title: On a SVEIRS Markov chain epidemic model with multiple discrete delay times and sensitivity analysis to determine vaccination effects

Abstract: A novel discrete time general Markov chain SEIRS epidemic model with vaccination is derived and studied. The model incorporates finite delay times for disease incubation, natural and artificial immunity periods, and the period of infectiousness of infected individuals. The novel platform for representing the different states of the disease in the population utilizes two discrete time measures for the current time of a person's state, and how long a person has been in the current state. Two sub-models are derived based on whether the drive to get vaccinated is inspired by close contacts with infectious individuals or otherwise. Sensitivity analysis is conducted on the two models to determine how vaccination affects disease eradication.

This is joint work with Chinmoy Rahul (University of Calgary) and Divine Wanduku (Georgia Southern University).

Noah Hallman, Georgia Southern University
email: nh02322@georgiasouthern.edu

Title: Modeling COVID-19 with Discrete-Time Markov Chains

Abstract: According to the WHO, globally, as of March 5, 2021, Coronavirus Disease 2019 (COVID-19) has infected over 115 million people, caused over 2.5 million deaths and widespread economic downturn. In this talk, we present our modeling, numerical simulation, and analysis of the stochastic dynamics of COVID-19 in a closed population that is considered the starting point of the outbreak of the disease. We present two COVID-19 epidemic models for the population, where at any given time an individual can be in any of the following categories: susceptible, exposed and mildly infectious, asymptomatic and infectious, symptomatic and infectious, symptomatic hospitalized and infectious, recovered with partial immunity, or deceased from disease related causes. Both models are discrete-time Markov chain (DTMC) models with multino-

mial transition probabilities. Using CDC data on daily infection rate for the state of Georgia, we attempt to fit the model to data using multiple linear regression and conduct sensitivity analysis on a selected stochastic model to determine the effects of varying disease parameters on the dynamics of the epidemic. The results from this work highlight the importance of applying statistical and stochastic methods to understand and control COVID-19 dynamics in a population.

This is joint work with Divine Wanduku (Georgia Southern University).

Special Session On Topics Related To Undergraduate Research I

Tim Eller, Georgia Southern University
email: te02816@georgiasouthern.edu

Title: Roots of t-fold Reciprocal Polynomials

Abstract: A reciprocal polynomial is one with palindromic coefficients. They have the interesting property that their zero sets are invariant under the taking of inverses. They can also be reduced in a way to polynomials of lesser degree. If it so happens that the reduced version of a reciprocal polynomial is again a reciprocal polynomial, then the original polynomial is called 2 fold reciprocal. A general t fold reciprocal polynomial is defined recursively with the same pattern. In this presentation, invariance properties of t fold reciprocal zero sets are discussed.

Mark Budden, Western Carolina University
email: mrbudden@wcu.edu

Title: An Excursion into Ramsey Theory: the Study of Set Partitions

Abstract: The subject of Ramsey theory builds on the foundational work of Frank Ramsey, in which he proved that once a set is large enough, certain collections of its subsets have predictable properties. This talk will focus on several different topics in Ramsey theory, concerning partitions within graphs and hypergraphs, sets of integers, and even geometric constructions. We will consider the interconnected nature of these seemingly distinct topics and the role Ramsey's theorem plays in each case.

Jared Schlieper and Michael Tiemeyer, Georgia Southern University
emails: jschlieper@georgiasouthern.edu, mtiemeyer@georgiasouthern.edu

Title: ALG Grants

Abstract:

Special Session On Topics Related To Undergraduate Research II

Frank Patane, Samford University
email: fpatane@samford.edu

Title: Sums of Squares and Beyond

Abstract: We begin our discussion with the question of "Which integers are represented by a sum of two squares?". This question falls under the category of "representations by quadratic forms", and we will take a leisurely stroll through this area of number theory. Although we will not be able to consider all details, we will see many of the "main attractions", and visit both old and new questions concluding with a look at current research. Our discussion will be self-contained and accessible to all undergraduate math majors.

Duc Huynh, Georgia Southern University
email: dhuynh@georgiasouthern.edu

Title: Easter eggs in mathematics

Abstract: We will talk about various easter eggs in mathematics, some are well-known, and some are slightly obscure. We will discuss both some history and mathematics behind various mathematicians.