Schedule of Contributed Talks

† denotes an undergraduate presenter, ‡ denotes a graduate student presenter

Friday

	YGCU 221	YGCU 222
2:00	Rhiannon Maynes† *The Committee Size Paradox in Three Candidate Elections*	Nalin Fonseka *Symmetry of positive steady states for an ecological model*
2:25	Charles Munter *Missouri secondary mathematics educators' perceived challenges of teaching mathematics*	Blake Ricketson† *A Weak Allee Growth Model Arising in Mathematical Ecology*
2:50	Hope Peck† *Straightening Identities in the Onsager Algebra of sl_4*	Tong Si‡ *A Novel Pearson-like Scaled-Bregman Divergence for Multivariate Time Series Change-Point Detection*
3:15-3:30	Break	Break
3:30	Ellesa Henning† *Cheating at the Card Game War*	Kieran Favazza† *Denseness of Canonical Algebraic Curvature Tensors and a Revision to the Signature Conjecture*
3:55	David McCune *Some examples of wacky single transferable vote elections*	Taylor Harrison *Statistics simulations for the classroom: From hands-on to computers*
4:20		Kevin Anderson *Let's talk about Euler's formula ($V - E + F$)*

Saturday

	YGCU 221	YGCU 222
9:10	Jennifer Whitley *Faculty Actively Fostering a Sense of Belonging to the College Mathematics Classroom Community*	Kayode Ayinde *Adopting Voting Technique to Choosing the Most Representative Average of Numerical Data Sets*
9:35	Lori McCune *TILTing Introductory Statistics*	Brody Johnson *Compressive Sensing and the Discrete Cosine Transform*
10:00	R. Lauren Miller *Math and Literature*	Yunge Wang‡ *Teaching for the First Time as an International Student*
10:25	Abraham Pascoe‡ *Local cohomology modules and simplicial homology*	Sydney Bement‡ *The Mathematics Behind the Inverse Conductivity Recovery Problem in Electroencephalography*

Abstracts

Kevin Anderson **Missouri Western State University**

Let's talk about Euler's formula $(V - E + F)$

In this talk we will explore topological invariant Euler's formula (V - E + F = ?) for 3D surfaces.

Kayode Ayinde*, Brian Haile **Northwest Missouri State University**
Taylor Harrison, and David Vlieger

Adopting Voting Technique to Choosing the Most Representative Average of Numerical Data Sets

The mode has been identified as an average which is most representative of a data set. Its non-existence and lack of uniqueness in a data set have made it to become less useful in research work. In the paper effort is made to overcome these challenges by adopting voting technique to choosing the most representative average (MRA) of a data set. More advantageously, the technique provides equal opportunity for all the averages to compete and be voted for by all the subjects as their representative; and thereafter, whichever average is popular, having the highest number or percentage of votes, is declared the winner, and therefore generally accepted as the most representative. Thus, every data set is free to identify its MRA. The educational data sets based on Mean SAT Scores of all the states in United State of America (USA) collected from National Center for Education Statistics (`https://nces.ed.gov/programs/digest/d19/tables/dt19_226.40.asp`) for a period of six years (2017-2022) were used to illustrate the technique. Results show that the MRA is not necessarily the mode as there are other averages including the Lehmer Mean, median, and the mid-range that are identified as the MRA. Furthermore, when the mode does not exist, any of other averages can be the MRA; and when it does exist but not unique, the best among the modes can easily be identified. In conclusion, the paper recommends the use of voting technique in deciding the MRA as it allows each subject in a data set to assess how well it is being measured by all the averages and to take a positive decision on only the one that provides its best representation.

Benjamin Barros and Brody Johnson* **Saint Louis University**

Compressive Sensing and the Discrete Cosine Transform

The presentation is based on a joint work with a recent master's student. The talk will include an introduction to compressive sensing, an area of mathematics that focuses on the representation and recovery of sparse vectors using a small number of linear measurements. The main result describes a sparse recovery algorithm based on the discrete cosine transform, which is an analog to an existing algorithm employing the discrete Fourier transform.

Sydney Bement **Saint Louis University**

The Mathematics Behind the Inverse Conductivity Recovery Problem in Electroencephalography

In this talk, we will be exploring the mathematics behind inverse problems and then delving into some partial differential equations that relate to electroencephalography. Problems in mathematics are either well-posed or ill-posed. We will start by expanding our knowledge of well-posedness and then developing a notion of ill-posedness. After a notion has been developed surrounding ill-posed problems, we will be introduced to electroencephalography and what ill-posed problems are present in regard to this medical test.

Kieran Favazza **Saint Louis University**

Denseness of Canonical Algebraic Curvature Tensors and a Revision to the Signature Conjecture

Algebraic curvature tensors generalize the notion of the Riemann curvature tensor at a single point on a manifold. By studying algebraic curvature tensors over a vector space in their own right, one can gain insight into local properties about curvature on manifolds and how curvature tensors with such properties can be realized. Distinguishing algebraic curvature tensors is a principal problem in this work. In particular, we investigate certain invariants of algebraic curvature tensors and revise a conjecture that attempts to create a strong invariant. Further, we describe the denseness of certain canonical algebraic curvature tensors and analyze how denseness impacts their overall structure.

Nalin Fonseka and Blake Ricketson* **University of Central Missouri**

A Weak Allee Growth Model Arising in Mathematical Ecology

We study positive solutions to the ecological model of the form:

$$\begin{cases} -u'' = \lambda f(u); \ (0,1) \\ u(0) = u(1) = 0 \end{cases}$$

where λ is a positive parameter representing the patch size, and $f(u) = -au^3 + bu^2 + u$ where a and b are positive parameters. This type of reaction-diffusion equation specifically models a population living in a habitat surrounded by a hostile exterior region (matrix). In it, our reaction term, $f(u) = -au^3 + bu^2 + u$, exhibits a Weak Allee growth of the population in the habitat. This means the per-capita growth rate, $\frac{f(u)}{u}$ is increasing at smaller population densities and decreasing at larger ones. The variable u represents the population density that is a function of the spatial variable x. In our model, the matrix is extremely hostile, to the point that the population on the boundary has a density of zero. In this study, we discuss the existence of a Weak Allee effect for any choices of a and b as well as the structure of positive steady states using a quadrature method. Specifically, we discuss the bifurcation curve modeling this scenario. Lastly, we look at the variation of the Weak Allee effect region length with respect to the parameters a and b.

Nalin Fonseka*, **Ratnasingham Shivaji** **University of Central Missouri**
Quinn Morris, Byungjae Son, and Jerome Goddard

We study the symmetry positive solutions to the steady state reaction diffusion equation:

$$\begin{cases} -u'' = \lambda u(1-u); \ (0,1) \\ -u'(0) + \gamma\sqrt{\lambda}[(A-u(0))^2 + \epsilon]u(0) = 0 \\ u'(1) + \gamma\sqrt{\lambda}[(A-u(1))^2 + \epsilon]u(1) = 0. \end{cases}$$

where u is the density of the population, λ is a domain scaling parameter, γ is a measure of the exterior matrix hostility, and $A \in (0,1)$ and $\epsilon > 0$ are constants. The boundary condition here represents a case when the dispersal at the boundary is U-shaped. In particular, the dispersal is decreasing for $u < A$ and increasing for $u > A$. We discuss the existence and multiplicity of positive steady states for this model and conditions under which positive solutions of this model are symmetric. Further, we will provide detailed bifurcation diagrams for symmetric and non-symmetric positive solutions and their evolution as the hostility parameter γ varies.

Taylor Harrison **Northwest Missouri State University**
Statistics simulations for the classroom: From hands-on to computers

A series of statistics activities that can be used in the introductory statistics classroom will be presented. Each of the activities starts with hands-on simulations before progressing to computer-based simulations. These activities are meant to build conceptual understanding of topics such as p-value, sampling distributions, and the central limit theorem.

Ellesa Henning **William Jewell College**
Cheating at the Card Game War

My professor's kid cheated at the card game War, but it wasn't clear if his method was actually effective. We evaluated his tactics with Monte Carlos simulations, implemented in python3. We tested his tactics against different variations of card decks and methods of playing and found his method to be advantageous across all variations.

Rhiannon Maynes **William Jewell College**
The Committee Size Paradox in Three Candidate Elections

As more jurisdictions across the U.S. look to use ranked choice voting (RCV) in elections, some researchers have begun to give RCV a harder look. We investigate a specific example anomaly that can occur within RCV single transferable vote (STV) elections. In these cases, the winner of a one seat election does not win if there are instead two seats available. We examine elections with 3 candidates, looking at both impartial culture and impartial anonymous culture, and using a combination of empirical and theoretical data to determine how often this phenomenon occurs under those conditions.

David McCune **William Jewell College**
Some examples of wacky single transferable vote elections

I'll present some funny examples of multiwinner single transferable vote (STV) elections which I found as part of a large project involving data mining of ranked choice ballot data. For example, in one election candidate Alan Jack won a seat on a local government council, but if we had given Jack one more first-place vote then he would not have won a seat. These kinds of strange electoral outcomes are possible when using the method of STV, which sometimes behaves irrationally in response to small perturbations of the ballot data.

Lori McCune **Missouri Western State University**
TILTing Introductory Statistics

Transparency in Learning and Teaching (TILT) has been shown to increase student success in individual courses and improve their persistence in college. In this talk, I will share my experience as part of a pilot group of 4 faculty members across disciplines who embedded the TILT framework in our introductory courses. I will discuss how I implemented TILT in Introductory Statistics using Canvas and Pearson MyLab and discuss preliminary results.

R. Lauren Miller **Saint Louis University**
Math and Literature

There are many children's books and graphic novel's about math and mathematicians. But how "mathy"are they? In this talk I will present a sample of books that cover concepts from algebra, topology, non-euclidian geometry, calculus, discrete structures and more. I will also discuss the

seminar course I designed to teach them and how you can work this nontraditional math texts into your coursework.

Charles Munter **University of Missouri-Columbia**
Missouri secondary mathematics educators' perceived challenges of teaching mathematics

In fall 2023, a random sample of 100 non-charter, public middle or high school mathematics teachers in Missouri were surveyed regarding their perceived challenges in teaching mathematics. The results revealed widespread concern about the effects of standardization, including the number of standards teachers are expected to "cover" in a year; students' preparedness for the current grade/class in which they are enrolled; and the negative effects of standardized testing. A strong majority connected standardized testing to reduced instructional time (84%), over-emphasis on test preparation (93%), and prioritizing performance over learning (93%). Fewer than one-fifth agreed that standardized testing helps improve learning opportunities, achievement, or equity. Respondents also weighed in about the secondary mathematics curriculum. About two-thirds said the traditional algebra 1-geometry-algebra 2 sequence creates a barrier for some students and should be reconsidered (e.g., more statistics or data science instead). Three quarters agreed that the traditional algebra 2 course should be optional. Most alarmingly, during a time of "teacher shortage," a majority (60%) reported seriously contemplating leaving the profession, and were significantly more likely to do so if they reported (a) experiencing the number of standards as a challenge; (b) a greater focus on student outcomes in their district than on equity or student experiences; or (c) insufficient time for supporting students in understanding and critiquing the world through mathematics and/or experiencing the wonder, joy, and beauty of mathematics. This presentation will invite Missouri mathematicians to consider the implications of these findings for mathematics education at all levels in the state.

Abraham Pascoe* **and Emily Witt** **University of Kansas**
Local cohomology modules and simplicial homology

In this talk, we will discuss the local cohomology modules of a ring R with respect to an ideal I of R. The vanishing of local cohomology modules has a rich research history as it helps to determine useful properties about a ring such as dimension and depth. Cohomological dimension of R in I is defined as the maximum index such that the local cohomology module is nonzero. A classical problem in local cohomology is determining when cohomological dimension is bounded by the depth of R/I. I will define a family of simplicial complexes whose simplicial homology determines the vanishing of local cohomology modules. In particular, I provide a way to calculate the cohomological dimension and in some cases relate it to the depth of R/I.

Hope Peck **William Jewell College**
Straightening Identities in the Onsager Algebra of sl_4

In this work, we prove straightening identities in the Onsager Algebra for $\mathfrak{sl}_4$. Lars Onsager was a Nobel Prize-winning physical chemist and theoretical physicist who introduced the Onsager Algebra. Broadly, the Onsager algebra is a Lie algebra, which is a vector space with a Lie bracket. We define the Onsager Algebra for $\mathfrak{sl}_4$ as the subalgebra of the loop algebra of $\mathfrak{sl}_4$, which is fixed by the Chevalley involution.

The commutative property is not applicable to this Lie algebra. Straightening identities are reordering formulas within the Lie algebra. These identities can be used to formulate linear combinations of the products of the basis elements into a preferred order. Doing so offers a tool for understanding the representation theory of this algebra in characteristic $p > 0$. We use double induction to prove these straightening identities. We formulate a general straightening identity and

our Onsager algebra straightening identities were applications of our general formula. Our general formula is a special case of the Baker-Campbell-Hausdorff formula that we prove using double induction. To our knowledge of the literature, the general formula has never been proven using this technique of double induction.

Tong Si **Saint Louis University**

A Novel Pearson-like Scaled-Bregman Divergence for Multivariate Time Series Change-Point Detection

Change-point detection (CPD) in multivariate time series data is a challenging problem. It has a number of applications across various real-world domains, and the primary objective of CPD is to identify specific time points where the underlying system undergoes transitions between different states, each characterized by its own distinct probability distribution. Precise identification of change points in time series omics data can provide insights into the dynamic and temporal characteristics inherent to complex biological systems. For example, it can elucidate the mechanisms behind gene regulatory network rewiring during cell cycle progression and shed light on the evolution of disease patterns over time. Many change-point detection methods have traditionally focused on the direct estimation of data distributions. However, these approaches become unrealistic in the context of high-dimensional data due to the curse of dimensionality. Density ratio methods, such as the Kullback-Leibler (KL) importance estimation procedure (KLIEP), unconstrained least-squares importance fitting (uLSIF), and relative uLSIF (RuLSIF), have emerged as promising approaches for change-point detection. This is due to the fact that estimating density ratio is generally easier than directly estimating individual densities. Nevertheless, the divergence measures used in these methods, such as the KL, Pearson, and alpha-relative Pearson divergence, are non-metric measures. Additionally, the KL and Pearson divergence introduce issues related to unboundedness, moreover, the alpha-relative Pearson divergence used in the RuLSIF approach does not measure the dissimilarity between two distributions of data, but mixture of distributions. To overcome the limitations of existing density ratio-based methods, we propose a novel approach called the Pearson-like scaled-Bregman divergence-based (PLsBD) density ratio estimation method for change-point detection. We provide mathematical proof that under certain conditions, the square root of the Pearson-like scaled Bregman divergence can constitute a metric. Our theoretical studies yield an analytical result of the Pearson-like scaled-Bregman divergence using a mixture measure. It further demonstrates that PLsBD exhibits greater sensitivity to changes in time series data compared to the RuLSIF method. This finding is further supported by subsequent data analysis. We integrate the Pearson-like scaled Bregman divergence with a kernel regression model and apply it to identify change points in synthetic time series data and omics data of drosophila during its life cycle from the embryonic, larval, pupal periods, to the adulthood. Our PLsBD method demonstrates superior performance compared to current density ratio estimation methods in multivariate change-point detection.

Yunge Wang **Saint Louis University**

Teaching for the First Time as an International Student.

Most academics offer teaching assistantships to graduate students, which require grading, leading discussions, or even teaching a course independently. Over 450,000 international graduate students are studying in the United States. I have been teaching at SLU for three semesters, being my first teaching experience in my non-native language. This talk will cover my experience as an instructor, especially the preparations and obstacles I have encountered. It will also introduce some suggestions for colleges to prepare international graduate students well for teaching.

Jennifer Whitley **Park University**

Faculty Actively Fostering a Sense of Belonging to the College Mathematics Classroom Community

The session will engage attendees in timely discussion regarding student belonging and engagement in college mathematics. Prior research indicates a high sense of belonging positively impacts student engagement and academic success. As faculty, the learning environment we create and the teaching strategies we employ can either support or diminish students' sense of belonging in our classrooms. The session will include findings from a mixed-methods study on the trajectory of belonging and engagement in student's 100-level algebra course, and what perceived impact the instructional practices and behaviors have on student sense of belonging within the college mathematics classroom community.