
THE • MATHEMATICAL • ASSOCIATION • OF • AMERICA •
MAA - FL
MCMLXVII
FLORIDA SECTION

2025 Joint Meetings

Of The

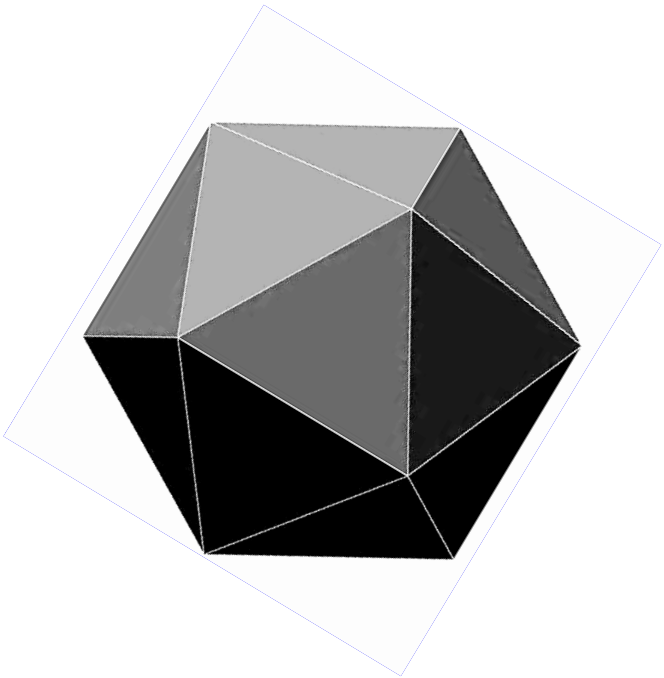
Florida Section

Of The

Mathematical Association of America

And

The Florida Two-Year College Mathematics Association



Embry-Riddle Aeronautical University

February 21-22, 2025

Florida Section of the Mathematical Association of America

2024 – 2025

Section Representative	Monika Kiss, Saint Leo University
President	Chuck Lindsey, Florida Gulf Coast University
Past President	Sean Murphy, Eckerd College
Vice-President for Programs	Anthony Okafor, University of West Florida
Vice-President for Site Selection	Joseph Ours, State College of Florida
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VP for Site Selection-elect	Ala Alnaser, Florida Polytechnic University
Chair of Local Arrangements	Keshav Acharya, Embry-Riddle Aeronautical University

Florida Two-Year College Mathematics Association

2024 – 2025

President	Sidra Van De Car, Valencia College
Past President	Sybil Brown, Lake-Sumter State College
Vice-President for Programs	Mike Long, Polk State College
Secretary	Claire Geiger, State College of Florida
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Webmaster	Altay Özgener, State College of Florida
President-elect	Altay Özgener, State College of Florida
Historian	Robert Shollar, State College of Florida

PROGRAM

Friday, February 21, 2025

FL – MAA

10:00 – 12:00 **FL-MAA Executive Committee Meeting** **SU 428**

FTYCMA

11:00 – 12:30 **FTYCMA Annual Business Meeting** **SU 165B/C**

CONFERENCE

11:00 – 6:00 **Registration and Hospitality Room** **SU 165A**

Please note that for the duration of the conference we have designated **Student Union Room 165A** as the *Hospitality Room* where you can meet with old and new friends. Enjoy the conference! **No password is needed for Guest Wi-Fi: EagleNet**

Building Legend:
SU-Student Union, **COB**-College of Business, **COA**-College of Aviation, **IC**-Instructional Center, **COAS**-College of Arts and Sciences,
(See Map on page 50 of this program)

WELCOME

1:45 – 2:00 **Welcoming Remarks** **SU 165B/C**

Dr. Peter Hoffmann, Dean, College of Arts and Sciences, ERAU
Sidra Van De Car, President, FTYCMA
Chuck Lindsey, President, FL-MAA

2:00 – 2:50 **Plenary Session** **SU 165B/C**

Victor Piercey, MAA Chair of Congress
Ferris State University

Reflections on Interdisciplinary Teaching Partnerships

3:00 – 4:50 **Student Events** **SU 165B**

3:00 – 3:50 **Student Integration Contest**

Put your integration skills to the test! This 50-minute competition will feature integration problems requiring a variety of calculus techniques. Calculators and notes are not allowed. Undergraduate students of any background are welcome to participate, and the top three scores will receive Amazon Gift Cards in addition to being recognized for their achievement.

4:00 – 4:50 Student Problem-Solving Contest

Put your reasoning skills to the test! This 50-minute competition will feature a variety of fun problems spanning the gamut of the field of mathematics. Calculators and notes are not allowed. Undergraduate students of any background are welcome to participate, and the top three scores will receive Amazon Gift Cards in addition to being recognized for the achievement.

3:00 – 3:45 Contributed Papers Session I

Full Session

Anwar Hossain, Vi Nguyen, Asrafi Yesmin (Graduate Students) **COB 216**
University of North Florida

Regression-Based Analysis of the Jacksonville Housing Market

Jorge Gonzalez, Maxime Breden and Jason Mireles-James **COB 125**
Florida Atlantic University

Validated enclosure of renormalization fixed points using Chebyshev expansions

Ruthmae Sears, Aizhan Bakytbek (Graduate Student), Robert Potter, Stephanie Arthur, Alexandro Castellano, and Brandy Jackson **COB 127**
University of South Florida

Enhancing and Transforming STEM Teaching and Learning with Mechatronics

Michael Long **COAS 204**
Polk State College

The Triangle: A Geometric Structure or An Array of Numbers

Session A 3:00–3:20

Frederique Drullion **COAS 203**
Embry Riddle Aeronautical University

Improving student learning in math classes by enabling deliberate reflections through assignment wrapper.

Douglas Pfeffer **IC 103**
University of Tampa

The Bernoulli Triangle and a Dual Dimensional Slicing Problem

Session A 3:00–3:20 (Continued)

Jacob Duncan **COB 118**
Winona State University

Saving the World with Mathematical Modeling: An Introductory Course in Mathematics for Sustainability

Kaitlyn Williams (Undergraduate Student) **IC 203**
University of West Florida

Trajectory Prediction of Rockets using Ballistic Principles and Numerical Methods

Ken Mulzet **COB 119**
Florida State College at Jacksonville

How to Integrate a Differential Equation

Session B 3:25–3:45

Yoon-Seob Kim (Graduate Student) **IC 103**
Embry Riddle Aeronautical University

Finite Difference Method in Richards Equation

Ethan McWhirter (Undergraduate Student) and Ala' Alnaser **IC 203**
Florida Polytechnic University

Exploring the Impact of False Data Injection Attacks on Basic Control Systems for Autonomous Vehicles

Donald McGinn and Ross Belgram **COB 118**
University of West Florida

Hyper Face-Magic Graphs

Ronald Adams **COA 350**
Embry-Riddle Aeronautical University

Well-posedness of a generalized Kuramoto-Sivanshinsky equation

Pitambar Acharya **COB 119**
University of Alabama at Birmingham

On One Dimensional Advection - Diffusion Equation with Variable Diffusivity

4:00 – 4:45 Contributed Papers Session II

Full Session

Sami Hamid **COB 125**
University of North Florida

Four-Dimensional Matrix Convolution in the Space (L1,L1).

Scott Hochwald **COB 127**
University of North Florida

Tales from the Harmonic Series

Carrie Grant **COB 216**
Flagler College

Activities for Bootstrapping, Randomization, & Nonparametric Methods

David House **COAS 204**
University of North Florida

A Practical Application Using Principles Learned in MGF1130/1131 and Microsoft Excel Building a Car Amortization Schedule

Session A 4:00 – 4:20

Kyle Ambrose (Graduate Student) **IC 103**
University of North Florida

Mathematical Problems in Logistics

Milé Krajcevski **COAS 203**
University of South Florida

A picture is worth a1001 words

Tre Hellwig (Graduate Student), Raymond Fleming, Anam Khan, Melanie Sutton, Mark Melissa, Justice Mbizo, Anthony Okafor **COB 118**
University of West Florida

Refocusing Educational Goals Using Generative AI to Improve Statistical Reasoning

Session A 4:00 – 4:20 (Continued)

Kelley Cummings, Sandra Vernon- Jackson, Ruthmae Sears, Chuqian Song (Graduate Students), Keisha Albritton, Alfredo Rodriguez Vera (Graduate Student) **COA 143**
University of South Florida

Building Blocks to Cultivating a Productive Learning Environment in Intermediate Algebra

Spencer Logan (Undergraduate Student) and Aflonso Rodriguez **IC 203**
Florida Polytechnic University

Using the asymptotic homogenization method to determine effective properties of complex dielectric composites.

Session B 4:25 – 4:45

Jenna Bradley, Daniela Genova, and Dennis Perusse **IC 103**
University of North Florida

Organizing Undergraduate Mathematics Conference Series: Successes and Challenges

Kalia Lafferty (Undergraduate Student) and Ala' Alnaser **IC 203**
Florida Polytechnic University

Deriving a Differential Equation Model for Vehicle Dynamics Using Sensor Data and Statistical Methods for Autonomous Vehicle Testing

Michael Carnival (Graduate Student) **COB 118**
University of West Florida

On Wavelet-Based Features for Classifying Functional Data

Nicole Tuovila **COA 350**
University of Central Florida

Direct Interaction Approximation (DIA) for generalized stochastic models in the turbulence problem

Justin Homeier **COA 143**
Florida Polytechnic University

Reconstructing Zero-divisor Graphs with Annihilator Generators

5:00 – 5:45 **Section Representative's Session** **SU 165B**

Monika Kiss
Saint Leo University

What Can the MAA Do for You and What Can You Do for the MAA?

5:00 – 5:50 **Publisher and Sponsor Exhibits** **SU 165A**

Browse the displays of participating publishers and learn about their new textbooks and online platforms. Stop by and thank our sponsors for supporting our conference and students.

5:00 – 5:50 **Graduate Recruitment Fair** **SU 165D**

Students are invited to visit the booths of the participating universities to learn more about their graduate programs.

Participating Institutions include:

University of Florida (UF)
Florida State University (FSU)
University of Central Florida (UCF)
University of West Florida (UWF)
University of North Florida (UNF)
University of South Florida (USF)
Florida Institute of Technology (FIT)
Embry-Riddle Aeronautical University (ERAU)
Florida Atlantic University (FAU)

5:00 – 5:50 **Contributed Posters Session** **SU 165D**

Kyle Ambrose, Blaine DuBois, Ryan Farrell (Graduate Students)
University of North Florida

Mathematical Strategies for a Spinner Game

Anwar Hossain, Vi Nguyen, Asrafi Yesmin (Graduate Students)
University of North Florida

Jacksonville House Prices: A Data-Driven Analysis

Vi Nguyen (Graduate Student)
University of North Florida

The Domination Number of a Graph

5:00 – 5:50 Contributed Posters Session (Continued)

Alexander Wiser (Undergraduate Student)
University of West Florida

A Comparative Analysis of Euler, RK4, and Houbolt Methods for Projectile Motion with Air Resistance

Emmanuel Paalam (Undergraduate Student)
University of West Florida

Predicting Student Dropout with Statistical Machine Learning

FNU Shrishti (Undergraduate Student), **Achraf Cohen**
University of West Florida

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Mathematical Modeling of an Antenna in the 5G RF2 Range

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A Picnic with Newton: Serving Up a Raspberry Pi to Analyze the Mathematical Foundations of Spectroscopy

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Finite Element Spaces of Double Forms

Naya Adla (Undergraduate Student) and Thomas Vogel
Stetson University

Tracking Hate Speech on Twitter among in the Arab Region using Python-Based Tools

Jackson Schuler (Graduate Student)
Embry-Riddle Aeronautical University

Explicit Solver for Hinge-Offset Origami Structures

Bhawana Poudel Devkota (Graduate Student)
Embry-Riddle Aeronautical University

High-Performance Comparison of Gaussian Blur Implementation Using Advanced Computational Techniques

6:00 – 6:50 **Plenary Session** **IC 101**

Opel Jones, MAA NAM Speaker
Johns Hopkins University Applied Physics Laboratory

Pattern Avoidance in Restricted Permutations

7:00 – 8:30 **Dinner Banquet** **SU 165B/C**

8:00 – 9:30 **Movie: *THE COUNTED OUT SCREENING TOUR*** **SU 165B/C**
Presented by Reellink

https://www.eventbrite.com/e/florida-section-mathematical-association-of-america-counted-out-screening-tickets-1216905279449?aff=oddtdtcreator

Saturday, February 22, 2025

8:45 – 9:00 **Welcome back! Registration open** **SU 165B/C**

9:00 – 9:45 **Contributed Papers Session III**

Session A 9:00 – 9:20

Ryan Farrell (Graduate Student) **IC 104**
University of North Florida

How to Teach a Computer Tic-Tac-Toe

Keshav Acharya **IC 102**
Embry-Riddle Aeronautical University

Breimesser-Pearson Theorem for vector-valued discrete Schrodinger operators

Matthew Kimm, Jay Sparks, Brian Le, Gary Marmon, Kelie Kan, and Anthony Okafor **COB 118**
University of West Florida

Components of an Interactive Course Planner

Muhammad Najjar (Graduate Student), Samaraweera Dumindu **IC 103**
Embry-Riddle Aeronautical University

Mitigating Adversarial Attacks in Federated Learning

Shimin Zhang (Graduate Student) **COB 119**
University of South Florida

Risk Incorporated Portfolio Optimization with Deep Reinforcement Learning

Vilmaris Alvarado (Undergraduate Student) **IC 201**
Florida Atlantic University

Group Rings

9:00 – 9:45 Contributed Papers Session III (Continued)

Session B 9:25 – 9:45

John Diller (Graduate Student) **IC 102**
University of North Florida

Polynomial invariants for $GL(n)$

Barrett James McDonald, Kandethody Ramachandran **COB 119**
University of South Florida

Modeling Win Rate in League of Legends for Top Lane and Bottom Lane Champions

Thanh Bui (Graduate Student) **COB 118**
University of West Florida

Modified Linear Failure Rate Odds Ratio Distribution Generator

Greg Spradlin **IC 104**
Embry-Riddle Aeronautical University

An Optimization Problem Arising from Radiation Treatment

Shelletta Baker **COB 127**
Valencia College

*Beyond the Minds of Machines: Design questions that challenge A*I

Vincent Stafford (Undergraduate Student) **IC 201**
Florida Atlantic University

Stuck in Space: An Introduction to Distinguishability

10:00 – 11:45 Workshop Talks and Special Session

Abigail Burrows, Jacci White, and Monika Kiss **COB 214**
Saint Leo University (**Workshop**)

Harnessing Generative AI for R Programming in Introductory Statistics and Linear Algebra

Sirani M. Perera (ERAU), Xianqi Li (FIT), Aaron Welters (FIT) **COB 216**
(**Special Session – 5 Talks**)

State-of-the-art (SOTA) in Classical and Machine Learning (ML) Algorithms and Applications

Special Session-5 Talks (Continued)

Oshani Jayawardane (Graduate student)
Embry-Riddle Aeronautical University

A Low-complexity Hybrid Learning to Decode Algebraic Codes Over a Finite Field

Hansaka Aluvihare (Graduate student)
Embry Riddle Aeronautical University

A Low-complexity Structured Neural Networks Approach in Multibeam Beamforming

Brady Heddon (Undergraduate Student)
Embry-Riddle Aeronautical University

A Low-complexity Image Recognition and Classification Algorithms

Xianqi Li
Florida Institute of Technology

Diffusion Model based Super-resolution for Medical Images

Aaron Welters
Florida Institute of Technology

Monotonicity and Concavity of the Principal Pivot Transform

10:00 – 10:45 Contributed Papers Session IV

Full Session

Ruthmae Sears, Kelley Cummings, Sandra Vernon- Jackson, Chuqian Song (Graduate Student), Keisha Albritton, Alfredo Rodriguez Vera (Graduate Student) **COB 126**
University of South Florida

Facilitating Trauma Informed Instructional Practices to Promote Learning and Sense of Belonging in Developmental Mathematics

Alexander Dranishnikov **COB 125**
University of Florida

Topology of robot motion planning

10:00 – 10:45 Contributed Papers Session IV (Continued)

Jenna Bradley, Dennis Perusse **COB 127**
University of North Florida

From Theory to Play: Bridging Gamification and Math Education with Real-World Examples

Session A 10:00 – 10:20

Bidur Devkota **IC 102**
Embry-Riddle Aeronautical University

A study on estimation of PM2.5 using machine learning and satellite data in the Kathmandu Valley

Kyle Villalobos (Undergraduate Student) **IC 201**
Florida Atlantic University

On Gradient Flow Across Geometric Hierarchies

Deepak Bastola (Graduate Student) **COB 122**
Florida Atlantic University

Forecasting Crime Trends in Chicago: A Time Series Analysis Using SARIMA

Thomas Luckner **COB 127**
Flagler College

d-translated unit sensitive primes

Francis Baffour-Awuah Junior **COB 119**
Florida State University

Modeling Immune Protein Dynamics and their Impact on Host-Pathogen Interactions in Septic Patients

Beyza Aslan **IC104**
University of North Florida

Crocheting Mathematics

Session B 10:25 – 10:45

Liu Yongxin, Marc Jacquet, Yujing Zhou, Faheem Khan, Madison Newell, Robel Dawit, Skyler Fabre, Dev Sarawat, Yongxin Liu — **IC 102**
Embry-Riddle Aeronautical University

Machine Learning for Cyber Attacks

Peter Alspaugh — **COB 119**
University of South Florida

Structures of Monoids Motivated by DNA Origami

Blake Gisclair (Undergraduate Student) — **IC 201**
Florida Institute of Technology

Peek Ensembling

Angela Angeleska and Miranda Serna — **COB 122**
University of Tampa

Algebra in Wonderland

Sabrina Hussain (Graduate Student) — **IC 104**
University of North Florida

Fourier Transformation of Non-Periodic Functions and Its Application in Imaging Science

Kelie Tamini (Graduate Student) — **COB 118**
University of West Florida

Understanding Life Satisfaction vs Salivary pH Through Perceived Stress and Sleep Quality

11:00 – 11:45 Contributed Papers Session V

Full Session

Subhash Bagui — **COB 125**
University of West Florida

The Stirling Numbers of the Second Kind and Their Applications

Chuck Lindsey — **COB 126**
Florida Gulf Coast University

Abandoning dot-age for d-ism in 1820's Cambridge

11:00 – 11:45 Contributed Papers Session V (Continued)

Margaret Byrns **COB 127**
Flagler College

Flipped Classrooms & Engaging Classwork

Dennis Perusse **COB 114**
University of North Florida

A Quiddity-Infused, Sinciput-Overloaded, Ultracrepidarian Ramble Through Mathematical Thought and the Art of Teaching at the Edge of Disarray by a Sesquipedalian Logophile

Session A 11:00 – 11:20

Mohammad Tasrif Khan (MO KHAN) (Graduate Student) **IC 102**
Embry-Riddle Aeronautical University

Mathematical Modeling of Cybersecurity in Space Operations: Optimizing Satellite Network Resilience

Hongliang Wang **COB 119**
University of South Florida

Kolmogorov–Arnold Neural Network in Image Reconstruction Learning

Lei Hsin Kuo **COB 118**
University of West Florida

ALSS, A Convergent Extension of Tikhonov Regularization over Complex Spaces.

Tedi Draghici and Philip Son **COB 122**
Florida International University

Halving Triangular and Trapezoidal-like Pancakes

Abigail Denton (Undergraduate Student) **IC 201**
Stetson University

Primitive Star Decompositions of Complete Graphs

Lindsay Spence **IC 103**
Embry-Riddle Aeronautical University

Using Discrete Fourier Transforms (DFTs) and Fast Fourier Transforms (FFTs) to solve the Quantum Mechanics Wave Equation

Session A 11:00 – 11:20 (Continued)

Bernadette Mullins, Jared Bunn, and Satyajith Boyana, Justin Hoffmeier, and Dipali Swain **IC 104**
Florida Polytechnic University

Inter-rater reliability of rubric scoring in a multi-section course

Session B 11:25 – 11:45

Matthew Chin and Carina Shanahan **IC 102**
Embry-Riddle Aeronautical University

Parallelizing the Finite Difference Method for Solving a 2-Dimensional Wave Equation

Terje Hill **COB 119**
Florida Atlantic University

How Group Work and LAs Transformed My Calculus Class

Alberto Domínguez (Graduate Student) and Shusen Pu **COB 118**
University of West Florida

The Regime-Switching Merton Jump-Diffusion Model and Volatility Smile Fitting

Mozhgan (Nora) Entekhhabi **COB 122**
Florida A&M University

Inverse Source Problems for Wave Propagation

Michael Schroeder **IC 104**
Stetson University

Primitive cycle decompositions of graphs

Yuanchang Sun **IC 103**
Florida International University

Structure Constrained Nonnegative Matrix Factorizations: Convergence and Computation

Celeb Stewart (Undergraduate Student) **IC 201**
Florida State University

Image Segmentation via Role Extraction with Neighborhood Pattern Similarity Measure

12:00 – 12:50 Contributed Posters Session **SU 165D**

Kyle Ambrose, Blaine DuBois, Ryan Farrell (Graduate Students)
University of North Florida

Mathematical Strategies for a Spinner Game

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Florida Institute of Technology

Finite Element Spaces of Double Forms

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Embry-Riddle Aeronautical University

High-Performance Comparison of Gaussian Blur Implementation Using Advanced Computational Techniques

12:00 – 12:50 Graduate Recruitment Fair **SU 165D**

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Florida State University (FSU)
University of Central Florida (UCF)
University of West Florida (UWF)
University of North Florida (UNF)
University of South Florida (USF)
Florida Institute of Technology (FIT)
Embry-Riddle Aeronautical University (ERAU)
Florida Atlantic University (FAU)

1:00 – 1:50 Plenary Session **SU 165B/C**

Shusen Pu, FL State Speaker
University of West Florida

Decoding Neural Dynamics Using Machine Learning

1:50 – 2:00 Closing Remarks **SU 165B/C**

Sidra Van De Car, President, FTYCMA
Chuck Lindsey, President, FL-MAA

2:10 – 3:30 Luncheon, Award Ceremony and FL-MAA Business Meeting **SU 165B/C**

ABSTRACTS

Contributed Papers Session I

Full Session

Anwar Hossain, Vi Nguyen, Asrafi Yesmin (Graduate Students) - University of North Florida

Regression-Based Analysis of the Jacksonville Housing Market

This study applies linear and non-linear regression to analyze and predict the housing market in Jacksonville, Florida. Linear regression examines the relationship between house prices and key factors, while non-linear regression enhances predictive accuracy. The goal is to provide valuable insights for buyers, sellers, and policymakers.

Jorge Gonzalez, Maxime Breden and Jason Mireles-James - Florida Atlantic University

Validated enclosure of renormalization fixed points using Chebyshev expansions

We develop a general framework for proving existence, isolation, and stability results for real analytic fixed points of m-th order Feigenbaum-Cvitanović renormalization operators. The universality properties associated to the fixed points, first discovered by Feigenbaum for m=2 in the context of population dynamics, describe different routes to chaotic behavior in multiple contexts in Mathematics and the physical sciences. We demonstrate the advantages of using Chebyshev expansions for a general approach in this case where the domain of analyticity of the fixed points has a fractal shape enclosing the real and imaginary axis. We present results for renormalization fixed points of order m=3 through order 10, and of high critical degree at the origin. Moreover, we reprove the existence of the classical m=2 Feigenbaum renormalization fixed point, and compute its universal constants up to 500 correct decimal digits.

Ruthmae Sears, Aizhan Bakytbek (Graduate Student), Robert Potter, Stephanie Arthur, Alexandro Castellano, and Brandy Jackson - University of South Florida

Enhancing and Transforming STEM Teaching and Learning with Mechatronics

This presentation will provide insights into how the NSF-funded project "Mechatronics Integrated into STEM Teaching for Transformative Inclusive Communities (MISTTIC)" is designed to support the integration of mechatronics into STEM learning environments. Mechatronics applications in STEM education can promote problem-solving, modeling, reasoning, and computational thinking skills. Furthermore, it can catalyze students' interests in pathways to STEM disciplines and promote their engagement and understanding of how applications of mechatronics can address the needs of industry and the community, as well as promote sustainable development. Thus, we will provide an overview of the project goals and accomplishments and reflect on paths forward.

Michael Long - Polk State College

The Triangle: A Geometric Structure or An Array of Numbers

To many, the triangle is a geometric structure, but to a number theorist and others in the field of mathematics, it can be an interesting array of numbers. In this session, we explore the unique properties of triangular arrays of numbers (Pascal, Bernoulli, and Katie… you might now know that one just yet) and how these properties are shared, related, and different

Session I-A

Frederique Drullion - Embry Riddle Aeronautical University

*Improving student learning in math classes by enabling deliberate reflections through assignment wrapper***.**

To enhance student reflection and assignment preparation, several instructors introduced "assignment wrappers" in their courses. These post-assignment quizzes focused on test preparation, study habits, and concept comprehension, encouraging students to reflect, assess, and adjust their study strategies. The outcomes were analyzed from three perspectives: students, faculty, and the department. For students, this mandatory reflection fostered accountability, leading some to improve their grades and understanding. Faculty gained insights into student study methods and challenging concepts, enabling them to offer additional resources. At the departmental level, the widespread adoption of assignment wrappers sparked valuable discussions and resource allocation, such as tutoring and review sessions. The project was assessed through one-on-one discussions between the Center for Teaching and Learning Excellence (CTLE) and faculty, mid-term feedback from students, and additional questions in the end-of-semester student survey.

Douglas Pfeffer - University of South Tampa

The Bernoulli Triangle and a Dual Dimensional Slicing Problem

The Bernoulli Triangle is the triangle formed by taking partial sums of the classical Pascal's Triangle. It is well-known that specific paths through the Bernoulli Triangle count the number of regions into which dimension-j space is cut into when sliced by n hyperplanes of dimension j-1. We introduce a 'Dual Pascal Triangle' whose coefficients are given by multi-set coefficients instead of binomial coefficients. We show that the same paths through the associated 'Dual Bernoulli Triangle' answer a geometrically dual question. Specifically, they count the number of codimension-j objects (i.e. points) when dimension j space is sliced by n+j hyperplanes of dimension j-1. This is joint work with Matthew German at the California Institute of Technology and Keith Copenhaver at Eckerd College.

Jacob Duncan - Winona State University

Saving the World with Mathematical Modeling: An Introductory Course in Mathematics for Sustainability

Some of the biggest challenges facing humanity today stem from issues surrounding unsustainable environmental, social, and economic practices. The need to address the ramifications of these issues from a STEM perspective is greater than ever. This talk centers around a recently developed course called Mathematics for Sustainability which applies an array of mathematical concepts and tools to quantitatively explore real-world, topical problems and data pertaining to sustainability. Topics are motivated by engaging hands-on experiences, e.g., experiments, demonstrations, and outdoor data collection excursions. This introductory course is designed primarily for undecided or non-STEM majors with the intent of sparking interest in the usefulness of mathematical modeling in solving the world's pressing environmental, social, and economic problems.

Kaitlyn Williams (Undergraduate Student) - University of West Florida

Trajectory Prediction of Rockets using Ballistic Principles and Numerical Methods

The Ballistic Equations of Motion (EOMs), which describe the motion and orientation of a projectile, remain open and have never been solved due to their complexity, nonlinearity, and the degree of variation of their parameters.
This report uses Euler's methods to discretize the differential EOMs, then apply numerical methods (such as Newton's method) to linearize the nonlinear system raised at each time step and plot the trajectories of three projectiles (the Sierra 168 bullet, the single-stage Scud A [R-11 Zemlya] rocket, and the multi-stage Falcon 9 rocket) for a bullet and single-stage rocket, systematically creating a stable algorithm capable of mapping the trajectory of a multi-stage rocket with relatively large time steps and little computing time. This report also proposes a "delayed-term reduction method" and finds that it is stable and accurate compared to other methods, while being simpler to derive than Newton's method.

Ken Mulzet -Florida State College at Jacksonville

How to Integrate a Differential Equation

In any introductory differential equations course, the student is exposed to the method of integrating factors. This method is used to solve a differential equation of the form
In this talk, we will discuss ways to use the same method to solve higher-order linear differential equations with both constant and variable coefficients, as well as first-order systems of differential equations with both constant and variable coefficients. Several examples of each solution technique will be presented, and all methods can be generalized to higher-order equations and systems as well.

Session I-B

Yoon-Seob Kim (Graduate Student) - Embry Riddle Aeronautical University

Finite Difference Method in Richards Equation

Richards equation is an important equation in earth science that could help model landslides. The equation is a non-linear partial differential equation with boundary conditions. This project investigates the equation in cylindrical coordinates. However, using Kirchhoff Integral Transform, we could transform it into a functionally linear equation and apply finite difference method to approximate the solution by bounding the functional coefficients. We will be using computer codes to find the solutions and stability of each forward, backward, and central difference method. However, numerical solutions have been found but verification of stability could not be shown in this project.

Ethan McWhirter (Undergraduate Student) and Ala' Alnaser - University of North Florida

Exploring the Impact of False Data Injection Attacks on Basic Control Systems for Autonomous Vehicles

Autonomous vehicles (AV) and Advanced Driver Assistance Systems (ADAS) rely on control systems that process sensor data to maintain stability and performance. False Data Injection (FDI) attacks disrupt this data, introducing erroneous inputs that can destabilize the system. Using mathematical modeling and analysis, we study a simplified AV control system model to learn how these stochastic perturbations influence critical parameters. The study employs tools from linear algebra, stochastic processes, and differential equations to simulate and analyze the dynamics of the control system under various FDI attack scenarios.

Donald McGinn and Ross Belgram - University of West Florida

Hyper Face-Magic Graphs

For a planar graph G of order n whose vertices are distinctly labeled by elements from the set {1, 2, ... n}, we define the face-value of each face to be the sum of the labels of its boundary vertices. The graph is said to be hyper face-magic if there exists a vertex labeling such that the face-value of each face is equal. In this talk, we state various properties of hyper face-magic graphs and construct several classes of hyper face-magic graphs.

Ronald Adams - Embry-Riddle Aeronautical University

Well-posedness of a generalized Kuramoto-Sivashinsky equation

In this paper we study the generalized Kuramoto-Sivashinsky equation. The Kuramoto-Sivashinsky equation arises in a variety of applications, among which are modeling reaction-diffusion systems, flame-propagation and viscous flow problems. We show that such equations are well-posed, thus admitting a unique smooth solution, continuously dependent on its initial data.

Contributed Papers Session II

Full Session

Sami Hamid - University of North Florida

Four-Dimensional Matrix Convolution in the Space (L1,L1).

This talk investigates the algebraic structures of four-dimensional matrices in the space (L1,L1) under convolution, characterizing the sum-preserving subclass (L1,L1; P) and establishing that (L1,L1) forms a Banach algebra under convolution. The main result is a Mercerian-type theorem establishing conditions under which the absolute summability of a double sequence implies the absolute summability of a related double sequence under certain convolution transformations. This work extends classical results to higher dimensions, offering new insights into the interplay between matrix transformations and sequence spaces.

Scott Hochwald - University of North Florida

Tales from the Harmonic Series

I will present a collection of my favorite facts about the harmonic series, including truncations and decimations, with mathematical motivations and a few insightful proofs.

Carrie Grant - Flagler College

Activities for Bootstrapping, Randomization, & Nonparametric Methods

At Flagler College, a two-semester sequence of statistics is offered. The first course is required for all students at the college while the second course is designed for those students majoring in natural or social science. In the second course, bootstrapping, randomization, and other nonparametric techniques are presented and discussed. Outside of class, students are expected to read the textbook sections and watch a short introductory video while completing guided notes. In class, students work through well designed activities to foster a deeper understanding of the content. Active learning techniques are used to engage the students in the material. In this talk, activities designed to explore bootstrapping, randomization, and other nonparametric techniques using StatCrunch will be shared. Course content, course content, and scheduling will also be discussed.

David House - University of North Florida

A Practical Application Using Principles Learned in MGF1130/1131 and Microsoft Excel
Building a Car Amortization Schedule

This is a great project that explores the use of Microsoft Excel for constructing a car loan amortization schedule, providing a step-by-step guide to effectively manage and analyze loan repayment structures. The primary objective is to demonstrate how Excel's built-in functions can be applicable to the material being taught in a course such as MGF1130 or the like. By leveraging Excels capabilities in accordance with the financial math equations presented in the course, we can calculate monthly payments, interest, and principal components over the life of a loan. We also discuss how to research interest rates in relation to credit scores to have a realistic understanding of the loan's progress and impact each has over the life of the loan. This lecture includes a practical case example, illustrating the creation of a dynamic model that allows students to adjust loan terms, interest rates, and payment frequencies, offering a flexible tool for both personal and financial planning applications. Throughout this process, we aim to provide both a methodological framework and a user-friendly solution for students seeking to find answers to the question, "When am I ever going to use this in real life?"

Session II-A

Kyle Ambrose (Graduate Student) - University of North Florida

Mathematical Problems in Logistics

Mathematics plays a critical role in solving logistical challenges essential for efficient supply chains. This presentation introduces many problems in logistics while focusing on two fundamental problems: The Bin Packing Problem, which involves optimizing the arrangement of items in limited storage space, and The Vehicle Routing Problem, which seeks the most efficient delivery routes while minimizing costs and meeting constraints. Through these problems, we demonstrate how mathematical models can provide practical solutions that improve operational efficiency and decision-making in logistics.

Milé Krajcevski-University of South Florida

A picture is worth a1001 words

Increased use of computer-generated graphics into educational practice in recent years may lead some to believe that hand-drawing as an act of creating visual representation depicting mathematical objects or notions is an artifact of the past. As evidenced by researchers in cognitive psychology and neurobiology, students' exposure to predetermined and ready to use images of mathematical objects is not a substitute for an active creation of images of these objects. In this short presentation I will demonstrate how a simple hand-drawn picture can be used to facilitate in-class discussion about solving problems and creating engaging mathematical questions that encourage deeper thinking.

**Tre Hellwig (Graduate Student), Raymond Fleming, Anam Khan,
Melanie Sutton, Mark Melissa, Justice Mbizo, Anthony Okafor -** University of West Florida

Refocusing Educational Goals Using Generative AI to Improve Statistical Reasoning

Student's access to Generative AI (GenAI) for statistical coursework represents a sea change in student learning, curriculum implementation, and course facilitation. Concurrently, an active embrace of GenAI in coursework compromises legacy learning models and demands educators refocus on post-graduation applications. Incorporating case studies and project-based student-led research designs can enhance student learning and faculty engagement. Student outcomes using this model focus on identifying and utilizing foundational statistical concepts like research question and study design, variable identification, and practical application of statistical tools. Onboarding of faculty, adjuncts, and teaching assistants involves role-playing with AI chatbots to foster curiosity and imagination in decision-making of instructional redesign. Combined, these approaches can ensure course instructors and facilitators reinforce students' critical thinking skills as they simultaneously prepare graduates for occupations utilizing AI-augmented workflows.

Kelley Cummings, Sandra Vernon- Jackson, Ruthmae Sears, Chuqian Song (Graduate Students), Keisha Albritton, Alfredo Rodriguez Vera (Graduate Student) - University of South Florida

Building Blocks to Cultivating a Productive Learning Environment in Intermediate Algebra

In this presentation, we will describe strategies to promote student success in MAT 1033 – Intermediate Algebra by gaining insights into students' unique attributes. Notably, we will share insights relative to students' experiences, beliefs, and attitudes when they introduce themselves in a mathematical setting. This presentation has implications for creating environments where all students learn and thrive.

Spencer Logan (Undergraduate Student) and Aflonso Rodriguez - Florida Polytechnic University

Using the asymptotic homogenization method to determine effective properties of complex dielectric composites.

The asymptotic homogenization method is applied to a complex dielectric periodic composite with a fiber reinforced geometry (specifically with the fibers laid out in a rectangular lattice pattern). Applying this method here simplifies a complex partial differential equation with rapidly oscillating coefficients into 2 real valued boundary value problems from which the effective dielectric properties of the composite can be extracted. Closed-form formulas for the effective complex dielectric tensor are produced for truncation orders 1 and 2. The real closed-form formulas are useful for estimating gain and loss enhancement properties of the composites. Numerical computations are performed to compare with the square lattice case and to demonstrate the accuracy of the closed-form formulas.

Session II-B

Jenna Bradley, Daniela Genova, and Dennis Perusse - University of North Florida

Organizing Undergraduate Mathematics Conference Series: Successes and Challenges

Any conference is hard to organize, but this is especially true for a conference series intended for a vast variety of participants' levels and background areas. The authors will share their experience of starting and running the *Osprey Mathematics Conference Series* at UNF and hope to inspire the audience in organizing their own. Our annual conference is intended for faculty, graduate and undergraduate students from a variety of mathematics related disciplines. This talk discusses planning, engaging student-organizers, motivating faculty to advise and inspire student-presenters, obtaining support from the administration, and attracting local industry partners. Most importantly, tips and handouts that motivate students and attract participants and funding will be shared.

Kalia Lafferty (Undergraduate Student) and Ala' Alnaser - Florida Polytechnic University

Deriving a Differential Equation Model for Vehicle Dynamics Using Sensor Data and Statistical Methods for Autonomous Vehicle Testing

This study investigates vehicle dynamics by employing statistical modeling techniques on sensor data, with a focus on predicting acceleration. The results are instrumental in enhancing the testing frameworks for Autonomous Vehicles (AVs) and Advanced Driver Assistance Systems (ADAS). By statistically building a model employing the throttle, braking, steering angle, and velocity effect on acceleration, using actual sensor readouts, we lay the groundwork for more robust AV testing protocols.

Michael Carnival (Graduate Student) - University of West Florida

On Wavelet-Based Features for Classifying Functional Data

Functional data, such as curves and signals, is widely used in various applications, including mass spectrometry, speech, and data from wearable devices. It has an infinite number of dimensions, which poses challenges for computation and predictive modeling. This paper investigates a wavelet- based approach to extract features for classifying mass spectrometry (MS) or similar datasets. We applied PCA to the features to reduce the dimensionality of the data to a few principal components (PC) for interpretation and data exploration of the MS spectrum. The Hotelling T 2 statistics were applied to the reduced space of approximation and detail coefficients principal components to obtain the overall T 2 statistic of the original MS spectrum. Finally, the T 2 statistics from each MS sample was used in a few machine learning models to classify the data. Our test without and without oversampling the imbalance class dataset will be discussed.

Nicole Tuovila - University of Central Florida

Direct Interaction Approximation (DIA) for generalized stochastic models in the turbulence problem

We discuss the application of the DIA to a linear damped stochastic oscillator system using a Tsallis type autocorrelation model with an underlying non-extensive entropy measure and describe the resulting stochastic process. We show that the non-perturbative aspects excluded by Keller's perturbative procedure are minimized in the white-noise limit. In the opposite limit, the physical variances between the different random process models don't seem to materialize, and the Uhlenbeck-Ornstein and Tsallis type models are shown to yield the same result. We also deduce some apparently novel mathematical properties of the gamma distribution and the Tsallis non-extensive entropy.

Justin Homeier - Florida Polytechnic University

Reconstructing Zero-divisor Graphs with Annihilator Generators

In the integers modulo n, a pair of zero-divisors are exact if one generates the annihilator of the other. We can construct graphs from these exact pairs. In some cases, the graph structure alone is sufficient to glue these exact components together and get the (non-exact) zero-divisor graph. This talk explores two tractable cases.

Contributed Papers Session III

Session III-A

Ryan Farrell (Graduate Student) - University of North Florida

How to Teach a Computer Tic-Tac-Toe

Ultimate Tic-Tac-Toe consists of a three-by-three grid containing nine games of Tic-Tac-Toe. In this game, players take turns playing moves in each of these cells in the hopes of winning three games in a row. This presentation seeks to develop a winning strategy to Ultimate Tic-Tac-Toe using the tools of reinforcement learning (RL). We start by introducing the central object of study in RL: the Markov Decision Processes

(MDP). Discussions of how to construct the agent, states, actions and rewards in an MDP to best complete the given objective are considered before analyzing the trade-off between exploration/exploitation and ultimately using Bellman's equations to find a solution to the optimal policy problem.

Matthew Kimm, Jay Sparks, Brian Le, Gary Marmon, Kelie Kan, and Anthony Okafor - University of West Florida

Components of an Interactive Course Planner

In this work, we examine the existing solutions to course planning for on-time graduation. In doing so, we identify deficiencies with the existing solutions. We discuss our existing solutions to on-time graduation and propose approaches of incorporating these solutions as part of the constraints in building a robust interactive course planner. As part of the proposed interactive course planner, we discuss how to solve a STRIPS problem commonly used in automated planning or AI planning.

Muhammad Najjar (Graduate Student), Samaraweera Dumindu-Embry-Riddle Aeronautical University

Mitigating Adversarial Attacks in Federated Learning

Federated learning is a distributed learning mechanism widely used in applications such as Connected and Autonomous Vehicles (CAVs), Unmanned Aerial Vehicles (UAVs), and aerospace to enhance data privacy by sharing model weights instead of raw sensor data. However, exposing model weights still poses security risks, such as membership inference and model inversion attacks. While homomorphic encryption and differential privacy offer protection, they introduce significant computational and communication overhead, making them impractical for resource-constrained UAV environments. To address this, we propose a selective encryption approach that identifies and encrypts only the most critical model weights, reducing overhead while maintaining accuracy. Our initial results show a significant decrease in encryption time and improved efficiency compared to existing methods. This approach enhances privacy protection without compromising model performance, making it well-suited for real-time applications in UAVs and aerospace systems.

Shimin Zhang (Graduate Student) - University of South Florida

Risk Incorporated Portfolio Optimization with Deep Reinforcement Learning

Portfolio optimization is a critical process for investors seeking to allocate wealth effectively across a diverse range of assets while considering individual risk-return preferences. Recent advancements in Deep Reinforcement Learning (DRL) have shown remarkable potential in enhancing portfolio optimization strategies. The entropic risk measure, a widely used tool in financial mathematics, provides a robust approach to quantifying the risk of uncertain outcomes.
This study introduces the integration of the entropic risk measure into the Deep Deterministic Policy Gradient (DDPG) framework, facilitating risk-aware updates to both the critic and actor networks. Furthermore, we extend this approach by incorporating the entropic risk measure into DPG with Episodic Memory (EM), enhancing decision-making under uncertainty. Experimental results demonstrate that the entropic risk measure-enhanced DDPG achieves superior cumulative returns compared to standard DDPG, while its extension with EM further improves performance, outperforming DDPG with EM in terms of cumulative returns.

Vilmaris Alvarado (Undergraduate Student) - Florida Atlantic University

Group Rings

Group rings are algebraic structures composed of a group G and a ring R. Each element of a group ring R[G] is a sum of all elements of G together with a coefficient from R. Elements in R[G] that satisfy certain properties can be labeled as idempotents, nilpotents, units, and zero-divisors. Elements of group rings can be multiplied using Excel, especially with groups of high order.

Session III-B

John Diller (Graduate Student) - University of North Florida

Polynomial invariants for $GL(n)$

Every action of a group G on a vector space V can be extended to an action of G on the set of polynomials on V. In 1900, Hilbert asked the following question: is the algebra of G-invariant polynomial on V finitely generated? In the 60s, Munford proved that the previous algebra is finitely generated for a large class of complex groups (called reductive). However, finding a minimal set of generators can very challenging and is still open for most of the classical complex groups.
In my talk, I will look at the action of GL(n) on V = rMat(n x n) (r copies of Mat(n x n)) and show that the traces of non-commutative polynomials generate the GL(n)-invariant polynomials in C[V]. This result has been obtained by Procesi, using some results of Weyl on invariant tensors

Barrett James McDonald, Kandethody Ramachandran - University of South Florida

Modeling Win Rate in League of Legends for Top Lane and Bottom Lane Champions

League of Legends is a free-to-play multiplayer online battle arena (MOBA) game developed and published by Riot Games and first released in 2009. In 2020, the game made 1.75 billion US dollars in revenue. This research represents an initial attempt to create a model for the win rates of champions in the Top Lane and Bottom Lanes of the map. Exploratory data analysis reveals multicollinearity among some of the predictors, and a principal component analysis approach is used to deal with such. This is followed by the creation of a principal component regression model. The principal component regression models show some level of predictive capability, but the results suggest that a more fruitful approach may be to study champions via cluster analysis rather than map position.

Thanh Bui (Graduate Student) - University of West Florida

Modified Linear Failure Rate Odds Ratio Distribution Generator

This paper introduces an innovative and robust distribution model known as the Modified Linear Failure Rate Odd Ratio-G (M-LFRD-G). This model merges the versatility of the exponentiated odd ratio with the foundational concept of the Linear Failure Rate (LFR) distribution. We provide a comprehensive exploration of its mathematical and statistical properties, showcasing the model's effectiveness in representing the bathtub shape of hazard rate. Through the analysis of device and software fault datasets, we validate the practical applicability and robustness of the M-LFRD-G distribution, highlighting its significant potential for modeling failure rates in real-world applications.

Greg Spradlin - Embry-Riddle Aeronautical University

An Optimization Problem Arising from Radiation Treatment

Radiation treatment for cancer kills both healthy and malignant cells. When a fixed total dose of radiation is spaced over a time period, the number of healthy cells and the number of malignant cells killed both vary depending on how the treatments are scheduled. Using the popular linear-quadratic or LQ model, the number of healthy cells killed can be modeled using a simple double integral. When the total amount of radiation and the number of malignant cells are held constant as constraints, we obtain an optimization problem, whose solution is the treatment schedule that minimizes the damage to healthy cells. Under some hypotheses (all healthy cells recover at the same rate, or at one of two rates), the problem has an analytical solution.

Shelletta Baker - Valencia College

*Beyond the Minds of Machines: Design questions that challenge A*I

Beyond the Minds of Machines: Design questions that challenge AI. With rapid technological developments and students' over-reliance on machines. This talk will discuss human design of authentic questions involving multiple steps that challenge Artificial Intelligence. During this session participants will be introduced to strategies and sample problems involving real-world context that challenge student's use of AI.

Vincent Stafford (Undergraduate Student)-Florida Atlantic University

Stuck in Space: An Introduction to Distinguishability

The notion that all points in a topological space must have their own unique neighborhoods is among the most frequently used in mathematical reasoning. Despite this, spaces that do not satisfy this requirement often arise in both pure and applied mathematics, from constructed counterexamples such as Sierpiński space to the clustering of data points in information space. We explore examples of spaces that break this norm, the process of converting these spaces into T0 spaces using Komlogorov's Quotient and the intrinsic connections between a space and its Kolmogorov Quotient; particularly in the realm of pseudometrization and their relations to metrizable spaces

Workshop Talks and Special Session

Abigail Burrows, Jacci White, and Monika Kiss - Saint Leo University (**Workshop**)

Harnessing Generative AI for R Programming in Introductory Statistics and Linear Algebra

Generative AI transforms how we approach problem-solving and instruction in mathematics and statistics. In this hands-on workshop, participants will explore how to leverage AI tools to create and enhance R programming for Introductory Statistics and Linear Algebra courses. We will demonstrate how to use AI to generate scripts for data analysis, visualization, and matrix operations, allowing educators to simplify code creation while focusing on conceptual understanding. Participants will engage in live coding activities, guided examples, and discussions about best practices for integrating AI into their teaching.
To maximize the session's impact, attendees are encouraged to bring laptops with R and R Studio installed. Join us for an exciting opportunity to explore the intersection of technology, education, and mathematics.

Sirani M. Perera (ERAU), Xianqi Li (FIT), Aaron Welters (FIT) - (**Special Session - 5 Talks**)

State-of-the-art (SOTA) in Classical and Machine Learning (ML) Algorithms and Applications

The utilization of classical algorithms to solve linear and non-linear systems has been improved over the years. There is extensive literature on classical algorithms that solve problems in scientific computing, engineering, physics, and computer science disciplines using so-called low-complexity algorithms. This complexity reduction in the classical algorithms stems from exploring the structure of linear or non-linear systems. Thus, one can also investigate the hidden structure of neural networks to develop low-complexity machine learning (ML) algorithms. Hence, to open a path in solving non-linear systems using low-complexity ML algorithms.
This session will explore how classical and machine learning algorithms can solve complex linear and non-linear systems. We will utilize classical or ML algorithms, applying their theoretical foundations to solve problems in mathematics, data science, engineering, and computer science. The main goal is to obtain efficient and elegant classical and ML algorithms that are accurate, reliable, and numerically stable to tackle challenges in these disciplines. Thus, this special session addresses complex data-intensive problems by converging ideas from early- and mid-career mathematicians, data scientists, and graduate and undergraduate students to collaborate on solving problems in STEM disciplines utilizing the SOTA in classical and ML algorithms.

Oshani Jayawardane (Graduate student) - Embry-Riddle Aeronautical University

A Low-complexity Hybrid Learning to Decode Algebraic Codes Over a Finite Field

The algebraic-geometric approaches in recovering codes often involve exhaustive search methods or heavy algebraic proofs. These methods are based on the concepts of algebraic geometry, which are computationally expensive, especially when dealing with cardinality of the field or complex code structures.
In this talk, we present a hybrid decoding algorithm that significantly reduces the computational complexity of classical algebraic-geometric methods for recovering algebraic codes over finite fields. The proposed method uses an FFT-like algorithm to locally recover codes, then applies a machine learning algorithm to retrieve the remaining missing codes in the codewords based on the locally recovered ones. Due to the utilization of the FFT-like algorithm, the proposed hybrid learning algorithm reduces

computational complexity. We also maintain accuracy based on the code structure and finite field properties.

This is joint work with Hansaka Aluvihare, Sirani M. Perera, Xianqi Li, Anthony Várilly-Alvarado, and Kshitij Khare. Students' work was partially supported by the National Science Foundation award number 2229473.

Hansaka Aluvihare (Graduate student) - Embry Riddle Aeronautical University

A Low-complexity Structured Neural Networks Approach in Multibeam Beamforming

Beamforming has been widely explored for its diverse applications across fields, such as radar, communication, and imaging. The realization of microwave/millimeter wave M-beam beam formed signals cost $O(M^2)$ delay complexity. It is hard to realize beamformers due to the underlying complexity of signal flows.

Thus, in this talk, we will present a novel neural network (NN) architecture to realize multi-beam beamformers using structure-weight matrices and sparse submatrices. The proposed NN architecture achieves a complexity of $O(Mp^2L)$, a significant improvement over the $O(M^2L)$ complexity of conventional fully connected networks, where M represents the number of nodes in the layers, p is the number of submatrices per layer, L is the total number of layers, and $p << M$.

Finally, we show the efficacy of this architecture in realizing multi-beam beamformers using numerical simulations, emphasizing its significant complexity savings while maintaining feasible accuracy.

This is a joint work with Sirani M. Perera, Arjuna Madanayake, and Xianqi Li. This work was supported by the National Science Foundation award numbers 2229473 and 2229471.

Brady Heddon (Graduate Student) - Embry-Riddle Aeronautical University

A Low-complexity Image Recognition and Classification Algorithms

Recognition and classification tasks have become increasingly popular for automation in several fields. These tasks are commonly carried out using convolutional neural networks (CNNs) and feedforward neural networks (FFNNs). Their adaptability and feature extraction lead to high-accurate image recognition results; despite being computationally expensive. However, high computational demands, large volumes of labeled data, and storage requirements all hinder CNN's and FFNNs' efficiency.

In this talk, we first present a computationally efficient neural network based on the low-complexity discrete Cosine transform algorithm to recognize images. Once the network is designed, we compare the accuracy and precision of the network with the FFNNs, CNN, and Eigenfaces. Finally, we share image classification results utilizing the Forward-forward (FF) algorithm, which helps the network to learn as it propagates. We sum up by presenting the testing and training errors of the FF and comparing them with the FFNN results for image classification.

This is joint work with Adam Kuzmicki, Kaitlyn A. Cavanaugh, Hansaka Aluvihare, Kristiyan Stefanov, and Sirani M. Perera. Students' work was partially supported by the National Science Foundation award numbers 2229473 and 2142514

Xianqi Li - Florida Institute of Technology

Diffusion Model based Super-resolution for Medical Images

High-resolution medical imaging is critical for precise diagnosis and optimal patient care. Obtaining such images requires long scanning times, causing patient discomfort and increasing the risk of scan failures from movements. To address these challenges, super-resolution techniques were proposed and offered a

promising avenue for enhancing the quality of medical images. Nevertheless, traditional super-resolution methods often fall short of preserving intricate details inherent to medical images.
In this talk, we discuss the fundamental challenges in medical image super-resolution and the limitations of conventional methods. We also address deep learning approaches for image super-resolution. We delve into the principles of diffusion models and shed light on why they are promising in this application. Experimental results will be showcased, comparing our diffusion model-based approach with other SOTA super-resolution methods. The outcomes reveal notable improvements in preserving fine-grained details and critical structures, making it an invaluable tool for clinicians.
This is the joint work with Mohammed Alsubaie, Sirani M. Perera, and Ovidiu Andronesi.

Aaron Welters - Florida Institute of Technology

Monotonicity and Concavity of the Principal Pivot Transform

We present our recent results [1] on the monotonicity and concavity of the principal pivot transform (PPT), which is motivated by the celebrated Loewner's Theorem [3]. Moreover, these results are an improvement of certain results by Clements and Wimmer [2] on the regulator problem and the monotonicity of Riccati operators for discrete-time linear systems. In particular, we discuss the minimum hypotheses for which the PPT is matrix monotonic with respect to the Loewner partial order on Hermitian matrices. In addition, we present a new variational principle for the PPT which is intricately connected with the Legendre-Fenchel transform from convex analysis. We then use this minimization principle to show how to establish the concavity of the PPT. Throughout we utilize the fundamental properties of Schur complements and the Moore-Penrose pseudoinverse under the Loewner ordering.
This is joint work with Kenneth Beard (Louisiana State University)

Contributed Papers Session IV

Full Session

Alexander Dranishnikov - University of Florida

Topology of robot motion planning

The configuration space of a robot or an autonomous mechanical system could have very complicated higher dimensional topology. The navigation problems for programming such a system lead to some topological invariants. We will discuss progress in studying one of them called the topological complexity TC(X) of a configuration space X.

Ruthmae Sears, Kelley Cummings, Sandra Vernon- Jackson, Chuqian Song (Graduate Student), Keisha Albritton, Alfredo, Rodriguez Vera (Graduate Student) - University of South Florida

Facilitating Trauma Informed Instructional Practices to Promote Learning and Sense of Belonging in Developmental Mathematics

In this presentation, we will describe students' perspectives on the extent to which their MAT 1033-Intermediate Algebra instructors demonstrated trauma-informed instructional practices. Students experience trauma in various ways and may not always have adequate coping mechanisms or support.

Trauma could be influenced based on psychological, social, and cultural factors. To promote trauma-informed practices, instructors are encouraged to address core values: safety, trustworthiness, choice and control, collaboration, and empowerment (Davidson, 2017). Therefore, we collected qualitative and quantitative data to support programmatic improvement efforts in our in-person, synchronous, and asynchronous sections of Intermediate Algebra. The results suggest that instructors generally exhibit trauma-informed practices and offer support to cultivate mathematical learning and foster a sense of belonging in introductory mathematics classes.

Jenna Bradley, Dennis Perusse - University of North Florida

From Theory to Play: Bridging Gamification and Math Education with Real-World Examples

This talk will focus on core elements of gamification and game-based learning, their differences, and their impact on student learning and engagement. We will examine best practices for the implementation of gamification in a course, as well as some practical game-based learning activities, including 3D modeling techniques and files to 3D print a truth tables game.

Session IV-A

Bidur Devkota - Embry-Riddle Aeronautical University

A study on estimation of PM2.5 using machine learning and satellite data in the Kathmandu Valley

The problem of air pollution has created significant environmental and health challenges worldwide. Specifically, fine particulate matter (PM2.5) is one of the major risk factors. This study estimates PM2.5 using machine learning and deep learning approaches as a low-cost alternative to traditional methods. Meteorological and Sentinel-5P satellite air pollution data from the Kathmandu Valley, Nepal, were utilized for the purpose. Algorithms such as K-Nearest Neighbors (KNN), Support Vector Machine (SVM), Extreme Gradient Boosting (XGBoost), Random Forest (RF), ensemble, and hybrid methods, were implemented and evaluated. Using only Sentinel-5P data, XGBoost achieved the highest R^2 (0.8284) and the lowest RMSE (11.0024). After integrating meteorological data to it, the ensemble method improved performance with an R^2 of 0.8324 and RMSE of 10.8747. These findings highlight the potential of novel datasets and emerging techniques for cost-effective PM2.5 estimation, offering valuable insights for regions lacking ground-based monitoring stations.

Kyle Villalobos (Undergraduate Student) - Florida Atlantic University

On Gradient Flow Across Geometric Hierarchies

Currently, no established framework exists for decomposing gradient flow in diverse geometric settings. We formalize the Elementary Decay Property (EDP) and establish necessary conditions for this property to hold in R2 before extending our analysis to R3 and further into Rn, exploring the effects of higher-dimensional spaces on these conditions. Additionally, we generalize our findings to curved and singular spaces. By studying the influence of curvature, singularities, and measure concentrations, we analyze how these factors disrupt the smooth gradient behavior required for the EDP. This generalization enables us to classify gradient flow across all metric spaces, including those where the decay of the gradient norm is not well-defined. Our work provides a foundational framework for understanding stability and structure in smooth spaces and beyond.

Deepak Bastola (Graduate Student) - Florida Atlantic University

Forecasting Crime Trends in Chicago: A Time Series Analysis Using SARIMA

This study investigates the temporal patterns of crimes in Chicago using a publicly available dataset spanning Jan 2001 to Nov 2024. The dataset is aggregated to capture overall crime trends at the monthly level, avoiding specific crime type analyses. Time series modeling using SARIMA (Seasonal Auto-Regressive Integrated Moving Average) is employed to predict future crime numbers. Initial observations indicate a declining trend in reported crimes, which is corroborated through statistical modeling and visualization. The forecast results provide actionable insights for urban planning and resource allocation, aiding policymakers and law enforcement in anticipating future crime levels and adjusting strategies accordingly. The methodology ensures robustness by including train-test splits and error evaluations, confirming the model's reliability for predicting crime trends in a dynamic urban environment like Chicago using python.

Thomas Luckner - Flagler College

d-translated unit sensitive primes

We use covering systems to construct an arithmetic progression of d-translated unit sensitive integers for any nonnegative integer d. Let an integer be d-translated unit sensitive when translating the number d digits forward and changing the new unit digit to any base 10-digit results in a composite number. We provide the first known example of a prime that is d-translated unit sensitive for any positive integer d. We also add the condition that the prime is widely digitally delicate.

Francis Baffour-Awuah Junior - Florida State University

Modeling Immune Protein Dynamics and their Impact on Host-Pathogen Interactions in Septic Patients

Sepsis arises from a dysregulated immune response to infection and remains highly lethal, particularly in low-income countries. Despite advances in diagnosis and treatment, its mortality rate remains high. Mathematical models help analyze immune system interactions and their role in sepsis pathophysiology. Here, we develop a model linking immune protein expression in septic patients to key immune components, including pro-inflammatory and anti-inflammatory responses, as well as the pathogen. Model parameters are inferred using proteomic data from septic patients. By fitting the model to patient data, we estimate key parameters that define sepsis dynamics. The model produces clinically relevant outcomes that reflect immune dysregulation in suspected sepsis cases. We also explore how variations in key parameters affect these outcomes. This approach improves our understanding of sepsis-related immune dysfunction and may aid in optimizing treatment strategies for distinct patient subgroups.

Beyza Aslan - University of North Florida

Crocheting Mathematics

Crocheting is a very nice way of observing otherwise difficult to visualize geometry, making it possible to explore the beauty of mathematics in a less abstract way. This talk focuses on some of the well-known surfaces such as hyperbolic plane, Costa's surface, cross-capped disk, Klein bottle, and more recently discovered Einstein tiling. In addition, we will also talk about the history of Islamic geometric designs and crocheting such geometry.

Session IV-B

Liu Yongxin, Marc Jacquet, Yujing Zhou, Faheem Khan, Madison Newell, Robel Dawit, Skyler Fabre, Dev Sarawat, Yongxin Liu - Embry-Riddle Aeronautical University

Machine Learning for Cyber Attacks

The paper presents our simulation of cyber-attacks and detection strategies on the traffic control system in Daytona Beach, FL. using Raspberry Pi virtual machines and the OPNSense firewall, along with traffic dynamics from SUMO and exploitation via the Metasploit framework. We try to answer the research questions: are we able to identify cyber attacks by only analyzing traffic flow patterns. In this research, the cyber attacks are focused particularly when lights are randomly turned all green or red at busy intersections by adversarial attackers. Despite challenges stemming from imbalanced data and overlapping traffic patterns, our approach using Random Forest achieved 75% accuracy when detecting hacks. Key features for successful detection included occupancy, jam length, and halting durations. Future work will refine the network topology, use containerization, and explore deep and unsupervised learning for better detection.

Peter Alspaugh (Undergraduate Student), Peter Alspaugh, James Garrett, Natasha Jonoska, Masahico Saito - University of South Florida

Structures of Monoids Motivated by DNA Origami

DNA Origami provides a method to create DNA nanostructures via bottom-up self-assembly rather than traditional top-down fabrication. A DNA Origami structure consists of a single long cyclic strand called a "scaffold" and numerous short "staple" strands, which force the scaffold into a desired shape during self-assembly. We propose an algebraic system, the origami monoid, to describe varying staple arrangements within a rectangular fold of the scaffold. To each arrangement, we associate an element of the monoid and design the operation to represent concatenation of graphical representations of the origami shapes.
We prove several algebraic properties of the monoid, including restrictions on the forms of its elements, facts about its Green's classes, and we find an unexpected occurrence of contextual commutation between certain generators. Besides possible applications to DNA Origami, our approach also provides new ways to build and study algebraic structures.

Blake Gisclair (Undergraduate Student) - Florida Institute of Technology

Peek Ensembling

Ensembling leverages the strengths of multiple machine-learning models to enhance overall performance. They are most effective when the models make decorrelated errors. We hypothesize this is the case for convolutional neural networks (CNNs). PEEK (Probabilistic Explanations for Entropic Knowledge extraction) is a method that identifies information-dense areas within the latent representations of input images at each layer within the network. This work introduces a technique for building powerful ensembles of CNNs using loss terms designed to counteract redundant representations amongst the models by penalizing pixel-level similarities of maps among corresponding layers of the CNNs, encouraging the maps to be different and forcing them to focus on different regions of the images, thus reason differently. We tested this hypothesis on both a small and large model, and found that - when

maps were sufficiently distinct from one another - the resulting ensemble did, in fact, perform (between 1-4%) better than the component models.

Angela Angeleska and Miranda Serna - University of Tampa

Algebra in Wonderland

The talk is inspired by the hidden mathematical illusions inside the well-known story "Alice in Wonderland" by Lewis Carroll. The author Lewis Carroll also worked and published in mathematics, under his real name Charles Dodgson. Here we briefly talk about the mathematical career of Lewis Carroll and his contributions to recreational math. In addition, we give a brief historical overview of the trends and discoveries in mathematics around the time he wrote "Alice in Wonderland". All of that is leading our presentation towards revealing the concealed layers of mathematical logic, geometry, and abstract algebra that are strategically imbedded in the story's famous scenes and conversations.

Sabrina Hussain (Graduate Student) - University of North Florida

Fourier Transformation of Non-Periodic Functions and Its Application in Imaging Science

Fourier analysis plays a fundamental role in signal processing and imaging applications, with computed tomography (CT) being a prominent example. CT imaging relies on reconstructing cross-sectional images of objects from multiple projections, a process deeply rooted in the mathematical framework of the Fourier series and its extensions. This talk explains the fundamentals of Fourier Transform and explores the mathematical principle behind CT, demonstrating how periodic and non-periodic functions can be decomposed into sinusoidal components to facilitate image reconstruction. By connecting Fourier series with computed tomography, this presentation highlights the mathematical elegance and practical significance of frequency-domain analysis in medical imaging and beyond.

Kellie Tamini (Graduate Student) - University of West Florida

Understanding Life Satisfaction vs Salivary pH Through Perceived Stress and Sleep Quality

This study explores the relationship between life satisfaction and salivary pH, considering the influences of sleep quality and perceived stress. Life satisfaction, a key aspect of subjective well-being, has been linked to various factors, including academic performance and health. Recent research suggests indirect connections between life satisfaction and both perceived stress and sleep quality. Additionally, salivary pH has been correlated with sleep quality and stress levels. Our research investigates salivary pH as a potential, easily accessible biomarker for life satisfaction among students. Participants underwent a series of evaluations, including stress, sleep quality, and life satisfaction assessments, and provided saliva samples for analysis. The study employs standard statistical methods, such as correlation and regression analysis, to examine these relationships. From the 45 samples collected, the results supported a weak direct correlation between salivary pH and life satisfaction, a weak indirect correlation between salivary pH and perceived stress and a weak indirect correlation between salivary pH and sleep quality. Additionally, a weak indirect correlation between life satisfaction and perceived stress was found, aligning with the findings of past papers. This could highlight salivary pH as a practical and cost-effective tool for gauging life satisfaction, offering insights into student health and well-being.

Contributed Papers Session V

Full Session

Subhash Bagui - University of West Florida

The Stirling Numbers of the Second Kind and Their Applications

The Stirling numbers of the second kind have numerous applications in mathematics and statistics. However, these applications are not generally known to college mathematics and statistics students. This paper aims to propagate the use of the Stirling Number of the second kind to college mathematics and statistics students. We approach the Stirling numbers of the second kind very lucidly so that college students can grasp them quickly. We derive a formula for the Stirling numbers of the second kind using the concept of one-to-one and onto functions. Using this formula, we derive a recurrence relation. By the multinomial theorem, we express a monomial r^n in terms of the Stirling numbers of the second kind and falling factorial of order r. Using this generating function, we gave a closed form of the sums of integral powers of integers. Finally, as applications in statistics, we offer closed form for nth (raw) moments of a few discrete distributions such as Binomial, Poisson, Geometric, and Negative Binomial.

Chuck Lindsey - Florida Gulf Coast University

Abandoning dot-age for d-ism in 1820's Cambridge

In the decade from 1815 to 1825, Cambridge University made a transition in calculus pedagogy from the notation and methodology of fluxions to (mainly) that of differentials, following the work of contemporary French mathematicians. One of the individuals involved in this transition was Thomas Jephson, Fellow of St. John's College, who wrote one of the first calculus textbooks by an Englishman that used primarily differential notation. We will review the Cambridge *milieu* of this era, including the efforts—often student-led—to adopt the continental notation and methods, and Jephson's role in this. We will discover the surprising reason why Jephson's textbook was not considered for use at Cambridge and examine the question of whether his text was superior to the translations of French texts that were then in use.

Margaret Byrns - Flagler College

Flipped Classrooms & Engaging Classwork

Flipped classrooms have become an increasingly popular method of mathematics instruction
This presentation will cover an overview of my use of the flipped classroom in my calculus and statistics courses. I'll cover the techniques I've found effective, the challenges along with strategies for overcoming them, and general "dos" and "don'ts" when setting up your own flipped classroom. Additionally, I'll share information on my use of instructor-created course packets and how I have found these course packets to work well in conjunction with the flipped classroom. A return to paper-and-pencil techniques blended with appropriate technology, the use of these course packets has led to greater group discussion and engagement during flipped classroom activities.

Dennis Perusse - University of North Florida

A Quiddity-Infused, Sinciput-Overloaded, Ultracrepidarian Ramble Through Mathematical Thought and the Art of Teaching at the Edge of Disarray by a Sesquipedalian Logophile

A mathematician's bailiwick is ever-expanding—especially when they embrace the unpredictable joys of UREs, mathematical storytelling, and hands-on experimentation. This talk covers the ways in which multidisciplinary research, 3D design and 3D printing (including a truth table game with shareable files), and contextualized math problems increase student engagement. Also, a quick LaTeX trick to make PDFs accessible. Expect structured disarray and inspired pedagogy.

Session V-A

Mohammad Tasrif Khan (MO KHAN) (Graduate Student)- Embry-Riddle Aeronautical University

Mathematical Modeling of Cybersecurity in Space Operations: Optimizing Satellite Network Resilience

As satellite networks become increasingly interconnected, the risk of cyberattacks poses significant challenges to space operations. This study introduces a mathematical framework integrating orbital mechanics, linear algebra, graph theory, game theory, and optimization to enhance satellite cybersecurity. Cyber threat propagation is modeled using orbital state vectors and differential equations to assess how positional and velocity components influence intrusions. Linear algebra techniques, including adjacency matrices and eigenvalue analysis, identify vulnerabilities, while matrix decomposition detects anomalies in communication protocols. Graph theory is used to analyze network resilience, and game theory anticipates attacker-defender interactions to develop strategic countermeasures. Optimization ensures efficient allocation of cybersecurity resources, such as encryption and firewalls. This interdisciplinary approach offers a scalable solution to fortify satellite constellations used in GPS, telecommunications, and Earth observation, providing a comprehensive strategy for mitigating cyber threats in space infrastructure.

Hongliang Wang - University of South Florida

Kolmogorov–Arnold Neural Network in Image Reconstruction Learning

The Universal Approximation Theorem serves as a cornerstone of modern neural network architectures. However, the Kolmogorov-Arnold Representation Theorem offers a compelling alternative in machine learning, providing a powerful framework for representing multivariate continuous functions through compositions of single-variable functions. This unique structure enables compact, interpretable, and theoretically robust models, distinguishing it from traditional deep networks. In this talk, we will delve into its applications in image learning, exploring its potential to enhance model efficiency and interpretability.

Lei Hsin Kuo - University of West Florida

ALSS, A Convergent Extension of Tikhonov Regularization over Complex Spaces.

This study presents a novel regularization method, the Approximate Least Square Solution (ALSS), designed to mitigate rank-deficiency issues in linear least squares problems while significantly improving the convergence rate of the penalty term. Furthermore, the proposed method extends to Radial Basis Function (RBF) interpolation problems, effectively addressing invertibility challenges across all considered RBFs.

Tedi Draghici and Philip Son - Florida International University

Halving Triangular and Trapezoidal-like Pancakes

Given two bounded regions (pancakes) in the plane, the Pancake Theorem guarantees that there exists a line that simultaneously halves the areas of the two pancakes. This is an existence result, without any indication on how a halving line could be found. In fact, for general pancakes, there is no hope of explicitly finding a halving line. However, one could try to do so for special pancakes. We obtain some results (a couple not entirely new, but with a new approach) regarding the problem of constructing with straight edge and compass the halving line for triangular and/or trapezoidal-like pancakes.

Abigail Denton (Undergraduate Student), Michael Schroeder - Stetson University

Primitive Star Decompositions of Complete Graphs

A decomposition D of a graph G is primitive if no proper, nontrivial subset of D is a decomposition of an induced subgraph of G. The existence of primitive decompositions has been studied for path and cycle decompositions of complete and cocktail party graphs. This work addresses the existence of primitive m-star decompositions in complete graphs with n vertices. We specifically focus on cases with even m, where $2m \leq n \leq 4m$.

Lindsay Spence - Embry-Riddle Aeronautical University

Using Discrete Fourier Transforms (DFTs) and Fast Fourier Transforms (FFTs) to solve the Quantum Mechanics Wave Equation

Discrete Fourier Transforms (DFTs) are a special numerical technique that is commonly used to solve complex problems that are unrealistic to solve by hand. In astronomy, DFTs are typically used for signal analysis through either increasing the signal-to-noise ratio (SNR) or determining the peak frequency of a time-based data set. The main disadvantage of DFTs is their computation time due to the necessity of repeated summation. To reduce computation time, the Fast Fourier Transform (FFT) was created. Although FFTs are faster, there is an increased need of available memory to perform computations. My project aims to compare the performance of DFTs and FFTs with added high performance computing techniques on the same problem using Vega (a supercomputer). To compare the performance of both methods, their respective efficiency and speedup were measured.

Bernadette Mullins, Jared Bunn, Satyajith Boyana, Justin Hoffmeier, and Dipali Swain - Florida Polytechnic University

Inter-rater reliability of rubric scoring in a multi-section course

In this IRB-approved study, we investigate to what extent a rubric training program can achieve a high level of inter-rater reliability in scoring student work in a multi-section precalculus course. We describe the goals of the program, the process that a team of instructors used to write and refine assessment questions and rubrics, practice scoring with the rubrics together, and then independently score student work and compare the results. In this preliminary report, we present data from the first of four rounds of implementation and describe plans for future work.

Session V-B

Matthew Chin and Carina Shanahan - Embry-Riddle Aeronautical University

Parallelizing the Finite Difference Method for Solving a 2-Dimensional Wave Equation

This project explores the parallelization of solving a 2D wave equation on a square domain using the finite difference method (FDM). We implement four parallel strategies, with a primary focus on MPI, to accelerate the solution process. The wave equation is solved with Dirichlet boundary conditions, and a Gaussian pulse is applied at the center of the domain as the initial condition. We present both the results of the simulation and an analysis of the parallel performance. Lastly, we discuss potential directions for future work.

Terje Hill - Florida Atlantic University

How Group Work and LAs Transformed My Calculus Class

FAU recently adopted the Learning Assistant (LA) model as part of its new QEP initiative, aiming to enhance student learning through active engagement. In alignment with this effort, we redesigned the Calculus I course to incorporate active learning strategies that foster group collaboration, critical thinking, and independent discovery. Over the past three semesters, our LA-supported Calculus I course has seen remarkable success, transforming the classroom into an interactive learning environment where students actively engage with mathematical concepts, receive real-time feedback from instructors and LAs, and develop a deeper appreciation for the subject. In this talk, I will share insights from my experience, highlighting both the successes and the challenges of implementing this model. I will discuss what has worked well in facilitating student engagement and conceptual understanding, as well as areas where improvements are needed to further enhance the effectiveness of group work and peer learning in calculus instruction.

Alberto Domínguez (Graduate Student) and Shusen Pu - University of West Florida

The Regime-Switching Merton Jump-Diffusion Model and Volatility Smile Fitting

We present a stock option pricing model where the underlying asset dynamics are governed by a continuous-time Markov chain with two distinct regimes, each characterized by diffusion processes with lognormal jumps. The model is applied to pricing near-the-money European call and put options on the S&P 500 index. Numerical solutions are computed using the Milstein scheme. Model parameters are estimated through both econometric analysis of historical S&P 500 index data (1928–2024) and direct optimization by minimizing the L2 error between model predictions and observed option market prices. We discuss the trade-off between accuracy and interpretability in parameter selection and introduce a measure to assess model fragility, considering both internal consistency and external validity.

Mozhgan (Nora) Entekhhabi - Florida A&M University

Inverse Source Problems for Wave Propagation

Inverse source problems for wave propagation represent a critical area of research with far-reaching implications in various scientific disciplines. These types of problems focus on deducing the characteristics of a source that generates a measured wave field and other characteristic of domains, making them particularly important in applications such as medical imaging, geophysics, acoustics, and

antenna design. This research focuses on developing a technique to recover the source function of the Helmholtz equation, along with certain classical systems, using boundary data obtained at multiple wave numbers. This is applicable when the source is compactly supported within an arbitrary bounded C^2 boundary domain. The study establishes uniqueness for the source derived from Cauchy data on any open, non-empty section of the boundary for any positive value of K and demonstrates increased stability as the wave number K increases in two- and three-dimensional general domains. Various studies indicate that uniqueness can be achieved by employing multifrequency boundary measurements within a non-empty frequency interval (0; K).

Keshav Acharya - Embry-Riddle Aeronautical University

Breimesser-Pearson Theorem for vector-valued discrete Schrodinger operators

The Breimesser-Pearson Theorem provides the theory of value distribution for the boundary value of Herglotz functions and provide the relation between value distributions with the asymptotic behavior of the solutions of Schrödinger equations on the half-line. In this talk, we will generalize the Breimesser-Person theorem for vector-valued discrete Schrodinger operators.

Michael Schroeder - Stetson University

Primitive cycle decompositions of graphs

Given a graph G and a decomposition D of G, we say that D is primitive if no proper, non-trivial subset of D acts as a decomposition of an induced subgraph of G In this talk, we show that the necessary numerical conditions are sufficient for a cocktail party graph to have a primitive C4-decomposition.

Yuanchang Sun - Florida International University

Structure Constrained Nonnegative Matrix Factorizations: Convergence and Computation

In this talk, we introduce two structure constrained non-negative matrix factorization (NMF) approaches designed to address nonnegative blind source separation challenges. We develop corresponding iterative multiplicative update rules and establish their convergence properties. To demonstrate the effectiveness of our proposed methods, we provide numerical experiments using facial images.

Celeb Stewart (Undergraduate Student) - Florida State University

Image Segmentation via Role Extraction with Neighborhood Pattern Similarity Measure

Image segmentation is a fundamental task in computer vision, aiming to parse an image into meaningful objects or regions. As traditional methods are prone to over-segmentation or are overly rigid, we propose a novel approach using role extraction. Role extraction takes a collection of connected nodes, called a network, and simplifies it by grouping similarly behaving nodes into roles. To find these roles efficiently and effectively, we apply the neighborhood pattern similarity measure (NPSM) to the network representation of the image. We then group the nodes into roles with a clustering algorithm and reconstruct the image based on role assignments. Preliminary results show precise segmentation, reinforcing NPSM's utility and extending the role extraction problem to image segmentation. By simplifying segmentation, this technique provides a new approach with widespread industry applications

Contributed Posters Session

Kyle Ambrose, Blaine DuBois, Ryan Farrell (Graduate Student) - University of North Florida

Mathematical Strategies for a Spinner Game

This poster investigates a game in which a spinner is repeatedly spun until a target score is reached. The twist of the game is that after each round, the player may choose to increase or decrease the most recently spun value on the spinner. This simple mechanic introduces layers of control and complexity which lead to a mathematically rich and interesting problem. We study the dynamics of such a game, including the existence of a guaranteed-winning strategy as well as several intuitive approaches to the development of optimal play.

Anwar Hossain, Vi Nguyen, Asrafi Yesmin (Graduate Students) - University of North Florida

Jacksonville House Prices: A Data-Driven Analysis

In this study, we utilize house selling data in Jacksonville, Florida, from January 2022 to December 2024. Our analysis begins by using linear regression to examine the relationship between house prices and key factors such as property details and location. We then employ non-linear regression to enhance predictive accuracy. This study aims to provide valuable insights for buyers, sellers, and policymakers by improving the understanding of house price determinants.

Vi Nguyen (Graduate Student) - University of North Florida

The Domination Number of a Graph

A dominating set in a graph is a subset of the vertices in the graph such that every vertex of the graph is either in the dominating set or is adjacent to a vertex in the dominating set. The minimum size of a dominating set for a particular graph is its domination number. We discuss some well-known results and provide some applications.

Alexander Wiser (Undergraduate Student), Jason Kuo - University of West Florida

A Comparative Analysis of Euler, RK4, and Houbolt Methods for Projectile Motion with Air Resistance

Systems of nonlinear ordinary differential equations, ubiquitous in scientific and engineering applications, often do not yield to analytical techniques, and so in practice the most powerful tool at our disposal for modeling physical phenomena with such a system are numerical techniques. Some such techniques, namely Euler's Method or Runge-Kutta, have simple starting procedures that require only initial values. However, these methods are only conditionally stable and are computationally intensive. Other methods, namely the Houbolt method, require more data to start, but are stable under large time-steps and therefore less computationally intensive. This report concerns itself with the prospect of splicing these algorithms together, such that we may use only initial values to begin a Runge-Kutta type procedure to generate the necessary data and then complete the computation using the Houbolt Method. This method is applied to the problem of quadratic air resistance.

Emmanuel Paalam (Graduate Student), Achraf Cohen - University of West Florida

Predicting Student Dropout with Statistical Machine Learning

Academic dropout is a critical issue across all education levels, prompting extensive research to understand and mitigate it. This study explores machine learning models for predicting student dropout using the Education Longitudinal Study 2002 (ELS:2002) dataset, which tracks 16,000 students across the state through high school and postsecondary education. The dataset includes over 4,000 variables on academic performance, socioeconomic status, school engagement, and family background. We employed classification-focused supervised learning models, applying feature selection, imputation, encoding, and oversampling to enhance data quality. Model performance was evaluated using precision, recall, and F1-score metrics. XGBoost, combined with SMOTE oversampling and data imputation, demonstrated the best predictive balance. Our findings align with prior research on XGBoost's effectiveness in dropout prediction and contribute new insights by utilizing ELS:2002, which to our knowledge has not previously been applied to machine learning-based dropout forecasting.

FNU Shrishti (Graduate Student), Achraf Cohen - University of West Florida

Cherry Blossom Prediction with Conformal Prediction

The captivating phenomenon of cherry blossom trees inspires our exploration into predicting their bloom timing using advanced machine learning and uncertainty quantification (UQ). This project's focus is twofold: developing regression models to predict the cherry blossom day of the year in Washington, D.C. and incorporating UQ techniques to evaluate the reliability of these predictions. By leveraging diverse data sources on weather and climate change (e.g., temperature distribution, climate incidents, humidity, rain), We built models to minimize the mean absolute difference between predicted and actual values. We also quantified uncertainty using conformal prediction to guarantee the actual value lies within an interval with at least 90% probability. This approach generates reliable prediction intervals with guaranteed coverage. This dual approach enhances prediction accuracy while providing valuable insights to support tourism planning and ensure a better experience for visitors anticipating peak bloom.

Gianna Napoleon and Samuel Quinutolo (Undergraduate Students) - Embry-Riddle Aeronautical University

Mathematical Modeling of an Antenna in the 5G RF2 Range

This project aims to study the mathematical modeling of an antenna in a frequency range (26-52 GHz) in the 5G RF2 Band to be tested in an Over-The-Air (OTA) chamber and explore the modification of the model to investigate radiation patterns. In this project, we experiment with how different environments generate different path loss models and present some examples of the environments with their corresponding antennas. We brainstorm recommendations for the antenna to be used based on a particular environment to minimize the path loss. We examined different types of antennas and created simulations for the path loss to witness the effects of the signal strength. Substituting the chamber, the path loss of the antenna was tested in a closed-environment simulation. In conclusion, a double-ridge horn antenna is the best-suited antenna design for examining the behavior of the path loss to accommodate the frequency band

Onyx De Brock (Undergraduate Student) - University of North Florida

A Picnic with Newton: Serving Up a Raspberry Pi to Analyze the Mathematical Foundations of Spectroscopy

Newton's observations of the rainbow laid the foundation for spectroscopy, but today, digital methods allow for precise mathematical analysis of spectral data. In this project, we use a Raspberry Pi to capture diffraction images and apply mathematical models to extract wavelength distributions. Through pixel intensity analysis, curve fitting, and calibration techniques, we transform raw image data into a meaningful spectral breakdown, showcasing the power of computational spectroscopy.

Lily DiPaulo (Graduate Student) - Florida Institute of Technology

Finite Element Spaces of Double Forms

We develop finite element spaces of tensor products of differential forms. These spaces can be used to construct matrix fields and tensor fields used in numerical methods for elasticity and general relativity. We build upon the foundational work of Arnold, Falk, and Winther on finite element exterior calculus, as well as the results of L. Li on higher order finite element spaces for symmetric bilinear forms. Symmetric bilinear forms can be thought of as symmetric tensor products of 1-forms; we denote this space Λsym1,1. We extend Li's ideas to the symmetric product of 2-forms Λsym2,2.

Naya Adla (Undergraduate Student) and Thomas Vogel - Stetson University

Tracking Hate Speech on Twitter among in the Arab Region using Python-Based Tools

Arabic speakers rank fourth among social media users worldwide. Hate speech on social media has been extensively investigated. However, there is a lack of research on hate speech in Arabic. Using the *arHateDetector* dataset, the study investigated hate speech in the MENA region with Matplotlib, Pandas, and NumPy. The region was divided into three regions and seven sub-regions according to geocultural similarity. Dataset keywords were split into an ordinal scale according to offensiveness. Results were visualized using a 3D bar chart generated with Matplotlib. Kuwait and Iraq exhibited significantly higher frequency of hate speech, β=1.26, $p < 0.01$ while Qatar and Bahrain exhibited significantly lower frequency of hate speech, β=−1.59, $p< 0.01$). Disparities in hate speech among different MENA sub-regions could be related to socioeconomic and religious disparities. These findings offer an understudied thought-provoking view on online hate speech in a vibrant and dynamic environment like the MENA region.

Jackson Schuler (Graduate Student) - Embry-Riddle Aeronautical University

Explicit Solver for Hinge-Offset Origami Structures

In order to become useful in real-world applications, the two-dimensional art form of origami requires the addition of thickness, bringing complexity to the otherwise simple process of solving its angle relationships. By performing a tensor restructuring of the hinge rotation matrices and applying the two laws of thick-panel origami, an algorithm to explicitly obtain the solution-space of an arbitrary hinge-offset origami structure is obtained. The n-dimensional results are then reported through a dimension-reducing transformation, showcasing unique patterns which emerge from the characteristics of the specific structure simulated. The speed and accuracy of this algorithm is verified both virtually and experimentally through end translation and rotation values.

Bhawana Poudel Devkota (Graduate Student)-Embry-Riddle Aeronautical University

High-Performance Comparison of Gaussian Blur Implementation Using Advanced Computational Techniques

The popularity of parallel computing systems is increasing for dealing with complex problems and huge data. Gaussian blur is considered as a suitable image processing technique which consumes more time and resources. This work utilizes the different methods for working with the image data using Gaussian filter in different platform. This work explores different methods for performing Gaussian Blur, including NumPy, NumExpr, Numba (JIT), and MPI (Message Passing Interface). Each of these methods provides computational optimization in terms of execution time and scalability. The result depicts the performance comparison of the parallel systems in terms of the execution time and scalability. Numba is considered as the best solution for optimization in terms of execution time. MPI excels in scalability, making it ideal for large datasets. For smaller images, NumExpr provides a good balance of speed and simplicity, while NumPy remains a baseline for straightforward implementations.

Plenary Sessions

Victor Piercey, MAA Chair of Congress, Ferris State University

Bio: Victor Piercey is a Professor of Mathematics at Ferris State University, where he also serves as the Honors Program Director. Piercey earned a Ph.D in mathematics from the University of Arizona with a dissertation in algebraic geometry. He also holds a law degree from Columbia Law School with a certificate in international and comparative law, and an interdisciplinary humanities bachelor's degree from Michigan State University with concentrations in history, economics, and Russian.

Interdisciplinary work is at the heart of Piercey's teaching and scholarship. He has worked closely with business, social work, and nursing faculty to develop a quantitative reasoning course titled Quantitative Reasoning for Professionals. He has integrated his legal experience into his actuarial science teaching, particularly in his financial mathematics course. In addition, he co-leads a team integrating ethical reasoning in mathematics, and has done so himself in his quantitative reasoning and actuarial science courses. He has recently started conducting research using data science to contribute to genocide prevention. In his spare time, he enjoys reading history and playing guitar.

Reflections on Interdisciplinary Teaching Partnerships

Working with interdisciplinary partners to improve teaching is a rewarding experience and makes for better student learning environments. The SUMMIT-P consortium is an NSF-sponsored collection of 12 institutions where mathematics faculty are working with partner discipline faculty to revise and improve course offerings in the first two years of undergraduate education. Their work is based on research entitled "The Curriculum Foundations" conducted by the MAA Committee on Curriculum Renewal Across the First Two Years. In this talk I will share reflections on the SUMMIT-P experience, including both what we have done at Ferris and what has taken place at other institutions. I will also discuss ways other institutions could implement what we have learned from SUMMIT-P

Opel Jones, MAA NAM Speaker, Johns Hopkins University Applied Physics Laboratory

Bio: Opel is a loving husband, dedicated father, and servant to the community. He mentors, tutors, volunteers in his free time through his fraternity, and coaches youth football and youth baseball. Throughout the years, Opel has worked as an engineer, mathematics and statistics lecturer, development officer, and computer scientist, at several institutions and the federal government. He also served as Director of the Leadership Institute for several years at Hampton University, teaching leadership studies and developing leaders in addition to teaching mathematics and honors seminars. Currently, he is a mathematician and analyst at The Johns Hopkins University Applied Physics Laboratory. Additionally, he is currently serving on the County Council in Howard County, Maryland. He was first elected to office in 2018 and just re-elected in 2022.

Opel earned the B.S. in mathematics from Hampton University, the M.S. in mathematics from Howard University, and the Ph.D. in mathematics also from Howard University. He is a Life Member of Alpha Phi Alpha Fraternity, Inc., initiated at Hampton University, and past president of the local Howard County chapter. His professional associations include the American Mathematical Society, the Mathematical Association of America, and the National Association of Mathematicians. Opel loves music, football and baseball, reading, Sudoku puzzles, and is a lifelong practitioner of martial arts. He and his wife, Shaundra, are extremely proud parents of three: Opel II, Ivan, and Whitley!

Pattern Avoidance in Restricted Permutations

In 1974 Dumont found two types of permutations are counted by the same sequence. The first type is a permutation in which each even entry is followed by a smaller entry, and each odd entry is followed by a larger entry or ends the permutation. The second type is a permutation wherein if an entry is a deficiency, it must be even, and if an entry is an exceedance or a fixed point, it must be odd. These are now known as Dumont permutations of the first and second kinds. There are two other types of permutations which are also counted by the same sequence, known as Dumont permutations of the third and fourth kinds. In this talk we will discuss several enumerations of restricted Dumont permutations, that is Dumont permutations avoiding certain patterns. We will also briefly discuss their proofs which involve methods using induction, block decomposition, Dyck paths, and generating functions. We will conclude with a conjecture that the patterns 2143 and 3421 are indeed Wilf-equivalent on Dumont permutations of the first kind.

Shusen Pu, FL State Speaker, University of West Florida

Bio: Shusen Pu is an Assistant Professor in the Department of Mathematics and Statistics at the University of West Florida (UWF). He earned his Ph.D. in Applied Mathematics from Case Western Reserve University in 2020, specializing in stochastic processes in biological systems. Prior to joining UWF, he worked in the Department of Biomedical Engineering and Department of Mathematics at Vanderbilt University, where he focused on computational neuroscience and data analysis.

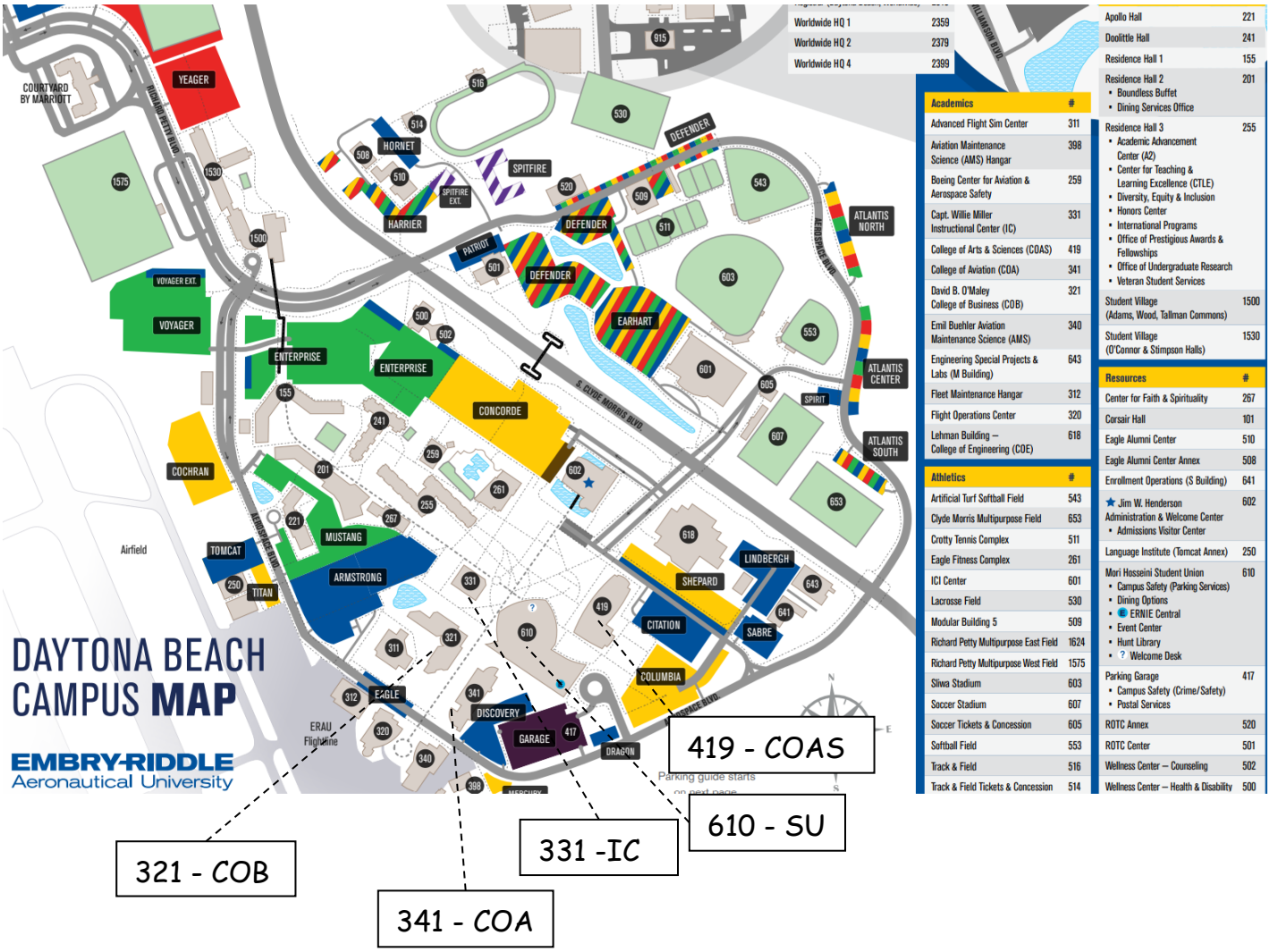
Dr. Pu's interdisciplinary research spans computational neuroscience, mathematical statistics, data analytics, and deep learning. He applies advanced mathematical and machine learning models to explore neural dynamics, working memory, and decision-making processes. His recent work has appeared in journals such as Nature Communications and Neuro Computation, and he has developed novel statistical distributions for applications in medicine, finance, and ecology. At UWF, Dr. Pu leads several research projects and has been recognized with awards for excellence in teaching and undergraduate research mentoring. An active member of the academic community, he organizes conference sessions and presents his findings at major international events, contributing to the advancement of computational biology and data science.

Decoding Neural Dynamics Using Machine Learning

This work explores prefrontal neural dynamics in working memory and passive states through machine learning and dimensionality reduction techniques. Neural data from rhesus monkeys were analyzed to decode task-related information and uncover cognitive mechanisms. Supervised learning models, including logistic regression and shallow neural networks, predicted task variables from firing rates with over 90% accuracy, revealing robust encoding in prefrontal and posterior parietal cortices. Principal component analysis further showed that prefrontal neurons represent stimuli in low-dimensional manifolds, undergoing rotations to minimize interference and support cognitive flexibility. These transformations occurred even without task training but became more structured post-training, aligning with task demands.

This study highlights the power of machine learning in decoding neural activity and provides insights into neural representations and their dynamic roles in cognition, bridging neuroscience and AI applications.

BUILDING MAP



321 - COB

341 - COA

331 -IC

610 - SU

419 - COAS

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