10th Annual Coastal Bend Mathetmatics and Statistics Conference

Hosted by the Department of Mathematics & Statistics at Texas A&M-Corpus Christi

Full Schedule of Talks

Schedule at a Glance

8:00 am - 8:30 am	Registration in OCNR Lobby and Refreshments in OCNR 135
8:30 am - 8:45 am	Inauguration and Remarks in OCNR 145
	Dr. D. Palaniappan
	Interim Chair, Department of Mathematics & Statistics
	Dr. Robert McKallip
	Dean, College of Science
9:00 am - 12:00 pm	Parallel Sessions in OCNR
12:00 pm - 1:00 pm	Lunch in UC Rotunda
1:00 pm - 3:00 pm	Parallel Sessions in OCNR
3:00 pm - 3:30 pm	Coffee Break in OCNR 135
3:30 pm - 6:00 pm	Parallel Sessions in OCNR

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Schedule of Sessions by Speaker and Title

DF1: Statistical Theory, Bayesian Methods & Applied Statistics

Time: 9:00-12:00; Location: OCNR-115; Chair: Mike Lindstrom

09:00-09:20	~~**Mai Dao** [WSU]~~ ~~Change Point Detection Using Bayesian Adaptive LASSO Quantile Regression~~	~~Abstract~~
09:20-09:40	**Jose H. Guardiola** [TAMU-CC] Inferential Methods For The Spherical-Dirichlet Distribution	Abstract
09:40-10:00	**George Yanev** [UTRGV] Monotone Empirical Bayes Estimation For Generalized Poisson Distribution	Abstract
10:00-10:20	**Min Wang** [UTSA] & **Zhuanzhuan Ma** [UTRGV] A Simple Two-Sample Bayesian Hotelling's T^2 For Equality Of Means	Abstract
10:20-10:40	**Sarjinder Singh** [TAMUK] Whispers Of Truth: A Hands-On Journey Into Warner's Randomized Response Model	Abstract
10:40-11:00	**Thirupathi Reddy Mokalla** [BCM] The Existence Of Treatment Response Heterogeneity Should Neither Be Dismissed Nor Presumed: Evidence From Multi-Period Crossover Design Trial Interventions	Abstract
11:00-11:20	**Mounika Kandukuri** [BCM] Measuring The Prevalence Of Dramatizing Language In Childhood Obesity Research	Abstract
11:20-11:40	**Hongwei Wang** [TAMIU] Enhancing Statistics Learning In An Engineering Class	Abstract
11:40-12:00	**Mike Lindstrom** [UTRGV] Patterns Of Multimorbidity Among Low Income Smokers: Insights From Moderation And Latent Class Analysis	Abstract

DF2: Machine Learning, Deep Learning & Remote Sensing

Time: 9:00-12:00; Location: OCNR-116; Chair: Sreelekha Guggilam

09:00-09:20	**Md Rashedur Rahman [UIW]** Deep Learning-Driven Quantitative Analysis Of Astrocyte Networks In Dense Fluorescent Micrographs	Abstract
09:20-09:40	**Madhavi Pagare [TAMU-CC]** Satellite Image Interpolation Using Diffusion Models	Abstract
09:40-10:00	**B. Veena S. N. Rao [TAMU-CC]** Bridging Mathematical Biology And AI: A Hybrid KAN-VBGF Framework For Fish Trajectories	Abstract
10:00-10:20	**Sreelekha Guggilam [TAMU-CC]** Large Deviations Anomaly Detection for Multivariate Time Series	Abstract
10:20-10:40	**Yifan Hsu [TAMUK]** Detecting Hidden Bias In AI Models Using Propensity Scores	Abstract
10:40-11:00	**Lei Jin [TAMU-CC]** Investigating Asthma Disparities In Hispanic Communities Using Machine Learning Algorithms On The All Of Us Researcher Workbench	Abstract
11:00-11:20	**Ashutosh Tiwari [TAMU-Ag]** Representation Learning And Multi-Modal Data Modeling For Crop Canopy Volume Prediction	Abstract
11:20-11:40	**Lei Zhao [TAMU-Ag]** Neural CDEs For Robust Time-Series Forecasting Of Crop Growth Dynamics	Abstract
11:40-12:00	**Benjamin Ghansah [TAMU-Ag]** Predicting Canopy Height Of Crops Using ICESat-2 Photons, SkySat Images And ResUNet Deep Learning Model	Abstract

DF3: Applied ML & Precision Agriculture

Time: 13:00-15:00; Location: OCNR-115; Chair: Zhuolin Qu

13:00-13:20	**Zheng Wei [TAMU-CC]** Shape-Aware Deep Learning For Models Of Production	Abstract
13:20-13:40	**Yuri Calil [TAMU-Ag]** Bayesian Yield Forecasting And Optimal Farm Decisions: A Digital Twin Approach To Production And Price Risk In South Texas Cotton	Abstract
13:40-14:00	**Pankaj Pal [TAMU-Ag]** Digital Twin Framework For Cotton Feature Forecasting And Management Recommendations	Abstract
14:00-14:20	**Sayantan Sarkar [TAMU-Ag]** Use Of A Five-Parameter Logistic Function To Model Cotton Growth	Abstract
14:20-14:40	**Jose L. Landivar [TAMU-Ag]** Representation Learning And Multi-Modal Data Modeling For Crop Canopy Volume Prediction	Abstract
14:40-15:00	**Mahendra Bhandari [TAMU-Ag]** CropCAST: An In-Season Crop Growth Forecasting Framework Using Satellite Imagery and Context-Aware Deep Learning	Abstract

DS1: Data Science and AI in Agriculture

Time: 9:00-12:00; Location: OCNR-145; Chair: Zheng Wei

09:00-09:20	**Belinda Arnero [TAMUK]** Algae based biofertilizer for sustainable crop production and soil health improvement	Abstract
09:20-09:40	**Zak Zapata [TAMU-CC]** Shape-Aware Deep Learning For Panel Data Models Of Production	Abstract
09:40-10:00	**Chen Liu [TAMU-CC]** Bayesian Neural Networks Based Stochastic Frontier Model	Abstract
10:00-10:20	**Christopher Salazar [TAMU-CC]** A Controlled Study Of Root Growth Response Using Environmental Manipulation And Data Analysis	Abstract
10:20-10:40	**Ashley Marines [TAMU-CC]** Modeling Lightning Activity With Kolmogorov–Arnold Networks Based Poisson Regression For Lighting Count Prediction	Abstract
10:40-11:00	**CJ Perez [TAMU-CC]** Gaussian Process Regression With Matérn Kernels For Modeling Gaia Stellar Time Series	Abstract
11:00-11:10	**Jacob Poland [TAMU-CC]** Low-Power Distributed Soil Monitoring Network Using LoRa Mesh And LTE Connectivity	Abstract
11:10-11:20	**Francisco J. Trevino [TAMUK]** Effects Of Biochar And Organic Amendments On Cover Crop Growth And Soil Water Holding Capacity In Clay Loam Soils	Abstract
11:20-11:30	**Allyson Furlan [TAMU-CC]** Defining Extreme Heat: A Statistical Framework For Heatwave Detection	Abstract
11:30-11:40	**Ernesto Reyes [TAMU-CC]** The Use Of Remote Sensing Technologies To Evaluate Grazing Behavior In A Cow-Calf Operation In The South Texas Region	Abstract
11:40-11:50	**Cheyenne Martin [TAMU-CC]** Greenhouse Robotics for Autonomous Intelligent Labor	Abstract
11:50-12:00	**Sushil Paudyal [TAMU]** Is Association Between Serum Energy Metabolites, Milk Metabolites And Composition Different In Mastitic And Healthy Dairy Cows?	Abstract

DS2: Medical & Health AI

Time: 13:00-14:40; Location: OCNR-145; Chair: Aden Ahmed

13:00-13:20	**Gifty Duah [UTRGV]** A Bayesian-Optimized Ensemble Deep Learning Framework For Automated Retinal Disease Classification Using OCT Imaging	Abstract
13:20-13:40	**Peggy Enyonam Akabuah [UTRGV]** Investigating Optimal Deep Learning Methods And Machine Learning Methods For Predicting Diabetes Type 2 Using Longitudinal Data	Abstract
13:40-14:00	**Christopher Attafuah [UTRGV]** Multimodal Transformer Modeling Of Alzheimer's Disease Severity Using Longitudinal Clinical And Neuroimaging Data	Abstract
14:00-14:20	**Samanvitha Karri [TAMU-CC]** Multimodal Feature Fusion: Combining CNNs And Sequence Models For Pneumonia Progression	Abstract
14:20-14:40	**Gowtham Kamle [TAMU-CC]** Towards AI-Assisted Orthopedics: Real-Time Pediatric Wrist Fracture Detection	Abstract
14:40-15:00	**Hossein Naderi [TAMU-CC]** Modeling Vaccination Uptake Using Demographic And LLM-Extracted Neighborhood Features From Street-Level Imagery	Abstract

DS3: Statistical Methods & Computational Science

Time: 13:00-15:00; Location: OCNR-116; Chair: Jose H. Guardiola

13:00-13:20 **Huynh Lan Phuong Le [TAMU-CC]** Abstract
Lomb-Scargle Method For Robust Trend Estimation In Environmental Time Series With Systematic Missingness

13:20-13:40 **Suhong Ye [TAMU-CC]** Abstract
Block Bootstrap For Comparing The Mean Directions Of Two Circular Time Series

13:40-14:00 **Arianna E. Ortiz [TAMIU]** Abstract
From Data To Decision: Using ANOVA To Select Valid Statistical Models In Laboratory Research

14:00-14:20 **Yashaswi Bastakoti [TAMUK]** Abstract
A New Forced Randomized Response Model

14:20-14:40 **Omar Sharif [UTRGV]** Abstract
Prion Spread On The Mouse Connectome: A Stochastic Network Model

14:40-15:00 **Maria Vasquez [TAMIU]** Abstract
Age, BMI Percentile, And Kidney Function In Hispanic Children: A Cross-Sectional Study Of eGFR And Gender Differences

DS4: Computing, ML & Engineering

Time: 15:30-17:30; Location: OCNR-145; Chair: Lei Jin

15:30-15:50 **Anshika Rani [TAMU-CC]** Abstract
Knowledge Distillation For Time-Series Analysis

15:50-16:10 **Manidhar Aduri [TAMU-CC]** Abstract
Accelerating Computational Fracture Mechanics: A Reproduction Study Of Fourier Neural Operators

16:10-16:30 **Fatmir Gjergji & Nathan Castro [UIW]** Abstract
Predicting Student Performance Using Machine Learning Techniques

16:30-16:50 **Emmanuel Boadi [UTRGV]** Abstract
Backbone-Aware Semi-Supervised Learning For DNS-Based DDoS Detection Under Extreme Class Imbalance

16:50-17:10 **Yejin Hwang [TAMU-CC]** Abstract
Financial Time-Series Forecasting With Deep Learning Models And Social Media Sentiment

17:10-17:30 **Jahnavi Krishna Koda [TAMU-CC]** Abstract
Kolmogorov–Arnold Networks As Interpretable Autoregressive Surrogates For Next-Frame Crack Path Prediction In Phase-Field Fracture

DS5: Health, Social Science, Environmental & Applied Research

Time: 15:30-17:30; Location: OCNR-116; Chair: Kun Gou

15:30-15:50 **Nene Coulibaly [TAMU-CC]** Abstract
Predicting Global Lightnings Using Deep Neural Networks

15:50-16:10 **Shishir Sapkota [TAMU-Ag]** Abstract
Monitoring spatio-temporal dynamics of forage species using high resolution satellite and UAV imagery under rotational stocking management strategy

16:10-16:30 **Mariah Roberts [TAMU-CC]** Abstract
Real-Time Structural Assessment In Post-Disaster Environments Using 3D Reconstruction

16:30-16:50 **Kristel Rochell Herrera [TAMIU]** Abstract
Application Of The Taguchi Method For Aircraft Engine Remaining Useful Life (RUL) Prediction

16:50-17:10 **Mirzobedil Dzhamolzoda [TAMIU]** Abstract
How Strongly Do Education Investment And Enrollment Predict Economic Growth Across Countries?

17:10-17:30 **Jose Herrera [TAMIU]** Abstract
Statistics Of Student Enrollment At TAMIU

Ed1: Mathematics Education Morning Session

Time: 9:00-11:50; Location: OCNR-130; Chair: Celil Ekici

09:30-09:50 **Aaron L. Modic [TAMIU]** Abstract
Bridging The Gap: Mathematical Hurdles In Undergraduate Electromagnetism

10:00-10:20 **Daniel Arias [TAMUK]** Abstract
On Improved Calibration Estimation In Stratified Sampling

10:30-10:50 **Arturo Villarreal [TAMIU]** Abstract
Wronskian Method

11:00-11:20 **Jasmin Ortiz [TAMIU]** Abstract
The Influence Of Secondary Education On Students And Its Result On STEM Engagement

11:30-11:50 **Qiuchen Hai [UTSA]** Abstract
A Project-Based Approach To Teaching Elementary Statistics

Ed2: The Influence of Secondary Education on Students and Its Result on STEM Engagement
Time: 13:00-13:40; Location: OCNR-130; Chair: Craig McCarron

13:00-13:40	**Craig McCarron [TAMUSA]** Panel Discussion On Collaboration To Provide Remote Upper-Level Mathematics Courses	Abstract

MF1: Advanced Numerical Methods for PDEs and Multiscale Problems
Time: 9:00-12:00; Location: OCNR-117; Chair: Maria Vasilyeva

09:00-09:20	**Loic Cappanera [UH]** Artificial Compressibility Method For Incompressible Multiphase Flows	Abstract
09:20-09:40	**Ahsan Ali [Baylor]** Efficient Multigrid Solvers For Time-Dependent Rayleigh-Bénard Convection	Abstract
09:40-10:00	**Ram Manohar [TAMU-CC]** Convergence Analysis Of Adaptive Finite Element Schemes For Regularized Variational Models Of Quasi-Static Brittle Fracture In Strain-Limiting Elastic Media	Abstract
10:00-10:20	**Natasha S Sharma [UTEP]** Numerical Analysis Of The First Finite Element Method For The Phase Field Crystal Equation	Abstract
10:20-10:40	**Saqib Hussain [TAMIU]** Computational Efficiency Through Degree-Of-Freedom Reduction In Weak Galerkin Finite Element Methods	Abstract
10:40-11:00	**Arash Goligerdian [TAMU-CC]** Coupled Cahn-Hilliard Systems With Reaction	Abstract
11:00-11:20	**Yiwei Wang [UCR]** Learning From SDE Snapshots Data: How Do Energy-Dissipation Laws Help Learn Dynamics?	Abstract
11:20-11:40	**Maria Vasilyeva [TAMU-CC]** Multiscale Graph Reduction For Discrete Diffusion	Abstract

MF2: Data-Driven Methods, Networks, and Discrete Mathematics

Time: 9:00-12:00; Location: OCNR-118; Chair: Lihua Zuo

09:00-09:20 **Simona Hodis [TAMUK]** Abstract
Quantifying Predictability And Surprise In Music

09:20-09:40 **E Cabral Balreira [Trinity]** Abstract
An Iterative Method For Redistricting

09:40-10:00 **Aden Ahmed [TAMUK]** Abstract
PQ Penny-Flip Game

10:00-10:20 **Qi Han [TAMUSA]** Abstract
A Short Proof Of The Logarithmic Derivative Lemma In Several Complex Variables

10:20-10:40 **Jingbo Liu [TAMUSA]** Abstract
On The Spinor Genus And The Lattice Isomorphism Problem

10:40-11:00 **Lihua Zuo [TAMU-CC]** Abstract
Sea Surface Temperature Modeling Using Stochastic Differential Equations

11:00-11:20 **Juan B. Gutiérrez [UTSA]** Abstract
A Mathematical Theory Of Discursive Networks

11:20-11:40 **Genival da Silva [TAMU-SA]** Abstract
On The $C^{p'}$-Conjecture

MF3: Nonlinear Mechanics and Mathematical Physics

Time: 13:00-15:00; Location: OCNR-117; Chair: Qi Han

13:00-13:20 **Reza R. Ahangar [TAMUK]** Abstract
Nonlinear Operator Differential Equations

13:20-13:40 **Kun Gou [TAMUSA]** Abstract
Mechanical Characterization And Hyperelastic-Damage Modeling Of Decellularized Human Umbilical Arteries For Vascular Graft Applications

13:40-14:00 **Dambaru Bhatta [UTRGV]** Abstract
Stress–Strain Behavior In Transversely Isotropic Strain-Limiting Thermoelastic Media Under Linearly Varying Vertical Displacement Loading

14:00-14:20 **Cesar Contreras [TAMIU]** Abstract
Asymptotic Stabilization Of Mechanical Systems On Semidirect Product Lie Groups With Broken Symmetry Via Controlled Lagrangians

14:20-14:40 **John Harrison [TAMU-CC]** Abstract
High-Energy Neutrino Flavor State Transition Probabilities

MF4: Mathematical Biology and Data-Driven Life Sciences

Time: 15:30-17:30; Location: OCNR-117; Chair: Juan B. Gutiérrez

15:30-15:50 **Md Nazmul Hassan [TAMUK]** Abstract
Modeling Elemental Constraints Across Aquatic Food Webs

15:50-16:10 **Zhuolin Qu [UTSA]** Abstract
Density-Mediated Emergence Impacts The Success Of Wolbachia-Based Mosquito Population Reduction Strategies

16:10-16:30 **Md Mustafijur Rahman [TAMUSA]** Abstract
Computational Approaches To Stochastic Biological Systems With Migration And Interaction.

16:30-16:50 **Gangadhara Boregowda [UTRGV]** Abstract
Stability And Bifurcation Analysis Of Prion Dynamics With The Unfolded Protein Response And Aggregation-Fragmentation Process

16:50-17:10 **Jun Chen [TAMUK]** Abstract
Unraveling The Effects Of Fungicides On Honey Bee Populations: A Mathematical Modeling With Seasonality

MS1: Mathematical Modeling of Complex Biological, Physical, and Engineering Systems

Time: 9:00-12:00; Location: OCNR-259; Chair: Harry Lee

09:00-09:20	**Jenita Jahangir** [ULA] Backward Bifurcations In Discrete-Time Epidemic Models With Vaccination	Abstract
09:20-09:40	**Alfredo Razo** [LC] Determining Volumes Of Irregular Celestial Bodies	Abstract
09:40-10:00	**Joseph Medina** [TAMUSA] Weighted Yes-No Voting And The U.N. Security Council	Abstract
10:00-10:20	**Alessandra Martinez** [UTRGV] Mathematical Framework For Modeling Non-Genetic Heredity In Vesicle Systems	Abstract
10:20-10:40	**Nicholas McLain** [TAMU-CC] Modeling The Impact Of Adipose Tissue And Immune Dynamics On Tumor Growth And Treatment Efficacy	Abstract
10:40-11:00	**David Figueroa** [TAMIU] Ordinary Differential Equations In Engineering	Abstract
11:00-11:20	**Ananya Gopal Hegde** [TAMU-CC] An Iterative Numerical Approach For Nonlinear Wave Propagation In Elastic Bars	Abstract
11:20-11:40	**Ruben Dominguez** [TAMU-CC] A Mathematical Model For Energy-Aware Task Scheduling In Energy-Harvesting Wireless Systems	Abstract

MS2: Data-Driven and Machine Learning Approaches

Time: 13:00-15:00; Location: OCNR-259; Chair: Saqib Hussain

13:00-13:20 **Jacob Kapita [LSU]** Abstract
Learning Reaction Rates From Product Formation-Time Data In Multi-Scale Stochastic Reaction Networks

13:20-13:40 **Chandana Pati [TAMU-CC]** Abstract
Learning Bounded Deformation: A SLE–KAN Framework For Interpretable Constitutive Modeling

13:40-14:00 **Mahidhar Reddy Patukuri [TAMU-CC]** Abstract
Kolmogorov-Arnold Networks As Interpretable Surrogates For Nonlinear Differential Equations

14:00-14:20 **Joel Williams [UTRGV]** Abstract
Generating Live Heatmaps Of EDR Data Through A Spatiotemporal Weighting

14:20-14:40 **Syed Izzat Ullah [TAMU-CC]** Abstract
A Finite Mixture Of Closed-Form Kinematic Primitives With Heteroscedastic Gaussian Uncertainty For Synthetic 3D Trajectory Generation

14:40-15:00 **Hyangim Ji [TAMU-CC]** Abstract
Machine Learning For Predator–Prey Equilibrium With Disease

MS3: Mechanics, Dynamical Systems, and Applied Mathematical Analysis

Time: 15:30-17:30; Location: OCNR-259; Chair: Dambaru Bhatta

15:30-15:50 **Changyan Shi [UTRGV]** Abstract
A Sasa-Satsuma-mKdV Equation And Its Various Soliton Solutions

15:50-16:10 **Saugata Ghosh [UTRGV]** Abstract
Numerical Investigation Of Crack-Tip Fields In Transversely Isotropic Media Under Piecewise Slope Loading

16:10-16:30 **Martin Reyes Jr. [LC]** Abstract
Does Center of Mass Affects the Buildings That We See?

16:30-16:50 **Gustavo Nieto [LC]** Abstract
Staying Balanced In Space: A Mathematical Approach To Satellite Stability

16:50-17:10 ~~**Changyan Shi [UTRGV]** Abstract~~
~~Integrable Discrete Massive Thirring Model~~

List of participants by organization

Baylor College of Medicine

Mounika Kandukuri
Thirupathi Reddy Mokalla

Baylor University

Ahsan Ali

Code Ag

Zak Zapata

Del Mar College

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Rebecca Nava

Laredo College

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Miguel Contreras
Paloma Diaz

Louisiana State University

Jacob Kapita

Rice University

George Chumbipuma

Southern Methodist University

Karl Backs

Texas A&M AgriLife Research

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Ashutosh Tiwari
Jose L. Landivar
Mahendra Bhandari
Pankaj Pal
Sayantan Sarkar
Shishir Sapkota
Benjamin Ghansah
Lei Zhao

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Cesar Contreras
David Figueroa
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Jasmin
Jose Herrera
Kristel Rochell Herrera
Maria Vasquez
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Saqib Hussain

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Sushil Paudyal

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Allyson Furlan
Ananya Gopal Hegde
Anshika Rani
Arash Goligerdian
Arjun Damaraju
Arkadz Kirshtein
Ashley Marines
B. Veena S. N. Rao
Chandana Pati
Chen Liu
Christopher Salazar
Cheyenne Martin
CJ Perez
Ernesto Reyes
Eva Marsden
George Tintera
Gowtham Kamle
Hossein Naderi
Huynh Lan Phuong Le
Hyangim Ji
Jacob Poland
Jahnavi Krishna Koda
John Harrison
Jose Baca
Jose H. Guardiola
Lei Jin
Lihua Zuo
Lucy Huang
Madhavi Pagare
Mahidhar Reddy Patukuri
Manidhar Aduri
Maria Vasilyeva
Mariah Roberts
Nene Coulibaly
Nicholas McLain
Raphael Pangilinan
Ram Manohar
Ruben Dominguez
S M Mallikarjunaiah
Samanvitha Karri
Shuvadeepa Basu
Sreelekha Guggilam
Subarna Biswas
Suhong Ye
Syed Izzat Ullah
Yejin Hwang
Zheng Wei

Texas A&M University - Kingsville

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Elsa Brown
Faranak Rabiei
Francisco J. Trevino
Guillermo Flores
Jake Johnston
Jun Chen
Kaniz Fatema Nipa
Md Nazmul Hassan
Reza R. Ahangar
Romualda C Barrera
Sanku Dattamudi
Sarjinder Singh
Simona Hodis
Yashaswi Bastakoti
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Kun Gou
Md Mustafijur Rahman
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The University of Texas at El Paso

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Min Wang
Qiuchen Hai
Tong Wu
Zhuolin Qu

The University of Texas Rio Grande Valley

Alessandra Martinez
Changyan Shi
Christopher Attafuah
Dambaru Bhatta
Emmanuel Boadi
Gangadhara Boregowda
George Yanev
Gifty Duah
Joel Williams
Justice Yaw Effah
Mike Lindstrom
Omar Sharif
Peggy Enyonam Akabuah
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E Cabral Balreira

University of California, Riverside

Yiwei Wang

University of Houston

Loic Cappanera

University of Louisiana at Lafayette

Jenita Jahangir

University of the Incarnate Word

Fatmir Gjergji
Md Rafiul Islam
Md Rashedur Rahman
Nathan Castro
Vinay Kumar

Wichita State University

Mai Dao

DF1: Statistical Theory, Bayesian Methods & Applied Statistics (09:00-12:00)

Change point detection using Bayesian adaptive LASSO quantile regression

Speaker: Mai Dao
Co-Authors: Ranran Chen, Donald Lien, Keying Ye, and Min Wang (UTSA)
Affiliation: Wichita State University, Wichita, KS
Time: 09:00-09:20

Statistical inference can be adversely impacted by abrupt changes or 'change points' in data series, such as those found in climate change analysis. Therefore, recognizing these change points is crucial to ensure accurate and reliable analysis. In this paper, we propose a novel Bayesian adaptive LASSO quantile regression (QR) model to robustly detect and locate change points in univariate data series exhibiting a simple linear trend. The model incorporates an asymmetric Laplace distribution (ALD) for the model error and independent Laplace priors on the regression coefficients. The paper presents an efficient Markov chain Monte Carlo (MCMC) sampling algorithm that takes advantage of the mixture representations of the ALD and Laplace distributions to draw samples from the joint posterior distribution of the unknown parameters. Numerical studies demonstrate that our approach delivers robust and accurate detection for multiple change points, as evidenced by high true detection rates and low false discovery rates in scenarios of varying sample sizes, error distributions, and change points' locations and jump sizes. The effectiveness of the proposed methodology is showcased through carefully designed simulation studies and two real-data applications, where our results exhibit favorable comparisons to those of an existing frequentist procedure. Thus, our proposed method offers a comprehensive solution for accurate change point analysis, further improving the reliability and applications of QR-based change point detection processes.

Inferential Methods for the Spherical-Dirichlet Distribution

Speaker: Jose H. Guardiola
Co-Authors: Jacob Harris - Texas A&M University Corpus Christi
Affiliation: Texas A&M University Corpus Christi, 6300 Ocean Drive
Time: 09:20-09:40

This work advances the theoretical foundation of the spherical-Dirichlet distribution (SDD) by developing a comprehensive inferential framework, including a closed-form Fisher information matrix and likelihood ratio tests (LRTs) for key directional hypotheses. In contrast to earlier studies that emphasized the generative and geometric aspects of the SDD, we focus on constructing concrete tools for statistical inference, such as tests for uniformity and for the equality of directional means within this constrained manifold setting. The resulting Fisher information facilitates both efficient computation and asymptotic analysis of maximum likelihood estimators. Through simulation studies, we validate chi-square approximations and demonstrate robust performance in finite samples. Finally, an established case study from the wine chemistry literature underscores the practical utility of the proposed methods.

Monotone Empirical Bayes Estimation for Generalized Poisson Distribution

Speaker: George Yanev
Co-Authors: Alberta Johnson, University of Northern Colorado
Affiliation: University of Texas Rio Grande Valley, 1201 W. University Dr., Edinburg TX 78539.
Time: 09:40-10:00

We construct an Empirical Bayes (EB) estimator for the parameter of the Generalized Poisson Distribution and prove that it is asymptotically optimal and estimate the rate of convergence. Simulation results indicate that the EB estimator suffers from "jumpiness", hence the need for monotonization. Finally, we establish that the monotone EB estimator outperforms other estimators by having smallest regret risk.

A simple two-sample Bayesian Hotelling's T^2 for equality of mean

Speaker: Min Wang[1] & Zhuanzhuan Ma[2]
Co-Authors: Ruizhe Zhang[3]; Keying Ye[1]
Affiliation: [1]UTSA Department of Statistics and Data Science
[2]University of Texas Rio Grande Valley; [3]Tufts University
Time: 10:00-10:20

In this talk, we provide an explicit closed-form Bayes factor for comparing the means of two-sample populations in multivariate hypothesis testing. The proposed approach not only encompasses many existing Bayesian tests as special cases but also serves as a Bayesian counterpart to the classical Hotelling's Tˆ2 test, highlighting its appealing properties in practical applications. It relies solely on data through the Hotelling's Tˆ2 test and can be easily integrated into a multivariate analysis course with a focus on Bayesian thinking. We also delve into the elicitation of prior specifications, a crucial step in the process. In addressing common challenges in high-dimensional mean vector testing problems, we discuss the generalization of this procedure in high-dimensional settings. Finally, we illustrate the practicality of this approach through several examples.

Whispers of Truth: A Hands-On Journey into Warner's Randomized Response Model

Speaker: Sarjinder Singh
Co-Authors: Yashaswi Bastakoti, Daniel Arias, Department of Mathematics, Texas A&M University-Kingsville, Kingsville, TX 78363, USA
Affiliation: Texas A&M University-Kingsville
Time: 10:20-10:40

In a world where some questions are too sensitive to answer honestly, how can we still discover the truth? This talk invites participants on a gentle and engaging journey into the heart of Warner's Randomized Response Model, a groundbreaking idea that protects privacy while revealing hidden realities. Through a carefully designed hands-on activity, participants will step into the roles of both respondent and researcher. Using simple randomization tools, such as coins, cards, or spinners, they will experience how anonymity can empower honesty. As the activity unfolds, what first appears as randomness gradually transforms into meaningful statistical insight. This session is not just about formulas and estimators: it is about trust, human dignity, and the courage to answer truthfully when protected. Participants will see how mathematics can serve as a bridge between sensitive human experiences and reliable scientific conclusions. By the end of the talk, attendees will gain both an intuitive and practical understanding of how Warner's model works, why it matters in real-world surveys, and how simple classroom activities can bring deep statistical ideas to life.

The Existence of Treatment Response Heterogeneity Should Neither Be Dismissed nor Presumed: Evidence from Multi-period Crossover Design Trial Interventions

Speaker: Thirupathi Reddy Mokalla
Co-Authors: Thirupathi Reddy Mokalla1; Mounika Kandukuri1; Natasha Chidekel Bergmann2; Raul Cruz3; Arno Greyling4; Filip K. Knop5; Henry Thomas Roberston6; and David B. Allison1* 1 Department of Pediatrics and USDA Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX, USA; 2Endocrine Unit, Copenhagen University Hospital - Herlev-Gentofte, Herlev, Denmark; 3Department of Epidemiology and Biostatistics, Indiana University School of Public Health-Bloomington, IN, USA; 4Unilever R&D, Wageningen, the Netherlands; 5Center for Clinical Metabolic Research, Copenhagen University Hospital - Herlev-Gentofte, Hellerup, Denmark (currently: Novo Nordisk, BagsvÃ¦rd, Denmark); 6Statistical Consultant, Pell City, Alabama, USA.
Affiliation: Department of Pediatrics and USDA Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX, USA
Time: 10:40-11:00

Treatment response heterogeneity (TRH) refers to the variation in response to a given treatment across individuals. Designing studies to accommodate TRH estimation and appropriately analyzing TRH could improve the precision and personalization of medical treatments. To illustrate TRH estimation, linear mixed-effects models were used to examine biomarkers in post-treatment individuals' data from four published multi-period crossover design studies evaluating metabolic, nutritional, glycemic, and pharmaceutical treatments. A study on glucagon-like peptide-1 (GLP-1) in obese patients found a significant subject-by-treatment interaction $p = 0.004$, suggesting interindividual variability in the glucagon biomarker. In the second study on D-allulose, erythritol, and satiety, a significant random effect for subject-by-treatment emerged only for cholecystokinin $p = 0.011$, indicating heterogeneous individual responses. In a third pharmacokinetic study of celecoxib or tramadol, no subject-by-treatment effects were observed for celecoxib or tramadol biomarkers, indicating no heterogeneous individual responses. In the fourth study of dose-response mulberry fruit extraction, a significant subject-by-treatment effect was found for plasma glucose and serum insulin, providing evidence of TRH. Our study shows that specific study designs and analysis may provide valid TRH estimations when direct variance estimation is unattainable. This study's results show that while statistically significant TRH can be found in certain situations, clinically meaningful TRH should not be presumed in others.

Key words: Treatment response heterogeneity; Interindividual variation; Glucagon; Insulin; C-peptide; D-allulose, and erythritol; GLP-1

Measuring the prevalence of dramatizing language in childhood obesity research

Speaker: Mounika Kandukuri
Co-Authors: Mounika Kandukuri1, Thirupathi Reddy Mokalla1, Wang Rita1, Salma Musaad1 ,Colby Vorland2, Jon Agley2, Danny Valdez2, Dana Larson. Anderson 2, Sabrina Ayoub-Charette3, Dana Tulodziecki 4 and David B. Allison1 1 USDA Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX, USA, 2Indiana University, Bloomington, IN, USA,3Unviersity of Toronto, Canada,4 Purdue University
Affiliation: Baylor College of Medicine
Time: 11:00-11:20

Background: Rigorous scientific writing usually requires objectivity and transparency, providing a more balanced view of the findings. Subjective and promotional language is becoming more prevalent in research articles across several disciplines, which also referred to as ”hype,” or ”spin,” has been noted in earlier research. It is plausible that terms like ”groundbreaking,” ”remarkably effective,” or ”crucial” can affect how research findings are viewed independently of the study results or methodological rigor. This effect could reasonably be hypothesized to have an impact on funding decisions, public perception, and researchers view about scientific evidence. We introduce the term ”drama words' to refer to the spectrum of dramatizing linguistic patterns in scientific communication. Motivated by these concerns, this study investigates whether research on childhood obesity has such non-objective linguistic patterns. Methods: We developed a search string to identify childhood obesity related empirical research articles published between 2012-2025 from PubMed Central. As part of the initial analytical phase, we selected a working sample of 1,000 articles for preprocessing and annotation. Titles and abstracts were preprocessed using standard NLP procedures including tokenization, lemmatization, and part of speech tagging with SpaCy and NLTK. Drama word candidates will be identified using an integrated lexicon technique that combines a previously established hype lexicon with a custom lexicon built from our dataset. Two independent annotators will review and classify each candidate term, with disagreements resolved through discussion. Inter-rater reliability will be evaluated using Cohen's Kappa. With predetermined threshold values $of \geq 0.8$ indicating acceptable agreement. Frequency counts will be normalized to ensure comparability among documents of variable length, enabling reliable longitudinal analyses. The Mann-Kendall test for monotonic trends and moving average trend visualization will be conducted. Expected Outcomes: This study will develop a customized lexicon of ”drama words' specific to childhood obesity-related research and take initial computational steps to identify the long-term trends in the use of non-objective descriptive language in scientific communication. Findings will support more transparent, objective, and ethically responsible scientific communication within childhood obesity research. Keywords: Drama words, Lexicon, promotional language

Enhancing Statistics Learning in an Engineering class

Speaker: Hongwei Wang
Co-Authors: Deepak Ganta, Maria Vasquez, Khaled Enab
Affiliation: Texas A&M International University. Laredo, TX
Time: 11:20-11:40

Statistical education is a crucial yet often overlooked aspect of AI in higher education. However, traditional approaches usually focus heavily on procedural knowledge, leaving students anxious about statistics and less confident in applying concepts to real-world problems. This study examines a method that enhances statistical learning outcomes by integrating data visualization and gamification strategies. Students were randomly assigned to either a control group (CG) or an intervention group (IG), and each group was further divided into teams. The curriculum was enhanced in a college statistics course offered for both engineering and math majors. IG students applied data visualization and gamification in a hands-on group project aimed at solving a real-world problem and competed as they presented their results. The effectiveness of this approach was assessed through statistical analyses comparing the performance of IG and CG in surveys, final grades, and project grades. The results from evaluation methods indicated that IG students outperformed CG students, demonstrating a positive impact of gamification on statistics education.

Patterns of multimorbidity among low income smokers: insights from moderation and latent class analysis

Speaker: Mike Lindstrom
Co-Authors: Monique T Cano (Yale School of Medicine); Oscar F Rojas Perez (Yale School of Medicine); Ricardo F Munoz (Department of Psychiatry, University of California, San Francisco)
Affiliation: The University of Texas Rio Grande Valley
Time: 11:40-12:00

In this talk, we examine a sample of low income smokers from California. By studying the presence or absence of 24 different physical/mental health conditions among participants, along with other health metrics, we gain insights into this unique patient population. We first study how patient-clinician communication moderates self-rated health given the relative abundance of diagnoses. We then use a Mixture of Bernoulli model to characterize participants as belonging to one of three clusters, each with their own unique risk profile.

DF2: Machine Learning, Deep Learning & Remote Sensing (09:00-12:00)

Deep Learning-Driven Quantitative Analysis of Astrocyte Networks in Dense Fluorescent Micrographs

Speaker: Md Rashedur Rahman
Co-Authors: Sarah Sayed (University of Houston), Demetrio Labate (University of Houston), Emanuel Papadakis (University of Houston)
Affiliation: University of the Incarnate Word, 4301 Broadway, San Antonio, TX 78209
Time: 09:00-09:20

Astrocytes are one of the most essential and complex subclasses of glial cells in the central nervous system, playing critical roles in regulating synaptic activity, maintaining the blood-brain barrier, controlling cerebral blood flow, and responding to injury. Despite their importance, many fundamental mechanisms of astrocyte function remain poorly understood. A major obstacle is the difficulty of quantitatively analyzing astrocytes from microscopy data, as these cells exhibit highly heterogeneous morphologies, intricate branching structures, and dense spatial interactions with neurons and other glial populations.

Current image analysis tools often struggle to capture astrocytes accurately, particularly in crowded environments where cell boundaries overlap or where shapes deviate significantly from standard geometric assumptions. This limitation restricts our ability to study astrocyte networks, measure structural alterations, and understand their responses under different physiological and pathological conditions.

To address these challenges, my work introduces a new deep-learning-based quantitative framework for the automatic detection and analysis of GFAP-immunolabeled astrocytes directly from brightfield and fluorescent micrographs. Building upon the state-of-the-art object detection architecture YOLOv8, we develop customized and optimized models specifically designed for astrocyte identification under highly complex imaging conditions. In addition, we propose a novel automated counting and performance evaluation pipeline that enables robust quantitative analysis at scale.

Extensive numerical experiments across diverse imaging modalities demonstrate that our approach achieves competitive and often superior accuracy compared to traditional and existing state-of-the-art techniques, with particularly strong performance in densely packed astrocyte regions where conventional methods fail. This framework provides an efficient and mathematically grounded tool for advancing quantitative neuroglial research and opens new possibilities for studying astrocyte behavior and interactions within the CNS.

Satellite Image Interpolation Using Diffusion Models

Speaker: Madhavi Pagare
Co-Authors: Vigneshwar lokoji, Danielle Smilovsky, and Sreelekha Guggilam, Texas A&M University Corpus Christi, Texas, USA
Affiliation: Texas A&M University - Corpus Christi
Time: 09:20-09:40

Different image interpolation methods have been developed to enhance the visibility of remotely sensed or other images. In satellite and remote sensing imagery, image interpolation refers to the process of estimating and filling the missing or corrupted pixel values. These are often caused by factors such as cloud contamination, shadows, sensor malfunctions, etc. Classical interpolation

methods such as linear interpolation, cubic spline, and spatio-temporal interpolation can introduce smoothing that is unrealistic and artifacts that blur sharp features and distort localized changes in satellite imagery. To address this limitation, we implemented a novel diffusion-based interpolation framework to perform temporal interpolation on InSAR satellite imagery. We considered InSAR satellite imagery for Corpus Christi, Texas, from year 2018-2025. Our proposed methods address.several key challenges for in- terpolating satellite images. 1)Our approach learns to reconstruct an intermediate or missing year by jointly using the left and right observations instead of treating them separately. 2)Beyond simple averaging, our method uses a diffusion process to revise an initial estimate, to minimize noise and improve spatial detail. 3)To train our model, we have used real left-middle-right year triplets, which enables it to directly learn realistic temporal changes from data. 4)Furthermore, the approach directly regulates the amount of diffusion applied during refinement by choosing the diffusion start step using actual ground-truth validation instead of fixing it beforehand. 5)Finally, by using random masking of inputs and min-SNR loss weighting, our approach improves training stability and robustness. The proposed approach is evaluated under two settings: midpoint image interpolation between consecutive yearly observations and ground-truth reconstruction(LOYO). We also present these findings across random seeds to guarantee consistent and dependable performance. The results show that diffusion based models, such as DiffusionSat and SatDiff, outperform classical interpolation, neural network, and CNN based ap- proaches and provide more balanced and reliable reconstruction performance.In our study, the findings indicate that these diffusion models significantly improve the state of the art over traditional interpolation methods by offering an effective and scalable solution for reconstructing missing satellite observations and preserving main spatial structure of InSAR imagery.

Bridging Mathematical Biology and AI: A Hybrid KAN-VBGF Framework for Fish Trajectories

Speaker: B. Veena S. N. Rao
Co-Authors: Chandana Pati
Affiliation: Texas A&M University - Corpus Christi
Time: 09:40-10:00

Accurately predicting juvenile fish growth is a persistent challenge in quantitative biology, as classical models capture broad developmental trends but miss critical, high-resolution individual deviations. To bridge this gap, we introduce a hybrid computational framework that synergizes the mechanistic Von Bertalanffy Growth Function (VBGF) with advanced machine learning. We first fit the classical VBGF to daily increment data, establishing a highly interpretable biological baseline parameterized by asymptotic size and growth rate. To capture the systematic discrepancies missed by this baseline, we deploy Kolmogorov-Arnold Networks (KANs) to explicitly model the residual growth dynamics. By evaluating a pure baseline alongside strict hybrid, teacher-forced autoregressive, and stabilized rollout models, we rigorously assess the structural stability and predictive accuracy of this residual learning approach. Ultimately, this framework transcends black-box methodologies by offering a biologically grounded, interpretable paradigm that pinpoints where classical models succeed and where data-driven corrections are essential for robust forecasting.

Large Deviations Anomaly Detection for Multivariate Time Series

Speaker: Sreelekha Guggilam
Affiliation: Texas A&M University-Corpus Christi
Time: 10:00-10:20

Time series anomaly detection is frequently used to identify extreme behaviors within a single time series. Identifying extreme trends in relation to a collection of other time series, on the other hand, is frequently of significant interest in domains such as environmental monitoring, economic surveillance, and infrastructure resilience. Using concepts from large deviations theory, we propose an online anomaly detection algorithm for identifying anomalies in a collection of multivariate time series that can scale to large, high-dimensional data. We demonstrate the effectiveness of the proposed Large Deviations Anomaly Detection (LAD) algorithm on real-world datasets, showing its ability to identify regions exhibiting anomalous trends across multiple correlated variables.

Detecting Hidden Bias in AI Models Using Propensity Scores

Speaker: Yifan Hsu
Co-Authors: Lee Carl, Central Michigan University
Affiliation: Texas A&M University-Kingsville
Time: 10:20-10:40

Pre-trained models such as CLIP have achieved remarkable success in extracting meaningful representations for a wide range of AI tasks. However, these latent representations often contain hidden biases that can negatively impact downstream performance. In this talk, I introduce a statistical framework for detecting and mitigating such bias using propensity scores.

By analyzing CLIP-generated representations, we show that samples with low propensity scores tend to lie near decision boundaries and are more likely to be misclassified. Removing these samples leads to improved classification performance, demonstrating the importance of data quality in model training.

Beyond this empirical result, I explore the distributional behavior of propensity scores across classes, revealing patterns such as heavy concentration near one and varying degrees of skewness. Motivated by these observations, I discuss how propensity scores can be extended beyond their traditional interpretation as probabilities into a more general measure of misclassification risk, using transformations such as the logit function and distributional modeling (e.g., Beta and logit-normal distributions).

Finally, I outline how this framework can be integrated into modern machine learning pipelines, including deep learning and large language models, to improve data quality during pre-training, model validation, and prediction. This work highlights a bridge between causal inference and AI, offering a principled approach to improving robustness and reliability in data-driven systems.

Investigating Asthma Disparities in Hispanic Communities Using Machine Learning Algorithms on the All of Us Researcher Workbench

Speaker: Lei Jin
Co-Authors: Rajesh Melaram , Texas A&M University-Corpus Christi
Affiliation: Texas A&M University-Corpus Christi
Time: 10:40-11:00

This study examined factors associated with asthma prevalence among Hispanic participants in the United States using data from the All of Us Research Program. We compared participants with and without asthma and applied logistic regression together with interpretable machine learning methods, including Multivariate Adaptive Regression Splines and Conditional Inference Trees, to identify important predictors and interactions. Logistic regression showed that older age, female sex, greater access barriers, higher BMI, lower income, and higher education were associated with higher odds of asthma. Participants with greater access barriers had 26.3% higher odds of asthma, and each one-unit increase in BMI was associated with a 2.9% increase in asthma odds. MARS and CIT further identified BMI, age, sex, income, education, and access barriers as key factors, highlighting nonlinear effects and important interactions. Higher asthma prevalence was especially evident among participants with high BMI, lower income, and greater access barriers. These findings identify important factors associated with asthma prevalence in Hispanic populations and may help inform efforts to reduce disparities related to obesity and healthcare access.

Representation Learning and Multi-Modal Data Modeling for Crop Canopy Volume Prediction

Speaker: Ashutosh Tiwari
Co-Authors: Lei Zhao, Sayantan Sarkar, Jose L. Landivar Scott, Juan Landivar, Mahendra Bhandari
Affiliation: Texas A&M Agrilife Research Center Corpus Christi
Time: 11:00-11:20

Crop canopy volume (CV), closely related to biomass, crop growth, and yield, is an essential variable for precision agriculture applications. Its accurate estimation usually depends on unmanned aerial system (UAS) measurements that reduce human effort and time but are infeasible to be scaled across fields and seasons. Here we present a multi-modal data modeling framework to estimate canopy volume using satellite and ancillary data, including PlanetScope vegetation metrics, Sentinel-2 multispectral reflectance, Sentinel-1 SAR backscatter, and weather information. Using crop fields in South Texas, we align multi-source observations to common field-scale grid cells and evaluate both baseline machine learning models and representation learning approaches for canopy volume prediction. Preliminary results show promising agreement between predicted and UAV-derived canopy volume, with performance improving later in the growing season. The results further suggest that PlanetScope carries strong field-scale predictive signal, Sentinel-2 contributes complementary spectral information, Sentinel-1 captures structural sensitivity, and heat units improve late-season prediction.

Neural CDEs for Robust Time-Series Forecasting of Crop Growth Dynamics

Speaker: Lei Zhao
Co-Authors: Dugan Um, Devanayagam Palaniappan, Jose Landivar, Juan Landivar, Mahendra Bhandari
Affiliation: Texas A&M Agrilife Research Center Corpus Christi
Time: 11:20-11:40

Cotton is a globally significant cash crop, yet its production is increasingly threatened by climate change and environmental degradation. Sustainable cotton production necessitates timely and accurate monitoring of crop growth dynamics to enable precision management. Canopy cover (CC) is a critical indicator of crop growth status and can reflect early signs of stress. However, its measurement via Unmanned Aerial Vehicles (UAVs) often yields irregularly sampled time series data, posing a substantial challenge for conventional deep learning models. To address this challenge, this study introduces a novel framework that integrates Neural Controlled Differential Equations (Neural CDEs) with a robust uncertainty quantification (UQ) methodology. By modeling temporal dynamics as a continuous process driven by incoming observations, our Neural CDE-based approach naturally handles the irregular sampling inherent in agricultural field data. To move beyond deterministic point predictions and provide actionable insights for decision-making, we incorporate the Monte Carlo Dropout method to generate calibrated prediction intervals, approximating predictive uncertainty by capturing both aleatoric and epistemic components.

Predicting Canopy Height of Crops Using ICESat-2 Photons, SkySat Images and ResUNet Deep Learning Model

Speaker: Benjamin Ghansah
Co-Authors: Jose L. Landivar Scott (Texas A&M AgriLife, Corpus Christi), Qiming Guo (Texas A&M University-Corpus Christi), Mahendra Bhandari (Texas A&M AgriLife, Corpus Christi), Michael Starek (Texas A&M University-Corpus Christi), Jamie Foster (Texas A&M AgriLife, Beeville)
Affiliation: Texas A&M Agrilife Research Center Corpus Christi
Time: 11:40-12:00

Crop canopy height is an important parameter in precision agriculture (PA). While contemporary studies have used deep learning models to predict canopy height, most of these studies target forest areas with less focus on croplands. Estimation errors of these models also tend to be greater and less effective in predicting canopy height of crops which tend to have lower height. This study predicted crop canopy height to a sub-meter vertical accuracy using the ResUNet deep learning model, Ice, Cloud and Land Elevation Satellite-2 (ICESat-2) photons and high-resolution SkySat images. ICESat-2 height measurements and SkySat images were captured over sugarcane field in Florida, USA on September 05, 2023. The ResUNet model was used to establish a relationship between ICESat-2 absolute canopy height and the SkySat image, enabling the development of a wall-to-wall canopy height model (CHM) for the croplands. Evaluation metric (RMSE) confirmed the accuracy of the model (training RMSE = 0.51 m, test RMSE = 0.68 m, validation RMSE = 0.68 m), achieving sub-meter vertical accuracy.

DF3: Applied ML & Precision Agriculture (13:00-14:40)

Shape-Aware Deep Learning for Models of Production

Speaker: Zheng Wei
Co-Authors: Zheng Wei, Huiyan Sang, Artem Prokhorov, and Yu Ma
Affiliation: MATH&STAT Dept at Texas A&M University-Corpus Christi
Time: 13:00-13:20

The stochastic frontier model (SFM) is widely employed in the analysis of productivity and efficiency, yet strict parametric forms, such as the Cobb-Douglas and Translog functions, are often assumed for modeling production, leading to potential misspecification issues. While semi- and nonparametric SFMs offer greater flexibility, they face challenges in imposing monotonicity and concavity to maintain their desirable economic interpretation. We develop a framework which enforces the shape restrictions within deep neural networks (DNNs). The stochastic frontier model we develop (DNN-SFM) leverages the flexibility and predictive power of DNNs while preserving key properties of a production function, such as free disposability and diminishing marginal product. Additionally, we demonstrate how to use Shapley values to measure and interpret global and local effects of individual inputs on the production frontier in cases when model parameters to not admit a simple interpretation. The performance of the proposed method is assessed using simulations while a real-world application to rice production in the Philippines illustrates empirical relevance of the proposed method.

Bayesian Yield Forecasting and Optimal Farm Decisions: A Digital Twin Approach to Production and Price Risk in South Texas Cotton

Speaker: Yuri Calil
Affiliation: Texas A&M AgriLife
Time: 13:20-13:40

Agricultural producers make irreversible input, hedging, and marketing decisions under substantial yield uncertainty that resolves only gradually across the growing season. We develop a decision-theoretic framework in which a digital twin, a sensor- and imagery-driven statistical model of the field, generates rolling Bayesian posteriors over end-of-season yield, progressively tightening the conditional variance as new information arrives. Embedding these evolving posteriors in a Lapan-Moschini-style hedging model with CARA preferences and jointly normal price, basis, and yield shocks, we derive closed-form expressions for the optimal futures position and show how the hedge ratio, expected utility, and certainty-equivalent profit respond to information arrival. We characterize the value of information as a function of forecast-precision gains and establish comparative statics linking digital-twin accuracy to risk premia and optimal input intensity. The framework is calibrated to South Texas upland cotton using in-season UAS-based yield forecasts and ICE No. 2 cotton futures. Preliminary results indicate economically meaningful gains in certainty-equivalent returns and measurable reductions in downside risk exposure.

Digital Twin Framework for Cotton Feature Forecasting and Management Recommendations

Speaker: Pankaj Pal
Affiliation: Texas A&M AgriLife
Time: 13:40-14:00

Effective monitoring and management of crops throughout the growing season are essential for optimizing yield. Over the past decade, unmanned aerial systems (UAS) have significantly transformed precision agriculture by enabling efficient and high-resolution remote monitoring. The integration of UAS-derived data with machine learning has further enhanced crop management practices, leading to substantial improvements in areas such as evapotranspiration estimation, irrigation scheduling, nitrogen use efficiency, and yield prediction.

To address the specific challenges associated with cotton crop management, we developed a Digital Twin (DT) framework that integrates UAS data with machine learning modeling. This framework enables the forecasting of key crop characteristics, including canopy cover, plant height, canopy volume, and the excess greenness index (ExG). Furthermore, a yield estimation model was developed to predict crop yield based on these forecasted features, providing a comprehensive decision-support tool for precision cotton management.

Use of a Five-Parameter Logistic Function to Model Cotton Growth

Speaker: Sayantan Sarkar
Affiliation: Texas A&M Agriculture Research, Corpus Christi, TX
Time: 14:00-14:20

Understanding how plants grow over time is important for agriculture and data analysis. In this study, we used a mathematical growth curve to describe how cotton plants height varies over a growing season. Plant height was measured several times using an aerial sensor mounted on a Uncrewed Aerial System (UAS). These repeated measurements formed a time series of plant growth. Several simple logistic and sigmoid curves with different numbers of parameters were tested to see which one best described the data. The five-parameter logistic function performed best with highest R2 (0.98) and lowest RMSE (6.41). The first and second order derivative of the five-parameter logistic function was performed to obtain several canopy growth parameters. These parameters were used to evaluate the maturity of cotton genotypes and correlated with yield. The maximum growth rate was correlated with yield (R2=0.46 in 2016 and R2=0.68 in 2021). Additionally, the time of onset of steady phase was used to rate maturity of the genotypes with 80% accuracy. This study shows that we can summarize complex growth patterns using a small number of meaningful parameters. Statistical analysis showed clear differences in growth patterns across years. This work shows how mathematical modeling and basic statistical tools can be used to simplify and understand real-world biological growth data.

Representation Learning and Multi-Modal Data Modeling for Crop Canopy Volume Prediction

Speaker: Jose L. Landivar
Affiliation: Texas A&M AgriLife Research 10345 TX-44, Corpus Christi, TX 78406
Time: 14:20-14:40

Ground-based sensing platforms like AgriVision Pro generate massive amounts of high-frequency data by capturing 1Hz measurements of canopy cover (CC), the Excess Green index (ExG), and canopy height (CH) using edge-AI vision and active LiDAR. Because this continuous raw data is often too granular and noisy for direct agronomic decision-making, we developed an automated statistical pipeline to translate these raw sensor readings into actionable Geographic Information System (GIS) visualizations. First, the continuous georeferenced data is spatially aggregated into predefined grids. This spatial averaging smooths out GPS jitter and high-frequency sensor variance, providing clear, localized crop metrics. Next, to autonomously generate variable-rate prescription maps without manual GIS intervention, the aggregated grid data is processed using the Jenks Natural Breaks optimization algorithm and categorizes the crop data into five classes. Operating entirely within a low-bandwidth cellular architecture, this computational framework bypasses the need for heavy data processing like photogrammetry. At the conclusion of a field operation, the system automatically generates and emails daily grid-summary files (CSVs) alongside finalized heatmap pictures for each measured feature (CC, ExG, CH). This integrated mathematical and edge-computing approach seamlessly transitions raw sensor data into automated, ready-to-use decision-support tools for precision agriculture.

CropCAST: An In-Season Crop Growth Forecasting Framework Using Satellite Imagery and Context-Aware Deep Learning

Speaker: Mahendra Bhandari
Co-Authors: Ramana Heggadal Math, Ashutosh Tiwari, Lei Zhao, Benjamin Ghansah, Jose Landivar Scott, Juan Landivar
Affiliation: Texas A&M AgriLife Research
Time: 14:40-15:00

Monitoring crop growth is key to informed agricultural decisions, and satellite-based forecasting offers a scalable, reliable solution. We propose an online, data-driven framework that uses satellite-derived Normalized Difference Vegetation Index (NDVI) obtained from PlanetScope as a representative canopy feature to simulate cotton crop growth and performance through the growing season. The training process is designed to extrapolate from incomplete growth trajectories to better learn correlations between input trajectories and the anticipated curve shape at randomly selected dates in the season. The growth simulation model is chained with a downstream yield prediction model to enable in-season yield forecasting. We created a multi-year dataset using PlanetScope imagery (2020-2024) from 23,000 grids covering diverse cotton fields across Texas. The framework was evaluated for both temporal and spatial variability. It produced accurate forecasts up to 30-45 days in advance, with performance improving as the season progressed across three fields located at south Texas and Texas High Plains. RMSE was computed for forecasts from 50 Days After Planting (DAP) to the end of the season, in 10-day intervals. Errors consistently decreased over time and locations as online fine-tuning progressed. Results were cross-checked with curve plots for every grid, confirming visual alignment. The strongest agreement occurred during the linear growth phase, a critical stage in the crop cycle. During data preprocessing, log-normal fitting was applied to NDVI trajectories to capture the rise, peak, and senescence phases of crop growth, reducing irregularities and seasonal variability in the data. The architecture integrates efficient data batching with an LSTM-based sequence-to-sequence model, trained to predict the remaining NDVI sequence from the first n days of growth. Position-awareness is enhanced through masked exposure, teacher forcing, and autoregressive decoding. Inertia-based parameters were introduced during online fine-tuning to ensure stable adjustments as new sequential data became available. Predictions are generated at 9 m Ã— 9 m resolution, providing field-level insights that help farmers and agronomists monitor and mage crops precisely. We are integrating this framework into a scalable microservices-based crop monitoring tool for seamless database integration through an intuitive user interface. Farmers and other end-users gain timely insights into crop health, development trends, and expected yields, highlighting the potential of satellite data and deep learning to bridge AI and agriculture.

DS1: Data Science and AI in Agriculture (09:00-12:00)

Effects of Biochar and Organic Amendments on Cover Crop Growth and Soil Water Holding Capacity in Clay Loam Soils

Speaker: Belinda Arnero
Co-Authors: Sanku Dattamudi, Saoli Chanda, Krishnaswamy Jayachandran, Belinda Arnero
Affiliation: Texas A&M University - Kingsville; 700 University Blvd, Kingsville, TX, 78363
Time: 09:00-09:20

Algae-based biofertilizers are emerging as a promising tool for enhancing crop productivity and improving soil health. Among these, blue-green algae (cyanobacteria) have gained attention as an innovative addition to organic nutrient management systems due to their multifunctional benefits. Additionally, the ecosystem services offered by these biofertilizers are significant for sustainable farming approaches. However, excessive proliferation of algae in freshwater systems, commonly known as harmful algal blooms (HABs), poses significant ecological challenges by limiting light penetration and inducing hypoxic conditions. Addressing this issue through resource recovery offers a sustainable pathway that links environmental remediation with agricultural productivity.

In this project, cyanobacterial biomass was harvested as slurry from multiple freshwater lakes in Central Florida, USA, processed into a biofertilizer, and applied to high-value cropping systems. The results demonstrated notable improvements in crop performance and soil health indicators. Overall, this approach highlights a circular and sustainable strategy in which the removal of algal biomass from freshwater ecosystems aids in restoring ecological balance while simultaneously providing an effective organic nutrient source for high-value crop production.

Shape-Aware Deep Learning for Panel Data Models of Production

Speaker: Zak Zapata
Co-Authors: Zheng Wei, Faculty Advisor, Texas A&M University Corpus Christi
Affiliation: Code Ag
Time: 09:20-09:40

Stochastic Frontier Modeling was first introduced by Aigner et al. (1977) and independently by Meeusen and van den Broeck (1977) as a parametric framework for estimating production efficiency while accounting for noise. Classical SFM typically requires specifying a production function based on prior knowledge of the relationship between input and output variables and was originally developed primarily for cross-sectional data. Later, panel data extensions were proposed by Battese and Coelli (1992, 1995), enabling efficiency analysis in longitudinal settings. In this paper, we review panel-data SFM models and their estimation algorithms for efficiency analysis and propose a neural network-based stochastic frontier model for panel data (Panel NN-SFM). The proposed approach extends the shape-aware deep learning framework developed by Wei et al. (2026). We demonstrate the capability of the proposed model through simulation studies, followed by an empirical application using rice production panel data from the Philippines, and employ SHapley Additive exPlanations (SHAP) values to interpret the neural network model and assess the contributions of input variables to production efficiency.

Bayesian Neural Networks based Stochastic Frontier Model

Speaker: Chen Liu
Co-Authors: Dr. Zheng Wei
Affiliation: Texas A&M University-Corpus Christi
Time: 09:40-10:00

Stochastic Frontier Models (SFMs) are widely used to evaluate efficiency, but traditional estimation methods often impose restrictive distributional assumptions that limit flexibility in capturing nonlinear production processes. This study develops an approach that incorporates Bayesian Neural Networks (BNNs) into SFMs, using probabilistic learning and Markov Chain Monte Carlo (MCMC) methods to move beyond parametric constraints and provide uncertainty-aware efficiency estimates. By combining the flexibility of neural networks with the Bayesian framework, the approach improves reliability in frontier estimation. Results indicate that BNN-based SFMs can produce more accurate and informative efficiency scores, marking a meaningful advancement in the study of frontier analysis.

A Controlled Study of Root Growth Response Using Environmental Manipulation and Data Analysis

Speaker: Christopher Salazar
Affiliation: Texas A&M University - Corpus Christi
Time: 10:00-10:20

Soil degradation, climate variability, and increasing food demand are creating a need for agricultural systems that use fewer resources and remain effective under challenging conditions. This study presents a controlled experimental approach to understanding how plant roots respond to changes in their environment within a smart greenhouse system. Radish microgreens were selected as a model crop because of their fast growth cycle, allowing repeated trials and consistent data collection. Two growing environments, a soil based rhizobox system and an aeroponic system, are operated side by side to enable direct comparison under similar conditions. Environmental factors including soil moisture, temperature, light intensity, and carbon dioxide are continuously monitored using sensors, while root growth measurements such as length and biomass are recorded over time. The system produces structured, time based datasets that allow for clear comparison of how roots respond to differences in water availability, nutrient distribution, and oxygen exposure. Initial work has established a repeatable experimental process and a reliable data collection pipeline. Expected outcomes include identifying statistically meaningful differences in growth patterns across systems, understanding how roots respond to environmental stress, and building a foundation for future predictive modeling. This work highlights the value of combining controlled experiments with data analysis to support more efficient and adaptive agricultural practices.

Modeling Lightning Activity with Kolmogorov-Arnold Networks based Poisson Regression for Lighting count Prediction

Speaker: Ashley Marines
Co-Authors: Zheng Wei and CODE-AG
Affiliation: Data Science Texas A&M University-Corpus Christi
Time: 10:20-10:40

Accurate forecasting of lightning occurrence is essential for improving severe weather warnings, aviation safety, and climate risk assessments. Traditional regression-based neural models often predict continuous-valued outputs, limiting their effectiveness when modeling discrete count data such as lightning strike occurrences. This thesis proposes a novel approach that integrates the recently developed Kolmogorov-Arnold Network (KAN) architecture with Poisson regression to directly model lightning counts as a stochastic process. The expected outcome is a novel neural modeling framework capable of both robust generalization and scientific interpretability, advancing data-driven lightning prediction for atmospheric sciences.

Gaussian Process Regression with MatÃ©rn Kernels for Modeling Gaia Stellar Time Series

Speaker: CJ Perez
Co-Authors: Dr. Wei (mentor)
Affiliation: Texas A&M University-Corpus Christi
Time: 10:40-11:00

Astronomical time-series data from the European Space Agency's Gaia mission are characterized by irregular sampling, heteroscedastic uncertainties, and complex correlated variability, posing significant challenges for traditional parametric modeling approaches. In this work, we develop a Gaussian Process (GP) regression framework using MatÃ©rn covariance kernels to model and reconstruct stellar light curves from Gaia observations. The MatÃ©rn kernel provides a flexible class of covariance functions capable of capturing varying degrees of smoothness in astrophysical signals, making it well-suited for representing realistic stellar variability.

Low-Power Distributed Soil Monitoring Network Using LoRa Mesh and LTE Connectivity

Speaker: Jacob Poland
Affiliation: Texas A&M University-Corpus Christi
Time: 11:00-11:10

Title: Low-Power Distributed Soil Monitoring Network Using LoRa Mesh and LTE Connectivity

Abstract: This project presents a distributed soil sensing network designed for low-power, remote data collection using a hub-and-worker architecture. Worker nodes, built on Arduino Uno microcontrollers, collect SDI-12 soil sensor data and transmit it over a serial connection to Heltec LoRa32 V3 boards running Meshtastic firmware. A central hub device, based on an Arduino Mega, receives data from the mesh network through a serial connection to a Heltec LoRa32 V3 board running the same Meshtastic firmware, and forwards collected data over I2C to a Blues Notecard LTE module, which uploads it to Google Sheets. To maximize battery life, all nodes implement relay-controlled power switching that selectively cuts power to the LTE modem, LoRa radio, and soil sensors when not in active use. The soil data aggregated through this network will serve as a training dataset for machine learning models aimed at analyzing soil conditions and optimizing water usage. This architecture enables scalable, energy-efficient soil monitoring across distributed field locations where wired infrastructure is unavailable, leveraging the long-range, low-power characteristics of LoRa mesh networking combined with reliable LTE connectivity for cloud data uploads.

Effects of Biochar and Organic Amendments on Cover Crop Growth and Soil Water Holding Capacity in Clay Loam Soils

Speaker: Francisco J. Trevino
Co-Authors: Francisco Trevino, Erik Zamora, Shad D. Nelson, Mahima Gumadala, Saoli Chanda, and Sanku Dattamudi; Department of AAES, Texas A&M University- Kingsville (TAMUK) Kingsville, TX
Affiliation: Texas A&M Kingsville; 1050 W Santa Gertrudis Ave Kingsville, TX 78363
Time: 11:10-11:20

Clay loam soils in South Texas are dense, compacted, and poorly drained, limiting crop productivity and soil function. This study applied a quantitative, experimental approach to evaluate the effects of biochar, organic amendments (cow manure and vermicompost), synthetic fertilizer, and biostimulants on okra (Abelmoschus esculentus €˜Clemson Spineless') growth under greenhouse conditions. Eight treatments were arranged in a randomized block design with three replications $n = 24 experimental units$. Treatments included an unamended control, two biochar application rates (6 and 12 t/ac equivalents), organic amendments, synthetic fertilizer, biostimulants, and a 50/50 synthetic fertilizer-biostimulant blend. Plant height, stem diameter, leaf width, and chlorophyll content (SPAD) were measured repeatedly over an 8-week period, generating Raw and Aggregated Observation Datasets for comparative analysis and transformed data sets. Treatment effects were evaluated through descriptive statistics and temporal trend analysis to assess differences in growth dynamics and physiological response. Additional observational data were collected following an unplanned heat stress event on September 1, enabling qualitative assessment of treatment-dependent resilience. Results indicated that organic amendments improved soil physical condition, while synthetic fertilizer promoted rapid early vegetative growth without measurable improvements in soil structure. Biochar treatments demonstrated consistent and sustained growth trajectories, with higher SPAD values relative to other treatments, particularly at the higher application rate. Across measured variables, biochar exhibited comparable or improved performance relative to both organic and synthetic inputs. These findings highlight the utility of structured experimental design and repeated-measures analysis in evaluating soil amendment efficacy and suggest that biochar may provide a stable, data-supported approach to improving soil quality and crop performance under variable environmental conditions.

Defining Extreme Heat: A Statistical Framework for Heatwave Detection

Speaker: Allyson Furlan
Co-Authors: Dr. Lucy Huang, Texas A&M University-Corpus Christi
Affiliation: Texas A&M University-Corpus Christi 6300 Ocean Dr Corpus Christi, TX 78412
Time: 11:20-11:30

Heat waves are typically defined as sustained periods of extreme temperature, yet the lack of a consistent quantitative definition creates challenges for statistical analysis and comparison across regions and time. This study develops a statistical framework for identifying and analyzing heat-wave events in Texas using threshold-based and time-series methods applied to historical climate data. Heat waves are characterized as sequences of consecutive days exceeding locally defined thresholds derived from the distribution of temperature observations. These thresholds may be based on statistical percentiles or other measures of deviation from typical conditions and are computed in a way that accounts for seasonal variability. Additional variables, such as humidity, are incorporated to capture the influence of atmospheric conditions on extreme heat. The framework is applied to a multi-year time series of temperature data across Texas to evaluate changes in heat-wave frequency, duration, and intensity. Preliminary analysis suggests increasing trends in both the frequency and persistence of extreme heat events, with variability across regions. Results also highlight the sensitivity of heat-wave detection to threshold selection and baseline definition. This work demonstrates how statistical methods can be used to systematically identify extreme temperature events and provide a flexible foundation for further spatiotemporal analysis of climate extremes.

The Use of Remote Sensing Technologies to Evaluate Grazing Behavior in a Cow-Calf Operation in the South Texas Region

Speaker: Ernesto Reyes
Co-Authors: Dr. Lucy Huang, Texas A&M University - Corpus Christi; Dr. Mahendra Bhandari, Texas A&M AgriLife Research Center - Corpus Christi; Dr. Jamie Foster, Texas A&M AgriLife Research Center - Beeville
Affiliation: Texas A&M University - Corpus Christi 6300 Ocean Dr, Corpus Christi, TX 78412
Time: 11:30-11:40

The use of remote sensing techniques in agriculture has proven to be a reliable, and rapid, tool in collecting data over large areas. By pairing Global Positioning Systems (GPS) and Geographical Information Systems (GIS), this research aims to demonstrate the utility of remote sensing to monitor cattle movement over a 90-day trial period, in a South Texas cow-calf operation. Computational tools were used to generate intensity maps, hotspot analysis maps, and interpolate area use. The results shown provide a strong backing for the use of remote sensing to managing livestock.

Greenhouse Robotics for Autonomous Intelligent Labor

Speaker: Cheyenne Martin
Co-Authors: Code-AG, Coral Robotics Lab; Angelina Reyes, Riley Rossner, Ethan Hughes, Russell Cain, Teran Hendricks
Affiliation: Texas A&M University - Corpus Christi
Time: 11:40-11:50

GRAIL (Greenhouse Robotics for Autonomous Intelligent Labor) is an interdisciplinary engineering project focused on improving efficiency and sustainability in greenhouse agriculture through automation. The system integrates machine vision, robotics, and closed-loop motion control to detect plant features and perform targeted actions such as pruning and monitoring. By combining an AI-enabled camera with a dual-axis linear motion platform and robotic arm, GRAIL creates a complete perception to action pipeline capable of consistent plant interaction. This work highlights the application of mathematical principles, including statics and dynamics for structural and motion analysis, coordinate transformations, kinematics, and data driven image segmentation to enable autonomous decision making in agricultural environments.

Is Association Between Serum Energy Metabolites, Milk Metabolites and Composition Different in Mastitic and Healthy Dairy Cows?

Speaker: Sushil Paudyal
Co-Authors: Sajinda Akter, Natalie Fagundo, Rajesh Neupane, Sushil Paudyal
Affiliation: Texas A&M University
Time: 11:50-12:00

The objective was to evaluate the association between serum energy metabolites and milk metabolites and milk composition in mastitis and healthy cows. Blood and corresponding milk samples were collected simultaneously from a total 627 cows were evaluated $n = 323 mastitic and n = 304 healthy$ at commercial laboratories (TVMDL and Texas DHIA respectively). Serum metabolic parameters included non-esterified fatty acids (NEFA), $\beta - hydroxybutyrate$ (BHBA), and cholesterol (CHOL), while corresponding milk parameters included milk protein%, milk fat% milk lacotse%, milk BHB, and milk acetone. In healthy cows, blood BHBA and CHOL demonstrated a weak negative correlation with milk protein $r = -0.256 and r = -0.171, respectively; p < 0.01$. These negative associations with milk protein were also present in mastitic cows but were weaker in magnitude $BHBA : r = -0.191, p < 0.001; CHOL : r = -0.137, p = 0.014$. A weak negative association between blood BHBA and milk fat was observed only in mastitic cows $r = -0.173, p = 0.002$. In addition, positive associations between blood NEFA and milk BHB were detected only in mastitic cows $r = 0.144, p = 0.010$. In healthy cows, NEFA was positively associated with milk acetone $r = 0.128, p = 0.026$, a weak positive association was observed between blood BHBA and milk BHB $r = 0.118, p = 0.036$, whereas this relationship was not significant in mastitic cows. In multivariable regression models, blood NEFA and BHBA were significant predictors of milk protein%; for each 1 unit increase in blood NEFA and BHBA, milk protein% decreased by approximately 0.60 and 0.24 units, respectively, controlling for mastitis status, days in milk, and lactation number constant $p < 0.001$. Blood NEFA, BHBA, glucose, and cholesterol were not significantly associated with milk fat or milk lactose. In contrast, mastitis status showed a consistent and strong association with milk lactose, with mastitic cows producing approximately 0.43 percentage units less lactose than healthy cows after adjustment for blood metabolites and covariates $p < 0.001$. These findings indicate that in healthy animals metabolic status is selectively linked with milk protein, whereas in mastitic animals this association is weaker and milk lactose is predominantly influenced by mastitis. Keywords: Metabolites, blood, milk, mastitis

DS2: Medical & Health AI (13:00-14:40)

A Bayesian-Optimized Ensemble Deep Learning Framework for Automated Retinal Disease Classification Using OCT Imaging

Speaker: Gifty Duah
Co-Authors: Eric Nyarko (University of Ghana), Gideon Nana Amo(Watborg Eye Services, Kasoa, Ghana) ,Theophilus Dwamena Frimpong(School of Mathematics and Statistical Sciences, University of Texas Rio Grande Valley, Edinburg, Texas) Anani Lotsi(University of Ghana)
Affiliation: University of Texas Rio Grande Valley
Time: 13:00-13:20

Retinal diseases remain a leading cause of avoidable blindness worldwide, particularly in low-resource set- tings such as Ghana. This study develops a Bayesian-optimized ensemble deep learning framework for au- tomated classification of four retinal conditions, glaucoma, macular edema, posterior vitreous detachment (PVD), and normal eyes, using optical coherence tomography (OCT) images obtained from a clinical facil- ity. Six convolutional neural network (CNN) architectures (VGG16, VGG19, DenseNet121, InceptionV3, ResNet50, and MobileNet) were fine-tuned using Gaussian Process-based Bayesian optimization to iden- tify optimal hyperparameters. Their outputs were integrated using two ensemble strategies: a soft-voting ensemble and a stacked ensemble with a meta-classifier. MobileNet achieved the highest single-model accuracy (96%), followed by DenseNet121 and ResNet50 (91%). The ensemble models outperformed all individual architectures. The soft ensemble achieved 97% accuracy and strong calibration, while the stacked ensemble achieved 98% accuracy, 0.98 precision/recall, specificity of 0.98, and a perfect ROC-AUC of 1.00. Disease-specific evaluation showed perfect recall for macular edema and PVD in the stacked ensemble. Grad-CAM visualizations confirmed clinically meaning- ful attention on the optic nerve head, macula, retinal layers, and vitreoretinal interface. The findings demonstrate that combining optimized CNNs significantly enhances robustness, reduces variance, and improves diagnostic reliability compared to individual models. This work provides the first fully ensemble-based OCT classification framework developed on a Ghanaian dataset, highlighting the po- tential of AI to support ophthalmic diagnostics in under-resourced environments. Future work includes multi-institutional data expansion, multimodal integration, and clinical deployment studies.

Investigating Optimal deep learning methods and machine learning Methods for predicting diabetes type 2 using longitudinal data

Speaker: Peggy Enyonam Akabuah
Co-Authors: Peggy Akabuah and Dr. Kristina Vatcheva
Affiliation: School of Mathematical & Statistical Sciences, University of Texas Rio Grande Valley, One West University Boulevard, Brownsville, TX 78520, USA
Time: 13:20-13:40

Type 2 Diabetes (T2D) remains a major global public health challenge, with increasing prevalence and substantial morbidity and mortality worldwide. Accurate early prediction of T2D is critical for effective prevention and timely intervention. While most existing traditional predictive models often rely on cross-sectional data, such approaches fail to capture the dynamic nature of disease progression. Longitudinal health data, which consist of repeated measurements over time, offer richer information but pose significant analytical challenges, including within-subject correlation, irregular follow-up, missing data, and class imbalance.

This study evaluates and compares the performance of machine learning (ML) and traditional methods for predicting T2D (Yes/No) using wave 2, 4, and 6 of the nurse visit data from the English Longitudinal Study of Aging (ELSA). Traditional longitudinal models such as Generalized Linear Mixed Models (GLMM) and Generalized Estimating Equations (GEE) were compared with ML methods, including Random Forest (RF), Mixed-Effects Random Forest (MERF), and Gradient Boosting (XGBoost). Models are trained and tested under consistent experimental conditions, with preprocessing strategies designed to address missingness, irregular observation intervals, and longitudinal structure. Predictive performance is assessed using discrimination, classification, and calibration metrics, including AUROC, PR-AUC, sensitivity, specificity, precision, F1-score, Brier score, and log loss.

Results demonstrate that the GLMM with a random intercept substantially outperforms ML approaches, achieving near-perfect discrimination and calibration. This performance is driven by extremely strong within-subject correlation in the data, as evidenced by a very high intraclass correlation coefficient $ICC \approx 0.98$, indicating that subject-specific heterogeneity dominates diabetes risk. ML models exhibit moderate discrimination but markedly reduced sensitivity at default classification thresholds due to severe class imbalance, highlighting the importance of threshold optimization and calibration. Among ML approaches, XGBoost shows comparatively better probability calibration, while RF demonstrates stronger ranking performance.

The findings highlight the importance of accounting for within-person correlation when modeling chronic disease risk over time and demonstrate that failure to do so can compromise predictive performance. This research contributes to the growing literature on AI-driven health analytics by providing systematic evidence on the suitability of ML and traditional approaches for longitudinal diabetes prediction, with implications for early detection, personalized risk stratification, and data-informed public health decision-making.

Keywords: Type 2 Diabetes, Longitudinal Data, Machine Learning, Predictive Modeling, Health Analytics

Multimodal Transformer Modeling of Alzheimer's Disease Severity Using Longitudinal Clinical and Neuroimaging Data

Speaker: Christopher Attafuah
Co-Authors: Dr. Hansapani Rodrigo
Affiliation: The University of Texas Rio Grande Valley
Time: 14:00-14:20

Alzheimer's disease (AD) severity is often modeled using coarse diagnostic categories that obscure gradual functional decline and limit longitudinal interpretation. This study presents a progression-aware, interpretable multimodal framework for visit-level severity staging using longitudinal clinical, cognitive, imaging, biomarker, and risk-context data. Severity is defined using four clinically meaningful stages derived from the Clinical Dementia Rating (CDR) global score: No Dementia (NOD), Very Mild Dementia (VMD), Mild Dementia (MD), and Moderate-Severe Dementia (MOD). A subject-wise, progression-safe data integration pipeline aligns multimodal measurements to CDR-defined visits while preventing future information leakage. Missing data are handled using strictly causal within-subject forward-fill combined with explicit missingness indicators. Interpretable baseline models (logistic, mixed-effects, and gradient-boosted trees) quantify which cognitive, biomarker, structural MRI, and PET features best explain stage membership. Imaging models provide region-level attributions, while risk-context variables; race, family history, and health history are incorporated to support clinically grounded interpretation. The proposed framework enables unified, interpretable analysis of Alzheimer's severity and progression, demonstrating how multimodal and risk-context signals jointly determine stage at each visit and evolve within individuals over time.

Multimodal Feature Fusion: Combining CNNs and Sequence Models for Pneumonia Progression

Speaker: Samanvitha Karri
Co-Authors: Professor S. M. Mallikarjunaiah
Affiliation: Texas A&M University Corpus Christi
Time: 14:20-14:40

Pneumonia remains a leading cause of global mortality, yet its primary diagnostic modality, chest X-rays (CXR), relies on manual interpretation that is subjective, time-intensive, and lacks standardized metrics for longitudinal monitoring. Current automated systems are fundamentally limited by their focus on binary classification, largely ignoring the critical need for continuous severity estimation and temporal progression tracking. To bridge this gap, this study introduces a unified, multimodal deep learning framework engineered for simultaneous pneumonia detection, quantitative severity regression, and spatiotemporal disease forecasting. By integrating large-scale imaging datasets (NIH, RSNA, and CheXpert) with vital clinical metadata such as SpO2 and patient demographics, our approach captures a holistic, data-driven patient profile. The computational pipeline is built on a robust preprocessing foundation, utilizing automated U-Net architectures for precise lung segmentation alongside CLAHE-based contrast enhancement. High-dimensional feature extraction is driven by advanced CNN backbones, including EfficientNet, DenseNet, and ResNet50. The core innovation lies in the dual-head network design: a classification module accurately detects the presence of pneumonia, while a parallel regression module estimates the precise degree of lung involvement. Crucially, the temporal dynamics of the disease are captured using recurrent neural networks (LSTM/GRU) and vision transformers to model sequential imaging data. Our findings demonstrate that fusing clinical metadata with sequential image analysis significantly elevates predictive accuracy across all tasks. The model exhibits strong performance in static classification, continuous severity estimation, and dynamic temporal forecasting. Ultimately, this proposed framework delivers a scalable, end-to-end computational tool, providing actionable and clinically relevant insights for real-time patient management and dynamic healthcare applications.

Towards AI-Assisted Orthopedics: Real-Time Pediatric Wrist Fracture Detection

Speaker: Gowtham Kamle
Co-Authors: Dimple Alekya Basimi, Gowtham Kamle, Prathyusha Pentam, S. M. Mallikarjunaiah
Affiliation: Texas A&M University Corpus Christi - 6300 Ocean Drive
Time: 14:20-14:40

Pediatric wrist fractures are among the most common orthopedic injuries in children, yet their accurate detection in radiographic images remains a challenging task requiring specialized clinical expertise. This project presents a comparative deep learning study for automated fracture detection using the GRAZPEDWRI-DX dataset, a large-scale pediatric wrist X-ray collection comprising over 20,000 annotated images. Three object detection architectures are evaluated , YOLOv8, YOLOv12, and RT-DETR , representing a progression from pure convolutional networks to transformer-based models, enabling a systematic analysis of how architectural design impacts detection accuracy. Models are trained and benchmarked across standard metrics including mAP, precision, and recall to identify the best-performing architecture for clinical applicability. The ultimate goal is to deploy the best model as an end-to-end web application using Fast API and Streamlit, providing clinicians with a real-time, AI-assisted diagnostic tool for pediatric wrist fracture detection.

Modeling Vaccination Uptake Using Demographic and LLM-Extracted Neighborhood Features from Street-Level Imagery

Speaker: Hossein Naderi
Co-Authors: Dr.Lucy Huang, Texas A&M University-Corpus Christi, College of Engineering and Computer Science
Affiliation: Texas A&M University-Corpus Christi, College of Engineering and Computer Science, 6300 Ocean Drive, Corpus Christi, TX 78412
Time: 14:40-15:00

Understanding spatial disparities in health behaviors requires scalable and interpretable characterization of neighborhood environments. Traditional approaches to measuring built environment conditions are often labor-intensive, difficult to standardize, or limited in spatial coverage. This study introduces a novel framework that leverages large language models (LLMs) to extract interpretable neighborhood features from Google Street View (GSV) imagery for use in statistical modeling of health outcomes. Street-level images from over 5,000 intersection locations in Corpus Christi, Texas, were processed using an LLM-based semantic interpretation approach to generate structured environmental indicators, including walkability, traffic intensity, greenery, and perceived disorder. These features were aggregated to the block-group level $n = 255$ and integrated into a statistical modeling framework to analyze COVID-19 booster vaccination rates. Linear (ordinary least squares) and non-linear (random forest) models were applied, and SHapley Additive exPlanations (SHAP) were used to quantify feature contributions and enhance interpretability. Results demonstrate that LLM-derived environmental features capture meaningful and interpretable signals related to vaccination uptake. Walkability and greenery were positively associated with booster rates, while traffic intensity and perceived disorder exhibited negative associations. Model performance indicates that these features contribute to explaining spatial variation in vaccination behavior, with random forest achieving the lowest prediction error $RMSE \approx 0.070$, while linear models exhibited comparable performance, suggesting predominantly linear relationships. This study positions LLMs as scalable semantic sensors for transforming unstructured street-level imagery into structured, policy-relevant environmental indicators. By integrating LLM-based feature extraction with interpretable statistical modeling, the proposed framework provides a transparent and extensible approach for analyzing neighborhood effects on public health outcomes.

DS3: Statistical Methods & Computational Science (13:00-15:00)

Lomb-Scargle Method for Robust Trend Estimation in Environmental Time Series with Systematic Missingness

Speaker: Huynh Lan Phuong Le
Co-Authors: Dr. Lei Jin - Department of Mathematics and Statistics, Texas A&M University-Corpus Christi
Affiliation: Texas A&M University-Corpus Christi
Time: 13:00-13:20

Environmental time series from coastal bays along the northwestern Gulf of Mexico frequently exhibit irregular sampling and structured missingness due to measurement constraints, environmental disruptions, and seasonal gaps. Harmonic regression is widely used to estimate seasonal components and long-term trends in such data; however, its robustness under incomplete and non-random observations remains insufficiently characterized. Structured missingness may truncate portions of the seasonal cycle and introduce bias in both amplitude and trend estimation. This study evaluates harmonic regression and Lomb-Scargle methods for trend estimation under different systematic missingness scenarios. Harmonic regression typically assumes regularly spaced observations, whereas the Lomb-Scargle periodogram accommodates uneven time grids without requiring interpolation. Although widely used in astronomy to address uneven sampling for periodicity detection, Lomb-Scargle performance relative to harmonic regression in long-term environmental monitoring data with systematic missingness has not been comprehensively examined. Via simulation under different missingness scenarios, we examine performance in terms of bias, variance, and root mean squared error (RMSE). This study provides a framework for assessing the reliability of long-term environmental trend detection and offers methodological insight for ecological monitoring programs where incomplete sampling is unavoidable.

Block Bootstrap for Comparing the Mean Directions of Two Circular Time Series

Speaker: Suhong Ye
Co-Authors: Lei Jin, and Jose Guardiola
Affiliation: Texas A&M University-Corpus Christi
Time: 13:20-13:40

Circular time series data arise naturally in many scientific fields, including environmental science, biology, and meteorology, where observations are directional and exhibit temporal dependence. Despite their increasing importance, existing methods for comparing two population mean directions are largely developed for independent circular observations and are not well suited for dependent time series settings. In this paper, we propose a novel nonparametric test for comparing the mean directions of two circular time series. The method is based on a two-sample block bootstrap procedure that accommodates temporal dependence while preserving the circular nature of the data. The test statistic is constructed from the difference between circular sample means, and its sampling distribution is approximated through resampling. We evaluate the performance of the proposed method through extensive Monte Carlo simulations under a variety of settings, including both independent and dependent circular processes. The results show that the proposed test maintains appropriate type I error control and achieves good power across different sample sizes and dependence structures. Overall, the proposed approach provides a flexible and practical tool for inference on circular time series and helps fill an important methodological gap in the analysis

of directional data.

From Data to Decision: Using ANOVA to Select Valid Statistical Models in Laboratory Research

Speaker: Arianna E. Ortiz
Affiliation: Department of Mathematics and Physics, Texas A&M International University
Time: 13:40-14:00

Experimental data can be correlated via an analysis of the variances (ANOVA) related to the data, provided the sample is large enough. This presentation focuses on the use of ANOVA methodology to encourage proper model selection for statistical analysis in a laboratory setting. Particularly, emphasis will be directed on identifying when to use one-way, two-way, or nested designs based on experimental structure. This will essentially explain how ANOVA breaks down total variance into manageable components (treatment variance vs. random error) to decide which factors to keep in the final model.

A new Forced Randomized Response Model

Speaker: Yashaswi Bastakoti
Co-Authors: Sarjinder Singh, Department of Mathematics, Texas A&M University-Kingsville
Affiliation: Texas A&M University-Kingsville
Time: 14:00-14:20

In this talk, we introduce a new forced randomized response methods which makes use of two decks of cards. An estimator of the population proportion of a sensitive characteristic is developed. The proposed estimator is shown to be unbiased estimator of the population proportion. The expression for the variance of the proposed model is derived. An unbiased estimator of the variance of the proposed estimator is also suggested. Then the proposed model is compared to its competitors for at least equal protection of the respondents through a simulation study.

Modeling Prion Protein Spread on the Mouse Connectome: A Stochastic Network Approach with Delayed Feedback

Speaker: Omar Sharif
Affiliation: UTRGV, Edinburg, TX
Time: 14:20-14:40

Neurodegenerative diseases (NDs), including Alzheimer's disease, Parkinson's disease, and prion diseases, are characterized by the progressive spread of toxic protein species throughout the brain. In prion diseases, the normal cellular prion protein (PrP^C) produced primarily by neurons, misfolds into a pathogenic isoform known as Scrapie prion protein (PrP^{Sc}). Misfolded prion proteins can spread between anatomically connected brain regions, inducing cellular stress responses and progressive neurodegeneration. Although extracellular mechanisms of prion conversion have been extensively studied, it is poorly understood how local misfolding dynamics interact with brain-wide anatomical connectivity to shape disease progression.

In this work, we develop a stochastic network-based model that couples extracellular prion conversion dynamics with interregional transport over the mesoscale structural connectome of the mouse brain. Brain connectivity is informed by the Allen Mouse Brain Connectivity Atlas derived by Oh et al., which provides a weighted directed network representation of axonal projections among anatomical regions. This connectivity is incorporated into the model through a graph Laplacian operator that captures network-mediated redistribution of misfolded prion protein across brain regions.

At each node (brain region) of the network, the model describes nonlinear interactions between healthy and misfolded prion protein concentrations, with time-delayed feedback representing unfolded protein response (UPR)-mediated regulation of protein production. Stochastic perturbations are included to account for intrinsic biological variability. Analysis of the resulting delayed stochastic network system reveals parameter regimes associated with prion clearance, persistence, and connectivity-driven propagation.

This integrated framework provides a quantitative bridge between molecular mechanisms and brain-wide network dynamics, offering new insights into the progression of prion disease and potential network-informed therapeutic strategies.

Age, BMI Percentile, and Kidney Function in Hispanic Children: A Cross- Sectional Study of eGFR and Gender Differences

Speaker: Maria Vasquez
Co-Authors: Dr. Hongwei Wang (Advisor)
Affiliation: Texas A&M International University/5201 University Blvd.
Time: 14:40-15:00

Childhood obesity is associated with early metabolic and renal alterations that may increase long-term chronic kidney disease (CKD) risk, particularly among Hispanic children. This cross-sectional study examined the relationship between age, BMI percentile, and estimated glomerular filtration rate (eGFR) in Hispanic children (ages 0-18) in South Texas, with gender stratified analyses. After data cleaning and restriction of extreme values, BMI was categorized as Slim $\leq 49th percentile$ and Non-slim $> 49th percentile$. Descriptive statistics, correlations, t-tests, and generalized linear models (GLMs) including age, ageˆ2, BMI group, and interaction terms were conducted. Age was the strongest predictor of eGFR in both genders $p < 0.0001$, demonstrating a nonlinear pattern: increasing in early childhood and declining during adolescence. BMI percentile was not an independent predictor after adjusting for age. Correlation analyses showed a negative association between age and eGFR, stronger in boys. No significant BMI-group differences were observed in girls, while Non-slim boys showed slightly higher mean eGFR. Overall, age, not BMI percentile, primarily drives pediatric eGFR trends, suggesting that BMI alone may be insufficient to identify early renal risk in Hispanic children.

DS4: Computing, ML & Engineering (15:30-17:30)

Knowledge Distillation for Time-series analysis

Speaker: Anshika Rani
Co-Authors: Prof. Sreelekha Guggilam (Assistant Professor)
Affiliation: Texas A&M University, Corpus Christi
Time: 15:30-15:50

Accurate time-series analysis typically demands large neural networks that are computationally expensive and difficult to deploy in resource-constrained or real-time settings. This challenge is particularly acute for multivariate sensor data, where models must capture complex temporal dependencies across many channels simultaneously. Knowledge distillation offers a principled solution by transferring the predictive capability of a large teacher model into a smaller, more efficient student model without significant loss in representational quality.

This work investigates knowledge distillation as a learning paradigm for multivariate time-series data, with application to both EEG signals and UAV flight telemetry. We explore whether compact student models can retain the temporal representations learned by specialist teachers across tasks including event detection, classification, and anomaly detection, while substantially reducing model complexity.

Accelerating Computational Fracture Mechanics: A Reproduction Study of Fourier Neural Operators

Speaker: Manidhar Aduri
Affiliation: Organization : Texas A&M University Corpus Christi, Address : 6300 Ocean Dr, Corpus Christi, TX 78412
Time: 15:50-16:10

Fatigue crack growth in structural systems, including offshore platforms and marine infrastructure subjected to constant wave loading, poses a significant safety challenge. While traditional physics-based simulation methods are highly accurate, they remain computationally expensive, which bottlenecks real-time structural health monitoring. Existing machine learning approaches have shown promise as surrogate models for accelerating these computations. This work reproduces the Fourier Neural Operator (FNO) framework proposed by Hamdi & Lejeune for predicting crack field evolution directly from phase-field simulations of brittle fracture.

The FNO architecture was trained on a comprehensive dataset of 6,000 phase-field simulations across six distinct loading scenarios, utilizing a 128Ã—128 spatial grid over 101 timesteps. The reproduced model successfully captures the global trajectory of crack propagation, achieving a Test Dice score of 0.41 (compared to the original benchmark score of 0.62). While this performance gap highlights the sensitivity of operator learning to hyperparameter tuning and hardware-limited training constraints, this study successfully validates the core effectiveness of FNOs as a highly efficient surrogate for fracture simulation. Furthermore, it establishes a functional, reproducible baseline for future extensions, including the application of FNOs to real-world experimental digital image correlation (DIC) data and more complex, three-dimensional crack growth scenarios.

Predicting Student Performance Using Machine Learning Techniques

Speaker: Fatmir Gjergji, Nathan Castro
Co-Authors: Nathan Castro; Student at University of the Incarnate Word
Time: 16:10-16:30

The increasing availability of educational data has created new opportunities to better understand student learning and improve academic outcomes. In this project, we explore the use of data science techniques to analyze student-related data from an online learning environment using the Open University Learning Analytics Dataset (OULAD). The dataset includes information on student demographics, course engagement, and assessment outcomes.

The primary goal is to investigate the structure of the dataset and identify potential research questions related to student behavior and performance. Initial efforts focus on data cleaning, exploratory data analysis, and visualization to uncover general patterns and trends. In addition, we implemented machine learning models, including logistic regression, decision trees, and random forests, to predict student performance outcomes based on available features.

Preliminary results suggest that patterns in student engagement and demographic factors may play an important role in predicting academic success. While the models are still being refined, this work demonstrates the potential of machine learning approaches in identifying at-risk students and supporting data-driven decision-making in education. Although this study is using an online dataset, still this data is applicable for in-person dataset.

Backbone-Aware Semi-Supervised Learning for DNS-Based DDoS Detection Under Extreme Class Imbalance

Speaker: Emmanuel Boadi
Co-Authors: 1. Hansapani Rodrigo (University of Texas Rio Grande Valley) 2. SJ Kumar (University of Texas Rio Grande Valley)
Time: 16:30-16:50

Distributed Denial of Service (DDoS) attacks targeting the Domain Name System (DNS) are a serious threat to network availability. Detecting DNS-based DDoS attacks is challenging due to extreme class imbalance and the limited availability of labeled traffic data in real-world networks. Semi-supervised learning (SSL) addresses this by using both labeled and unlabeled data for training.

In this paper, three SSL methods including Virtual Adversarial Training (VAT), FixMatch, and Suppressed Consistency Loss (SCL) are evaluated for DNS-based DDoS detection using the CI-CDDoS2019 dataset, which has a severe attack-to-benign imbalance ratio of approximately 1491:1. Each method is tested with two backbone architectures: a feedforward neural network and a TabTransformer designed for tabular data. A composite feature engineering step reduces 31 flow-level features to 22 interpretable features before model training.

Experiment results averaged over five independent runs show near-perfect attack detection across all configurations (ATTACK F1 $\{}geq$ 0.9998). However, methods differ in benign traffic classification. With the neural network, VAT achieves a BENIGN F1 of 0.8066, while FixMatch and SCL reach 0.8402 and 0.8392 respectively. Switching to TabTransformer improves VAT and SCL but slightly reduces FixMatch performance. SCL with TabTransformer gives the best results: BENIGN F1 of 0.8492, Macro-F1 of 0.9246, and AUC-ROC of 0.9992.

These results show that backbone architecture plays an important role in SSL-based DDoS detection and SCL provides the most stable and balanced performance under extreme class imbalance.

Financial Time-Series Forecasting with Deep Learning Models and Social Media Sentiment

Speaker: Yejin Hwang
Co-Authors: Sreelekha Guggilam
Time: 16:50-17:10

Stock price forecasting remains challenging due to the nonlinear nature of financial markets and the influence of investor sentiment. Recent advances in Transformer-based architectures have achieved strong results in time-series forecasting. However, most prediction models are univariate, limiting their ability to incorporate behavioral signals. This study examines the impact of Reddit-derived investor sentiment on financial forecasting through a multivariate deep learning framework based on the Temporal Fusion Transformer (TFT). The framework integrates FinBERT-based sentiment scores and spike-related behavioral features from r/WallStreetBets with traditional market variables such as price, volume, and calendar effects. Forecasting performance was evaluated for LSTM, PatchTST, TimesFM, and TFT-baseline models against sentiment-informed TFT model (TFT-sentiment). These findings demonstrate that incorporating Reddit-based behavioral sentiment enhances both forecasting accuracy and investment performance, effectively bridging quantitative modeling and behavioral finance.

Kolmogorov-Arnold Networks as Interpretable Autoregressive Surrogates for Next-Frame Crack Path Prediction in Phase-Field Fracture

Speaker: Jahnavi Krishna Koda
Co-Authors: S.M.Mallikarjunaiah, Texas A&M University-corpus christi
Time: 17:10-17:30

Phase-field simulations for brittle fracture have significant potential, however they are also very costly. This makes it attractive to develop fast surrogate models. Deep learning surrogate models can be used to accu- rately simulate crack evolution, but like many other AI models, they are considered un-interpretable 'black box' models. We suggest using an Au- toregressive Kolmogorov-Arnold Network (KAN), which will functionally serve as an autoregressive surrogate by predicting the next frame phase- field simulation based on the spatial coordinate location and the present damage field. The three new distinctions within this paper include: (i) KAN's Learnable Spline Activations provide the benefit of having a nat- ural fit to the sharp diffuse band profiles in the phase fields and therefore demonstrate improved accuracy over standard ReLU-based Multi Layer Perceptrons (MLPs); (ii) Symbolic Regression of the trained KAN results in recovery of closed form crack growth expressions, thus providing the first time an interpretable surrogate has been proposed for use in phase- field fracture modeling; (iii) The Spline Grid-Extension Property allows for training a model at a relatively coarse mesh size (approximately 93,000 nodes) and then generalize directly to a finer mesh size (approximately 371,000 nodes) with no additional training.

DS5: Health, Social Science & Applied Research (15:30-17:30)

Predicting Global Lightnings Using Deep Neural Networks

Speaker: Nene Coulibaly
Co-Authors: Li, Baokun; Coulibaly, Nene; Wei, Zheng; Liu, Chuntao
Affiliation: Texas A&M University-Corpus Christi
Time: 15:30-15:50

Understanding and predicting lightning activity is crucial for meteorological research, climate modeling, and hazard prevention. This study examines the influence of large-scale environmental factors on the occurrence of thunderstorms globally using deep neural networks (DNNs). By analyzing 16 years of Tropical Rainfall Measuring Mission (TRMM) data alongside ERA-Interim reanalysis, we assess the relative significance of Convective Available Potential Energy (CAPE), Convective Inhibition (CIN), low-level wind shear, and warm cloud depth (WCD) in predicting lightning activity. Unlike traditional statistical models, DNNs can capture complex, non-linear interactions between variables, improving predictive accuracy. By leveraging Poisson deep neural networks, we provide a framework for modeling lightning frequency with a likelihood-based approach. Our results highlight distinct differences in these environmental variables between convective features (CFs) with and without lightning and demonstrate that DNNs outperform classical regression models. Regional variations in prediction accuracy suggest that different atmospheric processes influence storm formation across locations. While the model successfully predicts lightning occurrences, further research is needed to explore the physical mechanisms driving regional differences in thunderstorm activity.

Monitoring spatio-temporal dynamics of forage species using high resolution satellite and UAV imagery under rotational stocking management strategy

Speaker: Shishir Sapkota[1,2]
Co-Authors: Jamie L. Foster[1,3], Mahendra Bhandari[1,2], Jose Landivar Scott[2], Ernie Reyes[2], Hamad Saad[3] and Pablo Guarnido Lopez[3]
Affiliation: [1]Texas A&M University, College Station, TX 77843; [2]Texas A&M AgriLife Research & Extension Center, Corpus Christi, TX, 76401; [3]Texas A&M AgriLife Research, Beeville, TX 78102
Time: 15:50-16:10

Accurate identification of forage species is essential for sustainable forage and stocking management of pastures. Forage communities are spatially patchy and difficult to classify using meter-level satellite imagery alone, making the integration of multi-sensor data critical for effective monitoring. This study investigated the spatio-temporal dynamics of dominant forage species under a rotational stocking management strategy using a multi-sensor remote sensing workflow integrating high-resolution UAV and satellite imagery.

The study was conducted on a rangeland at the Texas A&M AgriLife Research Station–Beeville in Bee County (28°27'05.3"N 97°42'10.3"W), covering a total area of 541.52 ha subdivided into 35 paddocks ranging in size from 0.317 ha to 38.46 ha, with cattle rotated among paddocks every three months. The dominant forage species present include bermudagrass, yellow bluestem, kleingrass, buffelgrass, and forbs. A multi-sensor workflow was developed integrating centimeter-resolution UAV imagery and 0.5-meter SkySat satellite imagery, with multi-temporal PlanetScope time-series imagery 3-meter processed in Google Earth Engine (GEE) to capture forage dynamics at the paddock scale.

High-resolution UAV-derived species maps (1.5 cm) were generated using a Multi-Layer Perceptron (MLP) classifier, achieving an overall accuracy of 90.4%, with vegetation indices and normalized DSM (nDSM) identified as important classification features. SkySat-based classification achieved an overall accuracy of 98.14% across four classes, though kleingrass and buffelgrass were unresolvable at 0.5-meter resolution. Time-series NDRE indices clearly delineated the stocking window, and 5-day NDRE rate-of-change curves differentiated dominant forage species with forbs showing lower NDRE change rates compared to bermudagrass and yellow bluestem, reflecting their non-palatability to cattle. A GEE application was developed to provide user-friendly visualization of SkySat-based forage maps alongside Planetscope based time-series vegetation index curves, demonstrating the potential of integrating high-resolution satellite and UAV imagery for spatio-temporal forage species monitoring in rangelands.

Real-Time Structural Assessment in Post-Disaster Environments Using 3D Reconstruction

Speaker: Mariah Roberts
Affiliation: Texas A&M University-Corpus Christi; 6300 Ocean Drive, Corpus Christi 78412
Time: 16:10-16:30

A real-time framework for structural analysis in post-disaster environments is introduced. The approach utilizes an OAK-D LR depth camera to acquire 3D data, which is represented as a point cloud capturing damaged and partially observable structures. To mitigate the effects of debris, occlusion, and sensor noise, the data undergoes filtering and refinement, yielding a more reliable geometric representation of the scene. The refined point cloud is subsequently integrated into a continuous volumetric model and converted into a surface mesh that approximates the underlying environment. Structural elements, including beams and load-bearing components, are identified through geometric grouping and analysis of local spatial characteristics, enabling estimation of their orientation and structural significance. By abstracting complex and partially collapsed environments into simplified structural components, the framework facilitates efficient damage assessment. In addition, it supports the detection of structural anomalies such as deformation, displacement, and misalignment through analysis of temporal variations in the reconstructed geometry. Overall, the framework establishes a robust and scalable approach for rapid structural assessment, with applications in search and rescue, infrastructure inspection, and autonomous robotic systems.

Application of the Taguchi Method for Aircraft Engine Remaining Useful Life (RUL) Prediction

Speaker: Kristel Rochell Herrera
Affiliation: Texas A&M International University
Time: 16:30-16:50

Keeping an aircraft engine in a reliable state is crucial when aircraft are exposed to various altitudes and conditions. The dataset used in this project has six different flight conditions simulated by C-MAPPS (Commercial Modular Aero-Propulsion System Simulation). The Taguchi method was applied along with an orthogonal array and signal-to-noise ratio to analyze aircraft engine performance. Through the use of the Taguchi method, specific operational configurations were identified to increase the Remaining Useful Life (RUL). This, in turn, would reduce the number of unscheduled maintenance events, thereby reducing costs for NASA.

"How strongly do education investment and enrollment predict economic growth across countries?"

Speaker: Mirzobedil Dzhamolzoda
Affiliation: TAMIU
Time: 16:50-17:10

This study investigates the extent to which education investment and enrollment predict economic growth across high-income countries using Canonical Correlation Analysis (CCA). Drawing on human capital theory and endogenous growth frameworks, the analysis conceptualizes education as a multidimensional construct captured through government expenditure on education, secondary enrollment, and tertiary enrollment—and economic performance as a dual-dimension outcome represented by GDP per capita and GDP growth. Data from 25 high-income countries were standardized and analyzed to uncover latent multivariate relationships between the two variable sets.

Results reveal one statistically significant canonical dimension. The first canonical correlation $\rho 1 = 0.62, p < 0.05$ indicates a moderate-to-strong association between education investment patterns and economic outcomes. Structure coefficients show that government expenditure on education and tertiary enrollment load most strongly on the education variate, while GDP growth dominates the economic variate. This suggests that countries investing more heavily in education, particularly at the tertiary level, tend to experience stronger short-term economic growth. The second canonical dimension was not statistically significant, indicating that the primary relationship is captured by the first pair of canonical variates.

Redundancy indices further demonstrate that education indicators explain a meaningful portion of variance in economic outcomes, supporting theoretical claims that education contributes to productivity, innovation, and long-run growth. Overall, the findings reinforce the central role of educational investment in shaping economic performance and highlight the value of multivariate approaches for understanding complex development dynamics across countries.

Statistics of Student Enrollment at TAMIU

Speaker: Jose Herrera
Affiliation: TAMIU Department of Mathematics and Physics - 5201 University Boulevard, Laredo, TX 78041
Time: 17:10-17:30

Forecasting student enrollment plays an essential role in strategic planning and decision-making within universities and colleges. Predictive modeling enables institutions to anticipate their student populations for upcoming semesters, facilitating vital decisions such as course and faculty scheduling. Understanding these patterns helps ensure that requirements are met for both students and staff. By gathering Texas A&M International University's student enrollment data for the previous years, a multivariate regression model was used to analyze and predict future enrollment trends. The dataset was cataloged by semester and contained key data points, including the overall student population, academic classification, college, enrollment status, and degree type. After the data was cleaned and organized, various regression models were applied to compare different relationships and patterns, providing a more accurate representation of the data. Using multiple regression models helps compare the correlation between the independent variable and the dependent variables, ensuring that the model fits the curve. In addition to predictive modeling, statistical process control techniques were used to assess the stability of enrollment trends over time and detect significant variations within each semester. Based on the best-fit model, the predictions will provide the university with a deeper understanding of future enrollment trends for upcoming semesters. This type of preparation will enable the university to ensure that proper resources, faculty, and courses are available to meet students' needs and support institutional growth.

Ed1: Mathematics Education Morning Session (9:00-11:50)

Bridging the Gap: Mathematical Hurdles in Undergraduate Electromagnetism

Speaker: Dr. Aaron L. Modic
Affiliation: Texas A&M International University, 5201 University Boulevard Laredo, Texas 78041
Time: 09:30-09:50

A robust mathematical foundation is essential for mastering physics, but many students struggle with bridging the gaps between abstract mathematical theories and their application to electromagnetism in upper-level physics courses. This talk examines several of these gaps, such as vector calculus and multivariable calculus, specifically regarding the mapping of physical parameters to variables. I will propose several pedagogical strategies designed to strengthen mathematical foundations and better prepare students for the rigors of applied physics.

On Improved Calibration Estimation in Stratified Sampling

Speaker: Daniel Arias
Co-Authors: Sarjinder Singh
Affiliation: Texas A&M University Kingsville, 700 University Blvd, Kingsville, TX 78363
Time: 10:00-10:20

Abstract

This study presents an improved calibration estimator for the population mean in stratified random sampling, with application to educational research contexts. The proposed method incorporates a calibration constraint based on second-order information from an auxiliary variable, extending traditional calibration estimation techniques commonly used in survey analysis. The estimator is derived through the minimization of a chi-square distance function subject to three calibration constraints and can be expressed within a regression-type framework. By more effectively integrating auxiliary information, the proposed approach is expected to improve the efficiency and accuracy of population estimates.

This method is particularly relevant in educational settings, where precise estimation of student outcomes, program effectiveness, and institutional performance is essential for data-informed decision making. An applied example from the field of education is included to demonstrate the practical utility of the estimator and its potential to support more reliable and equitable evaluation practices.

Wronskian Method

Speaker: Arturo Villarreal
Affiliation: Texas A&M International University, Laredo, TX
Time: 10:30-10:50

The Wronskian method was derived by a polish mathematician best known as Jozef Hoene-Wronski. The purpose of this presentation is to describe and explain the importance of the Wronskian method in Linear Algebra. The Wronskian method is a framework that facilitates the proficiency of determining solutions that are linearly independent in linear equations by calculating and solving for the determinant of the problem at the given interval. The process of the Wronskian method is that it incorporates getting the derivatives of the functions to be able to calculate their determinant (also known as Wronskians). With the use of the Wronskian method, after the

Wronskian is calculated, if the Wronskian is not zero at the given interval, then the function is linearly independent. If the Wronskian is zero at the given interval, then the function is linearly independent. In this presentation, we will use examples of problems to illustrate how the Wronskian method aids with the structure of linear/matrices functions. Overall, the main goal of this presentation is to emphasize the Wronskian method as a framework method to be able to provide theoretical foundation that facilitates mathematical differential linear algebra problems.

The Influence of Secondary Education on Students and Its Result on STEM Engagement

Speaker: Jasmin Ortiz
Co-Authors: Hongwei Wang, Orlando Patricio
Affiliation: Texas A&M International University 5201 University Boulevard, Laredo, Texas 78041
Time: 11:00-11:20

Despite data indicating rapid growth of the job-market towards STEM occupations (U.S. Bureau of Labor Statistics, 2023), students pursuing education beyond high school are not necessarily inclined to declare or continue a STEM major (Rosenzweig et. al, 2024). Research suggests that students who possess certain predictive factors demonstrate a greater interest in STEM related careers compared to their peers who lack these characteristics (Amalina, VidÃ¡kovich, & Karimova, 2025). The purpose of this study is to determine the predictive factors that influence college students from one of the universities in South Texas in determining their major of interest. To identify predictive factors, a survey was conducted to the student population to answer multiple choice questions regarding their STEM experience during high school. The Cronbach alpha for the survey questionnaire is .70, indicating moderate internal consistency among the items. From the questionnaire, 223 responses were obtained and analyzed using logistic regression model to determine the factors affecting the students' major field of study. The results indicate that self-efficacy is a strong predictor of STEM participation $\beta = 1.593; p < 0.001$. Students with higher confidence in their STEM abilities are more likely to pursue STEM majors. Engagement demonstrated a modest influence on STEM participation, but its effect was largely accounted for by self-efficacy. These findings highlight the important role that secondary education plays in influencing students' decisions to declare a major.

A Project-Based Approach to Teaching Elementary Statistics

Speaker: Qiuchen Hai
Affiliation: Department of Mathematics, The University of Texas at San Antonio
Time: 11:30-11:50

Project-based learning can enhance elementary statistics courses by helping students connect statistical concepts to real-world applications. In many introductory classes, students tend to focus on procedures without fully understanding how statistics is used in context. To address this, I have implemented the four components of statistical problem solving outlined in the Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report. As part of this approach, I designed a group project titled "How Fast Can You React?' This project not only strengthens students' teamwork skills but also develops their problem-solving abilities. Students engage in the full statistical process, including (i) formulating a research question, (ii) collecting data using appropriate tools, (iii) analyzing the data, and (iv) interpreting results within the context of real-world problems. Overall, project-based learning serves as an effective complement to traditional instruction, making statistics more meaningful and accessible for a diverse group of learners.

Ed2: The Influence of Secondary Education on Students and Its Result on STEM Engagement (1:00-1:40)

Panel Discussion on collaboration to provide remote upper-level mathematics courses

Speaker: Craig McCarron
Affiliation: Texas A&M University - San Antonio
Time: 13:00-13:40

We need to offer upper-level mathematics courses like Real Analysis, Modern Algebra, Modern Geometry, etc. for our mathematics majors but often face the "low enrollment" obstacle with administration when we offer these classes. Administration offers online options like Acadeum, but our students' learning outcomes will be poor if we rely on online courses for these rigorous courses. The administration's default of asynchronous online like Acadeum is not the optimal approach for this upper-level mathematics content. What if we create a cooperative amongst ourselves to offer these upper level courses with live face-to-face/remote format that engages students in the way a face-to-face course does? Let's discuss the possibilities.

MF1: Advanced Numerical Methods for PDEs and Multiscale Problems

Artificial compressibility method for incompressible multiphase flows

Speaker: Loic Cappanera
Co-Authors: Salvatore Giordano
Affiliation: University of Houston;
Time: 09:00-09:20

The approximation on incompressible flows with variable density has many applications in engineering and geosciences (e.g. batteries, alluminium production). After briefly mentioning some motivations and classic methods used to approximate the solution of such problems, governed by the incompressible Navier-Stokes equations with variable density, we will introduce two novel artificial compressibility techniques. Unlike projection method, such techniques consists of perturbing the incompressibility constraints so the update of the pressure unknown does not require to solve a Poisson problem. We also note that we make the choice of using the momentum, equal to the product of the density and velocity, as primary unknown which leads to a time independent mass matrix. We will first discuss the theoretical stability and convergence of the proposed methods. Then we will validate the methods numerically on various benchmarks and compare their performance to a classic projection method.

Efficient Multigrid Solvers for Time-Dependent Rayleigh-Bénard Convection

Speaker: Ahsan Ali
Co-Authors: Robert C. Kirby;
Affiliation: Department of Mathematics, Baylor University
Time: 09:20-09:40

In this work, we consider the efficient numerical solution of the time-dependent Rayleigh-Benard convection problem described by the incompressible Boussinesq equations. The system couples the Navier-Stokes equations with a convection-diffusion equation for temperature through a buoyancy term, leading to a nonlinear and strongly coupled problem. Classical time integration methods are typically limited to second-order accuracy due to the Dahlquist barrier, whereas implicit Runge-Kutta (IRK) methods allow for higher-order accuracy with strong stability properties. We employ an L-stable fully implicit Runge-Kutta (FIRK) method, resulting in large nonlinear systems at each time step, which are solved using Newton's method. This results in sequences of large linear systems with an incompressible saddle-point structure, coupled with temperature. To address this, we consider two approaches within the flexible GMRES method: an augmented Lagrangian preconditioner for the Navier-Stokes equations and a monolithic multigrid method with Vanka-type relaxation. Numerical results demonstrate robust and efficient performance across a range of physical regimes, including low-Prandtl-number flows, highlighting the effectiveness of combining high-order implicit time integration with tailored multigrid solvers.

Convergence Analysis of Adaptive Finite Element Schemes for Regularized Variational Models of Quasi-Static Brittle Fracture in Strain-Limiting Elastic Media

Speaker: Ram Manohar
Co-Authors: S. M. Mallikarjunaiah;
Affiliation: Texas A&M University-Corpus Christi
Time: 09:40-10:00

We present a rigorous convergence analysis of adaptive finite element methods for regularized variational models of quasi-static brittle fracture in strain-limiting elastic solids. Two novel adaptive mesh refinement algorithms, driven by local residual-type error indicators, are proposed for efficient energy minimization. It is shown that one algorithm converges up to a prescribed tolerance, while the other yields intrinsically convergent sequences without requiring an explicit stopping criterion. We demonstrate the performance of the proposed methods through numerical experiments, highlighting their efficiency and accuracy in capturing fracture behavior under anti-plane shear loading.

Numerical Analysis of the first finite element method for the Phase Field Crystal Equation

Speaker: Natasha S Sharma
Co-Authors: Patrick Tabiri;
Affiliation: The University of Texas at El Paso
Time: 10:00-10:20

The Phase Field Crystal (PFC) framework provides a continuum model capable of capturing the fundamental physics of crystal growth across atomic length and diffusive time scales. Mathematically, these processes are described by a nonlinear, sixth-order evolutionary partial differential equation. In 2007, Backofen et al. introduced an early finite element approach to the PFC equation by recasting it as a system of three coupled second-order equations and employing a semi-implicit time discretization. Although this scheme successfully simulated crystalline nucleation and growth, critical theoretical aspects, including well-posedness and energy dissipation, remained unaddressed. This talk examines these fundamental properties, establishing the specific conditions under which they hold. By detailing rigorous proofs of these key properties, we complete the numerical analysis of this pioneering numerical scheme.

Computational Efficiency Through Degree-of-Freedom Reduction in Weak Galerkin Finite Element Methods

Speaker: Saqib Hussain
Affiliation: Texas A&M International University
Time: 10:20-10:40

We present and compare two finite element approaches, the weak Galerkin (WG) and modified weak Galerkin (MWG) methods, for solving second-order elliptic problems with mixed boundary conditions. The standard WG method uses weak functions and discrete weak gradients to achieve optimal convergence, but carries extra degrees of freedom that increase computational cost. The MWG method addresses this by eliminating boundary unknowns, reducing the system size while maintaining the same optimal convergence rates in both H^1 and L^2 norms. Numerical exper-

iments on triangular meshes confirm the theoretical results and demonstrate the computational advantage of the MWG approach.

Coupled Cahn-Hilliard systems with reaction

Speaker: Arash Goligerdian
Co-Authors: Arkadz Kirshtein
Affiliation: Texas A&M University-Corpus Christi
Time: 10:40-11:00

This research study concerns the development of structure-preserving numerical methods for nonlinear partial differential equations arising in phase-field models and reaction-diffusion systems, with particular emphasis on reaction Cahn-Hilliard equations. These models incorporate high-order diffusion, nonlinear mobility, reaction mechanisms, and nonconvex free-energy structures, leading to significant analytical and computational challenges. The main focus is on constructing energy-stable discretizations that preserve key qualitative features of the underlying continuous system, including mass conservation and discrete energy dissipation. The analysis is based on compactness arguments, discrete energy estimates, and careful control of nonlinear terms to establish stability and convergence. The resulting framework provides both a rigorous mathematical foundation and a robust computational approach for the simulation of multiscale phase-separation dynamics in the presence of reaction effects.

Learning from SDE Snapshots Data: How do energy-dissipation laws help learn dynamics?

Speaker: Yiwei Wang
Affiliation: University of California Riverside
Time: 11:00-11:20

Learning dynamics from unpaired snapshot data is challenging because trajectory information is unavailable, and reconstructing velocity fields from snapshots can be noisy and unstable. In this talk, we present a variational approach based on the energy-dissipation structure of the Fokker-Planck equation. Instead of learning the force directly, we learn thermodynamic quantities such as the free energy from snapshot data. This leads to new loss functions based on the energy-dissipation law, including a formulation that avoids explicit OT-based velocity reconstruction during training. Numerical examples show that these losses recover underlying potentials and interaction kernels more accurately than direct velocity-based fitting, especially in low-density regions where OT and score estimation are unreliable.

Multiscale Graph Reduction for Discrete Diffusion

Speaker: Maria Vasilyeva[1]
Co-Authors: James Brannick[2], Ben S. Southworth[3]
Affiliation: [1] Texas A&M University-Corpus Christi; [2] Penn State University; [3] LANL
Time: 11:20-11:40

We present multiscale graph-based reduction algorithms for upscaling heterogeneous and anisotropic diffusion problems. The approach partitions the domain into balanced subdomains and applies spectral clustering via local generalized eigenproblems to capture key fine-scale features. Coarse spaces are constructed using energy-minimizing strategies, including unconstrained harmonic extensions and constrained formulations from non-local multiscale methods. Numerical experiments on graph Laplacians, perforated domains, channelized media, anisotropic cases, and pore networks demonstrate the accuracy and robustness of the proposed methods.

MF2: Data-Driven Methods, Networks, and Discrete Mathematics

Quantifying predictability and surprise in music

Speaker: Simona Hodis
Affiliation: Texas A&M University Kingsville
Time: 09:00-09:20

The aim of the study was to explore the mathematics behind the arrangement of musical scores that makes a sound beautiful and calming, using two musical genres: Classical music and Byzantine chanting. We applied the Detrended Fluctuation Analysis (DFA) to a total of 16 musical pieces (eight Classical music songs and eight Byzantine chanting hymns) and we analyzed the equal-temperament frequencies of the musical notes together with the time duration of each note. We have shown that all time series of pitches exhibit a self-affine fractal scaling range, as previous researchers found in other music genres. The results obtained in this study show consistent differences between the two genres of music, when we analyzed the pitch fluctuations and rhythmic trends at different time scales. We found that the Classical music songs presented more pitch variations and surprise compared with the Byzantine chanting hymns that showed smoother variations in pitch and more predictability.

An Iterative Method for Redistricting

Speaker: E Cabral Balreira
Affiliation: Trinity University
Time: 09:20-09:40

A common approach to detecting gerrymandering involves generating large ensembles of districting maps and identifying outliers based on relevant metrics. Starting from a valid plan, existing methods such as local swaps and ReCom produce new valid maps, forming a chain of feasible plans. However, because the space of all possible maps is large, our approach focuses on generating seed maps that would likely be more diverse starting points. We introduce an iterative method that begins with any partition of the map into connected districts, valid or not, and then we adapt the ReCom procedure to rapidly reach new valid seed maps. This flexibility also allows us to intentionally generate gerrymandered maps, which we can add to the ensemble to assess whether the sample adequately represents the space of all possible maps.

PQ Penny-Flip Game

Speaker: Aden Ahmed
Affiliation: Texas A&M University - Kingsville
Time: 09:40-10:00

In an episode of Star Trek: The Next Generation, Captain Picard faces a dire emergency aboard the starship Enterprise and is challenged by the enigmatic entity Q to a simple coin game known as the PQ Penny-Flip. With a coin placed heads up in a closed box, the two players alternately choose to flip or not flip the coin, without ever seeing its state. Q wins if the coin shows heads, Picard wins with tails. After repeated losses, Picard begins to suspect Q might be cheating. This talk explores the mathematical strategies and principles behind the PQ Penny-Flip game and uncovering whether Q's winning streak is due to chance, skill, or something more mysterious.

A Short Proof of the Logarithmic Derivative Lemma in Several Complex Variables

Speaker: Qi Han
Co-Authors: Jingbo Liu
Affiliation: Texas A&M University–San Antonio;
Time: 10:00-10:20

In this work, we provide a concise proof of the logarithmic derivative lemma in several complex variables. We start by giving a complete proof of a critical result by Biancofiore and Stoll (Ann. of Math. Stud., 1981) using matrix theory, and then follow Goldberg and Grinstein (Math. Notes, 1976) and Li (Trans. Amer. Math. Soc., 2011) to present the shortest proof to date.

On the Spinor Genus and the Lattice Isomorphism Problem

Speaker: Jingbo Liu[1]
Co-Authors: Cong Ling[2]; Andrew Mendelsohn[2]
Affiliation: [1] Texas A&M University-San Antonio, [2] Imperial College London
Time: 10:20-10:40

In this talk we address the spinor genus, a previously unrecognized classification of quadratic lattices in the context of cryptography, related to the lattice isomorphism problem (LIP). The spinor genus lies between the genus and isomorphism class, thus refining the concept of genus. We present algorithms to determine whether two quadratic lattices belong to the same spinor genus. If they do not, it provides a negative answer to the decisional variant of LIP.

Sea Surface Temperature Modeling Using Stochastic Differential Equations

Speaker: Lihua Zuo; **Co-Authors:** Aleksei Krasnikov; Toshiaki Shinoda
Affiliation: Texas A&M University-Corpus Christi
Time: 10:40-11:00

The sea surface temperature (SST) is important in climate dynamics. Traditional modeling often struggles to represent unresolved variability and stochastic environmental effects. In this work, SST is modeled using stochastic differential equations (SDEs) with random noise and a seasonal mean behavior. Numerical solutions was solving using Runge-Kutta-based schemes. The model is applied to real SST data (e.g., Gulf of Mexico) to examine variability, stability, and statistical behavior. The results demonstrate that the stochastic model produces more realistic variability compared to deterministic approaches while maintaining numerical stability.

A Mathematical Theory of Discursive Networks

Speaker: Juan B. Gutierrez
Affiliation: University of Texas at San Antonio
Time: 11:00-11:20

Large language models (LLMs) turn writing into a live exchange between humans and software. We characterize this new medium as a discursive network that treats people and LLMs as equal nodes and tracks how their statements circulate. We define the generation of erroneous information as invalidation, meaning any factual, logical, or structural breach, and show it follows four hazards: drift from truth, self-repair, fresh fabrication, and external detection. We develop a general mathematical model of discursive networks that shows that a network governed only by drift and self-repair stabilizes at a nonzero error rate. Giving each false claim even a small chance of peer review shifts the system to a truth-dominant state. We operationalize peer review with the open-source Flaws-of-Others (FOO) algorithm: a configurable loop in which any set of agents critique each other while a harmonizer merges their verdicts. We identify ethical transgressions that occurs when humans fail to engage in the discursive network. The takeaway is both practical and cultural: reliability in this medium comes not from perfecting single models but from connecting imperfect ones into networks that enforce mutual accountability.

On the $C^{p'}$-Conjecture

Speaker: Genival da Silva
Affiliation: Texas A&M University-San Antonio
Time: 11:20-11:40

In this talk, we discuss the optimal regularity of weak solutions to the p-Poisson equation $-\Delta_p(u) = f$ in the plane, where $p > 2$ and f is bounded. It is conjectured that such solutions are locally of class $C^{p'}$, where p' is the Hölder conjugate of p. While this result was previously established using sophisticated deformation techniques, we present a new and more direct proof based on a priori estimates.

MF3: Nonlinear Mechanics and Mathematical Physics

Nonlinear Operator Differential Equations

Speaker: Reza R. Ahangar
Affiliation: Texas A&M University Kingsville
Time: 13:00-13:20

Abstract: To study the nonlinear causal operator differential equations, we will present some basic concepts in Banach space with k-norm. We will use one example of the trajectory of moving object in the space, like spaceship to show the origin of causal operator differential equation.

Lipschitzian operators will be studied and apply to nonlinear differential equations. We will prove the existence and uniqueness of the solution using the contraction mapping of Banach Fixed point theorem.

Mechanical Characterization and Hyperelastic-Damage Modeling of Decellularized Human Umbilical Arteries for Vascular Graft Applications

Speaker: Kun Gou[1]
Co-Authors: Jin-Jia Hu[2]; Seungik Baek[3]
Affiliation: [1] Texas A&M University-San Antonio [2] National Yang Ming Chiao Tung University; [3] Michigan State University
Time: 13:20-13:40

Human umbilical arteries (HUAs) are promising small-diameter vascular graft candidates due to their structural and mechanical similarity to native arteries, but decellularization, removal of the cells to reduce immunogenicity, may alter their mechanical performance. This study characterizes the mechanical changes induced by abluminal layer removal and subsequent decellularization using a hyperelastic constitutive model incorporating isotropic and anisotropic damage. Five HUA samples were mechanically tested under large transmural pressure differences, and model parameters were identified through an improved fitting procedure with statistical evaluation of variability and significance. Results show that abluminal layer removal significantly increases compliance, whereas decellularization produces a mild reduction, leading decellularized HUAs to exhibit better compliance than native HUAs overall. These findings establish a robust parameter-estimation framework for evaluating mechanical compatibility and supporting the development of durable, mechanically congruent vascular grafts.

Stress-Strain Behavior in Transversely Isotropic Strain-Limiting Thermoelastic Media under Linearly Varying Vertical Displacement Loading

Speaker: Dambaru Bhatta[1]
Co-Authors: Saugata Ghosh[1]; S. M. Malliarjunaiah[2]
Affiliation: [1]; University of Texas Rio Grande Valley; [2] Texas A&M University-Corpus Christi
Time: 13:40-14:00

We analyze the stress-strain response of a transversely isotropic thermoelastic solid governed by a nonlinear strain-limiting constitutive relation. This formulation allows stresses to attain high magnitudes while ensuring that strains remain bounded, thereby removing the crack-tip strain singularities characteristic of linear elastic fracture mechanics. The coupled temperature and displacement fields are solved numerically using a Galerkin finite element method, and the resulting

stress and strain distributions are obtained through post-processing. The numerical results for the spatial variation of temperature, stress, and strain are presented for two fiber orientations.

Asymptotic Stabilization of Mechanical Systems on Semidirect Product Lie Groups with Broken Symmetry via Controlled Lagrangians

Speaker: Cesar Contreras[1]
Co-Authors: Tomoki Ohsawa[2]
Affiliation: [1] Texas A&M International University; [2] The University of Texas at Dallas
Time: 14:00-14:20

Building on our previous work on the stabilization of bottom-heavy underwater vehicles, where we established the matching condition for controlled Lagrangians through kinetic shaping of mechanical systems on semidirect product Lie groups with broken symmetry, we now extend these results to prove asymptotic stability. Specifically, we apply LaSalle's invariance principle to demonstrate stability in the case of steady translational motion of an underwater vehicle.

High-Energy Neutrino Flavor State Transition Probabilities

Speaker: John Harrison[1]
Co-Authors: Richard Anantua[2]
Affiliation: [1] Texas A&M University- Corpus Christi; [2] University of Texas at San Antonio
Time: 14:20-14:40

We analytically determine neutrino transitional probabilities and abundance ratios at various distances from the source of creation in several astrophysical contexts, including the Sun, supernovae and cosmic rays. In doing so, we determine the probability of a higher-order transition state from $\nu_\tau \to \nu_\lambda$, where ν_λ represents a more massive generation than Standard Model neutrinos. We first calculate an approximate cross-section for high-energy neutrinos which allows us to formulate comparisons for the oscillation distances of solar, supernova and higher-energy cosmic ray neutrinos. The flavor distributions of the resulting neutrino populations from each source detected on Earth are then compared via fractional density charts.

MF4: Mathematical Biology and Data-Driven Life Sciences

Modeling Elemental Constraints Across Aquatic Food Webs

Speaker: Md Nazmul Hassan[1]
Co-Authors: Angela Peace[2]
Affiliation: [1] Texas A & M University-Kingsville; [2] Texas Tech University
Time: 15:30-15:50

Accurate contaminant risk assessment requires understanding not only their effects on individual organisms but also the interplay of ecological interactions, elemental cycling, and natural stressors such as resource limitation. Evidence indicates that contaminant effects are strongly modulated by food conditions, including resource stoichiometry and nutrient availability. We develop and test robust, mathematically grounded models of population dynamics under concurrent stoichiometric and contaminant stressors, integrating empirical data to parameterize and validate them. This approach provides a unified theoretical framework for ecotoxicology, revealing how toxicants bioaccumulate through upper trophic levels under combined ecological and stoichiometric constraints.

Density-mediated emergence impacts the success of Wolbachia-based mosquito population reduction strategies

Speaker: Zhuolin Qu[1] **Co-Authors:** Lauren Childs[2], Michael Robert[2]
Affiliation: [1] University of Texas at San Antonio; [2] Department of Mathematics, Virginia Tech
Time: 15:50-16:10

Density dependence is a key ecological mechanism regulating population growth, yet its influence can vary substantially depending on which life stage it affects. Understanding these effects is critical for evaluating the success of Wolbachia-based mosquito population suppression strategies. We develop an ordinary differential equation model of Aedes aegypti dynamics that incorporates density-dependent regulation in development and mortality processes. Through analytical and numerical investigations, we show that when density dependence acts primarily on juvenile development, release-driven population suppression can produce counterintuitive, non-monotonic responses, where intermediate release rates transiently increase the uninfected adult population. In contrast, when density dependence acts only on juvenile mortality, this phenomenon does not occur. These findings highlight the importance of identifying which life-history processes are density-regulated when designing Wolbachia-based control programs.

Computational Approaches to Stochastic Biological Systems with Migration and Interaction.

Speaker: Md Mustafijur Rahman[1]
Co-Authors: Roger B. Sidje[2]
Affiliation: [1] Texas A&M University - San Antonio; [2] The University of Alabama
Time: 16:10-16:30

Biological and ecological systems exhibit stochastic dynamics coupled with spatial diffusion, where diffusion is modeled as a jump (migration) process between compartments. The reaction-diffusion master equation (RDME) captures these effects but leads to a significantly larger and more complex state space than the chemical master equation (CME). We tackle a metapopulation model using the RDME formulation. Numerical methods are used to analyze and predict the behavior of the model. We use tensor-based methods to efficiently handle the resulting high-dimensional system.

Stability and Bifurcation Analysis of Prion Dynamics with the Unfolded Protein Response and Aggregation-Fragmentation Process

Speaker: Gangadhara Boregowda
Co-Authors: Zhaosheng Feng; Michael R. Lindstrom
Affiliation: The University of Texas Rio Grande Valley
Time: 16:30-16:50

Prion diseases are neurodegenerative disorders characterized by the dynamical spread of toxic proteins throughout the brain. In this talk, we develop a mathematical model that accounts for the interaction, aggregation, and degradation of proteins, while also incorporating a cellular defense mechanism that introduces a time delay affecting protein translation. This formulation leads to a system of nonlinear delayed differential equations, a generalization of the Nowak model for prion production. Our first objective is to establish the existence of positive and bounded solutions to the model. Subsequently, we analyze the asymptotic behaviour of the system by deriving conditions on the parameters that govern its dynamics. Additionally, we derive conditions on the time delay under which the system exhibits a Hopf bifurcation.

Unraveling the Effects of Fungicides on Honey Bee Populations: A Mathematical Modeling with Seasonality

Speaker: Jun Chen
Affiliation: Texas A&M University Kingsville
Time: 16:50-17:10

Honey bee colonies are essential to ecosystems and agriculture, yet colony losses remain high under multiple stressors. Although fungicides are often considered relatively safe for bees, experimental evidence suggests they may negatively affect colony health. In this work, we develop and analyze mathematical models with seasonality to study how fungicide exposure influences honey bee population dynamics. By fitting the model to colony and pollen-consumption data, we show that higher fungicide concentrations increase adult mortality, reduce colony size, and shift peak egg-laying later in the season. The results suggest that fungicides can disrupt seasonal colony dynamics and increase the risk of colony collapse.

MS1: Mathematical Modeling of Complex Biological, Physical, and Engineering Systems (9am-12pm)

Backward bifurcations in discrete-time epidemic models with vaccination

Speaker: Jenita Jahangir
Co-Authors: Azmy S. Ackleh and Amy Veprauskas
Affiliation: University of Louisiana at Lafayette
Time: 09:00-09:20

We develop a discrete-time Susceptible-Infectious-Susceptible model with Vaccination (SISV) in which vaccination reduces but does not necessarily eliminate the risk of infection. After establishing the stability of the disease-free equilibrium (DFE), we apply an extension of the Fundamental Bifurcation Theorem to study the endemic dynamics arising when the DFE loses stability at the threshold quantity $R_0 = 1$, where R_0 denotes the basic reproduction number. We find that, as with its continuous-time counterpart, a backward bifurcation may occur in this model leading to bistable dynamics provided that the vaccine does not provide complete protection from infection and infected individuals are able to recover from the disease. For comparison purposes, we also present a second model formulation based on a different ordering of events, an issue that does not appear in continuous-time models. Specifically, we swap the order that vaccination and disease transmission occur within a unit of time. In contrast to the first model, we show that this alternative formulation may produce a backward bifurcation even when vaccination is completely effective.

Determining Volumes of Irregular Celestial Bodies

Speaker: Alfredo Razo
Affiliation: Laredo College
Time: 09:20-09:40

This presentation will revolve around determining the volumes of irregular celestial bodies such as asteroids or moons. Because most asteroids have an irregular shape, standard volume formulas cannot be used to determine their volume. In order to find the volume of these celestial bodies, the calculus technique of slicing is required. The asteroid will be modeled as a series of circular or elliptical cross sections perpendicular to a chosen axis. Each slice is estimated by determining the dimensions of the slices and then combining all of the slices gives the Riemann sum. The graphing software desmos will be used to visualize the irregular shape and Excel will be used to determine the Riemann sum. These functions are used to show how efficient these mathematical models are at approximating complex geometries. Approximating the volume of these celestial bodies is crucial for astronomy and physics as it can be used to determine mass or gravitational influence. These metrics can help predict the rotation or the potential impact energy of the celestial body.

Weighted Yes-No Voting and the U.N. Security Council

Speaker: Joseph Medina
Co-Authors: Joseph Medina; Qi Han
Affiliation: Texas A&M University-San Antonio
Time: 09:40-10:00

A weighted yes-no voting system is a system that has a set of weights, x, corresponding members withing a coalition where the sum of the weights within the coalition must equate to or be greater than a quote, q. The goal for this information is to observe the effect of veto power on a yes-no voting system as well as to question the resulting power asymmetries in the U.N. Security Council. The findings in this paper conclude that the UN Security Council is in fact a weighted yes-no voting system where the 5 permanent members have a $x = 7$, and the nonpermanent members have a weight of 1; the quota is found to be $q = 39$. This weight and quota fulfill the applied situation but raises the question of whether all yes-no voting systems are also a weighted voting system.

Mathematical Framework for Modeling Non-Genetic Heredity in Vesicle Systems

Speaker: Alessandra Martinez
Co-Authors: Myrine Barreiro-Arevalo, Daniel Gutierrez III, Eloi Camprubi-Casas, Michael R. Lindstrom
Affiliation: University of Texas Rio Grande Valley
Time: 10:00-10:20

The emergence of life on Earth remains one of the biggest unanswered questions in science. One of the most prominent hypotheses is the metabolism-first hypothesis, which suggests that life began with self-sustaining chemical networks that allowed for the growth and inheritance of traits via molecular composition. The simplicity of membrane-bound vesicles makes it a suitable model for the study of the growth, division, and non-genetic heredity of early cellular structures. We develop and analyze ordinary and partial differential equation models to simulate vesicle membrane and population dynamics, incorporating parameters such as lipid intake, outlet, vesicle growth, and division. These models provide insights into the conditions needed for the inheritance of membrane traits and radii across generations. By implementing experimental data into our models, we aim to find the foundational elements that permit Darwinian evolution to operate in the earliest stages before genes emerged.

Modeling the Impact of Adipose Tissue and Immune Dynamics on Tumor Growth and Treatment Efficacy

Speaker: Nicholas McLain
Co-Authors: Sarah Fleming, Lupe BuenRostro, B. Veena S. N. Rao
Affiliation: Texas A&M University - Corpus Christi
Time: 10:20-10:40

Cancer progression is governed by a complex interplay between tumor cells, the immune system, and the surrounding biological microenvironment. Notably, obesity acts as a biological catalyst for tumor growth via chronic inflammation, altered immune function, and adipose-derived signaling. This obesity-driven promotion directly counters the critical tumor-suppressing functions of natural killer (NK) cells and cytotoxic T lymphocytes (CTLs). While strategies such as chemotherapy and immunotherapy aim to bolster tumor control, the specific impact of obesity on treatment efficacy requires deeper quantitative understanding.

In this study, we develop a mathematical model to investigate the combined effects of obesity, immune response, and therapeutic intervention on cancer progression. We formulate a system of nonlinear ordinary differential equations to capture the temporal dynamics of tumor cells, immune populations, adipose tissue, and treatment concentrations. The framework incorporates logistic growth constraints alongside specialized interaction terms that quantify immune-mediated cytotoxicity, obesity-driven tumor promotion, and targeted treatment effects. We investigate the system's underlying dynamics through rigorous equilibrium and stability analyses, complemented by numerical simulations.

Our preliminary results indicate that elevated adipose tissue significantly accelerates tumor growth and compromises overall tumor control, potentially undermining therapeutic interventions. Conversely, a robust immune response, particularly driven by CTLs, is critical for tumor suppression. Furthermore, the model demonstrates that a synergistic approach combining immunotherapy and chemotherapy substantially improves treatment outcomes. Ultimately, this work provides a robust mathematical framework for elucidating the deleterious role of obesity in cancer dynamics and for optimizing multi-modal treatment strategies.

Ordinary Differential Equations in Engineering

Speaker: David Figueroa
Co-Authors: Hongwei Wang
Affiliation: Texas A&M International University
Time: 10:40-11:00

There is always a few common questions that occur within and outside the academic field. "Why do we need to learn about mathematics? This will never be used in the real-world so why teach us?' At first, it seems simple to reply with every day experiences, but we can expand our horizons. It can be stated that mathematics is everywhere around us, we just have to take the time to look. In fact, we can use engineering as a primary source to provide those answers. Furthermore, engineering shapes our daily lives as technology advances with each passing day. An interesting question to propose is asking if mathematics and engineering can be utilized together to demonstrate a direct correlation between the two STEM branches. We can rely on ordinary differential equations (ODEs) to provide a mathematical framework that can be applied onto physical systems that adapt and learn over time. ODEs enable engineers to model and optimize system behaviors and adjust when undesirable outcomes are predicted. ODEs are present in our transportation and traffic models, electric circuits, signal processing in our smartphones, and are a primary component in the infrastructure of our water systems. These real-world examples provide visual clarity how ODEs are applied into engineering scenarios that require practical solutions. In turn, applying these principles is how engineers invest, design, and adjust their systems to positively impact our local and global environments. This presentation will go over how ODEs are utilized across various branches of engineering that shape our everyday world and systems.

An Iterative Numerical Approach for Nonlinear Wave Propagation in Elastic Bars

Speaker: Ananya Gopal Hegde
Co-Authors: S. M. Mallikarjunaiah
Affiliation: Texas A&M University - Corpus Christi
Time: 11:00-11:20

This study presents a novel iterative numerical method to analyze nonlinear wave propagation in one-dimensional bars governed by algebraically nonlinear models. This approach establishes a robust computational framework that accurately captures the complexities of wave evolution, which are influenced by nonlinear elastic effects. The research derives the necessary constitutive equations and employs an iterative solution to approximate wave propagation characteristics across various boundary conditions. Numerical simulations validate the effectiveness of this method,

demonstrating its versatility and stability as a preferred alternative for modeling nonlinear wave propagation in elastic materials.

A Mathematical Model for Energy-Aware Task Scheduling in Energy-Harvesting Wireless Systems

Speaker: Ruben Dominguez
Affiliation: Texas A&M University-Corpus Christi, engineering department
Time: 11:20-11:40

Energy-harvesting (EH) wireless sensor nodes introduce a fundamental constraint in which computation and communication must be dynamically adapted to the availability of harvested energy. This work presents a mathematical framework for energy-aware scheduling in self-sustaining LoRa-based edge devices, building upon analytical models developed for maximizing throughput under stochastic energy conditions.

The proposed formulation models the node as an energy-constrained system in which the available energy budget evolves over time according to harvested input and consumption from sensing, processing, and transmission tasks. A scheduling strategy is derived to allocate transmission events and sensing operations such that energy expenditure remains bounded by the instantaneous stored energy, while maximizing long-term data throughput. The model incorporates communication-dependent costs through time-on-air formulations and spreading factor configurations, linking physical layer parameters directly to energy consumption.

This framework yields a constrained optimization problem in which task execution is governed by energy availability, leading to a dynamic scheduling policy that minimizes energy waste while maintaining system operation. The resulting equations are embedded directly into firmware, enabling real-time decision-making based on measured system states such as voltage, payload size, and communication parameters. Experimental validation demonstrates that the analytical model accurately predicts system behavior and enables sustained operation of battery-less nodes through adaptive scheduling.

This work highlights the role of mathematical modeling in bridging theoretical optimization and embedded implementation, providing a foundation for designing energy-neutral IoT systems where communication, computation, and energy harvesting are tightly coupled.

MS2: Data-Driven and Machine Learning Approaches (1pm-3pm)

Learning Reaction Rates from Product Formation-Time Data in Multi-scale Stochastic Reaction Networks

Speaker: Jacob Kapita
Co-Authors: A. Ganguly
Affiliation: Louisiana State University
Time: 13:00-13:20

Multi-scale stochastic reaction networks are widely used to model biochemical and molecular systems, where reaction dynamics are naturally described by high-dimensional Markov jump processes. Classical parameter inference in such models typically requires full observation of species trajectories. In many experimental settings, however, only the random times at which product molecules are formed are available, leading to severe partial observation and loss of state information.

In this work, we develop a mathematical framework for learning reaction-rate parameters from product formation-time data alone. Using multi-scale scaling and stochastic averaging, we reduce complex Michaelis-Menten-type networks to effective one-dimensional dynamics governing product formation. We then construct a weakly interacting particle system whose mean-field limit and propagation of chaos yield asymptotically independent event times. This structure leads to a tractable product-form likelihood for the reaction parameters.

The resulting approach enables both frequentist and Bayesian estimation directly from event-time observations, linking multi-scale stochastic analysis, interacting particle systems, and statistical learning.

Learning Bounded Deformation: A SLE-KAN Framework for Interpretable Constitutive Modeling

Speaker: Chandana Pati
Co-Authors: S.M. Mallikarjunaiah
Affiliation: Texas A&M University- Corpus Christi
Time: 13:20-13:40

Classical elasticity models fail to capture strain saturation in soft materials such as elastomers, biological tissues, and polymeric solids, where deformation becomes intrinsically bounded under large stress. We propose SLE-KAN, a hybrid constitutive modeling framework that integrates Strain-Limiting Elasticity (SLE) with Kolmogorov-Arnold Networks (KANs) to address this gap. The SLE model serves as a physics-based backbone enforcing bounded strain, odd symmetry, and vanishing tangent modulus, while the KAN learns smooth, low-amplitude residual corrections directly from data. Physical admissibility is guaranteed by construction through spline-based monotonicity and strain-saturation constraints embedded in the network architecture. The framework is validated on synthetic benchmarks across moderate and strong strain-limiting regimes $\beta = 0.5$ to $\beta = 10$, achieving $R2 > 0.999$ in smooth regimes, and applied to Treloar's classical rubber experiments under uniaxial, biaxial, and planar deformation. Regime-based analysis reveals a quantifiable trade-off between data fidelity and mechanical admissibility, with deviations under strong constraints arising from enforced physics rather than model limitations. SLE-KAN provides a transparent, extrapolation-robust alternative to black-box neural networks for experimental solid mechanics.

Kolmogorov-Arnold Networks as Interpretable Surrogates for Nonlinear Differential Equations

Speaker: Mahidhar Reddy Patukuri
Co-Authors: S. M. Mallikarjunaiah , B.Veena S.N.Rao
Affiliation: Texas A&M University-Corpus Christi
Time: 13:40-14:00

Physics-Informed Neural Networks (PINNs) have emerged as powerful tools for solving forward and inverse problems in computational science; however, traditional neural architectures often lack interpretability and can struggle with complex, high-dimensional solution spaces. In this work, we explore Kolmogorov-Arnold Networks (KANs) as an alternative neural function approximation paradigm for solving systems of nonlinear ordinary and partial differential equations. Leveraging their structured representation inspired by the Kolmogorov-Arnold theorem, KANs enable more interpretable mappings while maintaining strong approximation capabilities The proposed approach is evaluated across a range of benchmark problems, including first-order ordinary differential equations, coupled nonlinear dynamical systems, and nonlinear partial differential equations such as Burgers' and heat equations. Across these settings, the model demonstrates strong agreement with reference solutions and effectively captures complex nonlinear behaviors. Our results indicate that KAN-based models achieve competitive or improved accuracy compared to conventional neural approaches, while offering enhanced transparency through their structured functional representation. Additionally, we investigate convergence characteristics, robustness to data perturbations, and scalability across problem classes, highlighting the potential of KANs as a promising direction for interpretable scientific machine learning.

Generating Live Heatmaps of EDR Data through a Spatiotemporal Weighting

Speaker: Joel Williams[1]
Co-Authors: Mike Lindstrom[2]; Alberto Fornaci[3]; Sean Bohun[4]
Affiliation: [1] The University of Texas Rio Grande Valley; [2] UTRGV; [3] IATA; [4] Ontario Tech
Time: 14:00-14:20

This talk introduces a novel method for generating live heatmaps of Eddy Dissipation Rate (EDR) data through a spatiotemporal weighting designed to enhance turbulence visualization in aviation. As more flight data become available, approaches relying solely on in-flight EDR measurements have the potential to accurately nowcast and visualize turbulence with low computational cost. The proposed method significantly improves turbulence visualization capabilities of common commercial aircraft. This is particularly valuable for pilot decision-making and trip planning, enhancing flight safety and operational efficiency. This approach also incorporates an innovative uncertainty threshold, which refrains from predicting when there are insufficient data, thereby maintaining higher reliability in the nowcasts. Validation through K-Fold Cross Validation demonstrates the robustness and accuracy of our method, making it a promising tool for real-time turbulence monitoring.

A Finite Mixture of Closed-Form Kinematic Primitives with Heteroscedastic Gaussian Uncertainty for Synthetic 3D Trajectory Generation

Speaker: Syed Izzat Ullah
Co-Authors: Jose Baca
Affiliation: Collaborative Robots and Agents Laboratory, Texas A&M University-Corpus Christi
Time: 14:20-14:40

We present a probabilistic generative framework for synthesizing diverse three-dimensional trajectories as paired observation and prediction sequences. The generative model is formulated as a finite mixture over four families of closed-form kinematic primitives: constant-velocity linear motion, sinusoidal oscillation, trefoil-knot curves, and vertical harmonic motion. For each sample, a primitive is selected through a categorical distribution over mixture weights. Conditioned on the selected primitive, motion parameters such as speed, amplitude, frequency, phase, and spatial offsets are drawn from independent uniform priors, and a deterministic kinematic mapping rolls out the full state trajectory in position and velocity space R6. To model localization uncertainty, we inject heteroscedastic Gaussian noise whose variance scales linearly with cumulative path length, producing trajectory-dependent covariance structures compatible with probabilistic density estimation. The induced joint distribution over data pairs is expressed as a four-component mixture with parameters marginalized over their respective priors. We instantiate this framework as SynTraG, generating a corpus of 47,894 paired sequences partitioned into 3-second observation histories and 5-second prediction horizons. The mixture structure supports both in-distribution evaluation under the full prior and out-of-distribution testing through controlled modification of mixture weights or parameter support.

Machine Learning for Predator–Prey Equilibrium with Disease

Speaker: Hyangim Ji
Co-Authors: Maria Vasilyeva, Alexey Sadovski
Affiliation: Texas A&M University-Corpus Christi
Time: 14:40-15:00

We consider a predator–prey system with disease, modeled by coupling Lotka–Volterra dynamics for species interactions with an SIS framework for infection transmission. The resulting system of differential equations is simulated over a wide range of parameter values to generate data describing its long-term equilibrium behavior. We employ supervised machine learning to learn a mapping from model parameters to equilibrium states. Several models, including linear regression, decision trees, and neural networks, are trained on the generated dataset. The results demonstrate that machine learning can accurately approximate equilibrium solutions without repeatedly solving the governing differential equations.

MS3: Mechanics, Dynamical Systems, and Applied Mathematical Analysis (3:30-5:30pm)

A Sasa-Satsuma-mKdV equation and its various soliton solutions

Speaker: Changyan Shi
Co-Authors: Bao-Feng Feng
Affiliation: School of Mathematical and Statistical Sciences, UTRG
Time: 15:30-15:50

In this talk, we first propose the Lax pair and its bilinear form of a Sasa-Satsuma-mKdV equation from the ones of the three-component coupled Hirota equation. Then, by the Kadomtsev-Petviashvili (KP) reduction method, we derive its various soliton solutions including the bright, dark, bright-dark, as well as breather solutions. Their dynamical properties are also explored.

Numerical Investigation of Crack-Tip Fields in Transversely Isotropic Media Under Piecewise Slope Loading

Speaker: Saugata Ghosh
Co-Authors: Saugata Ghosh, Dambaru Bhatta, S. M Mallikarjunaiah
Affiliation: University of Texas Rio Grande Valley
Time: 15:50-16:10

This talk investigates the behavior of crack-tip fields in a transversely isotropic strain-limiting elastic solid under piecewise slope displacement boundary conditions. The mechanical response is modeled using a nonlinear constitutive relation between Cauchy stress and linearized strain, which eliminates the classical strain singularities near the crack tip. The governing equations are formulated as a quasi-linear elliptic boundary value problem and solved using a continuous Galerkin finite element method combined with a Picard iterative scheme. Piecewise linear displacement profiles with opposite slopes are imposed along the top and bottom boundaries. Numerical results for two different fiber orientations illustrate the combined effects of anisotropy and loading on stress and strain distributions. The talk highlights the effectiveness of piecewise slope loading as a realistic framework for analyzing fracture behavior in strain-limiting anisotropic solids.

Does center of mass affects the buildings that we see?

Speaker: Martin Reyes Jr.
Affiliation: Laredo College
Time: 16:10-16:30

This question may be one of the most asked/thought of: how can most things that we make maintain stability to stand up or hold up? My question for the presentation for the conference is, How can the center of mass affect the stability of vehicles, bridges, and buildings? The approach to this question is looking at formulas, graphs, and designs/sketches of products. Most of the research that I'm conducting or looking for is formulas used on the design/sketch and also what materials they are using. I've seen in my research that most of the formulas are similar to the one for the center of mass. I'm also not just focusing on finding formulas but also data that may be useful for the presentation. What I'm trying to see within my research is if center of mass is effective on vehicles, buildings, and bridges and how stability affects them differently. Most of the data that I've compiled is useful to answering the question. Mostly such as how an object has to be "balanced" correctly to find the perfect spot. I find this topic very interesting, mostly because I'm studying to become a civil engineer in the future. Plus, I also feel that this is one of the most talked-about questions in every building that we see today.

"Staying Balanced in Space: A Mathematical Approach to Satellite Stability"

Speaker: Gustavo Nieto
Affiliation: Laredo College
Time: 16:30-16:50

The center of mass is a fundamental concept in mathematics and physics, essential for understanding the behavior of objects in motion. This project focuses on determining the center of mass for a satellite, a critical factor in ensuring its stability and proper orientation in orbit.

To analyze this, the presentation uses both discrete and continuous models of mass distribution. Weighted averages are applied to discrete components, while integral calculus is employed for continuous distributions, allowing precise calculation of the satellite's center of mass. A simplified satellite model, including a central body and extended solar panels, is constructed to demonstrate these calculations. Diagrams and visual representations illustrate how each component contributes to the overall balance of the system.

The results show how changes in mass and geometry shift the center of mass, affecting the satellite's stability. These calculations highlight the connection between mathematical modeling and practical engineering problems, demonstrating how proper mass distribution prevents unwanted rotation or tumbling in space.

Understanding the center of mass of satellites is not only a theoretical exercise but a real-world necessity in aerospace engineering. This project emphasizes how calculus and mathematical reasoning can directly influence the design and function of complex technological systems, providing insights that are both academically engaging and practically significant.

Integrable discrete massive Thirring model

Speaker: Changyan Shi[1]
Co-Authors: Baofeng Feng[1], Junchao Chen[2]
Affiliation: [1] University of Texas Rio Grande Valley; [2] Lishui University
Time: 16:50-17:10

In the work, it is shown that the massive Thirring model can be bilinearized into a set of four equations. Moreover, these four bilinear equations can all be deduced from discrete KP hierarchy through Miwa transformation. Therefore, starting from four discrete KP equation, we can drive semi-discrete and fully discrete massive Thirring model via reductions.