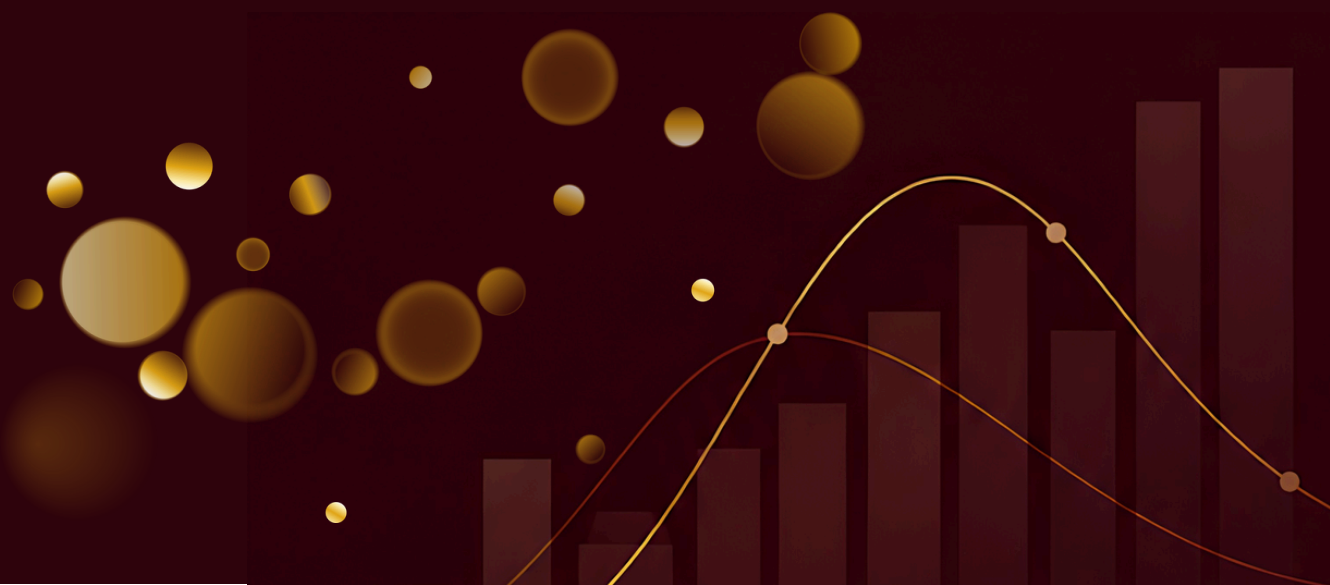
SPSTAt 2026

International Conference on Statistics, Data Science, and Analytics

"Evidence that Matters: Statistics for Better Decisions in an Uncertain World"
Uniting the Statistics Community, Advancing Evidence for a Better Future

October 19 - 21, 2026 | MSU-IIT, Iligan City, Philippines

BOOK OF ABSTRACTS



Message from the MSU-IIT Chancellor

Book of Abstracts

SPSTAt 2026 – International Conference on Statistics, Data Science, and Analytics



In an uncertain world, we are surrounded by numbers: measurements of changing climates, health outcomes, learning gaps, economic conditions, mobility patterns, and the many realities that shape people's lives. Yet numbers alone do not tell us what to do. They must be examined with rigor, interpreted with care, and transformed into knowledge that serves people and communities.

It is in this spirit that Mindanao State University-Iligan Institute of Technology (MSU-IIT) welcomes you to SPSTAt 2026 – An International Conference on Statistics, Data Science, and Analytics. As we observe the 2026 National Statistics Month, we gather around a timely and compelling call: "Evidence that Matters: Statistics for Better Decisions in an Uncertain World."

This conference recognizes statistics not simply as a technical discipline, but as a shared language for asking better questions, seeing patterns that may otherwise remain hidden, and making choices grounded in evidence rather than assumption. At a time when information moves quickly and uncertainty is a constant, the work of statisticians, data scientists, educators, researchers, public servants, and industry professionals has never been more consequential.

SPSTAt 2026 brings together a community whose work reaches far beyond datasets and models. Through its plenary discussions, technical sessions, workshops, and paper presentations, this gathering opens space for ideas that can strengthen research, guide public policy, improve systems, support innovation, and deepen our understanding of the communities we serve. It also gives emerging scholars and students an important opportunity to learn from experts, present their work, and find their place in a growing community of inquiry.

MSU-IIT is honored to host this international exchange in partnership with the Southern Philippines Society of Theoretical and Applied Statistics, Inc., and the VLIR-UOS TEAM SEABREEZE Project. We also value the continuing collaboration with Hasselt University and our partner institutions, whose engagement affirms the importance of research partnerships that connect local concerns with global expertise.

May these three days lead to thoughtful conversations, new research directions, enduring collaborations, and a renewed commitment to use data responsibly, communicate evidence clearly, and ensure that knowledge contributes to a more just and resilient future.

ALIZEDNEY M. DITUCALAN, J.D., LL.D.

Chancellor

Mindanao State University – Iligan Institute of Technology

Message from the SPSTAt President

Book of Abstracts

SPSTAt 2026 – International Conference on Statistics, Data Science, and Analytics



Welcome to SPSTAt2026!

On behalf of the **Southern Philippines Society of Theoretical and Applied Statistics, Inc.** (SPSTAt Inc.), it is my great pleasure to warmly welcome you to **SPSTAt2026:** *An International Conference in Statistics, Data Science and Analytics.*

This gathering is more than a conference. It is an opportunity for us to come together as a community; to learn from one another, exchange ideas and experiences, share our work, build collaborations, and celebrate the many ways in which Statistics contributes to knowledge and society.

SPSTAt Inc. was established with the purpose of bringing Statistics educators, students, researchers, and practitioners together to promote and advance the learning, teaching, research, and development of Statistics. Creating an active and dynamic avenue for the exchange of ideas and experiences is at the heart of what the Society hopes to achieve.

SPSTAt2026 is a reflection of that vision.

Whether you are presenting your research, learning from the work of others, joining a discussion, meeting old colleagues, or making new connections, I hope that you will find this gathering meaningful and inspiring.

For our students and young researchers, may this conference encourage you to pursue your ideas with curiosity and confidence. For our teachers and mentors, may it provide opportunities to share experiences and inspire the next generation. And for our researchers and practitioners, may it open doors to new collaborations and meaningful applications of Statistics.

Most importantly, I hope that you will experience SPSTAt Inc. not simply as an organization, but as a community—*a community of people who are willing to learn from one another and help one another grow.*

As we gather for SPSTAt2026, let us celebrate not only the advances in our discipline, but also the people who make those advances possible.

Welcome to SPSTAt2026. Welcome to SPSTAt Inc.

May this gathering be the beginning of new ideas, new partnerships, and new possibilities for Statistics in the Southern Philippines and beyond.

Let us learn together, collaborate generously, and advance Statistics together.

With warmest regards,

Daisy Lou L. Polestico, Ph.D.

President, SPSTAt Inc.

Message to SPSTAt 2026

Book of Abstracts

SPSTAt 2026 – International Conference on Statistics, Data Science, and Analytics



Congratulations to the Southern Philippines Society of Theoretical and Applied Statistics, Inc. for holding its 2026 International Conference on Statistics, Data Science, and Analytics. Congratulations to the Mindanao State University- Iligan Institute of Technology for hosting the conference. Your theme, Evidence that Matters: Statistics for Better Decisions in an Uncertain World, reflects the demands that statisticians, mathematicians, data analysts now face to provide policy makers with timely, granular, fit-for-purpose studies to address the issues that confront societies now. In many of my international engagements, our uncertain world faces some certainties. These certainties are captured by three global trends- demographic shifts, digitalization, climate change. All three are now being experienced by the Philippines.

I focus your attention to demographic shifts. The Philippines' population is still growing, but at a slower pace, from 1.6% annual population growth in 2020 to .8% in 2024. The demographic shift we see is that of a society with less young, those below 15 years of age; majority of working age, 15–64 years old; growing older population, 65 years old and above. For now, the Philippines is in a demographic sweet spot with 67% of our population working age. This is projected to continue up to 2050 after which this population group's share of the population will decline. Even as the country enjoys this demographic sweet spot, the country will be categorized as an ageing population by 2028. This is based on the UN definition of ageing population – one wherein those 65 years old and above comprise 7% of the total population. Another trend we are seeing in population and development is the rise of cohabitation, increase in live births from non-marital relations, increase in live births from girls below 15 years of age. What are the data, studies, policy recommendations that matter regarding this demographic shift in the country? They are those that can answer the main questions- How do we continue to accelerate economic growth of the country given the changing population structure? How do we ensure that economic growth is enjoyed by all citizens of the country – leaving no one behind?

I look forward to the success of the conference – indeed, we need statistics to navigate an uncertain world that gives us glimpses of our future!

Lisa Grace S. Bersales, Ph.D.

Professor Emeritus in Statistics, University of the Philippines Diliman

Undersecretary for Population and Development

Message from the Keynote Speaker

Book of Abstracts

SPSTAt 2026 – International Conference on Statistics, Data Science, and Analytics



I congratulate MSU-IIT and SPSTAt on this conference and on the society's formal inauguration. Your theme, "Evidence that Matters: Statistics for Better Decisions in an Uncertain World," calls us to move from data to decisions and from decisions to better outcomes for people.

Evidence does not matter merely because we have collected data, generated a report or produced an impressive graph. Evidence matters when institutions act on what the analysis reveals and then ask whether the action worked. The decisive moment comes after the analysis.

Evidence has to travel through planning, budgeting, delivery and course correction, not remain in an appendix. Evidence informs judgment. It does not replace public accountability or choices about values. In industrial policy, evidence should reveal productive capabilities and opportunities for better jobs. In education, analysis must lead to timely assistance. But a risk score must never define a child's future. In disaster preparedness, evidence must guide action on the ground. But a map does not protect a school by itself.

Prediction asks, "Who is likely to struggle?" Causation asks, "Why is that happening?" Intervention asks, "Which response will improve outcomes, for whom, and under what conditions?" Artificial intelligence offers opportunities but can magnify bias, error, and misplaced confidence. That is why AI needs more statistical thinking. Human professionals and public institutions must remain accountable for decisions.

I call for decision-focused research, trustworthy connected data, policy-relevant rigor, multidisciplinary local capabilities, and measurable impact that earns public trust, with fairness, privacy, and accountability. Evidence matters when it changes a budget priority, improves a classroom response, protects a community, or strengthens an industry.

And those of us in government must remember we should not collect evidence merely to justify decisions we have already made. Sometimes the highest value of evidence is that it causes us to reconsider them. Let me measure success not only by the sophistication of our models, the accuracy of our predictions or the number of papers we publish. Let us measure it by the quality of the decisions we help improve and the lives those decisions ultimately change. That, to me, is evidence that matters.

Maraming salamat po, and congratulations to SPSTAt 2026.

Condensed from the recorded keynote address.

Rafaelita M. Aldaba, Ph.D.

Undersecretary for Planning, E-CAIR, and PQF Secretariat

Department of Education

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Conference Program at a Glance

Monday, October 19, 2026

Opening activities; keynote presentation; first through fourth plenary presentations at MSU-IIT.

Tuesday, October 20, 2026

Fifth plenary presentation; poster presentations; four concurrent parallel sessions at PRISM, MSU-IIT; invited workshop on spatial statistics and visualization; conference banquet.

Wednesday, October 21, 2026

Conference highlights, networking, recognition, business meeting, and closing program.

Consult the official conference program for presentation times, venues, and subsequent schedule updates. Abstract identifiers retain the original program numbering.

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PL-01 Plenary Presentation 1

Statistics, Data Science, and Artificial Intelligence: New Tools for a Changing Data World

Paulo Canas Rodrigues[1]

[1]Federal University of Bahia, Salvador, Brazil

ABSTRACT

Artificial intelligence is changing the way we collect, analyze, and use data, while statistics continues to provide many of the ideas needed to understand uncertainty, variability, prediction, and decision-making. In this talk, I discuss how statistics, data science, and artificial intelligence are increasingly connected. The presentation moves from traditional statistical modeling to machine learning, neural networks, and more recent developments in generative AI. Particular attention is given to prediction and forecasting, where different approaches can often be combined to improve performance and provide more useful information. Examples from real-world applications will illustrate how these methods can support problems in environmental monitoring, public policy, forecasting, and decision-making. I will also briefly discuss large language models and other recent AI developments, highlighting both their potential and the continuing importance of statistical thinking in modern data analysis.

PL-02 Plenary Presentation 2

Advances in spatial integer-valued time series modeling

Cathy W.S. Chen[1], **Chun-Shu Chen, Hsiao-Hsuan Liao**

[1]Feng Chia University, Taiwan

ABSTRACT

This study develops an empirical Bayes (EB) spatial hurdle INGARCH model for weekly dengue fever counts and compares it with a spatial zero-inflated generalized Poisson (ZIGP) INGARCH framework, both of which capture spatio-temporal dependence and excess zeros. The EB-hurdle model introduces a data-adaptive empirical Bayes prior, reduces the number of parameters, and improves parsimony and stability while preserving flexibility for dynamic zero-inflation. In all spatial INGARCH models, the zero mechanism depends on lagged outcomes, so covariate effects enter the intensity equation indirectly. To enhance epidemiological relevance, this study incorporates seasonal components into the log-intensity equations using two approaches: periodic harmonic terms based on Fourier series and meteorological covariates. Model inference is conducted within a Bayesian framework, and performance is evaluated using the Deviance Information Criterion (DIC), Bayes factors, and predictive accuracy metrics, including mean squared error (MSE), mean absolute error (MAE), and mean absolute scaled error (MASE). The results highlight the distinct roles of seasonal and environmental covariates in dengue transmission dynamics. Modeling periodic effects with Fourier terms proves effective, especially when explicit meteorological data are unavailable or incomplete. The empirical Bayes approach enhances parsimony and stability over conventional hurdle INGARCH models.

PL-03 Plenary Presentation 3

Beyond Population Reference Intervals: Statistical Methods for Individualised Monitoring in the Era of Precision Health

Olivier Thas[1]

[1]Data Science Institute - Center of Statistics, Hasselt University, Belgium

ABSTRACT

Population Reference Intervals (PRIs) are a cornerstone of clinical decision-making, defining the range of values expected for a biomarker or diagnostic measurement in a healthy population. Yet population-based reference ranges ignore an important source of heterogeneity: individuals differ not only in their average levels, but also in their natural biological variability. Consequently, a measurement may be unusual for a particular individual while remaining well within the conventional population reference interval. This limitation becomes increasingly important as precision health, digital health technologies and longitudinal monitoring generate repeated measurements at the individual level.

Individual Reference Intervals (IRIs) provide a statistical framework for exploiting such longitudinal information. Rather than comparing every new measurement exclusively with a population distribution, an IRI characterises the range of values that can be expected for a particular individual. A major statistical challenge, however, is that individual time series are often short. Direct nonparametric estimation of subject-specific quantiles then becomes highly variable or practically infeasible.

We address this problem through quantile-based models combined with penalised estimation. Subject-specific reference limits are modelled directly as conditional quantiles, while penalisation allows information to be shared across individuals. The resulting approach lies between two extremes: a purely population-based analysis, which ignores individual heterogeneity, and a fully individual-specific analysis, which requires large numbers of repeated observations per subject. By borrowing strength across individuals while retaining individual-specific characteristics, reliable reference intervals can be constructed from substantially shorter longitudinal series.

A central feature of our approach is that construction of an IRI is viewed as a prediction problem rather than merely an estimation problem. The objective is not primarily to estimate an individual's underlying distribution as accurately as possible, but to construct an interval that contains a future measurement from that individual with a prespecified probability. This predictive perspective makes calibration and empirical coverage natural criteria for evaluating competing procedures.

We investigate the methodology through simulation studies covering different distributional assumptions and patterns of between- and within-individual heterogeneity. The results demonstrate the advantages of information sharing when individual time series are short and show that the proposed procedures are robust, with empirical coverage probabilities close to their nominal levels. The methodology is further evaluated using real-world longitudinal data.

More broadly, IRIs illustrate a statistical challenge that is becoming increasingly relevant in precision health and data-intensive population monitoring: how can information from a population be combined with a relatively small amount of individual-level longitudinal data to make well-calibrated predictions for a specific person? This population-to-individual learning problem extends beyond conventional laboratory medicine and provides opportunities for applications involving wearable and sensor data, longitudinal public-health surveillance, and the monitoring of health effects associated with changing environmental exposures.

PL-04 Plenary Presentation 4

Leveraging Large Language Models for Medical Data Analysis

Daniel Andrade[1]

[1]Education and Research Center for Artificial Intelligence & Data Innovation, Hiroshima University

ABSTRACT

Large language models (LLMs) based on the transformer architecture have in recent years become the essential foundation for natural language processing, and their usage has also been spreading to statistics and data analysis. In this talk, I will discuss our recent research on applying LLMs to medical data analysis, and in particular using LLMs for (1) medical diagnosis (ICD coding), and (2) the imputation of missing values. Regarding (1), our particular focus is on the interpretability of the LLMs' predictions, that is achieved by providing a faithful explanation of the medical diagnosis. Regarding (2), we will discuss our recent results of using LLMs for supporting the imputation of missing values in medical records.

PL-05 Plenary Presentation 5

A spatial orienteering-constrained design for ecological monitoring

Thomas Neyens[1,2]

[1]Hasselt University, Belgium

[2]KU Leuven, Belgium

ABSTRACT

Adaptive geostatistical designs choose sampling locations in batches, each batch placed where the model fitted to the data so far predicts worst. The rule is simple and effective, but in much ecological fieldwork a binding constraint is the time it takes to reach the locations: forest plots in a mountainous ancestral domain in Mindanao are reached on foot over steep terrain, and a design that scatters its next batch across the study region spends most of a campaign walking rather than measuring. This talk asks what an adaptive design should look like when travel time is taken into account.

The proposal borrows from the orienteering problem in operations research. Each candidate location carries a reward, its predictive variance under the current model, and the next batch is the route that collects the largest total reward within a fixed time budget, with the field team returning to camp at the end of the campaign. The resulting orienteering-constrained design is compared with the unconstrained predictive-variance design over several campaigns of a Gaussian geostatistical model, first in simulation and then on the Barro Colorado Island forest census, where local tree diversity is mapped from a sequence of plot visits. Under realistic travel-to-measurement ratios the constrained design visits several times more plots for the same time and reduces prediction error by a clear margin.

A further result makes the method usable in practice. A sensitivity analysis over the design parameters yields a rule of thumb for when the constrained design pays off. The gain is governed almost entirely by the fraction of the budget spent travelling, with the batch spacing and the geostatistical nugget-to-sill ratio as secondary corrections, and the rule transfers to the real data.

IW-01 Invited Workshop Speaker

A Bayesian Spatio-Temporal Framework for Malaria Risk Mapping with High-Resolution Environmental Exposures

Jose Alejandro Rozo Posada[1,2]

[1]KU Leuven

[2]Hasselt University

ABSTRACT

Environmental conditions, control interventions, and spatio-temporal dynamics jointly shape malaria transmission. However, their integration in routine surveillance analyses is challenging because malaria cases are often reported monthly, while environmental exposures are increasingly available at daily resolution. Aggregating these exposures may obscure important nonlinear and delayed effects on malaria risk.

We propose a unified Bayesian spatio-temporal framework for malaria risk mapping that integrates high-resolution environmental exposures, intervention information, and spatio-temporal dependence. We applied the framework to malaria surveillance data from 161 districts in Mozambique between 2017 and 2024, combining monthly cases with daily temperature, precipitation, and relative humidity, together with vegetation, elevation, and intervention data. Compared with a conventional monthly model, the framework improved predictive performance and uncertainty quantification and identified meaningful nonlinear relationships between environmental conditions and malaria incidence.

This framework provides a coherent approach for integrating routinely collected malaria surveillance data with high-resolution environmental information, supporting a more detailed understanding and mapping of malaria risk across space and time.

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Statistical Theory and Methodology, Applied Statistics

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PS-1-01

On Poisson Inverse Gaussian INGARCH Modeling: A Bayesian approach with Hamiltonian Monte Carlo – No U-turn Sampler

Michael L. Ayala[1,*], **Daisy Lou L. Polestico**[2,3]

[1]College of Applied Economics, University of Southeastern Philippines, Davao City, Philippines

[2]Department of Mathematics and Statistics, College of Science and Mathematics, Mindanao State University - Iligan Institute of Technology, Iligan City, Philippines

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ABSTRACT

Count time series data frequently display overdispersion, temporal dependence, and heavy-tailed behavior, which limit the applicability of classical Poisson-based models. To address these issues, this study develops a Bayesian framework for the log-linear Poisson Inverse Gaussian Integer-Valued GARCH (PIG-INGARCH) model, designed to capture these distributional characteristics. Parameter estimation is conducted using Hamiltonian Monte Carlo with the No-U-Turn Sampler (HMC-NUTS), providing efficient sampling, stable convergence, and rigorous uncertainty quantification. Simulation studies demonstrate the framework's ability to recover true parameter values and generate well-mixing chains. The approach is further applied to weekly dengue incidence data, where it achieves strong performance in terms of model fit and diagnostic measures while yielding interpretable lag effects of meteorological covariates. The findings strengthen the potential of the Bayesian PIG-INGARCH model as a robust tool for analyzing overdispersed count time series, with promising applications in public health surveillance.

PS-1-02

Simulation-based evaluation of SNP imputation methods under different missingness mechanisms and levels for genomic prediction

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ABSTRACT

Genomic prediction, an important tool in rice breeding, relies on high-quality single-nucleotide polymorphism (SNP) data. However, missing genotypes can compromise genomic relationships subsequently affecting prediction accuracy [1,2]. This study evaluated the performance of five SNP imputation methods namely K-Nearest Neighbor (KNN), singular value decomposition (SVD), random forest (RF), mean imputation, and linear interpolation (LI) under varying missingness mechanisms and levels to determine their effect on genomic prediction accuracy in rice. A reference panel of 250 rice accession and 7,098 SNP markers was used to simulate data sets under three missingness mechanisms across five missingness levels with three replicates for each condition. Imputation accuracy was assessed using concordance, Pearson correlation, and normalized root mean square error (NRMSE). Downstream genomic prediction was evaluated using genomic best linear unbiased prediction (GBLUP) for grain yield and milling recovery.

SVD generally achieved the highest imputation accuracy from 10% to 70% missingness across mechanisms, while KNN performed competitively at lower missingness levels but performed poorly as missingness increased. LI consistently showed the poorest imputation performance. For GBLUP prediction, KNN performed best at 10% missingness for both traits, whereas SVD showed relatively stable performance for grain yield across higher missingness levels. The findings demonstrate that optimal SNP imputation depends on both the missingness level and the downstream trait, highlighting the importance of simulation-based evaluation when selecting imputation strategies for genomic prediction.

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PS-1-04

Estimation of linear dynamic panel data models based on nonlinear moment conditions

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ABSTRACT

This paper studies an instrumental variable (IV) estimator for the lag parameter of linear AR(1) panel data models. The IV estimator is based on nonlinear moment conditions resulting from the assumption of no serial correlation in the idiosyncratic remainders, originally introduced by Ahn and Schmidt [1] and studied more extensively in [3]. Estimation and inference in a linear AR(1) panel data model are surprisingly complicated by the presence of nuisance parameters on top of the lag parameter [2]. In particular, we show that a nonstandard condition on the ratio of the variance of the time-invariant component to the variance of the time-varying idiosyncractic component needs to be imposed in order to recover standard inference even for the non-unit root case under large-n fixed-T settings and under large-n large-T sequential asymptotics. As a result, there are regions of the full parameter space which can be susceptible to poor performance. The implications of this nonstandard condition for applied empirical practice are explored, along with the resulting modifications of this nonstandard condition when using an alternative formulation of the moment conditions and when predetermined regressors are present.

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PS-1-05

Research Productivity in the Use of Structural Equation Modeling for Mediation Analysis as a Psychometric Testing Tool

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ABSTRACT

This study examines the increasing use of Structural Equation Modeling (SEM) in mediation analysis across disciplines and regions, highlighting its rapid growth in publications, particularly after 2020. SEM has emerged as a versatile analytical framework capable of addressing complex research questions in diverse fields. Psychology, social sciences, and education dominate the application landscape, with journals such as Frontiers in Psychology and PLoS ONE serving as primary publication outlets. Most studies were published in English (91.7%), underscoring its role as the predominant language of scholarly communication. Research contributions are concentrated in China, the United States, and Spain, while Southeast Asia and Latin America remain underrepresented, indicating the need for broader international collaboration. English dominates the documents, while Chinese, Korean, Spanish, and Japanese appear only in minor proportions.

Although SEM is widely applied in student perception studies and psychometric testing, its potential in energy and environmental sciences remains underexplored. The growing availability of user-friendly SEM software, including JAMOVI and R-Studio, has increased adoption, yet adequate methodological training is essential to ensure accurate implementation. In education and psychology, SEM has provided valuable insights into learning environments, socioeconomic determinants, and behavioral processes; however, longitudinal and cross-cultural studies are still limited. The findings emphasize SEM's interdisciplinary significance and call for expanding its applications into underrepresented research areas, such as policy evaluation, behavioral analysis, and complex systems modeling. Strengthening global research partnerships, enhancing training opportunities, and diversifying publication outlets will further advance SEM's role in generating rigorous, impactful scientific knowledge.

Keywords: Structural Equation Modeling, mediation analysis, Psychometric

PS-1-06

Beyond the Exponential: Special Functions and the Construction of Flexible Probability Distributions

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ABSTRACT

The exponential function plays a fundamental role in classical probability models. Its infinite-series representation motivates broader families of special functions, including the Mittag-Leffler and Prabhakar functions, while the Fox–H function provides a more general framework through Mellin–Barnes integral representations. Although these functions offer additional mathematical flexibility, their use as probability kernels raises essential questions concerning nonnegativity, integrability, normalization, and numerical evaluation.

This paper examines these challenges through the construction of elliptically contoured distributions. Particular attention is given to complete monotonicity as a sufficient condition for kernel nonnegativity and to radial integrability as a dimension-dependent requirement for valid density construction. The relationship between tail behavior and moment existence is also discussed. Motivated by ongoing research on multivariate Prabhakar–Normal distributions, the presentation illustrates how special-function kernels can be systematically evaluated before being adopted as statistical models.

The discussion provides a unified mathematical perspective on extending classical probability distributions while distinguishing analytic flexibility from probabilistic validity and computational feasibility.

Keywords: Special functions; Mittag-Leffler functions; Fox–H functions; complete monotonicity; elliptically contoured distributions.

RESEARCH PRESENTATIONS

Parallel Session 2

TRACK

Statistics Education, Citizen Science and Community Analytics

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PS-2-01

Measuring What Is Missing: Bridging the Philippine Learning Poverty Data Gap through Citizen Science and Community Analytics

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ABSTRACT

Learning poverty remains a critical educational challenge in the Philippines, but the problem is compounded by the lack of localized data needed to determine its depth and distribution at the community level. While global learning data provide important benchmarks for measuring human capital and learning outcomes, aggregated statistics may mask inequalities within marginalized communities. This study explores a citizen science and community analytics approach to generating localized evidence on learning poverty through community-based assessment involving learners and local stakeholders. Learner-level data on schooling deprivation and foundational literacy were collected and statistically analyzed to identify patterns of learning deprivation and educational inequality. Findings indicate substantial learning deprivation and demonstrate how community-generated data can provide more granular evidence that complements large-scale assessments. The study highlights the essential role of statistics in transforming community-generated data into measurable indicators that can inform educational planning and targeted intervention. It also positions communities not merely as beneficiaries but as active partners in generating and interpreting evidence about their learners. Building on this work, the proposed Iligan Learning Poverty Observatory (ILPO) at Mindanao State University–Iligan Institute of Technology will serve as a research and data hub for the systematic monitoring, statistical analysis, and evidence-based response to learning poverty. The next phase will expand community-based measurement from foundational literacy in reading to foundational numeracy, strengthening the evidence base for monitoring learning poverty and advancing Sustainable Development Goal 4.

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PS-2-02

Modeling Food Insecurity Among Tuberculosis Patients Using Bi-Level Regularized Quantile Regression

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ABSTRACT

Food insecurity is an important concern among tuberculosis (TB) patients, yet its associated factors may vary across different levels of food insecurity. This study examined the raw Household Food Insecurity Access Scale (HFIAS) score among TB patients using regularized quantile regression with bi-level variable selection. Data from 633 patients and 18 candidate predictors representing demographic, anthropometric, household, and behavioral characteristics were analyzed. Several bi-level variable selection methods were applied to simultaneously perform group-level and within-group variable selection across the 0.10, 0.25, 0.50, 0.75, and 0.90 quantiles. Results showed substantial sparsity at the middle quantiles, with only 2–3 of 18 variables retained, while 14 variables were selected at the 0.90 quantile. Education and HIV status were the most consistent predictors of food insecurity at the central quantiles, whereas severe food insecurity was associated with a broader set of factors, including age, body weight, household size, smoking and alcohol-related behaviors, TB type, and HIV status. Findings also demonstrate that bi-level selection provides a more parsimonious and interpretable model while maintaining predictive performance across quantiles, highlighting the heterogeneous factors associated with food insecurity among TB patients.

Keywords: food insecurity, tuberculosis, quantile regression, bi-level variable selection, HFIAS

PS-2-03

On mediating effects of teacher support, student motivation, and problem understanding on the relationship between SAMR-based digital instruction and academic performance in statistics

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ABSTRACT

The transformation of education through digital technologies has emphasized the need for instructional approaches that effectively integrate technology with pedagogy to improve student learning. Despite the widespread adoption of digital tools in mathematics education, limited empirical evidence explains how technology-enhanced instruction influences students' academic performance through pedagogical and motivational mechanisms. This study examined the mediating effects of Teacher Support, Student Motivation, and Problem Understanding on the relationship between SAMR-Based Digital Instruction and Academic Performance in Statistics among Grade 11 students. A quantitative descriptive-correlational research design was employed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The participants consisted of 281 Grade 11 students from the Accountancy, Business, and Management (ABM) and Science, Technology, Engineering, and Mathematics (STEM) strands of a private secondary school in Iligan City, Philippines. Data were collected using validated questionnaires measuring students' perceptions of SAMR-Based Digital Instruction, Teacher Support, and Student Motivation, together with a Claim–Evidence–Reasoning (CER) assessment and official fourth-quarter Statistics grades. The findings revealed that students perceived SAMR-Based Digital Instruction, Teacher Support, and Student Motivation at a high level, while Problem Understanding was classified as Moving Towards Mastery and Academic Performance as Very Satisfactory. Structural equation modeling showed that SAMR-Based Digital Instruction significantly influenced Teacher Support ($\beta = 0.668,\ p = .001$), Student Motivation ($\beta = 0.554,\ p = .001$), and Problem Understanding ($\beta = 0.534,\ p = .001$). Although the direct effect of SAMR-Based Digital Instruction on Academic Performance was not significant ($\beta = 0.103,\ p = .156$), Teacher Support, Student Motivation, and Problem Understanding fully mediated this relationship, with Teacher Support exhibiting the strongest indirect effect. These findings indicate that technology integration enhances academic performance not through technology alone but through supportive teaching practices, increased learner motivation, and improved conceptual understanding. The study recommends that mathematics teachers intentionally align digital technologies with the SAMR framework and learner-centered pedagogical strategies that strengthen teacher support, foster student motivation, and develop students' problem understanding to maximize learning outcomes in Statistics.

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PS-2-04

PHILEQ-STAT: An Interactive Statistical Analytics Platform for Earthquake Risk Prediction and Disaster Resilience

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ABSTRACT

Earthquakes continue to pose significant threats to human safety, infrastructure, and sustainable development in the Philippines, underscoring the need for data-driven approaches that translate complex seismic records into actionable insights for planning and risk reduction. This study developed PHILEQ-STAT (Philippine Earthquake Statistical Analytics and Risk Intelligence Tool), an interactive decision-support platform that transforms large-scale earthquake data into evidence for disaster preparedness, infrastructure planning, and public policy. Using more than 130,000 earthquake records from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) covering the period 2018 to 2026, the study integrated descriptive statistics, spatial analytics, temporal trend analysis, modeling, and Poisson-based exceedance probability estimation within a unified analytics framework. Results revealed significant spatial variation in earthquake activity, with Mindanao recording the highest event frequency and the highest mean earthquake magnitude among the major island groups. Earthquake magnitude also differed significantly across depth categories, with deep-focus earthquakes exhibiting higher average magnitudes, while the strongest recorded events were associated with shallow earthquakes. Temporal analyses demonstrated relatively stable seismic characteristics throughout the observation period, whereas exceedance probability estimates highlighted the substantial long-term likelihood of damaging earthquakes. These statistical outputs were translated into an interactive web-based application featuring dynamic dashboards, risk calculators, and planning modules designed to support evidence-informed decision-making among local government units, disaster risk reduction managers, educators, researchers, and development planners. By converting historical seismic observations into accessible risk intelligence, the study demonstrates how applied statistics can reduce uncertainty, strengthen preparedness, and support more informed allocation of resources.

Keywords: Earthquake Analytics, Disaster Risk Reduction, Exceedance Probability, PHILEQ-STAT, Sustainable Development Goals.

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PS-2-05

Evaluating ChatGPT as learning support tool in trigonometry problem solving

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ABSTRACT

This research addressed the limited local evidence on the effectiveness of ChatGPT as a learning support tool in improving Grade 9 students' trigonometry problem-solving skills, particularly in relation to students' awareness, accuracy, problem-solving performance and experiential learning. The study took place during the School Year 2025– 2026 and focused on students' awareness of ChatGPT, their performance in formative assessment, problem-solving skills using tools such as ChatGPT perceived accuracy of ChatGPT in solving trigonometry problems, and perceptions on experiential learning experiences that align with the use of technology tools. This is mix method research with 37 total population of Grade 9 students. Data were collected using adapted and researcher-made questionnaires, formative assessments, problem-solving tests, and experiential learning surveys. Results revealed that students had a high level of awareness in using ChatGPT ($M = 3.75$). Most of the students achieved an average level of mastery in formative assessments (59.46%) and problem-solving skills (37.84%), which suggests that ChatGPT can facilitate conceptual understanding and procedural learning without always resulting in mastery. Formative assessment performance significantly positively correlated with problem-solving skills ($r = 0.545,\ p < 0.001$). ChatGPT was rated by a student sample to be generally accurate at solving trigonometry problems ($M = 3.78$) and teacher-raters rated ChatGPTs accuracy as high ($M = 4.67$). Students had similarly positive perceptions of the experiential learning ($M = 3.88$), but also encountered caveat issues as longer explanations, some inaccuracy and teacher guidance required. By the end of the study, it was decided that ChatGPT is a useful supplemental learning tool when supported by teacher facilitation. Drawing on these results, an AI-guided integrated framework was created to help teachers effectively and responsibly incorporate ChatGPT into their teaching strategies, in a way that supports engagement, critical-thinking skills, and problem-solving abilities in trigonometry. The study recommends implementing the proposed AI-assisted learning framework and conducting further research with larger and more diverse samples to validate its effectiveness across different mathematics topics and educational settings.

Keywords: ChatGPT, Problem-Solving Skills, Learning Support Tool, Formative Assessment, AI-Assisted Learni

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PS-2-06

Enhancing Action Research Skills: Empowering Senior High School Teachers at Maputi National High School

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ABSTRACT

This study investigates the effectiveness of action research training for Senior High School teachers at Maputi National High School in Misamis Oriental, Philippines. It addresses a gap in empirical evidence regarding short-term, needs-based training and its impact on teachers' research competencies. Seventeen teachers participated in the training, which aimed to assess skill development pre- and post-training and identify challenges faced in conducting action research. Before training, teachers expressed needs for motivation, foundational refreshers, and guidance on research structure and statistical understanding. Post-training, significant improvements were observed in organizing topics, understanding data-gathering methods, and ethical adherence.

Wilcoxon test was used for statistical analysis, and the results showed a significant improvement in teachers' action research skills in the post-training assessment compared with the pre-training assessment, indicating that the training intervention was effective. However, participants indicated difficulties in finding appropriate research topics, managing time and workload, identifying relevant literature, and engaging students in the research process. The study therefore shows the importance of targeted and contextualized training for the enhancement of teachers' research competency, while highlighting the necessity of continuous mentoring, institutional support, and practical assistance to overcome the persistent barriers to teachers' participation in action research

Keywords: Action research, teachers across various educational fields, pre- and post-assessments

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RESEARCH PRESENTATIONS

Parallel Session 3

TRACK

Data Science, Artificial Intelligence, Computational Statistics, Spatial and Spatio-temporal Analytics

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PS-3-01

Information-Theoretic Interaction Pruning: Mitigating Imputation Artifacts in Multicenter Clinical Risk Models

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ABSTRACT

Imputing missing data in clinical prediction models creates interaction terms between imputed features and missingness indicators ($I_j = X_j^{\text{imp}} \cdot Z_j$). These terms often learn missingness patterns rather than actual clinical signals. We used the Conditional Mutual Information (CMI) Gap to measure this artifact effect and implemented the Information-Theoretic Interaction Pruning (ITIP) method to filter out high-risk interaction terms. Testing on the METABRIC dataset showed a Spearman correlation of $\rho = 0.84$ ($p = 0.133,\ n = 6$) and $F_1 = 0.80$ under missing-not-at-random conditions, meeting Tier 2 validation criteria. We evaluated the pipeline on MIMIC-IV (n = 27,530) and eICU (n = 19,282). The method flagged 24 critical-risk features in MIMIC-IV and 22 in eICU, with 15 features overlapping between datasets ($p = 0.009$). Removing these flagged terms kept prediction accuracy stable on MIMIC-IV (XGBoost AUC-ROC: 0.836 full vs. 0.834 pruned) and improved external performance on eICU for logistic regression (LR AUC-ROC: 0.748 full vs. 0.789 pruned; DeLong test $Z = 10.96,\ p < 0.001$). Logistic regression estimates on eICU were uncalibrated (ECE 0.493–0.570) and require recalibration before real-world use. Comparisons with univariate screening, penalized regression, and random pruning showed that conditioning on the missingness indicator Z_j is necessary for external generalization. ITIP works as a practical screening step for clinical prediction pipelines before model deployment.

PS-3-02

Non-Recursive Covariance-Based SEM (CB-SEM) Approach to Estimating the DeLone and McLean Information Systems Success Model for Electronic Medical Records

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ABSTRACT

This study evaluated the effectiveness of the Electronic Medical Record (EMR) system at Northern Mindanao Medical Center using the DeLone and McLean Information Systems Success Model. It addressed gaps in previous studies that predominantly used recursive models, reflective constructs, traditional maximum likelihood estimation, and data from foreign hospitals by applying non-recursive SEM with mixed formative and reflective indicators and robust maximum likelihood estimation in a Philippine tertiary hospital. Data from 192 hospital personnel were analyzed using non-recursive covariance-based structural equation modeling in R. Results showed that perceived Net Benefits significantly influenced Intention to Use and Use ($\beta = 1.073,\ p < .001$), indicating that personnel are more likely to use the EMR when they recognize its practical benefits. System use also strongly influenced User Satisfaction ($\beta = 0.658,\ p < .001$). System Quality had a marginal influence, while Service Quality and Medical Data Quality had no significant direct effects. Greater system use may also slightly reduce perceived benefits because frequent users are more exposed to operational difficulties. The model demonstrated acceptable fit ($\chi^2/\text{df} = 2.057$, RMSEA = 0.074, SRMR = 0.068). The findings emphasize that EMR success in a mandatory-use hospital depends on practical value, efficient workflows, and a positive user experience.

PS-3-03

A Hierarchical Bayesian Dynamic Network for Seismic Hazard Modeling in Mindanao with Persistent Homology: A Preliminary Study

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ABSTRACT

Probabilistic seismic hazard modeling in Mindanao is challenged by spatially varying seismicity and non-stationary earthquake activity. This study develops a hierarchical Bayesian dynamic network model that incorporates persistent homology to estimate grid-specific seismic hazard. Earthquake epicenters from January 2021 are gridded at 0.1° resolution, and 0- and 1-dimensional persistence entropies are computed from Vietoris–Rips filtrations. Grid-specific magnitude features are constructed using a power-law attenuation structure with prior-specified parameters; these features serve as inputs to the second-stage model. The Stage 2 model is a dynamic Bayesian network with latent Active/Quiet states, a graph Laplacian spatial regularizer, and an entropy-based homotopy regularizer. Posterior inference is performed via Markov Chain Monte Carlo in PyMC. Results show good convergence ($\widehat{R} \approx 1.00$) and a WAIC of $-90{,}925$ for the magnitude likelihood. Posterior means indicate positive associations between peak ground acceleration and magnitude, elevation, and liquefaction probability. Latent state probabilities reveal temporal variability in seismic activity. This work is a preliminary methodological study demonstrating the feasibility of the proposed framework. Key limitations are that Stage 1 attenuation parameters are currently prior-specified rather than inferred from the observed magnitude likelihood, and that only one month of data is analyzed.

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PS-3-04

Geospatial and Stochastic Modeling of Canine Rabies Incidence in Abra, Philippines, 2021–2025

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ABSTRACT

Rabies remains endemic in the Philippines, yet provincial surveillance data are often limited for detailed spatial and temporal analysis. This study examined 57 laboratory-confirmed canine rabies cases reported in Abra from 2021 to 2025 using descriptive mapping, retrospective space-time scan statistics, municipal count regression, inter-event-time modeling, and conditional renewal simulation. Municipal dog population and vaccination-service records were available for 2025. Annual cases varied from 7 to 20, with 2025 accounting for 35.09% of all reports. Bangued recorded the highest cumulative count, while Dolores had the highest 2025 incidence at 4.69 cases per 1,000 estimated dogs. SaTScan identified candidate high- and low-rate clusters, but neither was statistically significant ($p = 0.185$ and $p = 0.362$). The Poisson model was retained because dispersion was approximately 1. Vaccination-service intensity was positively associated with reported incidence in the full-sample model (IRR = 1.1509, 95% CI: 1.0910–1.2141, $p < 0.001$), but the association became non-significant after omitting three high-service municipalities (IRR = 1.0444, $p = 0.6748$). The Weibull model fit inter-event times better than the exponential model (AIC = 496.46 vs. 501.72), with shape $k = 0.7678$ and scale $\lambda = 27.47$ days. Conditional probabilities of another province-wide reported case were 49.88%, 73.33%, and 85.24% within 30, 60, and 90 days, respectively. Under the primary 60-day scenario, Tayum ranked first at 32.1%, followed by Bangued at 17.6% and Pidigan at 12.4%. However, Tayum's position declined under alternative weighting, which demonstrated sensitivity to model specification and vaccination-service assumptions for local prioritization. Scenario-based municipal rankings were broadly correlated but not identical. The findings support tiered and decentralized surveillance planning rather than definitive municipal risk classification.

Keywords: canine rabies; geospatial analysis; stochastic modeling; surveillance prioritization; Abra

PS-3-05

ML-Based Adaptive Approach for Testing Differential Abundance in Microbiome Data

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ABSTRACT

The microbiome, a crucial determinant of host health, is currently quantified using DNA sequencing technologies to measure microbial abundances. The resulting sequence count data are statistically challenging; they are sparse, compositional, overdispersed, and deviate from the assumptions of traditional models like the Poisson or negative binomial distributions. Numerous methods are available for identifying differentially abundant (DA) taxa between conditions. However, the performance of these existing methods varies strongly depending on the specific data characteristics, such as sparsity, sample size, and compositional effects. This variability stresses the need for more robust and adaptive analytical frameworks. We propose a Machine Learning (ML)-based adaptive test designed for two-group differential abundance analysis. It is driven by the assumption that differences in count distributions between taxa in a single group are similar to differences between distributions of taxa between groups. We use data from a single group to construct pseudo-data containing a set of pseudo-taxa that are labeled as DA or non-DA. An ML classifier is subsequently trained on this pseudo-data using ordered normalized counts as predictor variables. The classifier's predictions on the original data then define the ML-based adaptive test statistic. P-values are derived from the permutation null distributions and are adjusted using the Benjamini-Hochberg procedure to control the False Discovery Rate (FDR). The new method is empirically evaluated in a simulation study under various conditions and compared to several competitors. Preliminary results indicate that this method exhibits good overall FDR control and competitive sensitivity, and, very importantly, it does not break down under any of the scenarios studied.

PS-3-06

Modeling the Dynamic Effects of Rainfall and Temperature on Dengue Cases in Iligan City Using a Bayesian Transfer Function Model

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ABSTRACT

Dengue remains a significant public health concern in the Philippines, where changing meteorological conditions may influence the temporal patterns of disease incidence. Rainfall and temperature are important environmental factors that may be associated with dengue cases, including effects that occur after a certain time lag. This study applies an existing Bayesian transfer function model to investigate the dynamic relationships between rainfall, temperature, and dengue cases in Iligan City, Philippines. Weekly dengue case counts are modeled using a negative binomial distribution to account for overdispersion, while rainfall and temperature are incorporated as exogenous variables to examine their potential delayed effects on dengue incidence. Bayesian estimation is used to obtain posterior distributions of the model parameters and quantify uncertainty in the estimated effects. Model adequacy is evaluated using appropriate diagnostic and model assessment criteria. By applying the transfer function framework to local dengue and meteorological data, this study aims to characterize the temporal relationships between weather conditions and dengue incidence in Iligan City. The findings may provide locally relevant evidence to support dengue surveillance, risk assessment, and the planning of public health interventions in the Philippines.

Keywords: Bayesian transfer function model, dengue cases, Iligan City, negative binomial distribution, rainfall, temperature

RESEARCH PRESENTATIONS

Parallel Session 4

TRACK

Student Category

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PS-4-01

Bayesian Modeling of Nonlinear Mixed Negative Binomial INGARCHX Models with Delayed Climatic Covariates

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ABSTRACT

Weekly dengue counts commonly exhibit serial dependence, overdispersion, abrupt epidemic surges, and structural changes that may not be adequately represented by a single linear count process. This study develops a Bayesian nonlinear INGARCHX framework for weekly dengue surveillance in Iligan City, Philippines (2010–2024), incorporating rainfall and temperature as covariate-specific delayed climatic drivers and using two flexible mixed negative-binomial observation laws: the negative binomial–inverse Gaussian (NBIG) and negative binomial–reciprocal inverse Gaussian (NBRIG) distributions. Four nonlinear specifications are evaluated: Markov-switching NBIG INGARCHX, Markov-switching NBRIG–INGARCHX, smooth-threshold NBIG INGARCHX, and smooth-threshold NBRIG– INGARCHX. Climatic delays are selected through a regularized profile maximum-a-posteriori procedure, while posterior inference is performed using Hamiltonian Monte Carlo with the No-U-Turn Sampler (HMC–NUTS). Discrete Markov states are analytically marginalized and the threshold transition is represented by a differentiable logistic gate to maintain compatibility with gradient-based sampling. Among the four proposed models, the smooth-threshold NBRIG–INGARCHX(1,1) specification provides the best empirical support, yielding the smallest LOOIC (3677.05) and WAIC (3655.45). Posterior diagnostics indicate stable HMC– NUTS sampling, with $\widehat{R}$ values essentially equal to one and effective sample sizes of approximately 3,649 and 14,607 for the NBRIG size and mixing parameters, respectively. The fitted conditional mean reproduces the principal epidemic fluctuations, and most residual autocorrelations remain within the reference limits, although isolated residual spikes persist during unusually large outbreaks. Holdout forecasting further gives RMSE = 8.54 and MAE = 6.51. The rainfall and temperature coefficients are positive in some regimes, but their 95% credible intervals include zero, indicating that the individual delayed climatic effects remain uncertain after accounting for nonlinear persistence and regime-dependent dynamics. Hence, the results favor the smooth-threshold NBRIG formulation as the most coherent and predictively useful specification among the proposed nonlinear mixed negative-binomial INGARCHX models for the Iligan dengue series.

Keywords: Bayesian count time series; NBIG–NBRIG distributions; HMC–NUTS; nonlinear INGARCHX; dengue surveillance.

PS-4-02

A Simulation Study of Maximum Likelihood and Maximum A Posteriori under the Four-Parametric Logistic IRT Model

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ABSTRACT

Accurate estimation of examinee ability is a fundamental objective in item response theory (IRT), particularly under the four-parameter logistic (4PL) model, which accounts for both lower and upper asymptotic effects associated with guessing and slipping. This study investigates and compares maximum likelihood estimation (MLE) and maximum a posteriori (MAP) estimation for recovering examinee ability under the 4PL framework. A simulation study was conducted in which examinee abilities and item parameters were generated from specified probability distributions, followed by the generation of dichotomous response data using the 4PL response function. Ability parameters were estimated using iterative numerical procedures based on the likelihood score and Fisher information, with convergence safeguards incorporated to improve numerical stability. The performance of the estimators was evaluated in terms of root mean square error (RMSE), bias, average standard error, and convergence rate. Results indicate that MAP estimation generally achieved smaller RMSE, lower absolute bias, and more stable standard errors than MLE under the simulation conditions considered. In contrast, MLE was more susceptible to numerical instability under extreme response patterns and conditions associated with very low information. The incorporation of a normal prior in MAP estimation provided regularization that yielded more stable and finite ability estimates. The findings suggest that MAP estimation is a viable and stable alternative to MLE for ability estimation under the 4PL model, particularly in situations where numerical stability and reliable finite estimates are essential.

Keywords: Ability estimation; four-parameter logistic model; item response theory; maximum likelihood estimation; maximum a posteriori estimation.

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PS-4-03

Effects of Temporal Aggregation on Causal Structure and Vector Autoregressive Estimation: Evidence from Philippine Rice Market Time Series

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ABSTRACT

This study examines how temporal aggregation affects causal identification in Philippine rice-market time series from 1996 to 2025 using Vector Autoregressive (VAR) modelling and graphical causal analysis. The approach applies the graphical identification framework of Moneta [1], where conditional independence relationships among VAR residuals are used to identify contemporaneous causal structures represented through Directed Acyclic Graphs (DAGs). For the baseline analysis, 120 quarterly observations were used, and a seasonal VAR(2) model was selected based on model selection criteria, stability, and residual diagnostics. Preliminary results suggest that contemporaneous relationships in the rice market are concentrated among prices, stocks, and production inputs, with farmgate price linked to rice stocks and retail price, and fertilizer price linked to retail price and diesel price (STOCK $\rightarrow$ FG $\leftarrow$ RT $\rightarrow$ FERT $\leftarrow$ DSL), while rice imports appeared as an isolated variable. These findings suggest that short-run interactions in the rice market are more closely associated with domestic prices, stocks, and input costs than with imports at the quarterly frequency. The ability of the model to represent these contemporaneous relationships may help inform policies aimed at improving rice price stability, affordability, and availability. The analysis will be extended to higher and lower frequency versions of the same data to assess whether the identified causal structure and structural VAR results remain stable under temporal aggregation.

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PS-4-04

Finite-sample Performance of Residual-Based Nonlinearity Tests in VARMA Models

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ABSTRACT

This exploratory simulation study evaluates residual-based tests for neglected nonlinearity when the null model is a linear vector autoregressive moving average (VARMA) process. The Harvill–Ray [1] test and the principal-component procedure motivated by Psaradakis and Vávra [2] are adapted using auxiliary regressions based on fitted VARMA residuals and lagged observations. Their finite-sample performance is assessed through Monte Carlo simulation. The experiments consider bivariate VARMA-type processes with sample sizes of 300, 400, 500, and 1000, Gaussian, Student-t, and centered exponential innovations, contemporaneous correlations of 0 and 0.5, and 5000 replications. Empirical size is evaluated under linear specifications, while power is assessed against quadratic, threshold, smooth-transition, and Markov-switching alternatives. The results show that the tests are reasonably sized under Gaussian and Student-t innovations, although moderate size distortion occurs for the complex M4 specification under centered exponential innovations. Power is high against quadratic alternatives and generally good against threshold and smooth-transition alternatives, while Markov-switching nonlinearity remains difficult to detect. The cumulative-variation rule and Harvill–Ray statistic provide relatively stable performance across the scenarios considered. The study strengthens diagnostics for complex dynamic systems, contributing to United Nations Sustainable Development Goal (SDG) 9 on industry, innovation and infrastructure and supporting SDG 8 on decent work and economic growth.

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PS-4-05

Development and structural validation of a student mathematical problem-solving engagement scale: A confirmatory factor analysis based on Reeve's multidimensional model

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ABSTRACT

The study validated the structure of the Student Mathematical Problem-Solving Engagement (SMPSE) Scale based on the multidimensional concept of student engagement proposed by Reeve (2012), comprising cognitive, emotional, behavioral, and agentic dimensions. While research on student engagement has steadily increased, context-specific measures remain limited, hindering assessment during particular learning activities such as mathematical problem solving. To address this gap, the study developed and validated the SMPSE Scale to measure engagement during these tasks. Split-sample factor analyses ($n_1 = 190$, $n_2 = 286$) confirmed an excellent model fit, with CFI, TLI, NFI, and IFI exceeding 0.95, SRMR = 0.048, and RMSEA = 0.057. The scale demonstrated strong internal consistency (McDonald's $\omega = 0.974$), convergent validity (AVE = 0.719–0.807), and discriminant validity (HTMT = 0.161–0.432). Overall, the findings provide strong evidence that the SMPSE Scale is a reliable and valid instrument supporting Reeve's conceptualization of four distinct yet interrelated engagement dimensions. Beyond establishing psychometric soundness, this study advances engagement theory within the domain of mathematics education by offering a context-specific tool to better understand, assess, and foster active student participation during complex problem-solving tasks.

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PS-4-06

Utilization of SOLO-HOTS-based instruction and assessment through discovery and inquiry-based methods in statistical probability

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ABSTRACT

This study examined the effectiveness of utilizing SOLO-HOTS-based instruction and assessment using Discovery and Inquiry-based methods, on students' mathematics achievement and problem-solving in statistical probability. The research was conducted in Lingating Integrated School, involving 80 Grade 10 students from two sections Pavlov and Dewey as participants. The study had a quasi-experimental design, supplemented with qualitative data. Learning outcomes were measured using three expert validated instrument namely; Achievement Test, Problem-solving Test and Formative Assessment. Results showed significant improvement on students' mathematics achievement (from "Low Mastery" to "Average"), problem-solving ability (from "Very Low" to "Moving Towards Mastery''), and formative assessment (from ''Very Low'' to "Moving Towards Mastery") for both Discovery and Inquiry-Based method groups. Students had "Very High" positive perception on the utilization of SOLO-HOTS as basis for instruction and assessment using discovery and inquiry-based method emphasizing its nature as enjoyable, systematic, and highly effective in enhancing academic performance, students' engagement and motivation in statistical probability.

Keywords: SOLO-HOTS, Statistical Probability, Problem-Solving Skills, Discovery Method, Inquiry-Based Method, Formative Assessment

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RESEARCH PRESENTATIONS

Poster Presentations

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PP-01

A Bayesian Spatio-Temporal Hurdle Beta Negative Binomial INGARCHX Model for Complex Count Processes

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ABSTRACT

Developing an appropriate model for count processes evolving across space and time requires accommodating several interacting features that conventional count frameworks may not capture simultaneously. This study proposes a Spatio-Temporal Hurdle Beta Negative Binomial INGARCHX (ST-H-BNB-INGARCHX) model that jointly accounts for excess zeros, overdispersion, heavy-tailed behavior, temporal and spatial dependence, and the effects of exogenous variables. The hurdle structure separates the occurrence of zero counts from the generation of positive counts, with the latter modeled using a zero-truncated Beta Negative Binomial distribution to provide greater flexibility for highly dispersed and extreme observations. Temporal dynamics and the influence of external covariates are incorporated through the INGARCHX framework, while spatial dependence accounts for interactions among neighboring locations. Bayesian inference using adaptive Markov Chain Monte Carlo (MCMC) methods is employed for parameter estimation and uncertainty quantification. The performance of the proposed model will be assessed through simulation studies, focusing on its ability to recover the true parameter values, the accuracy of parameter estimates, and the convergence of the adaptive MCMC procedure. The resulting framework is intended to provide a flexible and comprehensive approach for analyzing complex count processes and improving statistical inference and prediction for data that evolve across both space and time.

PP-02

Developing a Bayesian generative architecture for uncertainty-aware imputation and censored time-to-event analysis

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ABSTRACT

Missing clinical laboratory values frequently follow Missing Not At Random (MNAR) mechanisms [1], complicating downstream survival analysis. Standard deep imputation pipelines often fail to distinguish between inherent data noise (aleatoric uncertainty) and model ignorance (epistemic uncertainty) [2]. This limitation is particularly problematic in clinical settings where the pattern of missingness itself often signals higher illness severity. The evaluation cohorts themselves reflect this challenge: METABRIC (N = 1,981), MIMIC-IV (N = 27,530, 14.6% missing), and eICU (N = 19,282, 21.9% missing) span a combined 48,793 patients, with the two critical care cohorts already exhibiting substantial real-world missingness. We plan to address this gap by developing a Bayesian generative framework that provides explicit uncertainty decomposition for both imputed clinical features and survival risk estimates under informative missingness, extending our prior work on threshold-interaction MNAR modeling [3]. We will introduce a Bayesian extension of a variational autoencoder augmented with a Cox proportional hazards objective. The proposed architecture will use a heteroscedastic decoder to capture aleatoric uncertainty and Monte Carlo dropout to approximate epistemic uncertainty during inference. We will propagate the resulting uncertainty in the latent risk score to individual survival curves via a Nelson-Aalen-based estimator. To ensure the reliability of these uncertainty estimates under heavy right-censoring, we plan to formulate a calibration regularizer that penalizes the deviation of predicted survival credible intervals from nominal coverage probabilities, using a risk-decile Kaplan-Meier surrogate. We will evaluate the framework on three distinct clinical cohorts (METABRIC, MIMIC-IV, and eICU) under simulated threshold-interaction MNAR conditions, alongside a controlled synthetic dataset for direct validation of the uncertainty decomposition. We hypothesize that incorporating principled uncertainty quantification will yield calibrated confidence measures without degrading the core imputation and survival prediction performance. We expect the resulting per-imputation confidence scores to inform clinical decision-making by clearly distinguishing highly reliable predictions from those reconstructed from minimal information.

Keywords: Missing Not At Random, Variational inference, Bayesian deep learning, Uncertainty quantification, Survival analysis, Missing data

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PP-03

Real-time rainfall-induced landslide risk prediction: Integrating random forest machine learning, landslide susceptibility, and meteorological data

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ABSTRACT

Rainfall-induced landslides pose a significant hazard to communities in Iligan City, while conventional susceptibility and hazard maps remain largely static and cannot reflect changing meteorological conditions. This study develops a real-time geospatial prediction system that integrates machine learning, landslide susceptibility modeling, and meteorological data to provide dynamically updated landslide risk estimates. Eleven topographical and environmental variables were integrated using Google Earth Engine to construct a spatial feature set for a 500-tree Random Forest classifier. The model was evaluated using 1,000 sampling points partitioned through a 70/30 training-testing split and achieved an overall classification accuracy of 92.77%. The resulting susceptibility raster was incorporated into a Python-based Streamlit dashboard, which retrieves current precipitation and 14-day hourly precipitation data through the Open-Meteo API and uses the precipitation history to derive an antecedent moisture component for rainfall-conditioned risk assessment. The system further applies predefined risk thresholds to classify affected areas and generate barangay-level evacuation directives, while an accumulation-based time-to-threshold calculation provides an estimate of when critical risk levels may be reached. The developed framework demonstrates the integration of geospatial machine learning, real-time meteorological data, and automated decision rules into a deployable decision-support system for more responsive rainfall-induced landslide preparedness and disaster risk management.

PP-04

Realistic Mathematics Education (RME) based module on the problem-solving performance of Grade 11 students in Basic Calculus

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ABSTRACT

Despite the increasing emphasis on learner-centered mathematics instruction, many Grade 11 students continue to experience difficulties in developing conceptual understanding, mathematical reasoning, and problem-solving performance in Basic Calculus because existing instructional materials often emphasize procedural computation rather than meaningful and contextualized learning experiences. Addressing this gap, this study developed and evaluated a Realistic Mathematics Education (RME)-Based Learning Module on derivatives to enhance the problem-solving performance and learning experiences of Grade 11 STEM students. The study employed a Research and Development (R&D) approach following the modified Borg and Gall model integrated with a mixed-methods quasi-experimental one-group pretest-posttest research design. It was conducted at La Salle Academy, Iligan City, involving the total population of 197 Grade 11 STEM students during the second semester of the School Year 2025–2026. The developed RME-Based Learning Module, Problem-Solving Skills Assessment, expert validation instrument, and students' reflection journals were developed and validated by mathematics education experts prior to implementation. Quantitative data were analyzed using descriptive statistics, the Shapiro–Wilk Test, and the Wilcoxon Signed-Rank Test, while qualitative data were analyzed using Braun and Clarke's thematic analysis. The developed module obtained an overall mean of 4.12 (SD = 0.42), interpreted as Highly Valid and Highly Acceptable. The Wilcoxon Signed-Rank Test revealed a statistically significant improvement in students' problem-solving performance following the implementation of the module ($p < .001$). Thematic analysis further revealed meaningful learning through real-life contexts, improved conceptual understanding, enhanced problem-solving and critical thinking skills, increased confidence and engagement, and collaborative learning. The results provide empirical evidence that the developed Realistic Mathematics Education (RME)- Based Learning Module is a valid, acceptable, and systematically implemented instructional material that enhanced Grade 11 STEM students' problem-solving performance and learning experiences in Basic Calculus, supporting the use of contextualized instruction grounded in the principles of Realistic Mathematics Education.

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PP-05

Bayesian Seasonal Zero-Inflated Beta-Negative-Binomial INGARCHX Model

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ABSTRACT

This study formulates a Bayesian framework for count time series in which dependence on recent history, a recurring annual cycle, delayed responses to exogenous covariates, overdispersion, and excess zeros in low-incidence periods occur together. A Zero-Inflated Beta-Negative-Binomial INGARCHX model of general autoregressive and feedback order, with Fourier seasonal terms, is proposed as an extension of the Negative-Binomial INGARCHX framework of Khamthong et al. [1]. The INGARCH recursion carries serial dependence, lagged exogenous covariates enter the conditional mean, Fourier terms represent the annual cycle as a smooth curve with amplitude and phase estimated from the data, and a zero-inflation component estimates the probability that a given observation is a structural zero, without classifying individual observations. The conditional distribution is the point of departure from existing specifications: a Beta-Negative-Binomial law introduces a second level of mixing beyond the Negative-Binomial, so that Poisson sampling variation, overdispersion, and heavy-tailed behavior enter the conditional variance as separate terms rather than being absorbed by a single dispersion parameter. Bayesian inference is used for parameter estimation and uncertainty quantification, with posterior distributions obtained through a two-stage adaptive Markov chain Monte Carlo sampler. A simulation study assesses the performance of the MCMC procedure through parameter recovery, credible-interval coverage, and the ability of the model-selection criteria to recover the true order and the true conditional distribution. The proposed framework is intended to provide a flexible approach for count time series in which serial dependence, seasonality, overdispersion, excess zeros, and exogenous effects occur simultaneously.

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PP-06

Bayesian Change-Point Detection of Learning-Process Drift in Mathematics Learning Analytics

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ABSTRACT

Learning analytics increasingly provides longitudinal data that make it possible to examine learning as a dynamic process rather than as a sequence of independent outcomes. However, conventional analyses often focus on average changes or pre- and post-intervention comparisons, leaving an important question unresolved: when does the underlying learning process change? Change-point detection has recently been explored in educational settings to identify temporal changes in classroom engagement [2]. Building on this perspective, this study proposes a Bayesian change-point framework for detecting learning-process drift in mathematics learning analytics. The approach adapts a Koyck distributed-lag model [1] by allowing the relationship between a learning-related predictor and a mathematics-learning outcome to change at an unknown time point. Bayesian inference is used to estimate the posterior probability of each candidate change point, thereby representing uncertainty about the timing of the transition rather than relying solely on a single break estimate.

A controlled Monte Carlo simulation was conducted as a methodological proof of concept. Learning streams of sizes $n = 50,\ 100$, and 200 were generated under different magnitudes of structural change ($\Delta\beta = 0.5,\ 1.0,\ 1.5$) and error variability ($\sigma = 1,\ 2$), with 200 replications for each condition. The true change point was positioned at 60% of each simulated learning sequence. Detection performance was evaluated using the highest posterior probability (HPP), mean absolute error, bias, root mean squared error, and the proportion of estimates falling within $\pm 5\%$ of the true change point. Results demonstrate that posterior localization improves as the magnitude of process drift increases and deteriorates as stochastic variability increases. The findings demonstrate the feasibility of Bayesian change-point detection as an uncertainty-aware tool for identifying shifts in the relationship between learning-related inputs and mathematics performance. The proposed framework provides a statistical foundation for future empirical applications using authentic longitudinal mathematics learning-analytics data and offers a pathway toward more timely, process-oriented educational decision-making.

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PP-07

Integer-Valued GARCH Models for Count Data Exhibiting Seasonality and Zero Inflation

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ABSTRACT

This study develops a Bayesian time-series framework for modeling count data characterized by excess zeros, overdispersion, serial dependence, exogenous influences, and seasonal variation. A Zero-Inflated Negative Binomial INGARCHX model with Fourier seasonal terms is formulated as an extension of the Negative Binomial INGARCHX framework, providing a more flexible representation of complex count processes. The zero-inflation component is introduced to accommodate an unusually large number of zero observations, while the negative binomial distribution accounts for extra-Poisson variation. Temporal dependence is modeled using the INGARCH structure, relevant external factors are incorporated as exogenous covariates, and Fourier terms are used to represent smooth, recurring seasonal patterns over time. Bayesian inference is employed for parameter estimation and uncertainty quantification, with Markov chain Monte Carlo methods used to obtain the corresponding posterior distributions. The proposed model will be evaluated through simulation studies, with its performance assessed against competing INGARCHX specifications using model comparison criteria, posterior predictive checks, forecast accuracy measures, and residual diagnostics. The proposed framework is intended to provide a unified and flexible approach for analyzing and forecasting seasonal count time series in which excess zeros, overdispersion, temporal dependence, and external effects occur simultaneously.

PP-08

Mapping Pestalotiopsis-affected rubber (Hevea brasiliensis) plantations: A Landsat-based spectral anomaly approach

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ABSTRACT

Pestalotiopsis leaf fall disease poses a growing threat to rubber (Hevea brasiliensis) plantations, causing canopy deterioration, reduced leaf area, and potential declines in rubber productivity [2]. This study evaluated temporal vegetation stress in Pestalotiopsis-affected rubber plantations in Goodyear, Kabasalan, Zamboanga Sibugay using Landsat-based remote sensing and Geographic Information System (GIS) techniques. A quantitative, descriptive, and geospatial research design was employed using Landsat 8/9 imagery from 2021, 2023, and 2025. Satellite images were cloud-masked, with cloud cover limited to a maximum of 30% to improve data reliability. Five spectral indices—Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI), Soil-Adjusted Vegetation Index (SAVI), Normalized Burn Ratio (NBR), and Plant Senescence Reflectance Index (PSRI)—were generated and analyzed to characterize temporal changes in plantation condition. Spectral vegetation indices provide useful indicators of vegetation vigor, moisture status, canopy condition, and plant stress [1] [4]. Results showed significant declines in NDVI, NDMI, SAVI, and NBR from 2021 to 2025, indicating decreasing vegetation vigor, moisture availability, and overall canopy condition. In contrast, PSRI significantly increased, reflecting progressive vegetation senescence and stress. These temporal patterns indicate worsening plantation health and are consistent with the potential of satellite imagery to characterize phenological and canopy changes associated with Pestalotiopsis infection in rubber plantations [3]. The findings demonstrate the potential of Landsat-based spectral anomaly mapping as a practical and cost-effective approach for monitoring plantation health, identifying areas exhibiting vegetation stress, and supporting timely field assessment and management interventions.

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PP-09

Bayesian Spatio-Temporal Poisson Inverse Gaussian Hurdle-INGARCHX Model

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ABSTRACT

Epidemiological count data collected across locations and over time may simultaneously exhibit excess zeros, overdispersion, temporal autocorrelation, spatial dependence, and effects of external factors. Existing count models often address only subsets of these characteristics, motivating the development of a more unified modeling framework. This study proposes a Bayesian Spatio-Temporal Poisson Inverse Gaussian Hurdle-INGARCHX (ST-PIG-H-INGARCHX) model that integrates these features within a single count time series framework. The hurdle component separates the occurrence of zero observations from the positive count process, while positive counts are modeled using a zero-truncated Poisson Inverse Gaussian distribution to account for overdispersion and heavy-tailed observations. Temporal dynamics are incorporated through an INGARCH structure based on lagged counts and conditional means, whereas the INGARCHX extension allows the inclusion of exogenous covariates that may influence the evolution of the count process. Spatial dependence is incorporated to account for associations among neighboring locations and to characterize the joint evolution of observations across space and time. Bayesian inference using adaptive Markov Chain Monte Carlo (MCMC) methods is employed for parameter estimation and uncertainty quantification. A simulation study is conducted to evaluate the proposed framework in terms of parameter recovery, estimation accuracy and precision, and convergence of the adaptive MCMC algorithm. The proposed model seeks to provide a flexible statistical framework for the analysis and prediction of complex epidemiological count processes exhibiting excess zeros, overdispersion, and spatio-temporal dependence.

PP-10

A linear projection approach to introduce instrumental variables to undergraduates

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ABSTRACT

I provide a projection-based perspective on instrumental variables suitable for the undergraduate level. The mechanics of the estimator are first derived using algebraic relationships between the coefficients of a multiple linear regression and the coefficients of a simple linear regression. The identifying assumptions underlying instrumental variables, namely the exclusion restriction, instrument relevance, and instrument exogeneity, are subsequently interpreted within that framework. This perspective reduces the amount of conceptual build-up needed to reach a causal inference topic like instrumental variables, corrects misconceptions that even instructors have [2], and connects to even more recent developments in the instrumental variables literature [1, 3].

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PP-11

Variational inference under joint threshold-interaction missingness for multimodal survival data

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ABSTRACT

Missing data in multivariate survival studies frequently violates the Missing At Random (MAR) assumption of standard imputation methods. When the probability of missingness depends on the unobserved value itself, the mechanism is Missing Not At Random (MNAR) under Rubin's taxonomy [1], and likelihood-based inference must account for the missingness model to avoid bias. This paper addresses a setting not handled by existing multi-omics survival imputation methods: joint MNAR missingness across heterogeneous data modalities, where clinical and biomarker data are simultaneously subject to a threshold-interaction MNAR mechanism in which missingness probability is a function of both the feature value and whether patient age exceeds a threshold. We propose a variational inference framework that models this joint mechanism within a multimodal evidence lower bound (ELBO) derived formally under MNAR conditions [2]. The mask-conditioned posterior directly amortizes the missingness model into the inference network, providing a formal alternative to pattern-mixture and selection model approaches [3]. Three fusion strategies for aggregating modality-specific posteriors are compared: linear projection, cross-modal attention, and Product of Experts. We show analytically that under joint MNAR with increasing missingness severity, both unimodal posteriors develop unbounded variance, causing the Product of Experts shared posterior to collapse exactly to the standard normal prior and rendering the latent representation uninformative for both reconstruction and survival prediction. The framework is evaluated on the METABRIC breast cancer cohort ($N = 1{,}979$) under simulated threshold-interaction MNAR and validated externally on an independent cohort ($N = 1{,}071$) without retraining. Survival discrimination is assessed via the concordance index under Cox partial likelihood supervision [4]. Results show that explicit MNAR mask encoding is the most critical design factor for unbiased imputation, while cross-modal attention preserves the best cross-modality reconstruction under severe joint missingness.

Keywords: Missing Not At Random, Variational inference, Multimodal survival analysis, Product of Experts, Missing data, Concordance index

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PP-12

Estimating the Effect of COVID-19 on Iranian Public Hospital Revenues: A Bayesian Structural Time Series Approach with Kalman Smoother-Adaptive MCMC

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ABSTRACT

This study combines the Kalman filter and smoother with an adaptive Markov Chain Monte Carlo method to estimate intervention effects in time series data. Traditional Interrupted Time Series Analysis often encounters difficulties, including autocorrelation, confounding factors, and the assumption of stationarity. Bayesian structural time series models address these limitations by handling nonstationary data, modeling underlying trends, and incorporating confounders. Intervention effects are estimated by comparing the observed series with a predicted counterfactual in the absence of the intervention. Performance was evaluated using simulated datasets with interventions, MCMC diagnostics, and sensitivity analysis, showing high detection accuracy even for minimal effect sizes. The approach was then applied to reanalyze the effect of COVID-19 on public hospital revenues in Iran. The proposed approach is a flexible and reliable tool for estimating the effects of policy changes, natural disasters, and other external events, including successive interventions.

PP-13

Enhancing Density-Based Spatial Clustering of Application with Noise (DBSCAN) through Kernel Density Estimation

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ABSTRACT

Density-Based Spatial Clustering of Applications with Noise (DBSCAN) is one of the prominent methods that are efficient at uncovering clusters of various shapes, however, it faces limitations when dealing with datasets containing clusters of varying densities. To address this limitation, this study integrates kernel density estimation (KDE) into the DBSCAN algorithm to enhance its capacity to capture density variations and handle irregularly shaped clusters. Specifically, we employ KDE using Epanechnikov as the kernel function and the grid search method with cross-validation for the bandwidth selection, along with the added density threshold. The simulation study shows that the proposed procedures were able to specify the number of clusters even for varying densities correctly. Moreover, empirical results show that the proposed clustering procedure enhanced the DBSCAN algorithm and gave meaningful results.

PP-14

Forecasting Quarterly Palay Production in Caraga: A Comparative Evaluation of Time-Series Models

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ABSTRACT

This study evaluates forecasts of quarterly palay production in Caraga using the Basic Structural Model (BSM), seasonal-naive, SARIMA, and ETS models through rolling-origin evaluation. The BSM achieved the lowest aggregate RMSE (16,742.6 metric tons), MAE (11,498.3 metric tons), and MASE (0.708), while ETS achieved the lowest MAPE (15.72%). Diebold–Mariano tests generally found no statistically significant difference between BSM and seasonal-naive forecasts. The BSM provides an explicit structural decomposition into level, deterministic drift, evolving seasonality, and irregular variation, offering an interpretable basis for agricultural forecasting. The findings support the use of forecasts as decision-support inputs alongside information on stocks, demand, prices, capacity, and operational constraints. By improving the evidence base for agricultural production and food-security planning, the study contributes to SDG 2 (Zero Hunger), while its potential to support more efficient production and resource planning aligns with SDG 12 (Responsible Consumption and Production).

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