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Statistical methods for randomized clinical trials: applications in healthcare studies in Vietnam

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Joint work with colleagues from ANIBIO Ltd. and collaborating hospitals

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Abstract

Randomized controlled trials (RCTs) provide a rigorous framework for evaluating treatment efficacy and generating reliable evidence in medical research. This presentation highlights some statistical methods and analytical tools for analyzing RCT data, including parametric and nonparametric hypothesis tests, treatment effect estimation, longitudinal data analysis, adjustment for multiple comparisons, and microbiome data analysis, using software such as R, SPSS, GraphPad Prism, and QIIME. Applications of these methods are illustrated through case studies conducted in Vietnam, covering pediatric respiratory and gastrointestinal diseases and women's reproductive health. These case studies demonstrate how statistical methods can extract meaningful insights from diverse clinical datasets, inform evidence-based medical decisions, and address practical challenges in the analysis and interpretation of RCT results.

Keywords: *Randomized controlled trials; Statistical methods; Clinical data analysis; Treatment efficacy; Healthcare research.*

Adaptive Bayesian neural networks with fixed priors

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Abstract

Bayesian neural networks combine flexible function approximation with probabilistic modelling, but their statistical guarantees often rely on priors that change with the sample size. In this talk, we ask whether a single fixed prior can adapt to unknown function smoothness while achieving near-optimal estimation accuracy. We study shallow ReLU networks in Gaussian nonparametric regression and construct hierarchical priors whose network width is random, without using the sample size or the smoothness and size of the target function. We connect neural-network approximation to the concentration of fractional posteriors, obtained by tempering the likelihood, and establish results for uniform, Gaussian and Student t weight distributions, including Cauchy distributions. With a data-dependent clipping rule, the resulting posterior mean achieves the classical minimax rate for mean squared prediction error up to a logarithmic factor under standard conditions on the covariate distribution. The procedure requires no advance knowledge of the target's smoothness or range. These results show how fixed Bayesian priors can support adaptive neural-network estimation as more data become available.

Machine Learning-Based Modeling of Natural Soil CO_2 Flux to Support Leakage Monitoring in Carbon Capture and Storage Systems

Nguyen Thi Hoai Linh

Abstract

Establishing a reliable pre-injection baseline of natural soil CO_2 flux is essential for distinguishing environmental variability from potential CO_2 leakage at geological carbon capture and storage (CCS) sites. Previous CCS studies have characterized natural soil CO_2 flux and developed empirical and geochemical approaches for leakage monitoring, while machine learning (ML) has been applied to other types of monitoring data. However, the use of ML to establish a site-specific, condition-dependent pre-injection baseline for subsequent leakage monitoring remains largely unexplored. This study develops data-driven models to estimate soil CO_2 flux using sensor-based measurements of soil and atmospheric conditions at an onshore CCS site. Among the ML algorithms evaluated, the Random Forest model exhibited the best performance, achieving a mean absolute error (MAE) of 0.62 mmol/m²/h on a test set obtained through a random 80:20 train-test split. However, its predictive performance was substantially lower on an independent forward-in-time validation set, with an MAE of 5.09 mmol/m²/h. The model was trained using field measurements of soil CO_2 flux collected using the accumulation chamber method in Kashiwazaki City, Niigata Prefecture, Japan, together with atmospheric data provided by the Japan Meteorological Agency (JMA). Feature importance and SHAP analyses identified soil temperature and moisture as the most influential predictors of natural soil CO_2 flux, while atmospheric variables had comparatively smaller contributions. Furthermore, an ML-based, three-level early-warning framework was developed to identify deviations from the predicted natural CO_2 flux baseline. Gaussian process regression (GPR) was also explored for the temporal interpolation and extrapolation of soil CO_2 flux during periods without continuous sensor measurements.

Does satellite machine learning beat last season's harvest? Benchmarking yield forecasts for Robusta coffee in Dak Lak, Vietnam

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Abstract

Robusta coffee underpins smallholder livelihoods, land use, and dry-season irrigation demand in Vietnam's Central Highlands. Remote sensing and machine learning are widely promoted for yield forecasting, but published studies are usually benchmarked only against a naive sample mean, rarely against what a planner already holds: a district's own yield history and last year's harvest. We built a district-year panel for Dak Lak Province (2018-2024, 14 eligible districts, mean yield 2.522 t/ha) with 717 satellite, climate, terrain, and coffee-system predictors from Sentinel-1/2, Landsat, MODIS, CHIRPS, TerraClimate, and SRTM. District identity alone explains 78.6% of yield variation. Under three blocked validation designs (leave-one-year-out, rolling-origin, and leave-one-district-out), Gradient Boosting and Random Forest had higher error than simple district history in every one of ten random seeds (RMSE 0.238-0.242 versus 0.206 t/ha). In rolling-origin tests over 2022-2024, last year's harvest remained the strongest benchmark (RMSE 0.165 t/ha, 5.2% mean absolute percentage error); an early-season Gradient Boosting model scored lower than rolling district history every test year, but the advantage was not robust to district-block resampling and disappeared once two anomalous district-years were excluded. Terrain-only models also transferred poorly to districts outside the training set. These results suggest that, at administrative scale, satellite and climate data mainly offer a complementary, within-season check on expected yield rather than a substitute for historical records, and that yield-prediction studies should report historical baselines and both temporal and spatial validation before informing forecasting or water-management decisions.

Keywords: *Robusta coffee; yield prediction; historical baseline; blocked validation; spatial transfer; water management*

The Conditions Behind Statistical Guarantees: A Lasso Case Study

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Abstract

Statistical theory provides guarantees for statistical methods under certain conditions. In practice, however, it is often unclear whether these conditions hold for a given dataset.

In this talk, we consider the compatibility condition for the lasso, a widely used method for regression with many explanatory variables. This condition plays an important role in deriving theoretical bounds on prediction error. We describe a numerical optimization approach for evaluating the associated compatibility constant when the set of relevant variables is specified. Through simulations and real-data examples, we examine its behavior and compare the resulting error bounds with observed prediction errors. We also follow the steps of the proof to investigate where the bounds become loose.

Nonlinear price feedbacks and fleet coexistence in a bioeconomic model of transboundary fisheries

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Abstract

Transboundary fish stocks are often managed independently by individual States, despite their movement across national waters. This study develops a bioeconomic model to investigate the economic implications of cooperative management for artisanal and industrial fishing fleets exploiting a shared small pelagic fish stock. The model is developed based on a case study of a transboundary small pelagic fishery in West Africa. Fish are assumed to follow an Ideal Free Distribution, while fishing fleets move between zones according to resource availability. The model also incorporates a variable local market price for artisanal catches and a fixed international price for industrial catches. Analytical results and numerical simulations show that variations in local market prices can stabilize the system and enable the coexistence of artisanal and industrial fleets, thereby avoiding competitive exclusion. The study highlights the importance of incorporating market dynamics into the bioeconomic analysis of cooperative management of shared fishery resources.

Long time behaviour of a stochastic SIR epidemic model with general incidence rate and Markov switching

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Abstract

We consider the long-term behavior of a stochastic SIR epidemic model with a general incidence function under the influence of multiple white and colored noises. In this framework, the stochastic perturbations affect the model through both linear and nonlinear coefficients. We construct a threshold value, based on the sign of which the long-term evolution of the disease can be fully classified. Concretely, a negative threshold value implies eventual extinction. In contrast, when the threshold value is positive, the disease persists in the population, and the system admits a unique invariant probability measure. Furthermore, we establish the polynomial convergence of the transition probability toward this invariant measure in the total variation norm, and derive the asymptotic convergence rates in both the extinction and persistence regimes. Several numerical examples are provided to illustrate that the dynamics of the switched system depends not only on the dynamics of every non switched system but also on the regime switching.

Is the Center Always Safe? Spatial Predation Risk in Fish Schools

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Abstract

Fish schooling can reduce predation risk, but the protection provided to individuals may depend on their spatial positions. In this study, we investigate the spatial distribution of predation hazard in cohesive fish schools using a three dimensional stochastic differential equation model. Two predator strategies are considered: proximity weighted prey directed attack and center directed attack. Connected component analysis is used to verify school cohesion. Surviving prey are dynamically divided into inner, middle, and outer layers to calculate their predation hazard. Simulations with prey group sizes ranging from 100 to 400 show that overall predation hazard generally decreases as group size increases. Under center directed attack, the inner layer consistently experiences the highest hazard, while the outer layer has the lowest. Under proximity weighted prey directed attack, the outer layer generally shows the lowest hazard, but the inner and middle layers have no consistent ordering. These findings suggest that spatial predation risk depends strongly on predator attack strategies.

If we cannot stop global deforestation, can we at least save pockets of forest in developing countries?

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Abstract

In a provocative Linkin op-ed, Robert Nasi (director of CIFOR- Centre for International Forestry Research) asked the question: *We keep researching forests and keep losing them. Is what we do not know the real issue?* We think most researchers reckon that our global lifestyle is inextricably linked to the trading products that replace huge forest tracts (cf. palm oil). Even if we fail to address the global issue, may we still suggest solutions to save a percentage of forest under a defined set of conditions? Even when we must accept marginal cases, do not challenge the overall logic.

If we (Ton Viet Ta, Kyushu University, Jesse Abrams, North Arizona University, and I) assume protected areas are required to save biodiversity, how do we know which conditions best maintain protected-area quality? The short answer is we do not know. However, we can try to understand how local perceptions, actions to support/oppose protection, and conservation outcomes work on the ground.

A review of 50 peer-reviewed papers shows researchers are split between those who claim trust is crucial, those who argue conservation sidelines community concerns, and those who believe community is largely irrelevant. We learn little by comparing studies, as they use different methods. We suggest applying the same approach to three cases, examining each element in a causal sequence from perceptions to actions, ending with environmental outcomes.

We select three countries where trade-offs between conservation and development exist, yet we still see examples of successful nature protection. We will use a two-tier approach, with a big-data framework that links socio-economic and biodiversity data in one exercise. A second exercise focuses on socio-economic data linked to the land-use data. The data are the same in both cases, but the focus varies. The three suggested countries include Ecuador, Madagascar and Vietnam.

Ecuador is considered one of the mega-biodiverse countries and has a history of initiatives designed to conserve natural environments and ensure local well-being. However, hard evidence is scant, which is an argument for doing research here. Madagascar is another mega-biodiverse country and among the poorest states in the world. Examples show that, under certain circumstances, conservation may work by providing educational and health facilities the state does not supply. In Vietnam, biodiversity is in distress inside national parks, but new evidence suggests an increasing local interest in pockets within them. International and Vietnamese tourists are willing to pay substantial sums of money to photograph wildlife.

Wood properties and stress-wave prediction of *Erythrophleum fordii* and *Nauclea orientalis* from Vietnam

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Abstract

Reliable information on the wood properties of *Erythrophleum fordii* and *Nauclea orientalis*, two native hardwood species of Vietnam, remains limited. To our knowledge, this study provides the first comprehensive characterization of selected physical, mechanical, and acoustic properties of these two species and evaluates the applicability of the stress-wave method for estimating their bending properties. Five trees of each species were sampled, and then air-dry density (AD), stress-wave velocity (SWV), dynamic modulus of elasticity (MOEd), static modulus of elasticity (MOE), and modulus of rupture (MOR) were determined. *E. fordii* had higher AD, MOE, and MOR, whereas *N. orientalis* exhibited higher SWV. SWV was more strongly correlated with MOR and MOE in *N. orientalis* (r = 0.74 and 0.77) than in *E. fordii* (r = 0.49 and 0.39), whereas AD showed moderate correlations with MOR and MOE in *E. fordii* (r = 0.57 and 0.69) and in *N. orientalis* (r = 0.47 and 0.36). MOEd showed strong correlations with MOE and MOR in both species (r = 0.72-0.79). These results demonstrate substantial species-specific differences and support stress-wave measurements, particularly when combined with density, for rapid nondestructive assessment of bending properties.

Keywords: *Erythrophleum fordii, Nauclea orientalis, air-dry density, mechanical properites, stress-wave velocity.*

Agricultural mechanization in Ho Chi Minh City: a new trend in the market for agricultural machinery and equipment

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Abstract

Agricultural mechanization is increasingly important for improving productivity, reducing production costs, addressing rural labour shortages, and modernizing agricultural production in Vietnam. The recent administrative restructuring and expansion of Ho Chi Minh City following the merger with Binh Duong and Ba Ria-Vung Tau have substantially enlarged the city's agricultural space and diversified its production systems. This transformation creates new and differentiated demand for agricultural machinery and equipment, while also providing opportunities for the development of machinery rental and mechanization service markets. This study examines the current status of agricultural mechanization in Ho Chi Minh City and identifies emerging trends in the market for agricultural machinery, equipment, and mechanization services.

The study uses a combination of descriptive statistics and policy analysis. Primary data were collected through a survey of 300 stakeholders, including agricultural production establishments, processing facilities, machinery and equipment suppliers, research and technology-transfer organizations, and agricultural management officials. Secondary data were obtained from statistical yearbooks, government reports, sectoral documents, policy and legal instruments, and information on machinery and equipment suppliers. Descriptive statistics were used to examine machinery ownership, utilization, mechanization demand, purchasing and rental behaviour, constraints to machinery adoption, and the structure of machinery supply. Policy analysis was applied to assess how recent national and municipal policies influence investment, technology adoption, land consolidation, private-sector participation, and the development of mechanization services.

The results indicate that approximately 72.5% of surveyed production establishments reported demand for further mechanization, primarily to improve production efficiency, reduce costs, and address labour shortages. However, the existing machinery stock remains concentrated in low- and medium-power equipment, suggesting considerable potential for machinery upgrading and replacement. Mechanization application is also uneven across production stages, with relatively high adoption in irrigation and land preparation but persistent gaps in planting, harvesting, transportation, and post-harvest operations. Machinery rental and service provision have become increasingly important, particularly for capital-intensive, high skill required, and seasonal operations, indicating a gradual shift from individual machinery ownership toward shared and service-based mechanization.

On the supply side, the market includes a diverse network of machinery and equipment suppliers, but remains concentrated in conventional agricultural machinery, irrigation equipment, and general-purpose technologies. Significant supply gaps remain in specialized machinery, harvesting technologies, post-harvest handling, preservation, and processing equipment. High machinery prices, limited access to information and finance, and concerns about equipment quality remain major barriers to market expansion.

The study argues that the emerging machinery-hire-services market should be developed through an integrated ecosystem involving government agencies, private enterprises, cooperatives, machinery suppliers, service providers, and farmers. Policy support should gradually shift from subsidizing individual machinery ownership toward facilitating access to mechanization services, promoting private and cooperative investment, linking land consolidation with mechanization infrastructure, and strengthening specialized machinery and post-harvest technology markets. These changes could position Ho Chi Minh City as an emerging regional market for agricultural machinery, equipment, and mechanization services in Vietnam.

Keywords: *Agriculture, Mechanization, Market, Services, Ho Chi Minh*

Determine the characteristics of novel low-dose resveratrol-loaded CMC/nanochitosan/green pomelo essential oil bionanocomposite film

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Abstract

A low-dose of resveratrol (Res) combined with nanocomposite of carboxymethyl cellulose (CMC), nanochitosan (nCh), and green pomelo essential oil (GPO) has demonstrated promising potential as an active food packaging. The coating formulations were prepared using a blending method with the Res concentrations ranging from 0% to 0.01%. The film samples were named as CGR0, CGR1, CGR2, and CGR3 followed by the increasing of Res concentration. The incorporation of Res and GPO changed the physicochemical properties of the films, and the antibacterial activity. The results showed that CGR0 exhibited the greatest film thickness, whereas CGR3 displayed the smallest film thickness. The WVP values significantly decreased with increasing concentrations of Res. The concentration increasing of Res significantly increased the surface roughness, particularly for the CGR3 film. Significant differences were observed among the films in total color parameters. Structural characterization using scanning electron microscopy and atomic force microscopy revealed the formation of a dense and integrated film network.