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The "International Annual Meeting of CIMA – Mathematics and Applications, Azores 2025" takes place after the "CIMA Annual Meeting 2024" that took place at the University of Madeira, following the tradition of bringing together in the same place regional, national and international researchers who carry out work in the areas of applied Mathematics such as: Differential Equations and optimization; Logic, Algebra and Geometry; Dynamic Systems; Statistics, Stochastic Processes and Applications. This meeting represents a unique opportunity for professors and researchers from the University of the Azores, as well as from other participating Portuguese Universities, to share ideas and promote their knowledge, creating an increasingly engaging community, providing contact with the most recent and current research taking place in these fields of research at an international level.

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International Annual Meeting of CIMA Mathematics and Applications, Azores 2025

Book of Abstracts

June 12, 2025

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Preface

Dear Participants, Colleagues and Friends

It is a great honor and a privilege to give you all a warmest welcome to the International Annual Meeting of CIMA – Mathematics and Applications, Azores 2025.

This conference takes place at University of Azores, located in the beautiful city of Ponta Delgada, Azores, Portugal. The host institution, as well as the associated scientific research center, are committed to the event, hoping that it will be a benchmark for scientific collaboration between all participants, members and invited, in the all-research fields of CIMA.

The main scientific topics of the conference are the one related with the amazing research that emerges from all the scientific lines of our groups of CIMA:

Differential Equations and Optimization (DEO)
Logic, Algebra and Geometry (LAG)
Dynamical Systems (DS)
Statistics, Stochastic Processes and Applications (SSPA)

Be welcome,
João Manuel Gonçalves Cabral

Main Talks

The masters honor us with their presence and their words will remain forever in our memory.

–

Alberto Cabada

Professor Alberto Cabada Fernández is a prominent mathematician specializing in Mathematical Analysis at the University of Santiago de Compostela (USC), Spain.

He is currently the head of the Institute of Mathematics at USC and is affiliated with the Department of Statistics, Mathematical Analysis and Optimisation, as well as the Galician Center for Mathematical Research and Technology (CITMAga).

His research is primarily devoted to nonlinear differential equations, encompassing ordinary, partial, difference, and fractional equations.

He is renowned for his work on the existence and multiplicity of solutions in differential equations, employing topological and iterative methods.

A significant part of his research centers on the quantitative and qualitative properties of Green's functions, which are fundamental in the study of boundary value problems.

Professor Cabada leads the Nonlinear Differential Equations research group at USC, and a leading figure in mathematical analysis, particularly in the theory and applications of nonlinear differential equations, with a distinguished record in research, teaching, and academic leadership.

Discrete System of a Relativistic Operator coupled to Dirichlet Boundary Conditions

Alberto Cabada
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Facultade de Matemáticas, Universidade de Santiago de Compostela,
Santiago de Compostela, Galicia, Spain

(This paper is done in collaboration to Professors Petru Jebelean and Călin Şerban)
The talk is divided in two parts:

Firstly, we deal with Dirichlet systems of difference equations having the general form

$$\begin{cases} \Delta\left[\phi(\Delta u(n-1))\right] = f(n, u(n-1), u(n), u(n+1)), & n \in \{1, \dots, T\} \\ u(0) = 0_{\mathbb{R}^N} = u(T+1), \end{cases}$$

where $T \in \mathbb{Z}$ is positive and fixed, $\Delta u(n-1) := u(n) - u(n-1)$ is the usual forward difference operator and $f : \{1, \dots, T\} \times (\mathbb{R}^N)^3 \to \mathbb{R}^N$ is continuous. Moreover $\phi : B_1 \to \mathbb{R}^N$ is the homeomorphism

$$\phi(y) = \frac{y}{\sqrt{1 - |y|^2}} \quad (y \in B_1),$$

where $|\cdot|$ denotes the usual Euclidean norm on $\mathbb{R}^N$ and B_1 is the open ball in $\mathbb{R}^N$ centered in $0_{\mathbb{R}^N}$ of radius 1.

Our approaches mainly rely on Brouwer degree arguments.

In a second part, by means of critical point theory for convex, lower semicontinuous perturbations of C^1-functionals, it is proved the multiplicity of solutions for potential systems of the form

$$\begin{cases} -\Delta\left[\phi(\Delta u(n-1))\right] = \lambda \nabla G(n, u(n)) & n \in \{1, \dots, T\} \\ u(0) = 0_{\mathbb{R}^N} = u(T+1), \end{cases}$$

where $\lambda > 0$ is a real parameter, $G(n, \cdot) : \mathbb{R}^N \to \mathbb{R}$ is C^1 for all $n \in \{1, \dots, T\}$ and ∇G stands for the gradient of G with respect to the second variable.

The obtained results are compiled in [1].

References

[1] A. Cabada, P. Jebelean, C. Serban, Dirichlet systems with discrete relativistic operator, *Bull. London Math. Soc.* **56** (3), (2024), 1149–1168.

Martin Grothaus

Professor Martin Grothaus is a Full Professor specializing in Functional Analysis at the Department of Mathematics, RPTU (formerly University of Kaiserslautern), Germany.

He is the head of the Functional Analysis and Stochastic Analysis group and serves as the speaker of the Priority Area "Mathematics Applied to Real-World Challenges" (MathApp) within the Rhineland-Palatinate Research Initiative

Professor Grothaus is recognized for his contributions to the theory of hypocoercivity, particularly its generalization for physically relevant evolution systems, building on concepts introduced by Fields Medalist Cédric Villani.

His group has developed machine learning methods combined with Monte Carlo approaches to drastically reduce computation times for financial mathematics applications, such as Solvency II calculations for insurance companies.

He has contributed to mathematical modeling of real-world problems, including COVID-19 dynamics, pension product classification for the German Federal Ministry of Finance, and industrial mathematics projects.

He is involved in visionary projects on the mathematical foundations of machine learning and quantum computing algorithms.

Professor Martin Grothaus is a leading mathematician in functional analysis, probability, and stochastic analysis, with a distinguished career marked by international collaborations, influential publications, and innovative research at the intersection of theory and real-world application. His leadership at RPTU and his role in major research initiatives underscore his impact on both the academic and applied mathematics communities.

An improved characterization theorem - interpretation in Malliavin calculus - applications to SPDEs

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Joint work with:
José Luís da Silva, **Jan Müller**,
Andreas Nonnenmacher, **Herry P. Suryawan**.

June 6, 2025

Abstract

We consider spaces of test and regular generalized functions of white noise. These spaces 20 years ago were characterized by holomorphy on infinite dimensional spaces together with an integrability condition. We, instead, give a characterization in terms of U-functionals, i.e., classic holomorphic functions on the one dimensional field of complex numbers, together with the same integrability condition. The characterization of regular generalized functions is useful for solving singular SPDEs. Whereas, the characterization of test functions is useful for showing smoothness of solutions to SPDEs in the sense of Malliavin calculus. We present concrete examples confirming the usefulness in both cases. Furthermore, we show an application to stochastic currents of Brownian motion.

References

[1] M. Grothaus, J. Müller and A. Nonnenmacher. An improved characterisation of regular generalised functions of white noise and an application to singular SPDEs. Stochastics and Partial Differential Equations: Analysis and Computations. 10, 359–391, 2022

[2] M. Grothaus, H.P. Suryawan and J.L. da Silva. A white noise approach to stochastic currents of Brownian motion. Infinite Dimensional Analysis, Quantum Probability and Related Topics. 26(1), Article No. 2250025, 2023

Contributed Talks

The diversity of ways of writing and presenting each of the communications, in these simple abstracts, is something very valuable for a center like CIMA, whose members work on theoretical constructions that are soon translated into practical applications in the most beautiful dance of scientific knowledge.

–

Carlos A. Braumann

Professor Braumann has been a central figure at the University of Évora since 1975, where he began as an assistant and later became a full professor. He played a foundational role in the institution's modern era, delivering its first lecture after its restoration. Over the years, he has held several key positions, including: Rector of the University of Évora (2010–2014); Vice-Rector, President of the Scientific Council, and President of the Department of Mathematics; Director of the Research Centre in Mathematics and Applications (CIMA); Coordinator of various academic programs in Probability, Statistics, and Operations Research.

He was awarded the title of Professor Emeritus in 2018.

Professor Braumann's research centers on stochastic differential equations and their applications, particularly in: Modeling population growth and harvesting in randomly varying environments; Animal growth modeling in farming; Mathematical models in population genetics, epidemiology, and human mortality; Financial mathematics, especially the application of stochastic differential equations; Advanced statistics and statistical methods for estimation, testing, and prediction.

Professor Carlos A. Braumann's career is marked by a profound impact on the development of mathematical statistics and stochastic modeling in Portugal and internationally. His leadership roles, prolific research output, and dedication to teaching and scientific service have established him as a leading figure in his field.

CONSEQUENCES OF PARAMETER ESTIMATION ERRORS WHEN HARVESTING IN RANDOM ENVIRONMENTS

Carlos A. Braumann[1] (presenter) and Nuno M. Brites[2]

[1] Universidade de Évora, Centro de Investigação em Matemática e Aplicações;
Universidade de Évora, Escola de Ciências e Tecnologia

[2] ISEG/UL – Universidade de Lisboa, Department of Mathematics;
REM – Research in Economics and Mathematics, CEMAPRE

We model a harvested population in a random environment by a stochastic differential equation (SDE) and study the consequences of parameter estimation errors on the optimal harvesting efforts and corresponding profits from the harvesting activity, both in terms of prediction accuracy and in terms of effective profit losses. We look at two harvesting policies, the optimal variable effort policy (VEP) based on stochastic optimal control, which has important shortcomings, and the sub-optimal constant effort policy (CEP).

For illustration purposes, we will use population and economic data from [1] for the Bangladesh shrimp with a Gompertz average natural growth. The model and the VEP, CEP and other harvesting policies were originally studied in [2]. The consequences of parameter estimation errors will appear in ([3]).

Acknowledgements: C.A. Braumann is a member of the Centro de Investigação em Matemática e Aplicações, supported by Fundação para a Ciência e a Tecnologia - FCT (Portuguese Foundation for Science and Technology), Project UID/04674/2020, https://doi.org/10.54499/UIDB/04674/2020.
N.M. Brites was partially funded by FCT, Project CEMAPRE/REM - UIDB/05069/2020, through national funds.

References

[1] Kar, T.K., Chakraborty, K. (2011). A bioeconomic assessment of the Bangladesh shrimp fishery. *World Journal of Modelling and Simulation* 7(1): 58 – 69. https://api.semanticscholar.org/CorpusID:13890373

[2] Brites, N.M., Braumann, C.A. (2019). Fisheries management in randomly varying environments: Comparison of constant, variable and penalized efforts policies for the Gompertz model. *Fisheries Research* 216: 196–203. https://doi.org/10.1016/j.fishres.2019.03.016

[3] Brites, N.M., Braumann, C.A. (2025). Optimal harvesting in randomly varying environments: Sensitivity of profit and effort to population and economic parameters. *Submitted.*

Clara Carlota

Assistant Professor in the Department of Mathematics at the University of Évora. Professor Carlota has supervised and co-supervised numerous master's and doctoral theses, particularly in the fields of applied mathematics, statistics, biostatistics, biometrics, and educational administration. She is a highly active academic at the University of Évora, recognized for her contributions to mathematics education, research, and the scientific community. Her career is marked by a strong commitment to teaching, supervision, and the organization of significant academic events, as well as a robust publication record in applied mathematics and statistics.

On existence of bang-bang solutions for pointwise state-constrained linear first-order control BVPs using two controls in the plane

Clara Carlota, Mário Lopes, António Ornelas

CIMA (Centro de Investigação em Matemática e Aplicações),

Escola de Ciências e Tecnologia, Universidade de Évora

Abstract

Aim of this talk is to present results concerning existence of bang-bang solutions for pointwise state-constrained linear first-order control BVPs using two controls in the plane.

References

Clara Carlota; Mário Lopes; António Ornelas. "Geometric Characterization of Validity of the Lyapunov Convexity Theorem in the Plane for Two Controls under a Pointwise State Constraint". Axioms (2024).
https://doi.org/10.3390/axioms13090611

Diogo Baptista

Professor Diogo Pedro Ferreira Nascimento Baptista is associated with the Department of Mathematics at the Instituto Politécnico de Leiria (Polytechnic Institute of Leiria), Portugal. Has participated in scientific events and research projects, including presenting at conferences such as those organized by CIMA (Centro de Investigação em Matemática e Aplicações) at the University of Évora.

Professor Diogo Batista is a mathematician and academic at the Polytechnic Institute of Leiria, actively engaged in research and teaching within the Department of Mathematics. His work involves mathematical modeling and applied mathematics, with participation in national research networks and scientific conferences, marking him as a significant contributor to the academic and scientific community in Leiria.

Complexity Along Isentropic Curves in the Lozi Map: A Secondary Invariant Approach

Diogo Baptista[1] and Alexandra Nascimento[2]

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Abstract

We investigate the complexity structure of the Lozi map in the parameter space region associated with the existence of a strange attractor. This study extends previous work, including the construction of Markov partitions [1] and the analysis of Lyapunov exponents [2], aiming to identify additional dynamical invariants that may provide a finer characterization of the system's chaotic behavior. Inspired by the approach of Sousa Ramos [3] we explore the possibility of defining a second invariant that captures changes in complexity along isentropic curves, potentially contributing to a deeper understanding of complexity in piecewise-affine dynamical systems in two dimensions.

References

[1] Baptista, D. (2023). *Markov partition in the attractor of Lozi maps. Journal of Difference Equations and Applications*, 29(9–12), 952–964. https://doi.org/10.1080/10236198.2023.2186155

[2] Baptista, D., & Severino, R. (2012). *Symbolic dynamics and Lyapunov exponents for Lozi maps. ESAIM: Proceedings*, 36, 121–125. https://doi.org/10.1051/proc/201236010

[3] Almeida, P., Lampreia, J. P., & Sousa Ramos, J. (1996). *Topological invariants for bimodal maps.* In: Iteration Theory (Batschuns, 1992), Grazer Math. Ber. 334, Karl-Franzens-Univ. Graz, 1–8.

Feliz Minhós

Feliz Manuel Barrão Minhós, is a distinguished Portuguese mathematician and Full Professor at the Department of Mathematics, University of Évora, Portugal, and is the current Director of the Research Center in Mathematics and Applications (CIMA) at the University of Évora, a leading research institution in mathematical sciences.

Professor Minhós is internationally recognized for his prolific research in mathematics, particularly in the areas of: Differential equations (ordinary and partial);Boundary value problems (including higher-order and functional types); Fixed point theory; Nonlinear analysis; Green's functions; Coupled systems and impulsive problems.

He has published over 100 articles in peer-reviewed journals and collaborated with more than 70 researchers worldwide. His most cited works address existence, uniqueness, and multiplicity of solutions for nonlinear differential equations and systems, often employing advanced methods such as upper and lower solutions, fixed point theorems, and variational techniques.

Professor Feliz Minhós is a prominent mathematician whose research, teaching, and leadership have had a profound impact on the mathematical community in Portugal and internationally.

Third-order functional problems: existence, non-existence and multiplicity results

Feliz Minhós[a,b], Nuno Oliveira[b]

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Instituto de Investigação e Formação Avançada,

Universidade de Évora. Rua Romão Ramalho, 59,

7000-671 Évora, Portugal

Abstract

This work presents an Ambrosetti-Prodi alternative for functional problems composed of a fully third-order differential equation with two types of functional boundary conditions. The discussion of existence and non-existence of solution is obtained in a more general case, and the multiplicity of solution is done with restrictive boundary conditions-

The main arguments are based on the lower and upper solutions method, together with the Leray-Schauder topological degree theory. We stress that the multiplicity situation requires different speed growths on the variables.

An example illustrates the results' applicability and shows a technique to estimate the bifurcation values of the parameter.

2020 Mathematics Subject Classification: 34B15; 34K10; 34K18.

Keywords:.Ambrosetti-Prodi alternative, Functional boundary conditions, Lower and upper solutions, Nagumo condition, Degree theory.

João M. G. Cabral

Professor João Manuel Gonçalves Cabral is an academic and researcher at the Universidade dos Açores, where he serves as an Associate Professor in the Department of Mathematics and Statistics at the Faculty of Science and Technology

He has co-supervised PhD and Master's theses in areas such as economics and management, educational mathematics, and bioinformatics, including topics like human mobility and logistics for regional development, and the analysis of activities to combat school failure in mathematics

Professor João Manuel Gonçalves Cabral is a highly respected academic at the Universidade dos Açores, recognized for his contributions to applied mathematics, particularly in dynamical systems and mathematical modeling, with a strong record of research, teaching, and international collaboration. His work bridges mathematics with applications in natural and social sciences, education, and tourism, and he is actively engaged in both research and the supervision of emerging scholars.

A Virus Evolution Fuzzy Model

João MG Cabral[1,2]

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[2]CIMA- Research Center in Mathematics and Applications, University of Évora, Portugal

June 5, 2025

Abstract

When the logistic curve became insufficient to establish a dynamic prediction of the COVID-19 viral evolution, during the pandemic, many models began to emerge through the application of mathematical techniques and formulas that would otherwise have remained buried in time.

This work shows, using models supported by the Gompertz curve, calibrated with a Gaussian structure that establishes the rules of a Fuzzy model, how to build a viral evolution prediction model. Even dealing with the uncertainty of the input data, the outputs allow for an interpretation accurate enough to support the various logistic decision processes in the field of health care.

Acknowledgements: This work is supported by FCT (Portuguese Foundation for Science and Technology), under the Project UID/04674/2020.

References

[1] Bressan, Glaucia & Stiegelmeier, Elenice. (2023). Fuzzy Modelling on the Evolution of COVID-19 Epidemic under the Effects of Intervention Measures. Brazilian Archives of Biology and Technology. 66. 10.1590/1678-4324-2023220425.

[2] Pelinovsky, E.; Kokoulina, M.; Epifanova, A.; Kurkin, A.; Kurkina, O.; Tang, M.; Macau, E.; Kirillin, M. Gompertz model in Covid-19 spreading simulation. *Chaos, Solitons and Fractals* (2021). doi: https://doi.org/10.1016/j.chaos.2021.111699

[3] Shaobo, H.; Peng, Y.; Sun, K. SEIR modeling of the Covid-19 and its dynamics. *Nonlinear Dynamics* (2020), *101*, 3, 1667–1680.

[4] Balloni, A. J. & Winter, R. (2020). A) The Constant K and the Gaussian Temporal Evolution for COVID-19. In International Journal on Engineering, Science, and Technology (IJONEST), 2(1), 8-15.

[5] Chowell, G. Fitting dynamic models to epidemic outbreaks with quantified uncertainty: a primer for parameter uncertainty, identifiability and forecasts. *Infectious Disease Modelling* (2017), *2*, 3, 379–398.

Joaquim M. C. Correia

Professor Joaquim Correia have a PhD in Mathematics (Mathematical Analysis), defending the work: "Approximations of Hyperbolic Conservation Laws." He is a distinguished mathematician and academic at the University of Évora, recognized for his contributions to mathematical analysis and modelling, international scientific cooperation, and leadership in academic networks across Europe and Asia. His career encompasses significant research, teaching, supervision, and organizational roles, reflecting a broad and impactful presence in the mathematical sciences.

The Riemann problem for a model in elastoplasticity with hysteresis

Joaquim M.C. Correia
Dept. Matemática, Universidade de Évora

We revisit the 1-D(imensional) case of the 3-D Antman-Szymczak model for the longitudinal motion in an elastic-plastic bar [1, 2]. As far as real-world appli cations are under consideration the model captures two main behaviour phenomena: limit "total compression", and tension and compression yield points (elastic-plastic phase transitions, allowing for hysteresis). A major technical difficulty here is on handling the Lipschitz continuous low regularity of the so-called flux function, a consequence of the elastic-plastic phase transition, which imply discontinuous wave speeds. While in the past we solved a general class of Riemann problems for 1st order hyperbolic systems of conservation laws with Lipschitz continuous flux-functions [3] capturing the model under consideration we are now concerned with how to handle, directly, the common in applications 2nd order hyperbolic pdes, e.g., what if we rewrite the model as a nonlinear wave equation? Finally, a second reason to revisit this model is because of our (pre)occupation on the proper mathematical modelling of "physical phenomena": hysteresis has a viscosity like effect, i.e., it is an interesting energy dissipative mechanism.

References

[1] Antman, S.S., Szymczak., W.G.: Nonlinear elastoplastic waves. Contemp. Math. **100**, 27–54 (1989)

[2] Trangenstein, J.A., Pember, R.B.: The Riemann problem for longitudinal motion in an elastic-plastic bar. SIAM J. Sci. Stat. Comput. **12(1)**, 180–207 (1991)

[3] Correia, J.M.C., LeFloch, P.G., Thanh, M.D.: Hyperbolic systems of conservation laws with Lipschitz continuous flux-functions: the Riemann problem. Bol. Soc. Bra. de Mat. **32(3)**, 271–301 (2001)

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José Luis da Silva

José Luís da Silva is a Professor of Mathematics at the Universidade da Madeira. He is recognized for his research in the areas of stochastics and white noise analysis.

Professor da Silva is widely cited in the fields of stochastic analysis and mathematical physics. His work on fractional calculus and stochastic differential equations has contributed to the understanding of complex systems in both natural sciences and engineering. He stands out as a leading figure in stochastic mathematics, with a rich publication record, significant interdisciplinary contributions, and a strong international profile in mathematical research.

Green Measures for a Class of Non-Markov Processes

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Joint work with **Herry P. Suryawan**, Sanata Dharma University, Yogyakarta, Indonesia.

June 5, 2025

Abstract

In this talk, we show the existence of the Green measure for a class of non-Gaussian processes in $\mathbb{R}^d$. These measures are associated with the family of generalized grey Brownian motions $B_{\beta,\alpha}$, $0 < \beta \leq 1$, $0 < \alpha \leq 2$. This family includes both fractional Brownian motion, Brownian motion, and other non-Gaussian processes. We show that the perpetual integral exists with probability 1 for $d\alpha > 2$ and $1 < \alpha \leq 2$. The Green measure then generalizes those measures of all these classes.

References

[1] H. P. Suryawan and J. L. da Silva. Green Measures for a Class of Non-Markov Processes. Mathematics 2024, **12**, 1334.

[2] Y. Kondratiev, Y. Mishura, and J. L. da Silva. Perpetual Integral Functionals of Multidimensional Stochastic Processes. Stochastics 2021, **93**, 1–12.

José A. Rodrigues

José Alberto de Sousa Rodrigues is a distinguished Portuguese mathematician and academic, currently serving as a Coordinator Professor at the Instituto Superior de Engenharia de Lisboa (ISEL), part of the Instituto Politécnico de Lisboa. He holds a PhD in Mathematics from the University of Minho, with a specialization in Applied Mathematics. His doctoral thesis focused on "Modeling, mathematical and numerical analysis of a vacuum breaker. Implementation and numerical simulation.

Professor José A. Rodrigues is a leading academic in applied mathematics in Portugal, contributing significantly to research, education, and scientific community service at ISEL and beyond.

DIRICHLET-NEUMANN DOMAIN DECOMPOSITION FOR PHYSICS-INFORMED NEURAL NETWORKS: A HYBRID MESHLESS SOLVER FOR PDEs

José A. Rodrigues

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Abstract

Accurately and efficiently solving partial differential equations (PDEs) remains a fundamental challenge in computational science and engineering, particularly for large-scale or high-dimensional problems. Traditional discretization-based methods, such as finite element and finite difference schemes, often face difficulties with scalability and adaptability in complex domains. Recently, physics-informed neural networks (PINNs) [1, 2] have emerged as a meshless alternative, embedding physical laws into the training process of neural networks. Despite their potential, standard PINNs may suffer from slow convergence and limited accuracy in multiscale or high-dimensional settings due to the global nature of their optimization.

To overcome these challenges, we propose a hybrid meshless framework that integrates PINNs with non-overlapping domain decomposition methods (DDMs) [3]. Specifically, we recuperate the Dirichlet-Neumann domain decomposition strategy to partition the computational domain into smaller subdomains. Each subdomain is independently solved using a localized PINN, and interface conditions are enforced to ensure global consistency. This approach leverages the strengths of classical DDMs—such as parallelizability and scalability—while maintaining the flexibility and geometric adaptability of meshless PINNs.

Numerical experiments on a variety of benchmark PDEs, including elliptic, parabolic, and nonlinear problems, demonstrate significant improvements in convergence rate and solution accuracy compared to conventional PINN approaches. The modular design also facilitates adaptive refinement and data assimilation, making this method well-suited for solving complex, high-dimensional PDE-driven systems where traditional methods become impractical.

References

[1] Maziar Raissi, Paris Perdikaris and George Em Karniadakis, ***Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations*** ; Journal, Journal of Computational Physics, 2019, 378, 686-707, pp. 1-22, 2019. DOI: 10.1016/j.jcp.2018.10.045

[2] José Alberto Rodrigues, ***Using Physics-Informed Neural Networks (PINNs) for Tumor Cell Growth Modeling***; Journal, Mathematics, 2024, 12(8), 1195, pp. 1-13, 2024. DOI: 10.3390/math12081195

[3] Alfio Quarteroni and Alberto Valli, ***Domain Decomposition Methods for Partial Differential Equations***; Book, Oxford University Press, 1999, ISBN: 9780198501562.

Luís M. Grilo

Professor Luís Miguel Grilo holds a PhD in Mathematics and Statistics from the Technical University of Lisbon (2006). He is currently an Assistant Professor in the Department of Mathematics at the University of Évora, Portugal, a position he has held since December 2022. Previously, he served as an Adjunct Professor at the Department of Mathematics and Physics at the Polytechnic Institute of Tomar (PIT) from 1999 to 2022, where he was also the Department Director from 2014 to 2022. Additionally, he has been a Visiting Professor at the Open University in Lisbon from 2013 to 2023, and has held teaching roles at the Institute of Languages and Administration of Santarém and the Instituto Superior de Gestão e Administração de Santarém.

Young Researcher Award, International Conference on Advances in Interdisciplinary Statistics and Combinatorics (AISC2007), for work on near-exact distributions for the generalized Wilks Lambda criterion.

Best Presentation Award (Doctoral Student Category), International Conference on Statistics, Combinatorics and Related Areas (SCRA2003), for work on approximations to the distribution of the product of independent Beta random variables.

Professor Luís Miguel Grilo is a leading figure in applied mathematics and statistics in Portugal, with a distinguished career spanning academia, research, and industry. His expertise in distribution theory, statistical modeling, and interdisciplinary applications has earned him national and international recognition, editorial roles, and leadership in scientific communities.

Evaluating Estimators in Structural Equation Modeling Using Ordinal Data

Luis M. Grilo[1,3,4] **and Guaner Rojas**[2]

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[3] *CIMA (Center for Research in Mathematics and Applications), University of Évora, Évora, Portugal*

[4] *NOVA Math (Center for Mathematics and Applications), NOVA University of Lisbon, Portugal*

Talk Abstract

Abstract: In Structural Equation Modeling (SEM), Diagonally Weighted Least Squares (DWLS) is commonly regarded as a robust alternative to Maximum Likelihood (ML) estimation, especially when working with ordinal data (such as Likert scales) and when the assumption of multivariate normality is not met. Unlike ML, which relies on the full covariance matrix, DWLS focuses on estimating the polychoric correlation matrix –which captures the correlations between underlying continuous latent variables corresponding to the observed ordinal variables– and then uses only the diagonal elements of this matrix to weight the differences between the observed and model-implied correlations. To ensure proper convergence, this method usually requires a sufficiently large sample size. Therefore, the consistent Partial Least Squares (PLSc) estimator was also considered, which has been effectively applied to ordinal data and is particularly suitable for situations involving small sample sizes and non-normal data distributions. These two estimators were compared using ordinal observed variables related to workers' health and well-being. The main results of the study suggest that the PLSc estimator can be seen as a reliable alternative.

Keywords: DWLS estimator, PLSc estimator, polychoric correlation, small sample, well-being.

Acknowledgements

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Referências

[1] C. G. Park, Implementing alternative estimation methods to test the construct validity of Likert scale instruments. *Korean J Women Health Nurs*, 2023; 29(2): 85-90. https://doi.org/10.4069/kjwhn.2023.06.14.2

[2] D. Mindrila, Maximum Likelihood (ML) and Diagonally Weighted Least Squares (DWLS) Estimation Procedures: A Comparison of Estimation Bias with Ordinal and Multivariate Non-Normal Data. *International Journal of Digital Society (IJDS)*, Volume 1, Issue 1, 2010.

[3] J. Benitez, J. Henseler, A. Castillo & F. Schuberth (2020). How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory IS research, *Information & Management*, Volume 57, Issue 2, 103168. https://doi.org/10.1016/j.im.2019.05.003

[4] J. F. Hair, G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks & S. Ray, *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*. Springer, 2021.

[5] L. M. Grilo, T. F. Braz, H. L. Grilo, J. P. Maidana & M. Stehlik, Modeling the facets of burnout in Lisbon airport border officers using PLSc-SEM estimator. *Stochastic Analysis and Applications*, 2023. https://doi.org/10.1080/07362994.2023.2266492

Marco Garapa

Professor Marco Paulo Ferreirinha Garapa is a mathematician and researcher affiliated with the University of Madeira, specifically within the Department of Mathematics and Engineering. He is actively involved as a researcher at CIMA (Centro de Investigação em Matemática e Aplicações), the university's research center focused on mathematics and its applications.

Professor Marco Paulo Ferreirinha Garapa's curriculum reflects a strong emphasis on mathematical logic, computational reasoning, and practical problem-solving. His teaching integrates foundational theory with applied logic programming, preparing students for advanced work in mathematics, computer science, and artificial intelligence. His research and supervision activities further reinforce his expertise in belief base dynamics and knowledge representation, making him a significant academic figure in his field.

Non-prioritized belief revision

Marco Garapa and Maurício Reis

June 6, 2025

The area of belief change addresses the problem of how to rationally incorporate new information into an agent's belief state. One of the foundational contributions to this field is the AGM model, proposed by Alchourrón, Gärdenfors and Makinson in 1985. In the AGM paradigm, primacy is given to new information, meaning that incoming information is always accepted and fully incorporated into the agent's belief state — a principle formalized by the *success* postulate. However, this assumption is not entirely realistic, as rational agents may choose to reject new information or accept only parts of it, particularly when the incoming information is perceived as unreliable or contradicts highly entrenched beliefs. In this talk, we present a survey of non-prioritized belief revision operators, which are operators that weaken the success postulate by allowing for the non-acceptance of incoming information, thereby offering a more flexible and realistic approach to belief change.

Maurício D. L. Reis

Maurício D. L. Reis is an Associate Professor in the Department of Mathematics at the Faculty of Exact Sciences and Engineering of the University of Madeira (UMa), and a researcher at CIMA (Centro de Investigação em Matemática e Aplicações). He obtained a PhD in Mathematics, specialising in Logic and Computer Science, from UMa in 2011. Prior to that, he graduated in Mathematics from UMa in 2001 and earned an MSc in Applied Mathematics from Instituto Superior Técnico – Technical University of Lisbon, in 2004. His main research interests are in the field of the Logic of Belief Change, and his principal scientific contributions concern multiple contraction, belief base revision, and non-prioritised belief change. His scholarly work includes several articles published in leading scientific journals and in the proceedings of top-tier scientific conferences. With over two decades of teaching experience, his pedagogical activities have encompassed a broad spectrum of courses at both undergraduate and master's levels, covering subjects including, among others, Logic, Applied Logic, and Computability Theory.

On the adaptation of the AGM model to belief bases

Maurício Reis and Marco Garapa

June 6, 2025

The central goal of the area known as the logic of belief change (also referred to as belief revision) is to study the modifications that may occur in the belief state of a rational agent upon receiving new information.

In 1985, Alchourrón, Gärdenfors, and Makinson proposed a model of belief change that is now known as the AGM model. In this framework, it is assumed that each belief of an agent is represented by a formula, and the agent's belief state is modeled as a belief set –a logically closed set of formulas, meaning it is closed under logical consequence. In the original paper, the authors introduced the class of *partial meet contractions*, providing both a constructive definition and a precise characterization based on rationality postulates.

Subsequently, in 1991, Hansson adapted the definition of partial meet contraction to the setting where an agent's belief state is represented by a set of formulas that is not necessarily logically closed –the so-called belief bases. He also obtained a postulate-based characterization of these operators.

In this talk we will present several classes of belief base contraction operators which are more general than the class proposed by Hansson. These operators arise as alternative adaptations of AGM contraction to the belief base framework and result in more flexible and expressive models of belief change.

Michael Grinfeld

Professor Michael Grinfeld is a distinguished academic in the field of mathematics, currently serving as a Reader in the Department of Mathematics and Statistics at the University of Strathclyde, United Kingdom. His career is marked by significant contributions to applied mathematics, mathematical modeling, and interdisciplinary research, with a strong record in both research and academic leadership.

Professor Grinfeld has a strong record of interdisciplinary collaboration, working with researchers in mathematics, physics, engineering, and life sciences. His research has contributed to advances in understanding complex systems, such as disease modeling, ecological diversity, and material behavior

Professor Michael Grinfeld is recognized for his expertise in mathematical modeling and applied mathematics, with a significant portfolio of research publications, leadership in funded research projects, and active engagement in the academic community through editorial and organizational roles. His work demonstrates both theoretical depth and practical relevance, impacting areas from public health to materials science.

Speaker: Michael Grinfeld, University of Strathclyde, Glasgow, UK and CIMA, U. Évora.

Title: Admissibility criteria and wild solutions in gas dynamics

Abstract: Recent work using convex integration techniques has uncovered a wealth of new weak solutions of equations of fluid dynamics (for an extended discussion, please see [1]). These results raise the question of how one deals with radical non-uniqueness of solutions of Cauchy problems. In the context of the Riemann problem for isentropic compressible Euler equations, we show that a version of the least action principle allows us to pick a unique solution [2, 3].

This is joint work with H. Gimperlein (U. Innsbruck), R. J. Knops (Heriot-Watt U.), and M. Slemrod (U. Wisconsin, Madison and Weizmann Institute of Science, Rehovoth).

References

[1] G. Eyink, H. Gimperlein, N. Goldenfeld, M. Grinfeld, I. Karlin, R. J. Knops, F. Kogelbauer, O. Kreml, L. McLarty, S. Markfelder, M. Osipov, and M. Slemrod, Interpreting convex integration results in hydrodynamics, to appear in Magazine EMS (2025).

[2] H. Gimperlein, M. Grinfeld, R. J. Knops, and M. Slemrod, The least action admissibility criterion, Arch. Rat. Mech. Anal. **249** (2025), 22, `https://doi.org/10.1007/s00205-025-02094-z`.

[3] H. Gimperlein, M. Grinfeld, R. J. Knops, and M. Slemrod, On action rate admissibility criteria, submitted to Z. Angew. Math. Physik (2025).

Nuno Sá

Professor Nuno Barros e Sá is a physicist affiliated with the Universidade dos Açores, where he serves as a Professor of Physics. He is also associated with the Instituto de Astrofísica e Ciências do Espaço (IA), contributing to the Portuguese astrophysics and cosmology community.

Professor Barros e Sá has published work in areas related to general relativity and quantum mechanics, which are foundational to modern cosmology and his publication record includes contributions to international conferences and journals, with at least one documented contribution to the CHARGED 2008 conference, discussing topics in high-energy physics that are often relevant to cosmological models.

A New Perturbative Method for Systems of Algebraic Equations

Nuno Barros e Sá[1,2]

[1]FCT, Universidade dos Açores, 9500-321 Ponta Delgada, Portugal
[2]Instituto de Astrofísica e Ciências do Espaço, 1349-018 Lisboa, Portugal

June 5, 2025

Abstract

We present a new perturbative method to find the solutions to systems of algebraic equations in the neighbourhood of known solutions. Given a known solution to a system of equations, the proposed method allows one to find both the dimension of the solution space around it and to construct a power series for the set of solutions in its neighbourhood – and it does provide as many such answers as there may be discontinuous sets of solutions. It is in principle suited both for numerical methods (by generating approximate solutions around a known solution) and for analytical methods (by providing the dimension and topology of the set of solutions around that point).

References

[1] N. Barros e Sá and I. Bengtsson, "Families of complex Hadamard Matrices", Lin. Alg. App. 438, pp. 2929-2957 (2013)

[2] A. Ben-Israel and T. Greville, Generalized Inverses, Springer, USA (2003)

[3] R. Penrose, "A generalized inverse for matrices", Proc. Camb. Phil. Soc. 51, pp. 406-413 (1955)

Russell Alpizar-Jara

Professor of Mathematics at the University of Évora, specializing in Biomathematics, Statistical Ecology, and Sampling Animal Populations.

His research has had a significant impact in the fields of ecology and biomathematics, as evidenced by the high citation counts of publications and his involvement in influential handbooks and collaborative research networks.

Professor Alpizar-Jara is recognized for methodological innovations in wildlife population estimation and for bridging the gap between statistical theory and ecological application and is a leading expert in the application of advanced statistical methods to ecological and wildlife research, with a distinguished academic and research career marked by international collaboration and high-impact publications.

Inverse Moments of Discrete Random Variables

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Abstract

We investigate the distributional properties of the reciprocal (inverse) of nonnegative discrete random variables, focusing on commonly encountered distributions that include uniform, Poisson, binomial, negative binomial, and hypergeometric. We derive and present symbolic expressions for the expected value, second moment, and variance of the inverse of a discrete random variable X, i.e., $\mathbb{E}[1/X]$, $\mathbb{E}[1/X^2]$, and $\mathrm{Var}(1/X)$, where defined. In cases where closed-form solutions are not tractable, we provide numerical approximations and asymptotic bounds. Graphical analysis illustrates the behavior of inverse moments across parameter ranges, highlighting their sensitivity to distributional tail weight and support. This study contributes useful analytical insights for various applications, inverse expectation modeling, and sensitivity analysis involving reciprocals of count-based random variables.

Acknowledgements

This talk is supported by Centro de Investigação em Matemática e Aplicações (CIMA), through the Project UIDB/04674/2020 of FCT-Fundação para a Ciência e a Tecnologia, Portugal.

Communications Program Overview

Program of CIMA2025AZORES

Friday, June 28th, 2025

09h00-09h30: Reception and registration of participants

9h30-10h00: Opening of the Meeting

Session 1 (Chair: João Cabral)

10h00-11h00: ***International Invited Speaker*** – Martin Grothaus

An improved characterization theorem - interpretation in Malliavin calculus - applications to SPDEs

Martin Grothaus, José Luís da Silva, Jan Muller, Andreas Nonnenmacher and Henry P. Suryawan

11h00-11h30: Coffee break

11h30-12h00: Feliz Minhós

Third-order functional problems: existence, non-existence and multiplicity results.

Feliz Minhós and Nuno Oliveira

12h00-12h30: Nuno Sá

A New Perturbative Method for Systems of Algebraic Equations.

Nuno Barros e Sá

12h30-14h00: Lunch Time

Session 2 (Chair: Feliz Minhós)

14h00-15h00: ***International Invited Speaker*** – Alberto Cabada

Discrete System of a Relativistic Operator coupled to Dirichlet Boundary Conditions

Alberto Cabada

15h00-15h30: Michael Grinfeld

Admissibility criteria and wild solutions in gas dynamics.

Michael Grinfeld, H. Gimperlein, R. J. Knops and M. Slemrod

15h30-16h00: Joaquim M. C. Correia

The Riemann problem for a model in elastoplasticity with hysteresis.

Joaquim M. C. Correia

16h00-16h30: Coffee-Break

Session 3 (Chair: Jerónimo Nunes)

16h30-17h00: Diogo Baptista

Complexity Along Isentropic Curves in the Lozi Map: A Secondary Invariant Approach.

Diogo Baptista and Alexandra Nascimento

17h00-17h30: Maurício Reis

On the adaptation of the AGM model to belief bases.

Maurício Reis and Marco Garapa

17h30-18h00: Marco Garapa

Non-prioritized belief revision.

Marco Garapa and Maurício Reis

Saturday, June 29th, 2025

Session 4 (Chair: Áurea Sousa)

09h00-09h30: Carlos A. Braumann

Consequences of parameter estimation errors when harvesting in random environments.

Carlos A. Braumann and Nuno M. Brites

09h30-10h00: Russell Alpizar-Jara

Inverse Moments of Discrete Random Variables.

Russell Alpizar-Jara

10h00-10h30: José Luís da Silva

Green Measures for a Class of Non-Markov Processes.

José Luís da Silva and Henry P. Suryawan

10h30-11h00: Coffee-Break

Session 5 (Chair: José Luís da Silva)

11h00-11h30: João M. G. Cabral

A Virus Evolution Fuzzy Model.

João M. G. Cabral

11h30-12h00: **(Online)** Luís M. Grilo

Evaluating Estimators in Structural Equation Modeling Using Ordinal Data.

Luís M. Grilo and Guaner Rojas

12h00-12h30: **(Online)** José A. Rodrigues

Dirichlet-Neumann Domain Decomposition For Physics-Informed Neural Networks: A Hybrid Meshless Solver For Pdes.

José A. Rodrigues

12h30-13h00: **(Online)** Clara Carlota

On existence of bang-bang solutions for pointwise state-constrained linear first-order control BVPs using two controls in the plane.

Clara Carlota, Mário Lopes and António Ornelas

13h00-13h30: Closing of the meeting