MatHBioS Seminar

(Double Session)

Session 1: Fractional Derivatives : Applications in data fitting and Artificial Neural Networks.

Speaker: Prof. Hamza El Mahjour, Abdelmalek Essaâdi University, MA.

Date | **Time:** December 10, 2025 | from 14:00 to 14:30.

Place: Room 2.23 - Building IX.

Abstract: Fractional calculus introduces non-integer-order derivatives with a built-in memory effect, enabling more accurate modeling of history-dependent phenomena than classical integer-order derivatives.This talk focuses on that memory property and its practical impact. A clear example is the work of Barros et al. (2021): a fractional Caputo SIR model for COVID-19 that incorporates transmission hysteresis and reduces fitting errors by 10-20% on real data (Italy, South Korea) compared to the standard SIR model, using an adapted Adams–Bashforth–Moulton scheme.I will also briefly review the integration of fractional derivatives into artificial neural networks. By employing Caputo-type fractional operators, these networks gain memory-dependent dynamics and additional tunable parameters (the fractional orders), leading to improved accuracy, stability, adaptability, and ability to capture long-range dependencies in tasks from control and modeling to image processing and medicine.Overall, the memory effect of fractional derivatives provides tangible advantages in both epidemiological modeling and next-generation neural networks, making complex systems easier to represent and control.

References

[1] Barros, L. C. D., Lopes, M. M., Pedro, F. S., Esmi, E., Santos, J. P. C. D., & Sánchez, D. E. (2021). The memory effect on fractional calculus: an application in the spread of COVID-19. Computational and Applied Mathematics, 40(3), 72.

[2] Joshi, M., Bhosale, S., & Vyawahare, V. A. (2023). A survey of fractional calculus applications in artificial neural networks. Artificial Intelligence Review, 56(11), 13897-13950.

[3] Viera-Martin, E., Gómez-Aguilar, J. F., Solís-Pérez, J. E., Hernández-Pérez, J. A., & Escobar-Jiménez, R. F. (2022). Artificial neural networks: a practical review of applications involving fractional calculus. The European Physical Journal Special Topics, 231(10), 2059-2095.

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Session 2: An Introduction to Fractional Calculus: Theory and Challenges.

Speaker: Prof. Aadil Lahrouz, Abdelmalek Essaâdi University, MA.

Date | **Time:** December 10, 2025 | from 14:30 to 15:00.

Place: Room 2.23 - Building IX.

Abstract: This talk gives an introduction to fractional calculus, which extends classical calculus to non-integer orders. We start with the basic concepts, including the definitions of fractional integrals and fractional derivatives. We focus mainly on two approaches: the Riemann-Liouville and Caputo definitions. We explain their main properties and the key differences between these formulations in different function spaces. Next, we present the main theory of fractional differential equations. We cover existence and uniqueness results, continuation and blow-up theorems. We also explain

how fractional differential equations differ from classical ones, particularly in their memory effects and non-local behavior. Throughout the presentation, we point out several important theoretical challenges and open questions in the field.

References

[1] Samko, S. G., Kilbas, A. A., & Oleg, I. (1993). Marichev. Fractional integrals and derivatives: Theory and applications.

[2] Diethelm, K., & Ford, N. J. (2010). The analysis of fractional differential equations. Lecture notes in mathematics.

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