Open Invited Track

Fractional Calculus, Mathematical Modeling and Artificial Intelligence across Complex and Other Systems

Yeliz Karaca[1*], Dumitru Baleanu[2], Stéphane Jaffard[3], Ali Akgül[4]

[1] Department of Mathematics and Department of Neurology, University of Massachusetts Chan Medical School, Worcester, MA, USA
[*]e-mail: yeliz.karaca@ieee.org

[2] Department of Computer Science and Mathematics, Lebanese American University, Beirut, Lebanon and Institute of Space Sciences, Bucharest
e-mail: dumitru.baleanu@lau.edu.lb; dumitru.baleanu@gmail.com

[3] Université Paris Est Créteil, Department of Mathematics, France
e-mail: stephane.jaffard@u-pec.fr

[4] Siirt University, Department of Mathematics, Türkiye
e-mail: aliakgul@siirt.edu.tr

Open Invited Track identification code: 4aeum

Dynamic behaviors are generated by modified networks relying on multiple parameter values of models and co-existing synchronized stimuli, generating different patterns of chaos, bifurcation, periodic and excitable spiking, resting along with bursting behaviors with minimum computational errors possible. Mathematics-based neuronal modeling provides a structured approach for probing these dynamics, facilitating the comprehension of individual neuron behavior and collective activities of neural networks. In complex and other systems, fractional dynamics and differentiation come to the fore through models of ODEs or PDEs with integer order, ordinary and partial differential equations, and so on. Hence, novel mathematical-informed schemes enable various complex processes' understanding by comprising heterogeneous spatio-temporal scales, while AI is for maximizing models' accuracy and minimizing functions as well as computational burden.

Paradigms of nonlinear science owing to its interdisciplinary nature require the generation of a systematic mathematical framework where complexity of natural phenomena hints the identifying their commonalties. Via the reflection systems' actual properties, FC exhibits latent variations, which enables integration and differentiation. Thus, significance of generating and implementing viable solutions to problems in various applied sciences, engineering areas, medicine, neuroscience, biology, mathematical science, computer and data science, among many others, entails predictability, interpretability and reliance on mathematical sciences, with AI and machine learning being across the connecting nodes pertinent to different fields characterized by complex, transient, chaotic and nonlinear constituents to validate the most possible optimized approaches.

IFAC
INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL
13th IFAC Conference on Fractional Differentiation and its Applications
December 16-18 2025, Algiers, Algeria
ICFDA Algiers 2025




Based on these integrative, multilayered and sophisticated approaches while building on our previous and ongoing special sessions, special issues and academic events, our open invited track aims to exchange ideas, focusing on the advances towards merging interdisciplinary perspectives with new avenues in real systems and other respective realms.

The potential topics of our open invited track include but are not limited to:

- Fractals, fractional calculus, fractional differential equations, differential equations (PDEs, ODEs, DDEs, etc.)
- Fractional modeling in biology/medicine/neuroscience
- Chaos, bifurcation, stability and sensitivity
- Oscillation and nonlinear dynamics
- Fractional quantum calculus
- Fractional mathematical modeling based on computational complexity
- Fractional mathematical modeling and bioengineering applications
- Data-driven approaches and numerical computations
- Computational methods for dynamical systems of fractional order
- Data-driven fractional modeling in complex medical / neurological / biological systems
- Neuron dynamics and neuronal functions
- Synchronization of fractional dynamic systems on time scales
- Stochastic analysis, modeling and/or stochastic Markov processes
- Fractional calculus with deep neural networks
- Data mining with fractal / fractional calculus
- Computational medicine, biology and/or fractional calculus in nonlinear systems
- Neurocomputation and neuronal circuits' dynamics
- Fractional-order neurons and fractional models of neurons
- Fractional calculus, Bloch–Torrey equation with Nuclear Magnetic Resonance (NMR) and / or Magnetic Resonance Imaging (MRI)

Among many other related points with mathematical, theoretical, numerical analytical and computational modeling.

Key dates:

31 July 2025 - Paper submission deadline
15 September 2025 - Notification of acceptance
15 October 2025 - Final paper submission deadline

IFAC
INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL

13th IFAC Conference on Fractional Differentiation and its Applications
December 16-18 2025, Algiers, Algeria

ICFDA Algiers 2025