Fractional modelling and physics-informed neural networks in epidemiology

Anna Szafrańska[1],
joint work with Jacky Cresson[2]

[1] *Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, Poland, email:* `annszafr@pg.edu.pl`
[2] *University of Pau and Pays de l'Adour, France , email:* `jacky.cresson@univ-pau.fr`

Traditional compartmental models often lack the ability to reflect memory effects and anomalous transmission dynamics inherent in real-world epidemiological processes. In this presentation, we propose a framework that combines fractional-order differential equations with physics-informed neural networks (PINNs) to model the spread of infectious diseases. In the context of applications, we are particularly interested in domain-preserving neural networks.

Fractional derivatives introduce a non-local, history-dependent component that enhances the descriptive power of classical models, while PINNs provide a data-driven means of learning both the model dynamics and unknown parameters directly from epidemiological data. We demonstrate the effectiveness of our approach by applying it to dengue fever case data. This study highlights the potential of combining fractional calculus and neural differential solvers to improve both predictive accuracy and interpretability in epidemiological modeling.

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[2] Jacky Cresson, Anna Szafrańska. Neural networks preserving invariant domains and applications to population dynamics. In progress.

[3] J. Cresson, A.Szafrańska, M. Péré, Numerical approach to the identification of fractional differential equations and applications in epidemics. Under review.