Topological data analysis enhances investigation of dynamical systems

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Dynamical system theory can be successfully used in modelling and understanding of complex phenomena across various fields, including engineering, physics, and biology. A key concept in comparison and classification of dynamical systems is the notion of topological conjugacy. In the talk we will consider a problem of testing topological (semi-)conjugacy of two trajectories coming from unknown dynamical systems when only finite samples of those trajectories are given. In particular, we will discuss recently developed *ConjTests* methods, showing its scalability and robustness.

Moreover, as in data driven dynamics we often face significant challenges due to non-linearity and high-dimensionality, topological data analysis offers powerful technics to overcome these difficulties and get insight into the qualitative structure of dynamical systems. One noteworthy approach in this vein is the *Euler Characteristic Profile*. We will see that by capturing the underlying shape and connectivity of data, this method offers a robust framework for quantifying topological features and their evolution over time.

The talk is based on joint works ([1, 2]) with Paweł Dłotko, Michał Lipiński and Marta Marszewska.

[1] P. Dłotko, M. Lipiński, J. Signerska-Rynkowska. Testing topological conjugacy of time series. *SIAM Journal on Applied Dynamical Systems* **23** (2024), 2939–2982. https://doi.org/10.1137/23M1594728

[2] P. Dłotko, M. Marszewska, J. Signerska-Rynkowska. Topological characteristics of dynamics. (2025) *(in preparation)*