From Recurrence Plots to Random Geometric Complexes: Using Topological Data Analysis for Statistical Hypothesis Testing, with Applications to Detection of Periodic Impulses

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Recurrence plots are a classical tool for analysing the state space of a dynamical system. I will show how ideas from Topological Data Analysis (TDA) can be used to generalize this concept and get rid of parameter choices. Interpreting the state space as a sample from an unknown distribution, this leads to the notion of a random geometric complex. We use its Euler characteristic to develop a goodness of fit test, i.e. evaluating whether a sample follows some specific model. As an application, we analyse time series of from mechanical engineering and detect faults in rolling element bearings, which correspond to cyclic impulses in the signal. The talk is based on the joint work [1,2].

[1] Dłotko, Paweł and Hellmer, Niklas and Stettner, Łukasz and Topolnicki, Rafał, Topology-driven Goodness of Fit Tests in Arbitrary Dimension, *Stat Comput*, 2023

[2] Hellmer, Niklas and Hebda-Sobkowicz, Justyna and Zimroz, Radosław and Wyłomańska, Agnieszka and Dłotko, Paweł, Damage identification in rolling element bearings using topological data analysis, *In preparation*, 2024