

Mathematical Colloquia

Monday, 05 December 2022

17:15 h, lecture room B6 (ExWi)

Dr. Bernadette Stolz, EPFL

Applications of global and local persistent homology for the shape and classification of biological data

Topological data analysis (TDA) is an emerging mathematical field that uses topological and geometric approaches to quantify the “shape” of data. In the first part of this talk, I will showcase how persistent homology, a method from TDA, can be used to spatially characterise structural abnormality in tumour blood vessel networks reconstructed from experimental data. More specifically, I will show that the number of vessel loops and their spatial distribution in these networks change over time when tumours undergo treatment with vascular targeting agents and radiation therapy. I will also show what insight TDA can give when applied to synthetic data generated from mathematical models of tumour-induced vascular growth. In the second part of the talk, I will demonstrate applications of local persistent homology. I will show how local persistent homology can be used to select landmarks from large and noisy data sets inherent to biology. In contrast to existing methods, this subsampling process is robust to outliers and is developed specifically as a preprocessing step for persistent homology. Based on similar ideas, I will introduce a novel method that can detect geometric anomalies, such as intersections or boundaries, in point cloud data sampled from intersecting surfaces. This detection is based on the computation of persistent homology in local annular neighbourhoods around points and is less sensitive to the size of the local neighbourhood and surface curvature than local principal component analysis.