

SEMINAR: Relational Inductive Biases as a Key to Smarter Deep Learning Microscopy

JESUS PINEDA

March 05, 2025

12:00 to 13:00

Seminar Room

Geometric deep learning has revolutionized fields like social network analysis, molecular chemistry, and neuroscience, but its application to microscopy data analysis remains a significant challenge. The hurdles stem not only from the scarcity of high-quality data but also from the intrinsic complexity and variability of microscopy datasets. This presentation introduces two groundbreaking geometric deep-learning frameworks designed to overcome these barriers, advancing the integration of graph neural networks (GNNs) into microscopy and unlocking their full potential. First, we present MAGIK, a cutting-edge framework for analyzing biological system dynamics through time-lapse microscopy. Leveraging a graph neural network augmented with attention-based mechanisms, MAGIK processes object features using geometric priors. This enables it to perform a range of tasks, from linking coordinates into trajectories to uncovering local and global dynamic properties with unprecedented precision. Remarkably, MAGIK excels under minimal data conditions, maintaining exceptional performance and robust generalization across diverse scenarios. Next, we introduce MIRO, a novel algorithm powered by recurrent graph neural networks. MIRO pre-processes Single Molecule Localization (SML) datasets to enhance the efficiency of conventional clustering methods. Its ability to handle clusters of varying shapes and scales enables more accurate and consistent analyses across complex datasets. Furthermore, MIRO's single- and few-shot learning capabilities allow it to generalize effortlessly across scenarios, making it an efficient, scalable, and versatile tool for microscopy data analysis. Together, MAGIK and MIRO address critical limitations in microscopy data analysis, offering innovative solutions for multi-scale data analysis and advancing the boundaries of what is currently achievable with geometric deep learning in the field.

Hosted by: Prof. Dr. Maria Garcia-Parajo