

MATH 612D Topics in Mathematical Biology - TOPICS MATH BIOL

Mathematical and computational methods for image and 3D shape analysis in biology.

Term 2

Instructor: Khanh Dao Duc

Recent advances in microscopy and imaging had led to a surge of biological data accounting for complex 3D shapes, ranging from molecules at the nanoscopic scale, to cells at the microscopic scale. This course will introduce recent mathematical and computational methods to represent and analyze data in high dimensional 3D shape space, with specific applications for single particle and cell imaging.

We will start the course with a few introductions of foundations, including concepts in differential geometry, signal processing and Lie groups to understand state-of-the-art research papers on spectral shape analysis, 3D reconstruction, manifold learning and non-euclidean metrics. The course will also have various invited speakers who will present their research in this field with applications to structural biology, molecular and cell biology and neuroscience. Students will prepare and give presentations on research papers (a list of relevant papers will be provided) and perform a small course research project to reproduce and/or extend results. The students will be encouraged to complete and present their projects using Jupyter Notebooks and existing Python libraries (tutorial sessions will be provided if needed). For a quite exhaustive list of recent papers, see <https://github.com/yinyunie/3D-Shape-Analysis-Paper-List>