PhD Project

Multiscale stochastic filtering for dynamic processes in fluorescence microscopy

CENTURI
TURING CENTRE
FOR LIVING SYSTEMS

The Bioimage Mining Lab

Within the last decade, major breakthroughs in live fluorescence microscopy have opened the door to the understanding of disease at the molecule level in environments mimicking human tissues. However, the complexity and highly dynamic nature of these datasets challenge their visual interpretation, let alone drawing any conclusion on the underlying biology. In this context, our research focuses on the unsupervised identification of collective molecular processes in biomolecular clouds, and their exploration in bioimaging datasets of ever-growing size.

Project Background and Challenges

A fundamental challenge in the analysis of molecular dynamics stems from the low framerate imposed by fluorophores limitations. Conventional solutions include the modeling of a few representative motion types embedded in temporally greedy estimator. However, those efficient strategies are limited to sparse and homogeneous scenarios. This is especially problematic in 3D environments where cells and tissues move with a high degree of freedom. Accurately describing object displacements requires taking into account their multiscale nature: from diffusive behavior to rapid changes in cellular morphology and environmental forces.

Building upon our previous work, this research project will focus on the development of a piecewise-stationary model in space and time for the shared dynamic footprint of molecules. Model selection and boundaries detection will be approached through the use of stochastic filtering as well as their approximation with deep neural networks. Expected challenges include the investigation of scalable approaches for assignment of model prediction to measurement as well as the definition or training of a handful of priors applicable to a wide variety of scenarios.

In addition to enable the quantification of dynamics that is not currently within reach, we aim at providing a generic framework for the analysis of collective motions across scales. Those approaches will be calibrated in collaborative studies ranging from intracellular transport to multi-cellular flow in embryonic model.

Training

Supervisor: Philippe Roudot, PhD
The training will focus on computer vision approaches for fluorescence microscopy with a strong emphasis on dynamic modeling, filtering and discrete optimization. Support will also be provided toward efficient scientific communication with interlocutor of very diverse expertises.

The CENTURI PhD program

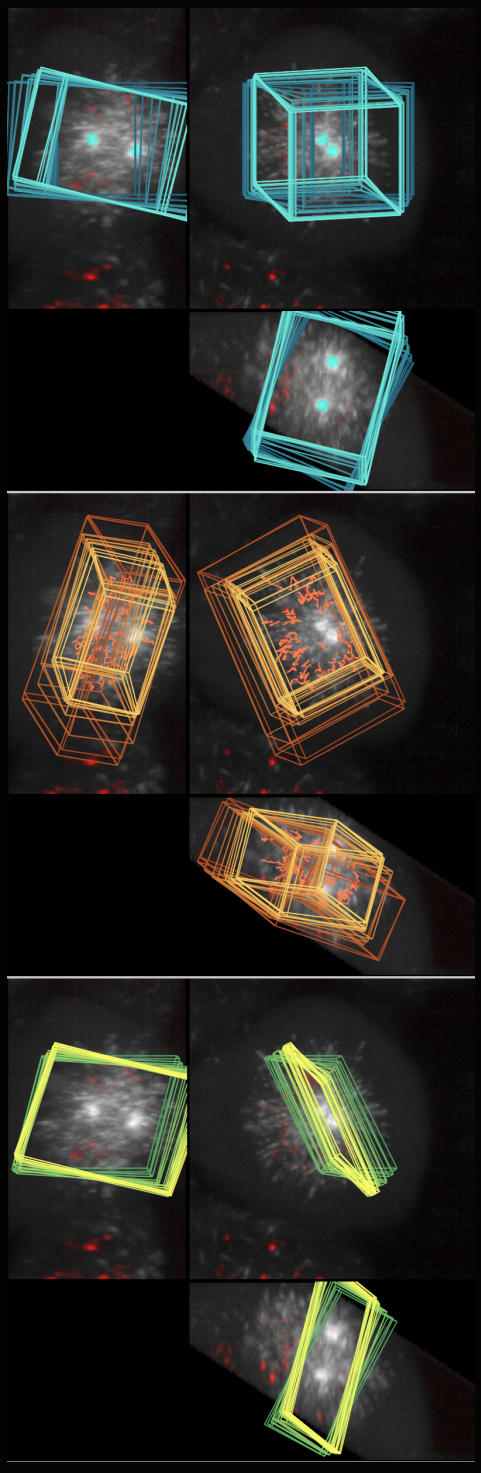
The Turing Centre for Living Systems (CENTURI, Marseille, France) aims at developing an integrated interdisciplinary community, to decipher the complexity of biological systems through the understanding of how biological function emerges from the organization and dynamics of living systems. The CENTURI PHD program set an interdisciplinary framework while promoting the expertise of each member in her/his respective field.

Candidate profile

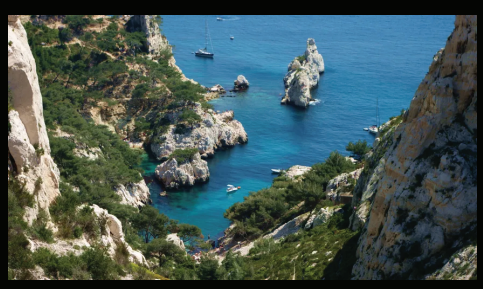
The PhD student will have a formal training in applied mathematics or computer science with a keen interest in biophysics, cell biology and the study of complex systems.

Application

Send a cover letter addressed to Philippe Roudot along with a CV and at least one recommendation letter at **philippe.roudot@univ-amu.fr** before **June 30 2021.**



Microtubule labelling combined with light-sheet microscopy and computer vision reveals the cascade of micrometric and nanometric motions that govern cell mitosis.



Suggiton Calanques are a walking distance from Aix-Marseille University campus where CENTURI is located.