Motion switching along cells receptors trajectories

Internship Position
Biological Image Analysis Unit, Institut Pasteur, Paris, France

Motion classification for cells receptors. Nowadays, fluorescence microscopy coupled with tracking algorithms allows the detection of particles at the cell membrane and the reconstruction of their trajectories. In a recent paper [1], these techniques are used to describe the trajectories of specific receptors (CCR5) in human cells that are involved in several inflammatory processes and in HIV infection. Dynamic characterization makes it possible to identify several receptor populations and study their role in the infection process.

The article [1] establishes a statistical method to distinguish standard classes of motion for CCR5 receptors (sub-diffusive, Brownian, directed). The method uses a decision test for characterizing motion [2] based on the maximum distance from the initial position.

This method has been improved by recent internship work, defining a machine learning method for classifying a larger family of movements. This work is based on the geometric characteristics of the trajectories [3] enabling different subdiffusive behaviors to be distinguished (Continuous-Time Random Walk, Ornstein-Uhlenbeck, Fractional Brownian Motion).

Project. The methods presented above allow us to classify movements for trajectories of a given length, thus describing their overall dynamics. However, the movement of receptors can change along their trajectory, depending on their biological environment and fate. The detection of switching points provides relevant information on receptor interactions and the effect of different treatments on them. There is little work on the detection of switching points, and existing approaches develop statistical methods based on the properties of Brownian motion [4].

The aim of this internship is to develop a new method for analyzing changes in motion along trajectories. The main objective is to define suitable parameters whose variation over time corresponds to a change in motion. In particular, the method should highlight motion variations in the sub-diffusive regime, which mainly characterize the behavior of CCR5 receprots.

Expected work. A good knowledge in mathematics and machine learning theory is need for this topic. After a review of the literature on stochastic processes and relative methods for motion classification, a new method of motion switching will be developed. The method validation will be performed on simulated trajectories and on experimental data.

Contacts :
Giacomo Nardi et Thibault Lagache, Biological Image Analysis Unit, Institut Pasteur
Emails : giacomo.nardi@pasteur.fr, thibault.lagache@pasteur.fr

References

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