



**Offer #2024-08514**

## **Statistical modeling and estimation of molecule diffusion in fluorescence microscopy**

**Contract type** : Fixed-term contract

**Renewable contract** : Yes

**Level of qualifications required** : PhD or equivalent

**Fonction** : Tempary Research Position

**Level of experience** : From 5 to 12 years

### **Context**

Understanding the molecular interactions and intracellular transport mechanisms in space and time is central in fundamental cell biology to characterize cellular functions, and crucial to the treatment and cure of human disease. In that context, it is of primary interest for biologists to be able to visualize and estimate molecular mobility within the cell.

To address this issue, we have developed a novel Eulerian method inspired from previous works [1, 2, 3, 4] that allows to estimate the diffusion and drift parameters attached to moving biomolecules within cells from 2D/3D individual trajectories. In the first step, the method estimates both drift and diffusion in local neighborhoods centered on trajectory points. The local spatiotemporal kernel estimators correspond to weighted averages of the trajectory elements. Unlike existing methods, the estimation of two or three-dimensional drift vector and the diffusion coefficient are performed on trajectory-sliding kernels, calculated at coordinates corresponding exactly to the coordinates given by the preliminary particle tracking. In the second step, each particle track point is labeled into three motion categories: confined motion (subdiffusion), Brownian motion (free diffusion), and directed motion (superdiffusion). The method is currently tested in several biological studies such as dynamics of transcription factors in the nucleus, MREB proteins in bacteria walls.

### **Bibliography**

1. BRIANE, M. VIMOND, C. KERVRANN. An overview of diffusion models for intracellular dynamics analysis, Briefings in Bioinformatics 21, 4, July 2020, p. 1136–1150, [doi:10.1093/bib/bbz052] , [hal:hal-02424761] .
2. BRIANE, C. KERVRANN, M. VIMOND. Statistical analysis of particle trajectories in living cells, Physical Review E 97, 6, June 2018, p. 1–20, [doi:10.1103/PhysRevE.97.062121] , [hal:hal-01961971].
3. BRIANE, M. VIMOND, C.A. VALADES-CRUZ, A. SALOMON, C. WUNDER, C. KERVRANN. A sequential algorithm to detect diffusion switching along intracellular particle trajectories, Bioinformatics 36, 1, June 2019, p. 317–329, [doi:10.1093/bioinformatics/btz489] , [hal: hal-02424777] .
4. SALOMON, C.A. VALADES-CRUZ, L. LECONTE, C. KERVRANN. Dense mapping of intracellular diffusion and drift from single-particle tracking data analysis, in : ICASSP 2020 – IEEE International Conference on Acoustics, Speech and Signal Processing, IEEE, p. 1–5, Barcelona, Spain, May 2020, [hal:hal-03087048] .
5. PRIGENT, C. A. VALADES -CRUZ, L. LECONTE, L. MAURY, J. SALAMERO, C. KERVRANN. BioImageIT: Open-source framework for integration of image data-management with analysis, Nature Methods, [doi: 10.1038/s41592-022-01642-9], [hal: hal-03474512], 2022.

### **Assignment**

The objective of the 10-month project is to improve the machine learning-based classification of trajectories by estimating the Hurst exponent in space and time, as well as to provide a user-friendly python software able to adapt to multiple scenarios in cell imaging and for a large range of applications. This software will be embedded within the BioImageIT middleware [5] especially designed for end-users and biology labs.

### **Main activities**

- Develop a method and an algorithm to estimate the Hurst exponent, in space and time, for trajectory classification.
- Evaluate the method on artificial and real datasets.
- Ensure interoperability with BioImageIT platform.
- Present the advancements to collaborators.

## Skills

Technical skills and level required :

Languages :

Relational skills :

Other valued appreciated :

## Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## General Information

- **Theme/Domain** : Optimization, machine learning and statistical methods  
Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city** : Rennes
- **Inria Center** : [Centre Inria de l'Université de Rennes](#)
- **Starting date** : 2025-02-01
- **Duration of contract** : 10 months
- **Deadline to apply** : 2025-02-07

## Contacts

- **Inria Team** : [SAIRPICO](#)
- **Recruiter** :  
Kervrann Charles / [charles.kervrann@inria.fr](mailto:charles.kervrann@inria.fr)

## About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

## The keys to success

- Programming (Python)
- Skills in statistics, machine learning, and stochastic processes in biophysics
- Skills in image and microscopy data analysis

**Warning** : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

## Instruction to apply

**Defence Security** :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating

to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy :**

As part of its diversity policy, all Inria positions are accessible to people with disabilities.