

## **Postdoc “Applied mathematics for cybergenetics”, Institut Pasteur and Inria, Paris**

We are looking for a highly motivated postdoc to work on an interdisciplinary French-Austrian project. The goal of the project is to make use of a recently-developed unique experimental platform (Chait et al., Nature Communications, 8(1):1535, 2017) to construct hybrid synthetic genetic circuits consisting of real biological parts and of virtual parts that only exist in the form of computational models. The selected candidate will be in charge of developing the theory, methods, models and algorithms that are needed for the successful implementation of hybrid circuits.

**Keywords:** stochastic chemical kinetics, stochastic processes, Bayesian inference, control theory, synthetic genetic networks, single-cell data, optogenetics

### **The Project**

Quantitative and synthetic biology live in a state of quiet denial: while the analogy of genetic to electronic circuits is commonly invoked and depicted, we routinely fail to make predictions about network dynamics from “known” properties of the network’s components that would agree with the data at the level expected in physics or engineering. Without composability, one must model and understand every network from scratch, even if it is assembled from known parts—a bleak prospect for the future of quantitative biology.

Inspired by recent developments in the nascent field of cybergenetics, the goal of this project is to construct hybrid “bio-digital” genetic circuits in order to approach questions in systems and synthetic biology from an entirely new angle. Biological and digitally modeled circuit parts will be connected through real-time optogenetic stimulation of individual cells. Hybrid circuits will be used for two purposes: (i) to replace single components of biological circuits by computational models in order to better understand them, (ii) to create virtual contexts for (parts of) biological circuits and to study how the circuit interacts with these contexts.

The candidate will be responsible for the required theory, models, methods and algorithms. This will include stochastic chemical kinetics models of synthetic gene networks and algorithms for parameter inference, model selection, sensitivity analysis that will be applied to data and connected to experimental platforms.

### **Links**

- <https://www.nature.com/articles/s41467-017-01683-1>
- <https://ist.ac.at/nc/news-media/news/news-detail/article/virtual-reality-for-bacteria/6/>

### **Qualifications**

Candidates should have a PhD in a theoretical field, such as mathematics, control engineering, physics, or computer science, and be capable of using methods from these fields to study dynamical systems and stochastic processes in applications. Any further experience with systems biology and continuous-time Markov chains, stochastic differential equations, or stochastic chemical kinetics is a plus.

Candidates must be capable of working in close collaboration with experimentalists. Scientific curiosity and the drive to depart on a project that intends to explore an entirely new scientific direction will be necessary.

## **Work environment**

Our group, InBio, is a joint initiative between Inria and Institut Pasteur. Inria is the French national institute for research in computer science, control, and applied mathematics promoting scientific excellence and technology transfer. The Pasteur Institute is a world-renowned non-profit private foundation dedicated to biomedical research and the fight against infectious diseases.

InBio is an interdisciplinary research group, combining experimental and theoretical biology in the same lab. We combine systems and synthetic biology approaches with control and active learning methods and stochastic and statistical modeling frameworks. Our main long-term goal is to develop a comprehensive methodological framework supporting the development of a quantitative understanding of cellular processes.

The group consists of scientists with diverse backgrounds (mathematics, physics, computer science, biology) and nationalities (French, German, Spanish, Montenegrin, and Indian). The spoken language is English. We have a “wet” lab as well as a “dry” lab, both located on the vibrant Institut Pasteur campus in the heart of Paris. Team’s website: <http://bit.ly/InBioPasteur>

The position is within a project that is co-funded by the French and Austrian science funding agencies (ANR and FWF) and a collaboration with the group of Calin Guet at IST Austria.

Applications are accepted immediately and candidates will be considered until the position is filled. The successful applicant will be hired on a two-year contract with possible extensions. Salary will be based on experience.

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Applications should include a CV, list of publications, and contact details of scientists willing to recommend the candidate.