

# PhD Position

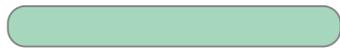
## Signal Amplification via Engineered Competition in Bacteria

### Topic profile

theory/math



wet-lab



### Tags

#synthetic biology

#genetic circuits

#bacterial conjugation

### Supervision

**Matthias Függer**

CNRS Researcher at ENS Paris-Saclay

**Thomas Nowak**

Professor at ENS Paris-Saclay

### Context

In the past few decades, synthetic biology has laid considerable focus on the re-programming of cells as computing machines, e.g., via genetic circuits and molecular control mechanisms. A central problem in this setting is to maintain a consistent state of circuit values among the bacteria. The problem of maintaining a consistent state among agents has been studied in distributed computing for decades in different contexts, e.g., for replicated state machines and mobile networks. Starting from a mathematical computing model, analysis of a system's behavior has led to correctness proofs and performance bounds of proposed solutions, also shedding light on how protocol parameters influence the quality of the outcome [1].

### We are looking for

Prerequisites are a Master degree in a relevant subject (e.g., biology or computer science). We expect a curious, driven attitude and interest to combine wet-lab and modeling work.

### The team

You will be part of an interdisciplinary research team at [Laboratoire Méthodes Formelles](#) in the [ENS Paris-Saclay](#), near Paris, working at the interface between computer science and synthetic biology.

### You are interested or would like to join us?

Please mail your questions or, in case you would like to apply, a short statement of interest and a curriculum vitae to Matthias Függer ([mfuegger@lmf.cnrs.fr](mailto:mfuegger@lmf.cnrs.fr)) and Thomas Nowak ([thomas@thomasnowak.net](mailto:thomas@thomasnowak.net)). Applications until the end of April 2024 will receive full consideration.

### Research

We use engineered competition to boost the relative population of one bacterial type over another for differential signal amplification. An initial mixed population of 60% bacteria of type Yes and 40% of type No being amplified into a population of, say, 95% of type Yes and 5% of type No makes downstream computations based on these signals less complex and more robust [2]. As such, this form of signal amplification is a relaxed variant of the distributed consensus problem. A simple yet effective algorithm to achieve signal amplification is to introduce the single inter-bacterial reaction  $\text{Yes} + \text{No} \rightarrow \emptyset$  that removes opposing bacteria. We will implement this mechanism by DNA communication of a genetic circuit part via bacterial conjugation [3]. The always present duplication and death reactions make the mathematical analysis challenging and non-standard. They do, however, actually introduce robustness to noise for our algorithm due to the fact that constant duplication keeps some high-variance stochastic effects caused by low population counts from occurring.

### References

[1] Cho et al. *Distrib. Comput.*'21. [URL](#)

[2] Aoki et al. *Nature*'19. [URL](#)

[3] Marken, Murray. *Nature Comm.*'23. [URL](#)