Control and optimal control for mathematical models of bacterial growth.

Level of qualifications required: Graduate degree or equivalent
Fonction: PhD Position

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) "Université Côte d'Azur (UCA)".

Context

The study of genetic regulatory networks has taken a qualitative leap through the use of modern genomic techniques that allow simultaneous measurement of the expression levels of all genes of an organism. In addition to high-throughput experimental methods, approaches in mathematics and computer science will be indispensable for analyzing the dynamics of genetic regulatory networks. BIOCORE team applies mathematical and computational methods from Control Theory and Dynamical Systems to the study of models of genetic networks and more general biological networks (metabolic networks, signaling networks...).

The work is done in collaboration with McTao Inria Team (Sophia) and IBIS Inria Team (Grenoble) within the ANR Maxicim project.

Assignment

The general goal of this work is to design control strategies for improving product yield and productivity in E.coli bacteria.

The Gene Expression Machinery of this bacterium has been modified (by techniques of genetic engineering) to obtain a strain where a chemical inducer controls the expression of RNA polymerase (an enzyme needed for the expression of the genes).

A simplified dynamical model of this controlled GEM will be developed (with our partners) and studied.

We will notably characterize the transients towards steady states and their duration, as well as the dependence of these properties on the concentrations of nutrients and inducer in the medium. Moreover, the possibility to externally adjust transients by choosing appropriate nutrients and inducer concentrations provides control parameters for, in the first place, the satisfaction of some biological constraints on the variables and dynamical behavior, and secondly, the optimization of product yield. Using optimal control, computer simulation and optimization, we will design control laws, possibly including feedback. The above analysis will also be carried out for fed-batch cultures in a fermenter (bioreactor), the condition most relevant for industrial biotechnological processes.

Main activities


Page of the team: [http://team.inria.fr/biocore](http://team.inria.fr/biocore)

Keywords

Gene networks, biological models, control, dynamical systems, computational biology, numerical simulation

Skills

We are looking for an applied mathematician with a background in the analysis of dynamical systems, and familiar with control theory (and optimal control). In addition, we expect a strong motivation to work on biological applications in genomics.
Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 1982€ brut per month (year 1 & 2) and 2085€ brut/month (year 3)