



## Offer #2024-07599

# Post-Doctoral Research Visit F/M Optimal control theory with applications to epidemiology

**Contract type :** Fixed-term contract

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

**Fonction :** Post-Doctoral Research Visit

**Level of experience :** Recently graduated

## Context

This research project is conducted in the framework of the project NOCIME (New Observation and Control Issues Motivated by Epidemiology), funded by the French National Research Agency (ANR) on the period 2024-2026 (three years). We are offering a 2-year position for a young PhD. Contracting may be immediate, and has to be achieved before January 1st, 2025.

NOCIME consortium includes researchers from Inrae (Montpellier), Inria (Paris, Lille, Metz) and IRD (Paris). The researchers in charge of the Working Package related to this position are located in Montpellier (Inrae, Campus de La Gaillarde) and Paris (Sorbonne Université). The postdoctoral supervisors are two senior researchers: Alain Rapaport (Inrae, Montpellier) and Pierre-Alexandre Bliman (Inria, Paris). The postdoctoral fellow will work mainly in Montpellier, with regular trips and contacts in Paris. Other scientific voyages (workshops, conferences) will be scheduled and funded.

## Assignment

The postdoctoral fellow will develop and test numerically new research results related to the topic. She/he will write scientific publications for international conferences and first-rank journals, mainly in the domains of Control theory and of Mathematical biology. He/she will present these results during international meetings and during the meetings organized for the advancement of the project NOCIME, within which he/she will be fully integrated as a collaborator.

## Main activities

The aim is to study various optimal control problems with unconventional criteria, and apply them to epidemiological models in continuous time, in relatively short dimension. By unconventional, we mean criteria that are not of the usual Lagrange, Mayer or Bolza form, such as crisis time, peak minimization, or maximization of the final size. The work will be both theoretical, in line with previous contributions, and numerical. In particular, we will study reformulations and/or approximations of these problems in a more classical form by extending the state vector in order to benefit from existing numerical methods (direct, Hamilton-Jacobi-Bellman, shooting methods...). For the applications, particular emphasis will be placed on the study of optimal control laws, especially in the form of state feedback. Guaranteed sub-optimality may be an alternative approach for problems where optimal state feedback is too difficult to characterize analytically. The coupling of control laws with state observers to be developed in the project could be studied in the second year of the postdoc.

References

[1] Bayen, T., Boumaza, K. and Rapaport, A. (2021) "Necessary optimality condition for

the minimal time crisis relaxing transverse condition via regularization", ESAIM Control, Optimization and Calculus of Variations, Vol. 27, N. 105, online.

[2] Beard, R.W., Saridis, G.N. and Wen, J.T. (1998) "Approximate Solutions to the Time-Invariant Hamilton-Jacobi-Bellman Equation". Journal of Optimization Theory and Applications 96, pp. 589626.

[3] Bliman, P.A., Duprez, M., Privat, Y., and Vauchelet, N. (2021). Optimal immunity control and final size minimization by social distancing for the SIR epidemic model. Journal of Optimization Theory and Applications, Vol. 189, pp. 408436.

[4] Haberkorn, T. and Trélat, E. (2011) "Convergence results for smooth regularizations of hybrid non-linear optimal control problems". SIAM Journal on Control and Optimization, 49 (4), pp.1498- 1522.

[5] Lenhart, S. and Workman, J. T. (2007). "Optimal control applied to biological models". Mathematical and computational biology. Boca Raton (Fla.), London: Chapman & Hall/CRC.

[6] Molina, E. and Rapaport, A. (2022) "An optimal feedback control that minimizes the epidemic peak in the SIR model under a budget constraint", Automatica, Vol. 46, online.

[7] Sharomi, O. and Malik, T. (2017) "Optimal control in epidemiology". Annals of Operations Research 251, pp. 5571.

[8] Smirnov, A. (2008) "Necessary optimality conditions for a class of optimal control problems with discontinuous integrand", Proc. Steklov Inst. Math., vol. 262, 1, pp. 213230.

[9] Vinter R. (2005), Minimax Optimal Control. SIAM Journal on Control and Optimization, 44(3), pp. 939-968

## Skills

Technical skills and level required : PhD, preferentially in Applied mathematics.

Languages : Sufficient practice of scientific English is required.

## 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 and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities

## General Information

- **Theme/Domain** : Modeling and Control for Life Sciences  
Scientific computing (BAP E)
- **Town/city** : Montpellier (MISTEA Research unit)
- **Inria Center** : [Centre Inria de Paris](#)
- **Starting date** : 2025-01-01
- **Duration of contract** : 2 years
- **Deadline to apply** : 2024-12-31

## Contacts

- **Inria Team** : [MAMBA](#)
- **Recruiter** :  
Bliman Pierre-alexandre / [Pierre-Alexandre.Bliman@inria.fr](mailto:Pierre-Alexandre.Bliman@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

The expected profile is a young or experienced PhD with a good knowledge of optimal control theory, motivated by both theoretical and numerical implementation aspects. Prior knowledge of mathematical biology, especially mathematical epidemiology, will be an asset. Experience of some of the conventional tools of numerical computing employed for test and simulation is expected, as well as experience with word processing for scientific editing.

On the personal side, taste for research in applied mathematics and skills in oral and written expression are awaited, as well as open-mindedness and capacity to work in cooperation.

For more information, contact (with a CV) the promoters Alain Rapaport (alain.rapaport@inrae.fr) and Pierre-Alexandre Bliman (pierre-alexandre.bliman@inria.fr).

**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.