



## Offre n°2024-07599

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

*Le descriptif de l'offre ci-dessous est en Anglais*

**Type de contrat :** CDD

**Niveau de diplôme exigé :** Thèse ou équivalent

**Fonction :** Post-Doctorant

**Niveau d'expérience souhaité :** Jeune diplômé

## Contexte et atouts du poste

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.

## Mission confiée

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.

## Principales activités

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

## Compétences

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

Languages : Sufficient practice of scientific English is required.

## Avantages

- 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

## Informations générales

- **Thème/Domaine** : Modélisation et commande pour le vivant  
Calcul Scientifique (BAP E)
- **Ville** : Montpellier (MISTEA Research unit)
- **Centre Inria** : [Centre Inria de Paris](#)
- **Date de prise de fonction souhaitée** : 2025-01-01
- **Durée de contrat** : 2 ans
- **Date limite pour postuler** : 2024-12-31

## Contacts

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

## A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général

communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

## L'essentiel pour réussir

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).

**Attention:** Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

## Consignes pour postuler

### Sécurité défense :

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

### Politique de recrutement :

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.