Offer #2025-08857

Post-Doctoral Research Visit F/M Solving Convex Optimization Problems in Nonlinear Predictive Control Based on Fast Quadratic Optimization

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with Paris-Saclay University and with the Institut Polytechnique de Paris since 2021.

The centre has 39 project teams , 27 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris. Its activities occupy over 600 scientists and research and innovation support staff, including 54 different nationalities.

Context

Every year Inria International Relations Department has a few postdoctoral positions in order to support Inria international collaborations.

The postdoctoral contract will have a duration of 24 months. The default start date is **November 1st, 2025 and not later than January, 1st 2026**. The postdoctoral fellow will be recruited by the Inria Centre Saclay in France and his/her time is shared between France and the partner’s country (please note that the postdoctoral

fellow has to start his/her contract being in France and that the visits have to respect Inria rules for missions).

Inria - Saclay

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The centre has 40 project teams , 32 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris; Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

DISCO project-team

The goal of the project-team is to better understand and formalize the effects of complex environments on the dynamics of the interconnections, as well as to develop methods and tools for the analysis and control of such systems. 1) Modeling of complex environments : The environment is seen as a dynamical object in order to model phenomena such as a temporary loss of connection, a nonhomogeneous environment or the presence of the human factor in the control loop but also the problems involved with technological constraints. 2) Questions of stability characterization or robust stabilization of possibly nonlinear infinite-diemensional are considered by various methods : H_∞-control, nonlinear control via Lyapunov-Krassovski techniques, observers, adaptative control, predictive control, set invariance. 3) Determination of finite-dimensional controllers of low order for infinite-dimensional systems.

Goals

Apply an algorithm developed by Valmorbida & Hovd for solving quadratic optimization problems to differentiable nonlinear optimization problems.

Apply this same algorithm developed by Valmorbida & Hovd for the resolution of relaxations of linear optimization problems.

Develop, following the same principles as for the QP algorithm, a method for solving Second Order Cone problems.

Produce a quadratic optimization package, with code developed in C/C++, its documentation and distribute it online.

Within the framework of a partnership

- International collaboration with the Universidade Federal do Rio Grande do Sul (Brazil)
- Exchanges with NTNU (Trondheim, Norway) are also planned.

Is regular travel foreseen for this post?

Two stays of at least in Porto Alegre/Brazil are planned. These stays will allow the candidate to develop joint work with Prof. João Manoel Gomes da Silva Jr. Travel expenses will be covered within the limits currently applied.

Assignment

Candidates for postdoctoral positions are recruited **after the end of their Ph.D. or after a first post-doctoral period:** for the candidates who obtained their PhD in the **Northern hemisphere, the date of the Ph.D. defense shall be later than September 1, 2022; in the Southern hemisphere, later than April 1, 2022.**

In order to encourage mobility, the postdoctoral position must take place in a scientific environment that is truly different from the one of the Ph.D. (and, if applicable, from the position held since the Ph.D.); particular attention is thus paid to French or international candidates who obtained their doctorate abroad.

Assignments :
With the help of Prof. Giorgio Valmorbida, the recruited person will

Apply an algorithm developed by Valmorbida & Hovd for solving quadratic optimization problems to differentiable nonlinear optimization problems.

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For a better knowledge of the proposed research subject :

Optimization-based control laws incorporating constraints and performance objectives require online computations. The digital implementation of these control

laws must run within sampling times ranging from tens of microseconds to milliseconds for mechanical and electrical systems with fast dynamics. Moreover, the complexity of systems regarding the number of variables and the need to optimize over long time horizons led to large-scale optimization problems.
On the other hand, computational platforms may be limited in either processing capabilities and/or memory. For these reasons, searching for simple, reliable, and embeddable algorithms is an active topic, even for standard optimization problems.

In this setting, we have recently proposed an algorithm to solve strictly convex Quadratic Programs (QPs) with inequality constraints [2]. In contrast with off-the-shelf implementations of interior point methods, the proposed algorithm looks for the solution of the QP by solving an implicit equation involving ramp nonlinearities. For some QPs arising in Model Predictive Control examples, the sparsity of the matrices used in the algorithm helps improve computational times by an order of magnitude when compared with state-of-the-art QP solvers (including other alternatives to interior-point methods). These results were obtained using a Matlab code. Further speed-up is expected from a C implementation of the algorithm.

[1] Morten Hovd and Giorgio Valmorbida. Solving LP-MPC problems using ramp functions. In 2023 IEEE Conference on Control Technology and Applications (CCTA), pages 445–450, 2023.

[2] Giorgio Valmorbida and Morten Hovd. Quadratic programming with ramp functions and fast online QP-MPC solutions. Automatica, 153:111011, 2023.

Collaboration :
Prof. João Manoel Gomes da Silva Jr (UFRGS/Brazil), Prof. Morten Hovd (NTNU/Norway)

Main activities

Main activities:

- Develop in C/C++ a toolbox for quadratic programming
- Compare the developed methods with other methods for solving QPs
- Perform convergence analysis of the developed algorithms.
- Carry out a bibliographic search on SOCP resolution methods
- Carry out a bibliographic search on the use of sequential QP methods for solving non-linear optimization problems

Additional activities:

- Write an activity report per semester
- Write scientific articles on the results obtained

- Present the results within the L2S laboratory and the project team

Skills

Technical skills and level required: Doctorate in Applied Mathematics / Doctorate in Automation / Doctorate in Systems/Process Engineering.

C/C++ programming

Matlab

Automatic / Dynamic Systems

Convex Optimization (Quadratic Optimization, Linear Optimization, Semi-Definite Optimization and Second Order Cones)

Languages: English, (French desirable)

Relational skills: The candidate will have to be part of a research team and will be required to work with doctoral students and Master's interns.

Benefits package

- Subsidized meals
- 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
- Access to vocational training

Remuneration

According to profile

General Information

- **Theme/Domain :** Optimization and control of dynamic systems
  Information system (BAP E)

- **Town/city :** Palaiseau
- **Inria Center :** Centre Inria de Saclay
- **Starting date :** 2025-10-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2025-08-31

Contacts

- **Inria Team :** DISCO
- **Recruiter :**
  Valmorbida Giorgio / giorgio.valmorbida@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 applicant must be strongly motivated in programming and software development (C, C++, Matlab, Python), and information sciences, Control, Dynamical Systems, and Optimization.

Teamwork, locally and remotely, will be part of the daily life of this job. The work will take place within the Inria-DISCO project team at the Signals and Systems Laboratory, a scientific environment of excellence where communication skills will be highly appreciated.

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.