



Offer #2024-08248

Post-Doctoral Research Visit F/M Control for frugality and resilience of software components: hierarchical and distributed approaches

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 Centre Inria de l'Université de Grenoble groups together almost 600 people in 22 research teams and 7 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (Université Grenoble Alpes, CNRS, CEA, INRAE, ...), but also with key economic players in the area.

The Centre Inria de l'Université Grenoble Alpe is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Context

The research will be conducted in the Inria centre at the University Grenoble Alpes. Inria is the French national institute for research in digital science and technology. Grenoble is an attractive city in the heart of the Alps, easily reachable from Paris, but also at a crossroads from Italy, Switzerland and Lyon, with a large student population and a number of cultural and sports facilities.

This postdoc grant is part of the ANR ADAPT project, that gathers 3 partners: Inria, Verimag, and FEMTO-ST. A PhD student and an engineer are also specifically dedicated to the project. Travel expenses are covered within the limits of the scale in force.

Assignment

Context - Control for Sustainable Computing

Control Theory has recently been successfully applied to manage the resources of computing systems, such as cloud services [1], high performance computing [2] or mobile applications [3]. Such software systems are typically a set of homogenous, distributed, communicating entities, possibly with a hierarchical architecture. Control is mostly used to handle their variability, e.g. in their workload or environment, and ensures the best performances [4]. This work is rather focused on ensuring properties, such as frugality and resilience, given the large and growing impact of computing systems and the increasing advent of extreme events.

Approach - Distributed Control Architecture

This project aims at using control theory tools for hierarchical and distributed software systems [5], e.g. control of multi-agent systems [6], with the aim of their adaptation. The architecture of structured and interacting elements, including controllers, are defined using formal tools (i.e. component-based system). The main challenges in the control design are (i) the hierarchical structure of the entities, organized based on spatial or temporal aspects, (ii) the large number of elements with low-computing capacity, (iii) the unreliable communication, leading to non-uniform sampling or event-based sampling, (iv) the low-reliability of the hardware, causing possibly stochastic behavior, (v) the highly unfavorable conditions, leading to highly variable behavior with extremely low availability of resources.

This general problem will also be studied with an application to energy/functionality management of [modular robots](#) forming programmable matter (e.g. a set of identical connected elements with low computing capacity), in collaboration with 2 PhD students (specialized in formal methods, and robotics & energy).

Main activities

Research Directions

The general objective of the project is to study frugality and resilience as a control problem in computing systems: i) express the problem of performance degradation for resource usage limitation, and ii) consider resilience of structured distributed systems.

The project covers the following research directions:

- state the problem of degradation of performance for resource usage limitation, e.g. with inspiration from brownout approaches [1],
- explore the distribution of control on a set of homogeneous systems, and extend to hierarchically structured systems,
- consider the resilience of the control system, under highly unreliable hardware and communication with high variability.

References

- [1] Klein, C., Maggio, M., Ārzn, K. E., & Hernandez-Rodriguez, F. (2014, May). Brownout: Building more robust cloud applications. In Proceedings of the 36th International Conference on Software Engineering (pp. 700-711).
- [2] Ismail Hawila, Sophie Cerf, Raphael Bleuse, Swann Perarnau, Eric Rutten. Adaptive Power Control for Sober High-Performance Computing. CCTA 2022 - 6th IEEE Conference on Control Technology and Applications, Aug 2022, Trieste, Italy. pp.1-8. [hal-03765849](#)
- [3] Sophie Cerf, Bogdan Robu, Nicolas Marchand, Sara Bouchenak. Privacy protection control for mobile apps users. Control Engineering Practice, 2023, 134 (May), pp.105456. [10.1016/j.conengprac.2023.105456](#). [hal-03977386](#)
- [4] Shevtsov, S., Berekmeri, M., Weyns, D., & Maggio, M. (2017). Control-theoretical software adaptation: A systematic literature review. IEEE Transactions on Software Engineering, 44(8), 784-810.
- [5] Scattolini, R. (2009). Architectures for distributed and hierarchical model predictive control—a review. Journal of process control, 19(5), 723-731.
- [6] Dorri, A., Kanhere, S. S., & Jurdak, R. (2018). Multi-agent systems: A survey. IEEE Access, 6, 28573-28593.

Skills

The applicant is expected to have a PhD in control or automation, or any related field. Experience or interest in distributed/multi-agent system is required. Skills in formal methods are not compulsory, but would be welcome.

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
- Access to vocational training
- Social security coverage
- Partial health insurance under conditions (15 euros max)

General Information

- **Theme/Domain** : Distributed Systems and middleware
- **Town/city** : Grenoble
- **Inria Center** : [Centre Inria de l'Universite Grenoble Alpes](#)
- **Starting date** : 2025-02-01
- **Duration of contract** : 1 year, 6 months
- **Deadline to apply** : 2024-11-15

Contacts

- **Inria Team** : [SPIRALS](#)
- **Recruiter** :
Cerf Sophie / sophie.cerf@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.

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.