Offer #2024-08187

Engineer H/F: Automated discovery of interference patterns in multi-core architectures

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : Temporary scientific engineer

Context

A major contribution of the Flowers team in recent years has been the development of curiosity-driven learning algorithms (Baranes & Oudeyer, 2013). These algorithms, coupled with deep representation learning techniques (Laversanne-Finot et al., 2018), have enabled both a better understanding of learning mechanisms in humans (Gottlieb & Oudeyer, 2018), but also the construction of machines/robots capable of efficiently exploring and learning repertoires of diverse tasks in high-dimensional spaces (Colas et al., 2019), or solving complex optimization tasks with local minima(Colas et al., 2018). This work has helped to introduce and develop a new field of research in artificial intelligence: intrinsically motivated learning.

Recently, the Flowers team discovered that these algorithms could be applied to a family of problems of great scientific and industrial importance: the automated exploration of complex systems (e.g. physico-chemical, biological or numerical) in order to discover new structures, learn new representations of them (deep learning techniques), make a map of them, and use this map to make the optimization of target structures more efficient (Etcheverry, 2023).

To encourage and facilitate the re-use of these tools by a broader audience of chemists, biologists, artists and others, we are designing a fully open-source interactive software that aims to provide tools to easily use exploration algorithms (e.g. the developed curiosity-driven ones) for assisting discovery in various complex systems (*Flowersteam/Adtool*, 2024/2024). We call them Automated Discovery Algorithms.

The objective of this Research Engineer position is to apply these automated exploration algorithms to a novel use case: the characterization of interference patterns in multi-core architectures. Indeed, whereas there exists reliable methods to predict worse-case execution time (WCET) in single-core architecture, these methods are not suited for predicting it in multi-core architecture (Courtaud, 2020; Courtaud et al., 2019; Maiza et al., 2020). The main reason is that multi-core architectures introduce temporal dependencies and strong interferences among programs executing in parallel, due to the concurrent access to shared resources (e.g. memory buses, caches etc ...). Thus, the conditions under which interference occurs, as well as their effects, can vary greatly and often seem random, making them very difficult to model and to predict. In other words, such architectures are complex systems: this is why we believe that our automated discovery algorithms can be very useful to characterize their behavior.

The proposed Research Engineer position is in the context of larger national research project on *Analysing Interferences with AI (AIxIA)*, involving several partners with a strong expertise in AI and onboard systems (IRT Saint Exupery), in multi-core architectures, system-on-chips, GPUs and temporal analysis (IRIT and IRISA), as well in automated discovery in complex systems (Inria-Flowers, where the proposed position will be located).

References

Baranes, A., & Oudeyer, P.-Y. (2013). Active Learning of Inverse Models with Intrinsically Motivated Goal Exploration in Robots. Robotics and Autonomous Systems, 61(1), 49–73. https://doi.org/10.1016/j.robot.2012.05.008

Colas, C., Fournier, P., Chetouani, M., Sigaud, O., & Oudeyer, P.-Y. (2019). CURIOUS: Intrinsically motivated modular multi-goal reinforcement learning. In K. Chaudhuri & R. Salakhutdinov (Eds.), Proceedings of the 36th international conference on machine learning (Vol. 97, pp. 1331–1340). PMLR. https://proceedings.mlr.press/v97/colas19a.html

Colas, C., Sigaud, O., & Oudeyer, P.-Y. (2018). GEP-PG: Decoupling Exploration and Exploitation in Deep Reinforcement Learning Algorithms. In J. Dy & A. Krause (Eds.), Proceedings of the 35th International

Conference on Machine Learning (Vol. 80, pp. 1039–1048). PMLR. http://proceedings.mlr.press/v80/colas18a.html

Courtaud, C. (2020). Caractérisation de la sensibilité aux interférences mémoire dans les systèmes temps-réels embarqués sur des plateformes multi-coeurs [Phdthesis, Sorbonne Université]. https://theses.hal.science/tel-03429679

Courtaud, C., Sopena, J., Muller, G., & Gracia Pérez, D. (2019). Improving Prediction Accuracy of Memory Interferences for Multicore Platforms. 2019 IEEE Real-Time Systems Symposium (RTSS), 246–259. https://doi.org/10.1109/RTSS46320.2019.00031

Etcheverry, M. (2023). Curiosity-driven AI for Science: Automated Discovery of Self-Organized Structures [Phdthesis, Université de Bordeaux]. https://theses.hal.science/tel-04504878

Flowersteam/adtool. (2024). [Python]. Flowers Team.https://github.com/flowersteam/adtool

Assignment

The main objective of this Research Engineer position will be to apply automated discovery algorithms to the problem of characterizing interference patterns in multi-core architectures. This will include:

- Understanding in detail the problem of interference characterization in such architectures, as well as automated discovery algorithms. This will involve a literature review on both topics, informed by discussions with the project partners.
- Studying and formalizing how automated discovery algorithms can be applied to the problem of interference characterization.
- Adapting and extending the automated discovery algorithms currently implemented in the adtools library to the considered problem.
- Running large-scale experiments to evaluate the method and refine it. This can be first performed on a simplified simulated model of mutli-core architectures, the final objective being to perform it on a real hardware architecture in collaboration with other partners.
- Analyzing the resulting data and publishing the results.

The contract duration is 18 months, starting as soon as possible.

Main activities

See above

Skills

Strong interest in IA and complex systems, with a strong motivation to apply state-of-the-art machine learning algorithms to concrete engineering problems.

Scientific programming

- Python
- Machine Learning algorithms and frameworks (e.g. Pytorch, JAX)

Prior experience with distributed computing architectures is a plus.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- 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

Remuneration

Between €2,692 and €2,977 gross per month (before taxs), depending on level of education and number of years of professional experience.

General Information

- **Theme/Domain :** Robotics and Smart environments
- **Town/city :** Talence
- **Inria Center :** Centre Inria de l'université de Bordeaux
- **Starting date :** 2024-12-01
- **Duration of contract :** 1 year, 6 months
- **Deadline to apply :** 2024-12-31

Contacts

- **Inria Team :** FLOWERS
- **Recruiter :**
  Moulin-frier Clément / clement.moulin-frier@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

Send an email to clement.moulin-frier@inria.fr AND pierre-yves.oudeyer@inria.fr with a CV and letter of motivation (with [APPLICATION] included in subject of email), in addition to applying on the Inria web site.
We encourage candidates to also provide reference letters, as well as documents related to previous projects they have worked on (e.g. reports, blog posts, code repositories, in particular on personal or professional projects they are particularly proud of, even if they are not directly related to the proposed project).

We strongly recommend that interested candidates contact us as soon as possible by email (this can be done with only a CV at first, before sending all application files).

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

Thank you to send:

- CV
- Cover letter
- Spport letters (mandatory)

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.