Offre n°2024-08187

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

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

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Ingénieur scientifique contractuel

Contexte et atouts du poste

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

Mission confiée

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.

Principales activités

See above

Compétences

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.

Avantages

- 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

Rémunération

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

Informations générales

- **Thème/Domaine** : Robotique et environnements intelligents
- **Ville** : Talence
- **Centre Inria** : Centre Inria de l'université de Bordeaux
- **Date de prise de fonction souhaitée** : 2024-12-01
- **Durée de contrat** : 1 an, 6 mois
- **Date limite pour postuler** : 2024-12-31

Contacts

- **Équipe Inria** : FLOWERS
- **Recruteur** :
  Moulin-frier Clément / clement.moulin-frier@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

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).

> **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

Thank you to send:

- CV
- Cover letter
- Spport letters (mandatory)

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.