Offre n°2025-08891

PhD Position F/M Large-scale graybox tunneling for multi-objective optimization

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

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

Created in 2008, the Inria center at the University of Lille employs 360 people, including 305 scientists in 15 research teams. Recognized for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria center at the University of Lille maintains a close relationship with large companies and SMEs. By fostering synergies between researchers and industry, Inria contributes to the transfer of skills and expertise in the field of digital technologies, and provides access to the best of European and international research for the benefit of innovation and businesses, particularly in the region.

For over 10 years, the Inria center at the University of Lille has been at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on avenue de Bretagne in Lille, on the EuraTechnologies site of economic excellence dedicated to information and communication technologies (ICT).

Contexte et atouts du poste

This PhD project will take place within the framework of the ANR PRCI TunnelOPT in collaboration with Colorado State University, USA.

Mission confiée

This PhD project aims at investigate new graybox tunneling techniques for multi-objective optimization (MO) problems. More specifically, we will consider combinatorial optimization problems where multiple objective functions are to be optimized simultaneously. Importantly, we consider graybox objective functions. This typically includes objective functions that can be linearly decomposed into sub-functions depending on a restricted number of variables. Other combinatorial problems could also be considered as far as they allow us to investigate and to apply specialized graybox evolutionary and search operators to design efficient solving mechanisms. The literature on graybox MO is in fact very limited and new state-of-the-art approaches are needed. Our general goal is then to develop new algorithmic tools to efficiently tunnel between Pareto Local Optima (PLO) solutions. By tunneling, we mean the design of new search techniques allowing us to efficiently navigate the space of PLO solutions. PLO solutions generalize the concept of LO using the dominance relation. Besides, we will consider the well-established MO decomposition concept as a natural approach to leverage existing single-objective techniques, and also those borrowed from the existing theory. Consistently with the three general tasks described below, **this PhD project will conduct fundamental research on graybox multi-objective optimization. Three key achievements are expected: (i) to understand the structure of PLOs under graybox tunneling, (ii) to design new tunneling mechanisms based on decomposition, and (iii) to smartly integrate tunneling into specialized MO search processes**.

Principales activités

The PhD project is organized into three task as described in the following.

Task 1. (M01?M06) Understanding the structure of Pareto Local Optima under tunneling. This task aims at conducting theoretical and empirical investigations, to discover and to inform about the structure of PLO solutions under graybox tunneling. At the theoretical level, we conjecture that in the MO setting too, PLOs organize into particular lattices. Firstly, we will consider applying graybox recombination to some input PLOs. This relatively simple setting undergoes a number of fundamental and challenging research questions. Secondly, connectivity of PLOs under tunneling can be modeled using a (hyper-)graph object by leveraging existing models and enabling in-depth empirical investigations on the PLOs connectivity structure.

Task 2. (M07?M18). **Designing new decomposition-based MO tunneling mechanisms.** This task takes inspiration from the well-established class of decomposition-based MO in order to design new tunneling mechanisms. In fact, a MO problem can be solved by decomposing it into a number of N single-objective problems. We will then study the idea of cooperative tunnellings, by mixing and recombining the local optima obtained for different neighboring subproblems. In

other words, we aim at tunneling between (single-objective) subproblems and transferring the knowledge among them. The fundamental question is to elicit the structure under which different (single-objective) local optima with respect to different (scalarized) subproblems obtained by decomposition, can organize in the objective space.

Task 3. (M19?M30) Integrating tunneling in a specialized MO search process. This task complements the two previous tasks, by integrating our findings into more sophisticated MO search processes. The tunneling mechanisms studied in Tasks 1 and 2 constitute the necessary building blocks for designing empowered MO algorithms. In the class of dominance-based MO algorithms, we will consider the generic framework of the well-established Pareto Local Search (PLS) algorithm as a natural candidate for integrating the tunneling mechanisms studied in Task 1. In the class of decomposition-based MO algorithms, we will consider the framework of well-established MOEA/D (Multi-objective Evolutionary Algorithm based on Decomposition) for integrating the tunneling mechanisms studied in Task 2. It is worth noting that these two generic algorithmic frameworks have several modern variants with a number of configurable components and parameters. Hence, the main challenge consists in the smart and efficient integration of tunneling within their respective algorithmic flow, including parallel or HPC accelerated algorithms.

Compétences

Languages : English

Other valued appreciated : keen to learn new concept and to work in a competitive international research environment

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
- Access to vocational training
- Social security coverage

Informations générales

- **Thème/Domaine :** Optimisation, apprentissage et méthodes statistiques
  Calcul Scientifique (BAP E)
- **Ville :** Villeneuve d'Ascq
- **Centre Inria :** Centre Inria de l'Université de Lille
- **Date de prise de fonction souhaitée :** 2025-09-01
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2025-06-06

Contacts

- **Équipe Inria :** BONUS
- **Directeur de thèse :**
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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'e?orce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

We look for a highly motivated student with excellent background in applied math and/or computer science.

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.