Principales activités

using massively parallel computing resources provide evidence on the efficiency of the designed approaches when tackling large-scale problems. To the best of our knowledge, investigating the synergies between gray-box deployment step, but also to open new parallel design opportunities. On the other hand, using algorithm, should be thought in parallel, not only to accommodate further engineering efforts at the designing decomposition, at the very-first step of the development of a gray-box optimization platforms. In fact, most of the knowledge used by gray-box optimization techniques is used in order to set up an innovative and solid fundamental understanding of their characteristics, while exploiting the computing power offered by modern heterogeneous and parallel (super-computing) platforms.

The successful candidate will be part of the BONUS team at Inria Lille, and will eventually collaborate with a number of international and highly recognized researcher partners, in particular in the USA (Colorado state university), and in Japan (RIKEN R-CCS). More information about the international research environment can be provided on-demand.

A propos du centre ou de la direction fonctionnelle

The Inria Lille - Nord Europe Research Centre was founded in 2008 and employs a staff of 360, including 300 scientists working in sixteen research teams. Recognised for its outstanding contribution to the socio-economic development of the Hauts-de-France region, the Inria Lille - Nord Europe Research Centre undertakes research in the field of computer science in collaboration with a range of academic, institutional and industrial partners.

The strategy of the Centre is to develop an internationally renowned centre of excellence with a significant impact on the City of Lille and its surrounding area. It works to achieve this by pursuing a range of activities and projects in fields of computer science such as the intelligence of data and adaptive software systems. Building on the synergies between research and industry, Inria is a major contributor to skills and technology transfer in the field of computer science.

Contexte et atouts du poste

The goal of this PhD is to foster the next generation of massively parallel large scale optimizers, by contributing to the design of advanced and effective computational intelligence algorithms and to set up an innovative and solid fundamental understanding of their characteristics, while exploiting the computing power offered by modern heterogeneous and parallel (super-computing) platforms.

The successful candidate will be part of the BONUS team at Inria Lille, and will eventually collaborate with a number of international and highly recognized researcher partners, in particular in the USA (Colorado state university), and in Japan (RIKEN R-CCS). More information about the international research environment can be provided on-demand.

Mission confiée

General statement: The research topic of this project falls at the crossroads of computational intelligence, optimization and parallel computing. On the one hand, computational intelligence implies problems and algorithms increasingly large-scale and heterogeneous in particular to deal with an increasing number of variables and objectives. The large-scale characteristics of nowadays optimization problems, e.g., solving complex AI tasks, raise difficult challenges that traditional approaches can hardly succeed in. On the other hand, the advent of massively parallel and/or distributed compute environments including up to millions of processing cores, while offering a number of opportunities for the advent of effective solvers, raise several other challenges related to parallel scalability and hardware heterogeneity. Accordingly, the objective of this PhD is to contribute to design and analysis of efficient computational intelligence algorithms in order to be able to scale both with the massive variable space and the massive parallel computing dimension.

Context: The project targets the design and analysis of novel massively parallel computational intelligence techniques. In particular, the focus will be on the so-called gray-box optimization algorithms and their hybridization with back-box techniques such as evolutionary algorithms, as well as, with machine-learning inspired techniques. In fact, one can classify optimization problems and/or methodologies in several classes according the amount of knowledge that is available a priori. At one extreme, in a black-box optimization scenario, a mathematical formulation of the objective function to be minimized/maximized, is typically not available. This is the case when the cost of one solution is for instance provided by some simulation process. Evolutionary optimization techniques are methods of choice as they are generic and require no information about the problem being solved. On the other hand, it should be clear that the more information is available about the optimization problem, the more the solving should be easier. In particular, knowing the interaction between variables and their combined effect on the objective function can highly help the optimization process. This is precisely what we term gray-box optimization. In such a setting guiding the (evolutionary) search towards the most interesting regions can be done using different on-line or off-line machine learning inspired techniques. Besides, knowing the components, in the decision space, that have the most important impact on solution quality, is another information that can be learned for designing highly effective recombination procedures and non-oblivious evolutionary search engines. Recently, such a methodology has shown its efficiency in tackling large-scale problems with hundreds of thousands of variables.

Research Objectives. The purpose of this project is to push further the limits of existing solvers by tackling even larger problems, of different nature, and more importantly to renovate the existing approaches to fit the massively parallel and heterogeneous nature of modern computing platforms. In fact, most of the knowledge used by gray-box optimization techniques is used in order to infer some decomposition of the decision space. This decomposition has a decentralized nature which makes it very appealing for parallel and high performance computing. On the one hand, designing decomposition, at the very-first step of the development of a gray-box optimization algorithm, should be thought in parallel, not only to accommodate further engineering efforts at the deployment step, but also to open new parallel design opportunities. On the other hand, using parallelism can allow to tackle increasingly complex problems and to design more powerful approaches. To the best of our knowledge, investigating the synergies between gray-box optimization and parallel computing has not been explored so far. As such, the main objective of the conducted research is to design new hybrid parallel gray-box optimization approaches and to provide evidence on the efficiency of the designed approaches when tackling large-scale problems using massively parallel computing resources.

Informations générales

- **Thème/Domaine:** Optimisation, apprentissage et méthodes statistiques
- **Ville:** Villeneuve d'Ascq
- **Centre Inria:** CRI Lille - Nord Europe
- **Date de prise de fonction souhaitée:** 2020-10-01
- **Durée de contrat:** 3 ans
- **Date limite pour postuler:** 2020-04-22

Contacts

- **Equipe Inria:** BONUS
- **Directeur de thèse:** Derbel Bilel / Bilel.Derbel@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 200 équipes projet agissent, en général communes avec des partenaires académiques, impliquent plus de 3500 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. 500 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 180 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.

Consignes pour postuler

Consignes pour postuler

**Prior to application, it is recommended to contact:** omarabdellka@inria.fr, arnauldifiegohe@inria.fr, bilel.derbel@inria.fr

To apply, the following is mandatory: CV + application letter + recommendation letters + references + school transcript(s)

**Sécurité défense:**

Si le candidat 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.

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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.
The overall research activities can be summarized as follows:

1. Analysis of the decentralized nature of existing (gray-box) optimization techniques
   - Elicit the decomposition components used in state-of-the-art algorithms
   - Classify the decomposition components according to their genericity

2. Hybridize gray-box evolutionary techniques with black-box optimization and machine learning
   - Learn the gray-box structure of a black-box optimization problem
   - Design adaptive gray-box search operators

3. Massively parallel gray-box decomposition
   - Accommodate the core design of existing techniques to fit the massively parallel nature of a modern CPUs/GPUs compute facilities
   - Implement and deploy the so-developed hybrid algorithms and study their parallel scalability

4. Validation and fundamental understanding (to be conducted with the other task):
   - Develop fitness landscape analysis tools to better understand the landscape implied by search operators based on gray-box techniques
   - Design variable dependency structures and study their impact on search performance
   - Develop benchmark problems to both assess the performance of existing gray-box techniques, and to better understand their weaknesses and strengths
   - Adopt a systematic approach for the design of autonomous gray-box search solvers

5. Dissemination
   - Publication in international conferences and/or journal(s)
   - The developed programs should be made available for the expert community

Compétences

Candidates with the following skills will be preferred:

- Fluent English, excellent communication skills, keen to team working
- Good background in optimization and/or evolutionary algorithms
- Good background in parallel and distributed computing
- Good background in machine learning
- Good experience in programming

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 (after 6 months of employment) 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

1st and 2nd year: 1 982€ Gross monthly salary (before taxes)
3rd year: 2085€ gross monthly salary (before taxes)