The goal of this PhD is to foster the next generation of large-scale parallel optimizers, by contributing to the design of advanced algorithms attacking big gray-box optimization problems and to set up an innovative and solid fundamental understanding of their characteristics, while exploiting the power offered by modern parallel 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 with whom the team is actively working, e.g., in the USA, UK, Japan, Hong Kong. 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 the boader field of optimization and parallel computing. On the one hand, optimization is ubiquitous to countless modern engineering and scientific applications and implies problems and algorithms increasingly large-scale and heterogeneous in particular to deal with a huge amount of variables. The large-size and heterogeneous characteristics of nowadays complex applications lead to “big” optimization problems [1] raising new important and difficult scientific challenges for researchers and practitioners, that traditional approaches will hardly succeed when facing them. On the other hand, the advent of massively parallel and/or distributed computers including up to millions of processing cores is a challenging opportunity. In fact, harnessing such amount of computing resources raises several performance issues related to parallel scalability and heterogeneity. All these scalability problems constitute numerous difficult challenges to the optimization community and give rise to new great research directions. In this respect, the ambition of this PhD is to contribute to design and analysis of efficient optimization algorithms, in a large-scale setting, and to foster the next generation of modern optimization approaches in order to be able to scale both with the massive variable space and the massive parallel computing dimension. Motivation. More specifically, the project targets the design and analysis of novel gray-box optimization algorithms [2] both at the theoretical and applied level.

In fact, one can classify optimization problems and/or methodologies in several classes according to the amount of knowledge that is available a priori before running the optimization process. At one extreme, in a black-box optimization scenario, the objective function to be minimized/maximized can be unknown, which is the case of optimization problem in multi-disciplinary engineering design where the cost of one solution is provided by some simulation process. In such a case, even a mathematical formulation of the problem might not be available. Evolutionary optimization techniques are method of choice as they require no information about the problem being solved and are generic enough to be applied to a wide range of problems. On the other extreme, in a white-box optimization scenario, a full information about the problem is available, e.g., in a continuous domain, the derivatives and the gradient are available. It should then be clear that the information available about the optimization problem have a substantial impact on the difficulty of its solving and the design of effective algorithms; the more information is available, the more the solving should be easier. In between these two extreme cases, one can seek for some information about the problem so that the (evolutionary) optimization process can be improved and accelerated [3]. This is precisely what we term gray-box optimization. For instance, knowing the interaction between variables can highly help the optimization process by guiding the evolution of solutions. This can be handled, for instance, by integrating techniques from graph theory to model the search regions of special interest. This can be performed either off-line, that is before the optimization process is started, or on-line typically using a machine-learning mechanism on the basis of the solutions explored so-far. Besides, knowing the components, in the decision space, that has the most important impact on solution quality, is another information that can be used for designing highly effective recombination procedures and non-oblivious evolutionary search engines. Recently, such a methodology has shown its usefulness. The knowledge about the (evolutionary) optimization problem process can be improved and accelerated.

**Research Objectives.** The purpose of this project is to push further the limits of existing solvers by tackling large-scale problems with hundreds of thousands of variables [4].

* Fluent English, excellent communication skills, keen to team working
* Good background in (combinatorial) optimization and/or evolutionary algorithms
* Good background in parallel and distributed computing
* Background in graph theory and machine learning
* Good experience in programming

**Contexte et atouts du poste**

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 with whom the team is actively working, e.g., in the USA, UK, Japan, Hong Kong. More information about the international research environment can be provided on-demand.

**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 : 2019-10-01
- Durée de contrat : 3 ans
- Date limite pour postuler : 2019-04-22

**Contacts**

- Equipe Inria : BONUS
- Directeur de thèse : Derbel Bilel / bilel.derbel@inria.fr

**A propos d’Inria**

Inria, l’institut national de recherche dédié aux sciences du numérique, promeut l’excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l’interface d’autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 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**

**Consignes pour postuler**

- CV + application letter + recommendation letters + references + school transcripts

**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.

**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.
Références


Principales activités

Given the difficult challenges raised by the project, a possible research approach that we propose to investigate is as follows:

1. Analysis of the decentralized nature of existing gray-box optimization techniques
   * Elicit the decomposition components used in the design of state-of-the-art algorithms
   * Classify the decomposition components with respect to their dependency to the problem being tackled. We will consider three classes of combinatorial optimization problems: pseudo-boolean functions, permutation-based problems, graph-based problems.

2. Refine the already existing gray-box evolutionary techniques by incorporating techniques from other connected fields such as graph theory and machine learning
   * Learning the gray-box structure of black-box optimization problems and develop novel scalable parallel decomposition techniques
   * Adapt the existing gray-box evolutionary operators to operate with the learned structure

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 heterogenous 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, i.e., selecting the most appropriate variants depending on instance features

5. Dissemination
   * Publications 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 (combinatorial) optimization and/or evolutionary algorithms
- Good background in parallel and distributed computing
- Background in graph theory and 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)
  - Access to vocational training
  - Social security coverage

Rémunération

1st and 2nd year : 1593.50€ Net monthly salary (after taxes)
3rd year : 1676.31€ Net monthly salary (after taxes)