**2023-06249 - Post-Doctoral Research Visit F/M**

**Primal-Dual relaxations for Non-Linear Problems**

**Type de contrat :** CDD  
**Contrat renouvelable :** Oui  
**Niveau de diplôme exigé :** Thèse ou équivalent  
**Fonction :** Post-Doctorant  
**Niveau d’expérience souhaité :** De 3 à 5 ans

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**A propos du centre ou de la direction fonctionnelle**


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**Contexte et atouts du poste**

Team AROMATH ([https://team.inria.fr/aromath/](https://team.inria.fr/aromath/)), Inria à Université Côte d’Azur, team leader Bernard Mourrain.

**Research topics:** computational algebraic geometry; efficient algorithms for solving the non-linear problems, exploiting algebraic structures, stable against numerical perturbation; high order geometric modeling exploiting algebraic representations; computational design; mechanical engineering; computer vision.

**Contact:** Bernard Mourrain ([http://www-sop.inria.fr/members/Bernard.Mourrain/](http://www-sop.inria.fr/members/Bernard.Mourrain/))

**Beside carrying out high quality research, we expect the postdoc to participate to the activities of the EU network TENORS on tensors and optimisation, which will start in January 2024.**

**The postdoc will also have the opportunity to collaborate with PhD students working on related topics.**

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**Mission confiée**

**Non-Linear Equations** are ubiquitous in domains such as geometric modelling, scientific computing, data analysis, … Finding their solutions is an instance of non-linear optimisation problems. A classical approach to tackle these non-linear problems is to use local methods, such as Newton method or gradient descent methods. This family of methods is widely used in practice, but it only provides local extrema with no guaranty for a global solution. Moreover, it is very sensitive to the choice of the initial point. Alternative algebraic approaches such as Gröbner bases have been developed over the last decades to compute all the solutions of polynomial equations [2]. They involve direct computations with the polynomial equations, but are not numerically stable. Border basis [6], which have been developed more recently for robustness purposes, also involves primal polynomial computations.

At the turn of this century, an innovative approach has been proposed by J.B. Lasserre, to approximate global optima [4]. It involves primal convex cones of sums of squares of polynomials and their dual cones of pseudo-moment sequences. The core of the approach is to approximate positive polynomials by sums of squares and moments of measures by positive pseudo-moment sequences. These primal-dual relaxations allow to recover the optimal value and all the solutions of the optimization problem.

The objective of the project is to explore new types of primal-dual relaxations, which lead to efficient methods for solving global non-linear problems.

The first part of the project will be dedicated to the study of non-linear problems with a finite number of solutions, based on linear primal and dual relaxations. We will investigate new methods extending the Truncated Normal Form (TNF) approach [5] for solving non-linear constraints. In a second part, we will consider non-linear optimisation problems defined on general basic semi-algebraic sets. We will investigate new primal and dual convex relaxations for other types of functions such as splines, polynomial exponential functions [3], or network functions used in Machine Learning for data fitting. We aim at analysing the capacity of approximations of these relaxations [1], their potential to recover the optimizers of the global optimization problem and their practical performance through their use in illustrative applications.

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**References**


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**Informations générales**

- **Thème/Domaine :** Algorithmique, calcul formel et cryptologie  
- **Ville :** Sophia Antipolis  
- **Centre Inria :** Centre Inria d’Université Côte d’Azur  
- **Date de prise de fonction souhaitée :** 2023-10-01  
- **Durée de contrat :** 1 an  
- **Date limite pour postuler :** 2023-12-30

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**Contacts**

- **Équipe Inria :** AROMATH  
- **Recruteur :** Mourrain Bernard / Bernard.Mourrain@inria.fr

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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 200 équipes-projets agiles, en collaboration avec des partenaires académiques, engagent plus de 3500 scientifiques pour relever les défis du numérique, souvent à l’interface d’autres disciplines. L’Institut s’efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l’économie.

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**L’essentiel pour réussir**

**Candidates must hold a Ph.D. in Mathematics or Computer Sciences.**

Candidates must also show evidence of research productivity (e.g. papers, conference presentations, etc.) at the highest level.

We prefer candidates who have strong mathematical background (or computer algebra, optimisation or scientific computing) and are familiar with territory on using mathematics to solve real problems and get insights. The candidate should also be knowledgeable on software development and have good programming skills. Previous experiences with Julia is a plus.

The position is for 12 months, renewable for one more year, for a total of 24 months.

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**Attention :** Les candidatures doivent être déposées en ligne sur le site Inria.
Principales activités

The research activity will follow a classical path: literature review, exchange, brainstorming, development of new results... Software development (for instance with Julia Language) and experimentation can be considered to validate new methods. The collaboration will be conducted through regular meetings with the advisors. The post-doctoral fellow will have the opportunity to bring his/her own expertise and will be encouraged to open up his/her own research avenues. He/she will benefit from the rich environment and expertise in effective algebraic geometry and computer algebra at the AROMATH team and at the University Côte d’Azur, from seminars and workshops and from our network of collaborators.

Compétences

The following skills are desired for this position:

- a strong research background in the domain of the project (or at least in a specific area such as computer algebra, geometry, optimization or scientific computing)
- good communication and reporting skills, and an interest in collaborative work
- proficiency in English

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
- Contribution to mutual insurance (subject to conditions)

Rémunération

Gross Salary: 2746 € per month