Offre n°2024-07253

Post-Doctoral Research Visit F/M Multipoint evaluation and spatial subdivisions

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

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

Contexte et atouts du poste

The INRIA team Gamble is part of the INRIA Nancy Grand Est research center and also of the department Algorithms, Computation, Geometry and Image of the LORIA laboratory of Université de Lorraine.

Classical computational geometry usually deals with linear objects in a Euclidean setting and when other situations happen, curved objects are typically linearized and non-Euclidean spaces are locally approximated by Euclidean spaces. The goals of the Gamble team are to address such limitations of classical computational geometry.

Mission confiée

The goal of this postdoc is to study questions that are relevant both to discrete and computational geometry and to computer algebra, by combining combining classical methods and recent developments from both fields.

As an example, consider the typical problem, underlying several questions in computational geometry and computer algebra, is semi-algebraic range counting: given a set \( P \) of \( n \) points and a set \( F \) of polynomials, count the number of pair \((f,p) \in F\times P\) such that \( f(p)>0 \). Consider for instance the case where the points are in \( \mathbb{R}^2 \) and the polynomials are bivariate. On one hand, recent results in computational geometry show that if \( F \) consists of \( n \) polynomials of constant degrees, then it is possible to do it in \( O(n^{4/3}) \) operations \[1\]. On the other hand, results in computer algebra based on a completely different set of tools show that if \( F \) is reduced to a single polynomial of degree \( n^{1/2} \), then the problem can be solved in \( O(n^{1.334}) \) operations \[2\]. Is it possible to combine these two sets of tools to obtain better bounds? Or could we obtain lower bounds for those problems, in the spirit of the recent lower bounds obtained for semialgebraic range reporting problems \[3\]?

State of the art

The main tools from computational geometry that we will consider are cuttings \[4, Ch. 4 and 6\] and their algebraic generalization \[5\]. Initially, cuttings were introduced to allow divide-and-conquer algorithms in geometry. For example, given \( n \) lines in the plane and a parameter \( 0<\delta<1 \), a \( \delta \)-cutting is a triangulation of \( \mathbb{R}^2 \) such that each triangle contains at most \( \delta n \) lines.

In computer algebra, the main tools used for fast bivariate polynomial evaluation are based on fast matrix multiplication \[6, Ch. 12\]. This tool was used to compute the modular composition of polynomials \[7\], and later extended to evaluate a bivariate polynomial on multiple points\[2\].

An important data structure underlying these approaches is the biclique partition. Given a subset \( S \) of a product of sets \( F\times P \), a biclique partition of \( S \) is a union of pairwise distinct subsets \( S_i \) of the form \( F_i\times P_i\) such that \( S = \bigcup S_i \). This kind of data structure appears notably in several geometric incidence and algebraic rigidity problems. Such problems include bounding the number of line intersections, or bounding the number of intersection of an algebraic surface with a Cartesian product \[8\].


**Principales activités**

The candidate will study the recent results on semi-algebraic-relational queries to try and narrow the gaps between upper and lower bounds. They will try to improve asymptotic bounds on related problems in computational geometry and computer algebra, and to compare and combine the methods from both fields.

Depending on the interests of the candidate, the postdoc can open up in a number of directions. For example, these problems are naturally studied in the Real RAM model of computation, but a comparison to the word-RAM model is relevant (in particular, it would be interesting to inspect the frontier between the classes NP and ETR, if any). Other possibilities include, but are not limited to, investigating from a computer algebra standpoint problems in discrete and computational geometry where polynomials play a key role (e.g. the various phenomena of algebraic rigidity that arise in incidence geometry, semi-algebraic graphs arising from geometry, certain LP-type optimization problems, etc.).

**Compétences**

Academic background: Ph.D. in computer science or mathematics.

Required knowledge and skills: algorithms in discrete and computational geometry.

**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**

2788 € gross/month

**Informations générales**

- **Thème/Domaine**: Algorithmique, calcul formel et cryptologie
- **Ville**: Villers-lès-Nancy
- **Centre Inria**: Centre Inria de l'Université de Lorraine
- **Date de prise de fonction souhaitée**: 2024-09-01
- **Durée de contrat**: 2 ans
- **Date limite pour postuler**: 2024-04-28

**Contacts**

- **Équipe Inria**: GAMBLE
- **Recruteur**: Moroz Guillaume / Guillaume.Moroz@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.
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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.