
**Contract type** : Public service fixed-term contract  
**Level of qualifications required** : Graduate degree or equivalent  
**Fonction** : Tempary Research Position

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**About the research centre or Inria department**

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 the socio-economic development of the Nord - Pas-de-Calais 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 ambitious research projects in such fields of computer science 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.

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**Context**

**Job environnements**

As part as a partnership between 2 teams Inria : GAIA and Ouragan

**Main objective**

The main objective of the PhD thesis is to develop a symbolic-numeric algorithm for the computation of certified numerical approximations of roots of polynomials and quasi-polynomials defined in an exact way. This problem is at the basis of many theoretical problems (computing Puiseux series, cylindirical algebraic decomposition, ...) and practical ones (certified curves plotting, stability of differential time-delay systems, ...)

**Assignments**

Under the supervision of Adrien Poteaux and Yacine Bouzidi, the PhD student will study the problem of the computation of certified numerical approximations of the roots of a polynomial given in an exact way. To achieve that, we shall follow the strategy developed by Poteaux [4]:

1. Compute the multiplicities of the roots of the polynomial modulo a well-chosen prime number \( p \).
2. Compute numerical approximations of the roots using the knowledge of the multiplicities.

Firstly, the PhD thesis will be devoted to the numerical computation of certified numerical approximations of the roots. Additionally, this method will provide approximations of the real roots of the polynomial.

Secondly, this algorithm will be used in problems such as the cylindrical algebraic decomposition (CAD) (and its application to the computation of the topology of curves) and the computation of Puiseux series (certified structure, real branches). These algorithms will be applied in automatic control problems such as the theory of parametric robust control currently developed in collaboration with Safran Electronics & Defense [5].

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**General Information**

- **Theme/Domain** : Algorithmics, Computer Algebra and Cryptology
- **Scientific computing** (BAP E)
- **Town/city** : Villeneuve d'Ascq
- **Inria Center** : CRI Lille - Nord Europe
- **Starting date** : 2018-10-01
- **Duration of contract** : 3 years
- **Deadline to apply** : 2018-05-02

**Contacts**

- **Inria Team** : GAIA
- **Recuriter** : Bouzidi Mohamed Yacine / yacine.bouzidi@inria.fr

**The keys to success**

**The keys to success**

This work is intended for candidates having a master degree or equivalent in either mathematics or computer science. The candidate should have good notions in algebra, algorithmic and programming. A good knowledge in computer algebra and interval arithmetic would be an asset.

**Conditions for application**

Candidates will be treated firstly with a complete file : CV + letter of motivation + one or more letters of recommendation + transcripts from previous years.

**Defence Security**

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy**

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

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**Warning** : you must enter your e-mail address in order to save your application to Inria.
Finally, we will extend the above algorithms to quasi-polynomials (polynomials in $s$ and $\exp(-hs)$, $h > 0$) for the study of the stability and the stabilization of differential time-delay systems.

**For a better knowledge of the proposed research topic**

For computing these roots, some algorithms proceed by numerical approximations [4]. In the presence of multiple roots, such algorithms do not provide guarantees on the certification of the result. Other algorithms perform the exact computation of the squarefree part of the polynomial before isolating the roots [3]. This operation turns out to be computationally costly in practice. Finally, recent methods perform changes of variables that shear the zeros in a generic position [1], but they have the drawback of breaking the system structure (symmetries, sparseness, etc.).

**Bibliography**


**Main activities**

**Main activities:**

- An exhaustive state of the art will be done on the subject.
- Acquire an expertise in interval arithmetic and certified numerical computations.
- Develop a prototype of a symbolic-numeric algorithm for the isolation of the roots of univariate polynomials with algebraic coefficients.
- By means of theoretical tools, study and improve the certification, the convergence and the complexity of such an algorithm.
- Extend this algorithm to quasi-polynomials and study the stability and the stabilization of differential time-delay systems.

**Further activities:**

- Use the developed algorithm for the computation of the CAD, the computation of algebraic curves and the computation of the Puiseux series, and test its practical efficiency.
- Develop a dedicated C library for academic and industrial uses.

**Skills**

**English spoken and written**

**Benefits package**

**Benefits**

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Sports facilities
- Flexible working hours
More information about Lille:
http://www.lille3000.eu/portail/
http://www.liilemetropole.fr/mel.html

Remuneration

The gross monthly salary is 1982€ for 1st and 2nd year and 2085€ gross for the 3rd year.