2018-00455 - Post-Doctoral - Rewriting theory for rings of functional operators (M/F)

Contract type: Public service fixed-term contract
Level of qualifications required: PhD or equivalent
Function: Post-Doctoral Research Visit

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.

Context

Job environments

Algebraic and computer algebra methods are the foundations of the GAIA project whose principal goal is to study systems defined by functional equations by means of algebraic methods, computer algebra (symbolic-numeric methods) and mathematical systems theory. The systems to be investigated can be linear, nonlinear, continuous, discrete, or originated from real life applications.

The second goal of GAIA is to study important problems coming from:

- control theory (e.g. parametric robust control, stabilization of multidimensional systems and differential time-delay systems)
- signal processing (e.g. parameter estimation problems, metric multidimensional unfolding)
- multidisciplinary domains (e.g. marine bivalves behavior, human-machine interaction, ionic activities in neuroscience)

The third goal of GAIA is to develop dedicated packages for functional systems and their applications and in parallel, eventual industry transfer.

Assignment

Assignments

Rewriting theory appears in various fields of mathematics for computing normal forms in quotient algebraic structures presented by generators and oriented relations. The confluence property is a fundamental property of Gröbner bases that certifies that every term admits a unique normal form which can be computed by successive applications of oriented relations [1, 2, 4].

An algebraic and algorithmic study of linear functional systems (e.g. (partial) differential equations, recurrence equations, time-delay equations, integro-differential equations) can be developed upon the rewriting theory for computing normal forms in rings of operators, such as (partial) differential operators, shift operators, time-varying delay operators, integro-differential operators. In particular, general approaches to the rewriting theory in two-sided ideals of tensor rings and to the algebraic analysis for linear systems over Ore algebras and Ore extensions were recently initiated [3, 5]. Tensor rings and Ore extensions are sets of non-commutative polynomials that capture the algebraic structures of a large class of functional operators [3, 5, 6, 7].

The aim of the post-doc project is to develop a general framework for the rewriting theory in left modules over an arbitrary ring A.

References

Main activities

There are two main directions for this work.

First, to develop completion procedures for computing Gröbner bases for left modules. When $A$ is a field, such a procedure can be done using Gaussian elimination and an alternative approach for arbitrary rings is to compute a generating set of syzygies (that is, relations between relations).

The second direction is to develop constructive methods for computing homological invariants of finitely-presented left modules to determine structural properties of linear functional systems that are important in mathematical systems theory and control theory. Such invariants can be computed using classical methods from rewriting theory and algebraic Morse reduction [8].

Skills

Excellent knowledge in the theory of Gröbner bases and non-commutative polynomial rings.

Good programming skills (Maple, Mathematica, GAP).

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration

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The gross monthly salary is 2653€