

PhD position at Inria Méditerranée, in Sophia Antipolis (France)

Group Theoretic Polynomial Bases for Global Optimization

funded within the European innovative training network POEMA.

Information and application at <https://easychair.org/cfp/POEMA-19-22>.

Topic. This project aims at improving the robustness of moment methods for polynomial optimisation. Based on group theoretic techniques we shall develop new algorithms for algebraic computations in non monomial bases.

Relaxation methods have seen the size of the moment matrices decrease by intertwining some steps of polynomial reductions, a technique typical of symbolic computation, with steps of semi-definite programming, performed numerically. Monomial bases have long prevailed in symbolic computation and polynomial reduction techniques are essentially based on monomial rewriting. Yet monomials need not form an appropriate basis. On one hand one cannot preserve symmetry with these. On the other hand, in the univariate case, analysts have stayed clear of these bases and used orthogonal polynomials for their good numerical properties.

Like other special functions, multivariate orthogonal polynomials have strong ties to group representations. This has hardly been explored algorithmically, neither in numerical nor symbolic computation. We shall exploit the group theoretic foundations of multivariate Chebyshev polynomials to establish efficient and robust arithmetics in forming moment matrices and polynomial reductions.

In the presence of symmetry, also given in terms of a group, adapted bases allow to block diagonalize the moment matrices, thus splitting the original problem in smaller pieces, improving the overall complexity and giving a better chance at numerical stability. We shall provide new technologies to compute and work with symmetry adapted bases efficiently.

Work environment. The PhD candidate will be part of the team AROMATH - Algebra, Geometry, Modelling and Algorithms, at Inria Méditerranée. Inria is the national institute in France for applied mathematics and computer science. At the heart of the thriving technopolis of Sophia Antipolis, in the French Riviera, the Méditerranée center boasts a wide research spectrum. The team AROMATH has a high international research profile in computational nonlinear algebra, with specific expertise in multivariate moment methods, solving polynomial and differential equations, and exploiting symmetry. Check out <https://team.inria.fr/aromath>.

Secondments. In addition to meetings and schools across the network, two internships are planned: at UiT - the Arctic University of Norway, with Cordian Riener, the emphasis will be on symmetry; at the UK based company NAG the focus will be on multivariate orthogonal polynomials.

Requirements. Applicants should hold a Master's degree (or equivalent diploma) in Mathematics, Physics, Computer Science, or Engineering by the end of 2019. They should be motivated and self-driven, with a developed inclination for computational mathematics, both practical and theoretical, algebra or numerical analysis. Fluency in English is required.

Additional information on the above position: Evelyne Hubert, evelyne.hubert@inria.fr;
On other opportunities in the POEMA network <https://easychair.org/cfp/POEMA-19-22>.