

Polynomial Optimization: Some challenges from applications

This PhD position is funded by the Marie Curie program of European Union through the innovative training network (ITN) POEMA on polynomial optimization.

More information at <https://easychair.org/cfp/POEMA-19-22>.

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Scientific context

Many problems in nonlinear dynamical systems and control can be cast as infinite-dimensional linear programming problems in the space of Borel measures. The Lasserre's moment-sum-of-squares hierarchy can then be deployed to obtain a sequence of finite-dimensional *convex* semidefinite programming problems whose solutions approximate, and typically converging to, the solution of the original problem (e.g., [5, 1, 3]).

The broad aim of this project to develop this framework further. There are two concrete directions to investigate, although a significant degree of freedom will be given to pursue other promising goals within this scope. The first direction will try to develop this framework for analysis and control of nonlinear partial differential equations. Here, preliminary results already exist [2, 6] but without convergence guarantees in the most general setting [2] and with only preliminary numerical results. The second direction will try to leverage spectral theory of linear operators with the aim to gain theoretical understanding as well as computational advantage within the moment-sum-of-squares framework for nonlinear systems. The starting point would be the close connection to the Koopman and Perron-Frobenius operator frameworks (e.g., [7]).

Working context

The PhD candidate will be hosted by LAAS-CNRS in Toulouse and affiliated with one of the two doctoral schools: Mathematics, computer science, telecommunications (MITT) or the Systems doctoral school (EDSYS). LAAS is one of the strongholds of the moment-sum-of-squares approach since the seminal work of [4] as well as the home to a large number of leading researchers in a variety of fields including nonlinear control, verification, artificial intelligence and robotics. Through the affiliation with a doctoral school, the student will have the opportunity to attend courses at one of the many universities in Toulouse.

Planned secondments

The student will be strongly encouraged to carry out secondments at research institutions related to the topic.

Required skills

A prospective candidate should hold – at the date of recruitment – a Masters degree in mathematics or engineering. The applicant should have a strong background in functional analysis, measure theory and operator theory as well as a strong level of independence and creativity. Basic knowledge of optimization and computer skills are a plus. The knowledge of French is not required.

The candidates are kindly asked to send an e-mail with "POEMA candidate" in the title, a CV and motivation letter to korda@laas.fr and to submit their documents at <https://easychair.org/cfp/POEMA-19-22>.

References

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- [7] I. Mezić. Spectral properties of dynamical systems, model reduction and decompositions. *Nonlinear Dynamics*, 41(1-3):309–325, 2005.