PhD thesis project proposal

Title: Polynomial and semi-algebraic optimization and its applications

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Abstract:

This doctorate thesis is part of the TAMING project funded by an ERC grant. TAMING intends to provide a systematic methodology for solving hard nonconvex polynomial optimization problems in all areas of science. Indeed the last decade has witnessed the emergence of polynomial optimization as a new field in which powerful positivity certificates from real algebraic geometry have permitted to develop an original and systematic approach to solve (at global optimality) optimization problems with polynomial (and even semi-algebraic) data. The backbone of this powerful methodology is the "moment-SOS" approach also known as "Lasserre hierarchy" which has attracted a lot of attention in many areas (e.g., optimization, applied mathematics, quantum computing, engineering, theoretical computer science) with important potential applications. However in its present form this promising methodology inherits a high computational cost and a (too) severe problem size limitation which precludes from its application many important real life problems of significant size.

Roughly speaking, this thesis is concerned with potentially all theoretical and computational aspects related to:

- applying and/or developing the moment-SOS approach to address new applications including: robust control, optimal control problems and inverse optimal control problems (possibly in collaboration with the GEPETTO robotics team at LAAS), some problems of computational geometry, optimal power flow (possibly in collaboration with IBM Dublin and/or RTE in France);
- addressing (and if possible overcoming) scalibility issues related to the standard moment-SOS approach when applied to some important problems. For instance one possible strategy is to develop alternative positivity certificates (and their associated hierarchy of relaxations for polynomial optimization), which should be less computationally demanding.