Series of lectures on polynomial optimization, control and applications
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Lecture 1: March 15 at h 16:30 in room B103
An introduction to the Lasserre hierarchy in polynomial optimization
Abstract: We survey a mathematical technology introduced in 2000 by Jean Bernard Lasserre to solve globally non-convex optimization problems on multivariate polynomials with the help of a hierarchy of convex semidefinite programming problems (linear matrix inequalities or LMI = linear programming problems in the cone of positive semidefinite matrices). Instrumental to the development of this technique is the duality between the cone of positive polynomials and the cone of moments. These basic objects are introduced and studied in detail, and some illustrative examples are described. Sketchy lecture notes are available at arXiv:1309.3112.

Lecture 2: March 16 at h 16:00 in room B103
Tutorial on polynomial optimal control solved with the Lasserre hierarchy
Polynomial optimal control consists of minimizing a polynomial Lagrangian over a polynomial vector field subject to semi-algebraic control and state constraints, a typically nonconvex problem for which there is no solution in classical Lebesgue spaces. To overcome this, polynomial optimal control problems are first formulated as linear programming (LP) problems in the cone of occupation measures (standard objects in Markov decision processes and ergodic theory of dynamical systems), and infinite-dimensional convex duality is used to establish the link with subsolutions of the Hamilton-Jacobi-Bellman partial differential equation satisfied by the value function. Then, the Lasserre hierarchy is applied to solve numerically these infinite-dimensional LP problems. Joint work with Jean Bernard Lasserre, Christophe Prieur and Emmanuel Trélat, see arXiv:0703377

Lecture 3: March 17 at h 10:00 in room B103
Optimal control of switched dynamical systems
We consider nonlinear switched systems where the control is the switching sequence. This is done by introducing modal occupation measures, which allow to relax the problem as a primal linear programming (LP) problem. Its dual linear program of Hamilton-Jacobi-Bellman inequalities is also characterized. The LPs are then solved numerically with the Lasserre hierarchy. Because of the special structure of switched systems, we obtain a much more efficient method than could be achieved by applying the standard Lasserre hierarchy for general optimal control problems. Joint work with MathieuClaeys and Jamal Daafouz, see arXiv:1404.4699.

Biosketch
Didier Henrion is a CNRS Senior Researcher at LAAS, an engineering laboratory in Toulouse, France. He is also a Professor at the Faculty of Electrical Engineering at the Czech Technical University in Prague, Czechia. Since 1994 he has been developing constructive tools for addressing mathematical problems arising from systems control and optimization. For more information, see homepages.laas.fr/henrion