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Advanced Lecture by Pr Jean-Bernard Lasserre

"In this advanced short course, we consider the Polynomial Optimization Problem, which consists in minimizing a (multivariate) polynomial function under polynomial constraints (extension to semi-algebraic functions is also possible). In particular, this problem includes the important class of non convex quadratic as well as discrete 0/1 optimization problems. In fact, Polynomial Optimization can be viewed as a particular instance (and even the simplest instance) of the Generalized Moment Problem (GMP) and the methodology described in this short course also applies for solving the GMP whose list of applications is endless and is concerned with many different fields, including algebraic geometry, optimization, signal & image processing, probability & statistics, computational geometry, control & optimal control, etc.

To address the polynomial optimization problem (and more generally to address the GMP) we invoke powerful results from Real Algebraic Geometry and their dual counterparts in Functional Analysis concerned with the so-called K-moment problem. In this short course we will describe:

- Main results on Positive Polynomials, and in particular (positivity) certificates for a polynomial to be positive on a compact semi-algebraic set K.
- The dual counterparts of positivity certificates, the K-moment problem.
- How to use such results for solving the polynomial optimization problem via solving a hierarchy of linear or semidefinite programs of increasing size.

If time permits, we will also describe how to use those positivity certificates and the above methodology in some applications outside optimization, viewed as instances of the GMP. For example: In computational geometry for computing the volume of a compact semi-algebraic set, in probability for providing bounds on measures with (finitely many) prescribed moments, in optimal control. Basic knowledge of Linear Programming and Semidefinite Programming is desirable but not mandatory."