Algorithms and software for structured semidefinite optimization

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

More info and positions at https://easychair.org/cfp/POEMA-19-22.
Contact at University of Birmingham: Michal Kocvara, m.kocvara@bham.ac.uk

Scientific context. The classical moment-SOS SDP hierarchy for Polynomial Optimization, although general and very powerful, is limited to problems of small to medium size only. This is due to the rapidly growing size of SDP problems that become unsolvable by the state of the art general purpose SDP software, such as MOSEK or PENSDP. While the SDP problems arising in the moment-SOS hierarchy have a specific structure, this structure cannot be utilized by the general purpose software. The way to use this specific structure was first shown by Kojima and his co-authors in their works on so-called sparse-POP problems. The goal of this project is to substantially extent the sparse-POP approach to various SDP problems arising in other work packages and beyond. We will use and extend the techniques of matrix completion and chordal sparsity in order to decompose the SDP problems either with large matrix variables or with large matrix constraints into problems with many small matrix variables or matrix constraints. The decomposed problems can then be solved much more efficiently by existing general purpose SDP software, as documented in current literature. We will a) extend the existing theory of matrix completion and matrix decomposition to new classes of matrices; b) develop corresponding algorithms for matrix decomposition and c) develop corresponding software. The software development will follow two lines: a) stand-alone software for matrix decomposition, whose outcome is an SDP problem solvable by general purpose SDP software such as MOSEK; b) software for matrix decomposition built in a modified version of the existing code PENSDP developed by the applicants. The resulting software will be tested using benchmark problems and, when applicable, industrial applications collected from other work packages.

Working Context. The PhD candidate will be hosted by the Optimization Group at the School of Mathematics of the University of Birmingham. The team, led by Professor Michal Kocvara, has a strong expertise in algorithms and software for large scale numerical optimization as well as optimization with (partial) differential equations.

Planned secondments. The PhD candidate will have a research stay (secondments) at Friedrich-Alexander University of Erlangen and at IBM Research in Dublin.

Required Skills. Motivated candidates should hold — at the date of recruitment — a Master's degree in Mathematics, Computer Science or Engineering (or any equivalent diploma). The applicant should have a solid background in optimization. Good programming skills are expected.

The candidates are kindly asked to send an e-mail with "POEMA candidate" in the title, a CV and motivation letter to m.kocvara@bham.ac.uk and to submit their documents at https://easychair.org/cfp/POEMA-19-22.