Polynomial optimization problems with symmetry

This PhD position is funded by the Marie Curie program of European Union through the innovative training network (ITN) POEMA on polynomial optimization – http://poema-network.eu

Contact at Konstanz University: Prof. Dr. Claus Scheiderer , Faculty of Mathematics and Statistics.

Scientific context: Polynomial optimization problems arising from applications frequently feature strong symmetries that one would like to take advantage of. One possible approach tries to detect the symmetries in SDP relaxations automatically, and then to reduce size using block decomposition. While one may find symmetries in this way even when they are hidden or poorly understood, such a technique can only be expected to work for small size problems. Another possibility is to analyse symmetries of SDP relaxations in advance. In principle, very large (even infinite) SDPs can often be reduced to small (in particular finite) SDPs in this way. But such an approach requires a considerable machinery of harmonic analysis tailored towards the specific problem, in particular for higher order relaxations. Instead we want to pursue a third approach, where the symmetry reduction is already done on the level of the original optimization problem before relaxation. The main difficulty then is to generalize Timofte's degree principles to general group actions of reductive groups on affine varieties, and to relate them to the Procesi-Schwarz result describing the orbit variety.

Working Context: The PhD candidate will be hosted by the Real Algebra and Geometry (RAG) group (https://www.mathematik.uni-konstanz.de/en/ragn) in the Mathematics and Statistics Department of Konstanz University. The city of Konstanz is beautifully located at Lake Constance in the south of Germany, bordering Switzerland. Konstanz University has been successful in all three funding lines of the German Excellence Initiative, both in 2007 and in 2012, and is therefore considered one of Germany's elite universities. The local RAG group has a strong expertise in real algebraic geometry and its applications to optimization, in particular moment problems.

Required Skills:

- The candidate should hold — at the date of recruitment — a Master's degree in Mathematics, Computer Science or Engineering, or an equivalent diploma.
- He or she should have a solid background in at least one of either algebra, (real) algebraic geometry or optimization. Good programming skills are also a plus.
- Language skills in German are not required.

Submission Guidelines:

Marie Sklodowska-Curie PhDs are paid a competitive gross salary of 3,270 €/month, adjusted for their host country, a Mobility Allowance of 600 €/month and, for researchers who have a family, a Family Allowance of 500 €/month. All amounts are subject to deductions and taxes. Family is defined as persons linked to the researcher by (i) marriage, or (ii) a relationship with equivalent status to a marriage recognised by the national legislation of the country of the beneficiary or of nationality of the researcher, or (iii) dependent children who are actually being maintained by the researcher; family status is determined at recruitment and does not evolve.

To apply for this PhD position, the applicant should fulfil the following conditions:

- Have — at the date of recruitment — a Master's degree in Computer Science, Mathematics or Engineering (or any equivalent diploma).
- Should have — at the date of recruitment — less than 4 years of a research career, and not have a doctoral degree. The 4 years are measured from the date when they obtained the degree which would formally entitle them to embark on a PhD, either in the country where the degree was obtained or in the country where the PhD is provided.
- Transnational mobility: The applicant — at the date of recruitment — should not have resided in the country where the research training takes place for more than 12 months in the 3 years immediately prior to recruitment, and not have carried out their main activity (work, studies, etc.) in that country. For refugees under the Geneva Convention (1951 Refugee Convention and the 1967 Protocol), the refugee procedure (i.e. before refugee status is conferred) will not be counted as 'period of residence/activity in the country of the beneficiary'.
- Be able to communicate fluently in English (speaking and writing). Oral interview with the prospective advisor may be required.
- Note: A Master's degree (or equivalent) is not necessary at the time of the application, but will be required at the date of recruitment (in July/August 2021).

To apply for this position, please send your application **before 30th June 2021** to POEMA Administrative Manager (linh.nguyen@inria.fr) including:

- A detailed CV including education, work experience, skills, dissertations, research interests, career objectives, and — if available at the date of submission — names and contact details of two referees, that can include the supervisor of the master thesis, willing to provide confidential letters of recommendation, a list of publications if any;
- A motivation letter regarding the position as well as the POEMA network;
- A transcript of the master studies' grades (including the overall grade and an explanation of the grading system) and the master's thesis if available;
- Any other supported documents (if any)