POEMA

H2020-MSCA-ITN-2018

Polynomial Optimization, Efficiency through Moments and Algebra

PERSONAL CAREER DEVELOPMENT PLAN

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Introduction

The Personal Career Development Plan (PCDP) describes both near and long term objectives of the fellow, to reflect on their progress, plan their future development, and take actions to realize their plans. The document must be completed and updated every 12 month by the fellow and his/her advisor. It will be monitored yearly by the Educational Committee who will also provide the feedback assessment results of the training programme on the occasion of the yearly meeting. Major deviations from the plan should be reported to the Educational Committee.

1 Individual Research Plan

1.1 Host Institution

Tilburg University, Tilburg, The Netherlands

1.2 PhD Advisor(s)

Etienne De Klerk, Juan Vera Lizcano

1.3 PhD Thesis Supervisor Committee (if applicable)

N/A

1.4 Short overall project description

Applications in Operations Research include logistic problems, such as developing practical approaches for the urban network clustering problem using binary polynomial optimization. The applications in Finance are centered on portfolio optimization and options pricing (in cooperation with experts in Finance at Tilburg University). We will focus on the quadratic assignment problem (QAP) and the binary portfolio optimization problem in order to provide new solution approaches for such problems. The main tools that we employ are semidefinite programming for sum-of-squares polynomial computations, as pioneered by Lasserre and Parrilo. This includes semidefinite programming approaches for polynomial optimization, but also for the generalised problem of moments.

1.5 First secondment

CNRS, Toulouse

1.6 Second secondment

Artelys, Paris

2 Research Outputs, Dissemination and Mobility

2.1 Research results

Mention here your research results

- Preprint in progress: "Convergence rates for RLT and Lasserre type hierarchies for the generalized moment problem over the simplex"

2.2 Research publications

Mention here your publications (ongoing, submitted, accepted, published)

Preprint in progress: "Convergence rates for RLT and Lasserre type hierarchies for the generalized moment problem over the simplex" (ongoing)

2.3 Dissemination and networking

Mention here in particular:

- *presentations at conferences/workshops (network events, other events)*
- *participation to conferences/workshops (network events, other events, research visits, etc)*
- *list the anticipated networking opportunities for the new period*

According to the DoA, the ESR is also solicited to contribute as part of their dissemination activities: blogs and open discussion lists on global optimization…

- Planned: Present "Linear relaxation hierarchies for the GPM" at SIAM Conference on Optimization (OP20) Hong Kong, The Hong Kong Polytechnic University, Hung Hom Campus, Hong Kong
  - This event did not take place
- 1st POEMA Workshop in Florence, Italy
  - 15th January – 17th January The 1st POEMA workshop - Research introductive workshop on Polynomial Optimization and Moments. The workshop will be organized at: **Department of Mathematics and Computer Science, Viale Morgagni, 67/a - 50134 Firenze, Italy**.
- 1st POEMA Learning week and 2nd POEMA Workshop in Konstanz, Germany
  - POEMA first learning week in Konstanz: March 23-27, 2020 (Monday to Friday)
    POEMA 2nd workshop in Konstanz: March 30 - April 3, 2020 (Monday to Friday)
    The 1st Learning week and 2nd workshop will be organized at:
    Fachbereich Mathematik und Statistik
    Universität Konstanz
    78457 Konstanz
- Planned: Present: "Convergence rates for RLT and Lasserre type hierarchies for the generalized moment problem over the simplex" at SIAM Conference on Optimization (OP21) Spokane, Washington

- Planned: Present: “Convergence rates for RLT and Lasserre type hierarchies for the generalized moment problem over the simplex” at SIAM Conference on Algebraic Geometry (AG21) College Station, Texas
- LNMB Network:
    - Description: The LNMB is a Dutch Network on the Mathematics of Operations Research (in Dutch: Landelijk Netwerk Mathematische Besliskunde; LNMB is the Dutch acronym). This network is an interuniversity co-operation in which all Dutch universities and the Centre for Mathematics and Computer Science (CWI) in Amsterdam participate. The LNMB offers courses for PhD and Master students. The PhD programme, which is centred around 18 courses, taught in a two-years cycle, aims at broadening and deepening the knowledge of the PhD students in the mathematics of Operations Research.
    - In my position as a PhD candidate I can participate in the network to further educate myself and connect to other researchers with similar interests.

- POEMA Network:
    - Description: POEMA aims to train scientists at the interplay of algebra, geometry and computer science for polynomial optimization problems and to foster scientific and technological advances, stimulating interdisciplinary and intersectoriality knowledge exchange between algebraists, geometers, computer scientists and industrial actors facing real-life optimization problems.
    - My position is one of fifteen within the POEMA Network.
- MINOA Network:
    - Description: The goal of the Mixed-Integer Non-Linear Optimisation Applications (MINOA) proposal is to train the next generation of highly qualified researchers and managers in applied mathematics, operations research and computer science that are able to face the modern imperative challenges of European and international relevance in areas such as energy, logistics, engineering, natural sciences, and data analytics.
    - One of my colleagues, Daniel Brosch, has a position in this network. Monique Laurent, who is regularly at Tilburg University also supervises a PhD candidate within the network, as well as Frank Vallentin at the University of Cologne, who supervised my Master thesis. All these connections already turned out helpful regarding my research.
- DIAMANT cluster:
    - Description: DIAMANT is one of the four 'mathematics clusters' in the Netherlands. DIAMANT stands for 'Discrete, Interactive and Algorithmic Mathematics, Algebra and Number Theory.'
    - As a PhD student of Etienne de Klerk I can participate in this cluster.
- Participation in reading group on Polynomial Optimization at CWI, hosted by Monique Laurent

2.4 Software, Data, other

Provide (and update) a list of materials (data, software, ...) that you have produced with the aim of making your research reproducible for other researchers within and/or outside the POEMA network.

- Implementation of the LP / SDP hierarchy in Julia
- Implementation of Symmetry Reduction for polynomial optimization problem invariant under the action of the group $S_2 \times S_n$ acting on the variables.

3 Personal Training Plan

3.1 Scientific training courses

List the courses that you have taken, including practical course information (organizing institution, number of equivalent ECTS credits, course dates) and the result of the course assessment (if applicable).

- Interior Point Methods, LNMB Course (4EC) , Once a week, September 09 – November 11.

  LNMB strands for Landelijk Netwerk Mathematische Besliskunde which is a Dutch Network on the Mathematics of Operations Research. It is an inter-university co-operation in which all Dutch universities and CWI participate. The network offers courses for PhD students. The course dealt with interior point methods for solving optimization problems. Reference: A mathematical view of Interior-Point Methods in convex optimization, J. Renegar (2001)

  Result 8.5/10

Give an overview of the courses that you are planning to take, including practical course information (organizing institution, number of equivalent ECTS credits, course dates) and a brief justification of why these courses are relevant for your research project and/or career development.

- As of now, there are no plans of taking a particular course.

3.2 Complementary training courses

List the complementary training courses such as: teaching or software etc.

N/A

3.3 Professional skill development

- *Management skills*
- *Communication skills*
  - Improve scientific writing
- *Technical skills*
  - Programming language Julia
- *Additional skills*

4 Personal Career Development

4.1 Plan for the next period

- Finish Preprint “Convergence rates for RLT and Lasserre type hierarchies for the generalized moment problem over the simplex”
- Present findings at SIAM Conference on Optimization (OP21) in Spokane, Washington
- and SIAM Conference on Applied Algebraic Geometry (AG21) in College Station, Texas.
- Complete first secondment at CNRS, Toulouse, France.
    - Work on joint project and aim for publication

4.2 Career objectives (Postdoctoral project, …)

Short-Term:

- Complete a PhD and publish findings in reputable journals
- Develop reasearch skills, programming and math knowledge
- Build academic network
- Build network to people in industry