



# **POEMA**

**H2020-MSCA-ITN-2018**

**Polynomial Optimization, Efficiency through  
Moments and Algebra**

**PERSONAL CAREER DEVELOPMENT PLAN**

<b>Project</b>	
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This document contains description of the POEMA project work and findings.

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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

Centrum Wiskunde & Informatica (CWI), Amsterdam,  
Group: Networks and Optimization

## 1.2 PhD Advisor(s)

Monique Laurent, Juan Vera (U. Tilburg)

## 1.3 PhD Thesis Supervisor Committee (if applicable)

N/A

## 1.4 Short overall project description

This project aims to investigate hierarchies of approximations for graph parameters. The methodology relies on combining tools from moment theory, semidefinite optimization. Example of specific questions that may be included:

- Study the convergence of the hierarchies
- Study new hierarchies for graph parameters
- Exploring techniques for proving results about convergence in approximation hierarchies

## 1.5 First secondment

UKON, Konstanz, Germany (Markus Schweighofer). September to November 2020

## 1.6 Second secondment

IBM, Dublin, Ireland. June to August 2021 (Martin Mevissen)

## 2 Research Outputs, Dissemination and Mobility

### 2.1 Research results

*I started my PhD in November and I have been focused on a depth study of the following relevant literature to acquire background knowledge on SDP, Polynomial Optimization and Graph Parameters.*

- A course on Semidefinite Optimization (Lecture Notes). M.Laurent, F.Vallentin.
- Semidefinite Bounds for the Stability Number of a Graph via Sum of Squares of Polynomial. N.Gvozdenovic, M. Laurent. *Mathematical Programming*. 2007.
- LMI Approximations for Cones of PSD Forms. L.F. Zuluaga, J. Vera, J. Pena. *SIAM Journal on Optimization* 2006.

### 2.2 Research publications

*Not yet applicable since starting working at CWI on 1 November 2019.*

### 2.3 Dissemination and networking

**Conference I have participated:**

1. First POEMA Workshop, Florence, Italy. 15-17 January, 2020.

**I have also participated in the following seminars provided at CWI:**

1. N&O Group seminars (2 Hour long lectures on Graph Theory given by visitors)
2. Reading group on Random Matrices (Studying proofs used in the topic of Random Matrices.) [hps://makrandsinha.github.io/reading/](https://makrandsinha.github.io/reading/)
3. CWI Lectures on Programming and Cryptology 2019 (21-22 Nov 2019) (An annual event hosted by CWI with varying topic. )
4. CWI Scientific Meeting 29 Nov 2019 (An event hosted by CWI where new CWI researchers present some of their work. )

**I plan to participate at the following future events.**

1. 1<sup>st</sup> POEMA learning week, Konstanz, Germany 23-27 Mar.2020.
2. 2<sup>nd</sup> POEMA Workshop, Konstanz, Germany 30 Mar.- 4 Apr. 2020.
3. 56<sup>th</sup> Dutch Mathematical Congress (NMC), Utrecht, Netherlands 14-15 Apr.2020.
4. SDP day CWI Amsterdam. 6-7 May 2020.
5. (Tentatively) Swedish Summer School in Computer Science 2020. Stockholm, June 28 to July 4.

*I also plan to participate in a reading group on Polynomial optimization hosted at CWI, Amsterdam. I plan to present a lecture on : Semidefinite Hierarchies for the Stability Number. February 2020.*

I hope to broaden my network by interacting more with the following networks.

1. **DIAMANT**: 'Discrete, Interactive and Algorithmic Mathematics, Algebra and Number Theory.'. One of the four mathematical clusters in the Netherlands of which CWI is a participant. DIAMANT organises a semi-annual DIAMANT symposium.

2. **LNMB:** 'Landelijk Netwerk Mathemasche Besliskunde' This network is an interuniversity co- operation in which all Dutch universities and the Centre for Mathematics and Computer Science (CWI) in Amsterdam participate. LNMB offers courses in Mathematics of Operations Research for PhD and Master students.  
<https://www.lnmb.nl/pages/home/>

## 2.4 Software, Data, other

Not yet available

## 3 Personal Training Plan

### 3.1 Scientific training courses

I am currently taking the following PhD Course close to my field of research: IntPM: Integer Programming Methods – 4EC, Utrecht University, Netherlands. Available at: <https://www.lnmb.nl/pages/courses/>

**LNMB:** 'Landelijk Netwerk Mathematische Besliskunde' This network is an interuniversity co-operation in which all Dutch universities and the Centre for Mathematics and Computer Science (CWI) in Amsterdam participate. LNMB offers courses in Mathematics of Operations Research for PhD and Master students. <https://www.lnmb.nl/pages/home/>

For the future I plan to take the following course Semidefinite Optimization - M1 - 8EC, Vrije Universiteit, Amsterdam, starting Feb. 2020. This course is given by my supervisor and is directly applicable to the topics of our research. (<https://elo.mastermath.nl/>).

### 3.2 Complementary training courses

Not yet available

### 3.3 Professional skill development

- Management skills
- Communication skills
- Technical skills
- Additional skills



## 4 Personal Career Development

### 4.1 Plan for the next period

I plan on investigating the techniques on:

- Creating hierarchies for graph parameters, e.g, the stability number
- Methods to prove the convergence of specific hierarchies for the stability number ( Lasserre hierarchy and de Klerk and Pasechnik hierarchy)

First, the plan is to understand and familiarize myself with these strategies to create bounds and with the proofs. After that, I will try to apply these concepts to other similar problems.

### 4.2 Career objectives (Postdoctoral project, ...)

- *Publish scientific papers in highly ranked Journals*
- *Finish my PhD program*
- *Finish a PostDoctoral Program*
- *Participate in projects on the connection between the Science and the Industry*