POEMA

H2020-MSCA-ITN-2018

Polynomial Optimization, Efficiency through Moments and Algebra

PERSONAL CAREER DEVELOPMENT PLAN

Project	
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ESR Name:	**ESR 4: Hyperbolic polynomials and the Generalized Lax Conjecture**
Host Institution:	Universität Konstanz
Advisor:	Markus Schweighofer
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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

Universität Konstanz

1.2. PhD Advisor(s)

Markus Schweighofer

1.3. PhD Thesis Supervisor Committee (if applicable)

Not yet available

1.4. Short overall project description

Hyperbolic polynomials and the generalized Lax conjecture

1.5. First secondment

Università degli Studi di Firenze with Giorgio Ottaviani

Update: Completed half presentially half remotely due to COVID-19.

1.6. Second secondment

Sorbonne Université with Mohab Safer El Din

Update: Delayed.

2.   Research Outputs, Dissemination and Mobility

2.1. Research results

The research is in progress and no result is still available. The topics covered by now in my readings encompass spectrahedral relaxations of hiperbolicity cones, polynomial convolutions and stability preservers, the connection between matroids and hyperbolic and stable polynomials, the Helton-Vinnikov theorem and further properties of real-zero polynomials, and the geometry of polynomials and interlacing zeros.

Update: Some small results have been found. These include several applications of the methods developed by my supervisor to certain cubics and and possibilities for extending the matrices of moments. Results are however very limited towards a solution of the GLC.

2.2. Research publications

No publication is available yet.

Update: Preprint written during secondment.

2.3. Dissemination and networking

Participation in the Convexity Day, held by the MPI für Mathematik in den Naturwissenschaften Leipzig.

During the next months, I will be involved in my first secondment as well as the first two POEMA meetings in the form of learning weeks and workshops in Firenze and Konstanz, respectively.

My blog in the web of the project is having its first post and I am connected with the network via the accounts in Slack and Twitter.

Update: Currently, I try to connect with other researchers through online seminars held remotely in the UKON as well as other seminars openly publicized in the site recently created with the purpose to post centralized announcements, links and advertisements related to online research seminars and workshops held in universities and other research institutions worldwide. Additionally, I helped researchers from a different area finding an example that they were looking for and that happened to be related to my current field of study.

2.4. Software, Data, other

Nothing available at this moment.

3.   Personal Training Plan

3.1. Scientific training courses

I attended to the Convexity Day and some convexity and real algebra lessons in my host institution. Moreover, I attended to a short course in representation theory in connection with decomposition of positive polynomials in SOS. Some of these topics are not directly related with the topic of my research but I hope that collecting some new ideas from other near fields could be beneficial for my own research.

During the next months, I will participate in the first POEMA learning week and a secondment in Firenze which will offer me the possibility to get and obtain new insight into my research area in addition to new ideas for the courses and the literature to read during the next period. Moreover, I am planning to attend to some summer school: I am particularly interested in the one about real algebraic geometry hold next June at UiT Tromsø. Again, the connection of these with my research topic is not direct but close enough.

Update: I attended all the POEMA learning weeks and seminars as well as other seminars held in the UKON and other ones publicized online that are openly accesible to all researchers: an unexpected positive consequence of the developments related to the COVID-19 pandemic.

3.2. Complementary training courses

At some point, when the research and the some mobility issues give me some free time, I would like to take some German language courses as I would like to continue working in academia and knowing the language is an indispensable obligation to pursue this objective.

3.3. Professional skill development

- Management skills: With the help of Markus, I am deciding what material and literature is worth to read and put effort in. I am also managing my schedule to write and lead the direction of my research into the subfields that I feel more valuable and in relation to the topics that I find more helpful in order to solve the problems in my area and come with new ideas.

- Communication skills: I am getting in touch with new ideas, language, (open) problems, results, conjectures and researchers from my area in order to become closer to the leading people in this area, with the intention to be able to participate more actively in the future development of the community and in the informed and objective decisions for the best and more promising and valuable choices of the main paths worth to follow during this process in order to accomplish efficiently and effectively the objectives of the research in this area. However, in view of my current knowledge, I am still far from the leading point and I have to continue improving, reading and learning about very different topics related to my area to accomplish this end.

- Technical skills: In an academic level, I am getting use to manage the bureaucracy surrounding the project and to deal with the times and issues that these processes cause. In a mathematical level, as mentioned before, I am developing my understanding of the problems and language in my area and, additionally, getting to know the main actors, people, institutions, publications, journals, books and agents in my field and their ideas and previous work and lines of research.

- Additional skills: Nothing valuable to mention at this point.

Updates:

- Resilience skills: This year has been strange and special and has forced us all to cut down or limit our social life as well as some other activities that we used to perform in different ways as we have to do during the current times. In research, this has not been different and these forced changes had certainly an impact that we do not fully understand yet - several changes might even be positive; e.g., online meetings and seminar are more open, accesible, public and easy to attend as they do not imply such a big deal in terms of time or resources management as face-to-face meetings do. There seem to be also negative counterparts because human socializing and communication is certainly not fully accomplished and carried out in a fully online environment: we are not machines. All in all, it is better however to take the positive outcome: this situation is a lesson that has taught us to be psychologically more resilient under the environmental pressure that a syndemic exercises over us researchers and students in particular and over all the society in general. Of course, these kind of skills are transversal across the skills previously mentioned.

Career Development Plan   Alejandro González Nevado

4.   Personal Career Development

4.1. Plan for the next period

As already mentioned, I have a programmed secondment in Firenze and I will continue with my journey along the literature available around my research topic with the guidance and advice of my supervisor and hopefully the counsels of the person holding my secondment (Giorgio Ottaviani) and other people in the area that I get to know in the coming times.

Update: The next period will be based in trying several different approaches to the -still open- problems on the field both through further analysis of more computational examples around these problems and a continuation of the deepening into the already existing extensive literature of the field.

4.2. Career objectives (Postdoctoral project, …)

Those mentioned before as it is still too soon to think in any postdoctoral project. By now, I can just add that an interesting postdoctoral project could be related with the further implications and applications of the techniques developed during this project to objects generalizing the concept of polynomials and matrices in different ways as well as the study of these properties over structures different from the ring of the real numbers generating deeper connections between the geometric and/or algebraic study of hyperbolic polynomials and other (as of yet) unrelated and distant topics obtaining thus hereafter and hereat a profounder integration of the fields of optimization and big data analysis within the realm of pure abstract mathematics, a more advanced connection between several branches of pure and applied mathematics that could benefit both areas in a two-way communication of ideas via this (thenceforth possible) new bonding path linking the world of everyday applications of mathematics to the wide range of deep developments impelling the advance of theoretical and pure mathematics.

Update: The objectives at this point did not change.