UC|UP MATH PhD Program

# Research Seminar Program

## UC|UP Joint PhD Program in Mathematics

**Date:** October 18th, 2017

**Place:** Room TBA, Department of Mathematics, University of Porto

**Program**

**11h00 -** Peter Lombaers[1]: *Integers and Ideals: There and Back Again.*
**Abstract:** In number theory, when you try to solve an equation in a number field, it is often more convenient to work with ideals than with integers. This stems from the fact that ideals have unique factorization, but integers may not. I will explain the advantages and difficulties of this method using concrete examples.

***Lunch Break***

**13h30 -** Willian Silva[2]: *Introducing $(T, V)$-categories*
**Abstract:** In this seminar we introduce the concept of $(T, V)$-categories through its fundamental examples. In order to do so, we explore the concepts of monads and quantales, also with examples. We finish relating to the work on cartesian closed categories.

**14h30 -** Mina Saee Bostanabad[3]: *SOS versus SDSOS polynomial optimization*
**Abstract:** It is NP-hard to decide whether a polynomial is nonnegative, however, semidefinite programming can be used to decide whether a polynomial is a sum of squares of polynomials (SOS) in a practically efficient manner. In the context of polynomial optimization, it has become usual to substitute testing for nonnegativity with testing for SOS. Since there are much fewer sums of squares than nonnegative polynomials, we get only a relaxation and one that does not scale very well with the number of variables and degree of the polynomial. Recently, Ahmadi and Majumdar introduced a more scalable alternative to SOS optimization that they refer to as scaled diagonally dominant sums of squares (SDSOS). The idea is searching for sums of squares of binomials, instead of general polynomials, which leads to a more scalable SOCP problem. In this presentation, we investigate the quantitative relationship between sums of squares of polynomials and scaled diagonally dominant polynomials. More specifically, we use techniques established by Blekherman to bound the ratio between the volume of the cones of these two classes of polynomials, showing that there are significantly less SDSOS polynomials than SOS polynomials. This drawback can be circumvented by using a recently introduced basis pursuit procedure of Ahmadi and Hall that iteratively changes the polynomial basis to a more suitable relaxation. We illustrate this by presenting a new application of this technique to an optimization problem.

[1]Peter Lombaers is a PhD student of the Joint PhD Program UC—UP, working at the University of Porto, in Number Theory, under the supervision of Professor António José Machiavelo.

[2]Willian Silva is a PhD student of the Joint PhD Program UC—UP, working at the University of Coimbra, in Category Theory, under the supervision of Professor Maria Manuel Clementino.

[3]Mina Saee Bostanabad is a PhD student of the Joint PhD Program UC—UP, working at the University of Coimbra, in Optimization, under the supervision of Professor João Eduardo da Silveira Gouveia.