

# CIMI Workshop on Computational Aspects of Geometry

November 6-8 2019

University Toulouse 3 Paul Sabatier, Institute of Mathematics of Toulouse, building 1R3, Amphitheatre Laurent Schwartz.

## Mini-courses

**Caroline Uhler (MIT)** Probabilistic Graphical Models : A Geometric, Algebraic and Combinatorial Perspective.

Graphical models are used throughout the natural sciences, social sciences, and economics to model statistical relationships between variables of interest. When studying graphical models, polynomial equations and combinatorial constraints naturally arise and call for algebraic and combinatorial methods to advance the statistical methodology. This mini-course will take a geometric, algebraic and combinatorial perspective on graphical models. A main objective is to discuss identifiability in graphical models and develop methods for learning the graph and its parameters. Towards this end, we will highlight the role of conic duality for Gaussian graphical models and discuss the inherent combinatorial structures for causal structure discovery. The overarching goal of this course is to provide an overview of the interplay of techniques from algebra, combinatorics, and algebraic geometry, with problems arising in graphical models.

**David Steurer (ETH Zurich)** High-dimensional estimation problems and the sum-of-squares method.

We study a class of estimation problems that captures a wide-range of interesting questions from various disciplines, including tensor decomposition, matrix and tensor completion, planted clique, community detection, clustering, and robust mean estimation. For many of these problems, the guarantees we know for computationally efficient methods are significantly worse than those of methods that may take exponential time in the size of the input. This situation raises the question if we can find computationally efficient methods with better guarantees or if the gap is inherent. In this course, we discuss a meta algorithm for estimation problems based on the sum-of-squares method. For many important estimation problems, this algorithm achieves substantially better guarantees than previous methods and it is plausible that those guarantees are best possible.

## Talks

**Pierre-Antoine Absil (Louvain University)** Curve fitting on Riemannian manifolds.

**Alexandre d'Aspremont (ENS, INRIA)** Feature Selection and the Shapley-Folkman Theorem.

**Marco Cuturi (Google Brain, ENSAE)** TBA.

**Vincent Duval (INRIA)** Exploiting the low rank property in off-the-grid sparse super-resolution.

**Gabriel Peyré (CNRS, ENS)** Multi-dimensional off the grid sparse estimation

**Irène Waldspurger (CNRS, Dauphine)** Rank optimality for the Burer Monteiro factorization.

Workshop on Computational aspects of Geometry				
Wednesday, November 6, 2019		Thursday, November 7, 2019	Friday, November 8, 2019	
09h00-09h15	Welcome			
09h15-10h45	Mini course Uhler	Mini course Uhler		Mini Course Steurer
10h45-11h00		Break		
11h00-12h30	Mini course Uhler	Mini course Uhler		Mini Course Steurer
12h20-14h00		Lunch		
14h00-14h45	Mini Course Steurer	Absil		D'Aspremont
14h45-15h30		Duval		Waldspurger
15h30-15h45		Break		
15h45-16h30	Mini Course Steurer	Cuturi		Peyré
16h30-17h15				