

## Description of the PSYCO project

The PSYCO project (Combinatorics : permutations and symmetric functions) is a project grouping together five young researchers in algebraic combinatorics. Four of them are permanent researchers in LaBRI (Bordeaux, France), and one is currently post-doc in Vienna. The coordinator of the project, and also the oldest member of the team, is Jean-Christophe Aval, researcher at CNRS in LaBRI since 2004. A small group of researchers working on algebraic combinatorics has recently emerged in Bordeaux, inside the internationally renowned team of combinatorics in LaBRI, and this project aims at helping it to develop. This project is of small size, but of great ambitions. Its objectives are essentially to tackle difficult problems of algebraic combinatorics. The project is organised around three main themes of research.

- 1) The first one is the study of tree-like tableaux (TLT) which are a new avatar of permutation tableaux. The latter, defined by A. Postnikov, proved their pertinence in the study of the PASEP model in theoretical physics. TLTs, recently introduced by members of the PSYCO project, enjoy two major features : an insertion algorithm, which is simultaneously simple and adaptable, and which has already shown its strength in a combinatorial context, and a natural underlying tree structure whose algebraic consequences remains to be investigated.
- 2) The second theme is the study of algebras of functions defined on Young diagrams. This arose in the work of Kerov and Olshanski on characters of symmetric groups. In the past few years, this topic has become more combinatorial, with the interpretation of some quantities as cardinalities of families of graphs drawn on surfaces. Recently, M. Lassalle has given numerical evidence that Jack polynomials seem to fit well in this context. It is thus a very challenging problem to find combinatorial proofs of these conjectures. Indeed, this would bring a new combinatorial insight on Jack polynomials.
- 3) The third and last theme deals with the space of diagonal coinvariants. This domain of research, which has generated an important activity in the past two decades, has very recently known a new advance, with the discovery by F. Bergeron of universal formulas (ie. independent of the number of alphabets) to develop the Hilbert and Frobenius series of diagonal coinvariants. This discovery implies remarkable conjectures, which are interesting challenges both from a combinatorial and algebraic point of view.

In order to attack these ambitious objectives, the PSYCO project is structured in three homogeneous, transversal and strongly-connected tasks.

- Task 1 works on graphs, trees, partially ordered sets, which are key objects for many objectives of the project.
- Task 2 deals with words, permutations, lattice paths, parking functions (word-like objects).
- Task 3 is centered on the symmetric group, its polynomial invariants and coinvariants, its representations.