Research topics

I can offer three vectors of research, all three are about algebraic varieties and their transformation groups. For each of them there is a demand for a computational framework to manipulate associated combinatorial objects.

1. Flexible varieties

An affine space A^n has a remarkable property: any point can be sent to any other point by additive transformations, such as $(x, y) \to (x + P(y), x)$. Moreover, any *n*-tuple of points can be sent to any other *n*-tuple. We say that such transformations act on A^n *infinitely transitively*, and we call A^n *flexible*.

I propose to search for other flexible varieties. In particular, you could check if *weighted projective spaces* are flexible, and also search for constructions that derive new flexible varieties from known ones.

2. Subdivisions of simplicial complexes

While possible automorphism groups of two-dimensional affine surfaces are almost completely classified, the automor-phism group structure in higher dimensions has yet to be studied.

In particular, a *strong factorization* exists in dimension two, when any map is decomposed into a sequence of *blowups* of points followed by a sequence of *contractions* of extremal curves.

I propose to study the strong factorization problem for a subclass of so called *inner* automorphisms. This problem is called *Oda's conjecture* and is expressed in terms of *weighted subdivisions* of simpicial complexes, such as triangle.

More specifically, you can implement a software package for manipulating subdivisions and look for heuristics that could help in solving the conjecture. Any progress counts!

3. T-varieties

Toric varieties are varieties on which an algebraic torus *T* acts with an open orbit. They are given by *polyhedral cones* in the affine case and by polyhedra in the projective case.

Most properties of a toric variety are expressed in via combinatorial properties of the corresponding polyhedron. Packages for toric varieties manipulations are implemented in a number of computer algebra systems.

Suppose now that orbits of a torus are of codimension 1. Then the variety is called a T-*variety* and is described by a finite set of polyhedra attached to points on the line.

A software package that allows manipulating such sets would be useful for various problems of algebraic geometry and high energy physics.