ALGEBRAIC GEOMETRY WITH A VIEW TOWARDS APPLICATIONS
SPRING 2011 AT MITTAG LEFFLER INSTITUT

Algebraic geometry is a classical discipline with a long and distinguished presence in many different areas of mathematics. Algebra, number theory, several complex variables, and, more recently, theoretical physics have traditionally been considered areas with a large intersection with algebraic geometry. Mittag-Leffler Institut dedicated the whole year 1996–1997 to the study of the emerging and powerful connection between Algebraic geometry and theoretical physics, represented by quantum cohomology and mirror symmetry.

In recent years new methods from algebraic geometry have led to significant and unexpected advances in other areas of mathematics, such as statistics, numerical analysis, combinatorics, and symbolic computation. Even though we use the word "new methods", the main ideas come from the very classical core of algebraic geometry: Solutions to systems of polynomial equations, algebraic varieties, complex and real.

The class of projective toric varieties plays an important role in the geometrical input for discrete data problems (present in all the areas listed above). This class of varieties enjoys the coexistence of a geometrical structure and a combinatorial one (due to the torus action). Thanks to a link for toric varieties between projective geometry and convex geometry, many problems in algebraic geometry have a particularly simple and compact solution in this class of varieties, allowing immediate use in applications.

Even though toric varieties have been intensively studied during the past few years, there is much more research that needs to be done, especially in connection with interpolation and elimination problems. The new and closely related field of tropical geometry is still at an early stage, but has also seen promising developments in these directions with a link between questions in piecewise linear geometry and toric and more generally projective geometrical questions.

To give an example of how much still needs to be done in "classical" algebraic geometry, even in connection with recent developments and applications, we mention the study of the secant varieties associated to a projective complex algebraic variety. Understanding the dimension, and eventually the defining ideal, of the secant variety is not only a long standing problem in algebraic geometry, but a central ingredient in algebraic statistics and symbolic computations.

This program will focus on recent developments in toric, tropical, and projective geometry in general, emphasizing the connections to other areas of mathematics. It is our plan to have three main themes and therefore divide the whole period in three parts:

(1) Toric geometry and tropical geometry
(2) Algebraic varieties in the real world
(3) Systems of polynomial equations

Program committee

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