
# DISCRETE AND COMPUTATIONAL MATHEMATICS

## DESCRIPTION

Different aspects of discrete mathematics are investigated both from an abstract and a computational point of view. Categorical, homological and combinatorial methods are combined to study associative algebras arising in different contexts, to deal with classification problems, and to investigate categories of algebraic or geometric nature that find application also in theoretical physics. Theoretical background and algorithms for optimization, including mathematical programming and combinatorial optimization, are also studied, particularly in the context of operations research. Many practical algorithmics are based on discrete structures such as graphs. Hence it is not surprising that efficient solutions require deep knowledge of the underlying theory of discrete mathematics.

Mathematical logic, especially proof theory and constructive mathematics, is pursued to uncover the computational content of mathematical proofs, e.g. algorithms with certificates of correctness. This partial realization of the revised Hilbert Programme is extended to conceptual areas, such as the theories of commutative rings and Banach algebras, where the finite underpinning of transfinite methods is a particular challenge.

## PROJECTS (2012-2016)

- **Abstract Mathematics for Actual Computation.** Hilbert's Program in the 21st Century. This project of the University of Leeds (co-project leader Olaf Beyersdorff) is granted by the John Templeton Foundation aims at extracting algorithms from proofs in conceptual mathematics, claiming that more abstract mathematics would give more efficient algorithms.
- **CATLOC - Categorical localisation: methods and foundations.** Progetto Ricerca di Base 2015, Università di Verona. Triangulated categories arise in all areas of mathematics dealing with homological algebra. In representation theory, the focus is mostly on the derived category of modules over a ring; in algebraic geometry it is the derived category of (quasi)coherent sheaves that takes centre stage; and in homotopy theory it is the homotopy category of spectra. Each area has developed different approaches to deal with its own problems, but there are questions of a transversal character, which form the body of this project. We study the interplay between different localisation techniques and we explore applications to relevant contexts. Moreover, we address some computational and foundational issues which are within the range of the homotopy type theory developed by Voevodsky and others.
- **Strutture Geometriche, Combinatoria e loro Applicazioni. PRIN – MIUR - 2012.** The main objective of this Project is to develop and promote basic research in the framework of Incidence Geometries, Galois Geometries and Combinatorics.

## SELECTED PUBLICATIONS (2012-2016)


- L. Angeleri Hügel, F. Marks, J. Vitória, Silting modules and ring epimorphisms, Advances in Mathematics vol. 303, pp. 1044–1076, 2016.
- L. Angeleri Hügel, D. Pospisil, J. Stovicek, J. Trlifaj. Tilting, cotilting, and spectra of commutative noetherian rings, Transactions of the American Mathematical Society. Vol. 366, pp. 3487Ð3517, 2014.
- L. Angeleri Hügel, M.Saorín. t-structures and cotilting modules over commutative noetherian rings. Mathematische Zeitschrift. Vol. 277, pp. 847Ð866, 2014.
- G. Abrams, F. Mantese, A. Tonolo, "Extensions of simple modules in Leavitt path algebras", Journal of Algebra vol. 431, pp. 78-106, 2015.
- F. Mantese, A. Tonolo "Derived dualities induced by a 1-cotilting bimodule" Journal of Algebra vol. 411, pp. 12-46, 2014.
- E. Birmelé, R.A. Ferreira, R. Grossi, A. Marino, N. Pisanti, R. Rizzi, G. Sacomoto. Optimal Listing of Cycles and st-Paths in Undirected Graphs. SODA, pp. 1884-1896, 2013.
- L.Esperet, G.Mazzuoccolo "On Cubic Bridgeless Graphs Whose Edge-Set Cannot be Covered by Four Perfect Matchings" Journal of Graph Theory vol. 77, pp. 144-157, 2014.
- D. Rinaldi, P. Schuster, "A universal Krull–Lindenbaum theorem", Journal of Pure and Applied Algebra vol. 220, pp. 3207–3232, 2016.
- H. Lombardi, I. Yengui, P. Schuster. The Gröbner ring conjecture in one variable. Mathematische Zeitschrift. Vol. 270, pp. 1181-1185, 2012.


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