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Geometry-driven algorithms for combinatorial functional equations by Hadrien Notarantonio

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Abstract. Enumerative combinatorics contains a vast landscape of problems that could hardly be solved without the consideration of special functional equations called “Discrete Differential Equations”. Among these problems, the enumeration of walks, planar maps carrying hard particles, etc. These functional equations relate formal power series in n variables with specializations of them to some of the variables (the specializations being generating functions related to the enumeration of interest). When the involved variables are “nested”, a celebrated result by Popescu (1986) implies algebraicity of the solutions. In 2006, Bousquet-Mélou and Jehanne provided an elementary proof of algebraicity of the solutions in the case $n = 2$. Their proof yields an algorithm, and it has been the state-of-the-art in enumerative combinatorics for solving these equations since then. In this talk, I will present a recent approach, based on the intensive use of effective algebraic geometry, in order to solve more efficiently such equations in the case $n = 2$. Also, I will introduce and discuss recent advances in the case of systems of such equations. The talk is based on joint works with Alin Bostan, Mohab Safey El Din and Sergey Yurkevich.