The Combinatorics Library of the Project ‘Algorithms’ at INRIA

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Extended Abstract

The programs which will be demonstrated are part of an overall framework to study decomposable combinatorial structures and their generating functions. We are interested in the automatic analysis of such structures, including their generation, enumeration and generating functions. We are developing programs to do manipulation and asymptotic analysis of these generating functions, and applying the results to the automatic complexity analysis of algorithms. A survey article covering this aspect of our research has appeared in the Journal of Symbolic Computation (1996).

The demonstration consists of a series of Maple worksheets that describe interactions between combinatorial analysis, discrete mathematics, and computer algebra. They discuss combinatorial explorations using the Maple system for symbolic computation, in conjunction with packages like Combstruct and Gfun that have been developed at Inria.

Here is a structured list of some of the worksheets that will be demonstrated. (These demos are available on the web at the URL `http://www-rocq.inria.fr/algo/libraries/autocomb`).

I. Combinatorics.

• Enumeration of Planar Configurations in Combinatorial Geometry. There, starting with Euler's counting of triangulations of an n-gon, many planar configurations can be counted, listed and randomly generated, automatically. This sheet may serve as an entry point to the Combstruct and Gfun packages.

• Enumerating alcohols and other classes of chemical moleculs, an example of Polya's theory. Classes of chemical compounds can be represented by combinatorial models using the Combstruct package.

• Balls and Urns, Etc. Balls and urns models are basic in combinatorics, statistics, analysis of algorithms and statistical physics. We demonstrate here how their properties can be explored using most of the functionalities of the Combstruct package.

II. Asymptotics.

• Patterns in words. How likely is it that a specific pattern occurs k times in a random word of length n? How does the probability of this event depend on the specific pattern? This worksheet applies Combstruct and Gfun to this problem which has a connection to questions from biology of the DNA.

• A Seating Arrangement Problem. What happens when n persons arrive at a luncheonette and are so unfriendly that no one wants to sit next to an already occupied seat? This worksheet explores properties of this problem when people arrive randomly. (This also serves as a simplified model of channel occupation in mobile communication.) The complete treatment is entirely based on the Gfun package and Maple's capabilities in solving differential equations.

• Polygons, a simplified model for self-avoiding walks. There, we count pairs of non-crossing paths in integer lattices of dimensions 2, 3 and more. We also get numerical asymptotics by a connection method. This sheet makes intensive use of the Gfun package.

III. Analytic Combinatorics.

• A Problem in Statistical Classification Theory. Classification theory makes use of classification trees. This worksheet explores properties of random classification trees using the Combstruct package and Maple.

• Pollard's Rho Algorithm. This algorithm is an efficient and simple technique used to find factors of integers. We show in this worksheet how Combstruct and Gfun can be used to analyze a realistic combinatorial model of the algorithm and thus derive a probabilistic complexity analysis of this algorithm and variants of it.