Algebraic Analysis of System Reliability, a Combinatorial Approach

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The use of combinatorial commutative algebra for the analysis of the reliability of coherent systems was first presented by Giglio and Wynn in [1]. The main idea is to associate a monomial ideal to a coherent system and use a free resolution of the ideal to obtain the reliability of the system. This approach provides a very general method to produce exact formulae and bounds for the reliability of coherent systems. In order to obtain tight bounds a key point is the computation of minimal free resolutions of monomial ideals, a computationally difficult problem. In [2] and [3] this algebraic method was developed and applied to some relevant systems in reliability theory obtaining good results when compared to other methods in the literature. The connexion between monomial ideals and coherent systems provides also new combinatorial tools to study the algebraic properties of some families of monomial ideals e.g. mincut ideals of two-terminal networks [4] . This promising connection between monomial ideals and coherent systems points to an interface between probability and combinatorial algebra that suggests a methodology to adress other challenging problems. This talk presents joint work with Henry P. Wynn (London School of Economics).

1. Giglio, B. and Wynn, H. P. 2004 *Monomial ideals and the Scarf complex for coherent systems in reliability theory.* The Annals of Statistics 32, 1289-1311

2. Sáenz-de-Cabezón, E. and Wynn, H. P. 2009 *Betti numbers and minimal free resolutions for multi-state system reliability bounds.* Journal of Symbolic Computation 44, 1311-1325

3. Sáenz-de-Cabezón, E. and Wynn, H. P. 2010 *Computational algebraic algorithms for the reliability of generalized k-out-of-n and related systems.* Mathematics and Computers in Simulation, to appear.

4. Sáenz-de-Cabezón, E. and Wynn, H. P. 2010 *Mincut ideals of two-terminal networks.* Applicable Algebra in Engineering, Communication and Computing, submitted.