Algebraic and SAT Methods for Classes of Covering Arrays

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In this work, we survey the current state-of-the-art for the generation of classes of covering arrays, such as optimal and sequence covering arrays, using methods originating from computer algebra as well as their hybridization with SAT solvers. Covering arrays are discrete structures where all t-way interactions of input parameters are covered up to a strength t and they are used in various fields of computer science, software engineering and cyber security among others. Sequence covering arrays consist of sequences, such that all subsequences with pairwise different entries of some length are covered, sharing similar properties like covering arrays, where they originate from the necessity of defining a rigorous mathematical structure in event-based testing. Concrete instances of covering arrays for given parameters will arise as points in a generated variety of a system of multivariate polynomial equations with Groebner Bases playing an important role [1]. In addition, for sequence covering arrays, we will provide various algebraic models taking the form of multivariate polynomial systems of equations and are then processed via supercomputing by a Groebner Basis solver in order to compute solutions from them [2]. For the cases where theoretical constructions on a tuple-modelling level are not possible, we will employ various SAT encodings in conjunction with greedy techniques (e.g. IPO-strategy [3]). We conclude with the current open problems for generation of (sequence) covering arrays which lie in the intersection of discrete mathematics, computer algebra and applied computer science.

References

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