Computing Periodic Golay Pairs Using SAT Solvers

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Abstract

In this paper we present new methods for computing periodic Golay pairs, a generalization of Golay pairs, using SAT solvers. In particular, they are characterized by their respective periodic autocorrelation sums and also, equivalently, by the condition that the sums of the squared magnitudes of their DFT coefficients equal a fixed exact constant. Unlike ordinary Golay pairs, which are conjectured to exist only for lengths of the form $2^a10^b26^c$, periodic Golay pairs have attracted more interest lately due to their existence for a broader spectrum of lengths and their usability for many applications of Golay pairs, such as the construction of Hadamard matrices.

Our main approach for computing periodic Golay pairs is to apply SAT solvers to find complementary sequences in $\{-2, 0, +2\}^{n/2}$ and determine whether those can be lifted to periodic Golay pairs in $\{-1, +1\}^n$. We investigate various ways to express the definition and certain properties of periodic Golay pairs as systems of Boolean polynomials and analyze their impact on the solving times of the resulting satisfiability instances. A key contribution is the reduction of the computation of periodic autocorrelation functions to the evaluation of certain Boolean circuits such as Hamming weight computations or adder networks. Our experiments show that this approach is very promising, and that well-chosen encodings significantly improve solver performance.