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Astronomical Bounds for finding inequivalent Hadamard Matrices

Hadamard matrices arise in Combinatorics and have a wide range of applications in Statistics, Coding Theory, Cryptography, Telecommunications and many other areas. For each permissible order (a multiple of 4) of Hadamard matrices there is only a finite number of Hadamard matrices of this order. The set of Hadamard matrices of a specific order is equipped with an equivalence relation and the representatives of the equivalence classes with respect to this relation are called inequivalent Hadamard matrices. The graph isomorphism criterion is a necessary and sufficient condition to test whether two given Hadamard matrices are inequivalent. The 4-profile criterion is a necessary, but not sufficient, condition to test whether two given Hadamard matrices are inequivalent. Both the graph isomorphism and the 4-profile criteria have been implemented in the Computer Algebra System Magma.

Using these and other criteria, various authors have established constructive lower bounds (of the order of a few hundreds) for the number of inequivalent matrices of many permissible orders. In this work we use the doubling construction for Hadamard matrices, in conjunction with the symmetric group (group of permutations) S_n , to construct millions on inequivalent Hadamard matrices of orders which are multiples of 8. Thus we establish constructively new lower bounds for many such orders, up to 100, by starting with some small initial sets of inequivalent, or equivalent, Hadamard matrices.

Joint work with G. Georgiou and C. Koukouvinos.