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Mathematics in Computer Science

Foreword

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This special issue of Mathematics in Computer Science is devoted to complex Hadamard matrices and their applications. While Hadamard matrices have been well studied since the 1930s for their connections to experimental designs and coding theory, interest in complex Hadamard matrices has been more recent. A primary motivation is the connection to important problems in quantum physics and quantum computing.

A workshop on *Real and Complex Hadamard Matrices and Applications* was held at the Rényi Institute of Mathematics in Budapest, Hungary from 10 to 14 July 2017. The workshop was organised by Máté Matolcsi and Ferenc Szöllősi, where many of the authors from the current volume were active participants. The Budapest workshop was the fifth in a series, with the previous meetings held in Seville (2007), Galway (2009), Melbourne (2012) and Lethbridge (2014). This special issue is the third in a series of proceedings volumes, which began with Volume 2, Issue 2 of *Cryptography and Communications: Discrete structures, Boolean functions and Sequences* in 2010 edited by Flannery and Horadam [1]; and continued with volume 133 of the *Springer Proceedings in Mathematics and Statistics* in 2014, edited by Colbourn [2].

Two of the papers in the current issue advance the study of real Hadamard matrices. Djokovic and Kotsireas use the Goethals–Seidel array and difference families to construct so-called *good* and *best* Hadamard matrices at previously unknown orders; and Crnkovic and Egan extend the study of Menon designs with additional properties.

Two more papers extend the study of cocyclic Hadamard matrices (the topic of two previous workshops) in exciting new directions. Barrera Acevedo and Dietrich investigate relationships between Williamson matrices, which are cocyclic, and certain perfect arrays over the quaternions; while Alvarez, Armario, Falcon, Frau, Gudiel, Guemes and Osuna report on a new heuristic search technique for cocyclic Hadamard matrices.

Two papers are devoted to applications of Hadamard matrices. Armario, Bailera, Borges and Rifà also study cocyclic Hadamard matrices, giving a new characteristation in terms of propelinear codes; while Colbourn and Syrotiuk explain how combinatorial structures can be used to detect faults efficiently and systematically.

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The remaining papers in this volume study complex Hadamard matrices. Gillespie, Ó Catháin and Praeger use a complex Hadamard matrix of order 6, and algebra over the split-quaternions to give a new construction of the outer automorphism of the symmetric group on six points; and Bruzda gives new results on the set of complex Hadamard matrices of order 8. Winterhof, Yayla and Ziegler define and explore near-complex Hadamard matrices and related objects, and Rajchel, Gąsiorowski and Życzkowski conclude our volume with an intriguing investigation into the geometry underlying applications of complex Hadamard matrices in quantum physics.

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References

1. Flannery, D.L., Horadam, K.J. (eds.): Special Issue on Design Theory. Cryptography and Communications, vol. 2, no. 2 (2010)
2. Colbourn, C.J. (ed.): Algebraic design theory and Hadamard matrices. In: Springer Proceedings in Mathematics and Statistics, vol. 133 (2015)