

Also available at <http://amc-journal.eu>
ISSN 1855-3966 (printed edn.), ISSN 1855-3974 (electronic edn.)
Ars Mathematica Contemporanea Volume 3, Issue 2, Year 2010, Pages 237-258

Examples of computer experimentation in algebraic combinatorics

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Abstract

We introduce certain paradigms for procuring computer-free explanations from data acquired via computer algebra experimentation. Our established context is the field of algebraic combinatorics, with special focus on coherent configurations and association schemes. All results presented here were obtained by the authors with the aid of computer algebra systems, especially COCO and GAP. A number of examples are explored, in particular of objects on 28, 50, 63, and 210 points. In a few cases, initial experimental data pointed to appropriate theoretical generalizations that yielded an infinite class of related combinatorial structures. Special attention is paid to algebraic automorphisms (of a coherent algebra), a fairly new concept that has already proved to have far-reaching consequences. Finally, we focus on the Doyle-Holt graph on 27 vertices, and some of its related structures.

Keywords: Computer algebra system, GAP, COCO, coherent configuration, association scheme, strongly regular graph, algebraic automorphism, total graph, Moore graph, Doyle-Holt graph, Gray configuration, generalized quadrangle.

Math. Subj. Class.: 05EXX, 05E30, 05–04

Math Sci Net: [05E30 \(05-04\)](#)

Primeri računalniškega eksperimentiranja v algebraični kombinatoriki

Povzetek

V članku predstavimo določene paradigme za razlago podatkov, pridobljenih z računalniško-algebrskimi poskusi. Naše delo se umešča v algebraično kombinatoriko s posebnim poudarkom na koherentnih konfiguracijah in asociativnih shemah. Vse tukaj predstavljene rezultate smo dobili s pomočjo računalniških algebrskih sistemov, še posebej sistemov COCO in GAP. Raziskali smo številne primere, predvsem objekte z 28, 50, 63 in 210 točkami. V nekaj primerih so nam pridobljeni začetni eksperimentalni podatki pomagali oblikovati primerne teoretične posplošitve, ki so vodile k odkritju neskončne družine sorodnih kombinatoričnih struktur. Posebno pozornost posvečamo algebraičnim avtomorfizmom (koherentne algebre); gre za dokaj nov koncept, za katerega pa se je že izkazalo, da ima daljnosežne posledice. Obravnavamo tudi Doyle-Holtov graf s 27 vozlišči in nekaj z njim povezanih struktur.

Ključne besede: Sistem računalniške algebre, GAP, COCO, koherentna konfiguracija, asociativna shema, krepko regularen graf, algebraični avtomorfizem, totalni graf, Moore-ov graf, Doyle-Holtov graf, Grayeva konfiguracija, posplošeni štirikotnik.