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Algebra and Geometry with Computers

Sir Roger Penrose once remarked that computers are intrinsically limited, compared to humans, when it comes to the doing of mathematics. Even those who think that such things can be proved may be interested in the empirical question: what kind of mathematics can computers do? Can a computer reason logically like humans and prove new theorems? A partial answer can be given using modern automated reasoning software such as Otter and Prover9. Otter, developed by William McCune at the Argonne National Laboratory, is the first widely used high-performance theorem prover. It is based on first-order inference rules, substitution principles, unification etc. Otter has since been replaced by Prover9, which is paired with Mace4, a counter-example generator. Both are available free for Mac OSX, Windows and the Unix platforms. In this presentation, we plan to give a brief survey of this relatively new area of experimental mathematics and give a list of "new" theorems proved with the help of these theorem-provers. In particular, we plan to show some live demonstrations of automated deduction in the following areas of algebra and geometry: 1. Ring theory - commutativity theorems (in collaboration with Yang Zhang) 2. Cancellation Semigroup Conjecture (in collaboration with Iraghi Moghaddam) 3. Inverse semigroups (in collaboration with Michael Kinyon and J. Araujo) 4. Lattice theory - uniquely complemented lattices and Huntington laws 5. Projective planes as groups (using Maple routines) 6. Cayley-Bacharach implications (in collaboration with Bob Veroff).