Finite Incidence Geometry in GAP

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Incidence geometry

- Synthetic viewpoint: points, lines, circles, etc. are abstract objects;
- there is an incidence relation between these objects;
- satisfying axioms.
- Finite geometry: extra assumption that the number of objects is finite.

Incidence geometry

- An automorphism of an incidence geometry is a type preserving map respecting the incidence relation.
- Interaction between groups and geometries is actually the birth of the field.
- Representing incidence geometries as group coset geometries is one possibility.
- Projective planes are coordinatised over an algebraic structure.
- Representing incidence geometries in an analytic way is another possibility.

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Philiosophy of doing incidence geometry in GAP

- We want the user to be able to explore geometries and their substructures
- Integrated with with existing (group theoretical) functions of GAP
- Ease of use has priority above super performance

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FinInG history

- 1999: **pg**: predecessor of FinInG (JDB, Patrick Govaerts and Leo Storme).
- 2006: John Bamberg, Anton Betten, Philippe Cara, Michel Lavrauw, and Max Neunhoeffer join.

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- Projective spaces over finite fields.
- Finite classical polar spaces.

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Semi-linear maps on vector spaces

- A collineation of a projective space is a semi-linear map of the underlying vector space
- These objects are implemented in fining, including there action on subspaces and nice monomorphisms.
- Functions based on orb and genss packages provide efficient ways of computing orbits and stabilizers directly.

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A group coset geometry

Overview of FinInG

- Projective spaces, classical polar spaces, affine spaces, generalized polygons, coset geometries and diagrams.
- Algebraic varieties
- Integration of all the different parts: collineation groups and group actions, geometry morphisms, stabilizer groups of elements and sets of elements, efficient enumerators for elements, etc.
- manual of $\pm$ 250 pages (including 288 examples), $\pm$ 50 pages of additional technical documentation

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Dependencies

- forms (John Bamberg and JDB)
- grape (Leonard Soicher)
- orb (Juergen Mueller, Max Neunhoeffer, Felix Noeske, M. Horn)
- genss (Max Neunhoeffer, Felix Noeske, M. Horn)
- cvec (Max Neunhoeffer, M. Horn)

How to get

`http://cage.ugent.be/fining`