GAP Group Rings Toolkit

Alexander Konovalov
Senior Research Fellow
Fellow of the Software Sustainability Institute
Centre for Interdisciplinary Research in Computational Algebra (@CIRCA_StAndrews)
University of St Andrews

Groups, Rings and the Young-Baxter equation
Spa, Belgium, 19-23 June 2017
What is GAP

• Open source software system for discrete computational algebra

• Website: https://www.gap-system.org

• GitHub: https://github.com/gap-system

• Twitter: @gap_system
Package system

• More than 130 packages (user contributed extensions) are redistributed with GAP

• Extend GAP with new mathematical functionality, databases, infrastructure, interfaces to other systems etc.

• Full list at http://www.gap-system.org/Packages/packages.html

• Why to put efforts into developing and submitting a GAP package:
  • to make it usable by other researchers
  • to find collaborators
  • to be regularly tested during GAP release cycle
  • to ensure its sustainability in the future
  • to get credit (citations, optional formal refereeing)
  • See bit.ly/gap_citations on Google Scholar
Group rings in GAP

- GAP 3 - no group rings built-in.
- lag.g program for GAP 3 by Richard Rossmanith (1997)
- GAP 4 (1999) - built-in group rings
- lag.g migrated to LAG package by Richard Rossmanith and then maintained by Greg Gamble
- superseded by LAGUNA package by AK and Victor Bovdi, Richard Rossmanith, Csaba Schneider (accepted in June 2003)
- UnitLib by AK and Elena Yakimenko (accepted in March 2007)
- Wedderga by Angel del Rio and Osnel Broche Cristo, Allen Herman, AK, Gabriela Olteanu, Aurora Olivieri, Inneke Van Gelder (accepted in January 2008)
- HeLP by Andreas Bächle and Leo Margolis (redistributed with GAP since February 2016)
LAGUNA

• Properties and attributes of group rings and their elements

• Lie properties of group algebras of finite groups

• Normalised unit group of a modular group algebra of a finite $p$-group over the field of $p$ elements
UnitLib

- Extends LAGUNA package
- Stores precomputed normalised unit groups in a database
- Tools to extend this collection and parallelised version of the computation of $V(KG)$
Wedderga

- Wedderburn decomposition of group algebras
- Computing a list of simple algebras whose direct sum is isomorphic to the group algebra $FG$ given as input, provided $G$ is a finite group and $F$ is either a finite field of characteristic coprime to the order of $G$, or an abelian number field
- Computing the primitive central idempotents of semisimple group algebras and a complete set of orthogonal primitive idempotents
- Constructing crossed products over a group with coefficients in an associative ring
- Calculating Schur index of a simple algebra
- Functions to create code words from a group ring element
no-name, unpublished

- GAP code developed mainly in last decade by AK & Victor Bovdi
- Uses ECLiPSe (via IF package by Marco Costantini) and Minion (via interface by Steve Linton) solvers
- Used to answer Prime Graph question affirmatively for 13 sporadic simple groups
- Still unpublished (sorry!)
- An interest in reproducibility of computational results significantly increased during the current decade
  - “Replication is not duplication”
- ReScience journal [http://rescience.github.io/](http://rescience.github.io/)
- And another implementation appeared!
HeLP

- HeLP = Hertweck-Luthar-Passi method
- Uses 4ti2 via interface by Sebastian Gutsche and normaliz via interface by Sebastian Gutsche, Max Horn and Christof Söger
- For sporadic groups, results agree with existing ones
- Implements some further tests e.g. so called Wagner test.
- Used to give a positive answer to the Prime Graph Question for groups of order divisible by at most three primes (Wolfgang Kimmerle & AK, 2017)
How to cite

• Please cite GAP, if you use it

• Please cite packages if you use them

• See GAP website for sample citations: http://www.gap-system.org/Contacts/cite.html

• Or use Cite(); and Cite(“package-name”);

• Please be precise about versions used
How can I contribute?

• In many ways: report issues, submit bugfixes, improve documentation, add tests, help other users, teach GAP, ...

• GAP development version: https://github.com/gap-system

• Contributing guide: https://github.com/gap-system/gap/blob/master/CONTRIBUTING.md

• Development versions of (some) GAP packages: http://gap-packages.github.io/
Advertising

- **GAP Tutorial** - satellite event on August 13th-14th, 2017, just after Groups St Andrews in Birmingham 2017: https://www.codima.ac.uk/gsta2017/

- It will include **GAP Software Carpentry Lesson**: http://alex-konovalov.github.io/gap-lesson/

- **CoDiMa** small travel grants for GAP and Sage developers and users based in the UK: https://www.codima.ac.uk/research-visits-programme/