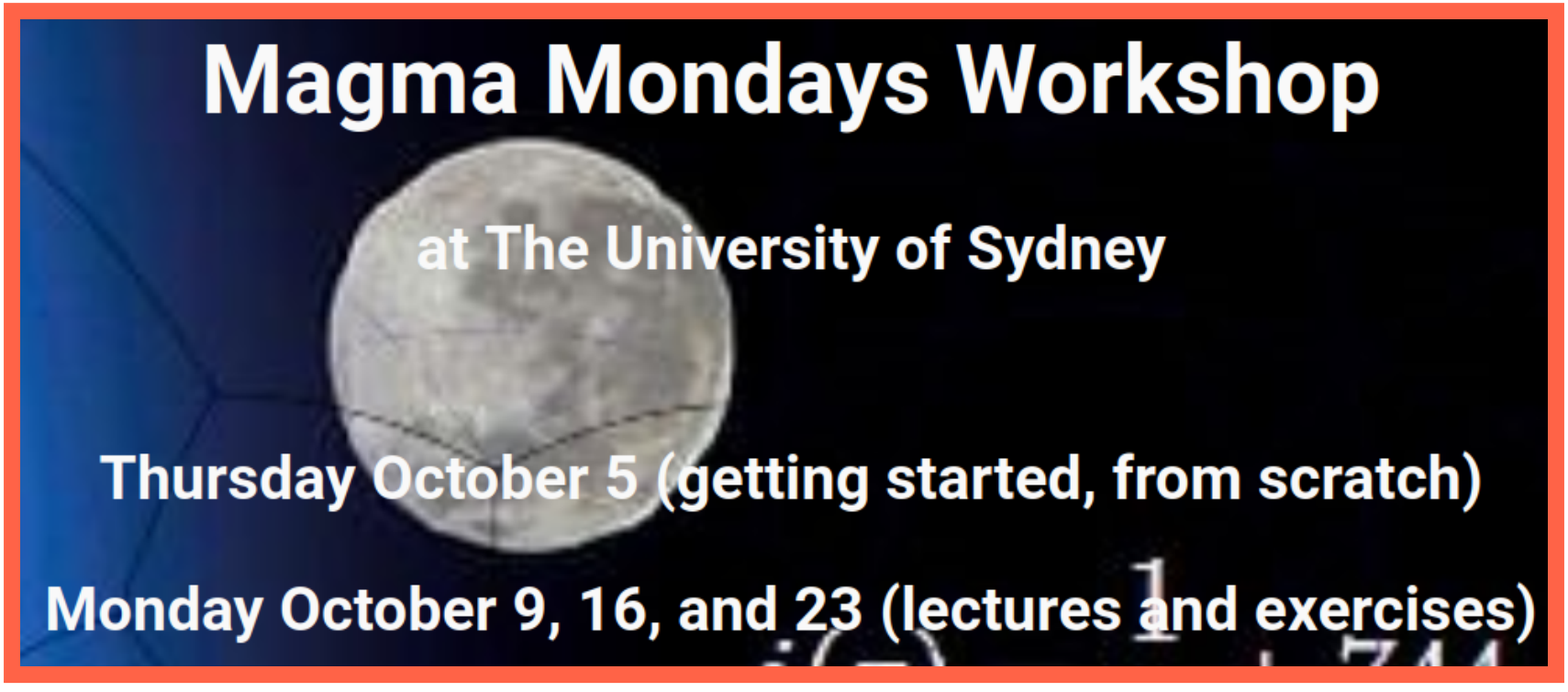
An Introduction to Magma

The "What, why and how?" of Magma

Magma Mondays but it is actually Thursday...

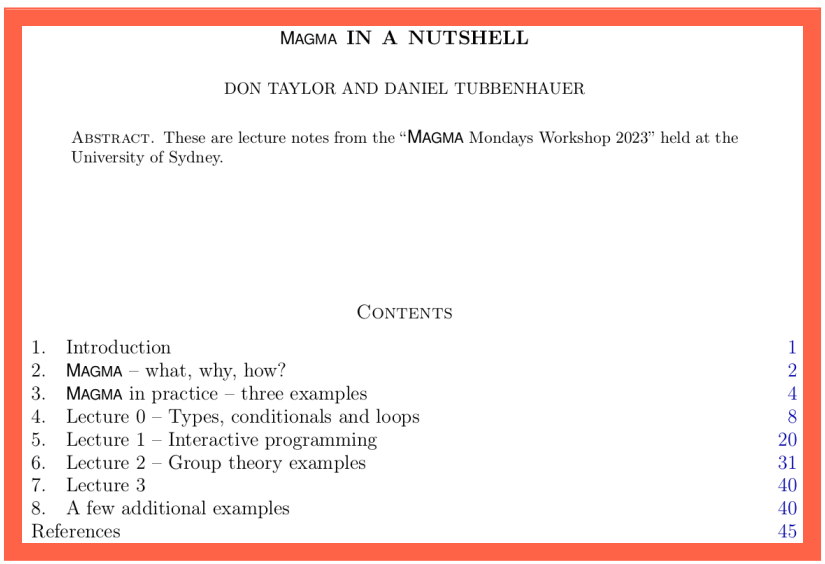
5 October 2023



Preliminaries

- We are not trying to give a comprehensive coverage of MAGMA, but we have rather several selected topics that we will explore.
- After a bit of background on the language, we will cover the combinatorics of groups and related objects.
- Our goal is to introduce the reader to the role MAGMA can play in mathematical research.

The main source is the lecture notes file on the MAGMA Mondays page: https://sites.google.com/view/magma-mondays/



MAGMA IN A NUTSHELL

DON TAYLOR AND DANIEL TUBBENHAUER

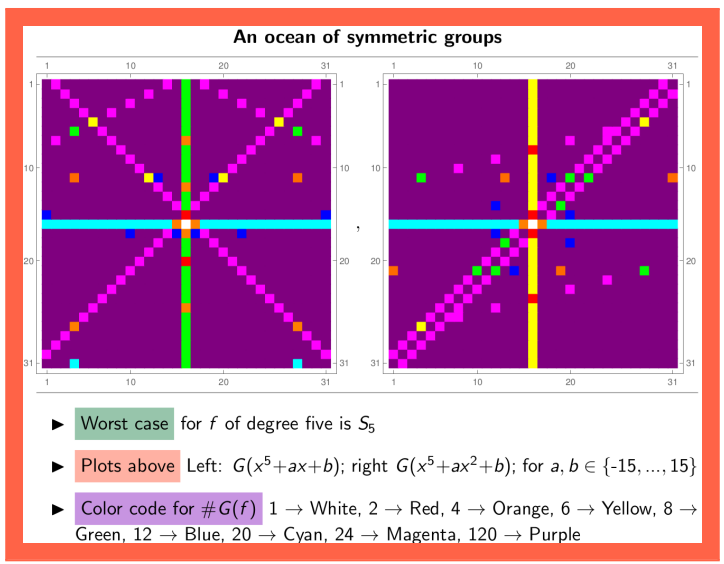
ABSTRACT. These are lecture notes from the "MAGMA Mondays Workshop 2023" held at the University of Sydney.

CONTENTS

What?

- MAGMA is a computer algebra system designed to solve problems in algebra and related fields.
- MAGMA is a huge system with several thousand pages of documentation.
- The design principles underpinning both the user language and system architecture are based on ideas from universal algebra and category theory.

Crucial. MAGMA performs exact calculations. In particular, one can use MAGMA output in papers or theses without loosing the exactness.



Why?

My main reasons to use MAGMA are:

- MAGMA has access to a large number of databases containing information (e.g. group character tables)
- Most of the major algorithms currently installed in the MAGMA kernel are state-of-the-art (e.g. the Meataxe algorithm)
- MAGMA is attractive for the working mathematician since are many build in functions spanning:

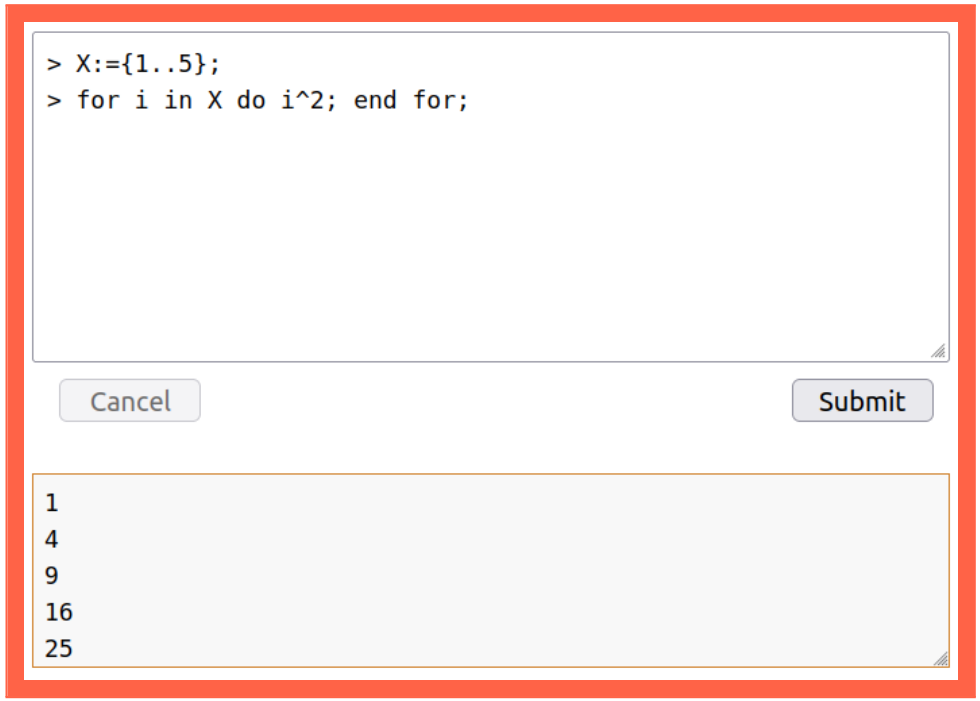
(a) The MAGMA Language and System;
(b) Groups;
(c) Semigroups and monoids;
(d) Rings and fields;
(e) Commutative rings;
(f) Linear algebra and module theory;
(g) Lattices and quadratic forms;
(h) Algebras;
(i) Representation theory;

(j) Homological algebra;
(k) Lie theory;
(l) Algebraic geometry and commutative algebra;
(m) Arithmetic geometry and modular arithmetic geometry;
(n) Finite incidence geometry;
(o) Differential Galois theory;
(p) Error-correcting codes;
(q) Cryptography;
(r) Mathematical databases.

Why?

My main reasons to use MAGMA are:

- MAGMAs syntax is pretty straightforward
- MAGMAs online calculator is easy to use and sufficient 90% of the time

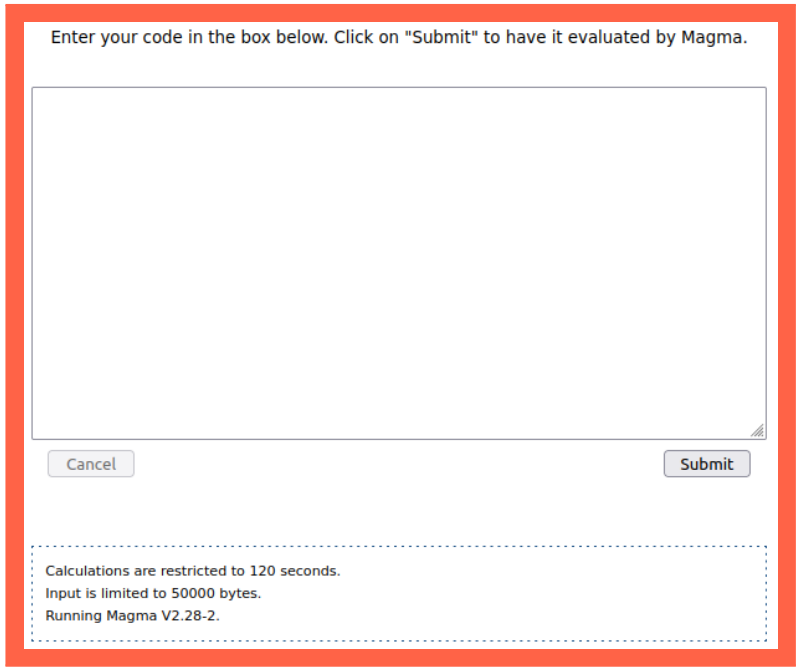


We will use the online calculator in this course – nothing you need to install

- MAGMA is noncommercial (however needs to cover on-costs)

How?

- MAGMA is a non-commercial system, but the costs (such as preparation of user documentation, the fixing of bugs, and the provision of of user support) need to be recovered. So MAGMA is non-commercial but not free, and the distribution is organized on a subscription basis. In order to get MAGMA on your machine use this site: http://magma.maths.usyd.edu.au/magma/ordering/
- Free, very useful, and completely enough for this course, is the *online calculator* http://magma.maths.usyd.edu.au/calc/:



Outline

Day 0
- We now open the online calculator and the lecture notes and do the first steps live together

Day 1
- The read-evaluate-print-loop (REPL)
- Interactive programming
  - A simple word game
  - The Catalan numbers
  - Projective planes, graphs, automorphism groups
  - Exploring small groups: the Small Groups Database

Day 2
- The type system and coercion
- Group theory examples
  - Constructing the Hall–Janko group
  - Group algebras and the group determinant
  - Central extensions of symmetric groups

Day 3
- Structure constant algebras
- Root data
- Reductive groups

Day >3
- We will have a vote on the course webpage about potential extra topics