

MA4N1-15 Theorem Proving with Lean

26/27

Department

Warwick Mathematics Institute

Level

Undergraduate Level 4

Module leader

Damiano Testa

Credit value

15

Module duration

10 weeks

Assessment

100% coursework

Study location

University of Warwick main campus, Coventry

Description

Introductory description

Introduce the students to formal proof verification and proof assistants using the program Lean. The module develops tools to understand the interaction between formalizing mathematical results and programming.

The module will contribute to training BSc, MMath and MSc students in skills which are asked for in many areas of research, business, industry and government.

[Module web page](#)

Module aims

This course provides an introduction to formalization of mathematics using Lean. This involves developing a strong link between the abstract mathematical knowledge on one side and the ability to translate it into a computer-checkable format. The module gives the basic tools needed to structure mathematical thinking in a way that can be effectively formalized and automatically checked. Naturally, there are two separate but interdependent parts: converting mathematical statements into machine-verifiable format and extending the software's ability to interpret mathematical language. The former draws more tools from mathematics, the latter draws more tools from computer science.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Topics from:

Formalization of mathematics
Proof verification
Proof assistant
Metaprogramming

Learning outcomes

By the end of the module, students should be able to:

- Learn the tactic framework of the computer program Lean for formalizing mathematics.
- Learn how to write code to verify mathematical results.
- Gain some experience with formal proof checkers.
- Gain some experience developing code in a group.

Research element

The students need to find their own formalization path to verify the proposed goals.

Interdisciplinary

The module sits naturally between mathematics and computer science. One of the eventual goals of the area is to increment automation and bring in also Artificial Intelligence and Machine Learning to help with the formalization of known results and the discovery of new results

Subject specific skills

See learning outcomes

Transferable skills

Students will acquire key reasoning, problem solving skills and programming tools which will empower them to address new problems with confidence. They will also gain experience of collaborating with other in a joint coding project.

Study

Study time

Type	Required
Lectures	10 sessions of 2 hours (36%)
Tutorials	9 sessions of 1 hour (16%)
Private study	26 hours (47%)
Total	55 hours

Private study description

26 hours to review lectured material and work on set exercises.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group A

	Weighting	Study time	Eligible for self-certification
Assessment component			
Formalization of Mathematics	70%	80 hours	No
Make progress in the formalization of some of the topics proposed in the module.			

Reassessment component is the same

Assessment component

Presentation	20%	10 hours	No
5 minutes pre-recorded presentation			

Reassessment component is the same

Assessment component

Project outline 10% 5 hours No

Outline an informal approach to formalizing your group project

Reassessment component is the same

Feedback on assessment

Short report

Availability

Courses

This module is Optional for:

- Year 1 of TMAA-G1P0 Postgraduate Taught Mathematics
- TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
 - Year 1 of G1PC Mathematics (Diploma plus MSc)
 - Year 2 of G1PC Mathematics (Diploma plus MSc)

This module is Core option list F for:

- Year 4 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Option list B for:

- Year 4 of UCSA-G4G3 Undergraduate Discrete Mathematics
- Year 5 of UCSA-G4G4 Undergraduate Discrete Mathematics (with Intercalated Year)

This module is Option list C for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
 - Year 4 of G105 Mathematics (MMath) with Intercalated Year
 - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
 - Year 3 of G103 Mathematics (MMath)
 - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G107 Undergraduate Mathematics (MMath) with Study Abroad
- Year 4 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe