

Computer Verification of Mathematical Proofs

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Course Overview:

This experimental course teaches how to write mathematical proofs both in conventional language (used by most mathematicians) and in the formal language (readable by computers). A formal proof can be automatically checked by a computer. This turns proof-writing into a (challenging) computer game allowing students to immediately see where their proof is incomplete or incorrect. We shall learn how to use LEAN4 proof assistant to state mathematical theorems and to prove them. We shall also develop familiarity with the structure and use of the extensive and growing library of formalized mathematics, called Mathlib.

During this course students will learn basic type theory and set theory, appreciate the difference between the two, and see how either can be used to formalize mathematics. They will also learn the Curry-Howard correspondence between

- programs and proofs,
- type declarations and mathematical theorems, and
- program compilation and proof checking.

Prerequisites: MATH 129, Discrete math or higher level math course, and access to a laptop.

Why take this course:

In the age of AI it becomes even more important to distinguish truth from fiction. What better area to achieve this than mathematics? By the end of this course you should be able to use AI to help you fill in the routine parts of your proofs. You will also be able to join the friendly Lean community, where you can immediately contribute to the current fast growing formalization and exploration of Mathematics.

Key Features:

- Immediate computer feedback as you are writing your proof and satisfaction when your proof compiles, turns proof writing into a computer game.
- Using LEAN4, a functional computer language, for writing Mathematics.