DOKUZ EYLUL UNIVERSITY FACULTY OF SCIENCE
DEPARTMENT OF MATHEMATICS

STUDENT SEMINARS

Proofs, Machine-Checked: The Power of Lean 4 Functional Programming, Lean, Aristotle, AI-Tools

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ABSTRACT

We will introduce **interactive theorem proving** and **functional programming** through **Lean 4**, alongside automated proof search with **Aristotle** and AI tools.

The foundation of computer-assisted proof verification relies on the *Curry–Howard Correspondence*, which establishes a direct isomorphism between logic and type theory:

$$\text{Propositions} \iff \text{Types}, \qquad \text{Proofs} \iff \text{Programs (Terms)}.$$

Formal Verification Principle. *Let P be a mathematical proposition formalized as a type in Lean 4. A term $P : p$ is accepted by Lean's kernel if and only if p constitutes a logically complete and error-free proof of P.*

We will demonstrate how classical analytical statements are translated into formal Lean syntax using the **Mathlib** library. Specifically, we will examine the convergence of real sequences; let $\{a_n\}$ be a sequence of real numbers converging to zero and $\{b_n\}$ be a bounded sequence of real numbers. We will formalize and prove that the product sequence $\{a_n b_n\}$ also converges to zero:

$$\lim_{n\to\infty} a_n = 0 \text{ and } \{b_n\} \text{ is bounded } \implies \lim_{n\to\infty} a_n b_n = 0.$$

We will reinforce this proof with live demonstrations in Lean's *Tactic Mode* and illustrate how AI-assisted provers like Aristotle help bridge incomplete proof steps (`sorry`). If time permits, we shall discuss other examples.

This seminar, as part of our graduation project titled *Proofs, Machine-Checked: The Power of Lean 4*, serves as an accessible introduction to formalizing undergraduate mathematics and verifying proofs with absolute logical certainty.

DATE & TIME: **23th November 2026, Monday, at 13:00**
CLASSROOM: **B254**