

How will AI help mathematicians?

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The advent of artificial intelligence raises important questions : can AI assist mathematicians in solving open problems in mathematics ? Could AI even prove mathematical results on its own ? This talk explores these questions from multiple perspectives.

AI for mathematics can often be divided in two branches : *AI for mathematical discovery* and *AI for automated theorem proving and formalization*.

Mathematical discovery. This first branch is based on the following observation : in a number of open problems intuition plays a central role to find a candidate solution, a conjecture, a good a priori estimate etc. This intuition can sometimes resemble a form of pattern matching : examples from previous problems, gives you an idea of how to proceed. Since pattern matching is a task that neural networks are good at, it is natural to ask whether one could train an AI model to predict such solutions, conjectures, or any other interesting quantities. We will present two methods : training a small language model from scratch to predict solutions to challenging problems, taken from [2] ; combining a classical algorithm and the iterative training of a generative model to create interesting mathematical constructions, taken from [4].

AI for automated theorem proving. This second branch consists of training an AI model (usually a Large Language Model (LLM)) to produce a proof of a mathematical statement. This could be done in natural language, such as French or English or in a formal language such as Rocq, Lean, Isabelle. While formal language may be harder to work with, formal proofs can be machine-checked with strong correctness guarantees, an important advantage when working with LLMs. A related task is the translation from natural language to formal language, known as formalization, or autoformalization when it is carried out by AI models. This field has been extremely active in recent years : from the first models solving non-trivial high-school exercises [1] a few years ago to recent milestones such as open problems essentially solved by these AI models, or textbooks fully autoformalized by AI models with no human intervention [3]. We will review several approaches from 2020 to 2026 that led to these achievements.

Références

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