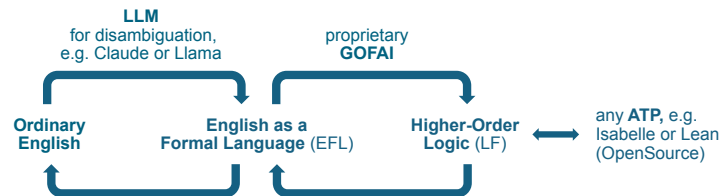# Summary of the Universal Prover concept

March 29, 2025

Introduction

The Universal Prover offers a solution for the problem of automating deductive reasoning, using natural language as input. It employs large language models (LLMs) for disambiguation and syntactic sugar, alongside proprietary GOFAI algorithms for translating disambiguated natural languages into formal languages. Reasoning is performed by leveraging the capabilities of automated theorem provers (ATPs), such as Isabelle or HOList.

The purpose of the Universal Prover is not to replace LLMs, but to enable them to perform flawless deductive reasoning—a task they cannot accomplish on their own. In other words, the Universal Prover is a module for LLMs that provides transparent, provably correct, and controllable reasoning capabilities, much like an ordinary calculator is used for very elementary arithmetical reasoning.

Key Benefits Compared to Alternative Approaches

Any LLM can, on its own, perform tasks that resemble reasoning. However, LLMs only *mimic* reasoning, as they are entirely based on probabilities derived from examples learned from vast datasets.

AlphaProof, a leading contender, famously earned a perfect score on each problem in the IMO 2024 — a performance equivalent to the top end of the silver-medal category, with caveats regarding time and human assistance [1]. It is based on a similar GOFAI/LLM hybrid approach, with LEAN providing the GOFAI component for proof-checking and LLMs used for natural language input and output and a specialized language model used for proof search. While AlphaProof is valuable for automating deductive reasoning in pure mathematics using natural language as input, it lacks the key virtues of UP-based systems, namely transparency, provable correctness, and controllability.

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[1] Benji Edwards, "Google claims math breakthrough with proof-solving AI models", Ars Technica, 26 July 2024, https://arstechnica.com/information-technology/2024/07/google-ai-earns-silver-medal-equivalent-at-international-mathematical-olympiad/

Development and IPRs

The scientists on the team have been working on research on related topics since the 1980s. Intellectual property (IP) related to UP's GOFAI algorithms is solely owned by the founding scientists. In addition to UP's proprietary algorithms, UP utilizes other technologies that may be commercially licensed or used under an open-source license (such as any ATP for reasoning and any LLM for disambiguation and syntactic sugar).

The algorithms have been largely defined. We are currently raising a small pre-seed funding round that is needed to equip LLMs for disambiguation, integrate ATPs for reasoning, and develop a Chat UI to complete the PoC prototype. The PoC version will be capable of handling deductive reasoning in a reasonably large fragment of (disambiguated) ordinary English.