Automated Theorem Proving via Few-Shot Programming

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Required skills: good programming skills are expected ; some previous exposure to logic, theorem-proving or program verification would be a plus

Description:

Large-language models such as GPT4 have proved surprisingly good at solving a wide range of tasks from a handful of examples and at generating structured data such as programs or mathematical formulas. Yet, their lack of reliability puts a limit on their ability to solve large problems that require many steps of reasoning.

Our work proposes a new programming paradigm called "few-shot programming", where domain experts write high-level problem-solving strategies in the form of nondeterministic programs whose choice-points are annotated with examples. This induces a search space that can be explored by querying large-language models for guidance. In addition, once enough examples are provided by humans for a strategy to bootstrap, this strategy can self-improve via an AlphaZero-like scheme, by solving a series of problems with search and extracting annotations from successful solutions.

We are looking for students to write expert strategies for a variety of tasks in automated theorem-proving, program synthesis and program verification within this paradigm of "few-shot programming". In particular, doing so successfuly will require students to think of original ways to decompose large problems into smaller ones that are tractable for large language models.

Related published work: *Learning to Find Proofs and Theorems by Learning to Refine Search Strategies: The Case of Loop Invariant Synthesis*, Jonathan Laurent & André Platzer, NeurIPS 2022