MATH FOR AI: ON THE GENERALIZATION OF LEARNING MATHEMATICAL PROBLEM SOLVING

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Overview

Cognitive neuroscience research has demonstrated that learning to solve mathematical problems enhances general reasoning abilities in humans.

Does learning mathematical problem-solving contribute to the development of a model's general reasoning abilities?

In other words, our project aims to investigate whether the mathematically fine-tuned LLM generalizes its capabilities on out-of-domain reasoning tasks (e.g., code generation and logical thinking)?

Previous Works

P1 No standard categorization of reasoning benchmarks ➡ ambiguous map between benchmarks and LLM's reasoning abilities

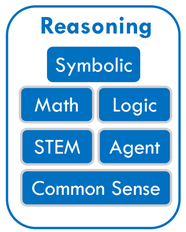
P2 LLMs suffer from overfitting, forgetting and unstable instruction-following ability ➡ inadequate evaluation

Objectives

Sol.1 Systematically categorize reasoning benchmarks

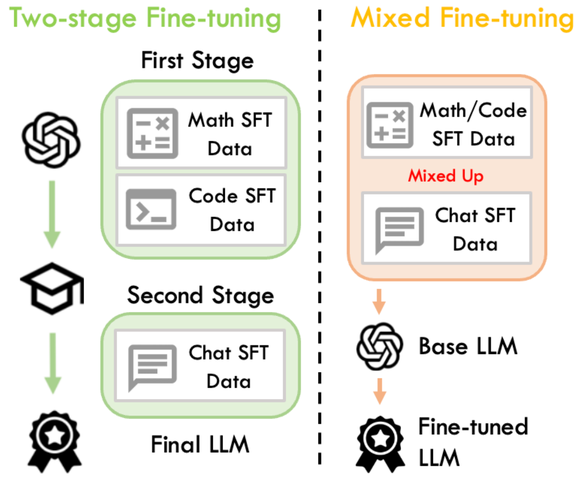
Sol.2 Adopt two fine-tuning strategies to mitigate overfitting and forgetting as well as stabilize the instruction-following capability of LLMs

Benchmarks



It's difficult to define general reasoning on a single benchmark. We categorize reasoning into 6 domains and setup benchmarks on all of them.

Pipelines

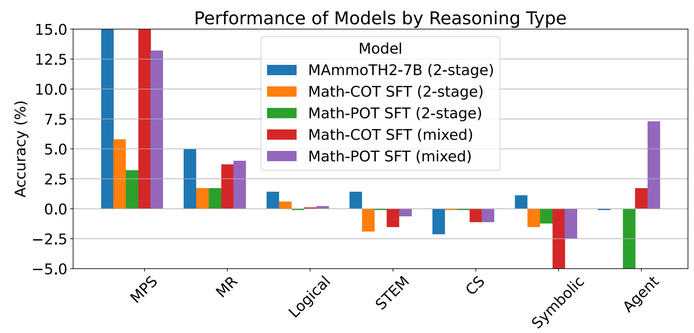


Two-stage Fine-tuning
- Make use of existing models.
- Adapt to instruction-following tasks.
- May weaken general reasoning abilities.

Mixed Fine-tuning
- Improve general reasoning abilities.

Progress

- ✓ Finish the benchmark categorization.
- ✓ Finish the design of fine-tuning strategies
- ✓ Finish the evaluation of two different fine-tuning strategies against baselines on most of selected benchmarks.



Conclusion

Insight: whether learning math improves the general reasoning.

Solution: two fine-tuning pipelines to mitigate overfitting & forgetting and stabilize instruction-following abilities.

Future Work: Incorporate Journey Learning to propose a brand-new fine-tuning pipeline so that we can improve both math and general reasoning abilities.