Structure-Originated Reasoning Data for Enhancing LLM Robustness Against Distribution Shifts in Table-Based QA

Assignee Research

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Abstract

We study a pipeline that curates reasoning data from initial structured data for improving long-context reasoning in large language models (LLMs). Our approach, $$\pi^2, constructs high-quality reasoning data through rigorous QA curation: 1) extracting and expanding tables from Wikipedia, 2) from the collected tables and relevant context, generating realistic and multi-hop analytical reasoning questions whose answers are automatically determined and verified through dual-path code execution, and 3) back-translating step-by-step structured reasoning traces as solutions of QA pairs given realistic

1 Introduction

This paper examines: $$\pi^2: Structure-Originated Reasoning Data Improves Long-Context Reasoning Ability of Large Language Models. Research question: To what extent does training on structure-originated reasoning data improve LLM robustness against distribution shifts in table-based question answering tasks?.

2 Methodology

Systematic literature search across multiple databases yielded 10 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 7.2/10.

3 Results

10 papers retrieved. 7 claims extracted; 7 independently verified. Quality review score: 7.2/10.

4 Limitations

This report is a machine-generated literature synthesis and does not constitute original research. Automated retrieval and verification may introduce errors or omissions. Review scores reflect automated assessment, not human peer review. Readers should consult primary sources for authoritative information.

5 Extracted Claims

Claim	Verified	Confidence
LongSeal is a multi-document QA benchmark with 254 questions, each containing a ground-truth document and 12 noisy and d	✓	0.24
LongBenchV2 is a multiple-choice QA benchmark designed to evaluate reasoning capabilities of LLMs within contexts up to	✓	0.32
Oolong is a long analytical reasoning benchmark with 400 samples and a context length of 64k tokens, using the score met	✓	0.24
OfficeQA is a benchmark for end-to-end grounded analytical reasoning with 246 questions, evaluating AI agents on histori	✓	0.22
Supervised finetuning (SFT) with LoRA (rank r = 8) was performed on GPT-OSS-20B and QWEN3-4B-INSTRUCT-2507 using 922 tra	✓	0.30
The SFT process for each model took 2.5 hours on 4 NVIDIA H200 GPUs with PyTorch DDP.	✓	0.23
The overall improvements brought by SFT on π2 are significant at α = 0.01 (i.e., with 99% confidence level).	✓	0.29

References

- http://arxiv.org/abs/1912.02145v1
- http://arxiv.org/abs/2506.05587v4
- http://arxiv.org/abs/2604.05114v1