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Pareto-Aware Acceptance for Multi-Criteria Self-Refinement of Large Language Model Outputs

Communication Info

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Abstract

Recently, Large Language Models (LLMs) have been improved by integrating self-refinement and multi-agent paradigms to make reasoning better and more stable. Existing methods such as Self-Refine and Reflexion show the benefits of iterative feedback but often use single-score optimization or heuristic stopping criteria, which can lead to unstable improvements across multiple quality dimensions [1, 2]. In parallel, multi-agent debate and LLM-based evaluation frameworks demonstrates the importance of structured interaction and reliable judging mechanisms [3,4]. This paper proposes a two-agent framework for multi-criteria self-refinement of LLM-generated outputs. The framework combines a generator agent that makes candidate responses with an evaluator agent that assesses outputs using a structured rubric covering factuality, coherence, evidentiary support, depth of analysis, and linguistic robustness. To ensure controlled refinement, a Pareto-aware acceptance rule is introduced to prevent degradation in individual criteria while allowing global improvements. Also, a dynamic convergence detector based on moving-window score variations is employed to terminate the refinement process without relying on fixed iteration limits. Experimental results on complex analytical prompts show that the proposed method consistently improves quality while maintaining balanced performance across evaluation criteria. These indicate that multi-objective control and convergence-aware stopping are essential for building reliable and scalable LLM self-refinement systems, complementing recent advances in LLM evaluation and verification methods [5].

References

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