Manifold-Aware Embedding Distances Enhance Adversarial Robustness in Out-of-Distribution Retrieval

Assignee Research

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Abstract

This report synthesises findings from 14 peer-reviewed papers addressing the following research question: Do manifold-aware embedding distances improve robustness against adversarial perturbations in out-of-distribution retrieval tasks across the BEIR dataset. Decoder-only large language models (LLMs) are increasingly replacing BERT-style architectures as the backbone for dense retrieval, achieving substantial performance gains and broad adoption. However, the robustness of these LLM-based retrievers remains underexplored. 14 claims were extracted from source literature; 13 were independently verified against retrieved documents. An automated multi-reviewer quality assessment produced a score of 8.5/10. This report is a machine-generated literature synthesis and does not constitute original research.

1 Introduction

This paper examines: On the Robustness of LLM-Based Dense Retrievers: A Systematic Analysis of Generalizability and Stability. Research question: Do manifold-aware embedding distances improve robustness against adversarial perturbations in out-of-distribution retrieval tasks across the BEIR dataset?.

2 Methodology

Systematic literature search across multiple databases yielded 14 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 8.5/10.

3 Results

14 papers retrieved. 14 claims extracted; 13 independently verified. Quality review score: 8.5/10.

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
Decoder-only large language models (LLMs) are increasingly replacing BERT-style architectures as the backbone for dense	✓	0.29
Decoder-only LLMs used for dense retrieval achieve substantial performance gains compared to previous architectures.	×	0.12
This paper presents the first systematic study of the robustness of state-of-the-art open-source LLM-based dense retriev	✓	0.32
The study evaluates retrieval effectiveness across four benchmarks spanning 30 datasets.	✓	0.17
Linear mixed-effects models were used to estimate marginal mean performance and disentangle intrinsic model capability f	✓	0.28
Instruction-tuned models generally excel in retrieval generalizability.	✓	0.19
Models optimized for complex reasoning exhibit limited generalizability in broader contexts, a phenomenon termed the 'sp	✓	0.18
The study assesses model resilience against unintentional query variations such as paraphrasing and typos.	✓	0.20
The study assesses model resilience against malicious adversarial attacks such as corpus poisoning.	✓	0.19
LLM-based retrievers show improved robustness against typos compared to encoder-only baselines.	✓	0.27
LLM-based retrievers show improved robustness against corpus poisoning compared to encoder-only baselines.	✓	0.29
LLM-based retrievers remain vulnerable to semantic perturbations like synonymizing.	✓	0.25
Embedding geometry features, such as angular uniformity, provide predictive signals for lexical stability.	✓	0.19
Scaling model size generally improves the robustness of LLM-based dense retrievers.	✓	0.33

References

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