Manifold-Aware Dense Retrievers vs. Sparse Methods on Domain-Shifted Benchmarks

Assignee Research

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Abstract

This report synthesises findings from 13 peer-reviewed papers addressing the following research question: How does the computational efficiency (inference latency, FLOPs) of manifold-aware DPR models compare to traditional sparse retrievers (e.g., BM25) when evaluated on domain-shifted benchmarks like. Dense Passage Retrieval (DPR) typically relies on Euclidean or cosine distance to measure query-passage relevance in embedding space, which is effective when embeddings lie on a linear manifold. However, our experiments across DPR benchmarks suggest that embeddings often lie on. 14 claims were extracted from source literature; 2 were independently verified against retrieved documents. An automated multi-reviewer quality assessment produced a score of 4.8/10. This report is a machine-generated literature synthesis and does not constitute original research.

1 Introduction

This paper examines: MA-DPR: Manifold-aware Distance Metrics for Dense Passage Retrieval. Research question: How does the computational efficiency (inference latency, FLOPs) of manifold-aware DPR models compare to traditional sparse retrievers (e.g., BM25) when evaluated on domain-shifted benchmarks like DPR's own NQ or HotpotQA?.

2 Methodology

Systematic literature search across multiple databases yielded 13 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 4.8/10.

3 Results

13 papers retrieved. 14 claims extracted; 2 independently verified. Quality review score: 4.8/10.

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
The experiments utilized an Intel(R) Core(TM) i7-14700HX CPU and an NVIDIA GeForce RTX 4070 Laptop GPU.	×	0.01
Average CPU utilization during measurement was approximately 5%.	×	0.00
The study evaluated MA-DPR against baselines including DPR with dEuclidean, DPR with dEuclidean + linear PCA, DPR with d	×	0.08
The DPR benchmarks used in the experiments are MS MARCO, NFCorpus, SciDocs, and ANTIQUE.	×	0.06
Two embedding models were used: msmarco-distilbert-base-tas-b (tas-b) trained on MS MARCO, and SciNCL trained on SciDocs	×	0.03
MS MARCO is treated as the in-distribution dataset for the tas-b model, while SciDocs is the in-distribution dataset for	×	0.03
All embeddings used in the experiments are 2-normalized.	×	0.03
Performance was assessed using Recall, Mean Average Precision (MAP), and Normalized Discounted Cumulative Gain (nDCG) fo	×	0.02
In a perfectly linear embedding space, the manifold-aware distance induced by dKNN_Euclidean + cDC should closely align	✓	0.15
In the presence of non-linear structure, manifold-aware distance and Euclidean distance are expected to diverge.	✓	0.18
In-distribution pairs (MS MARCO for tas-b, SciDocs for SciNCL) exhibit strong agreement and relevance distinction using	×	0.08
Out-of-distribution (OOD) settings show more misalignment between distance metrics compared to in-distribution settings.	×	0.14
The orange 'line' observed in the lower left of Figure 2 plots is caused by relevant documents that are 1-hop away from	×	0.09
Disconnected 'blobs' present in the plots correspond to different numbers of hops from the query in the manifold graph.	×	0.04

References

- http://arxiv.org/abs/2509.13562v1
- http://arxiv.org/abs/2605.07210v2
- http://arxiv.org/abs/2108.06279v2