Manifold-Aware Dense Passage Retrieval Latency and Memory Efficiency in Low-Resource Languages

Assignee Research

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Abstract

This report synthesises findings from 15 peer-reviewed papers addressing the following research question: How does MA-DPR affect retrieval latency and GPU memory consumption compared to cosine similarity in low-resource language settings on XQuAD. 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. 15 claims were extracted from source literature; 2 were independently verified against retrieved documents. An automated multi-reviewer quality assessment produced a score of 3.8/10. 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 MA-DPR affect retrieval latency and GPU memory consumption compared to cosine similarity in low-resource language settings on XQuAD?.

2 Methodology

Systematic literature search across multiple databases yielded 15 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 3.8/10.

3 Results

15 papers retrieved. 15 claims extracted; 2 independently verified. Quality review score: 3.8/10.

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.	×	0.03
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) and SciNCL.	×	0.04
MS MARCO is treated as the in-distribution dataset for the tas-b embedding model.	×	0.03
SciDocs is treated as the in-distribution dataset for the SciNCL embedding model.	×	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	×	0.04
In a perfectly linear embedding space, the manifold-aware distance induced by dKNN_Euclidean + cDC should closely align	✓	0.16
In the presence of non-linear structure in the embedding space, manifold-aware distance and Euclidean distance are expec	✓	0.20
In-distribution pairs exhibit strong agreement and relevance distinction using both Euclidean and manifold distance metr	×	0.10
Out-of-distribution (OOD) settings show more misalignment between Euclidean and manifold distances compared to in-distri	×	0.13
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.	×	0.05

References

- http://arxiv.org/abs/2108.06279v2
- http://arxiv.org/abs/2404.14464v1
- http://arxiv.org/abs/2509.13562v1