Which Programming Language and Model Work Best With LLM-as-a-Judge For Code Retrieval?

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Figure: Scan QR to connect to the project page.

Contents

Code Search and Code Generation-R is for Retrieval

Why this matters?

Developer onboarding, productivity, and maintenance.

Using a Retrieval Augmented code Generation (RAG)?

Even if you aren't searching code directly, your RAG system is. R (in RAG) is for retrieval.

Relevance and Benchmarks

- Tedious, time consuming, costly, difficult to find annotators, difficult to build data, and difficult to setup good dataset.

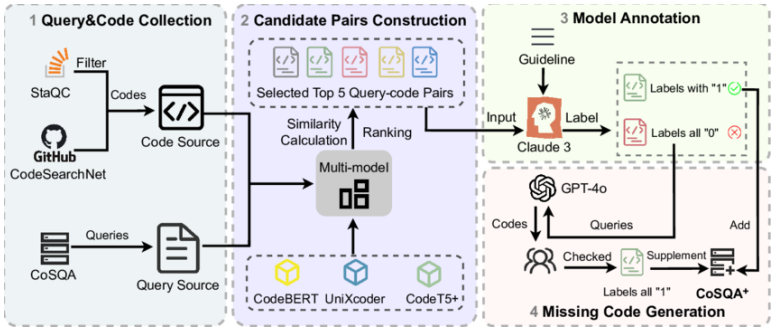


Figure: Construction of CosQA benchmark.

Why this matters?

A search system is a complex system of interlocking technologies.

Benchmarks allow us to track changes in performance across system changes.

LLM-as-a-judge

- Given query text and contents of each search result, concatenate with prompt template.
- Compare these relevance labels with those from human judgment.

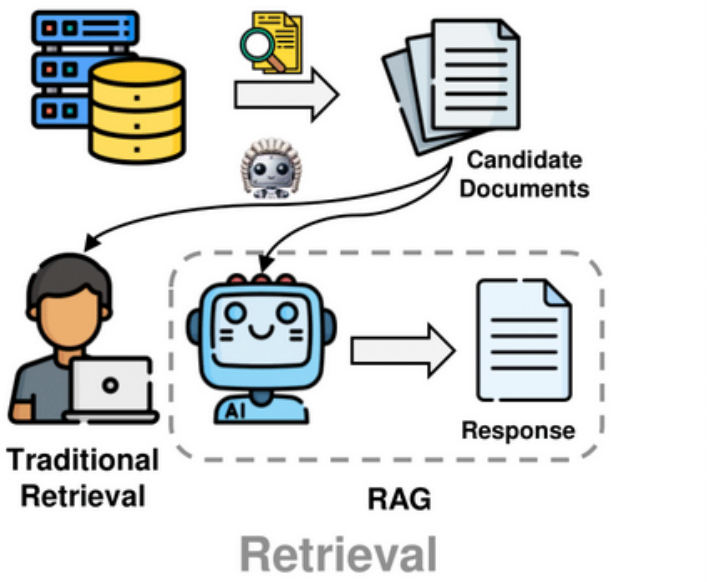
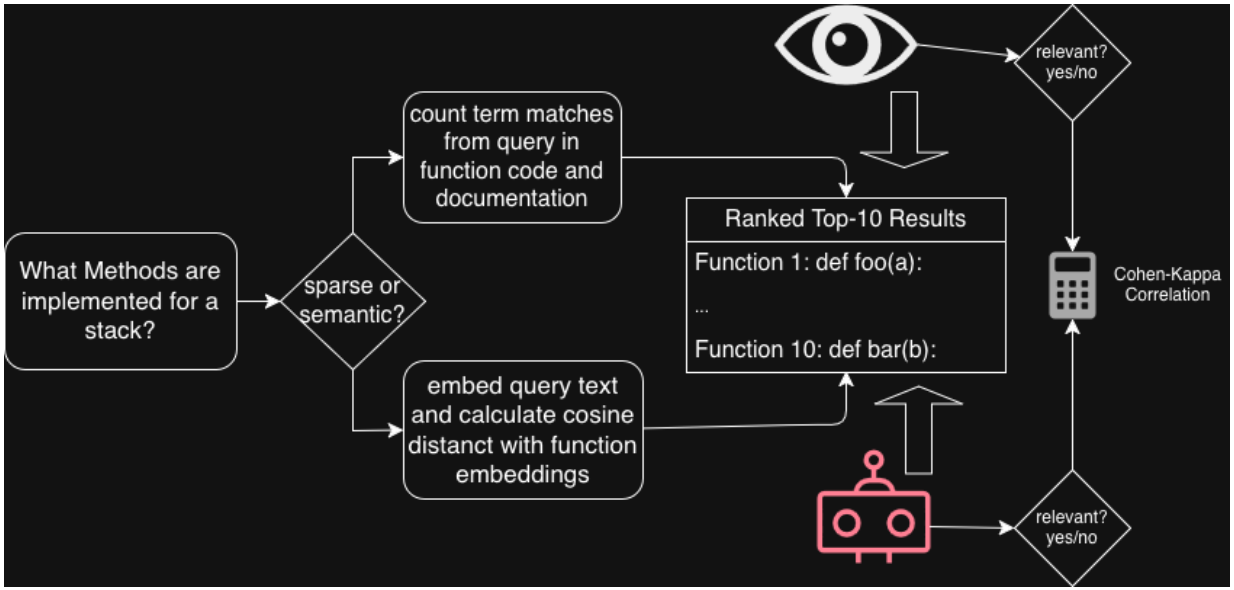


Figure: A standard LLM-as-a-judge workflow.

Experiment Workflow



LLM-as-a-judge annotation experiment process workflow.

- Sparse search uses BM25 for scoring/ranking.
- Semantic retrievers are transformers models trained on text & code. CodeBERT is encoder, CodeT5+ is encoder-decoder.
- Human (as-a-judge) label each query-result pair as relevant or not.
- LLM-as-a-judge: Nova-lite, gemini-2.0, gpt-4o-mini, Llama-4.

Research Questions

- Are there affinities between Programming Languages (PL) and LLMs when evaluating relevance?
- Does the representation (sparse vs semantic) matter when evaluating relevance?
- If there are affinities with PLs how to scale benchmarks to other PLs? (most existing benchmarks are in a single programming language)

Corpus

- We select git repositories with open source licenses across 5 popular programming languages.
- Java, Javascript, Go, Python, C.
- Each repository contains common data structures, Stacks, Priority Queues, Maps, etc.
- Parse the functions for each repo using a (programming) language parser, tree-sitter.

Software Heritage

THE GREAT LIBRARY OF SOURCE CODE

GitLab

Corpus Statistics

	C	Js	Python	Go	Java
Stack	✓	✓	✓	✓	✓
List	✓	✓	✓	✓	✓
Set	✓	✓	✗	✓	✓
Map	✓	✓	✗	✓	✓
Ordered Set	✓	✓	✗	✓	✓
Tree	✗	✗	✓	✓	✓
Queue	✓	✓	✓	✓	✓
Heap	✓	✓	✓	✓	✓
Trie	✗	✗	✓	✗	✗
% Docs Absent	25.17	93.87	56.94	54.01	19.91
# Functions	576	163	144	1,409	844
Lines of Code	7,285	1803	978	16,567	6,515
# Doc Tokens	32,762	677	502	17,344	27,057
# Code Tokens	43,257	12,326	6,724	132,402	42,482

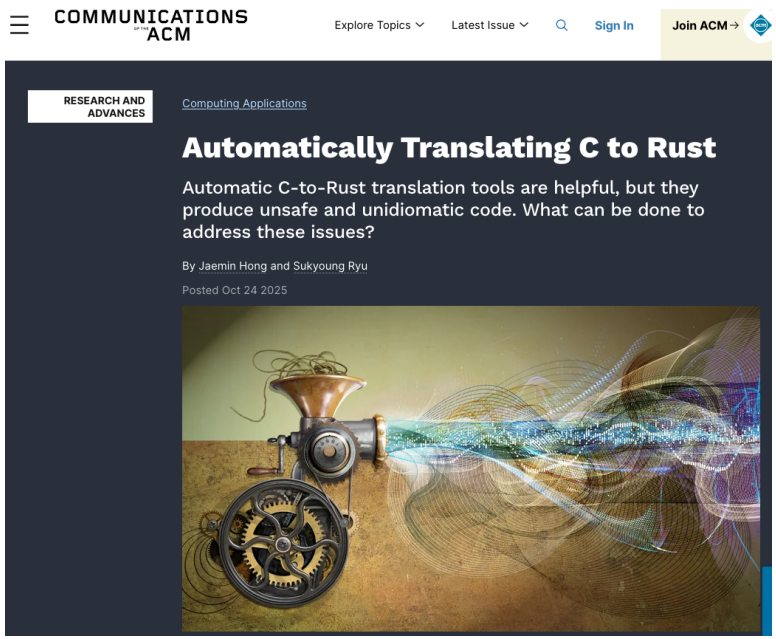
Search Queries

- We construct a list of queries, to cover the 3 main types of queries listed by Broder's taxonomy of web search.
- Some queries are constructed specifically for a certain data structure whilst others are parametrized by data structure name.
- Compared 3 retrievers, sparse: BM25, semantic: CodeBERT, and CodeT5+.
- Relevance labels from humans:

$$\underbrace{2}_{\text{humans}} \times \underbrace{5}_{\text{PLs}} \times \underbrace{3}_{\text{Retriever}} \times \underbrace{33}_{\text{query}} \times \underbrace{10}_{\text{Results size}} = 9,900.$$

Transpiler Experiment

- Translate from Python to C.
- We use the Cos-QA dataset which contains $19,000$ query, code, and relevance markings.
- Send the translated code to the LLM-as-a-judge.



Transpilers-Noteworthy Tools, Comm. ACM Oct 2025 Cover.

Programming Language Affinities

Cohen-κ correlation between human and LLM relevance determinations

	Code T5+		BM25	
	Nova-lite	GPT 4o-mini	Nova-lite	GPT 4o-mini
Python	0.23112	-0.05479	0.25286	0.02932
C	0.00075	0.22783	0.07680	0.36064
Go	0.13167	0.00389	0.28438	0.10107
Js	0.03704	-0.00464	0.14663	0.06904
Java	0.08710	0.19906	0.26513	0.01243

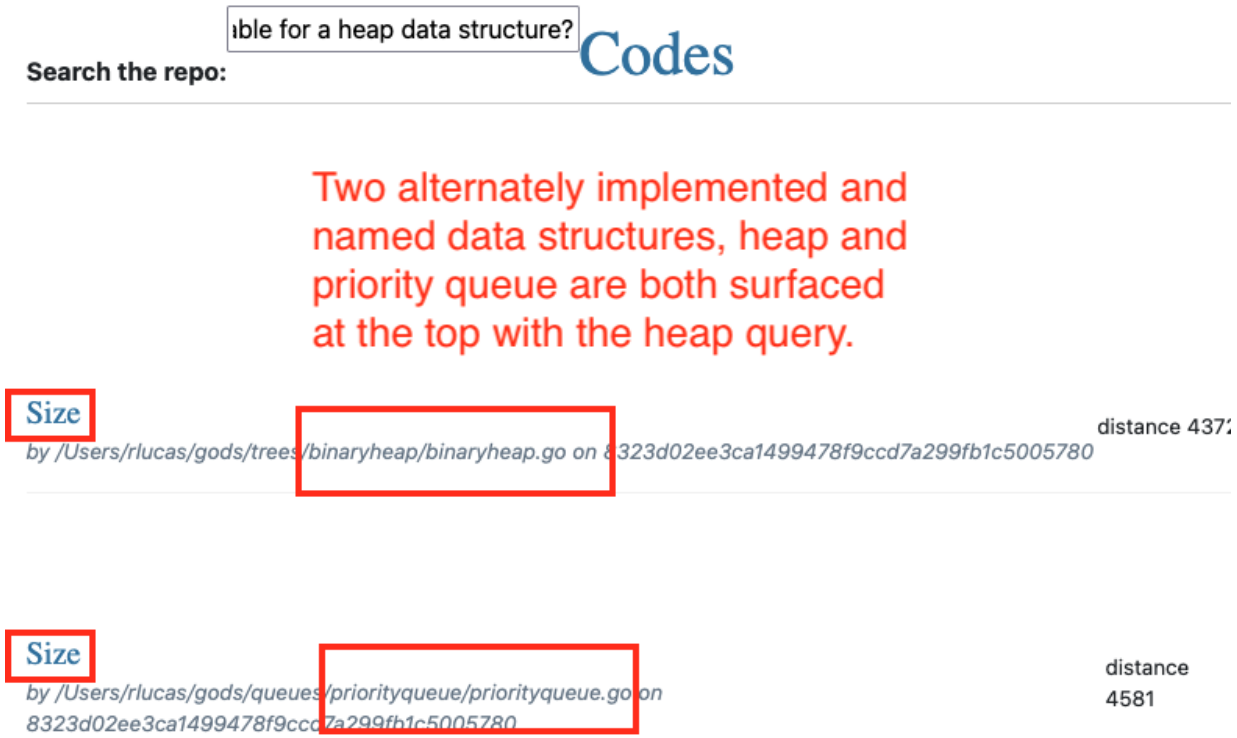
Many clear preferences-regardless of representation.
Many more metrics and model comparisons in the paper.

Representations

Improvement or Reduction in Human-AI Relevance Annotation Alignment (Cohen-κ correlation), Best Sparse and Best Semantic.

Language	BM25	CodeT5+	% change
Python	0.255286	0.23112	- 9.5%
C	0.36064	0.22783	-36.8 %
Go	0.10107	0.13167	30.3 %
Js	0.14663	0.03704	-74.7 %
Java	0.26513	0.19906	-24.9 %

Semantic Search Finds Data Structure Synonyms



Semantic Search finds heap/priority queue synonym. Whereas sparse methods like BM25 require thesaurus/query expansion/wordnet etc.

CosQA Transpiler (Py-2c) Results

LLM-as-a-judge on transpiled CosQA data, Python transpiled to C.

nova-lite	not-relevant	relevant	
not-relevant	3845	987	4832
relevant	3171	1018	4189
53.91%	7016	2005	9021

gpt-4o-mini	not-relevant	relevant	
not-relevant	2657	2175	4832
relevant	2060	2129	4189
53.05%	4717	4304	9021

Cohen-κ's are 11.19 % and 5.79% for the nova-lite and gpt-4o-mini models, respectively.

Findings Summary

- There are affinities with LLM-as-a-judge and PLs.
- Representation matters, perhaps (un)surprisingly, BM25 is a strong candidate for retrieval mechanism for code. Many design consequences from this choice.
- To scale benchmarks to other PLs consider using a transpiler.

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