Document Retrieval with Fine-grained Relevance Cues

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VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ FAKULTA INFORMAČNÍCH TECHNOLOGIÍ

1. Let Human Annotate Small Dataset

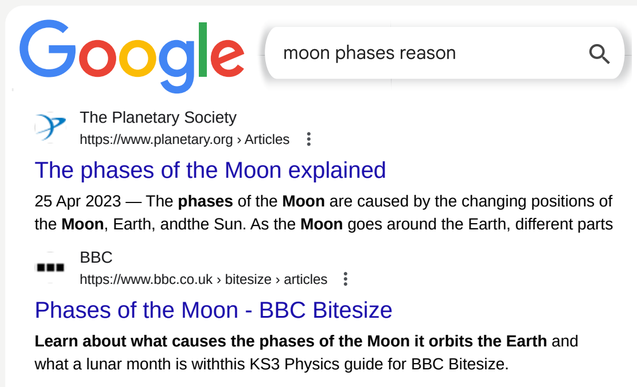
2. Evaluate LLM on Fine-Grained Extraction Task

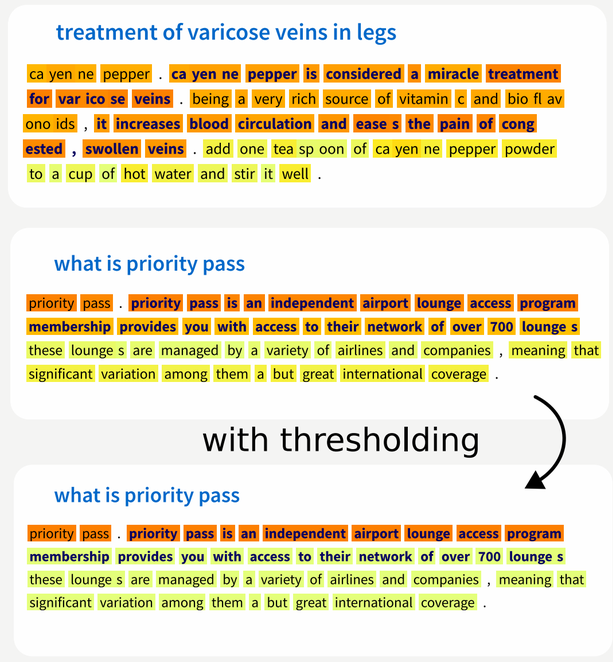
3. Use Winner LLM To Create Large-Scale Training Dataset

4. Modify Retrieval Model To Enable Token Extraction

5. Get LLM Quality Token Relevance Cues During Retrieval

Ever disappointed by Google's highlighting?





Fine-Grained Cues Motivation

- highlight => get information faster
- lowering halucination in RAG
- token-cues without calling LLM

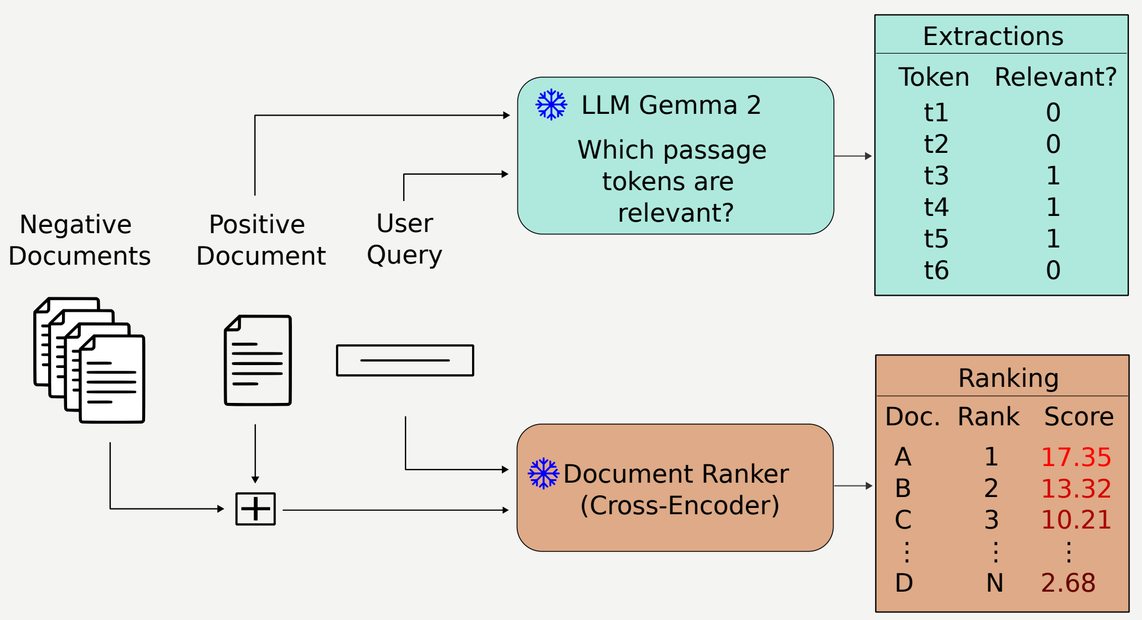
Model	Precision	Recall	F1 Score
human annotations (reference)	1.0000	1.0000	1
select-all (baseline)	0.3249	1.0000	0.4905
tf-idf (baseline)	0.5264	0.1716	0.2588
gemma2:27b-instruct-fp16	0.7635	0.7139	**0.7379**
gemma2:27b-instruct-q8	0.7592	0.7093	0.7334
gemma2:9b-instruct-fp16	0.6717	0.4037	0.5043
gemma2:9b-instruct-q8	0.6883	0.3654	0.4774
gpt-4o-2024-08-06	0.7667	0.6197	0.6854
gpt-4o-mini-2024-07-18	0.6823	0.6959	0.689
llama3.1:70b-instruct-q8	0.7495	0.6587	0.7012
llama3.1:70b-instruct-q4	0.7587	0.6371	0.6926
llama3.1:8b-instruct-fp16	0.5977	0.6042	0.6009

Table 1: Performanc of LLMs on fine-grained extraction task.

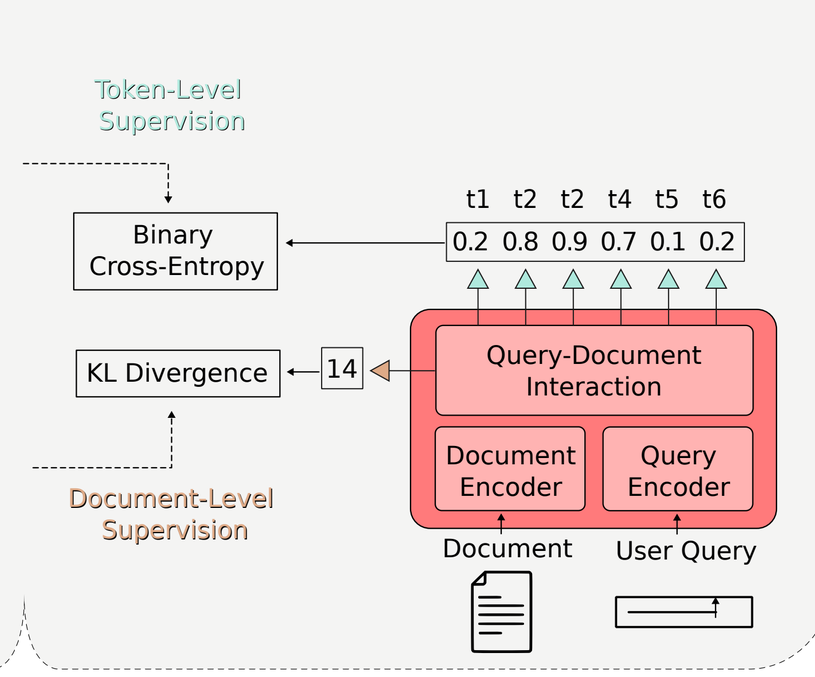
Dataset	1	2	3	4	5	6	7	>8
Train	497,922	250,182	33,030	7,561	2,238	816	335	364
Dev	4,472	2,101	267	61	25	5	1	6

Table 2: Number of extracted spans in a train and dev. sets (24 is max).

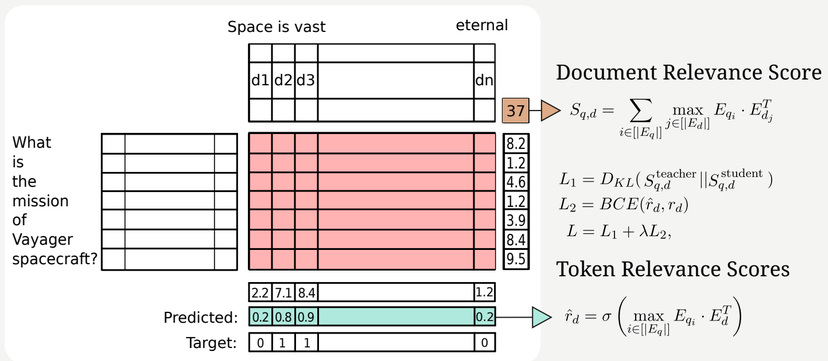
Generate Data For Distillation (Offline)



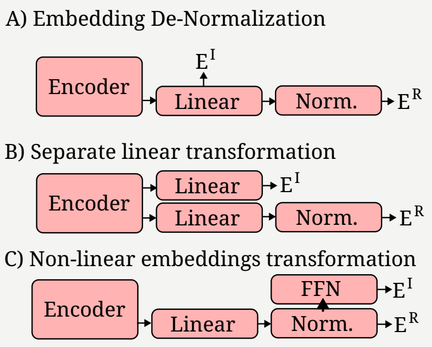
Joint Training of FGR-ColBERT



Query-Document Interaction



Encoding Architectures



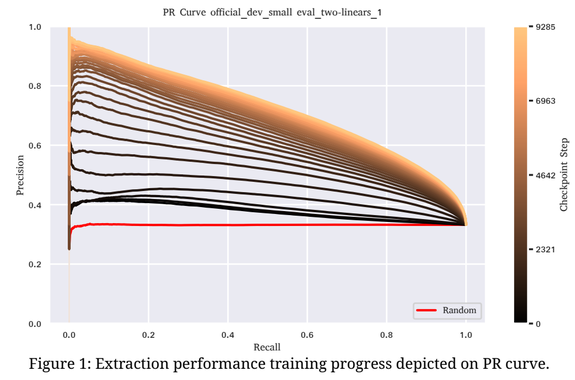
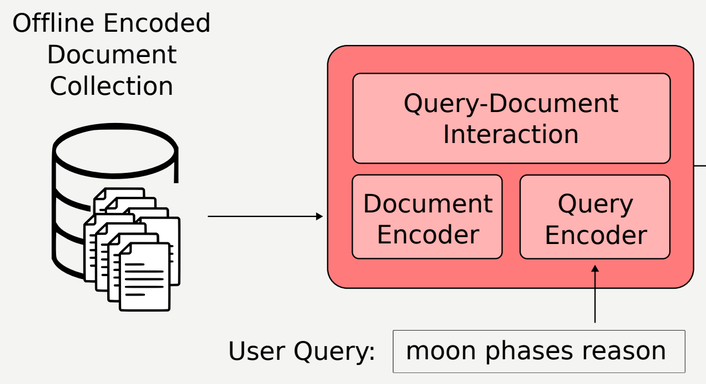


Figure 1: Extraction performance training progress depicted on PR curve.

FGR-ColBERT Inference Overview



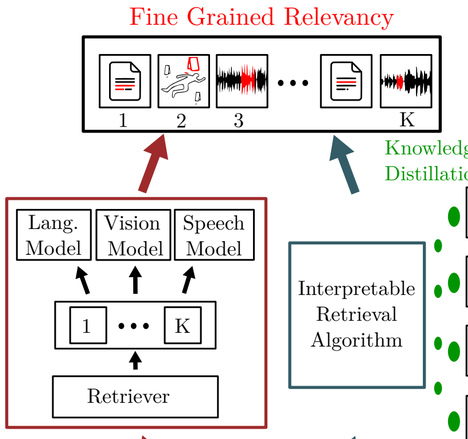
TOP ranked Documents With **Highlights**

1. The Moon looks different because of how sunlight hits it. Phases happen **due to the changing angles between the Earth, Moon, and Sun**. A full cycle takes about 29 days.

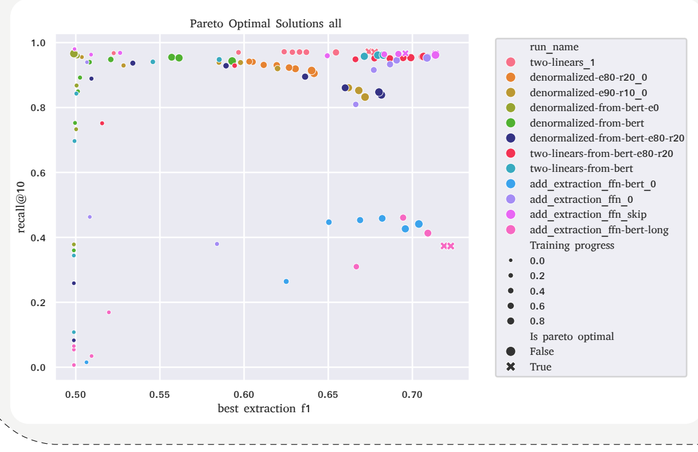
2. The Moon orbits Earth and reflects sunlight. We see **different parts of its lit side, causing the phases**. A full cycle takes about 29 days.

Holy Grail:

Output: Ranked list with Fine Grained Relevancy



Training & Evaluation



Model Architecture	Initialization	F1-score
Non-linear embeddings transformation	BERT	0.7038
	ColBERT	0.7093
Separate linear transformation	BERT	0.7067
	ColBERT	0.6775
Embedding de-normalization	BERT	0.6816
	ColBERT	0.6719
Retrieval Only	BERT	0.5008

Table 3: Human Match vs Doc Retrieval Performance

Conclusions

modified retrieval approach providing built-in relevance explainablity

cues obtained from our retrieval COLBERT (120 M) model even matched Gemma-2 (27 B)

three different approaches offering deployment flexibility

Quick Facts and Notes

Gemma size = 27B
Colbert size = 120M

Generation Errors:
792k / 808K total - (470K MS-MARCO + 317K Top-1 Retrieved)
98% generated correctly

Span Not Found (8400) + Nothing Selected (7800)

Huristacally Fixed 4600 Samples

Another Dataset of 160 unique samples
3 annotators inter agreement fleiss kappa 0.445

Previous evaluation on MD2D (Grad-SAM, AttCAT, Attention-Rollout)