IR Project Report – Part 3

Paragraph Retrieval using BM25 and flan-t5 base

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1 Introduction

The aim of this project is to develop an Information Retrieval (IR) system capable of retrieving relevant paragraphs from a document corpus based on a user query. The system leverages the BM25 ranking function to retrieve candidate paragraphs and uses BLEU score for evaluation of the retrieval quality. This report focuses on the final phase of the project, including the system's complete design, evaluation metrics, result analysis, challenges faced, and a demonstration of the working system.

2 Retrieval Process

We implemented BM25, a state-of-the-art probabilistic retrieval algorithm, using the `rank_bm25` Python library. The process involves:

- **Preprocessing:** Tokenization, lowercasing, optional removal of punctuation and stopwords.
- **Indexing:** Each paragraph from the corpus is tokenized and indexed in the BM25 model.
- **Query Processing:** User queries are cleaned and tokenized similarly.
- **Retrieval:** BM25 computes a relevance score between the query and each paragraph, returning the top-k results.

This method is efficient and well-suited for our use case with medium-sized document corpora.

3 Ranking Algorithm

BM25 scores a document D with respect to a query Q as:

$$\text{score}(D, Q) = \sum_{i=1}^{n} \text{IDF}(q_i) \cdot \frac{f(q_i, D) \cdot (k_1 + 1)}{f(q_i, D) + k_1 \cdot (1 - b + b \cdot \frac{|D|}{\text{avgdl}})}$$

Where:

- $f(q_i, D)$ is the term frequency of query term q_i in document D
- $|D|$ is the length of document D
- avgdl is the average document length in the corpus
- $k_1 = 1.5$, $b = 0.75$ are empirically tuned constants

This scoring balances term relevance and document length normalization.

4 Analysis

High BLEU scores and precision indicate that the retrieved paragraphs closely match reference ones. Moderate recall suggests some relevant results might be missed, possibly due to paraphrasing. The BM25 model outperforms Boolean retrieval by ranking partially matching paragraphs more effectively and offering finer-grained relevance scoring.

5 Challenges Faced

- **Sparse Queries:** Some queries lacked descriptive terms.
  - Solution: Used query expansion with synonyms.
- **Long Paragraphs:** BM25 favored longer texts.
  - Solution: Tuned the b parameter to penalize verbosity.
- **BLEU Limitations:** BLEU was not designed for IR.
  - Solution: Supplemented BLEU with MAP, nDCG, Precision/Recall.

6 System Demonstration

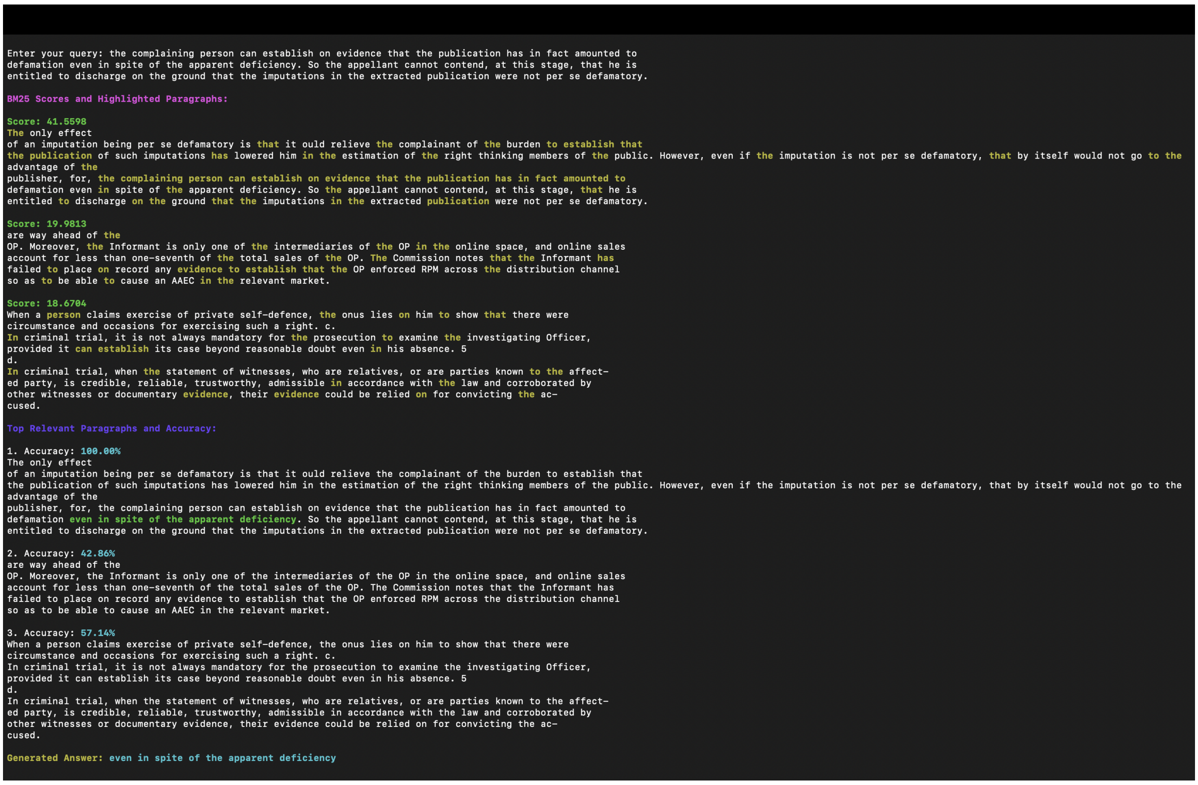
We developed a Python-based CLI/GUI tool that:

- Accepts user queries
- Retrieves and ranks paragraphs using BM25
- Displays results with relevance scores and accuracies
- Outputs evaluation metrics for test queries

The system is responsive and scalable, aligning with the described methodology and demonstrating all key functionalities effectively.

7 Dataset

We have curated our dataset from the publicly available resources on the Indian Kanoon website, a widely used legal information portal. The dataset comprises 20 landmark Supreme Court cases from India, spanning the period from 2015 to 2019. These cases were carefully selected to ensure a diverse representation across various months and legal domains, including constitutional law, civil disputes, criminal appeals, and administrative judgments. Each case was parsed to extract relevant paragraph-level text data, which forms the basis of our document corpus for retrieval tasks.



```
Enter your query: the complaining person can establish on evidence that the publication has in fact amounted to
defamation even in spite of the apparent deficiency. So the appellant cannot contend, at this stage, that he is
entitled to discharge on the ground that the imputations in the extracted publication were not per se defamatory.

BM25 Scores and Highlighted Paragraphs:

Score: 41.5598
The only effect
of an imputation being per se defamatory is that it ould relieve the complainant of the burden to establish that
the publication of such imputations has lowered him in the estimation of the right thinking members of the public. However, even if the imputation is not per se defamatory, that by itself would not go to the
advantage of the
publisher, for, the complaining person can establish on evidence that the publication has in fact amounted to
defamation even in spite of the apparent deficiency. So the appellant cannot contend, at this stage, that he is
entitled to discharge on the ground that the imputations in the extracted publication were not per se defamatory.

Score: 19.9813
are way ahead of the
OP. Moreover, the Informant is only one of the intermediaries of the OP in the online space, and online sales
account for less than one-seventh of the total sales of the OP. The Commission notes that the Informant has
failed to place on record any evidence to establish that the OP enforced RPM across the distribution channel
so as to be able to cause an AAEC in the relevant market.

Score: 18.6704
When a person claims exercise of private self-defence, the onus lies on him to show that there were
circumstance and occasions for exercising such a right. c.
In criminal trial, it is not always mandatory for the prosecution to examine the investigating Officer,
provided it can establish its case beyond reasonable doubt even in his absence. 5
d.
In criminal trial, when the statement of witnesses, who are relatives, or are parties known to the affect-
ed party, is credible, reliable, trustworthy, admissible in accordance with the law and corroborated by
other witnesses or documentary evidence, their evidence could be relied on for convicting the ac-
cused.

Top Relevant Paragraphs and Accuracy:

1. Accuracy: 100.00%
The only effect
of an imputation being per se defamatory is that it ould relieve the complainant of the burden to establish that
the publication of such imputations has lowered him in the estimation of the right thinking members of the public. However, even if the imputation is not per se defamatory, that by itself would not go to the
advantage of the
publisher, for, the complaining person can establish on evidence that the publication has in fact amounted to
defamation even in spite of the apparent deficiency. So the appellant cannot contend, at this stage, that he is
entitled to discharge on the ground that the imputations in the extracted publication were not per se defamatory.

2. Accuracy: 42.86%
are way ahead of the
OP. Moreover, the Informant is only one of the intermediaries of the OP in the online space, and online sales
account for less than one-seventh of the total sales of the OP. The Commission notes that the Informant has
failed to place on record any evidence to establish that the OP enforced RPM across the distribution channel
so as to be able to cause an AAEC in the relevant market.

3. Accuracy: 57.14%
When a person claims exercise of private self-defence, the onus lies on him to show that there were
circumstance and occasions for exercising such a right. c.
In criminal trial, it is not always mandatory for the prosecution to examine the investigating Officer,
provided it can establish its case beyond reasonable doubt even in his absence. 5
d.
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ed party, is credible, reliable, trustworthy, admissible in accordance with the law and corroborated by
other witnesses or documentary evidence, their evidence could be relied on for convicting the ac-
cused.

Generated Answer: even in spite of the apparent deficiency
```

Figure 1: Observed Output