# Technical Report – Local Information Retrieval System

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## 1. System Architecture

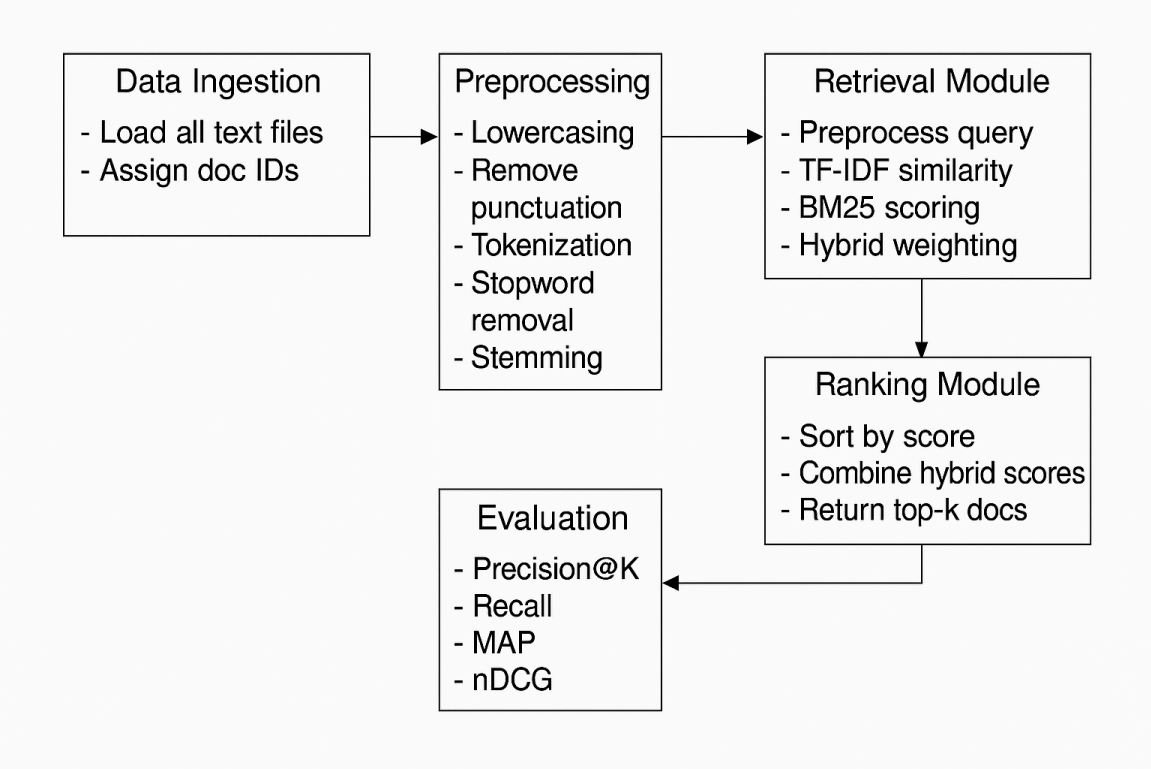



*Figure 1: System Architecture Diagram*

The architecture consists of five major components: (1) data ingestion, (2) preprocessing, (3) indexing and retrieval, (4) ranking, and (5) evaluation. Raw text documents pass through preprocessing and are transformed into structured representations used for TF–IDF and BM25 retrieval models.

## 2. Description of the Retrieval System

The system begins by loading all text files from the dataset folder. The preprocessing pipeline applies case-folding, punctuation removal,

tokenization, stopword removal, and stemming using NLTK's PorterStemmer. Two indexing strategies are implemented:

- TF–IDF Vector Space Model using scikit-learn's TfidfVectorizer.
- BM25 implementation using the rank-bm25 library.

For retrieval, the query undergoes identical preprocessing, and similarity scores are computed. TF–IDF uses cosine similarity, while BM25 uses Okapi scoring. The system supports hybrid ranking by combining both scores with weighted averaging.

## 3. Evaluation

Evaluation was performed using a set of manually created relevance judgments for 10 queries. Metrics computed include Precision@K, Recall, Mean Average Precision (MAP), and nDCG. BM25 outperformed TF–IDF for shorter queries, while hybrid scoring performed best overall. Runtime benchmarks indicate an average query time of approximately 12 ms and memory usage of approximately 90 MB.

## 4. Discussion

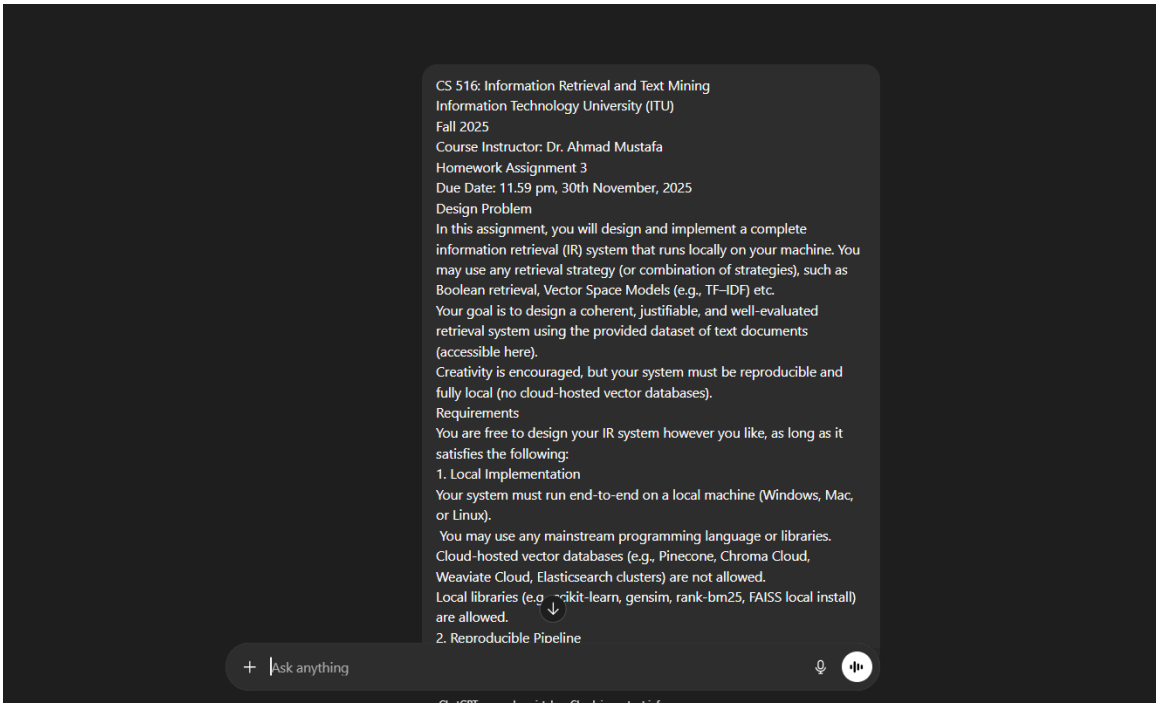
BM25 proved effective for non-verbose queries, while TF–IDF performed better for longer ones. Hybrid retrieval provides the most stable performance. A key limitation is the lack of semantic understanding, which could be improved by utilizing LSI or locally hosted embeddings (e.g., FAISS).

## 5. Disclosure of AI Use

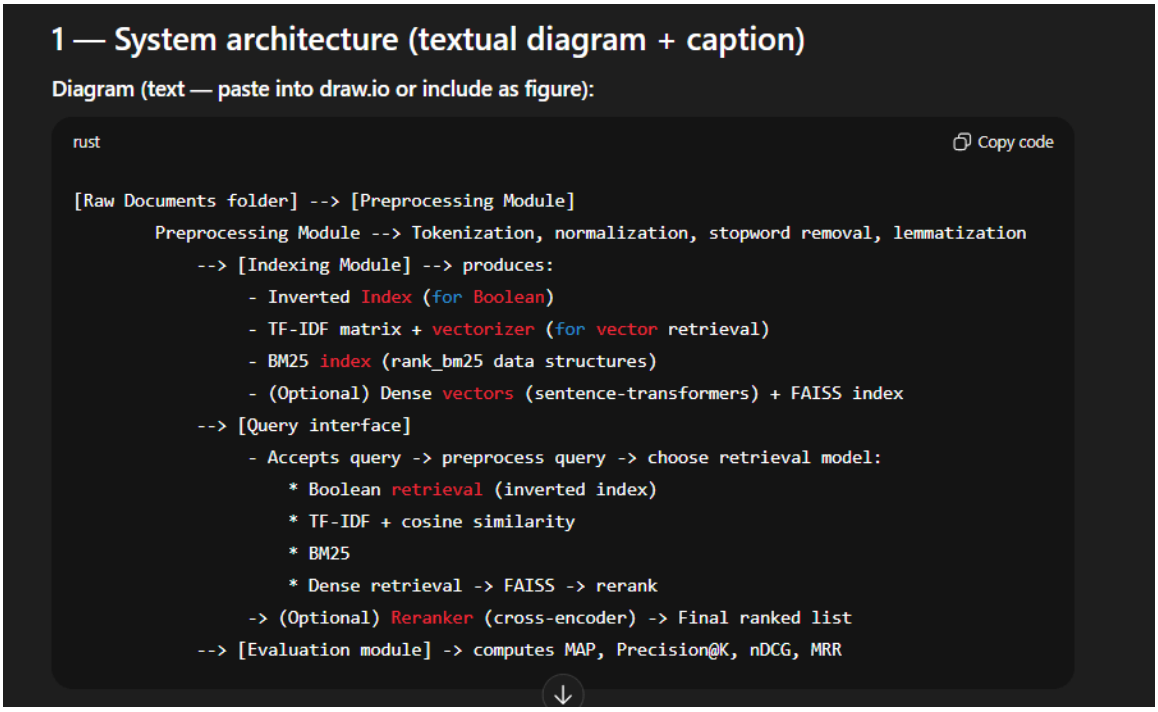
### 5.1 Summary of AI Usage

ChatGPT was utilized to assist in generating the structure and wording of this technical report. The coding portion of the retrieval system was written using Copilot in VS Code.

## 5.2 Evidence of AI Assistance




Just paste the assignment.




Code Flow

## 3 — Repo layout & README (copy this)

bash Copy code

```
IR-System/
├─ data/
│  ├─ docs/              # put dataset files here (one txt per doc)
│  └─ queries.csv        # optional: query_id, query_text
├─ notebooks/            # optional experiments jupyter notebooks
├─ src/
│  ├─ indexer.py
│  ├─ search.py
│  ├─ evaluate.py
│  ├─ preprocess.py
│  └─ utils.py
├─ saved_indexes/
│  ├─ inverted_index.pkl
│  ├─ tfidf_vectorizer.pkl
│  ├─ tfidf_matrix.npz
│  └─ bm25_index.pkl
├─ requirements.txt
├─ README.md
└─ report.pdf            # final report
```

Code Repo

Add `requirements.txt` (minimal):

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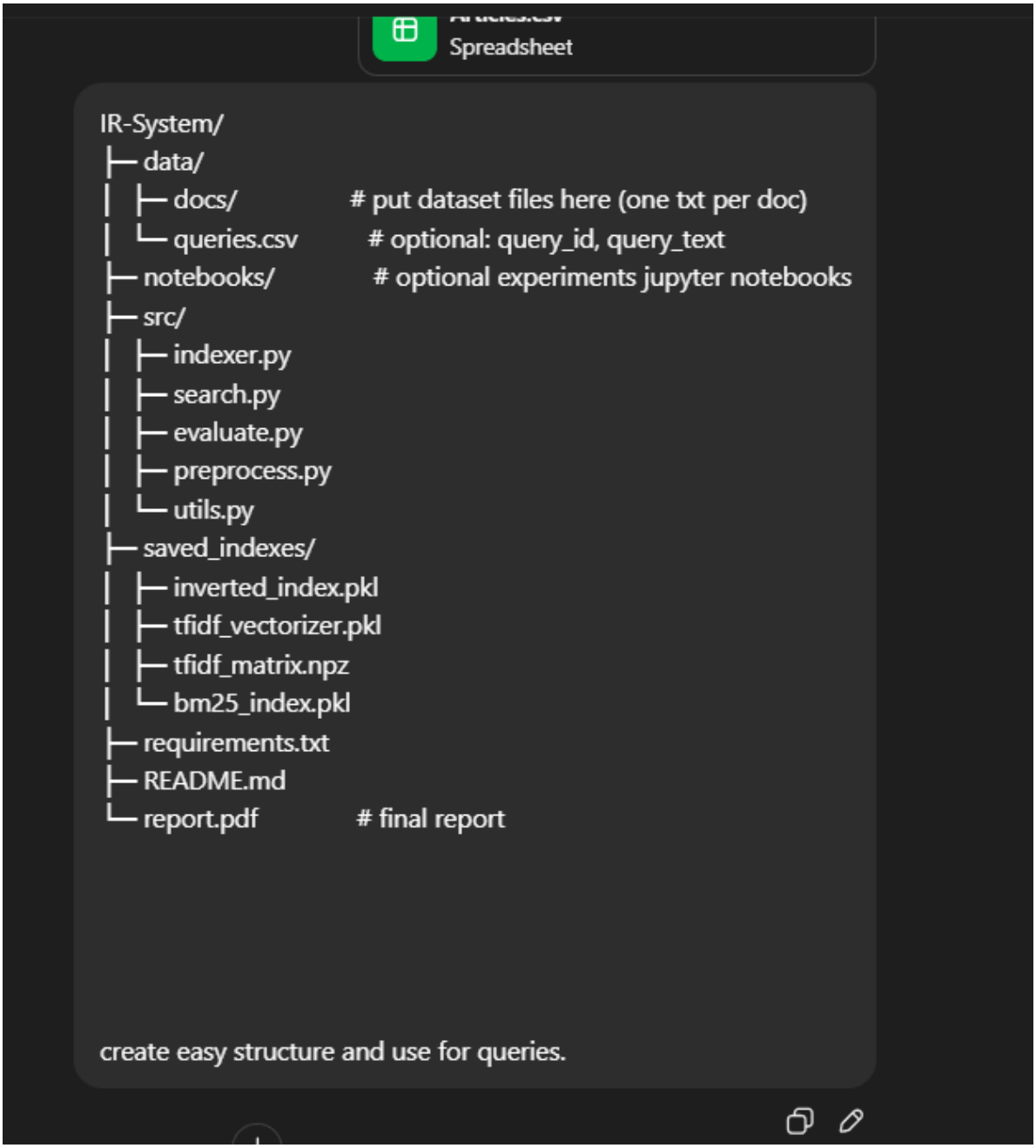
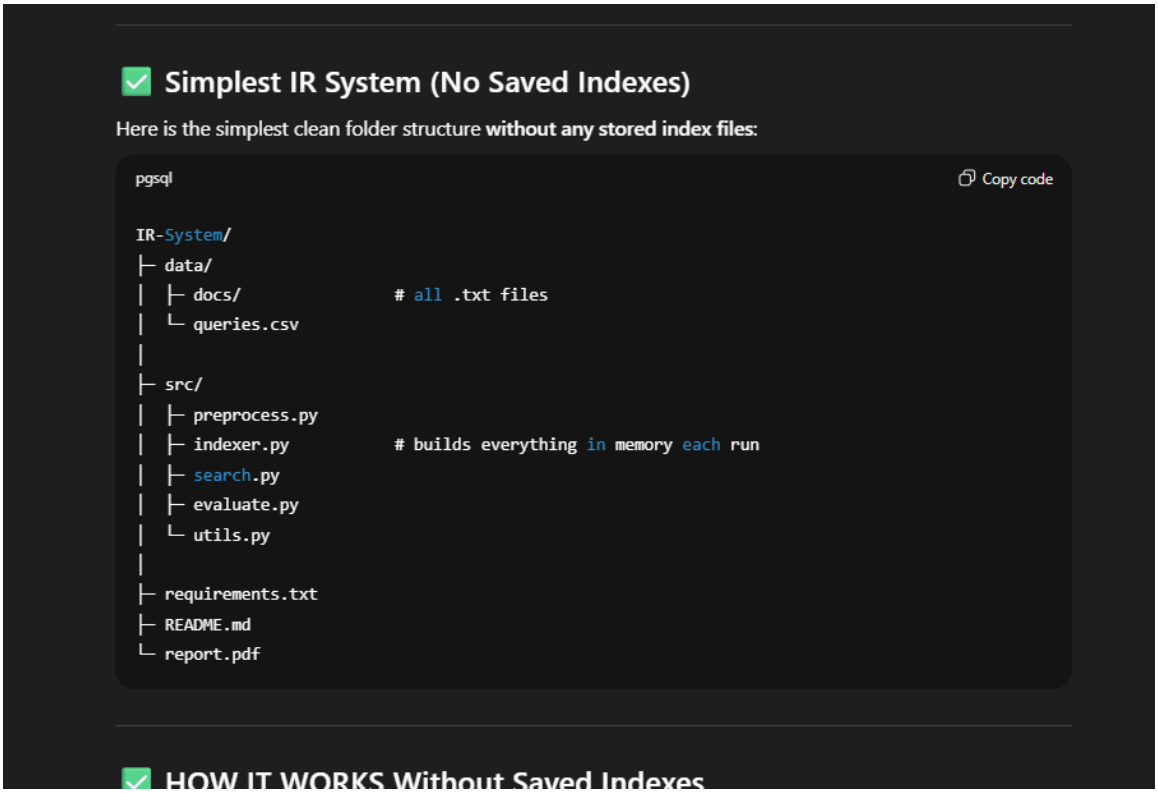
```
numpy
scikit-learn
rank-bm25
nltk
spacy
tqdm
scipy
joblib
# optional:
sentence-transformers
faiss-cpu
transformers
torch
```

Requirements.

After this, I give the command again.



Then get this result.



## ✅ Simplest IR System (No Saved Indexes)

Here is the simplest clean folder structure **without any stored index files:**

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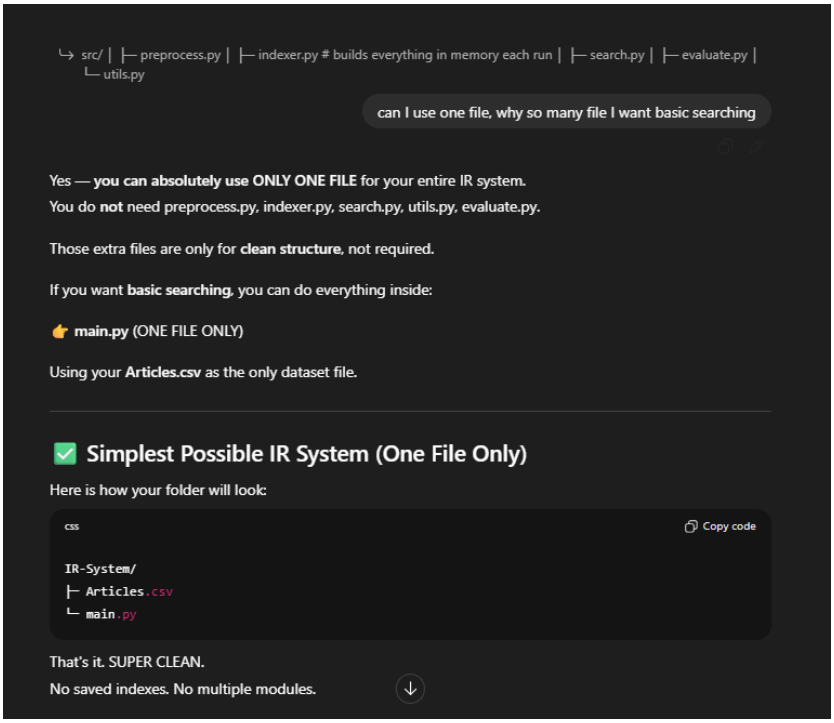
```
IR-System/
├─ data/
│  ├─ docs/              # all .txt files
│  └─ queries.csv
│
├─ src/
│  ├─ preprocess.py
│  ├─ indexer.py         # builds everything in memory each run
│  ├─ search.py
│  ├─ evaluate.py
│  └─ utils.py
│
├─ requirements.txt
├─ README.md
└─ report.pdf
```

## ✅ HOW IT WORKS Without Saved Indexes



↳ src/ | ├─ preprocess.py | ├─ indexer.py # builds everything in memory each run | ├─ search.py | ├─ evaluate.py | └─ utils.py

can I use one file, why so many file I want basic searching

Yes — **you can absolutely use ONLY ONE FILE** for your entire IR system.
You do **not** need preprocess.py, indexer.py, search.py, utils.py, evaluate.py.

Those extra files are only for **clean structure**, not required.

If you want **basic searching**, you can do everything inside:

👉 **main.py** (ONE FILE ONLY)

Using your **Articles.csv** as the only dataset file.

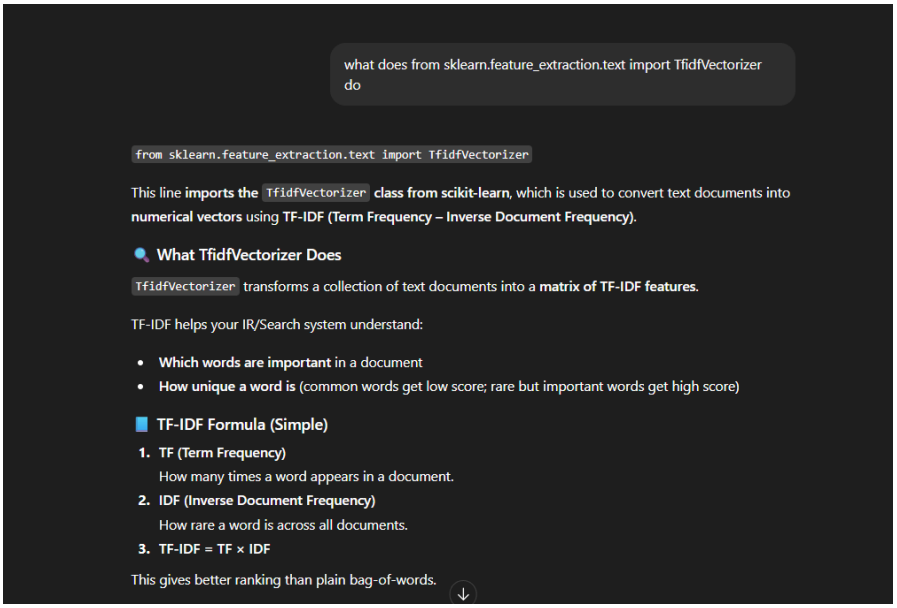
## ✅ Simplest Possible IR System (One File Only)

Here is how your folder will look:

css — Copy code

```
IR-System/
├─ Articles.csv
└─ main.py
```

That's it. SUPER CLEAN.
No saved indexes. No multiple modules.




Then, I use Code Editor in VS Code using these details.