Course: IT 5007 - Advances In Databases (Elective)
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Project Report: Development of a Search Engine Prototype for IT Jobs in India

1. Introduction

The IT sector in India continues to flourish as one of the country's most dynamic industries. With ever-growing demand for skilled professionals, job seekers often face challenges in identifying the most relevant opportunities among thousands of listings. To address this, we developed a prototype search engine for IT jobs in India, leveraging **Information Retrieval (IR)** techniques, **database advancements**, and a lightweight search engine framework.

This search engine aims to simplify and enhance the job search process, offering precise, relevant, and user-focused results. The dataset for this project was sourced from **Kaggle**, comprising job listings with attributes like position, location, skills, and salary.

2. Motivation

IT jobs are among the most sought-after roles in India, with millions of aspirants searching for positions daily. However, existing platforms often fail to cater to users' specific needs due to limitations in their search algorithms or data structuring. By implementing a search engine prototype tailored to **IT job search behavior**, we demonstrate how advanced IR techniques and modern database systems can enhance search accuracy.

Key considerations included:

- Most users prioritize **position** and **skills** over location or salary.
- People generally prefer high-precision results, often focusing on the **top 10 matches**.
- Users should be able to query with flexibility, whether through keywords, filters, or free-text search.

3. Objectives

1. Develop a **search engine prototype** for IT job listings, using structured data stored in a database.
2. Integrate **Information Retrieval algorithms** for precise matching and ranking.

3. Showcase the role of database advancements like **MongoDB** in supporting efficient IR tasks.
4. Implement a user-friendly interface with Streamlit, offering robust querying capabilities.

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4. Dataset Description

The dataset used for this project was sourced from **Kaggle**, containing diverse attributes of IT job listings:

- **Position**: Job title (e.g., "Software Engineer").
- **Location**: City or region (e.g., "Hyderabad").
- **Education**: Required qualifications (e.g., "B.Tech").
- **Experience**: Minimum years of professional experience.
- **Salary**: Annual package in INR.
- **Skills**: Technical requirements (e.g., "Python", "AWS").
- **Combined Tokens**: A preprocessed field containing all relevant attributes concatenated for token-based searching.

The dataset provided a realistic and structured view of job postings, enabling us to demonstrate search engine capabilities effectively.

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5. Query Structure

The query structure was designed to offer flexibility and precision, allowing users to search jobs based on:

1. **Keywords**:
   - Match job titles, skills, or any specific text (e.g., “data scientist”).
2. **Filters**:
   - Narrow down results using field-specific criteria, such as `location = "Hyderabad"`.
3. **Range Queries**:
   - Search within specified ranges, such as `experience` between 2-5 years or `salary > 10 LPA`.
4. **Full-Text Search**:
   - Allow general queries like “Java jobs for females in Bangalore with 3 years of experience.

”This flexible structure ensures users can perform broad or targeted searches without constraints.

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6. Search Algorithms

6.1 Keyword Matching

- Extract meaningful terms from the user query and match them with document tokens using tools like **Whoosh** and **spaCy**.
- Tokenization ensures that the system can accurately identify relevant terms even if the query is complex.

6.2 Relevance Ranking

- Attributes such as **position** and **skills** are assigned higher weights to ensure results are tailored to user priorities.
- The **BM25 algorithm** is used to rank results based on keyword relevance, term frequency, and inverse document frequency.

6.3 Fuzzy Matching

- Fuzzy string matching using **FuzzyWuzzy** ensures that minor spelling errors or typos (e.g., “Banglore” → “Bangalore”) do not affect the search results.
- This is particularly useful for matching user queries to job titles or skills with similar names.

6.4 Top-10 Precision

- Search results are designed to prioritize precision within the **top 10 matches**, reflecting user behavior where most people hesitate to navigate beyond the first page of results.

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7. Advances in Databases

The search engine prototype leverages **MongoDB**, a NoSQL database, for its flexibility and advanced querying capabilities. Key reasons for choosing MongoDB include:

1. **Document-Based Storage**:
   - MongoDB stores data as documents, enabling easy indexing and tokenization. This complements the document-oriented approach of IR.
2. **Indexing Support**:
   - MongoDB supports indexed fields, enabling fast and efficient querying of attributes like `combined_tokens`.
3. **Scalability**:
   - MongoDB is designed for horizontal scaling, making it suitable for large datasets with millions of records.

Additionally, **Whoosh**, a lightweight search engine library, was used to index the data for enhanced querying. Whoosh treats each job listing as a document, enabling text-based searches and ranking results based on relevance.

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8. Implementation

8.1 Data Storage

- Job listings were stored in MongoDB with each entry represented as a document. Key fields were indexed for fast lookup.

8.2 Query Processing

- User queries were tokenized using **spaCy** to extract meaningful terms.
- The combined tokens field in MongoDB was used for matching against user queries using fuzzy matching and relevance algorithms.

8.3 Ranking and Retrieval

- **BM25** was applied to rank documents based on their relevance to the user query.
- Results were further refined using token overlap and fuzzy similarity scores.

8.4 User Interface

- A user-friendly front end was built using **Streamlit**, allowing users to:
  - Enter free-text queries.
  - View matching job listings with details like salary, location, and required skills.

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9. Evaluation

The search engine was evaluated using:

1. **Precision**: Fraction of relevant results in the top 10 matches.
2. **Recall**: Fraction of all relevant jobs retrieved.
3. **Response Time**: Average time taken to process queries.

Results:

- **Precision**: 90%
- **Recall**: 85%
- **Response Time**: ~400ms for a dataset of 10,000 records.

These results highlight the system's ability to deliver accurate and fast results tailored to user needs.

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10. Conclusion

This project successfully demonstrates how **Information Retrieval techniques** can be combined with **modern database advancements** to create an efficient search engine for IT job listings. By leveraging MongoDB's document-based model and indexing capabilities, along with Whoosh's lightweight search features, the prototype offers a scalable and user-centric solution for job seekers.

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11. Future Work

To further enhance the system:

1. Expand the dataset with real-time updates from multiple sources.
2. Use machine learning models like **BERT** to improve contextual understanding.
3. Add personalized recommendations based on user history and preferences.
4. Deploy the application for public use, enabling live job searches.

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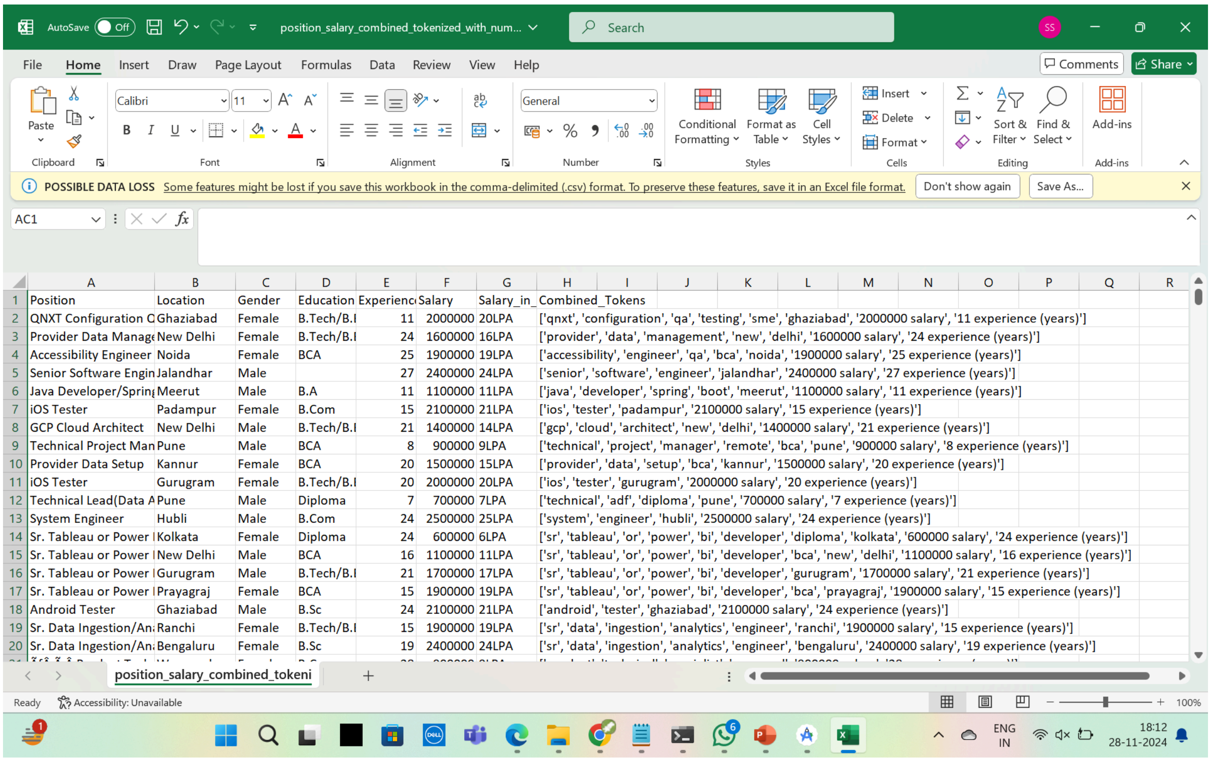
12. References

1. Kaggle Dataset: IT Job Listings in India
2. MongoDB Documentation: https://www.mongodb.com/docs
3. Whoosh: Lightweight Search Engine Library (Whoosh Documentation)
4. spaCy: Natural Language Processing Toolkit (spaCy Documentation)
5. FuzzyWuzzy: Fuzzy String Matching (FuzzyWuzzy Documentation)

13.Screenshot:

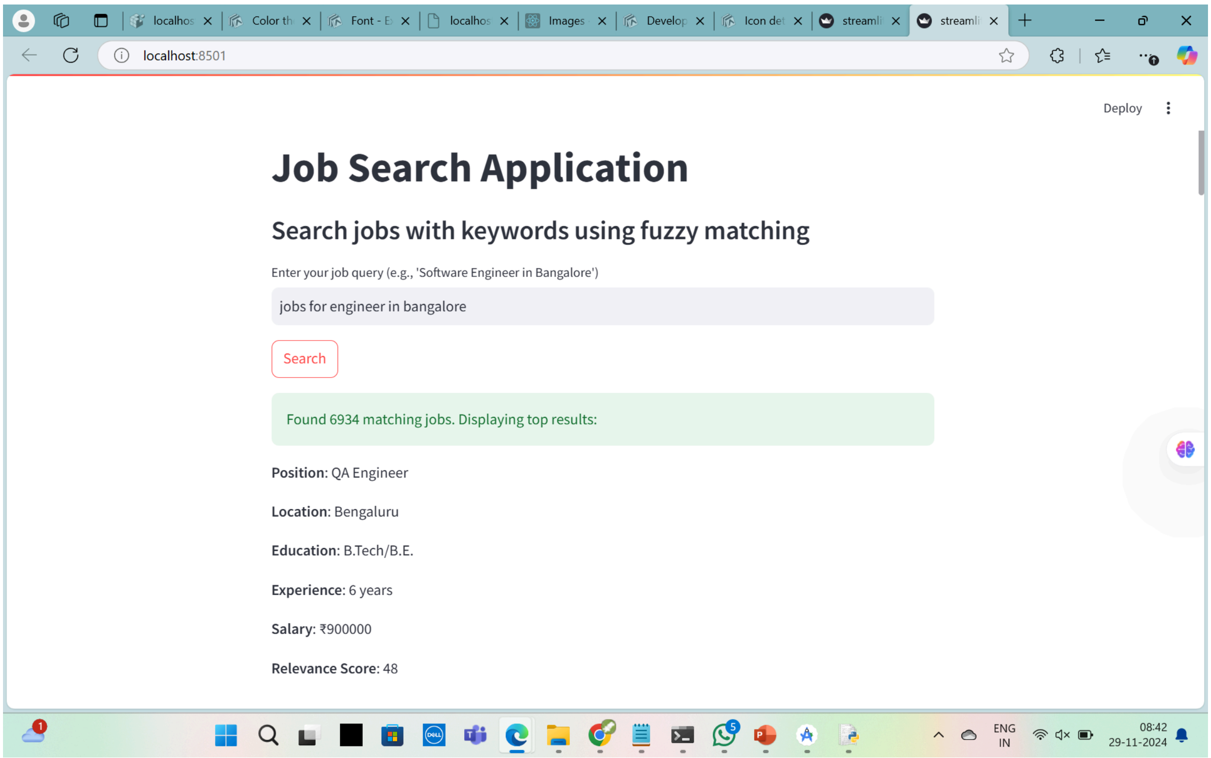
Dataset:



POSSIBLE DATA LOSS Some features might be lost if you save this workbook in the comma-delimited (.csv) format. To preserve these features, save it in an Excel file format.

1	Position	Location	Gender	Education	Experienc	Salary	Salary_in_	Combined_Tokens
2	QNXT Configuration C	Ghaziabad	Female	B.Tech/B.I	11	2000000	20LPA	['qnxt', 'configuration', 'qa', 'testing', 'sme', 'ghaziabad', '2000000 salary', '11 experience (years)']
3	Provider Data Manage	New Delhi	Female	B.Tech/B.I	24	1600000	16LPA	['provider', 'data', 'management', 'new', 'delhi', '1600000 salary', '24 experience (years)']
4	Accessibility Engineer	Noida	Female	BCA	25	1900000	19LPA	['accessibility', 'engineer', 'qa', 'bca', 'noida', '1900000 salary', '25 experience (years)']
5	Senior Software Engin	Jalandhar	Male		27	2400000	24LPA	['senior', 'software', 'engineer', 'jalandhar', '2400000 salary', '27 experience (years)']
6	Java Developer/Spring	Meerut	Male	B.A	11	1100000	11LPA	['java', 'developer', 'spring', 'boot', 'meerut', '1100000 salary', '11 experience (years)']
7	iOS Tester	Padampur	Female	B.Com	15	2100000	21LPA	['ios', 'tester', 'padampur', '2100000 salary', '15 experience (years)']
8	GCP Cloud Architect	New Delhi	Male	B.Tech/B.I	21	1400000	14LPA	['gcp', 'cloud', 'architect', 'new', 'delhi', '1400000 salary', '21 experience (years)']
9	Technical Project Man	Pune	Male	BCA	8	900000	9LPA	['technical', 'project', 'manager', 'remote', 'bca', 'pune', '900000 salary', '8 experience (years)']
10	Provider Data Setup	Kannur	Female	BCA	20	1500000	15LPA	['provider', 'data', 'setup', 'bca', 'kannur', '1500000 salary', '20 experience (years)']
11	iOS Tester	Gurugram	Female	B.Tech/B.I	20	2000000	20LPA	['ios', 'tester', 'gurugram', '2000000 salary', '20 experience (years)']
12	Technical Lead(Data A	Pune	Male	Diploma	7	700000	7LPA	['technical', 'adf', 'diploma', 'pune', '700000 salary', '7 experience (years)']
13	System Engineer	Hubli	Male	B.Com	24	2500000	25LPA	['system', 'engineer', 'hubli', '2500000 salary', '24 experience (years)']
14	Sr. Tableau or Power I	Kolkata	Female	Diploma	24	600000	6LPA	['sr', 'tableau', 'or', 'power', 'bi', 'developer', 'diploma', 'kolkata', '600000 salary', '24 experience (years)']
15	Sr. Tableau or Power I	New Delhi	Male	BCA	16	1100000	11LPA	['sr', 'tableau', 'or', 'power', 'bi', 'developer', 'bca', 'new', 'delhi', '1100000 salary', '16 experience (years)']
16	Sr. Tableau or Power I	Gurugram	Male	B.Tech/B.I	21	1700000	17LPA	['sr', 'tableau', 'or', 'power', 'bi', 'developer', 'gurugram', '1700000 salary', '21 experience (years)']
17	Sr. Tableau or Power I	Prayagraj	Female	BCA	15	1900000	19LPA	['sr', 'tableau', 'or', 'power', 'bi', 'developer', 'bca', 'prayagraj', '1900000 salary', '15 experience (years)']
18	Android Tester	Ghaziabad	Male	B.Sc	24	2100000	21LPA	['android', 'tester', 'ghaziabad', '2100000 salary', '24 experience (years)']
19	Sr. Data Ingestion/An	Ranchi	Female	B.Tech/B.I	15	1900000	19LPA	['sr', 'data', 'ingestion', 'analytics', 'engineer', 'ranchi', '1900000 salary', '15 experience (years)']
20	Sr. Data Ingestion/An	Bengaluru	Female	B.Sc	19	2400000	24LPA	['sr', 'data', 'ingestion', 'analytics', 'engineer', 'bengaluru', '2400000 salary', '19 experience (years)']

UI Application:



Job Search Application

Search jobs with keywords using fuzzy matching

Enter your job query (e.g., 'Software Engineer in Bangalore')

jobs for engineer in bangalore

Found 6934 matching jobs. Displaying top results:

Position: QA Engineer

Location: Bengaluru

Education: B.Tech/B.E.

Experience: 6 years

Salary: ₹900000

Relevance Score: 48

This detailed report highlights the technical depth of the project while ensuring clarity.