German Job Market: Data Engineering project

1

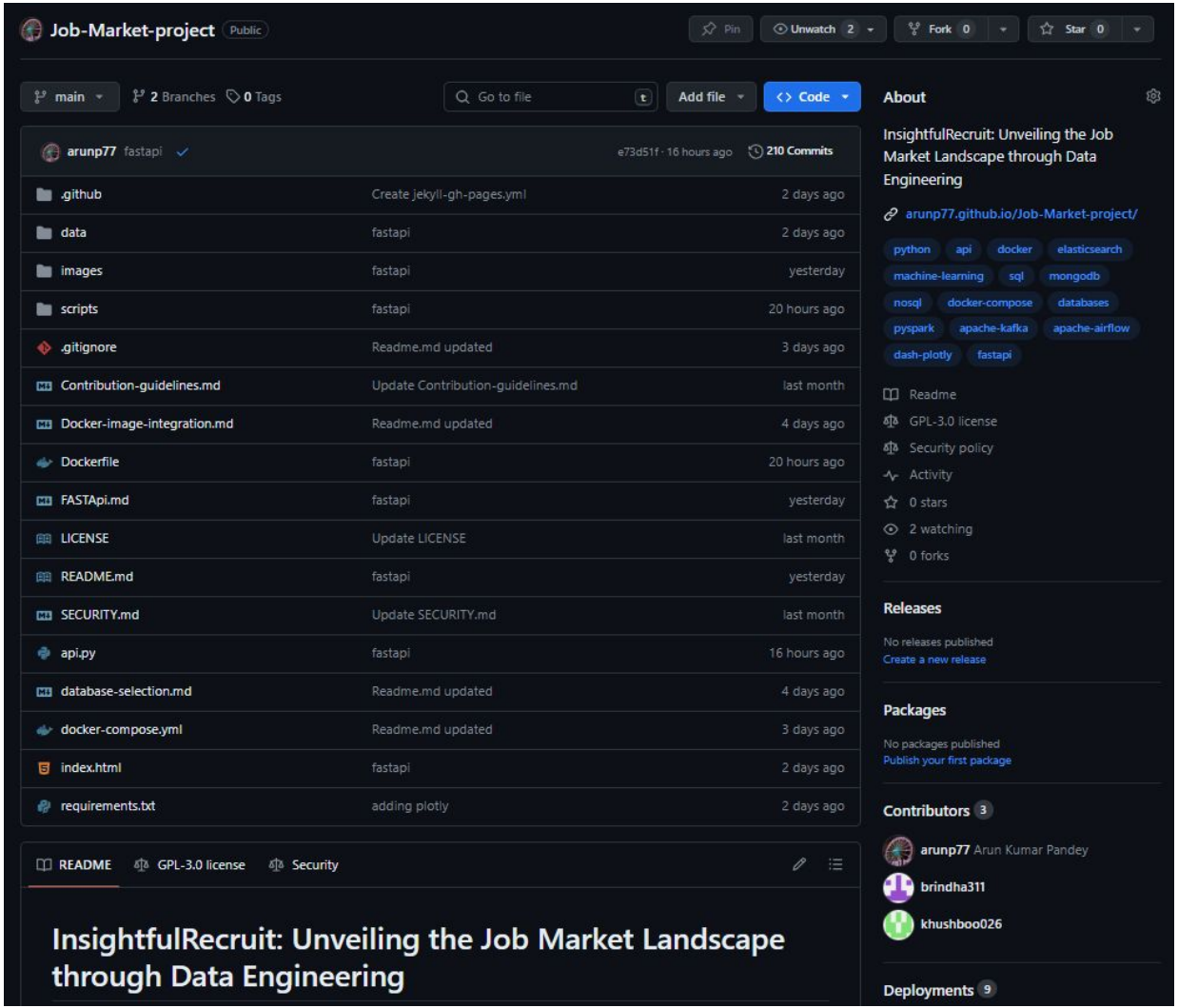
Objective : Data extraction/ cleaning

Project repo directory structure

```
Job-Market-project/
|
├── .env                                        # Environment variables file
├── .github/
|   └── workflows/                              # GitHub Actions workflow directory
|       └── ci.yml                              # CI/CD workflow file
├── images/                                     # Directory for image files
├── scripts/                                    # Directory for scripts
|   ├── web_scraping/                           # Directory for web scraping scripts
|   |   ├── adjurna.py                          # Script for Adjurna data extraction
|   |   ├── muse.py                             # Script for Muse data extraction
|   |   └── ss.py                               # Script for Stepstone data extraction
|   ├── etl/                                    # Directory for ETL scripts
|   |   └── etlscript.py                        # ETL script
|   ├── database/                               # Directory for database scripts
|   |   └── db_connection.py                    # Database connection script
|   └── plot_analysis/                          # Directory for plot analysis scripts
|       └── uscase.py                           # Use case plot analysis script
├── data/                                       # Directory for data
|   ├── scraped_data/                           # Directory for scraped data
|   |   ├── adjurna/                            # Directory for Adjurna data
|   |   |   └── csv/                            # Directory for CSV files
|   |   |       └── adzuna_scrapped_data.csv    # Adjurna scraped data file
|   |   ├── muse/                               # Directory for Muse data
|   |   |   └── csv/                            # Directory for CSV files
|   |   |       └── muse_scrapped_data.csv      # Muse scraped data file
|   |   └── ss/                                 # Directory for Stepstone data
|   |       └── ss_datascience_germany_20240221.csv # Stepstone data file
|   └── processed_data/                         # Directory for processed data
|       ├── adjurna_processed_data/             # Directory for processed Adjurna data
|       |   └── adzuna_scrapped_data.csv        # Processed Adjurna data file
|       ├── muse_processed_data/                # Directory for processed Muse data
|       |   └── muse_scrapped_data.csv          # Processed Muse data file
|       └── ss_processed_data/                  # Directory for processed Stepstone data
|           └── ss_datascience_germany_20240221.csv # Processed Stepstone data file
├── api.py                                      # FASTApi
├── README.md                                   # Readme file
├── ProjectPlan.md                              # Project plan file
├── LICENSE.md                                  # License file
├── Contribution-guidelines.md                  # Contribution guidelines file
└── UserStories.md                              # User stories file
```

Project Github Repo:
https://github.com/arunp77/Job-Market-project

Project repo directory structure



Objective

This project aims to gather, process, create a database and deploy using FASTApi. By the end of the project, we aim to have a clearer understanding of the job market, including sectors with the highest demand, required skills, active cities, and more.

Data Extraction/Processing

Two method of data extraction:

- Connect to API (Adzuna, Muse)
- Web scraping (Stepstone)

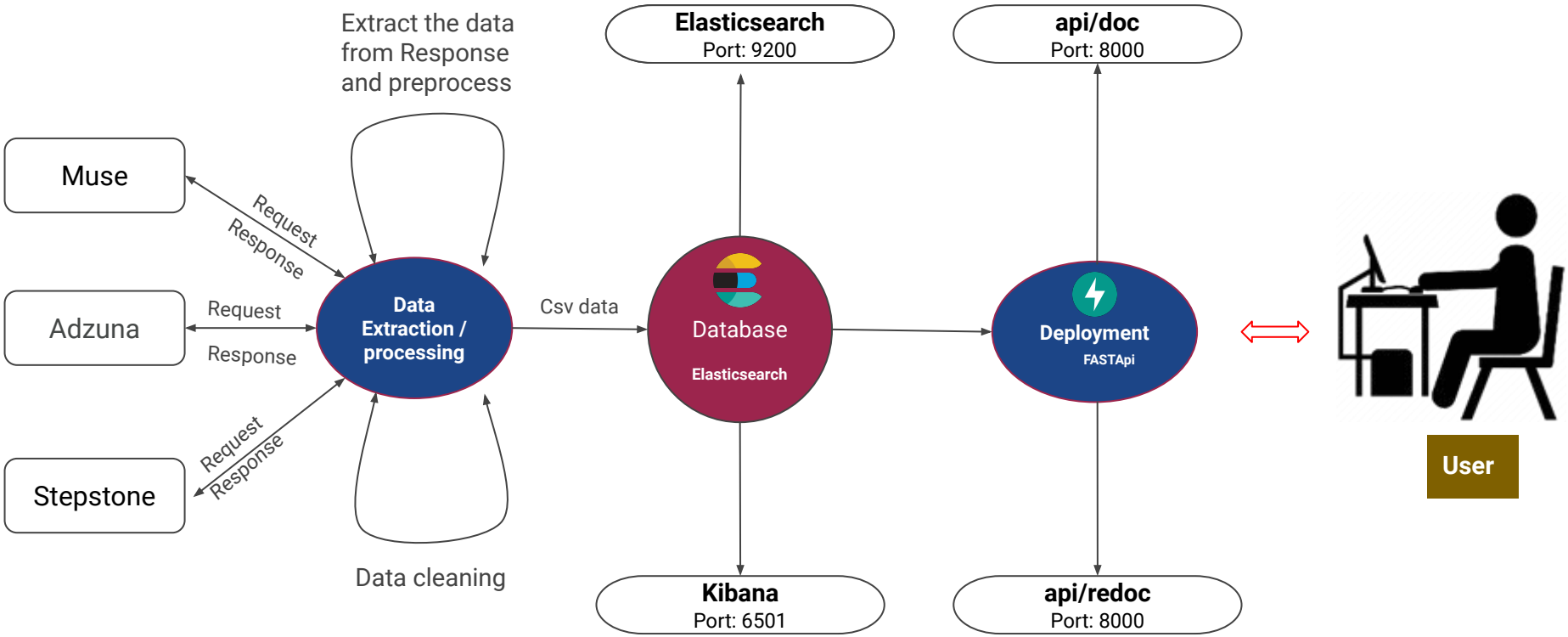
DataBase: Elasticsearch

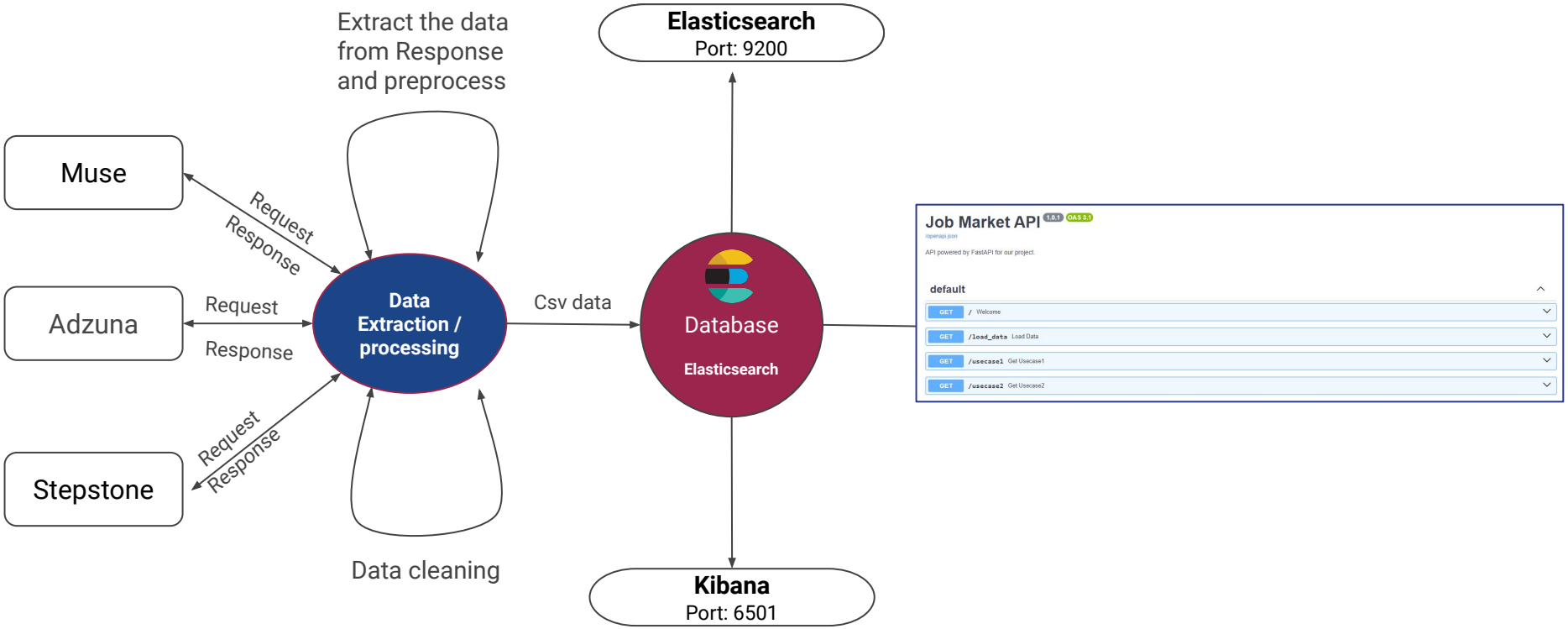
NoSQL DB is better for different schema data from different source

Elasticsearch is better compare to other DB for job market use case, as text search is important.

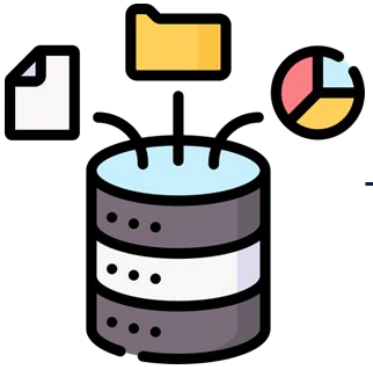
Deployment: FASTApi

Used FASTApi for deploying our app. The user can call the various APIs using this single app and can see the results.


Extract the data from Response and preprocess
Elasticsearch
Port: 9200
api/doc
Port: 8000
Muse
Request
Response
Adzuna
Request
Response
Stepstone
Request
Response
Data Extraction / processing
Csv data
Database
Elasticsearch
Deployment
FASTApi
User
Data cleaning
Kibana
Port: 6501
api/redoc
Port: 8000


Extract the data from Response and preprocess
Elasticsearch
Port: 9200
Muse
Request
Response
Adzuna
Request
Response
Stepstone
Request
Response
Data Extraction / processing
Csv data
Database
Elasticsearch
Job Market API
1.0.1
OAS 3.1
/openapi.json
API powered by FastAPI for our project.
default
GET / Welcome
GET /load_data Load Data
GET /usecase1 Get Usecase1
GET /usecase2 Get Usecase2
Data cleaning
Kibana
Port: 6501

Database : Query



Job Databases

Fetch

FastAPI
Application

Query

Result
Dataset

Users

Data Extraction : Processing

Data Extraction → **Data cleaning** → **Saving csv format**

Three sources:

- Muse Api
- Adzuna Api
- Web Scraping from Stepstone

Category: Data Science

- Translation of text from German to English
- Datetime handling (maintaining same date time format in the various data files)

Saved data format:

- CSV
- JSON

But have used csv for current project. But in future we also create pipeline, which also utilize the json format for further analysis.

Data Extraction : Processing

Data Extraction → **Data cleaning**

Three sources:

- Muse Api
- Adzuna Api
- Web Scraping from Stepstone

Category: Data Science

- Translation of text from German to English
- Datetime handling (maintaining same date time format in the various data files)

Challenges

APIs: Muse and Adzuna Apis are used to extract the data.

Limitations: Muse has limits on requests/hrs so had to manually set limits on datasets from Muse.

Web Scraping: Stepstone website is dynamic so using beautifulsoup for scraping was not doable. Used selenium to load the page and scrap the data.

For cleaning: the api could not translate the entire text. Have to find out the words and translate them separately in the code.

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Database : Elasticsearch

Database: Elasticsearch

- **Full-text Search:** Elasticsearch excels in text search tasks, ideal for job market analysis.
- **Scalability and Performance:** Elasticsearch handles large data volumes efficiently, focusing on search performance.
- **Real-time Analytics:** Elasticsearch supports real-time data analysis, crucial for timely insights in job market analysis.
- **Complex Querying and Aggregations:** Elasticsearch offers powerful analytical capabilities for in-depth job market analysis.

Generalized Data Schema

Field Name	Data Type
id	keyword
title	text
company	text
location	text
job_posted	date
categories	text
experience_level	text
full_part_time	text
description	text
link	text
source	text

Example query: Source Stepstone


```
{
  "_id": "qGgaeo4BdUjihSI212xp",
  "title": "Data Engineer (m/w/d)",
  "company": "Hermes Germany GmbH",
  "location": "Hamburg",
  "job_posted": "2024-02-17",
  "Link": "https://www.stepstone.de/stellenangebote--Data-Engineer-m-w-d-Hamburg-Hermes-Germany-GmbH--10751259-inline.html",
  "source": "stepstone"
}
```



```
_id: "qGgaeo4BdUjihSI212xp"
title: "Data Engineer (m/w/d)"
company: "Hermes Germany GmbH"
location: "Hamburg"
job_posted: "2024-02-17"
link: "https://www.stepstone.de/stellenangebote--Data-Engineer-m-w-d-Hamburg-Hermes-G…
source: "stepstone"
```

Example query: Source Adzuna API


```
{
  "title": "Data Scientist (f/m/d) - database development/BI, engineer",
  "company": "Capgemini",
  "location": "München, München (Kreis)",
  "job_posted": "2024-02-13",
  "description": "As a data scientist (f/m/d), you are part of our Insights & Data team, which carries out software and consulting projects with a focus on data science, analytics, SAP analytics, data warehousing, master data, data quality management and artificial intelligence. We train you in the technologies and processes for data analytics and get you ready for your projects. You will be trained and certified by us or our partners. For this position in the Defense area there is a...",
  "link": "https://www.adzuna.de/details/4567064802?utm_medium=api&utm_source=16b1dafa",
  "source": "adzuna"
}
```



```
title: "Data Scientist (f/m/d) - database development/BI, engineer"
company: "Capgemini"
location: "München, München (Kreis)"
job_posted: "2024-02-13"
description: "As a data scientist (f/m/d), you are part of our Insights & Data team, which c…
link: "https://www.adzuna.de/details/4567064802?utm_medium=api&utm_source=16b1dafa"
source: "adzuna"
```

Example query: Source Muse API


```
{
  "title": "Lead Data Science Engineer - Remote US",
  "company": "Siemens",
  "location": "Chicago, IL, Flexible / Remote",
  "job_posted": "2023-05-16",
  "categories": "Data and Analytics",
  "experience_level": "Senior Level",
  "full_part_time": "Full-time",
  "link": "https://www.themuse.com/jobs/siemens/lead-data-science-engineer-remote-us",
  "source": "muse"
}
```



```
title: "Lead Data Science Engineer - Remote US"
company: "Siemens"
location: "Chicago, IL, Flexible / Remote"
job_posted: "2023-05-16"
categories: "Data and Analytics"
experience_level: "Senior Level"
full_part_time: "Full-time"
link: "https://www.themuse.com/jobs/siemens/lead-data-science-engineer-remote-us"
source: "muse"
```

Elasticsearch : Launch

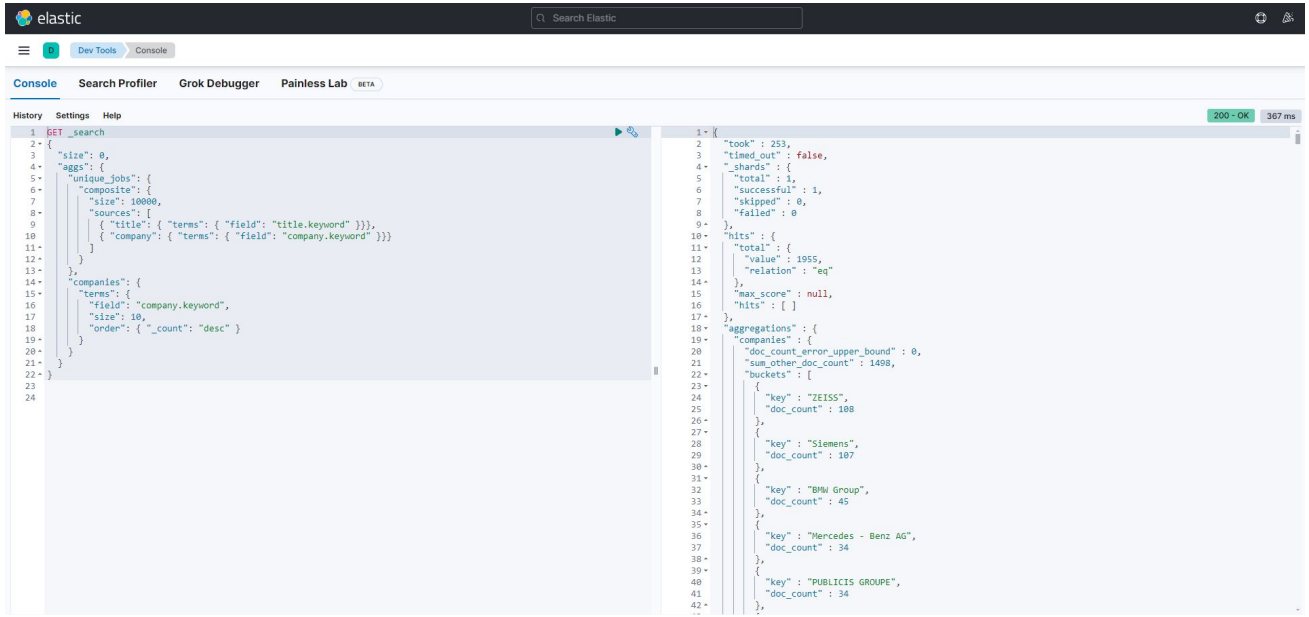
$ docker-compose up -d

```
PS D:\Arun 2022\Github\Data-engineering-courses\Job-Market-project> docker-compose up -d
[+] Building 170.8s (12/12) FINISHED
 => [python-app internal] load build definition from Dockerfile
 => => transferring dockerfile: 1.15kB
 => [python-app internal] load .dockerignore
 => => transferring context: 2B
 => [python-app internal] load metadata for docker.io/library/python:3.10
 => [python-app auth] library/python:pull token for registry-1.docker.io
 => [python-app internal] load build context
 => => transferring context: 354.63MB
 => [python-app 1/6] FROM docker.io/library/python:3.10@sha256:f9307a98b4ca854bfeb342f7a9c8402557e869a190c4d78ae57157ae82ce8c0d
 => => resolve docker.io/library/python:3.10@sha256:f9307a98b4ca854bfeb342f7a9c8402557e869a190c4d78ae57157ae82ce8c0d
 => => sha256:f9307a98b4ca854bfeb342f7a9c8402557e869a190c4d78ae57157ae82ce8c0d 1.65kB / 1.65kB
 => => sha256:86d840ffceff3d1631aefa53407536bb49b9d22c2ba45f3240f85e6f69ae188a 2.01kB / 2.01kB
 => => sha256:71215d55680cf0ab2dcc0e1dd65ed76414e3fb0c294249b5b9319a8fa7c398e4 49.55MB / 49.55MB
 => => sha256:3cb8f9c23302e175d87a827f0a1c376bd59b1f6949bd3bc24ab8da0d669cdfa0 24.05MB / 24.05MB
 => => sha256:5f899db30843f8330d5a40d1acb26bb00e93a9f21bff253f31c20562fa264767 64.14MB / 64.14MB
 => => sha256:530eb623b999b117ec9afb986a25b55456028c39df7dd1c7a86a7ebd3d2a95c7 7.34kB / 7.34kB
 => => sha256:567db630df8d441ffe43e050ede26996c87e3b33c99f79d4fba0bf6b7ffa0213 211.14MB / 211.14MB
 => => sha256:d68cd2123173935e339e3feb56980a0aefd7364ad43ca2b9750699e60fbf74c6 6.39MB / 6.39MB
 => => sha256:93260772815949a98e11044f6ca8173565a1b78f170949c5e6def9122a654ccc 17.15MB / 17.15MB
 => => extracting sha256:71215d55680cf0ab2dcc0e1dd65ed76414e3fb0c294249b5b9319a8fa7c398e4
 => => sha256:1f8ac46ddd20addb48905efe7110a45e526466cfa4edaf21a22b0352376c9c55 242B / 242B
 => => sha256:de8f8b8e2a8bcccb4bc0ab17ca323c3bedb4035c34b0e73962e2aef7793f1670 3.08MB / 3.08MB
 => => extracting sha256:3cb8f9c23302e175d87a827f0a1c376bd59b1f6949bd3bc24ab8da0d669cdfa0
 => => extracting sha256:5f899db30843f8330d5a40d1acb26bb00e93a9f21bff253f31c20562fa264767
 => => extracting sha256:567db630df8d441ffe43e050ede26996c87e3b33c99f79d4fba0bf6b7ffa0213
 => => extracting sha256:d68cd2123173935e339e3feb56980a0aefd7364ad43ca2b9750699e60fbf74c6
 => => extracting sha256:93260772815949a98e11044f6ca8173565a1b78f170949c5e6def9122a654ccc
 => => extracting sha256:1f8ac46ddd20addb48905efe7110a45e526466cfa4edaf21a22b0352376c9c55
 => => extracting sha256:de8f8b8e2a8bcccb4bc0ab17ca323c3bedb4035c34b0e73962e2aef7793f1670
 => [python-app 2/6] WORKDIR /app
 => [python-app 3/6] COPY . /app
 => [python-app 4/6] COPY requirements.txt .
 => [python-app 5/6] RUN pip install --no-cache-dir -r requirements.txt
 => [python-app 6/6] COPY . .
 => [python-app] exporting to image
 => => exporting layers
 => => writing image sha256:a4b551c6895c6242a3bce2a5d381213cc3d7797cb5e61f6bd8c2a2256428a65c
 => => naming to docker.io/library/job-market-project-python-app
[+] Running 3/3
 ✓ Container es-container                    Running
 ✓ Container job-market-project-python-app-1  Started
 ✓ Container kb-container                    Started
```

Elasticsearch : Launch

$ docker-compose up -d

http://localhost:5601/



Elasticsearch : Launch

```
$ docker-compose up -d
```

Challenges

- Choosing the right database is complex due to the multitude of options available in the market.
- For job market searches use cases Elasticsearch is better option,
  - The data received from various sources had different schema
  - we require extensive text analysis capabilities
- Bringing up analytical query have different challenges like data schema text and keyword work differently for same query.

Two use cases

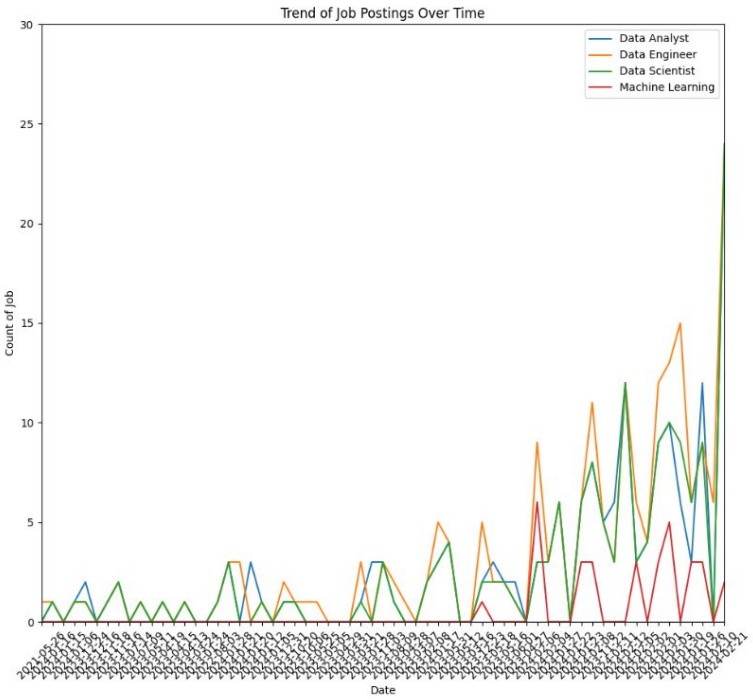
Use case 1

Get the trend of jobs like Data Engineer, Data Scientist, Machine Learning and Data Analyst over time

```
def usecase(usecase):
    if usecase == 1:
        query = {
            "aggs": {
                "job_posted_counts": {
                    "terms": {
                        "field": "job_posted",
                        "size": 200
                    },
                    "aggs": {
                        "data_engineer_count": {
                            "filter": {
                                "match": {
                                    "title": "Data Engineer"
                                }
                            }
                        },
                        "data_scientist_count": {
                            "filter": {
                                "match": {
                                    "title": "Data Scientist"
                                }
                            }
                        },
                        "machine_learning_count": {
                            "filter": {
                                "match": {
                                    "title": "Machine Learning"
                                }
                            }
                        },
                        "data_analyst_count": {
                            "filter": {
                                "match": {
                                    "title": "Data Analyst"
                                }
                            }
                        }
                    }
```

Project use case output:

https://arunp77.github.io/Job-Market-project/



Two use cases

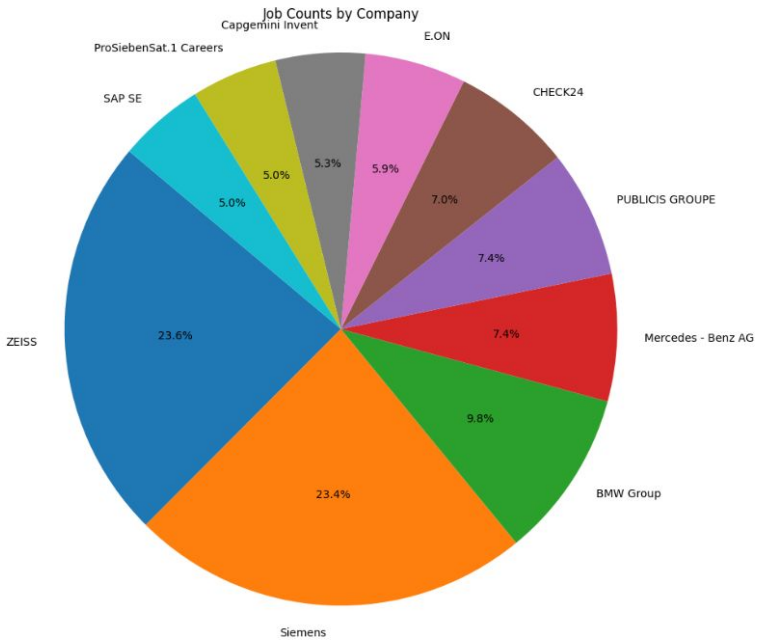
Use case 2

Get the top 10 maximum job posted companies to understand the companies which has max opening in the dataset

```
elif usecase == 2:
    query = {
        "size": 0,
        "aggs": {
          "unique_jobs": {
            "composite": {
              "size": 10000,
              "sources": [
                {"title": {"terms": {"field": "title.keyword"}}},
                {"company": {"terms": {"field": "company.keyword"}}}
              ]
            }
          },
          "companies": {
            "terms": {
              "field": "company.keyword",
              "size": 10,
              "order": {"_count": "desc"}
            }
          }
        }
      }
```

Project use case output:

https://arunp77.github.io/Job-Market-project/



3

Deployment : FASTApi and Docker image

FASTApi

Why to choose FASTApi?

- FastAPI offers exceptional performance, outperforming many traditional web frameworks.
- It provides built-in support for asynchronous programming, enabling efficient handling of concurrent requests.
- FastAPI automatically generates interactive API documentation, reducing the need for manual documentation efforts.
- It offers native support for type checking and validation, enhancing code reliability and reducing the likelihood of errors.
- FastAPI seamlessly integrates with existing Python libraries and frameworks, facilitating rapid development and deployment of APIs.
- With its intuitive syntax and declarative approach, FastAPI makes it easy to build scalable and maintainable web applications.

FASTApi

Run the server with:

```
$ uvicorn api:api --reload
```

api.py

Api object in api

http://localhost:8000/api/docs

api.py

```python
from fastapi import FastAPI
import uvicorn
api = FastAPI(
    title="Job Market API",
    description="API powered by FastAPI for our project.",
    version="1.0.1",
    docs_url="/api/docs",
    redoc_url="/api/redoc"
)

# Create a global Elasticsearch connection
es = db_connection()

@api.get("/")
def welcome():
    return {"message": "Welcome to the Job Market API!"}


@api.get("/load_data")
def load_data():
    return {"error": "Failed to load data into Elasticsearch."}

@api.get("/usecase1")
def get_usecase1():
    return {"error": "Failed to execute use case 1."}

@api.get("/usecase2")
def get_usecase2():
    return {"error": "Failed to execute use case 2."}

if __name__ == "__main__":
    uvicorn.run(api, host="0.0.0.0", port=8000)
```

Creates a new instance of the FastAPI class

Interactive OpenAPI docs

Alternative docs

Create a global Elasticsearch connection

Different Api endpoints

FASTApi

Run the server with:

```
$ uvicorn api:api --reload
```

api.py

Api object in api

http://localhost:8000/api/docs

```python
@api.get("/", description="Root endpoint to welcome users.")
def welcome() -> dict:
    """Root endpoint to welcome users."""
    return {"message": "Welcome to the Job Market API!"}
```

api.py

```python
from fastapi import FastAPI
```

```python
stAPI for our project.",
```

Interactive OpenAPI docs

Alternative docs

Create a global Elasticsearch connection

```python
Elasticsearch connection
ion()
```

Different Api endpoints

```python
@api.get("/")
def welcome():
    return {"message": "Welcome to the Job Market API!"}


@api.get("/load_data")
def load_data():
    return {"error": "Failed to load data into Elasticsearch."}

@api.get("/usecase1")
def get_usecase1():
    return {"error": "Failed to execute use case 1."}

@api.get("/usecase2")
def get_usecase2():
    return {"error": "Failed to execute use case 2."}
```

```python
if __name__ == "__main__":
    uvicorn.run(api, host="0.0.0.0", port=8000)
```

FASTApi

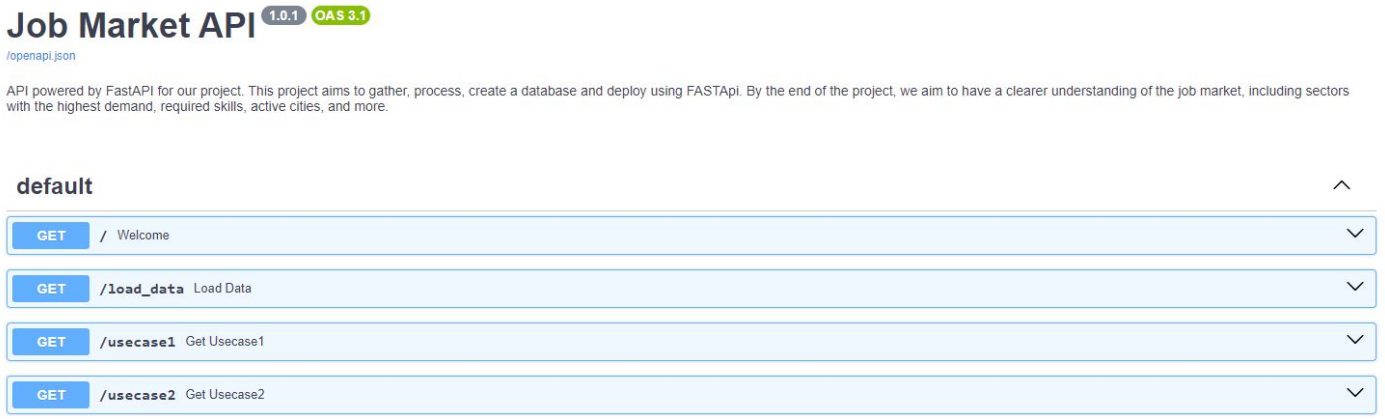
Run the server with:

```
$ uvicorn api:api --reload
```

api.py

Api object in api

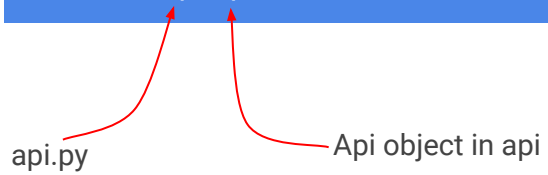
http://localhost:8000/api/docs



FASTApi

Run the server with:

```
$ uvicorn api:api --reload
```



Challenges

- Integrating existing database connections and use case scripts into the FastAPI framework
- Ensuring familiarity with the FastAPI framework and API ***conventions***
- Handling data serialization complexities for efficient data exchange
- Designing and documenting API endpoints effectively
- Implementing robust error handling mechanisms for data integrity

Docker Image

https://hub.docker.com/r/arunp77/job_market

Dockerfile

```
# Layer 1
# Use an official Python runtime as a parent image
FROM python:3.10

# Layer 2
# Copy the current directory contents into the container at /app
COPY requirements.txt /app/

# Layer 4
# Set the working directory in the container
WORKDIR /app

# Layer 5
# Install any needed dependencies specified in requirements.txt
RUN pip install --no-cache-dir -r requirements.txt

# Layer 6
# Copy the entire project directory into the container
COPY . /app/
# Layer 11
# Run script or command to start the application
ENTRYPOINT ["python", "api.py"]
```

arunp77 / **job_market**

Contains: Image • Last pushed: 2 minutes ago

Scout active ☆ 0 90 Public

Docker credentials

Docker Image

https://hub.docker.com/r/arunp77/job_market

ci-cd.yml

```yaml
- name: Build Docker image
  run: |
    docker build -t arunp77/job_market:latest .

- name: Push Docker image
  run: |
    echo "${{ secrets.DOCKER_PASSWORD }}" | docker login -u "${{ secrets.DOCKER_USERNAME }}" --password-stdin
    docker push arunp77/job_market:latest
```

arunp77 / job_market

Contains: Image • Last pushed: 2 minutes ago

Scout active ☆ 0 90 Public

4

Project Showcase: Live Demonstration

Project use case output:

https://arunp77.github.io/Job-Market-project/

Demonstration video

Limitations & Future Directions

Limitations

The quality of the data can be improved by web scraping from multiple sources of websites. But most of the sites don't allow scraping. We need to get permission.

Many APIs have rate limit which limits the data we can access from that site.

We are considering only few sources with few filters for job posting. We may not get all the data related to that posting.

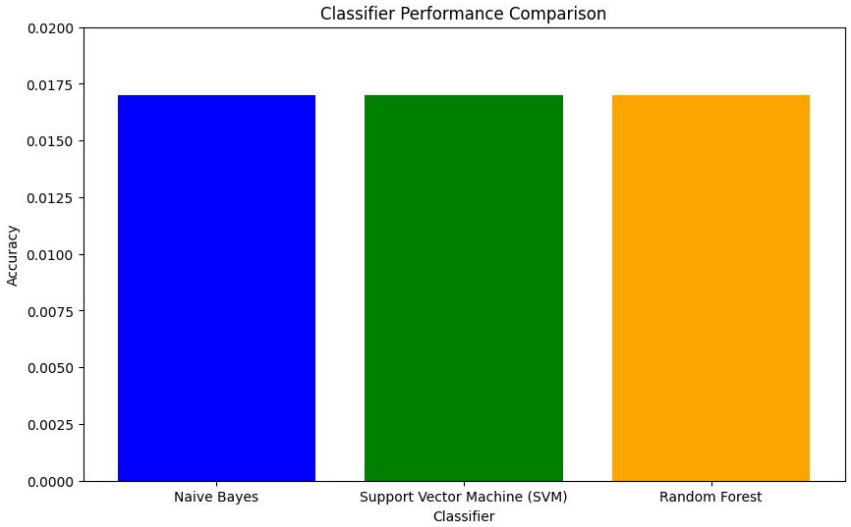
Future Direction

Machine learning: We plan to work on ‘Job title classification’, ‘Location based analysis’, `Job prediction`

Full Automation : Airflow

Add unit test and integrate with git CI/CD and then Deploy the final docker container in cloud and make available for global use.

Future direction in progress: Machine learning



JOB Title classification:

- **Task: 1** Classify job titles into predefined categories or clusters based on their descriptions or titles.
- **Algorithms**: Text Classification (Naive Bayes, Support Vector Machines (SVM), Random Forests)

Job Posting Frequency Prediction:

- **Task**: **2** Identify the most important features that influence job posting characteristics like job title, location, etc.
- **Algorithms:** Random Forests: Feature importances analysis.

Thank