Promptly Data Pipeline Report

1. Overview

The **Promptly Data Pipeline** is a structured workflow designed to process **user queries and documents (PDF, TXT files)** for an **AI-driven document-based Q&A system**. The system uses **Retrieval-Augmented Generation (RAG)** to fetch relevant answers based on user queries.

This pipeline is built using **Apache Airflow for orchestration, Supabase for database management, Google Cloud Storage (GCS) for document storage, and Data Version Control (DVC) for dataset tracking**. The pipeline follows **MLOps best practices** to ensure **data consistency, versioning, and automation**.

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2. Key Components in the Data Pipeline

The data pipeline follows a structured approach, covering **data acquisition, preprocessing, versioning, orchestration, tracking, and logging**.

2.1 Data Acquisition

Data Sources:

1. **User Queries**
    - **Source**: Retrieved from the `conversations` table in Supabase.
    - **Description**: This table contains user-generated queries, which we have pre-filled with custom data to simulate various interaction scenarios.
2. **Documents**
    - **Source**: Focused on IT specifications, we have curated data from publicly available requirements documents.
    - **Description**: We have selectively gathered documents that provide detailed IT specifications, particularly from the PURE dataset, which comprises 79 publicly available natural language requirements documents collected from the web.
    - Reference: https://zenodo.org/records/5195084

Implementation:

- Queries are fetched using the `supabase_utils.py` script.
- For IT specifications, we have gathered publicly available documentation and specification reports of multiple github projects from the reference specified above.
- All dependencies and external configurations are managed in `requirements.txt`.

Reproducibility:

- Data retrieval steps are automated through Airflow DAGs.
- Dependencies and configurations are versioned using **DVC** to ensure replicability.

2.2 Data Preprocessing

Query Processing:

- **Schema validation** using `validate_schema.py in both rag and user queries pipeline.`.
- **Text cleaning** using `data_utils.py` (stopword removal, special character removal, lowercasing).
- **Tokenization and Lemmatization** using `NLTK` and `WordNetLemmatizer`.

Document Processing:

- **Personally Identifiable Information (PII) Detection and Redaction** using **Presidio-based Named Entity Recognition (NER)** in `check_pii_data.py`.
- **Text Chunking** using `MarkdownSplitter` in `rag_utils.py`.

Output:

- Preprocessed **user queries and documents** are stored in **Supabase and GCS**.

2.3 Test Modules

Unit Testing Frameworks:

- `pytest`
- `unittest`

Implemented Test Cases:

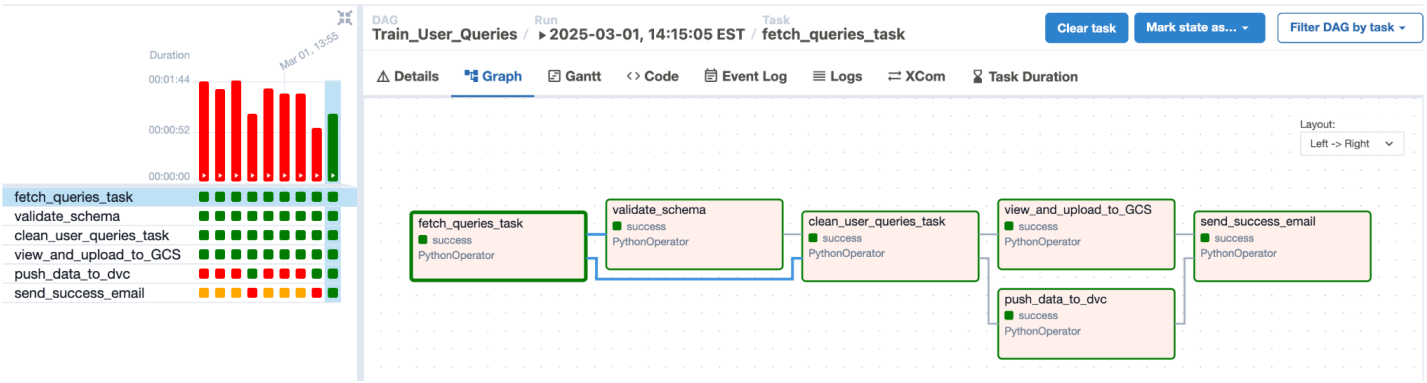
1. **PII Detection and Redaction** (`test_data_pii_redact_test.py`)
2. **RAG Pipeline** (`test_rag_pipeline.py`)
3. **User Query Pipeline** (`test_user_queries.py`)

2.4 Pipeline Orchestration (Airflow DAGs)

User Queries DAG: Train_User_Queries

Workflow:

1. `fetch_queries_task`: Retrieves queries from Supabase.
2. `validate_schema`: Ensures schema consistency.
3. `clean_user_queries_task`: Cleans and preprocesses text.
4. `view_and_upload_to_GCS`: Saves processed queries to **GCS**.
5. `push_data_to_dvc`: Enables versioning via **DVC**.
6. `send_success_email`: Sends completion notifications.

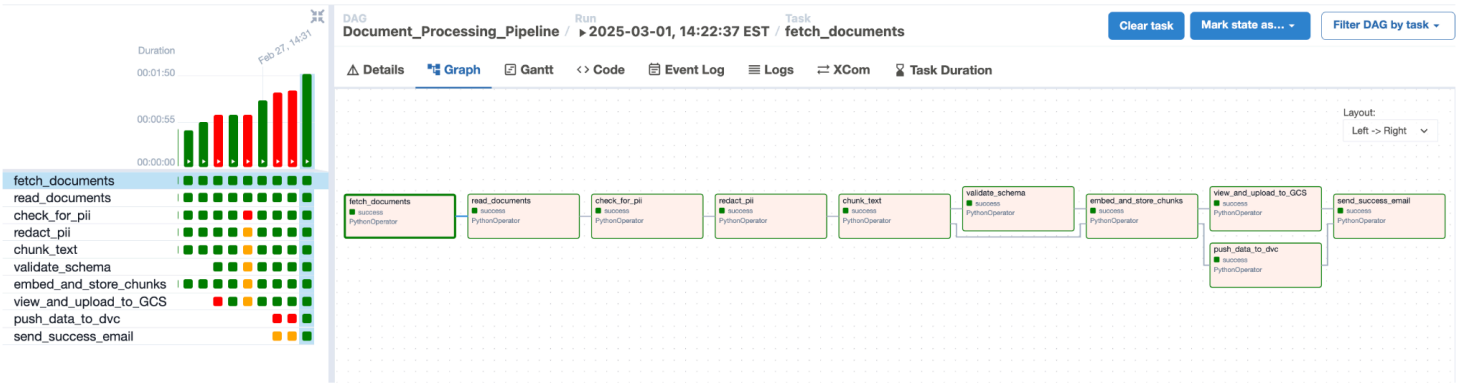


Document Processing DAG: Document_Processing_Pipeline

Workflow:

1. `fetch_documents`: Retrieves uploaded PDFs/TXT files.
2. `read_documents`: Extracts text using `pymupdf4llm`.
3. `check_for_pii`: Identifies PII using **Presidio**.
4. `redact_pii`: Redacts sensitive data.
5. `chunk_text`: Splits documents into structured chunks.

6. `validate_schema`: Ensures correct formatting.
7. `embed_and_store_chunks`: Generates embeddings using `Nomic` and stores them in **Supabase**.
8. `view_and_upload_to_GCS`: Stores chunked documents in **GCS**.
9. `push_data_to_dvc`: Enables versioning via **DVC**.
10. `send_success_email`: Sends completion notifications.



2.5 Data Versioning with DVC

Implementation:

- **User Queries**: Versioned using **DVC** (`preprocessed_user_queries.csv.dvc`).
- **Processed Documents**: Versioned using **DVC** (`preprocessed_docs_chunks.csv`).
- **GCS Remote Storage**: Configured in `.dvc/config`.

DVC Workflow:

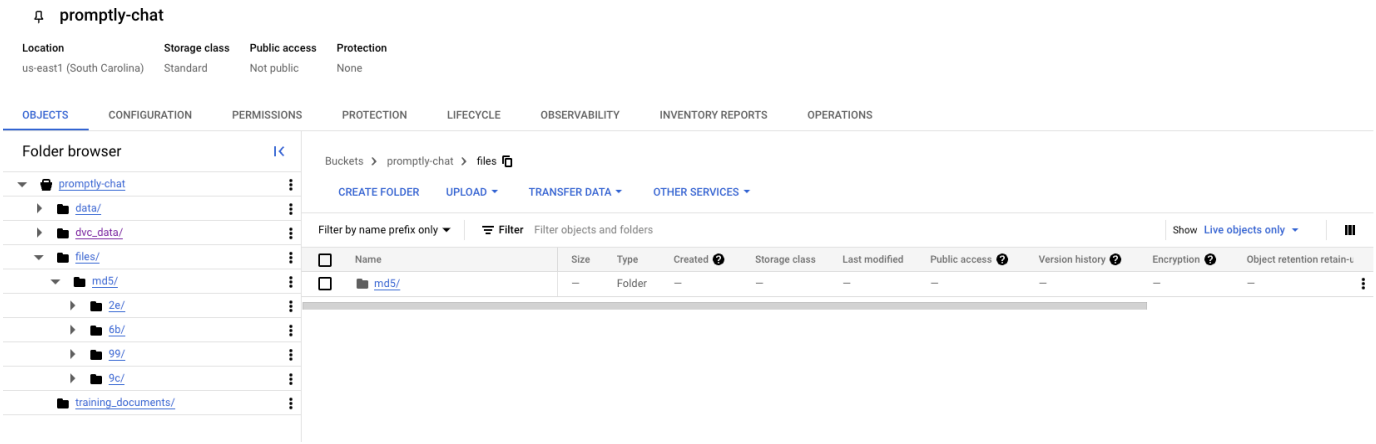
```
dvc init

dvc remote add gcs_remote gs://promptly-chat

dvc push
```

Benefits of Using DVC:

- Ensures **reproducibility** for dataset modifications.
- Allows **rollback** to previous versions.
- Provides **data lineage tracking** for query processing and document embedding versions.



2.6 Tracking and Logging

Logging Frameworks Used:

- **Airflow DAG Logs**
- **Python Logging Module**
- **Supabase Database Logging**

Implementation Example:

```
import logging

logging.basicConfig(level=logging.INFO)
```

Error Handling Strategies:

- **Retries in Airflow DAGs**
- **Failure Notifications via Email**
- **Exception Handling in Scripts**

2.7 Data Schema and Statistics Generation

Implementation:

- **Schema Validation**: Implemented in `validate_schema.py` before storing data in Supabase.
- **Statistics Generation**: Supabase logs track query/document statistics.

Justification for Not Using TFDV or MLMD:

- The system is **not an ML training pipeline**; it is focused on **retrieval**.
- Instead of **TensorFlow Data Validation (TFDV)**, schema checks are **embedded in preprocessing scripts**.

2.8 Anomaly Detection and Alerts

Implemented Anomaly Detection:

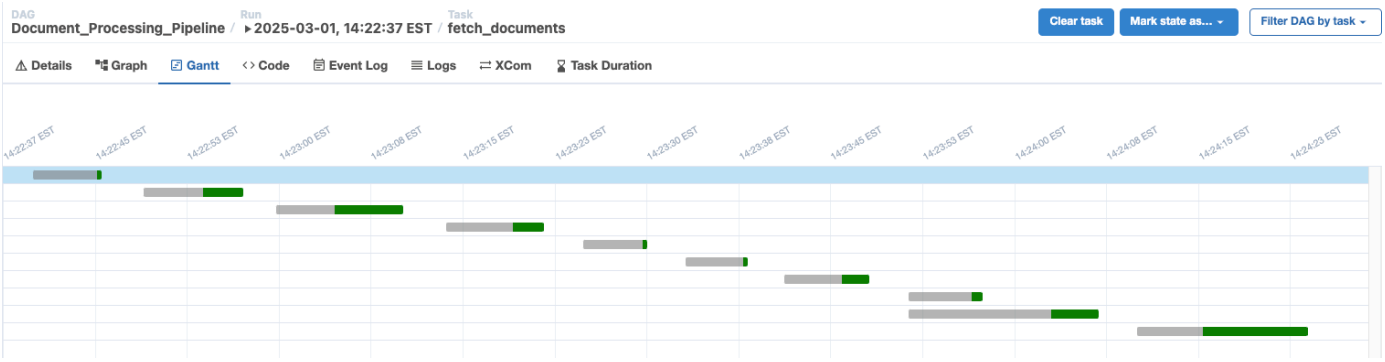
- **Missing Data Checks**: Handled in `validate_schema.py`.
- **Unexpected Formats Detection**: Managed in schema as well as in `data_utils.py`.

Anomaly Alerts / Notifications:

- The system operates **on batch processing**, not **real-time streaming data**.
- Pipeline failures are monitored through **Airflow Logs and email notifications**.

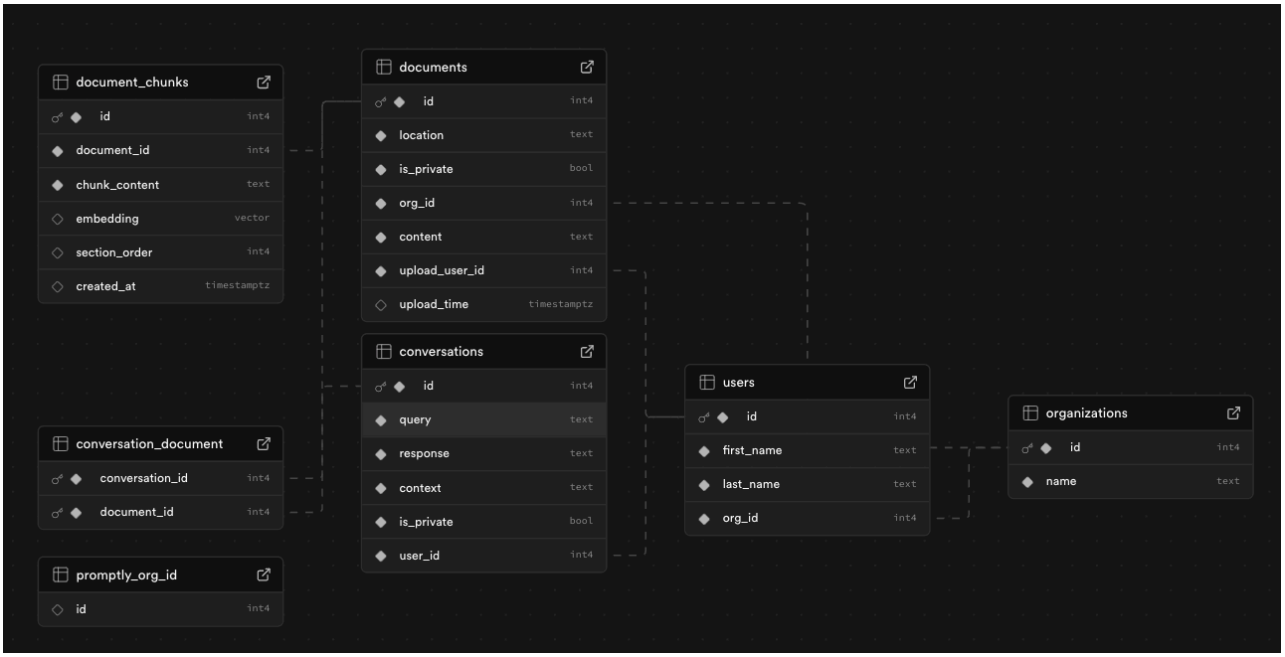
2.9 Pipeline Flow Optimisation

- We have tracked the Gantt chart for both DAGs that we have created, we make sure that every task is modular and consumes minimal time for execution.
- We have also implemented parallelization in some of our later processing functions.
- We have optimized our resources to optimise the cost and wait time for each pipeline task.(for example, reducing time from 5min->3min for one of the DAGs)



2.10 Database Schema

- We are using Supabase as our database and embedding store to store user conversations, documents and embedding chunks.
- Our project has 6 Tables:
  - Users
  - Organizations
  - Documents
  - Document_chunks
  - Conversations
  - conversation_document



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3. Data Bias Detection Using Data Slicing

Justification for Not Implementing Bias Detection:

- Our chatbot processes IT-related documents stored in a Retrieval-Augmented Generation (RAG) system, which contains purely technical content free from demographic or subjective influences.
- No Demographic Features: Our data lacks attributes like age, gender, or location, making subgroup analysis irrelevant.
- No Subjective Bias: The dataset consists of factual IT documentation, ensuring objectivity in responses.
- Unnecessary Overhead: Bias detection tools like TFMA or Fairlearn are designed for datasets with social implications. Applying them here would add complexity without meaningful insights.
- Since bias is not an inherent risk in our dataset, we will be focusing on enhancing precision and relevance in chatbot responses.

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4. Folder Structure and Code Organization

The project follows **MLOps best practices** for modularity and scalability.

```
├── assets/
|   ├── process_user_queries_dag.png  # User Query Pipeline DAG
|   ├── rag_data_pipeline_dag.png  # Data Pipeline Workflow Diagram
|
├── data_pipeline/
|   ├── dags/
|   |   ├── dataPipeline.py  # User Queries DAG
|   |   ├── rag_data_pipeline.py  # Document Processing DAG
|   |   ├── scripts/
|   |   |   ├── email_utils.py  # Email notifications
```

```
|   |   |   ├── upload_data_GCS.py  # GCS Uploading
|   |   |   ├── data_preprocessing/
|   |   |   |   ├── check_pii_data.py  # PII Detection
|   |   |   |   ├── validate_schema.py  # Schema Validation
|   |   |   |   ├── data_utils.py  # Query Cleaning Functions
|   |   |   ├── supadb/
|   |   |   |   ├── supabase_utils.py  # Supabase Integration
|   |   |   ├── rag/
|   |   |   |   ├── rag_utils.py  # Chunking & Embeddings
|   |   ├── tests/
|   |   |   ├── test_data_pii_redact.py  # Tests for PII detection
|   |   |   ├── test_rag_pipeline.py  # Tests for RAG doc pipeline
|   |   |   ├── test_user_queries.py # Tests for User Queries pipeline
|   ├── config.py  # API Keys & Configurations
|   ├── README.md  # Project Documentation
|
├── data/
|   ├── rag_documents/  # Original PDFs & Text Files
|   ├── preprocessed_docs_chunks.csv  # Cleaned & Chunked Data
|   ├── preprocessed_user_data.csv  # Processed Queries
|
├── .dvc/  # DVC Configuration
├── .gitignore
├── requirements.txt  # Dependencies
```

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5. Replicability and Reproducibility

Steps to Set Up:

1. **Clone the Repository:**

   ```
   git clone https://github.com/RajivShah1798/promptly.git

   cd promptly-data-pipeline
   ```

2. **Install Dependencies:**

   ```
   pip install -r requirements.txt

   Setup env file and add SUPABASE_KEY and URL
   ```

3. **Initialize DVC:**

   ```
   dvc init

   dvc remote add gcs_remote gs://promptly-chat

   dvc pull
   ```

4. **Run Airflow DAGs:**

   ```
   airflow db init

   airflow scheduler & airflow webserver

   airflow dags trigger Train_User_Queries
   ```

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6. Evaluation Criteria

The pipeline meets all **required evaluation criteria**:

- **Proper Documentation**

- **Modular Code & Error Handling**
- **DVC Versioning**
- **Pipeline Optimization**
- **Logging and Alerts**