Airflow

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What is Airflow?

Apache Airflow is an open-source workflow orchestration tool used by data engineers to programmatically author, schedule, and monitor workflows (pipelines). Workflows are defined in Python code and represented as Directed Acyclic Graphs (DAGs).

Key Features of Apache Airflow

Workflow Management

- **DAGs (Directed Acyclic Graphs):** Workflows are represented as DAGs ensuring tasks run in the correct sequence without cycles.
- **Task Dependencies:** Define upstream and downstream relationships clearly.

Scheduling & Execution

- **Scheduler & Executors:** Tasks are scheduled and distributed across executors (Local, Celery, Kubernetes, etc.).
- **Flexible Scheduling:** Cron-like expressions or time intervals; supports backfilling.

Monitoring & Management

- **Web UI:** Visual interface for monitoring DAG runs, logs, and task states.
- **Logging:** Centralized logs stored locally or in external systems (S3, GCS, Elasticsearch).
- **Alerts & Retries:** Automatic retries, failure callbacks, and alerts on errors.

Scalability & Integration

- **Horizontal Scalability:** Distribute workloads across multiple workers.
- **Integrations:** Works with AWS, GCP, Azure, Spark, Hive, Presto, Kubernetes, and many other tools.
- **Event-based Triggers:** Sensors for external jobs, file arrivals, and system events.

Security

- **Role-Based Access Control (RBAC):** Manage permissions by roles.
- **Authentication:** Integration with LDAP, OAuth, and other authentication systems.

Steps to Build and Run an Airflow Pipeline

Step 1: Install and Initialize Airflow

- Install Airflow (e.g., with pip install apache-airflow).
- Initialize the Airflow database:
- airflow db init

Step 2: Create the DAG File

- Write your DAG definition in a .py file.
- Save it inside the Airflow dags/ folder (default: ~/airflow/dags/).

Example DAG file: ~/airflow/dags/process_employees.py

```
import datetime
import pendulum
import os
import requests
from airflow.decorators import task, dag
from airflow.providers.postgres.hooks.postgres import PostgresHook
from airflow.providers.postgres.operators.postgres import PostgresOperator
@dag(
    dag_id="process_employees",
    schedule="0 0 * * *",
    start_date=pendulum.datetime(2021, 1, 1, tz="UTC"),
    catchup=False,
    dagrun_timeout=datetime.timedelta(minutes=60),
```

```
)
def ProcessEmployees():
    create_employees_table = PostgresOperator(
        task_id="create_employees_table",
        postgres_conn_id="tutorial_pg_conn",
        sql="""
            CREATE TABLE IF NOT EXISTS employees (
                "Serial Number" NUMERIC PRIMARY KEY,
                "Company Name" TEXT,
                "Employee Markme" TEXT,
                "Description" TEXT,
                "Leave" INTEGER
            );""",
    )

    create_employees_temp_table = PostgresOperator(
        task_id="create_employees_temp_table",
        postgres_conn_id="tutorial_pg_conn",
        sql="""
            DROP TABLE IF EXISTS employees_temp;
            CREATE TABLE employees_temp (
                "Serial Number" NUMERIC PRIMARY KEY,
                "Company Name" TEXT,
                "Employee Markme" TEXT,
                "Description" TEXT,
                "Leave" INTEGER
            );""",
    )
```

Step 3: Create the task

```
@task
def get_data():
    data_path = "/opt/airflow/dags/files/employees.csv"
    os.makedirs(os.path.dirname(data_path), exist_ok=True)

    url = "https://raw.githubusercontent.com/apache/airflow/main/airflow-core/docs/tutorial/pipeline_example.csv"
    response = requests.get(url)

    with open(data_path, "w") as file:
        file.write(response.text)

    postgres_hook = PostgresHook(postgres_conn_id="tutorial_pg_conn")
    conn = postgres_hook.get_conn()
    cur = conn.cursor()
    with open(data_path, "r") as file:
        cur.copy_expert(
            "COPY employees_temp FROM STDIN WITH CSV HEADER DELIMITER AS ',' QUOTE '""',
            file,
        )
    conn.commit()

@task
def merge_data():
    query = """
        INSERT INTO employees
        SELECT *
```

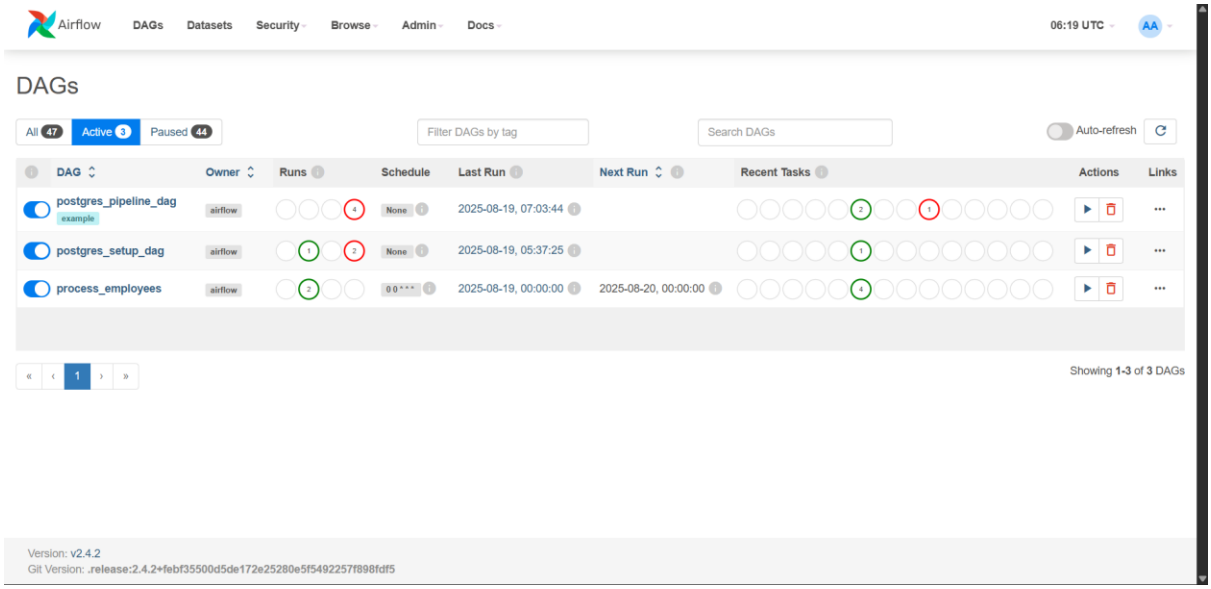
```
        FROM (
            SELECT DISTINCT *
            FROM employees_temp
        ) t
        ON CONFLICT ("Serial Number") DO UPDATE
        SET
          "Employee Markme" = excluded."Employee Markme",
          "Description" = excluded."Description",
          "Leave" = excluded."Leave";
    """
    try:
        postgres_hook = PostgresHook(postgres_conn_id="tutorial_pg_conn")
        conn = postgres_hook.get_conn()
        cur = conn.cursor()
        cur.execute(query)
        conn.commit()
        return 0
    except Exception as e:
        return 1
[create_employees_table, create_employees_temp_table] >> get_data() >> merge_data()
dag = ProcessEmployees()
```

Step 4: Start Airflow Services

- Start the scheduler:
- airflow scheduler
- Start the webserver:
- airflow webserver -p 8080

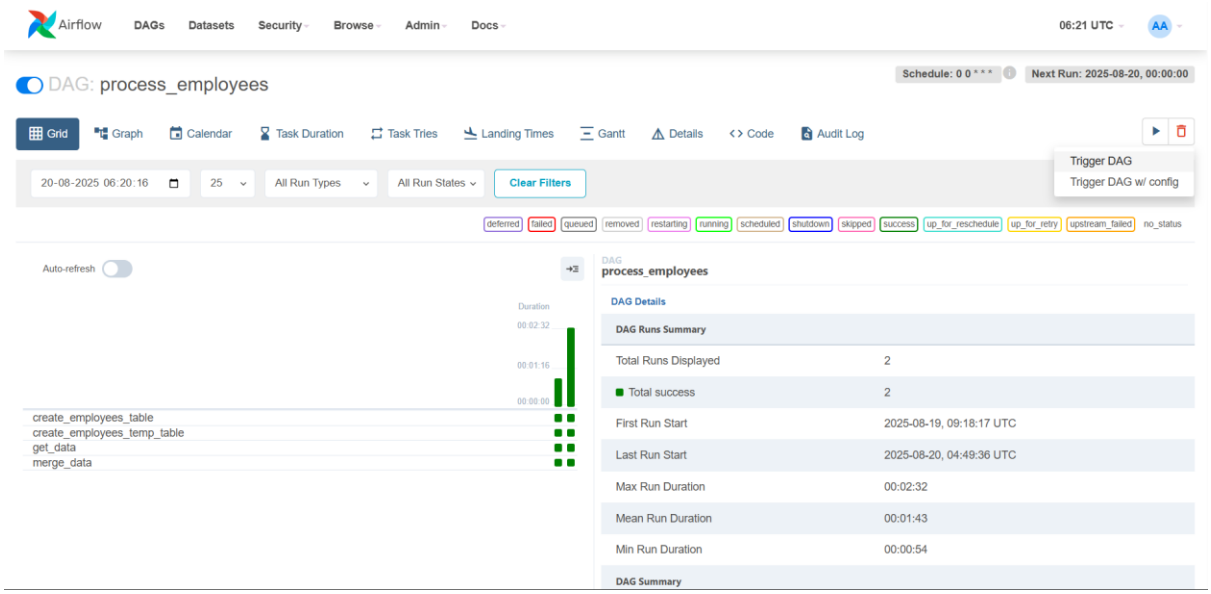
Step 5: Access the Airflow UI

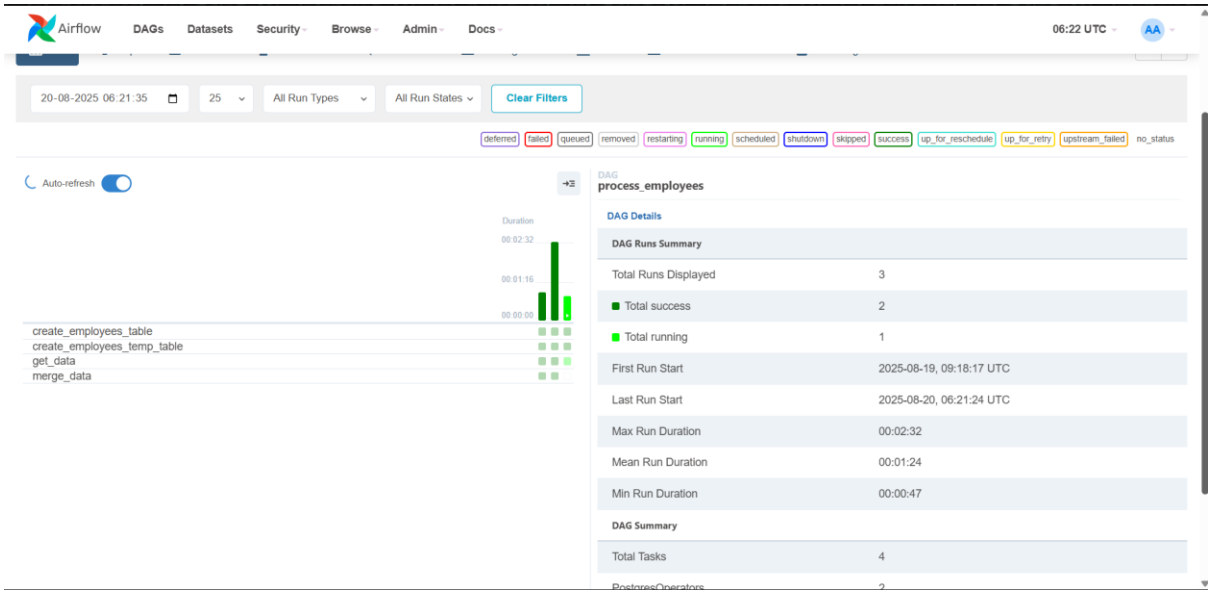
- Open your browser and go to: http://localhost:8080.
- Log in with the user created earlier.



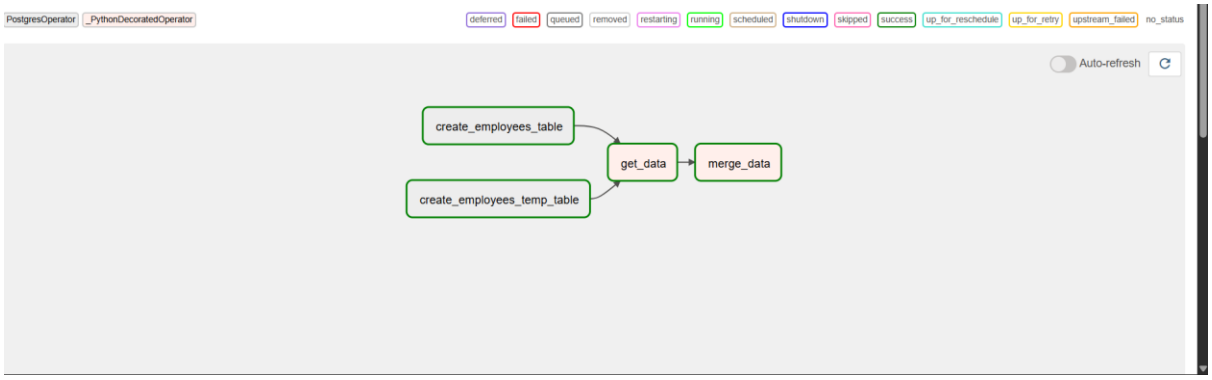
Step 6: Trigger and Monitor the DAG

- Enable the DAG in the UI.
- Trigger a run manually or wait for the schedule.

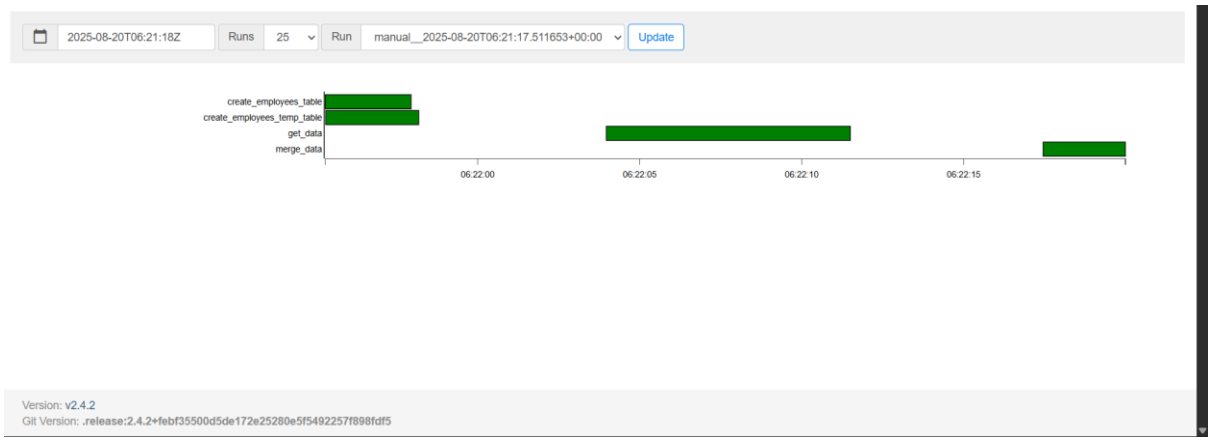




- **Graph View:** Visual DAG representation showing task dependencies.



- **Gantt View:** Duration and overlap of tasks.



- View logs and retries for each task.