
FOSDEM '24
Data Workflows
translating dbt to Apache Airflow
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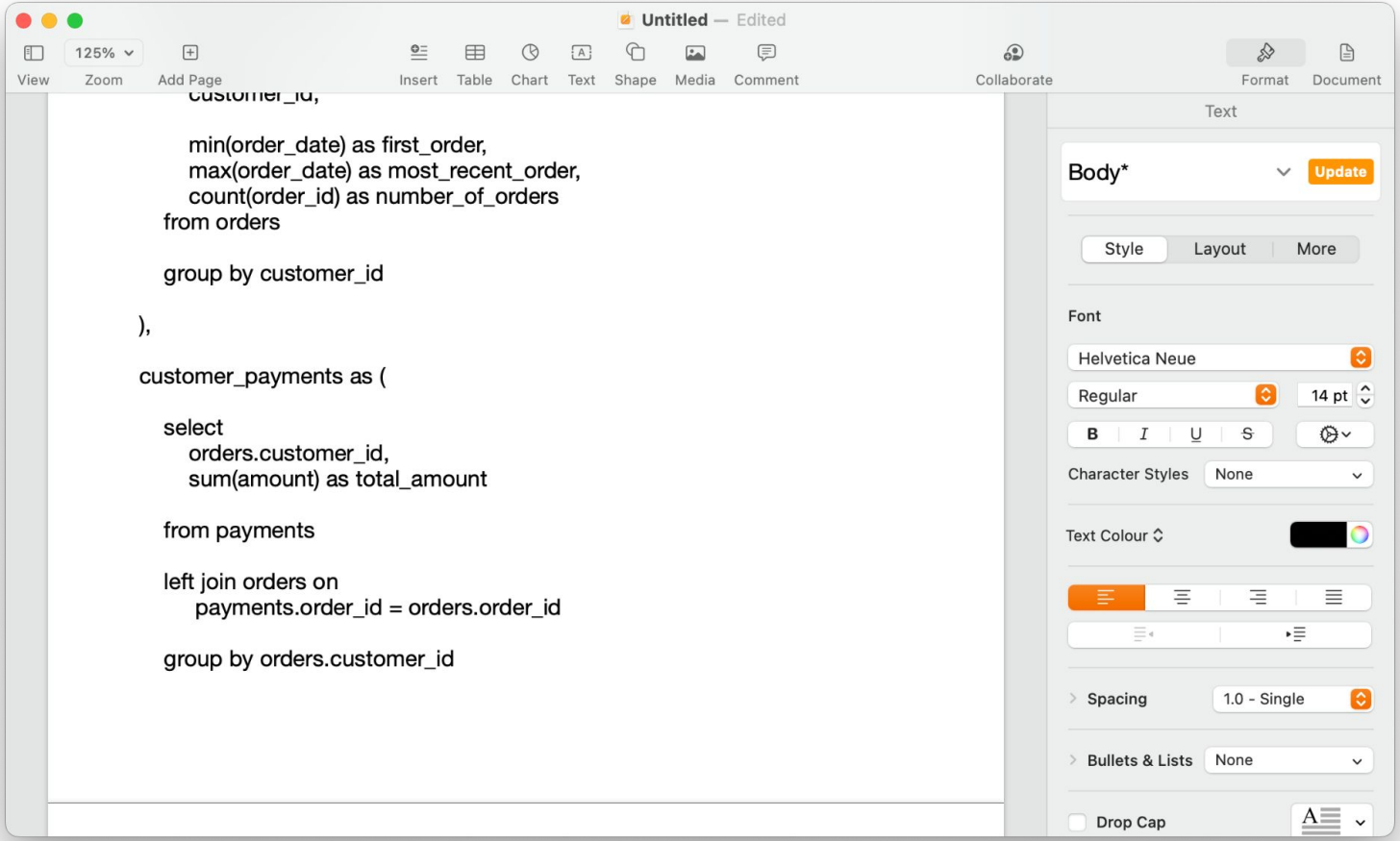
ASTRONOMER
Brussels ○ 24 February 2024

What is **dbt**?


Untitled — Edited
125%
View
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Add Page
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Comment
Collaborate
Format
Document
customer_id,
min(order_date) as first_order,
max(order_date) as most_recent_order,
count(order_id) as number_of_orders
from orders
group by customer_id
),
customer_payments as (
select
orders.customer_id,
sum(amount) as total_amount
from payments
left join orders on
payments.order_id = orders.order_id
group by orders.customer_id
Text
Body*
Update
Style
Layout
More
Font
Helvetica Neue
Regular
14 pt
Character Styles
None
Text Colour
Spacing
1.0 - Single
Bullets & Lists
None
Drop Cap

dbt Core

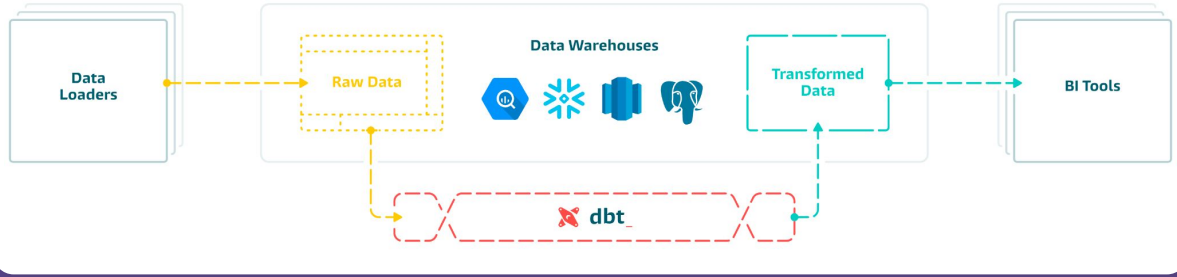
dbt (Data Build Tool) Core is an **open-source** tool for **data transformations** and analysis, using **SQL**

Growing in popularity as a standard for sql analysts and data mart builders

250 Contributors

6K Total Commits

6.5K GitHub Stars



dbt is the T in ELT. Organize, cleanse, denormalize, filter, rename, and pre-aggregate the raw data in your warehouse so that it's ready for analysis.

Why using **dbt** & **Airflow**?

Airflow is the de facto standard for job scheduling and workflow management

Strong Community of Data Professionals Who Know Airflow

12M Monthly Downloads

62% Downloads are Airflow 2

Pace of Innovation Only Accelerating, Quarterly Releases

2.2K Contributors

17K Total Commits

896 Commits in Last 90 Days

Usage is Growing Exponentially, Airflow 2 Changed the Trajectory

27K GitHub Stars

26K Slack Community

Airflow & **dbt Core (OSS)** high-level comparison

Airflow

- **Python** based and is meant for authoring, scheduling, and monitoring workflows
- **Flexible** and can be used for a wider range of tasks and use cases
- **Complex** interface and requires a deeper understanding of workflow management to write SQL transformations

dbt Core

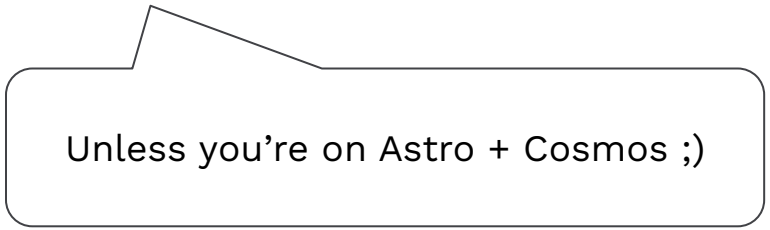
- **SQL** based focused specifically on transforming and analyzing data
- **Specialized** and provides a more focused set of features and tools for working with data in a data warehouse
- **Simple** interface for working with data and SQL transformations.

Where **dbt** beats **Airflow**

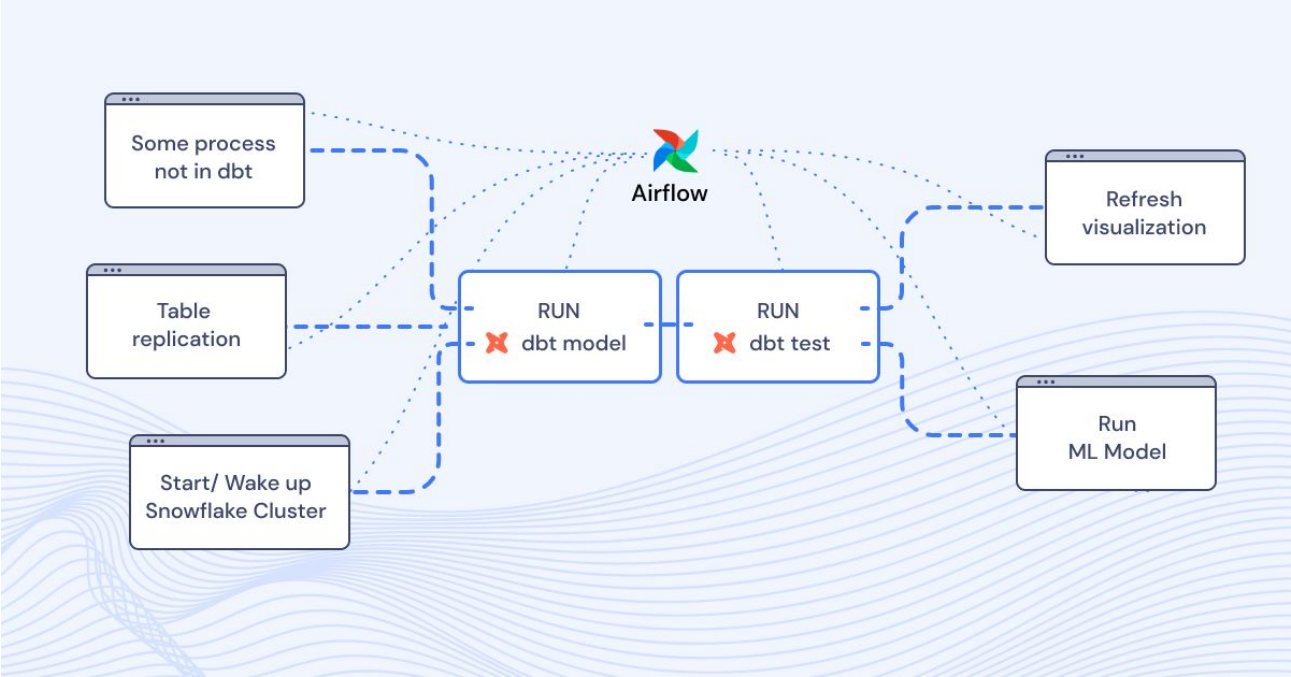
- Robust suite of declarative tests for each of your SQL models.
- Dependency Management dependencies between SQL models are automatically defined via Jinja templating.
- Easily assign model schemas through declarative yaml

Where **Airflow** beats **dbt**

- Flexibility in defining the “E” & “L” steps of ETL.
- As much as Airflow’s Complex Infrastructure can be a double-edged sword, it does allow for ML Operations to be run (against an Kubernetes infrastructure). There’s simply ***more*** that you can do with Airflow than dbt
- Using Airflow, you can achieve **everything** that dbt does, it’d just require more code maintenance (and technical know-how) to do it.



Why **compare**? Let's use **both**



How to use **dbt** & **Airflow**?

Just like **Airflow**, **dbt** has **DAGs**

```
.
├── LICENSE
├── README.md
├── dbt_project.yml
├── macros
|   └── drop_table.sql
├── models
|   ├── customers.sql
|   ├── docs.md
|   ├── orders.sql
|   ├── overview.md
|   ├── schema.yml
|   └── staging
|       ├── schema.yml
|       ├── stg_customers.sql
|       ├── stg_orders.sql
|       └── stg_payments.sql
├── packages.yml
├── profiles.yml
└── seeds
    ├── raw_customers.csv
    ├── raw_orders.csv
    └── raw_payments.csv
```

Just like **Airflow**, **dbt** has **database connections**

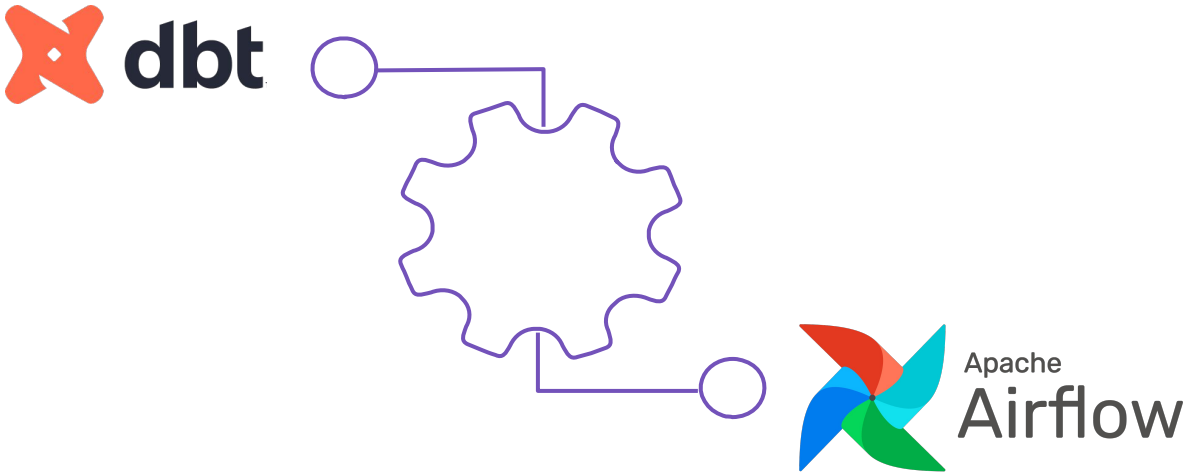
```
.
├── LICENSE
├── README.md
├── dbt_project.yml
├── macros
│   └── drop_table.sql
├── models
│   ├── customers.sql
│   ├── docs.md
│   ├── orders.sql
│   ├── overview.md
│   ├── schema.yml
│   └── staging
│       ├── schema.yml
│       ├── stg_customers.sql
│       ├── stg_orders.sql
│       └── stg_payments.sql
├── packages.yml
├── profiles.yml
└── seeds
    ├── raw_customers.csv
    ├── raw_orders.csv
    └── raw_payments.csv
```

profiles.yml (~/Code/astron.../dbt/jaffle_shop_demo) - VIM

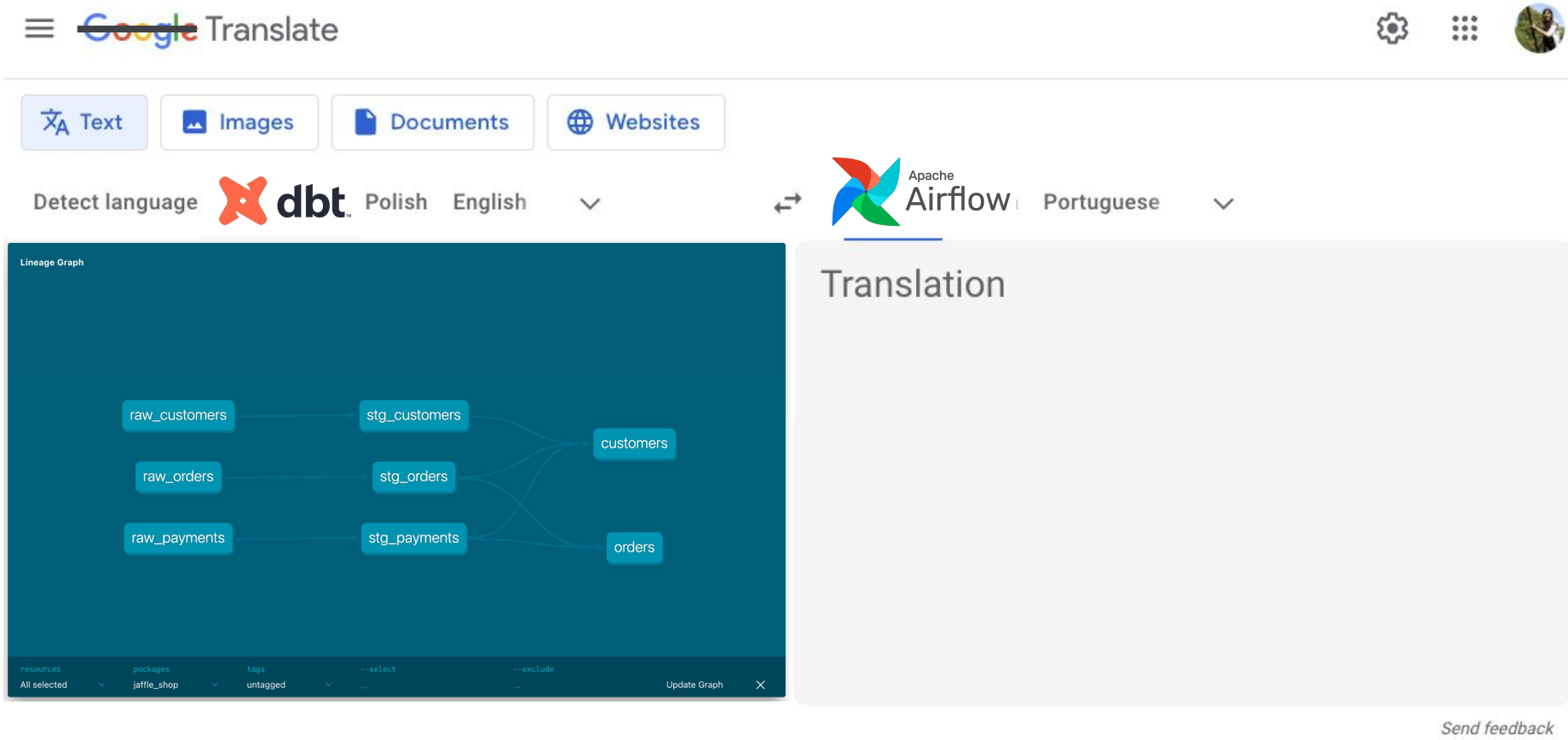
```yaml
jaffle_shop:
  target: dev
  outputs:
    dev:
      type: postgres
      host: "{{ env_var('POSTGRES_HOST') }}"
      user: "{{ env_var('POSTGRES_USER') }}"
      password: "{{ env_var('POSTGRES_PASSWORD') }}"
      port: "{{ env_var('POSTGRES_PORT') | int }}"
      dbname: postgres
      schema: public
      threads: 4
```

12,17 All

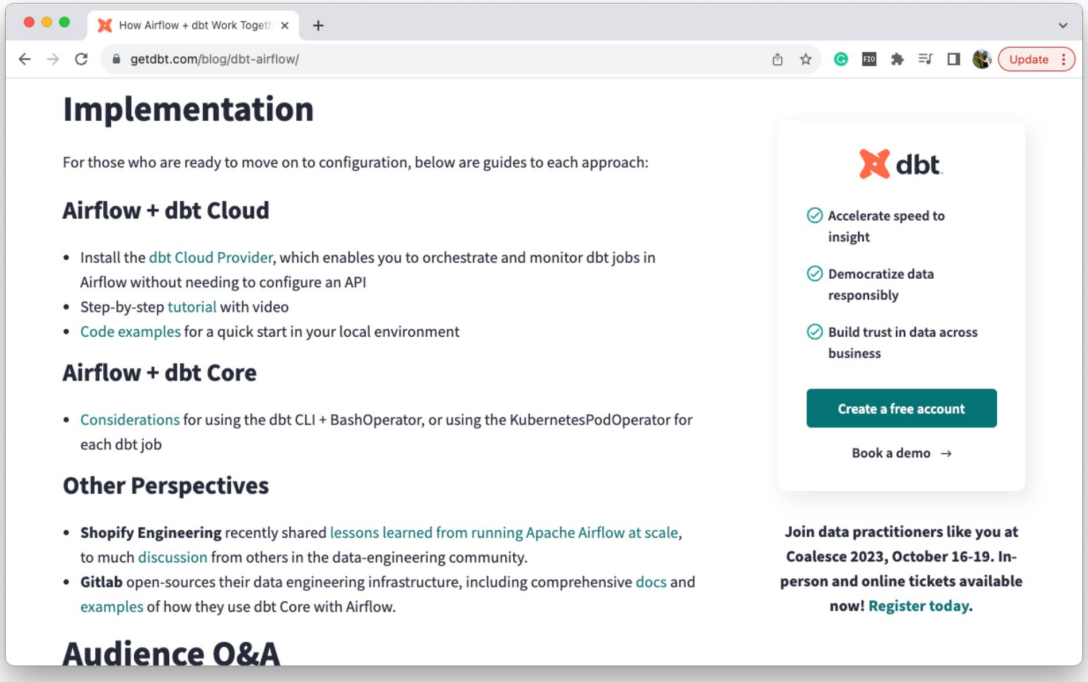
How can we bring them **together**?



DAG


Google Translate
Text
Images
Documents
Websites
Detect language
dbt
Polish
English
Apache
Airflow
Portuguese
Lineage Graph
raw_customers
stg_customers
customers
raw_orders
stg_orders
raw_payments
stg_payments
orders
resources
All selected
packages
jaffle_shop
tags
untagged
--select
--exclude
Update Graph
Translation
Send feedback

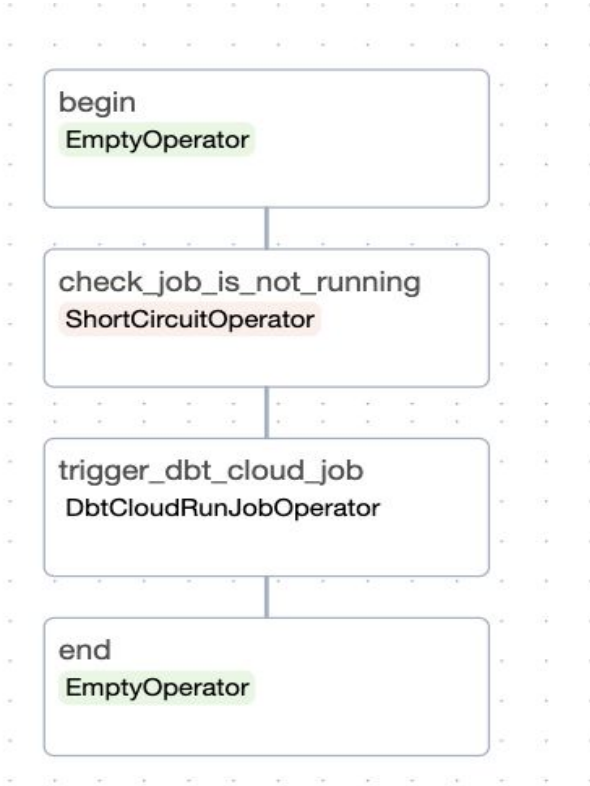
There are **a few** translation **approaches**



https://www.getdbt.com/blog/dbt-airflow/

apache-airflow-providers-**dbt-cloud**

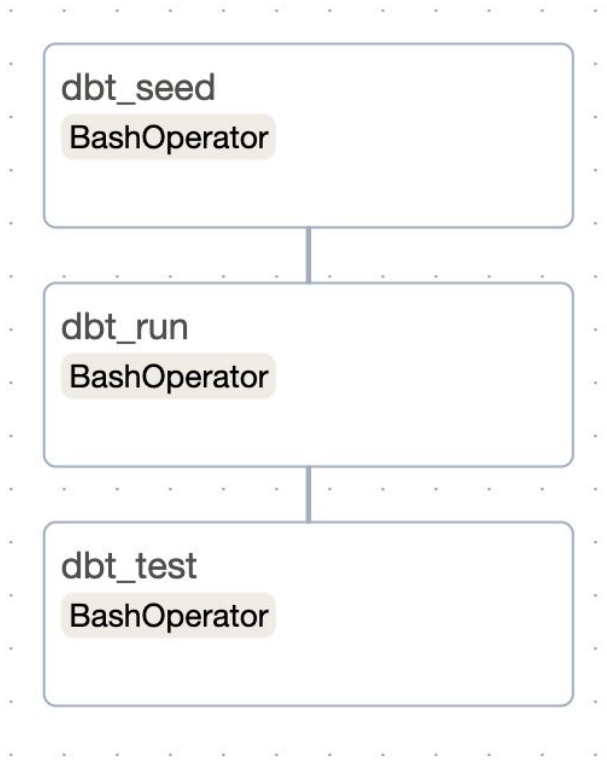
```python
@dag(
    start_date=datetime(2022, 2, 10),
    schedule_interval="@daily",
    catchup=False,
    default_view="graph",
    doc_md=__doc__,
)
def check_before_running_dbt_cloud_job():
    begin, end = [EmptyOperator(task_id=id) for id in ["begin", "end"]]

    check_job = ShortCircuitOperator(
        task_id="check_job_is_not_running",
        python_callable=_check_job_not_running,
        op_kwargs={"job_id": JOB_ID},
    )

    trigger_job = DbtCloudRunJobOperator(
        task_id="trigger_dbt_cloud_job",
        dbt_cloud_conn_id=DBT_CLOUD_CONN_ID,
        job_id=JOB_ID,
        check_interval=600,
        timeout=3600,
    )

    begin >> check_job >> trigger_job >> end
```



https://registry.astronomer.io/dags/dbt_cloud_operational_check/versions/3.0.0

BashOperator

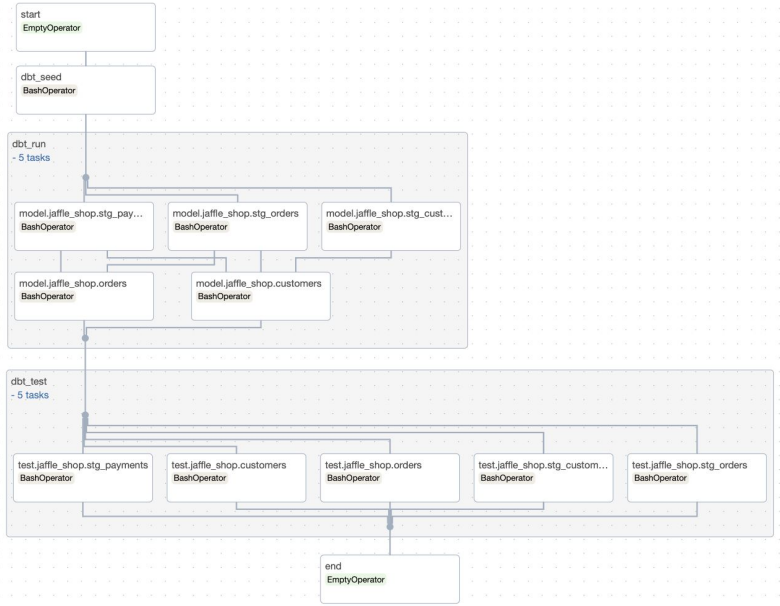
```
with DAG(
    "dbt_basic_dag",
    start_date=datetime(2020, 12, 23),
    description="A sample Airflow DAG to invoke dbt runs using a
BashOperator",
    schedule_interval=None,
    catchup=False,
) as dag:
    dbt_seed = BashOperator(
        task_id="dbt_seed",
        bash_command=f"dbt seed --profiles-dir {DBT_PROJECT_DIR}
--project-dir {DBT_PROJECT_DIR}",
    )
    dbt_run = BashOperator(
        task_id="dbt_run",
        bash_command=f"dbt run --profiles-dir {DBT_PROJECT_DIR}
--project-dir {DBT_PROJECT_DIR}",
    )
    dbt_test = BashOperator(
        task_id="dbt_test",
        bash_command=f"dbt test --profiles-dir {DBT_PROJECT_DIR}
--project-dir {DBT_PROJECT_DIR}",
    )
    dbt_seed >> dbt_run >> dbt_test
```



https://registry.astronomer.io/dags/dbt_basic/versions/1.0.3

dbt manifest parsing + **BashOperator**

```python
with DAG(
    "dbt_advanced_dag_utility",
    start_date=datetime(2020, 12, 23),
    description="A dbt wrapper for Airflow using a utility class",
    schedule_interval=None,
    catchup=False,
    doc_md=__doc__
) as dag:
    start_dummy = DummyOperator(task_id="start")
    dbt_seed = BashOperator(
        task_id="dbt_seed",
        bash_command=(
            f"dbt {DBT_GLOBAL_CLI_FLAGS} seed "
            f"--profiles-dir {DBT_PROJECT_DIR} --project-dir {DBT_PROJECT_DIR}"
        ),
    )
    end_dummy = DummyOperator(task_id="end")
    dag_parser = DbtDagParser(
        dbt_global_cli_flags=DBT_GLOBAL_CLI_FLAGS,
        dbt_project_dir=DBT_PROJECT_DIR,
        dbt_profiles_dir=DBT_PROJECT_DIR,
        dbt_target=DBT_TARGET,
    )
    dbt_run_group = dag_parser.get_dbt_run_group()
    dbt_test_group = dag_parser.get_dbt_test_group()
    start_dummy >> dbt_seed >> dbt_run_group >> dbt_test_group >> end_dummy
```



https://registry.astronomer.io/dags/dbt_advanced_utility/versions/1.0.3

Approaches **comparison**

dbt (Cloud) provider

- ⊖ Minimalistic DAG
- ⊖ Hard to identify failing dbt node
- ⊖ Inefficient retry (re-run all dbt nodes)
- ⊕ Trivial DAG parsing
- ⊕ Few worker slots
- ⊕ Asynchronous or Synchronous
- ⊖ Vendor lock-in

BashOperator (one task per cmd)

- ⊖ Minimalistic DAG
- ⊖ Hard to identify failing dbt node
- ⊖ Inefficient retry (re-run all dbt nodes)
- ⊕ Trivial DAG parsing
- ⊕ Few worker slots
- ⊖ Downstream use cases dependent on every dbt node succeeding

BashOperator (multiple tasks)

- ⊕ Detailed DAG similar to dbt
- ⊕ Failing dbt node is easy to identify
- ⊕ Efficient retries
- ⊖ DAG parsing can become slow
- ⊖ Worker slots grows with dbt nodes
- ⊕ Independent downstream use cases can succeed

Alternative approaches

- Translate DAG without dbt manifest
- Translate DAG using dynamic task mapping to group dbt nodes
- Pre-generate static DAG translating all tasks of interest
- Execute dbt commands using different operators
  - `KubernetesPodOperator`
  - `DockerOperator`
- Execute dbt compiled SQL using Airflow database-specific hooks
- ...

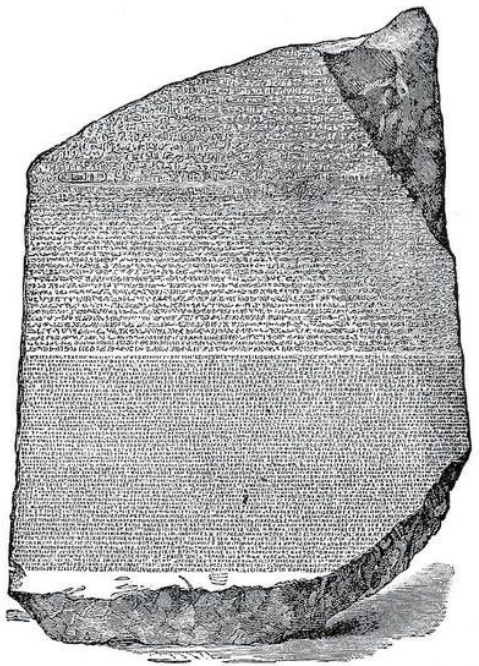
Astronomer **Cosmos**

“Open-source library that allows you to run
dbt Core projects as
Airflow DAGs and Task Groups
with a few lines of code.”

```
$ pip install astronomer-cosmos
```

https://github.com/astronomer/astronomer-cosmos
https://astronomer.github.io/astronomer-cosmos/getting_started/astro.html

Astronomer **Cosmos**



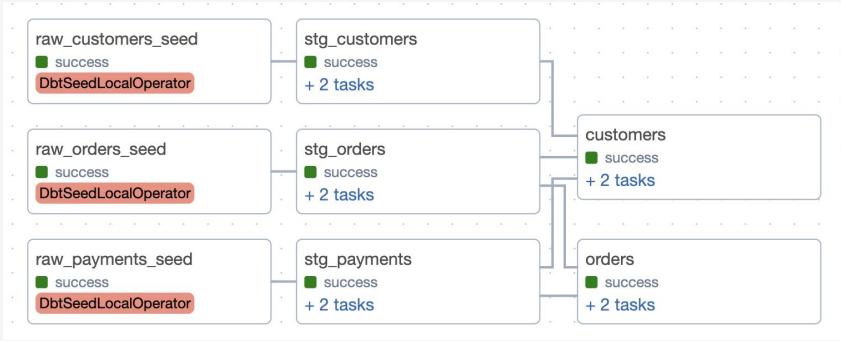
https://www.britishmuseum.org/blog/everything-you-ever-wanted-know-about-rosetta-stone

Cosmos

Google Translate

Text | Images | Documents | Websites

Detect language | dbt | Polish | English | Apache Airflow | Portuguese



Send feedback

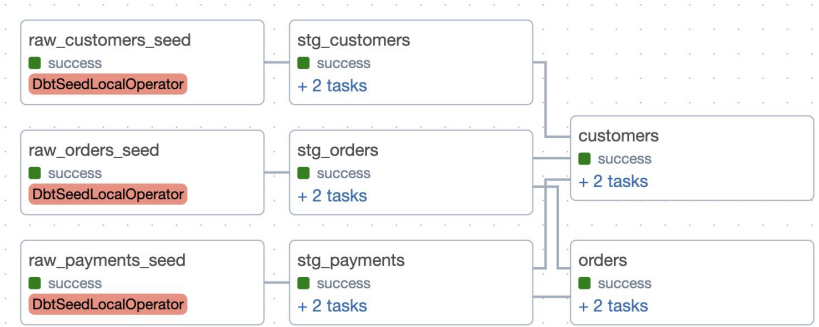
Translating from **dbt** to **Airflow** with **Cosmos**

```python
import os
from datetime import datetime
from pathlib import Path
from cosmos import DbtDag, ProjectConfig, ProfileConfig
from cosmos.profiles import PostgresUserPasswordProfileMapping

DEFAULT_DBT_ROOT_PATH = Path(__file__).parent / "dbt"
DBT_ROOT_PATH = Path(os.getenv("DBT_ROOT_PATH", DEFAULT_DBT_ROOT_PATH))

profile_config = ProfileConfig(
    profile_name="jaffle_shop",
    target_name="dev",
    profile_mapping=PostgresUserPasswordProfileMapping(
        conn_id="airflow_db",
        profile_args={"schema": "public"},
    ),
)
basic_cosmos_dag = DbtDag(
    project_config=ProjectConfig(
        DBT_ROOT_PATH / "jaffle_shop",
    ),
    profile_config=profile_config,
    schedule_interval="@daily",
    start_date=datetime(2023, 1, 1),
    catchup=False,
    dag_id="basic_cosmos_dag",
)
```

Apache Airflow



Translating from **dbt** to **Airflow** with **Cosmos**

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DBT_ROOT_PATH = Path(os.getenv("DBT_ROOT_PATH", DEFAULT_DBT_ROOT_PATH))

profile_config = ProfileConfig(
    profile_name="jaffle_shop",
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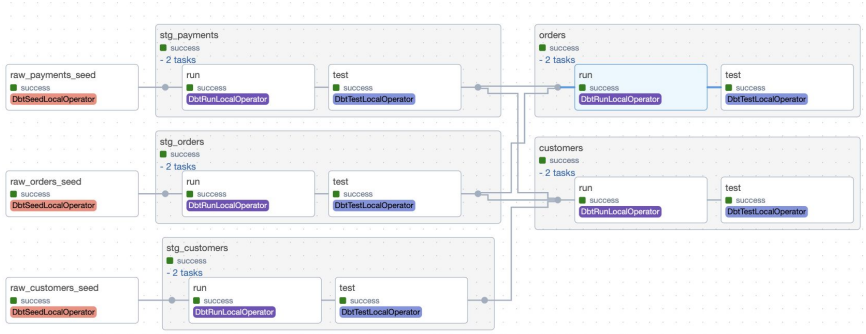
    profile_mapping=PostgresUserPasswordProfileMapping(
        conn_id="airflow_db",
        profile_args={"schema": "public"},
    ),
)
basic_cosmos_dag = DbtDag(
    project_config=ProjectConfig(
        DBT_ROOT_PATH / "jaffle_shop",
    ),
    profile_config=profile_config,
    schedule_interval="@daily",
    start_date=datetime(2023, 1, 1),
    catchup=False,
    dag_id="basic_cosmos_dag",
)
```

Apache Airflow



Demo

Cosmos **key features**

- Easily bring your dbt core projects within Astro/Airflow projects
- Author SQL models as in plain dbt projects
- Render your project as an Airflow DAG or Task Group
- Flexibility on the translation method and dbt execution
- Schedule with Airflow's robust features: cron, datasets, timetables
- Visualize the SQL associated to an Airflow Task
- Skip the paid dbt cloud subscription
- Growing **active** open-source **community**

Cosmos **dbt execution**

- Run SQL and Python dbt models (also deps, seeds, docs, ...)
- Customize the arguments used to run dbt
- Run dbt commands...
  - in the worker node, using `PythonOperator` subclasses
  - in the worker node, using `VirtualenvOperator` subclasses
  - in the worker node, using `DockerOperator` subclasses
  - remotely, using `KubernetesPodOperator` subclasses

https://astronomer.github.io/astronomer-cosmos/getting_started/execution-modes.html#local
https://astronomer.github.io/astronomer-cosmos/configuration/operator-args.html
https://astronomer.github.io/astronomer-cosmos/getting_started/execution-modes.html

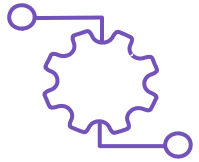
Cosmos **dbt execution**

- Customize the path to the dbt binary to avoid dependency conflicts

Airflow / DBT	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
2.2				x	x	x	x	x
2.3	x	x		x	x	x	x	x
2.4	x	x	x					
2.5	x	x	x					
2.6	x	x	x	x	x			
2.7	x	x	x	x	x			
2.8	x	x	x	x	x		x	x

https://astronomer.github.io/astronomer-cosmos/getting_started/execution-modes-local-conflicts.html

Cosmos **DAG translation**



- Several dbt DAG parsing strategies are available
  - **dbt** `manifest.json`
  - `dbt ls`
  - `dbt ls file`
  - custom parser
  - automatic
- Configurable Airflow DAG rendering
  - several built-in operators
  - multiple strategies for rendering test nodes
  - select and exclude nodes using dbt selectors syntax
  - customize the translation by dbt resource type

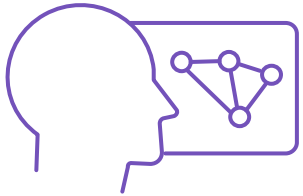
https://astronomer.github.io/astronomer-cosmos/configuration/parsing-methods.html
https://astronomer.github.io/astronomer-cosmos/configuration/render-config.html
https://astronomer.github.io/astronomer-cosmos/configuration/testing-behavior.html
https://astronomer.github.io/astronomer-cosmos/configuration/selecting-excluding.html

Cosmos **profile conversion**

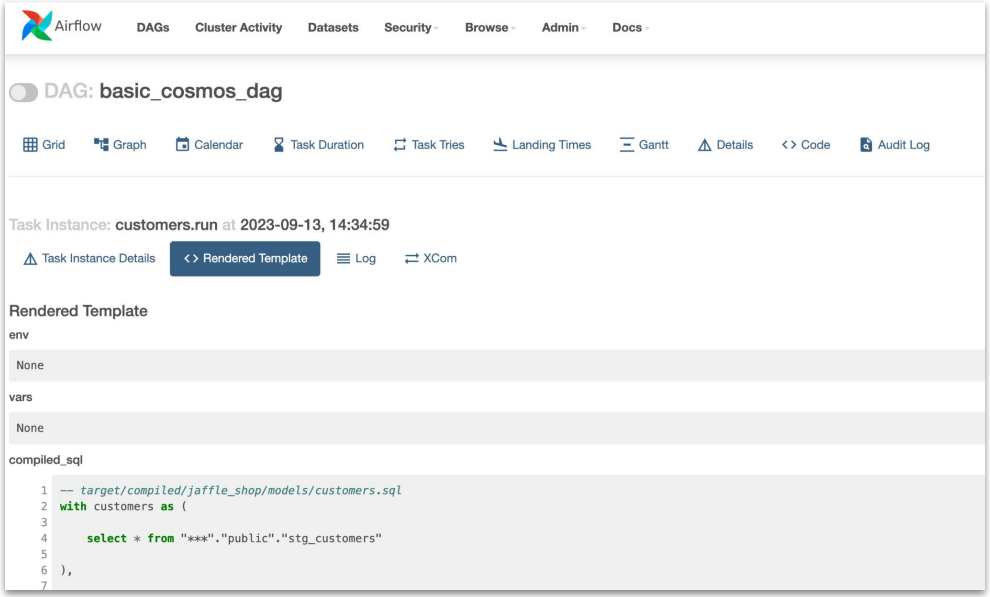
- Convert your Airflow connections into dbt `profiles.yml` using existing `ProfileMapping` classes
- Create custom `ProfileMapping` classes
- Bring your own dbt `profiles.yml`

https://astronomer.github.io/astronomer-cosmos/profiles/index.html

Cosmos **user-centered**



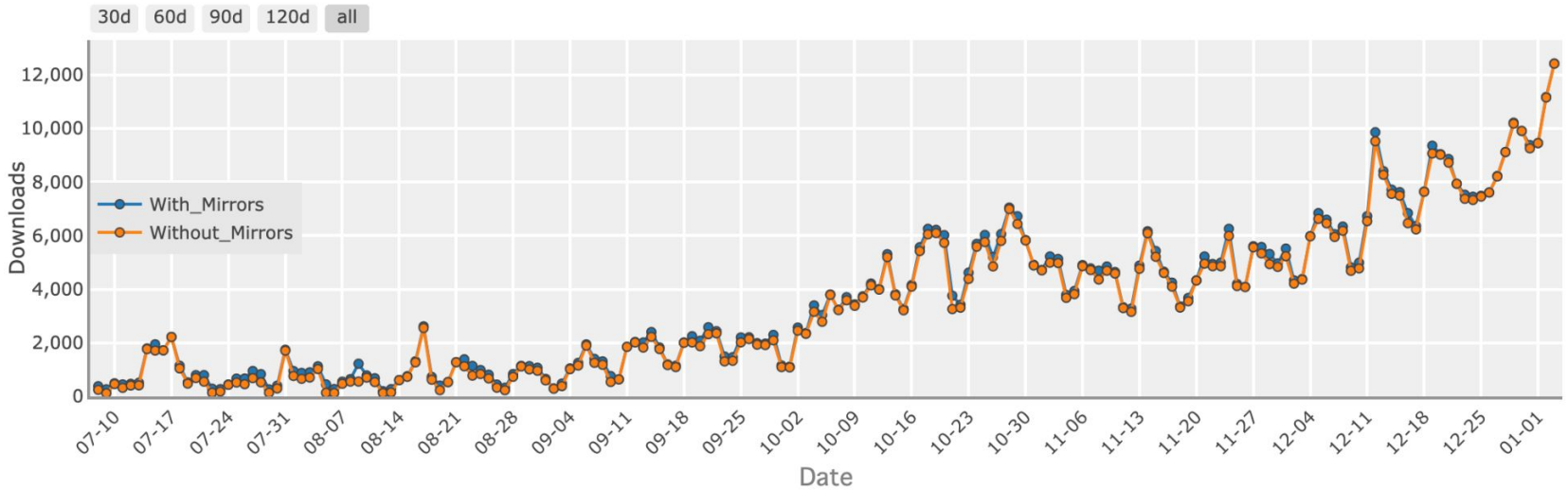
- Visualize dbt resources and their lineage similar to dbt, but in Airflow
- Retry individual dbt nodes
- Visualize dbt compiled SQL in Airflow task instances
- Generate and export dbt docs to GCS, S3, Azure or customize



https://astronomer.github.io/astronomer-cosmos/configuration/compiled-sql.html
https://astronomer.github.io/astronomer-cosmos/configuration/generating-docs.html

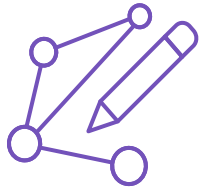
Cosmos **adoption**

- 239k downloads in a month (December 2023)
- 351 stars in Github



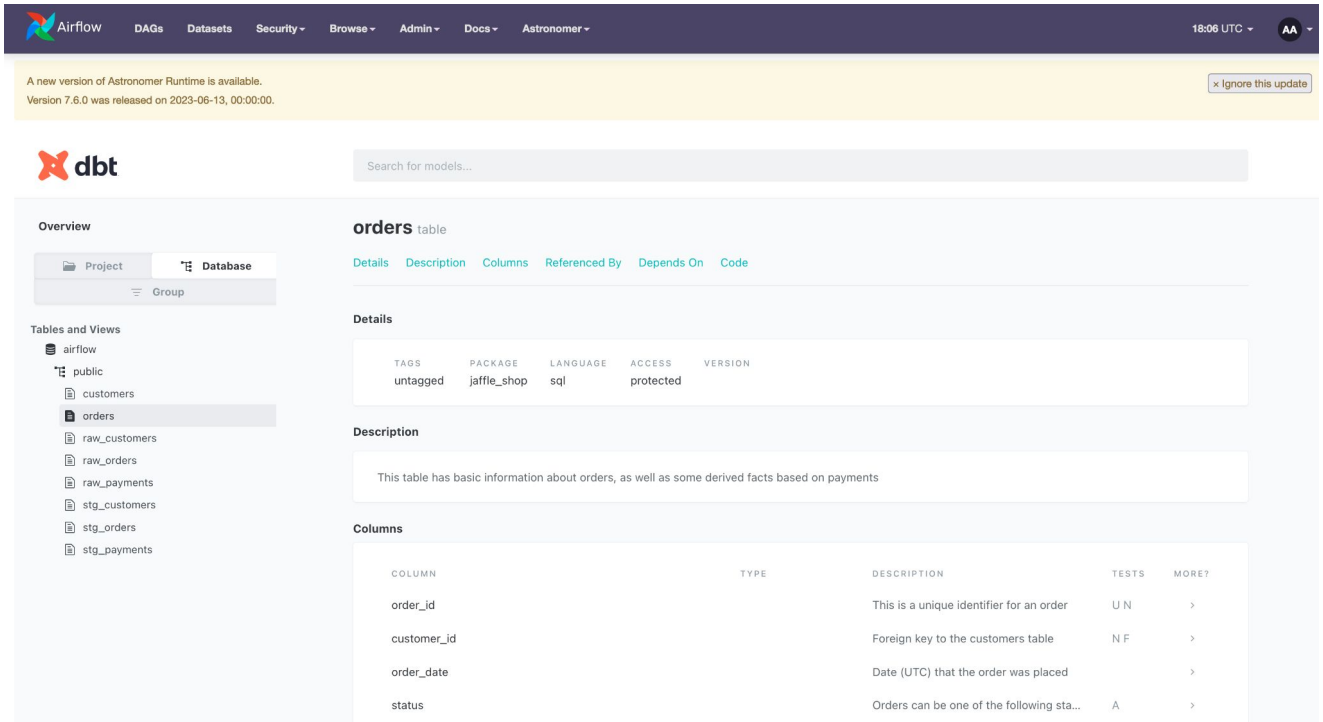
https://pypistats.org/packages/astronomer-cosmos

Cosmos **next steps**



- Showing dbt docs in the Airflow UI (#737 will be part of Cosmos 1.4)
- Strategies to improve DAG parsing performance
- Improve openlineage and dataset support
- Better support when dbt and Airflow are in separate repos
- Support running tasks in dbt Cloud

Cosmos **next steps**



Cosmos **community**

20 authors had 40 commits merged into **main** during November 2023.
Only 3 of these authors were Astronomer employees.

Since December 2022, 66 people contributed to the Cosmos repo.

There are 388 members in the #airflow-dbt Airflow Slack,
and daily interactions.

Cosmos **references**

- Intro to Cosmos website
- Github Repo astronomer/astronomer-cosmos
- Docs https://astronomer.github.io/astronomer-cosmos/
- Join the Apache Airflow slack #airflow-dbt channel
- More examples on how to use Cosmos
- Webinar “Introducing Cosmos” by Julian LaNeve

Note: Some of the slides were inspired by Julian LaNeve & Pádraic Slattery slides!


FOSDEM ‘24
thank you!
@tati_alchueyr
tatiana.alchueyr@astronomer.io
#airflow_dbt
ASTRONOMER
Brussels ○ 24 February 2024