Astro Python SDK

The Future of DAG Authoring

ASTRONOMER

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Who am I?

- Airflow PMC
- co-creator of the K8sExecutor
- Strategy Engineer @ Astronomer.io
- Excited to be in Australia (virtually!)

The Team

Tatiana Al-Chueyr

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Utkarsh Sharma

Mike Shwe

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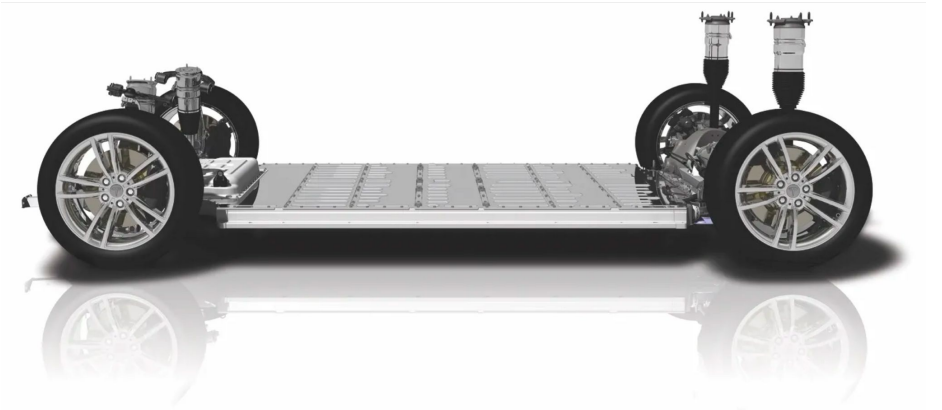
What is DAG Authoring?

What is DAG Authoring?

- Airflow = engine, DAG authoring = chassis
- Airflow 2.0: Massive improvements to the engine of Airflow (scheduler HA, improved k8sexec, etc.)
- “There’s a lot here for the Airflow admin, but what about for the DAG writer?”



Why is DAG authoring difficult?

- Current DAG writing involves obscure Airflow knowledge + python expertise → lengthy onboarding, challenging maintenance

- DAG author needs to keep track of how data is passed between tasks- more difficult to write and debug, especially collaboratively

Why is DAG Authoring Difficult?

```
from airflow.providers.snowflake.operators.snowflake import SnowflakeOperator
from airflow.providers.snowflake.transfers.s3_to_snowflake import S3ToSnowflakeOperator

create_table = SnowflakeOperator(
    task_id="create_table",
    sql=f"""CREATE OR REPLACE TABLE {SNOWFLAKE_ORDERS}
    (order_id char(10),customer_id char(10), purchase_date DATE, amount FLOAT)""",
    snowflake_conn_id=SNOWFLAKE_CONN_ID,
)

extract_data = S3ToSnowflakeOperator(
    task_id='extract_data',
    s3_keys=['orders_data.csv'],
    snowflake_conn_id=SNOWFLAKE_CONN_ID,
    stage=SNOWFLAKE_STAGE,
    table=SNOWFLAKE_ORDERS,
    file_format="(type = 'CSV',field_delimiter = ',')",
)
create_table >> extract_data
```

Attempt 1: Taskflow API

- simplified python task writing
- didn’t really do much in terms of data awareness
- Only works with python tasks
- Still dependent on XCom
- Ultimately you still need traditional operators

```python
from airflow.decorators import task

@task
def count_url(url):
   import pandas as pd

   c = pd.read_csv(url)
   return c.count()
```

Attempt 1: Taskflow API

```
extract_data = S3ToSnowflakeOperator(
    task_id='extract_data',
    s3_keys=['orders_data.csv'],
    snowflake_conn_id=SNOWFLAKE_CONN_ID,
    stage=SNOWFLAKE_STAGE,
    table=SNOWFLAKE_ORDERS,
    file_format="(type = 'CSV',field_delimiter = ',')",
)
```

```
from airflow.decorators import task
from airflow.providers.amazon.aws.hooks.s3 import S3Hook
from airflow.providers.snowflake.hooks.snowflake import SnowflakeHook
import io
import requests

@task
def s3_to_snowflake(key, bucket_name):
   snow_hook = SnowflakeHook(
       snowflake_conn_id=SNOWFLAKE_CONN_ID,
   )
   snow_hook.run("""
   COPY INTO testtable FROM s3://<s3_bucket>/data/
       STORAGE_INTEGRATION = myint
       FILE_FORMAT=(field_delimiter=',')
   """.format(
       aws_access_key_id=AWS_ACCESS_KEY_ID,
       aws_secret_access_key=AWS_SECRET_ACCESS_KEY))

with dag:
   loaded_data = s3_to_snowflake(KEY, BUCKET_NAME)
```

So... we started from scratch

Rewriting the Dag Authoring Story

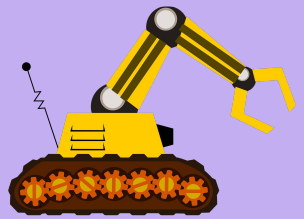
- Airflow DAG code should be almost indistinguishable from standard python
- Data Engineers should be able to treat SQL tables as first-class citizens in their python environment
- Moving data between SQL databases and python environments should be seamless
- Airflow users should be able to run the same DAG across different flavors of SQL, datastores, and data warehouses

Introducing Astro Python SDK

DAG authoring for data engineers reinvented:

Write self-documenting, Pythonic code

Move data between relational stores and python data structures without temp tables



Validate your data with built-in operators

Benefits: 50% fewer lines of code, simplified maintenance

When to use Astro Python SDK

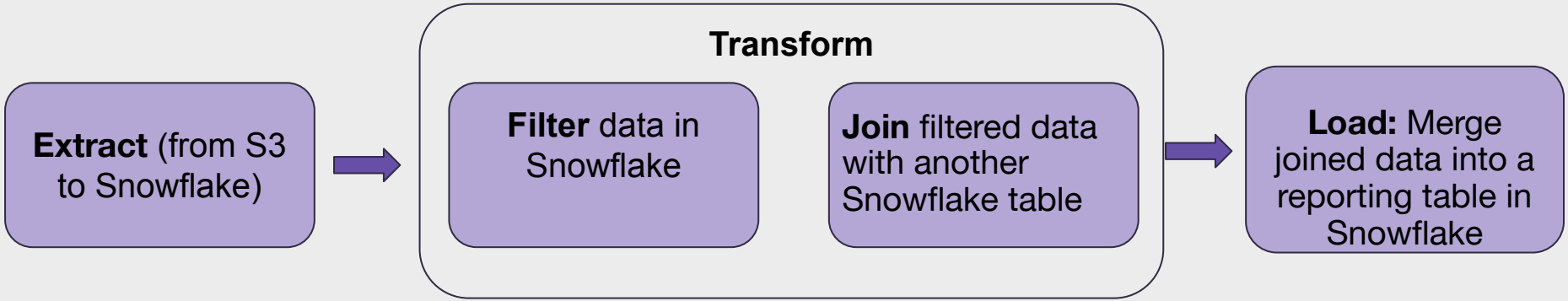
For data engineering teams who are:

- Writing new pipelines
- Re-factoring existing pipelines
- Creating DAGs with multiple-object stores or databases
- Augmenting their pipeline authoring team with data engineers lacking detailed Airflow knowledge and Python expertise

Let’s take a look!

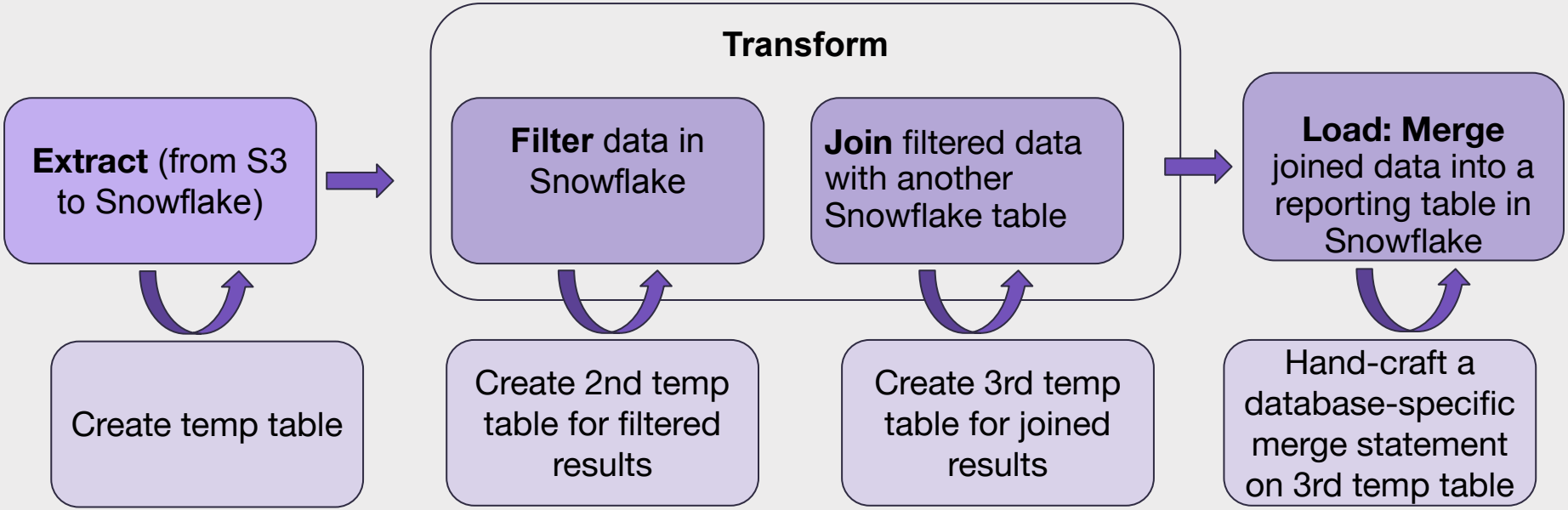
ETL conceptual steps

A very simple, common ETL workflow

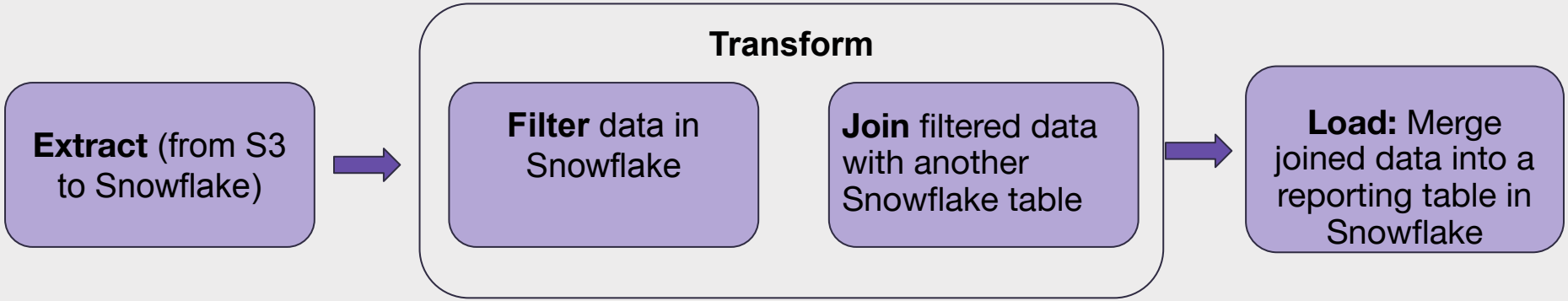


ETL with standard Airflow

Use temp tables to move data from one place to another

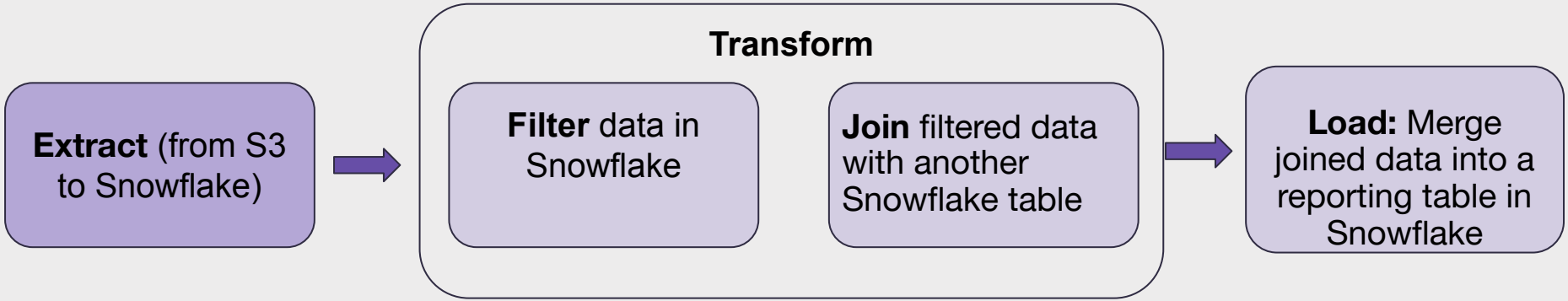


ETL with the Astro Python SDK



(Astro SDK does all this extra work for you!
Focus on the business logic, not the mechanisms to implement the logic)

Extract


Extract (from S3 to Snowflake)
Transform
Filter data in Snowflake
Join filtered data with another Snowflake table
Load: Merge joined data into a reporting table in Snowflake

Extract

`load_file` is the same for GCS→BQ as it is for S3→Snowflake, but:

GCS→BQ

```
extract_data = gcs_to_bq.GoogleCloudStorageToBigQueryOperator(
    task_id='extract_data',
    bucket='BQ_BUCKET',
    source_objects=['bigquery/orders_data.csv'],
    destination_project_dataset_table='BQ_TABLE',
    schema_fields=[
        {'name': 'order_id', 'type': 'STRING', 'mode': 'NULLABLE'},
        {'name': 'customer_id', 'type': 'STRING', 'mode': 'NULLABLE'},
        {'name': 'purchase_date', 'type': 'DATE', 'mode': 'NULLABLE'},
        {'name': 'amount', 'type': 'NUMERIC', 'mode': 'NULLABLE'},
    ],
    write_disposition='WRITE_TRUNCATE',
    dag=dag)
```

S3→Snowflake

```
create_table = SnowflakeOperator(
    task_id = "create_table",
    sql = f"""CREATE OR REPLACE TABLE {SNOWFLAKE_ORDERS}
    (order_id char(10),customer_id char(10), purchase_date DATE, amount
FLOAT)""",
    snowflake_conn_id = SNOWFLAKE_CONN_ID,
)

extract_data = S3ToSnowflakeOperator(
    task_id = 'extract_data',
    s3_keys = ['orders_data.csv'],
    snowflake_conn_id=SNOWFLAKE_CONN_ID,
    stage = SNOWFLAKE_STAGE,
    table = SNOWFLAKE_ORDERS,
    file_format = "(type = 'CSV',field_delimiter = ',')",
)
create_table >> extract_data
```

Extract

Simplified with a new `load_file` operator

```
orders_data = aql.load_file(
    file = File('s3://…/orders_data_header.csv',S3_CONN_ID),
    output_table=Table(conn_id=SNOWFLAKE_CONN_ID)
)
```

```
orders_data = aql.load_file(
    file = File('gs://…/orders_data_header.csv',GCS_CONN_ID),
    output_table=Table(conn_id=BQ_CONN_ID)
)
```

Extract

Simplified with a new `load_file` operator

Standard Airflow

```
create_table = SnowflakeOperator(
    task_id = "create_table",
    sql = f"""CREATE OR REPLACE TABLE {SNOWFLAKE_ORDERS}
    (order_id char(10),customer_id char(10), purchase_date DATE, amount
FLOAT)""",
    snowflake_conn_id = SNOWFLAKE_CONN_ID,
)

extract_data = S3ToSnowflakeOperator(
    task_id = 'extract_data',
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    stage = SNOWFLAKE_STAGE,
    table = SNOWFLAKE_ORDERS,
    file_format = "(type = 'CSV',field_delimiter = ',')",
)
create_table >> extract_data
```

Create temp table

Needs a staging table

Fill the temp table

Specify task dependencies

Astro Python SDK

```
orders_data = aql.load_file(
    file = File('/orders_data_header.csv',S3_CONN_ID),
    output_table=Table(conn_id=SNOWFLAKE_CONN_ID)
)
```

Extract

Simplified with a new, datastore- and database-agnostic `load_file` operator

Standard Airflow

```
create_table = SnowflakeOperator(
    task_id = "create_table",
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    (order_id char(10),customer_id char(10), purchase_date DATE, amount
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extract_data = S3ToSnowflakeOperator(
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    stage = SNOWFLAKE_STAGE,
    table = SNOWFLAKE_ORDERS,
    file_format = "(type = 'CSV',field_delimiter = ',')",
)
create_table >> extract_data
```

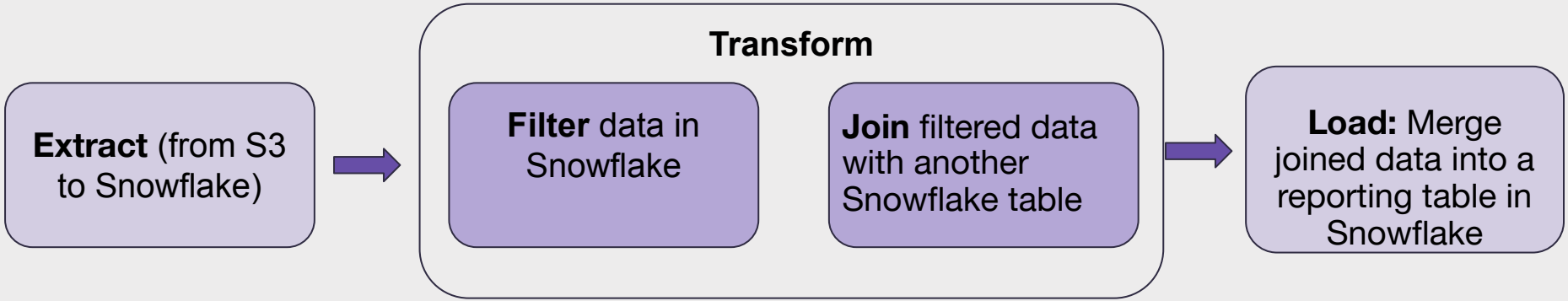
Where to pull from

Where to send it

Astro Python SDK

```
orders_data = aql.load_file(
    file = File('/orders_data_header.csv',S3_CONN_ID),
    output_table=Table(conn_id=SNOWFLAKE_CONN_ID)
)
```

Transform


Extract (from S3 to Snowflake)
Transform
Filter data in Snowflake
Join filtered data with another Snowflake table
Load: Merge joined data into a reporting table in Snowflake

Transform

Simplified with the new `transform` operator

Standard Airflow

```
filter_data = SnowflakeOperator(
   task_id = "filter_data",
   sql = f"""CREATE OR REPLACE TABLE {SNOWFLAKE_FILTERED_ORDERS} AS
        (SELECT * FROM {SNOWFLAKE_ORDERS} WHERE amount > 150)""",
   snowflake_conn_id = SNOWFLAKE_CONN_ID,
)

# assumes there's already a populated SNOWFLAKE_CUSTOMERS table
join_data = SnowflakeOperator(
   task_id = "join_data",
   sql =  f"""CREATE OR REPLACE TABLE {SNOWFLAKE_JOINED} AS
       (SELECT c.customer_id, customer_name, order_id, purchase_date,
amount, type FROM
       {SNOWFLAKE_FILTERED_ORDERS} fo JOIN {SNOWFLAKE_CUSTOMERS} c
       ON fo.customer_id = c.customer_id)"""

create_table >> extract_data >> filter_data >> join_data
```

Astro Python SDK

```
@aql.transform
def filter_orders (input_table: Table):
   return "SELECT * FROM {{input_table}} WHERE amount > 150"

@aql.transform
def join_orders_customers (filtered_orders_table: Table, customers_table :
Table):
    return """SELECT c.customer_id, customer_name, order_id, purchase_date,
amount, type FROM {{filtered_orders_table}} fo JOIN {{customers_table}} c ON
fo.customer_id = c.customer_id"""

with dag:
    customers_table=Table(name=SNOWFLAKE_CUSTOMERS,conn_id=SNOWFLAKE_CONN_ID)
    filtered_data = filter_orders(orders_data)
    joined_data = join_orders_customers(filtered_data, customers_table)
```

Transform

Simplified with the new `transform` operator

Standard Airflow

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filter_data = SnowflakeOperator(
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       ON fo.customer_id = c.customer_id)"""

create_table >> extract_data >> filter_data >> join_data
```

Create temp table to hold filtered orders

Create temp table to hold joined results

Specify task dependencies

Astro Python SDK

```
@aql.transform
def filter_orders (input_table: Table):
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fo.customer_id = c.customer_id"""

with dag:
    customers_table=Table(name=SNOWFLAKE_CUSTOMERS,conn_id=SNOWFLAKE_CONN_ID)
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Standard Airflow

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filter_data = SnowflakeOperator(
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        (SELECT c.customer_id, customer_name, order_id, purchase_date,
amount, type FROM
        {SNOWFLAKE_FILTERED_ORDERS} fo JOIN {SNOWFLAKE_CUSTOMERS} c
        ON fo.customer_id = c.customer_id)"""

create_table >> extract_data >> filter_data >> join_data
```

Create temp table to hold filtered orders

Create temp table to hold joined results

Specify task dependencies

Astro Python SDK

```
@aql.transform
def filter_orders (input_table: Table):
    return "SELECT * FROM {{input_table}} WHERE amount > 150"

@aql.transform
def join_orders_customers (filtered_orders_table: Table, customers_table :
Table):
    return """SELECT c.customer_id, customer_name, order_id, purchase_date,
amount, type FROM {{filtered_orders_table}} fo JOIN {{customers_table}} c ON
fo.customer_id = c.customer_id"""

with dag:
    customers_table=Table(name=SNOWFLAKE_CUSTOMERS,conn_id=SNOWFLAKE_CONN_ID)
    filtered_data = filter_orders(orders_data)
    joined_data = join_orders_customers(filtered_data, customers_table)
```

Inputs and outputs are Table objects

Transform

Tasks become importable components

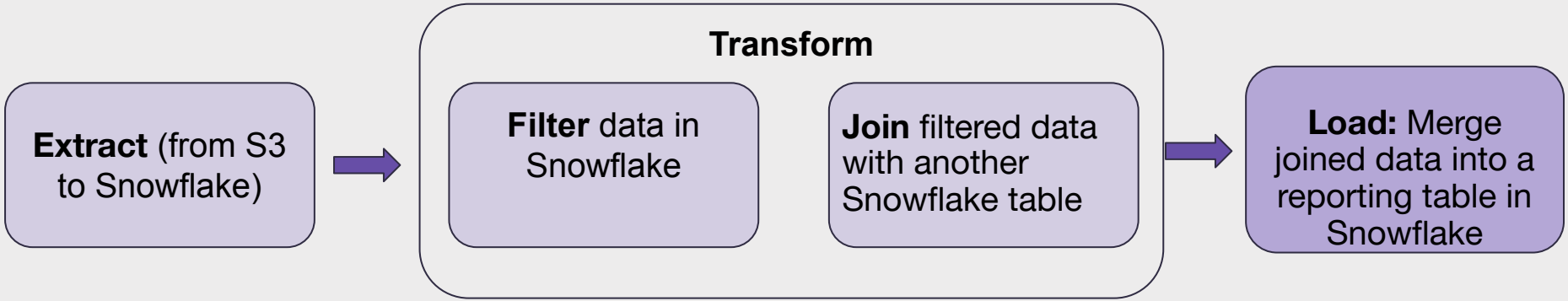
```
@aql.transform
def filter_orders (input_table: Table):
   return "SELECT * FROM {{input_table}} WHERE amount > 150"

@aql.transform
def join_orders_customers (filtered_orders_table: Table, customers_table :
Table):
    return """SELECT c.customer_id, customer_name, order_id, purchase_date,
amount, type FROM {{filtered_orders_table}} fo JOIN {{customers_table}} c ON
fo.customer_id = c.customer_id"""
```

```
from my.library import orders_data, filter_orders, join_orders_customers

customers_table=Table(name=SNOWFLAKE_CUSTOMERS,conn_id=SNOWFLAKE_CONN_ID)
with dag:
    joined_data = join_orders_customers(
                      filter_orders(orders_data),
                      customers_table=customers_table,
                  )
```

Load


Extract (from S3 to Snowflake)
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Merge

Simplified with a database agnostic `merge` operator

```
merge_data = SnowflakeOperator(
   task_id="merge_data",
   sql=f"""MERGE INTO {SNOWFLAKE_REPORTING} r using {SNOWFLAKE_JOINED} j
        ON r.order_id = j.order_id WHEN MATCHED THEN
        UPDATE SET r.customer_id = j.customer_id, r.customer_name = j.customer_name"""
)
```

Merge

Postgres

```
INSERT INTO {main_table} ("list","sell","taxes")
   SELECT "list","sell","taxes" FROM {merge_table}
       ON CONFLICT ("list","sell") DO
   UPDATE SET
"list"=EXCLUDED."list","sell"=EXCLUDED."sell","taxes"=EXCLUDED."t
axes"
```

Sqlite

```
INSERT INTO {main_table} (list,sell,taxes)
   SELECT list,sell,taxes FROM {merge_table} Where true
       ON CONFLICT (list,sell) DO
   UPDATE SET
list=EXCLUDED.list,sell=EXCLUDED.sell,taxes=EXCLUDED.taxes
```

Snowflake

```
merge into {{main_table}} using {{merge_table}} on
    Identifier(taxes)=Identifier(taxes) AND
    Identifier(age)=Identifier(age)
when matched then
    UPDATE SET {main_table}.list={merge_table}.list,
    {main_table}.sell={merge_table}.sell,
    {main_table}.taxes={merge_table}.taxes
when not matched then
    insert({main_table}.list,{main_table}.sell,{main_table}.taxes)
    values ({merge_table}.list,{merge_table}.sell,{merge_table}.taxes)
```

BigQuery

```
MERGE {table} T USING {merge_table} S
   ON T.list= S.list AND T.sell= S.sell
   WHEN NOT MATCHED BY TARGET THEN
        INSERT (list,sell,taxes) VALUES (list,sell,taxes)
             WHEN MATCHED THEN
        UPDATE SET T.list=S.list, T.sell=S.sell, T.taxes=S.taxes
```

Merge

Simplified with a database agnostic `merge` operator

Standard Airflow

```
merge_data = SnowflakeOperator(
   task_id="merge_data",
   sql=f"""MERGE INTO {SNOWFLAKE_REPORTING} r using {SNOWFLAKE_JOINED} j
        ON r.order_id = j.order_id WHEN MATCHED THEN
        UPDATE SET r.customer_id = j.customer_id, r.customer_name =
j.customer_name"""
)
```

MERGE syntax is database-specific

Astro Python SDK

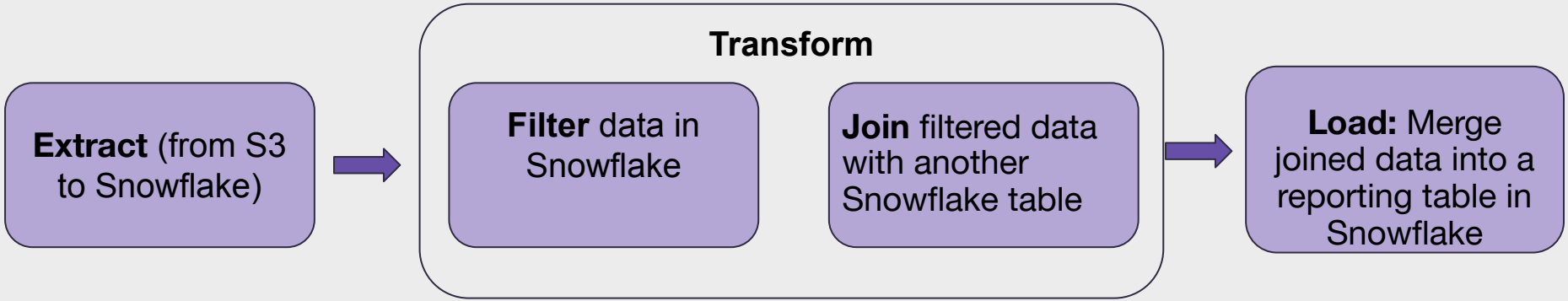
```
aql.merge(target_table =
Table(name=SNOWFLAKE_REPORTING,conn_id=SNOWFLAKE_CONN_ID),
    merge_table=joined_data,
    merge_columns=["customer_id", "customer_name"],
    target_columns=["customer_id", "customer_name"],
    merge_keys={"order_id": "order_id"},
    conflict_strategy="update")
```

MERGE syntax is database-agnostic

But What About Python?

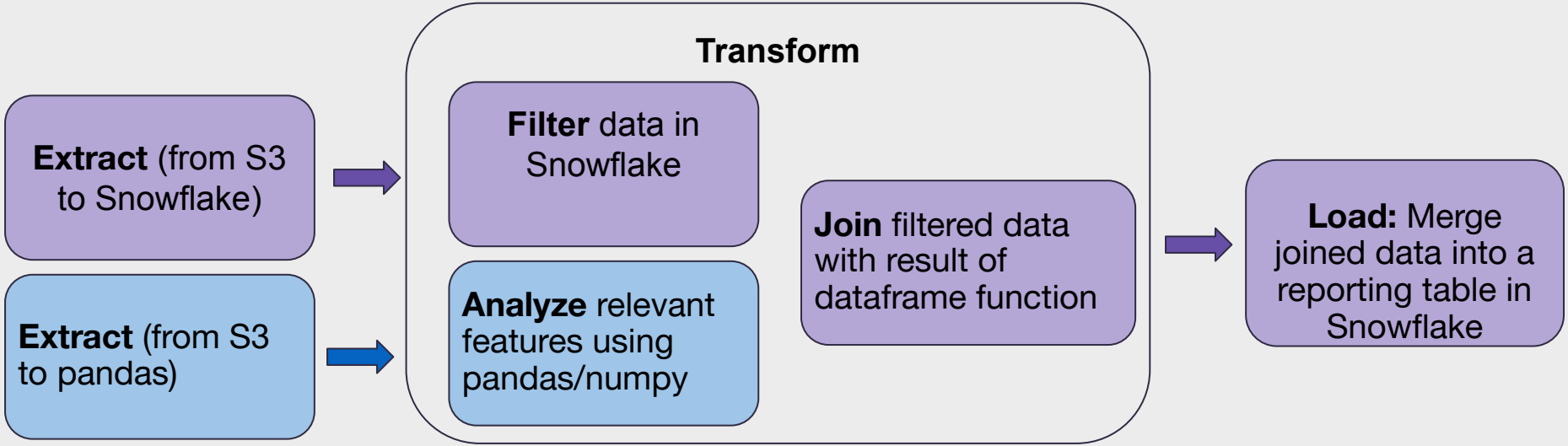
ETL with only SQL

A very simple, common ETL workflow



ETL with SQL and Dataframes

A slightly less simple, common ETL workflow



Moving Data Between Python and SQL

Traditional way: APIs, hooks, etc.

```python
from airflow.decorators import task
from airflow.providers.snowflake.hooks.snowflake import SnowflakeHook
@task
def add_one_to_column(conn_id: str, warehouse: str, table_name: str, output_table_name: str):
    table_hook = SnowflakeHook(
        snowflake_conn_id=conn_id,
        warehouse=warehouse,
        database=database,
        role=role,
        schema=schema,
        authenticator=authenticator,
        session_parameters=session_parameters,
    )
    table_df = table_hook.get_pandas_df(f"SELECT * FROM {table_name}")
    table_df["column_name"] = table_df["column_name"] + 1

    table_df.to_sql(
        name=output_table_name,
        con=table_hook.get_sqlalchemy_engine().connect(),
    )
```

The Dataframe Decorator

Move data between pandas dataframes and tables with ease!

```
@aql.dataframe
def my_df_func(input_df: DataFrame):
   input_df["column_name"] = input_df["column_name"] + 1


with dag:
   my_homes_df = aql.load_file(
       file = File('/orders_data_header.csv',S3_CONN_ID),
   )
   my_df_func(my_homes_df)
```

The Dataframe Decorator

Table -> Dataframe

```
@aql.dataframe
def my_df_func(input_df: DataFrame):
   input_df["column_name"] = input_df["column_name"] + 1


with dag:
   my_homes_table = aql.load_file(
       file = File('/orders_data_header.csv',S3_CONN_ID),
       output_table=Table(
           conn_id="postgres_conn",
       ),
   )
   my_df_func(my_homes_table)
```

The Dataframe Decorator

Table -> Dataframe -> Table

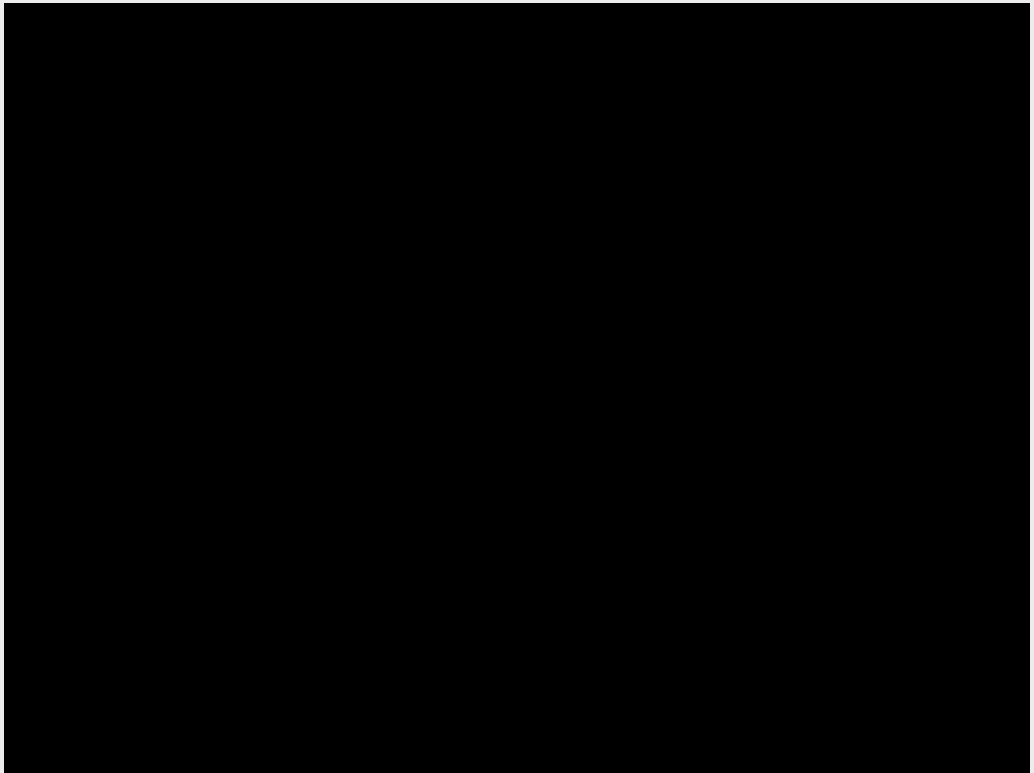
```
@aql.dataframe
def my_df_func(input_df: DataFrame):
   input_df["column_name"] = input_df["column_name"] + 1


with dag:
   my_homes_table = aql.load_file(
       file = File('/orders_data_header.csv',S3_CONN_ID),
       output_table=Table(
           conn_id="postgres_conn",
       ),
   )
   my_df_func(my_homes_table, output_table=Table(...))
```

Comparing the Two

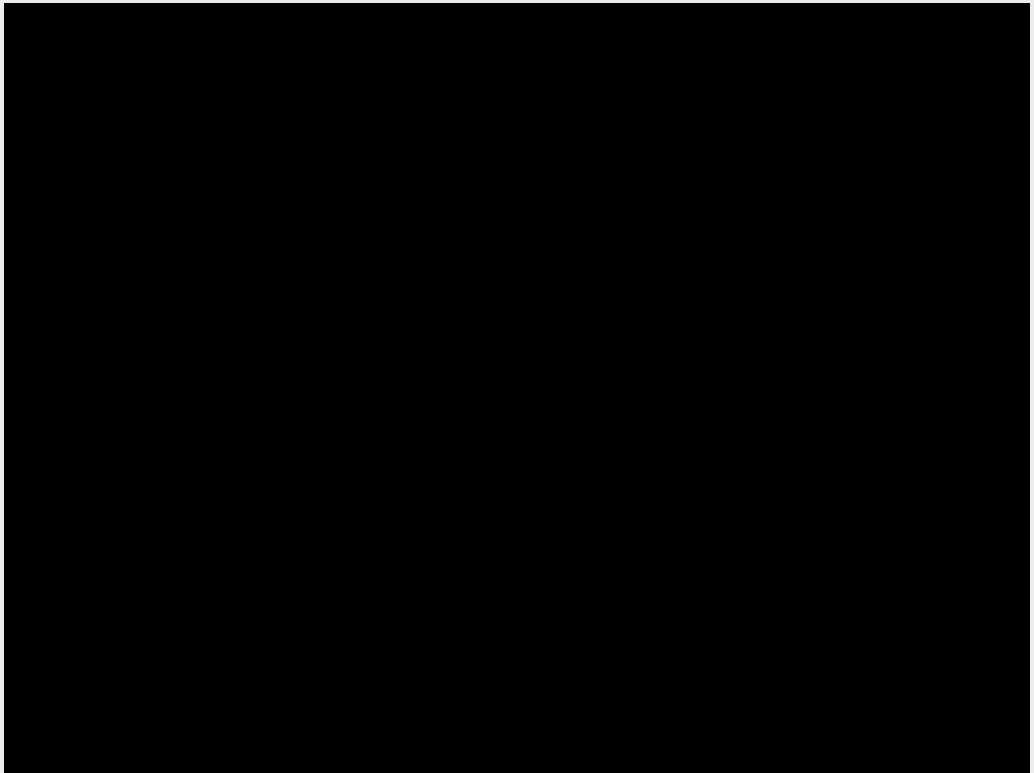
Comparing the Two

Traditional: 93 lines of code



Comparing the Two

Astro SDK: 66 lines of code



Coming Soon

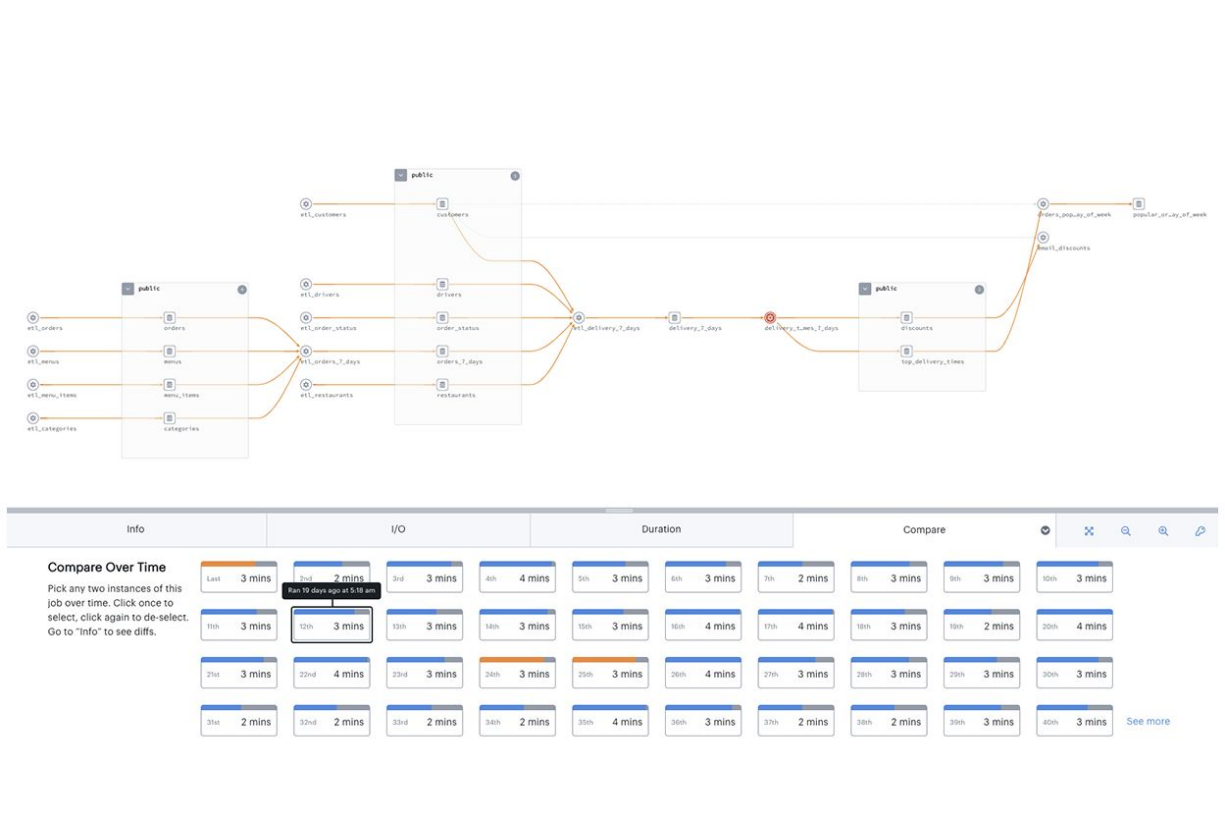
Data Validation

```
@aql.transform
def join_orders_customers(filtered_orders_table: Table, customers_table: Table):
   return """SELECT c.customer_id, customer_name, order_id, purchase_date, amount, type FROM
               {{filtered_orders_table}} fo JOIN {{customers_table}} c
              ON fo.customer_id = c.customer_id"""

checks = [Check("customer_id_not_null", "customer_id != null"), Check("order_has_cost", "cost >= 0")]

@dag(start_date=datetime(2021, 12, 1), schedule_interval="@daily", catchup=False)
def example_with_validation():
   transformed_data = join_orders_customers(
       df=extracted_data, output_table=Table(name="homes_data_long"),
       input_data_checks = checks)
```

Data Validation + Lineage



Distributed Dataframes

Move **bigger** data between dataframes and tables with ease!

```
@snowpark
def my_df_func(input_df: DataFrame):
   input_df["column_name"] = input_df["column_name"] + 1


with dag:
   my_homes_table = aql.load_file(
       path=f"{s3_bucket}/homes.csv",
       output_table=Table(
           conn_id="snowflake_conn",
       ),
   )
   my_df_func(my_homes_table, output_table=Table(...))
```

```
@spark
def my_df_func(input_df: DataFrame):
   input_df["column_name"] = input_df["column_name"] + 1


with dag:
   my_homes_table = aql.load_file(
       path=f"{s3_bucket}/homes.csv",
       output_table=Table(
           conn_id="snowflake_conn",
       ),
   )
   my_df_func(my_homes_table, output_table=Table(...))
```

Dynamic Task Templates

```
@aql.transform
def filter_snow_data(input_table: Table) -> Table:
   return """
   SELECT * FROM {{input_table}} WHERE amount > 150)
   """

@task
def print_value(val: str):
   print(f"the value is {val}")

with dag:
   filtered_data = filter_snow_data(input_table=Table(...))
   aql.run_per_row(table=filtered_data, task=print_value)
```

And Much More!

Some possibilities:

- Optimized file loading
- Support for asynchronous operators
- Support more databases: RedShift, Azure
- etc.

How to get involved

- Astro Python SDK is available in a **preview** release. Not ready for production use!
- Write some DAGS with it: give us your feedback on the interfaces so we can improve for your needs
- Improvements in progress:
  - Increase speed of file loads
  - Support larger data sets
- Working example: github.com/astronomer/astro-sdk/tutorial.md
- Find the code: https://pypi.org/project/astro-sdk-python/

Thank you

Tw: @danimberman

GH: @dimberman

Source: github.com/astronomer/astro-sdk/tutorial.md

Pypi: https://pypi.org/project/astro-sdk-python/

Appendix

Introducing Astronomer Open Source

What: Add-ons and code overlays complementary to Airflow core. Starting with the Astro Python SDK, Astro CLI, async providers

Why: Shorter development cycles

How: Apache 2.0 license

Who: Open for community contribution, maintained by Astronomers

Where: github.com/astronomer