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AIP-31: Airflow functional DAG

Airflow Summit 2020

Intro 👋

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Why functional DAG?

Example ETL pipeline

Extract

GET request to HttpBin `/get` endpoint

Data out: HttpBin JSON string

Transform

Parse JSON

Extract origin parameter

Format email subject and content

Data out: Email subject + content strings

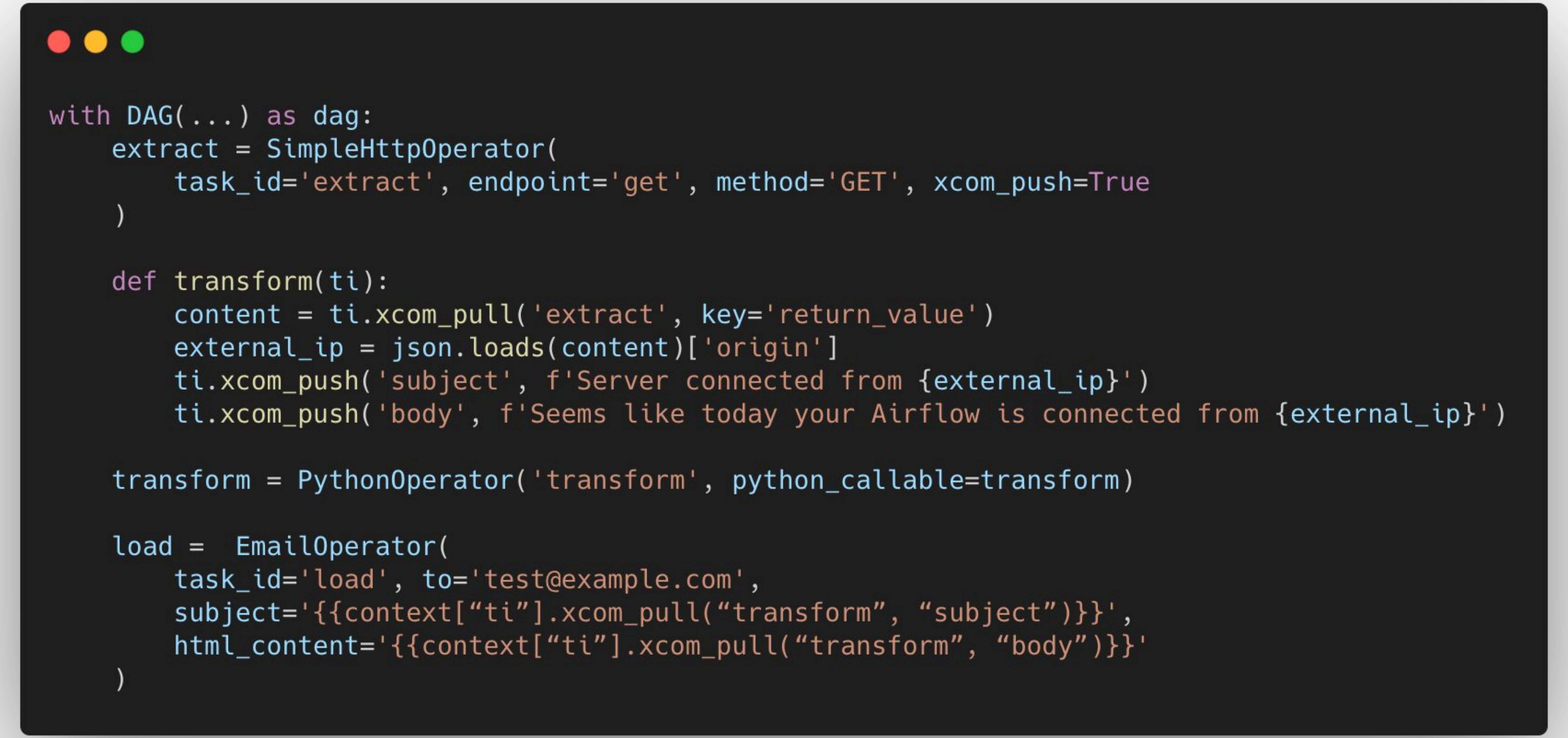
Load

Send email to myself to get current IP

Passing data between operators

- **XCom value vs Execution date based file paths**
- **Preferred:** XCom. **Why?**
  - Sometimes **data fits in DB**! Ex: model training metrics.
  - **More flexible paths**, not only date needed, custom config (HDFS cluster, GCS vs HDFS…)
  - XCom are **visible from Web UI**, easier to debug
  - Better **reusability** of operators
  - Already used by a lot of **OSS Airflow operators**!

Example DAG



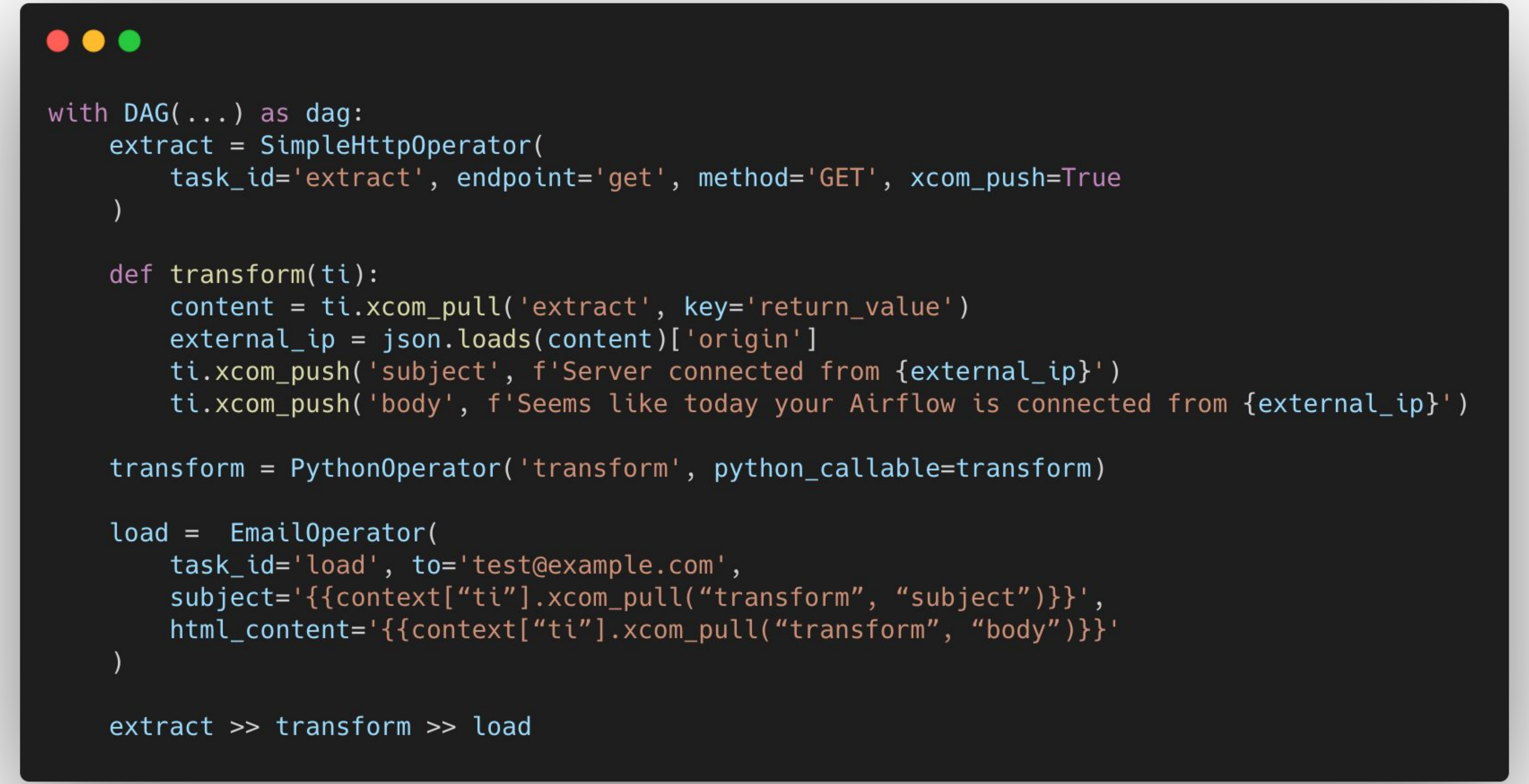
```
with DAG(...) as dag:
    extract = SimpleHttpOperator(
        task_id='extract', endpoint='get', method='GET', xcom_push=True
    )

    def transform(ti):
        content = ti.xcom_pull('extract', key='return_value')
        external_ip = json.loads(content)['origin']
        ti.xcom_push('subject', f'Server connected from {external_ip}')
        ti.xcom_push('body', f'Seems like today your Airflow is connected from {external_ip}')

    transform = PythonOperator('transform', python_callable=transform)

    load =  EmailOperator(
        task_id='load', to='test@example.com',
        subject='{{context[“ti”].xcom_pull(“transform”, “subject”)}}',
        html_content='{{context[“ti”].xcom_pull(“transform”, “body”)}}'
    )
```

Example DAG



```python
with DAG(...) as dag:
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    extract >> transform >> load
```

AIP-31: Motivation

- ETL workflow resemble functions: [Functional Data Engineering]
  - Variable == data artifact ≈ xcom metadata
  - Function == operator
- Data artifacts are **implicit** in Airflow (XCom table for metadata)
- Needs **explicit task dependency declaration**
- Custom **function to operator** is hard-ish (PythonOperator)

Prior art/Inspiration

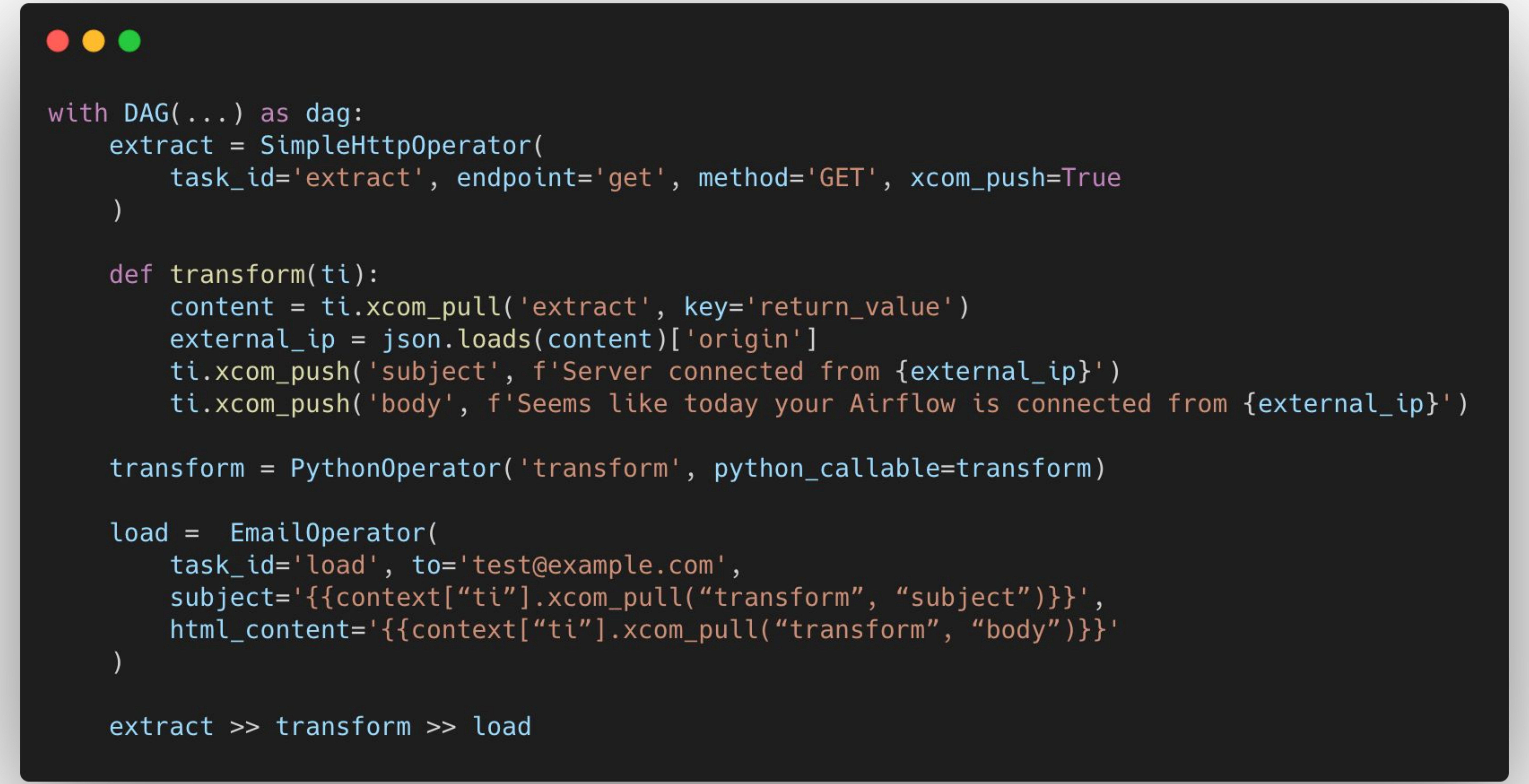
- Streamlined (Functional) Airflow roadmap
- TypedXComArg in ML Workflows (internal Twitter Airflow fork)
- ML pipelines investigation
    - Prefect Functional DAG
    - Dagster pipelines and solids
    - Te   nsorflow Extended pipelines
    - Square’s Bionic pipelines
    - Netflix Metaflow pipelines

Explicit XCom: XComArg class

XComArg: Reference to future XCom value

- Resolved on operator execution for templated fields
  - `XComArg(op, ‘subject’) == “{{context[‘ti’].xcom_pull(‘op_id’, ‘subject’)}}”`
  - `XComArg(op, ‘subject’).resolve() == ti.xcom_pull(op, ‘subject’)`
- Used in **DAG definition**
- Change XComArg key using **`__getitem__`**: **`val[‘body’]`**
- `BaseOperator` property to generate default XComArg: **`.output`**
- **Implicit task dependency** based on XComArg dependency

Example DAG



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    extract >> transform >> load
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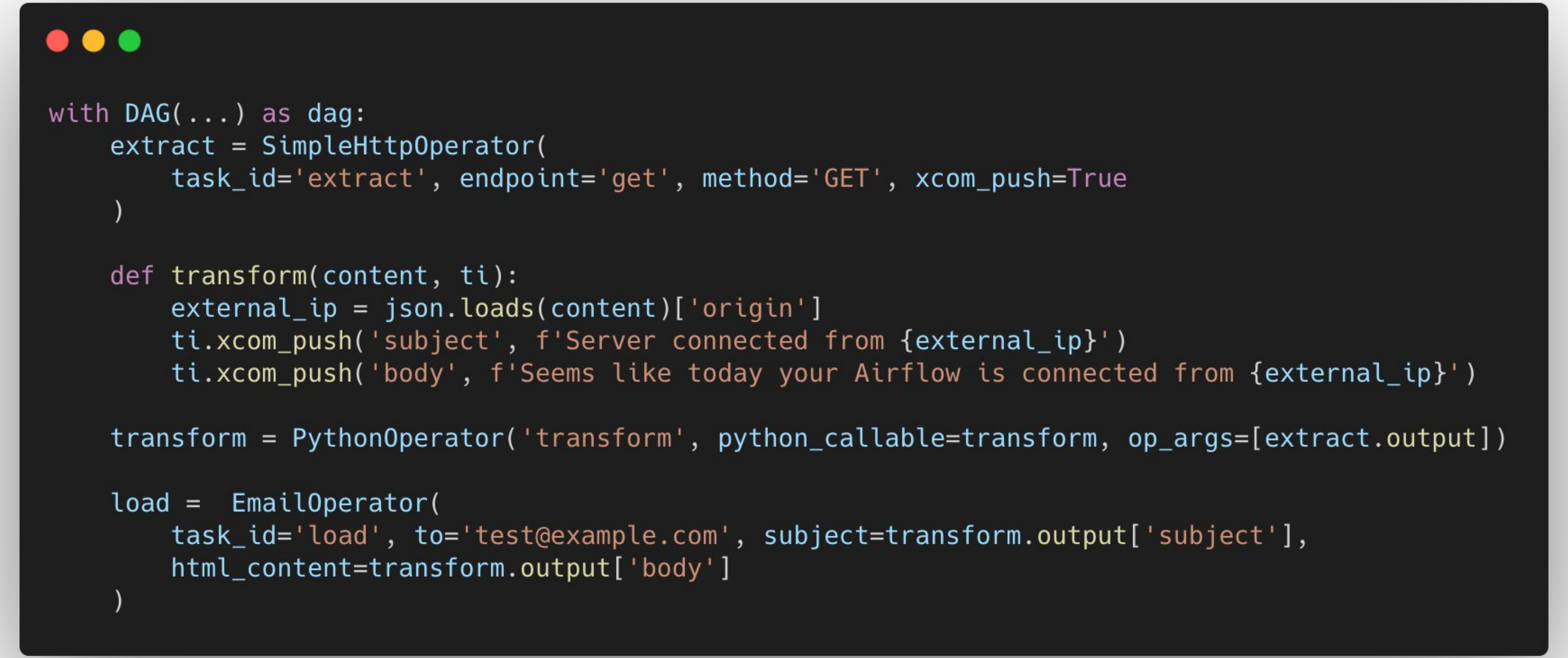
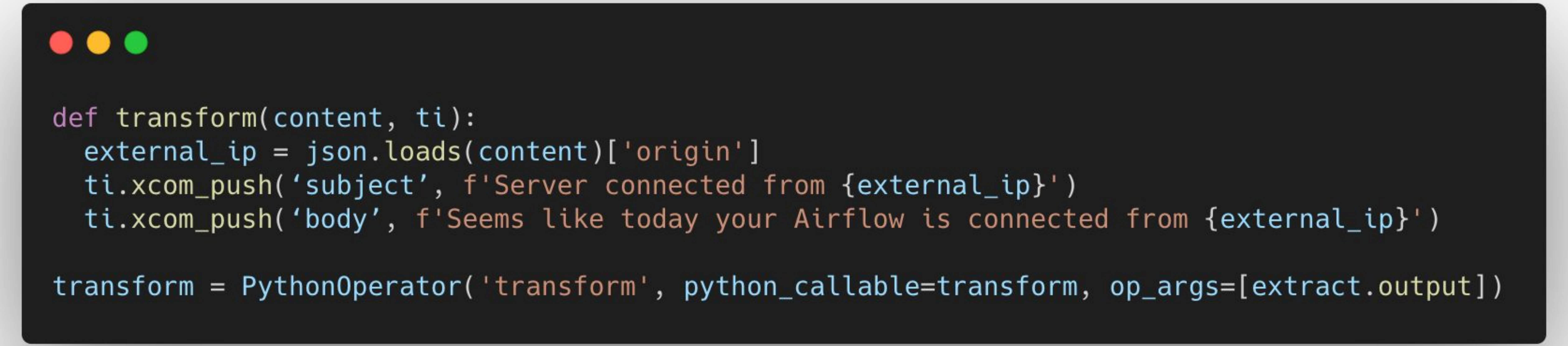
Example DAG



```python
with DAG(...) as dag:
    extract = SimpleHttpOperator(
        task_id='extract', endpoint='get', method='GET', xcom_push=True
    )

    def transform(content, ti):
        external_ip = json.loads(content)['origin']
        ti.xcom_push('subject', f'Server connected from {external_ip}')
        ti.xcom_push('body', f'Seems like today your Airflow is connected from {external_ip}')

    transform = PythonOperator('transform', python_callable=transform, op_args=[extract.output])

    load =  EmailOperator(
        task_id='load', to='test@example.com', subject=transform.output['subject'],
        html_content=transform.output['body']
    )
```

@task decorator

Python function to Airflow operator



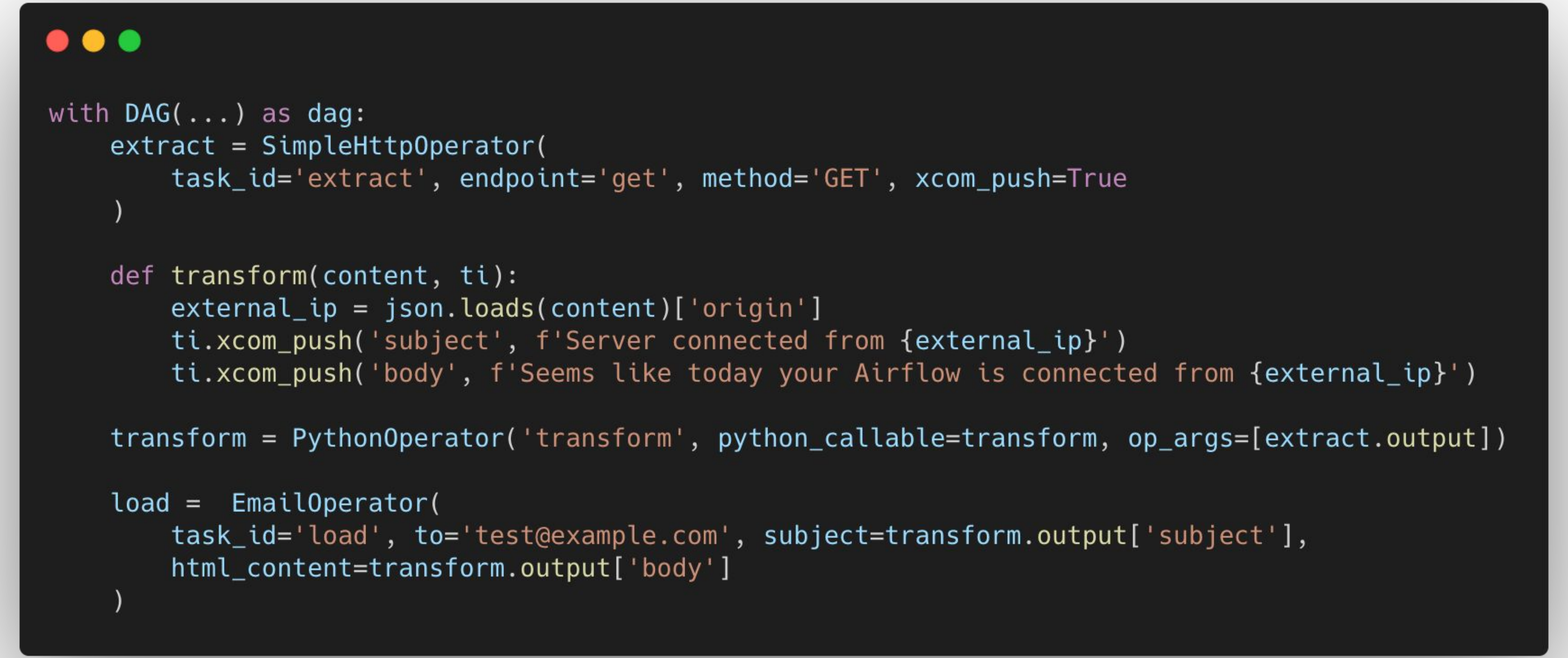
```python
def transform(content, ti):
  external_ip = json.loads(content)['origin']
  ti.xcom_push(‘subject’, f'Server connected from {external_ip}')
  ti.xcom_push(‘body’, f'Seems like today your Airflow is connected from {external_ip}')

transform = PythonOperator('transform', python_callable=transform, op_args=[extract.output])
```

@task decorator

- Usage:
  - **`@airflow.decorators.task`**
  - **`@dag.task`**
- Calling decorated function **generates PythonOperator**
- **Set `op_args` and `op_kwargs`**
- **Multiple outputs support**, return dictionary with string keys.
- **Generate Task ids** automatically
- **Return default XComArg** when called
- [UPCOMING] No context kwarg support, instead **`get_current_context()`**

Example DAG



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    extract = SimpleHttpOperator(
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    def transform(content, ti):
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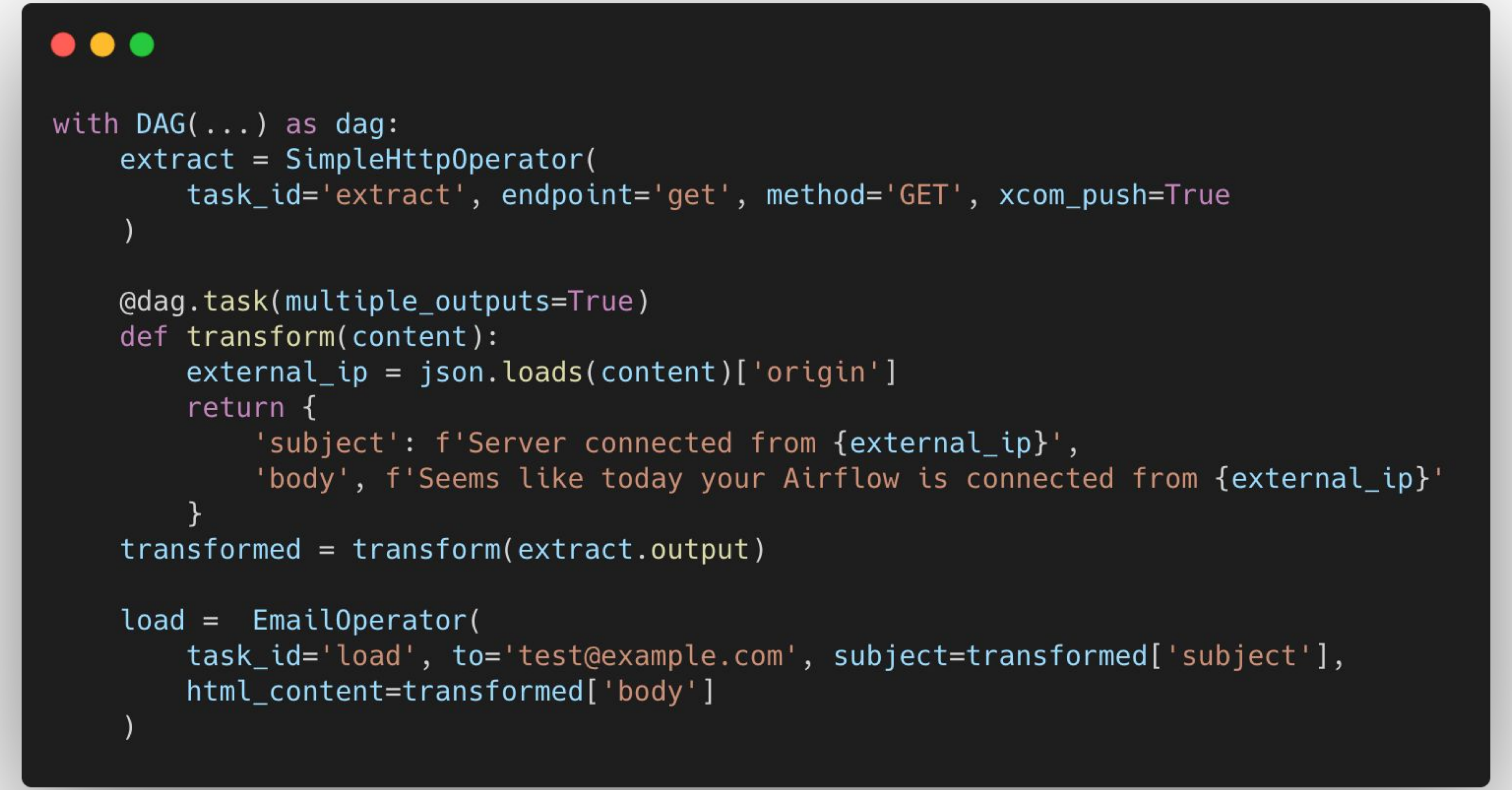
    transform = PythonOperator('transform', python_callable=transform, op_args=[extract.output])

    load =  EmailOperator(
        task_id='load', to='test@example.com', subject=transform.output['subject'],
        html_content=transform.output['body']
    )
```

Example DAG



```
with DAG(...) as dag:
    extract = SimpleHttpOperator(
        task_id='extract', endpoint='get', method='GET', xcom_push=True
    )

    @dag.task(multiple_outputs=True)
    def transform(content):
        external_ip = json.loads(content)['origin']
        return {
            'subject': f'Server connected from {external_ip}',
            'body', f'Seems like today your Airflow is connected from {external_ip}'
        }
    transformed = transform(extract.output)

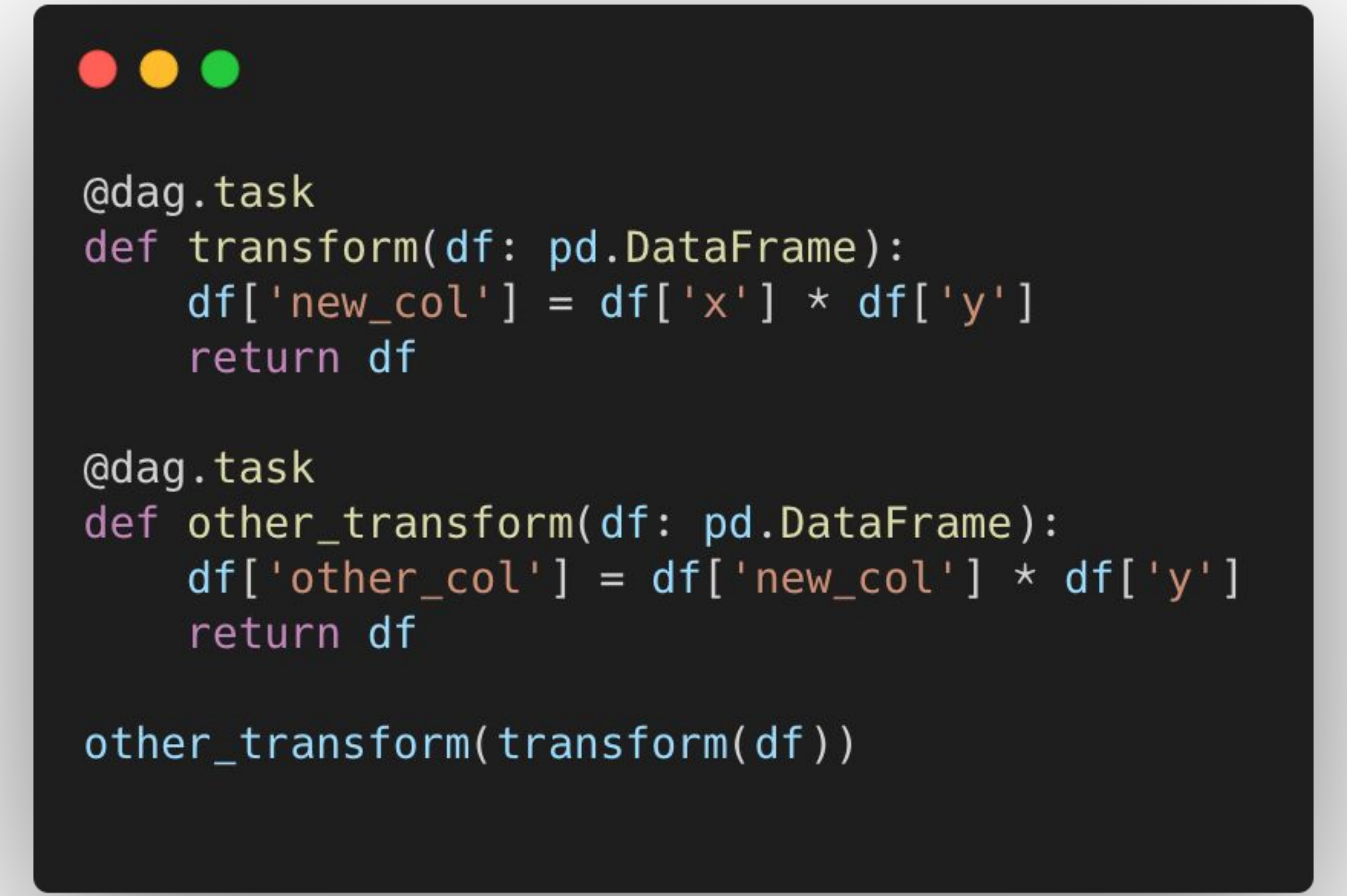
    load =  EmailOperator(
        task_id='load', to='test@example.com', subject=transformed['subject'],
        html_content=transformed['body']
    )
```

Future work! 🚀

Future work + Contributions

- **`@dag` decorator:** Same concept as `@task` but to create DAG
    - Function kwargs == DAG parameters
- **Type hints** support for multiple outputs
    - Automatically detect if output must be splitted into different XCom values.
- Custom XCom backends
    - Handle **serialization for specific Python classes**
    - Handle I/O for different centralized local file systems: HDFS, GCS, S3...
    - **Ex:** Serialize/Deserialize pandas from/into CSV in HDFS when used for XCom values

Custom XCom backend

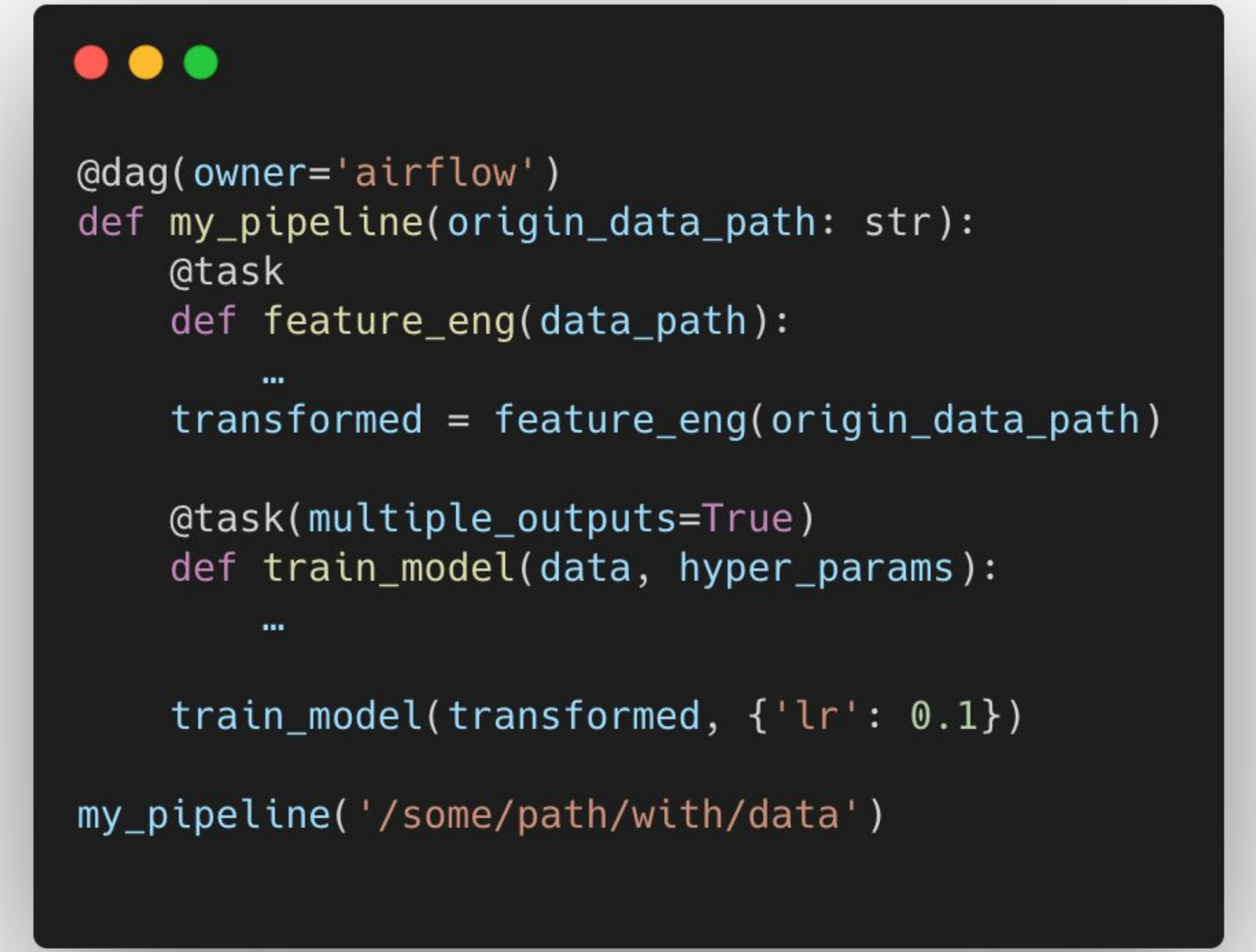


```
@dag.task
def transform(df: pd.DataFrame):
    df['new_col'] = df['x'] * df['y']
    return df

@dag.task
def other_transform(df: pd.DataFrame):
    df['other_col'] = df['new_col'] * df['y']
    return df

other_transform(transform(df))
```

@dag decorator



```
@dag(owner='airflow')
def my_pipeline(origin_data_path: str):
    @task
    def feature_eng(data_path):
        …
    transformed = feature_eng(origin_data_path)

    @task(multiple_outputs=True)
    def train_model(data, hyper_params):
        …

    train_model(transformed, {'lr': 0.1})

my_pipeline('/some/path/with/data')
```

Last but not least. Not working alone: Functional Ops SIG

Kudos to..

- Contributors for AIP-31
    - Tomek Urbaszek
    - Evgeny Shulman
    - Jonathan Shir

+ Airflow reviewers and committers (Kaxil, Ash, Jarek, Dan…)

Questions? 🤔

Thank you. 👋