Google Cloud

Manage Data Pipelines with Cloud Data Fusion and Cloud Composer

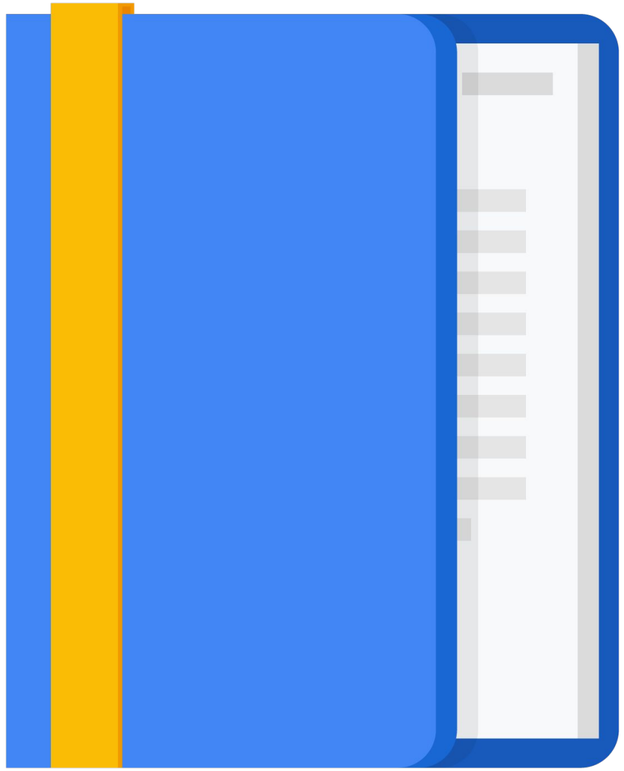
Agenda

Building Batch Data Pipelines visually with Cloud Data Fusion

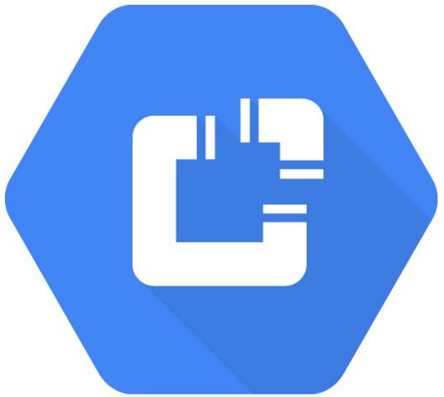
- Components
- UI Overview
- Building a Pipeline
- Exploring Data using Wrangler

Orchestrating work between GCP services with Cloud Composer

- Apache Airflow Environment
- DAGs and Operators
- Workflow Scheduling
- Monitoring and Logging



Cloud Data Fusion



Cloud Data Fusion is a fully-managed, cloud native, enterprise data integration service for quickly building and managing data pipelines.

Developer, Data Scientist and Business Analyst

1

Need to cleanse, match, de-dupe, blend, transform, partition, transfer, standardize, automate, and monitor.

2

Use Cloud Data Fusion to visually build integration pipeline, test, debug and deploy.

3

Run it at scale on Google Cloud, operationalize (monitor, report) pipelines, inspect rich integration metadata.

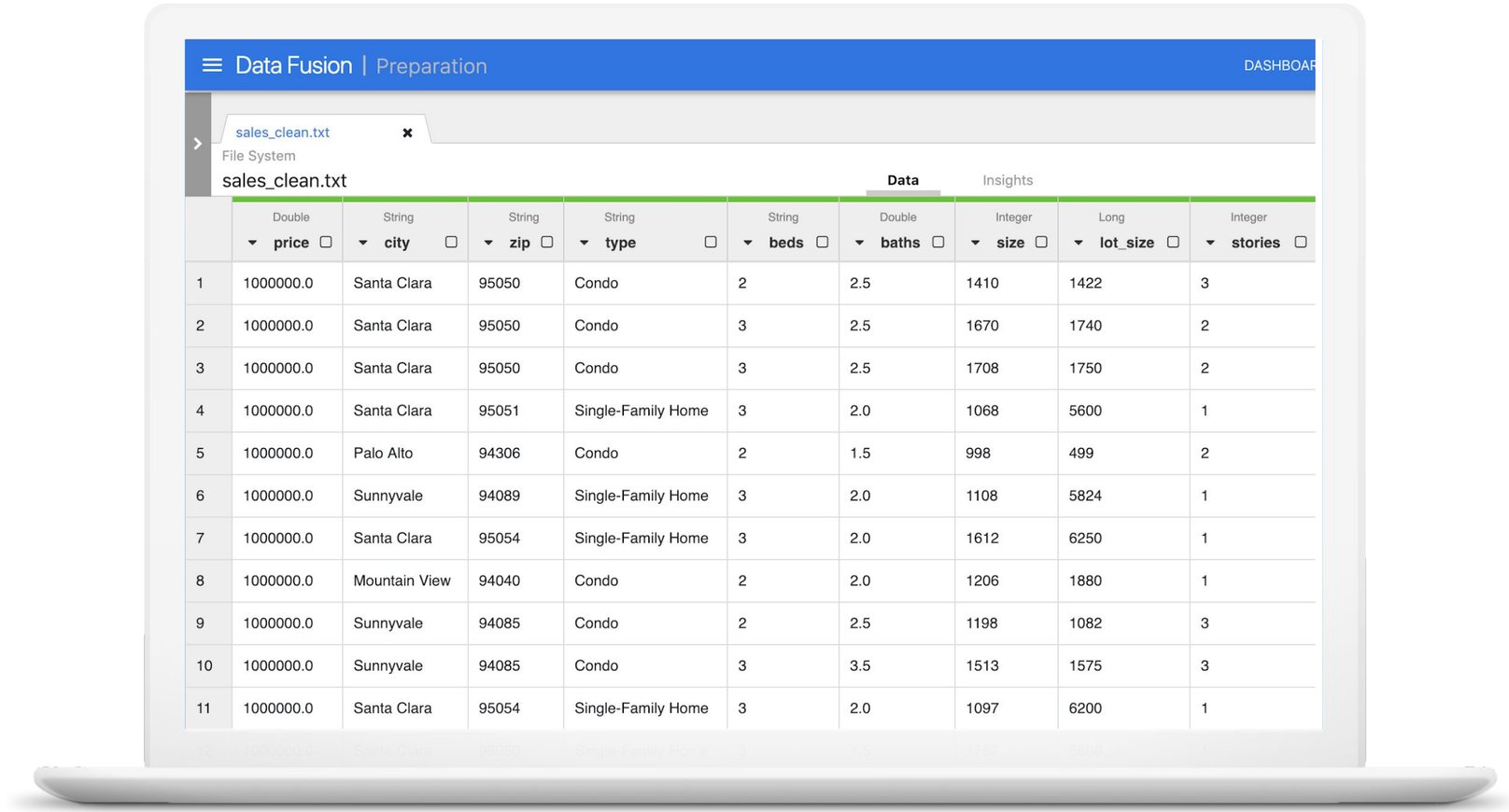
Benefits

Integrate with any data

Increase productivity

Reduce complexity

Increase flexibility



	Double price	String city	String zip	String type	String beds	Double baths	Integer size	Long lot_size	Integer stories
1	1000000.0	Santa Clara	95050	Condo	2	2.5	1410	1422	3
2	1000000.0	Santa Clara	95050	Condo	3	2.5	1670	1740	2
3	1000000.0	Santa Clara	95050	Condo	3	2.5	1708	1750	2
4	1000000.0	Santa Clara	95051	Single-Family Home	3	2.0	1068	5600	1
5	1000000.0	Palo Alto	94306	Condo	2	1.5	998	499	2
6	1000000.0	Sunnyvale	94089	Single-Family Home	3	2.0	1108	5824	1
7	1000000.0	Santa Clara	95054	Single-Family Home	3	2.0	1612	6250	1
8	1000000.0	Mountain View	94040	Condo	2	2.0	1206	1880	1
9	1000000.0	Sunnyvale	94085	Condo	2	2.5	1198	1082	3
10	1000000.0	Sunnyvale	94085	Condo	3	3.5	1513	1575	3
11	1000000.0	Santa Clara	95054	Single-Family Home	3	2.0	1097	6200	1

Google Cloud

Build data pipelines with a friendly UI

Rich graphical interface

100+ plugins - connectors, transforms & actions

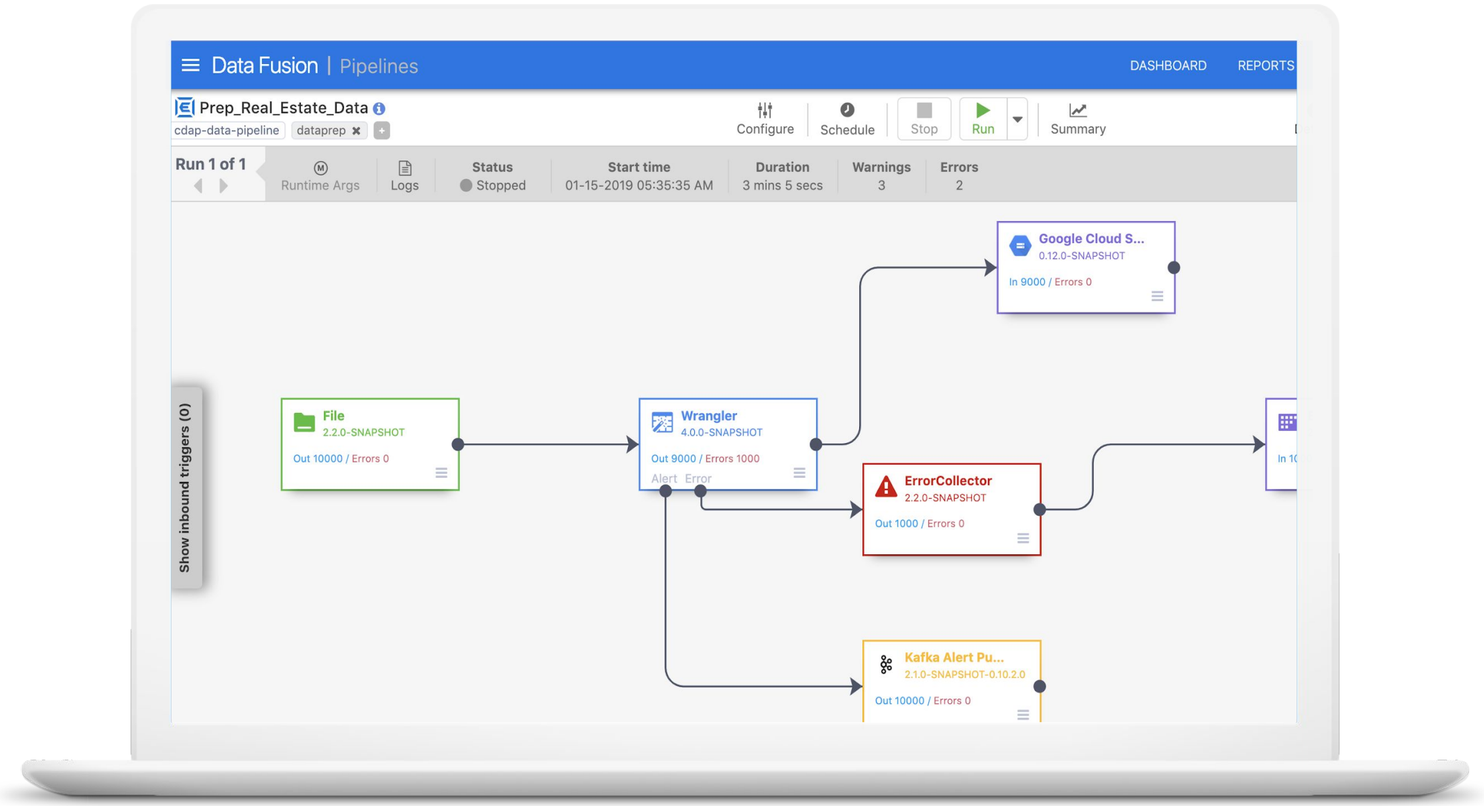
Code free visual transformations

1000+ transforms, data quality

Test and debug pipeline

Pre-built pipelines

Developer SDK



Google Cloud

Integration Metadata

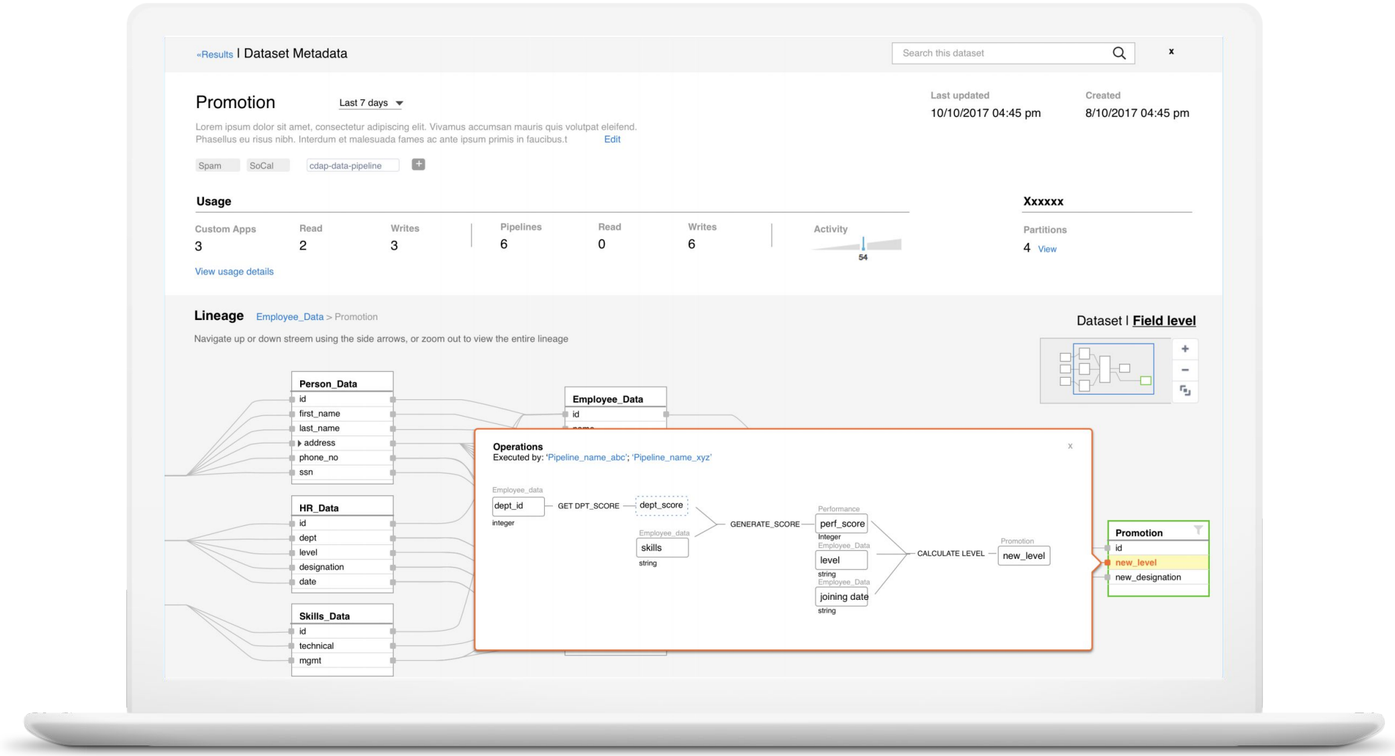
Tags and Properties support

- Pipeline
- Dataset
- Schema

Search integrated entities by

- Keyword
- Schema name and type

Dataset level and Field level Lineage



Google Cloud

Extensible

Pipeline templatization

Conditional Pipeline Triggers

Plugin Management

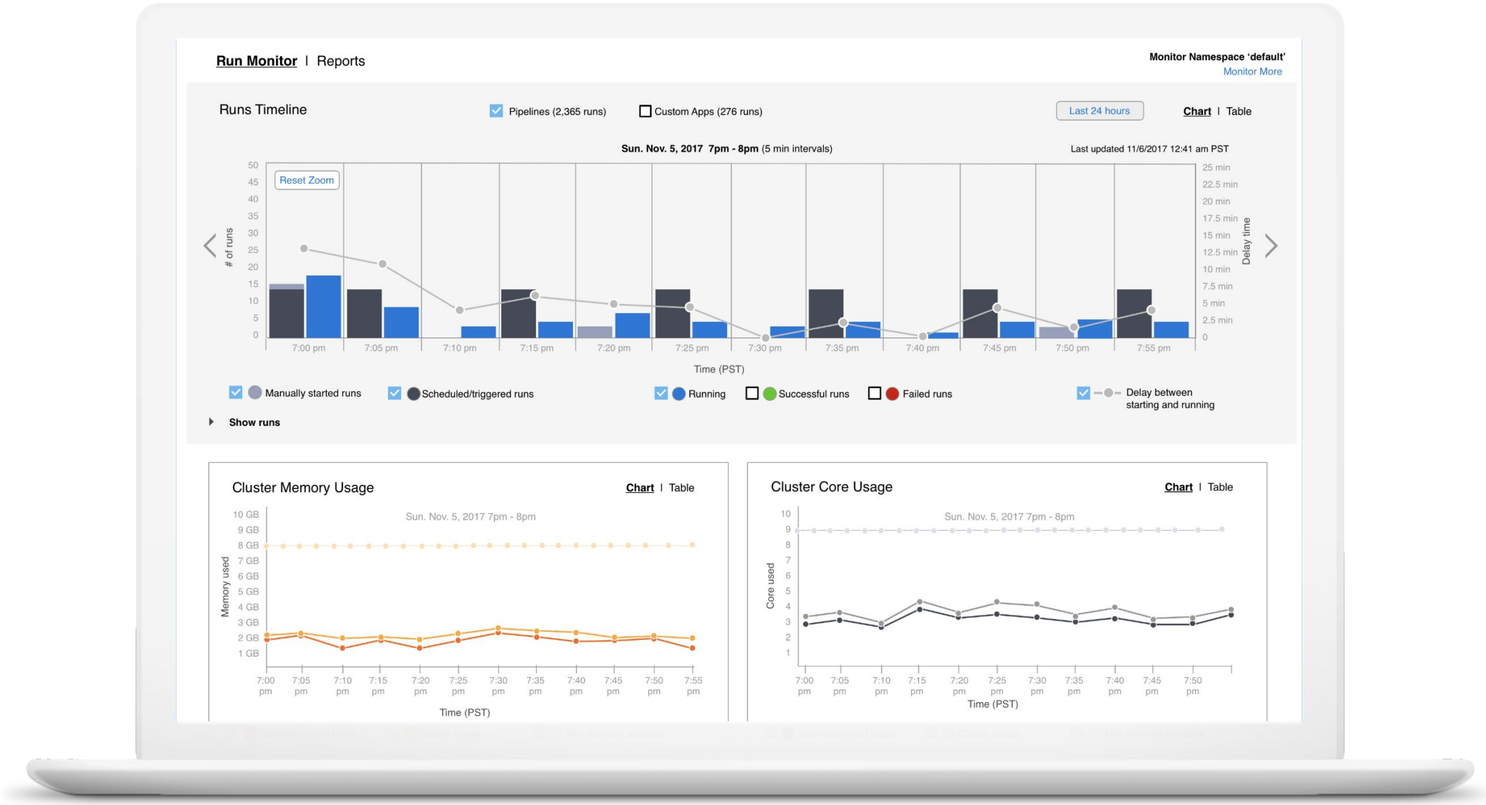
Plugin templatization

Plugin UI Widget

Custom Provisioners

Custom Compute Profiles

Hub Integration



Google Cloud

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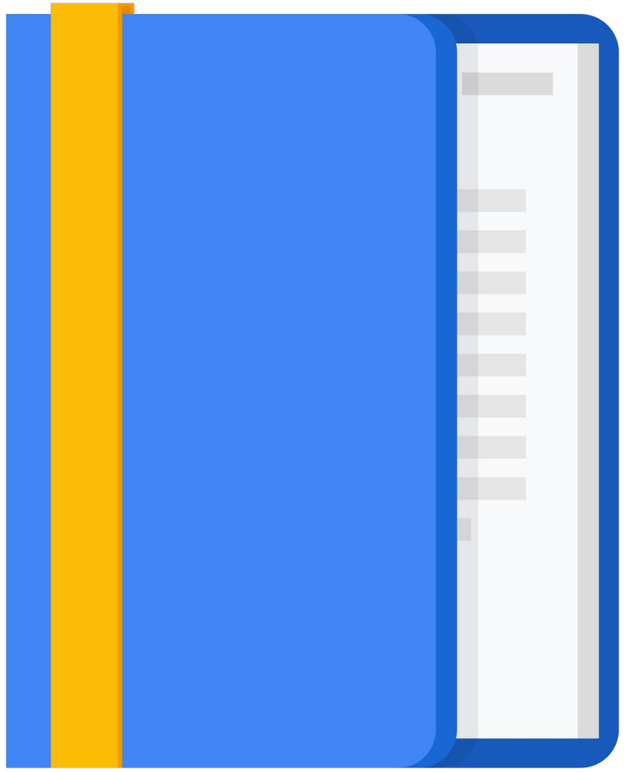
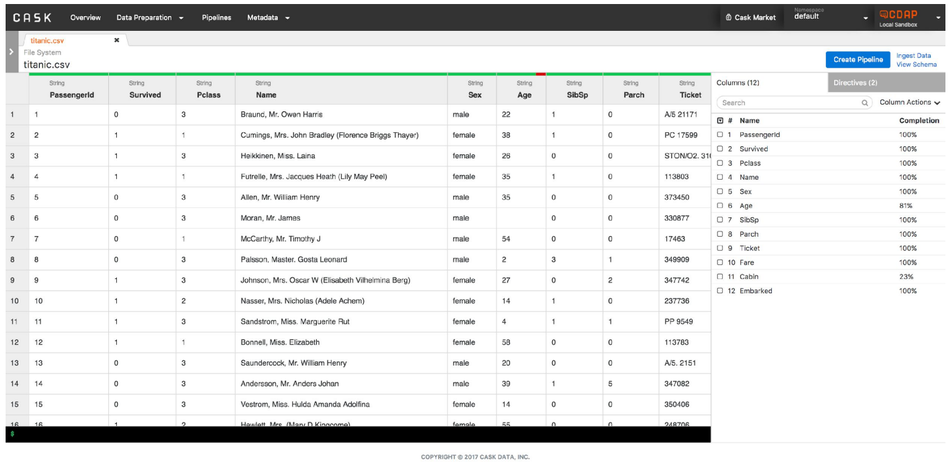
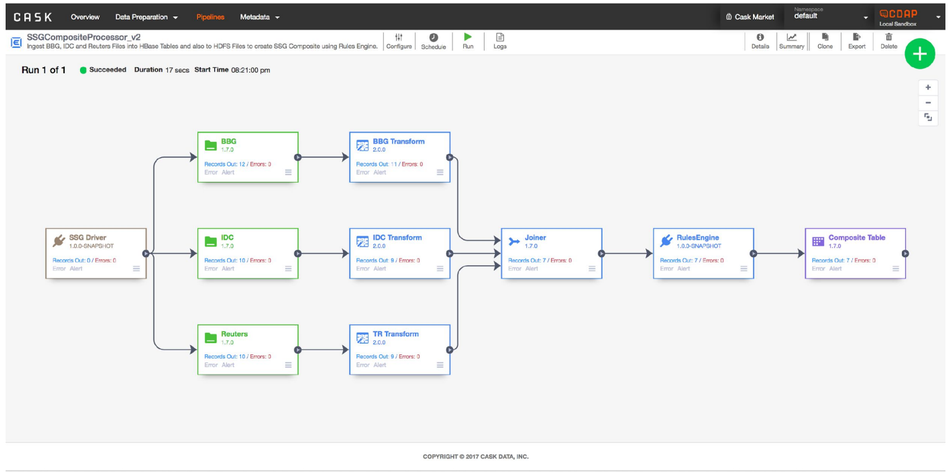


Components of Cloud Data Fusion



Wrangler — Framework

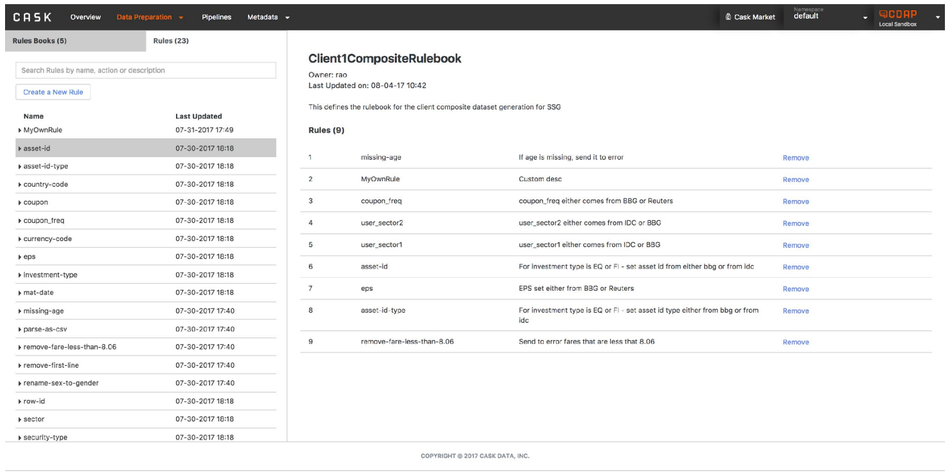
- Data Preparation for on-boarding new sources and datasets.
- Perform Data Transformations, Data Quality checks with visual feedback.
- Extend the Wrangler by building new user defined directives.
- Integrates with Data Pipeline for operationalizing transformations



Data Pipeline — Framework

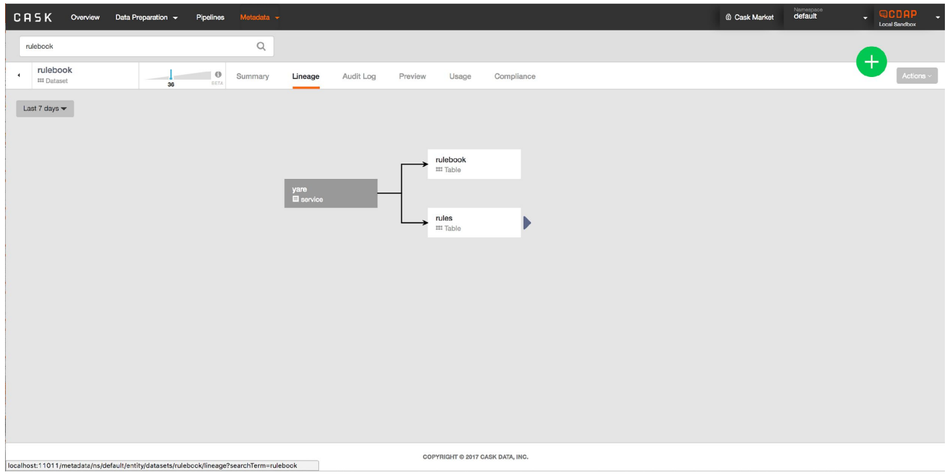
- User interface for building complex data workflows
- Join, Lookup, Aggregate, Filtering data in-flight
- Building complex workflows with 100s of connectors
- Extend Data Pipeline using simple APIs
- Integrates with Dataprep, Rule Engine and Metadata Aggregator

Components of Cloud Data Fusion



Rules Engine — Tool*

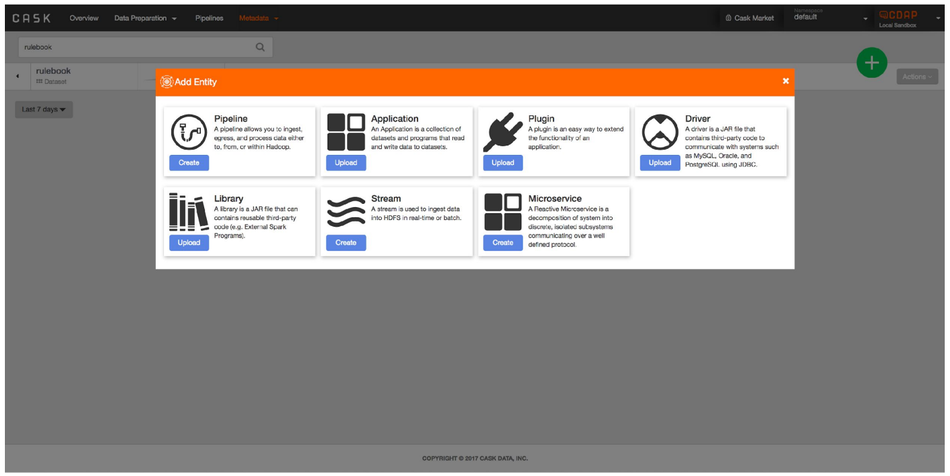
- Business Data Transformations and checks codified for business users
- Define Complex rules using intuitive and simple to use user interface
- Logically group Rules in Rulebook and trigger or schedule processing.
- Integrates with Data Pipeline for operationalizing Rules.



Metadata Aggregator — Tool

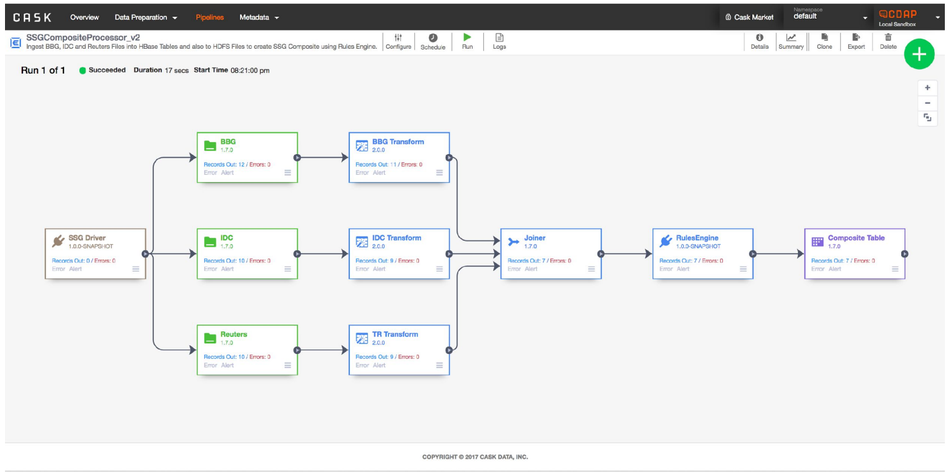
- Aggregate Business, Technical and Operational Metadata
- Track the flow of data (Lineage) for richer data needed for governance
- Create Data Dictionary and Metadata Repository
- Integrate with enterprise MDM solutions.
- Integrates with Data Pipeline, Rules Engine

Components of Cloud Data Fusion



Microservice — Framework*

- Build specialized logic for processing data
- Create loosely coupled network for processing events
- Bind processing to varied set of queues



Event Condition Action (ECA) — Application*

- Delivers a specialized solutions for IoT event processing
- Parses any events, triggers conditions and executes Action.
- Real-time notification system, with easy-to-use user interface for configuring event parsing, condition and actions

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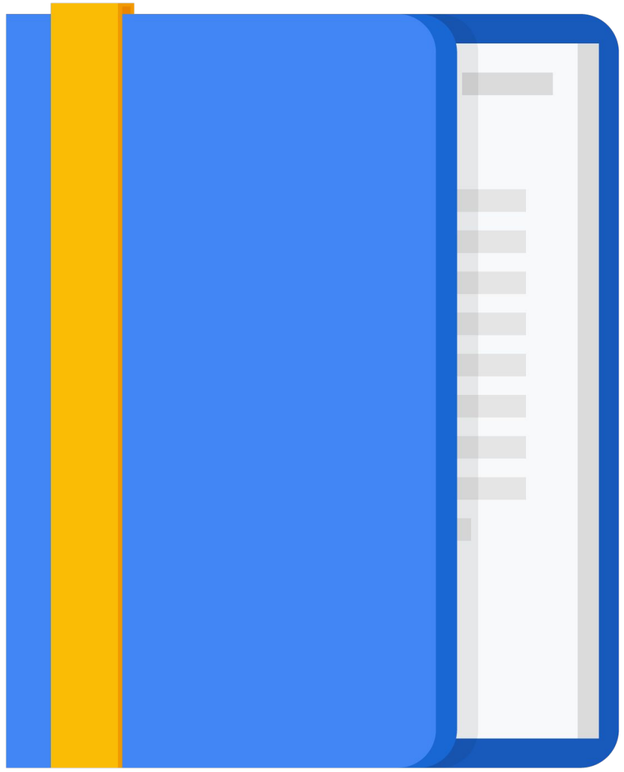
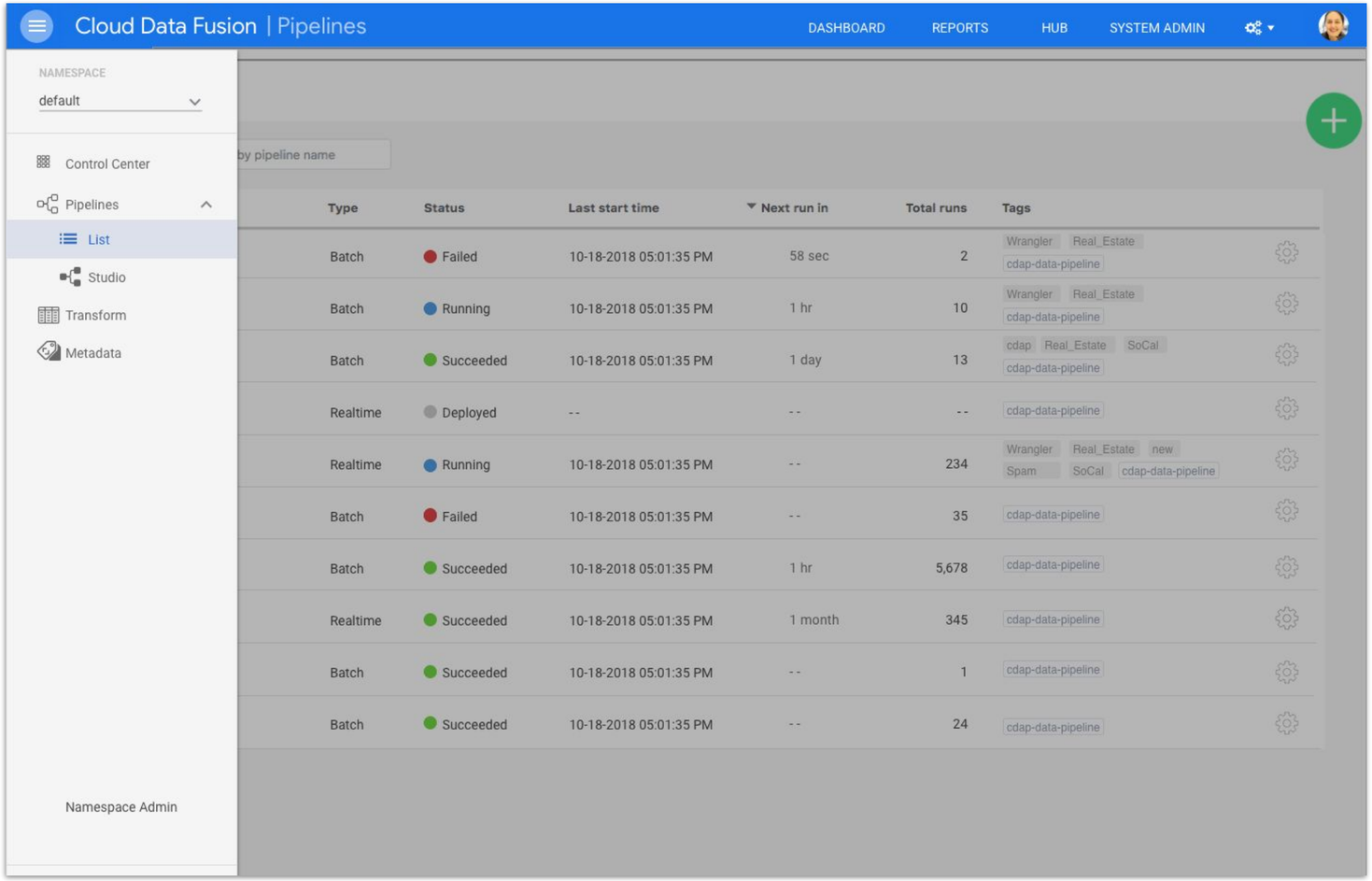


Cloud Data Fusion - UI Overview

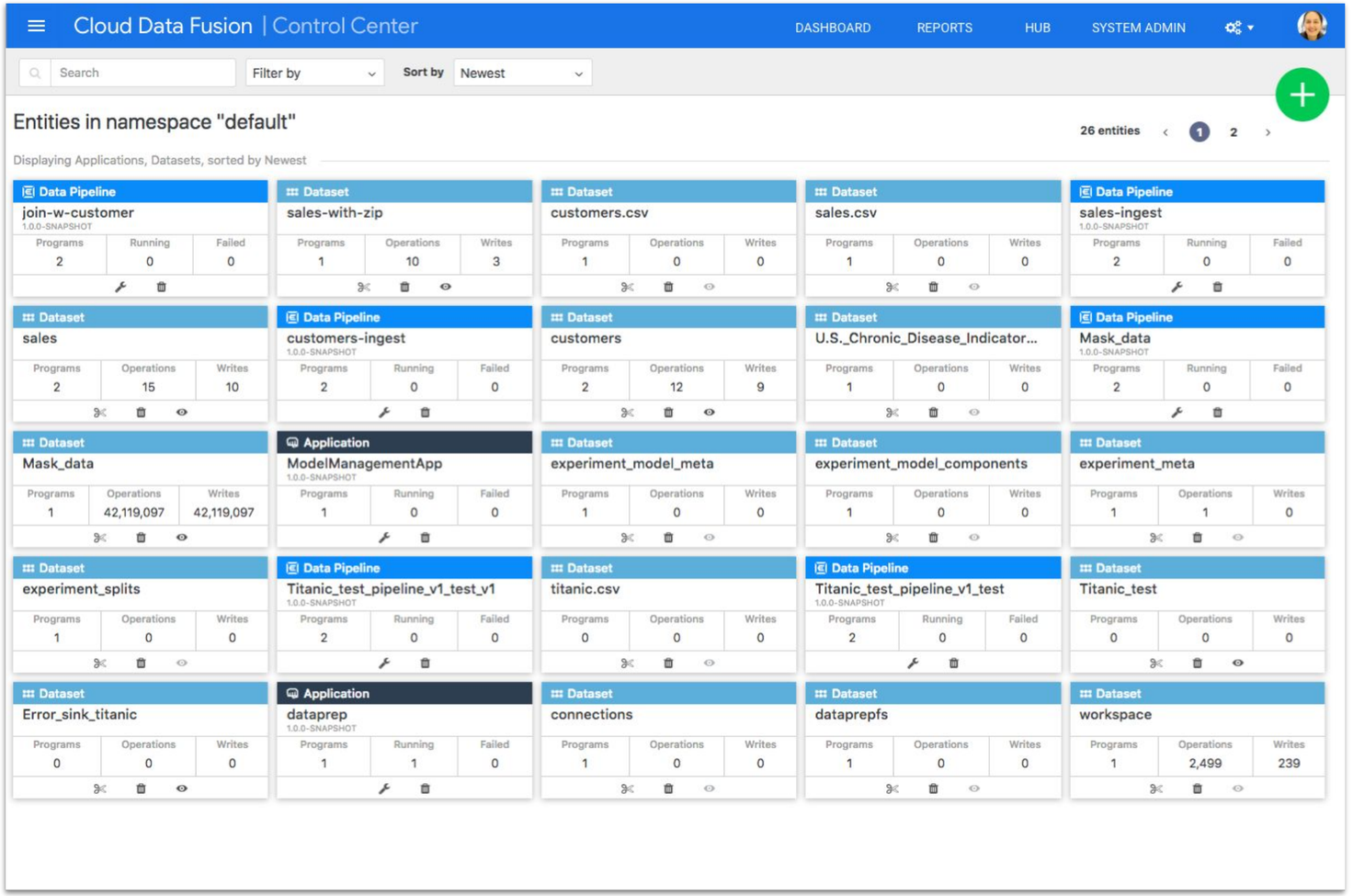
- Control Center
- Pipelines
- Wrangler
- Metadata
- Hub
- Entities
- Administration



Google Cloud

Control Center

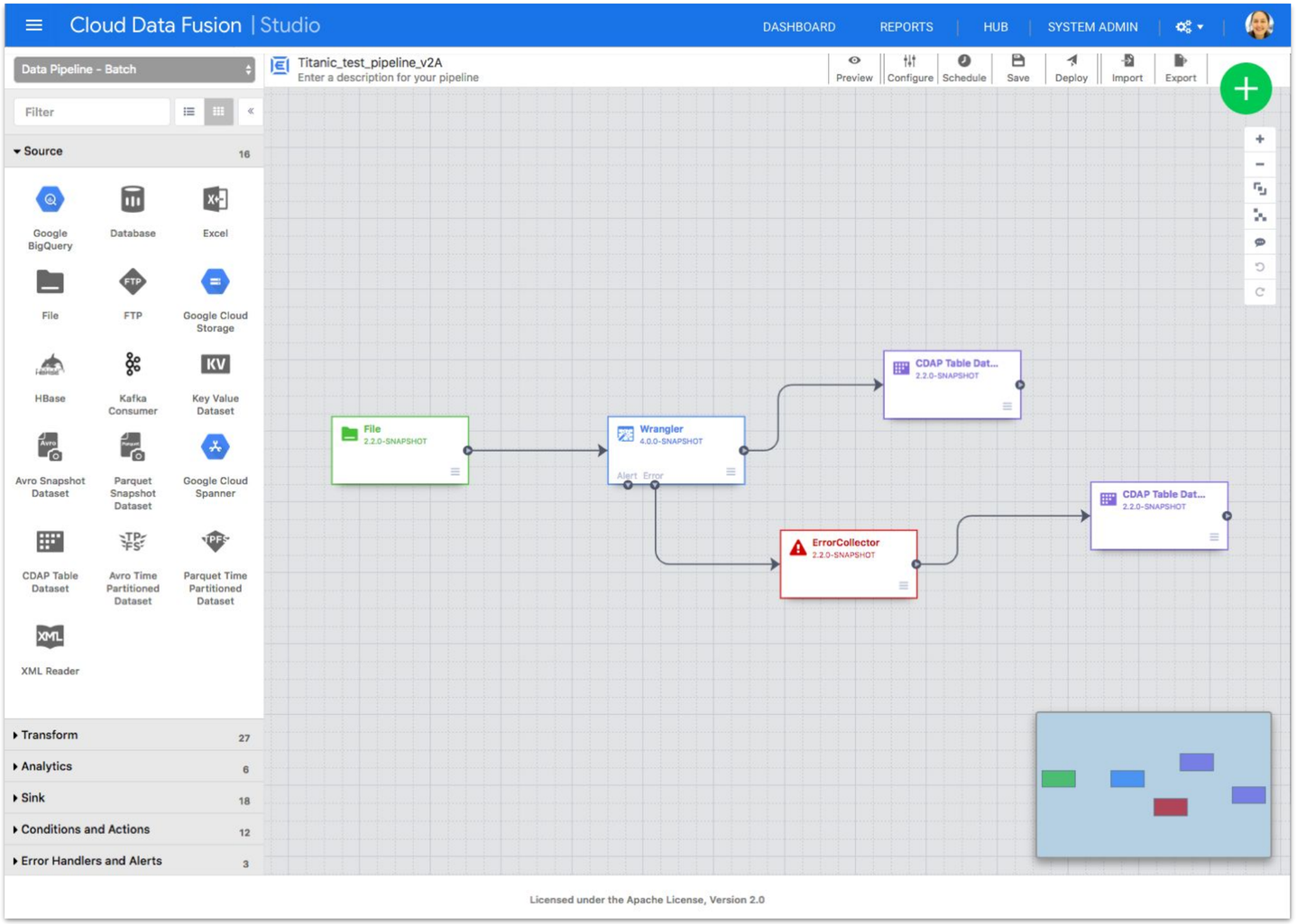
- Application
- Artifact
- Dataset



Google Cloud

Pipelines

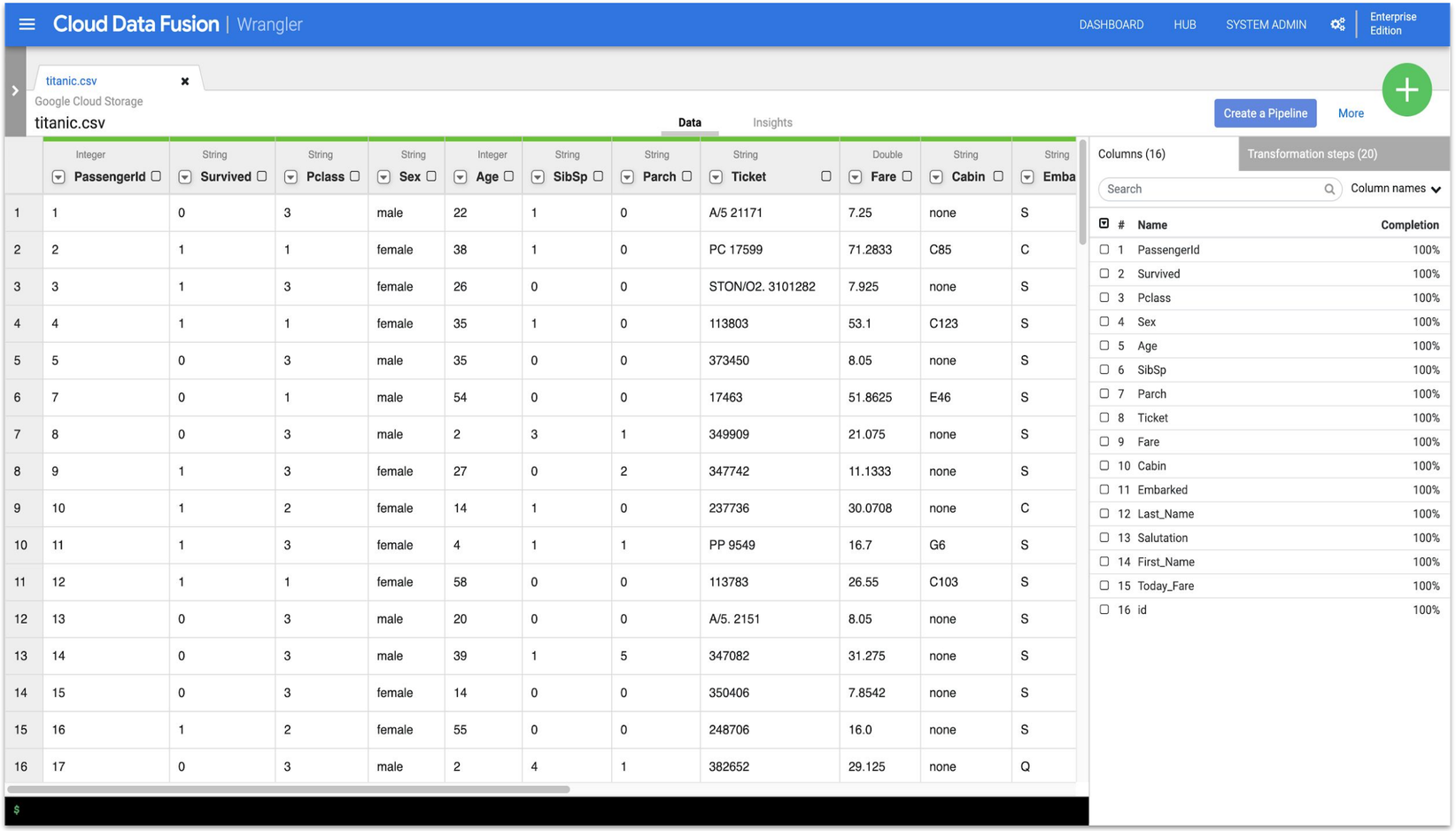
- Developer Studio
- Preview
- Export
- Schedule
- Connector and function palette
- Navigation



Google Cloud

Wrangler

- Connections
- Transforms
- Data Quality
- Insights
- Functions

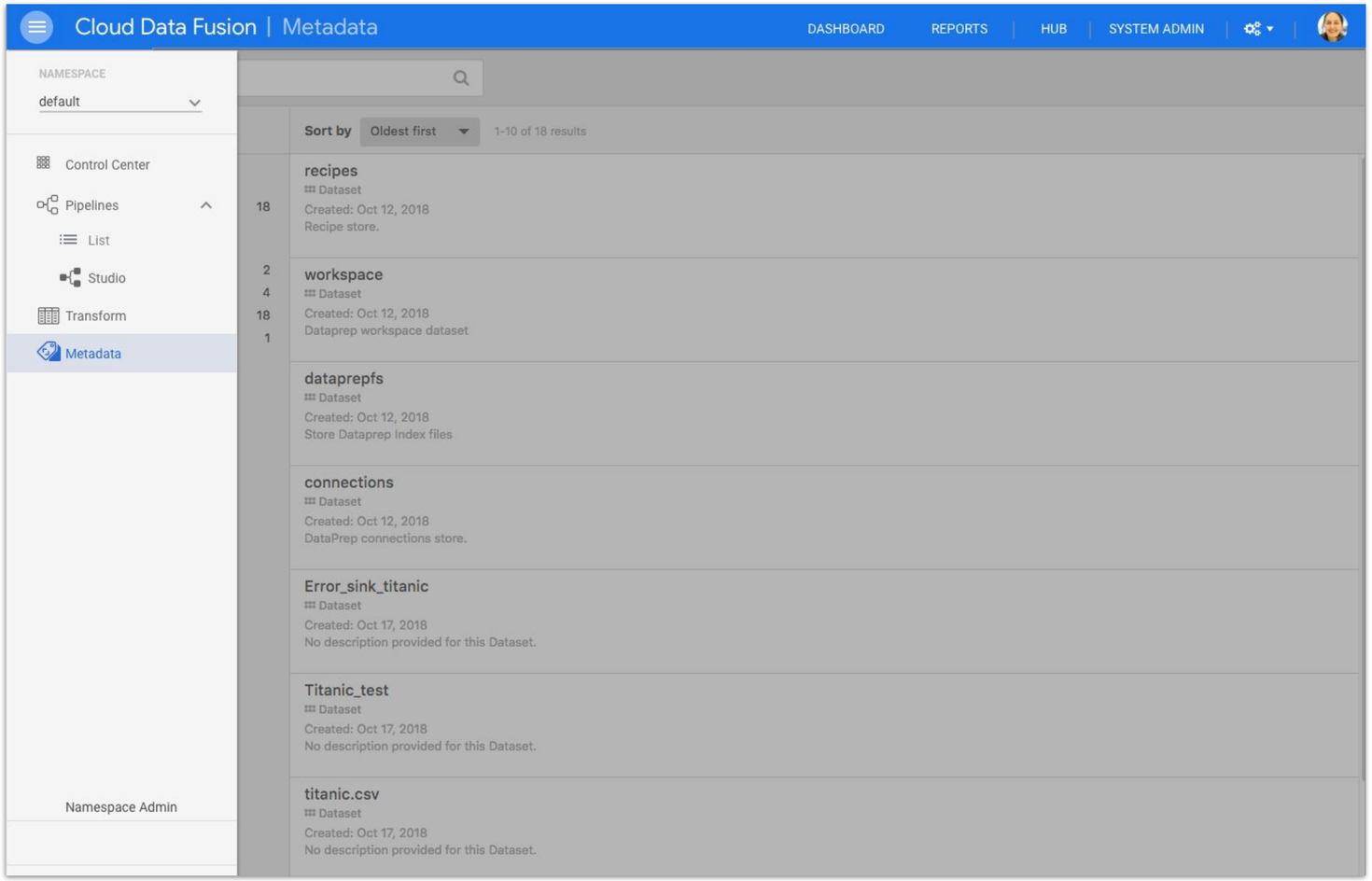


	Integer PassengerId	String Survived	String Pclass	String Sex	Integer Age	String SibSp	String Parch	String Ticket	Double Fare	String Cabin	String Emba
1	1	0	3	male	22	1	0	A/5 21171	7.25	none	S
2	2	1	1	female	38	1	0	PC 17599	71.2833	C85	C
3	3	1	3	female	26	0	0	STON/O2. 3101282	7.925	none	S
4	4	1	1	female	35	1	0	113803	53.1	C123	S
5	5	0	3	male	35	0	0	373450	8.05	none	S
6	7	0	1	male	54	0	0	17463	51.8625	E46	S
7	8	0	3	male	2	3	1	349909	21.075	none	S
8	9	1	3	female	27	0	2	347742	11.1333	none	S
9	10	1	2	female	14	1	0	237736	30.0708	none	C
10	11	1	3	female	4	1	1	PP 9549	16.7	G6	S
11	12	1	1	female	58	0	0	113783	26.55	C103	S
12	13	0	3	male	20	0	0	A/5. 2151	8.05	none	S
13	14	0	3	male	39	1	5	347082	31.275	none	S
14	15	0	3	female	14	0	0	350406	7.8542	none	S
15	16	1	2	female	55	0	0	248706	16.0	none	S
16	17	0	3	male	2	4	1	382652	29.125	none	Q

Google Cloud

Integration Metadata

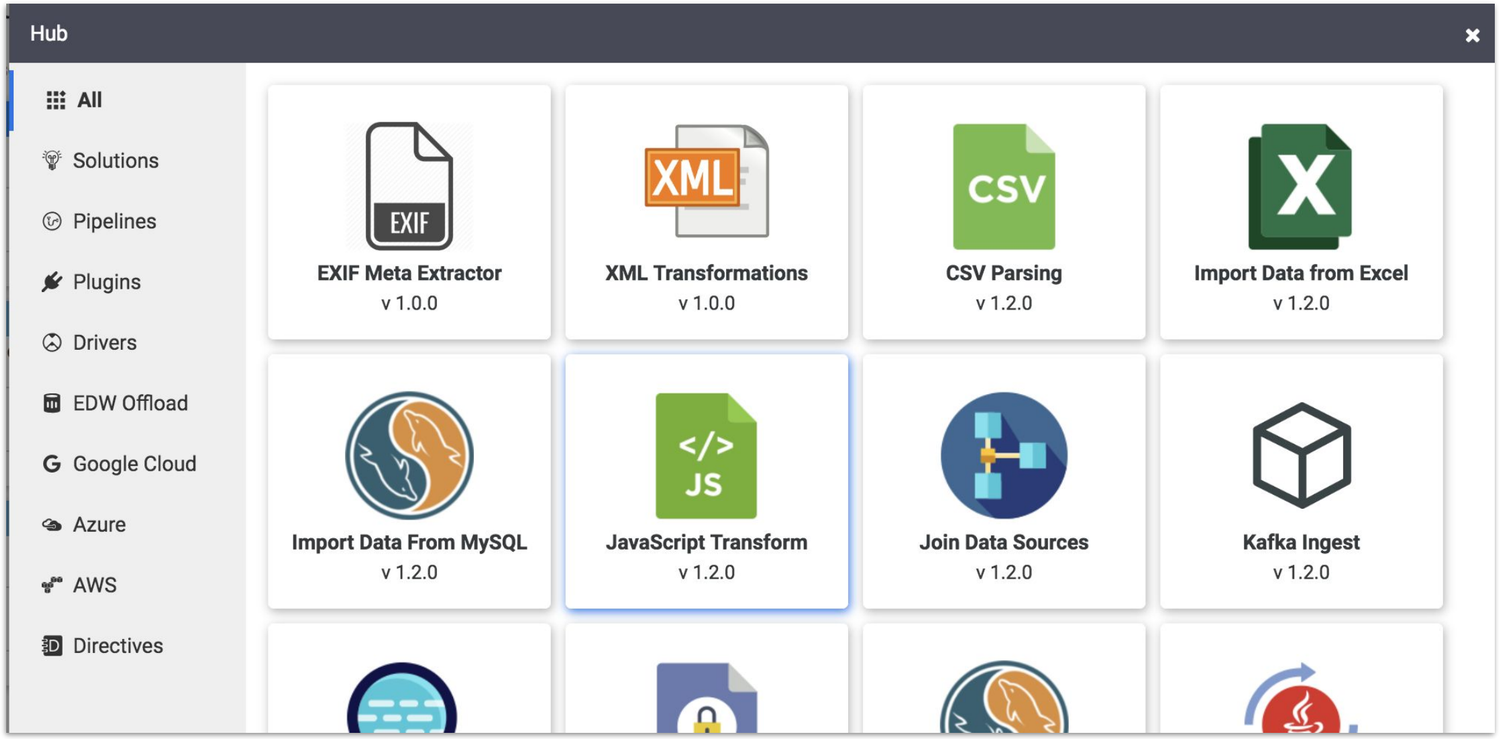
- Search
- Tags & Properties
- Lineage - Field and Data



Google Cloud

Hub

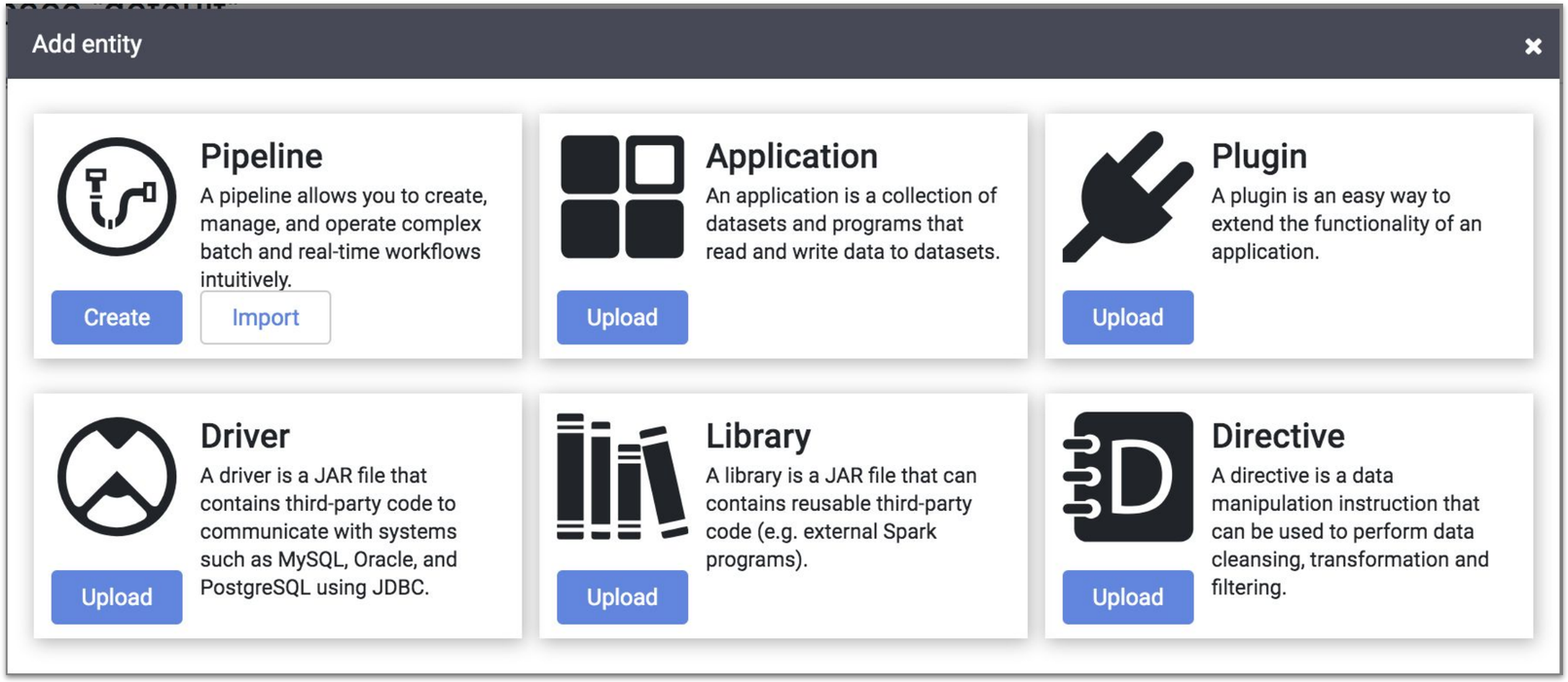
- Plugins
- Use cases
- Pre-built pipelines



Google Cloud

Entities

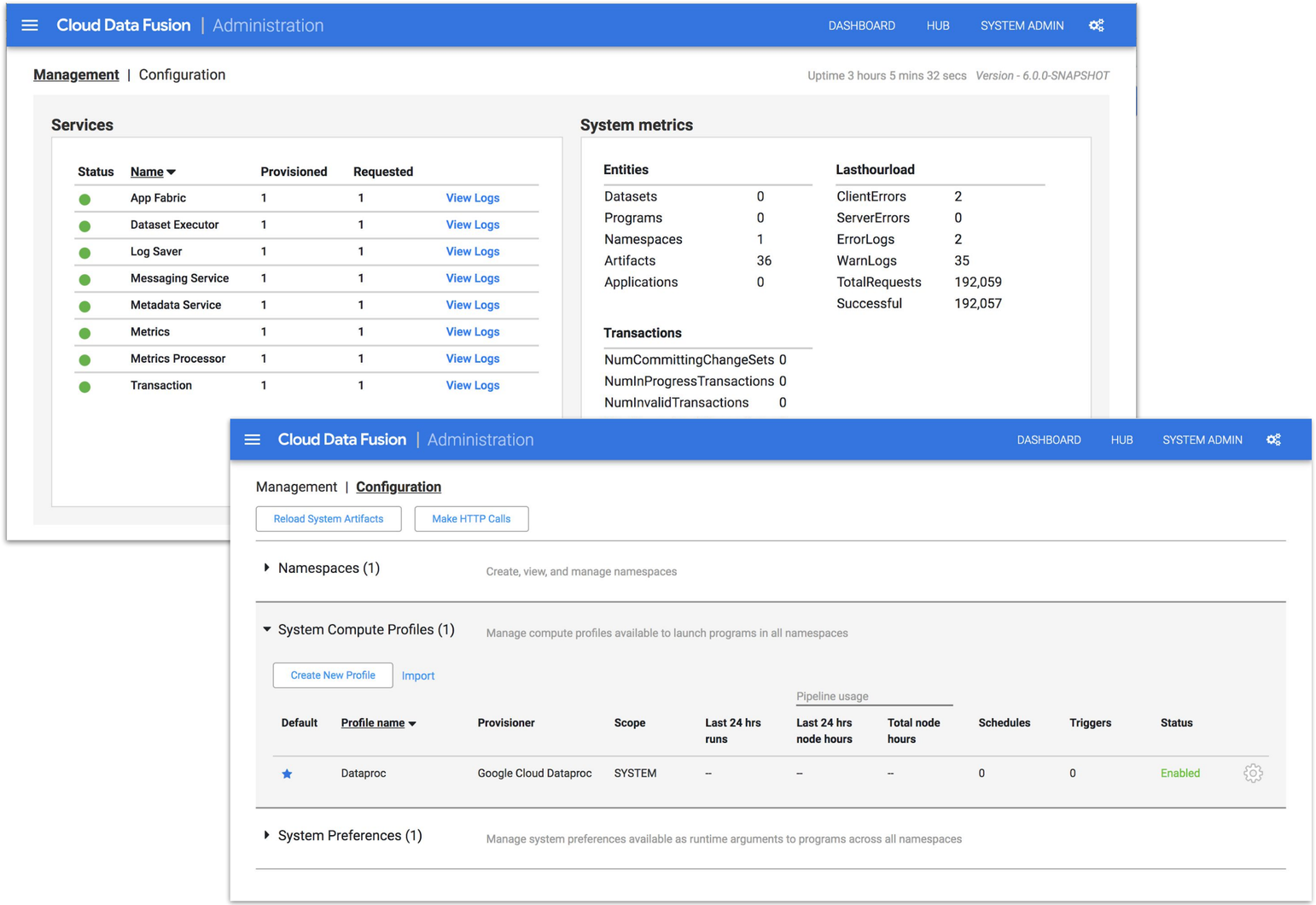
- Pipeline
- Application
- Plugin
- Driver
- Library
- Directive



Google Cloud

Administration

- Management
  - Services
  - Metrics
- Configuration
  - Namespace*
  - Compute Profiles
  - Preferences
  - System Artifacts
  - REST Client



Google Cloud

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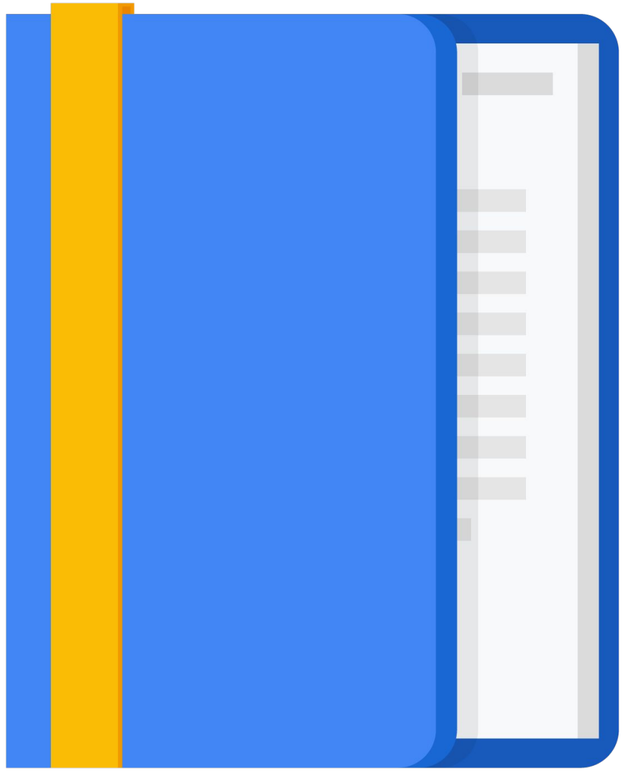
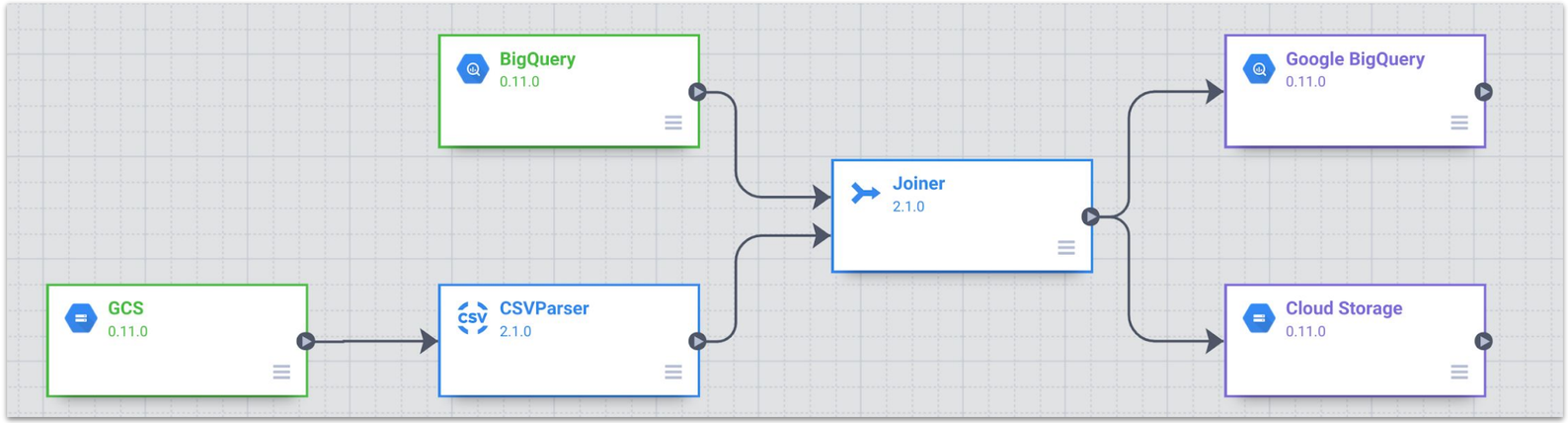


Data Pipeline | Directed Acyclic Graph (DAG)

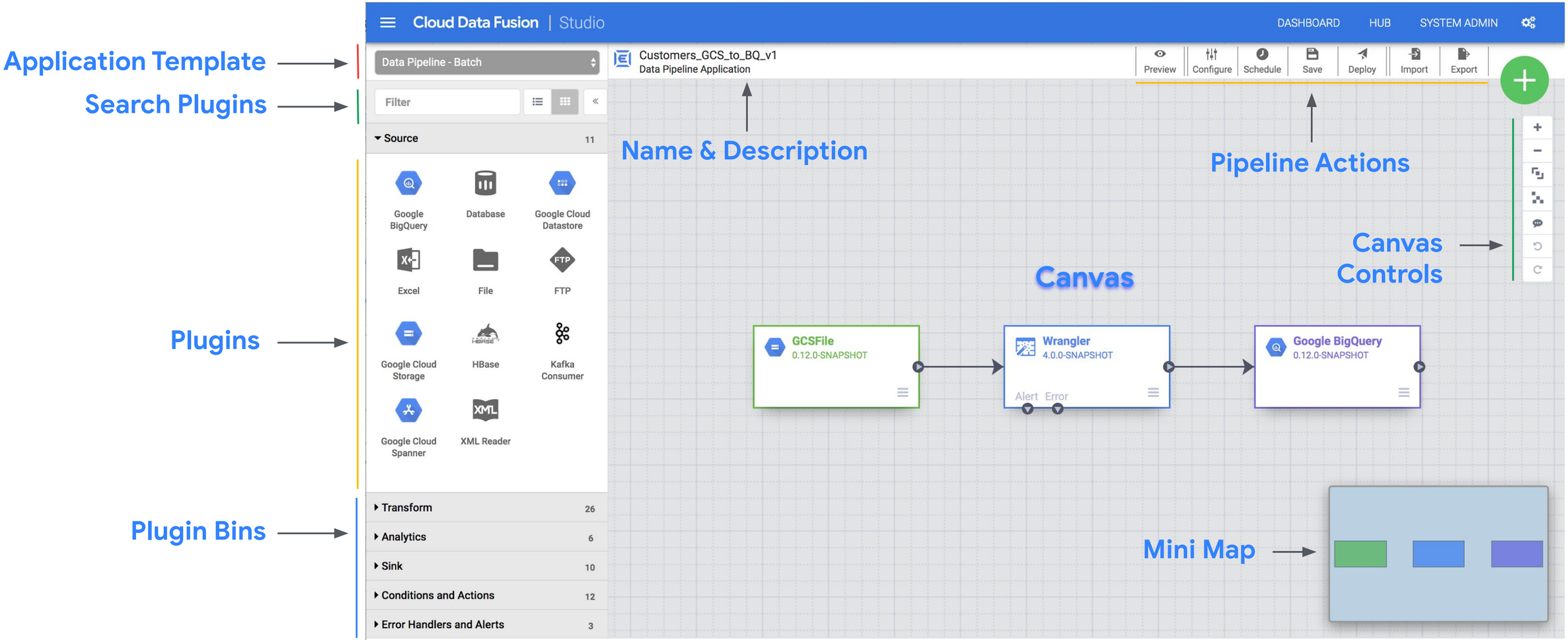
- Represented by a series of stages arranged in a DAG. This forms a **one-way** pipeline.
- Stages, which are the "nodes" in the pipeline graph, can be of different types



Data Pipeline

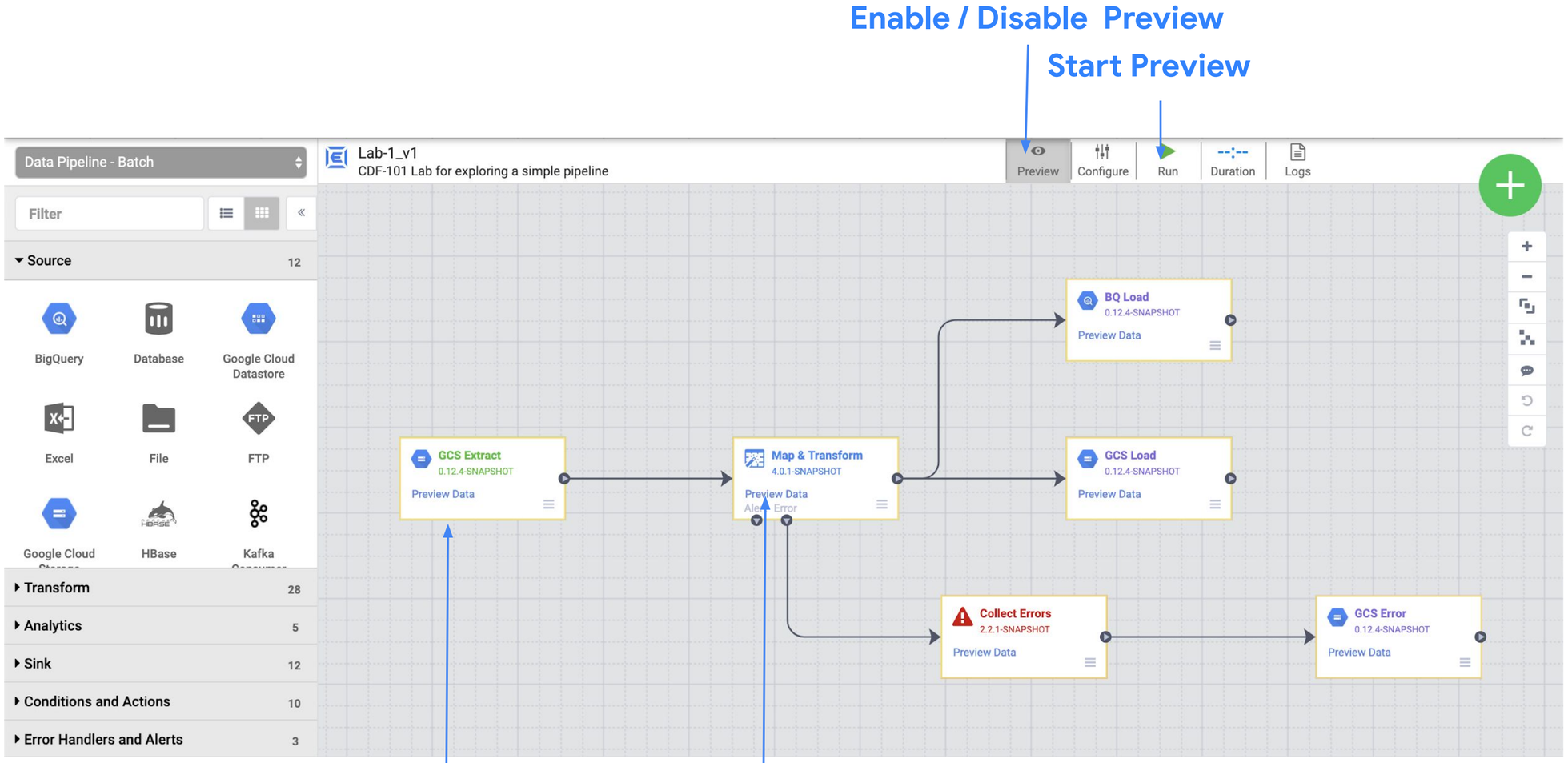
- Allows non-linear pipelines.
- Can fork from a node, where output from a node can be sent to two or more stages.
- Two or more forked nodes can merge at a transform or a sink node.

Studio is the UI where you create new pipelines



Google Cloud

Use Preview Mode to see how the pipeline will run

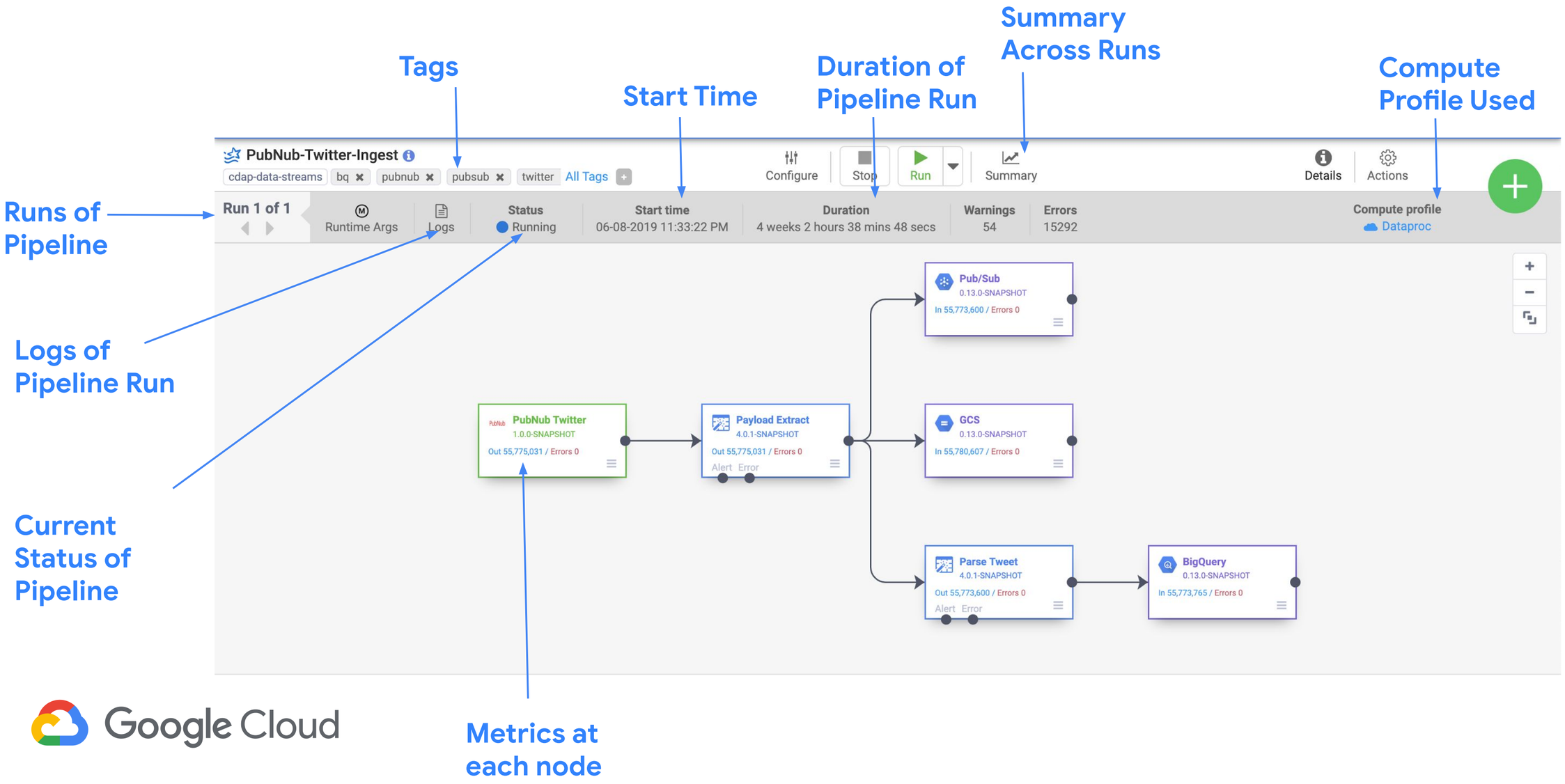


Nodes highlighted - Yellow glow

View Sample Data

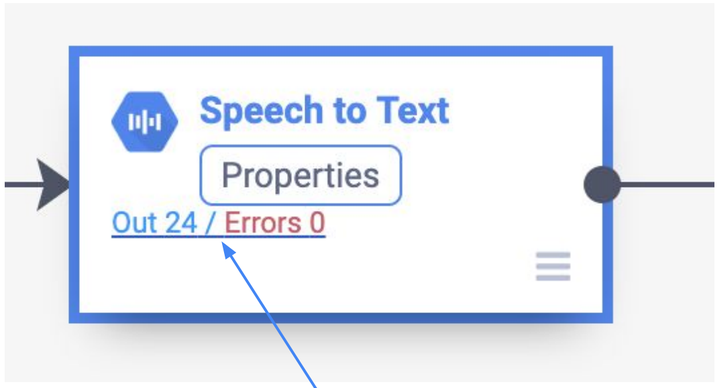
Google Cloud

Monitor the health of the entire pipeline



Google Cloud

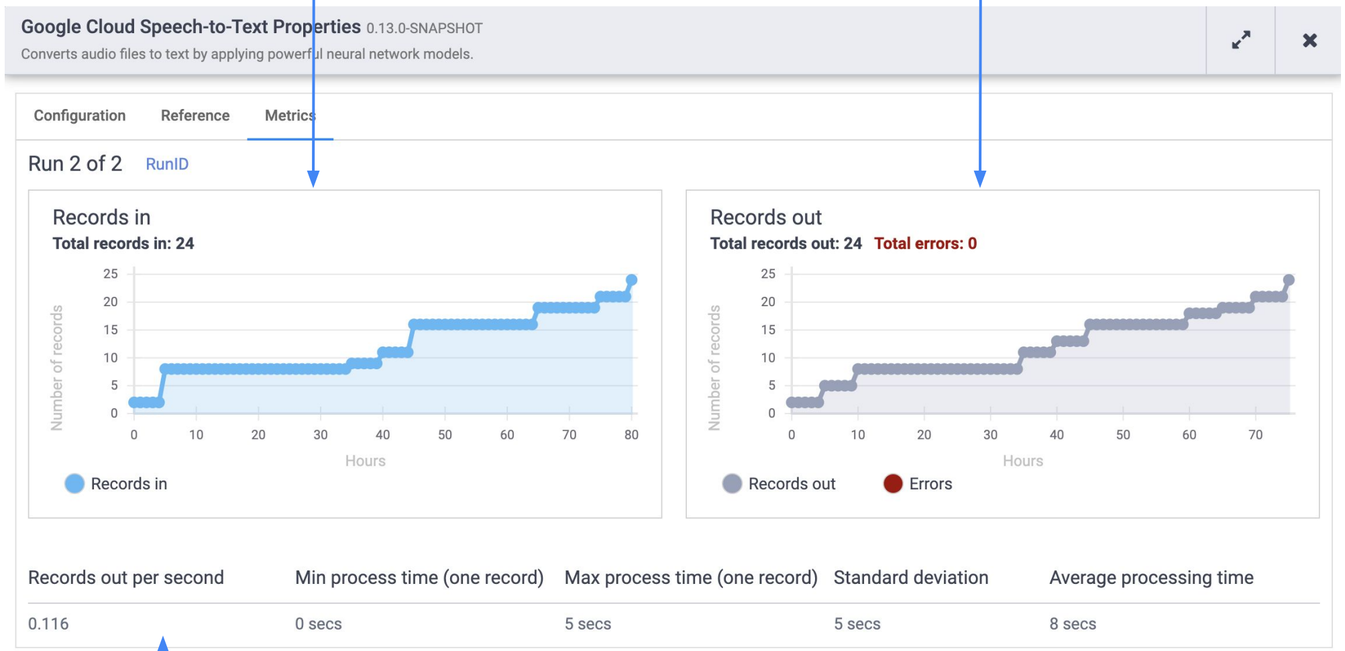
Monitor the health of a single node



Click to see each node detail

Incoming records

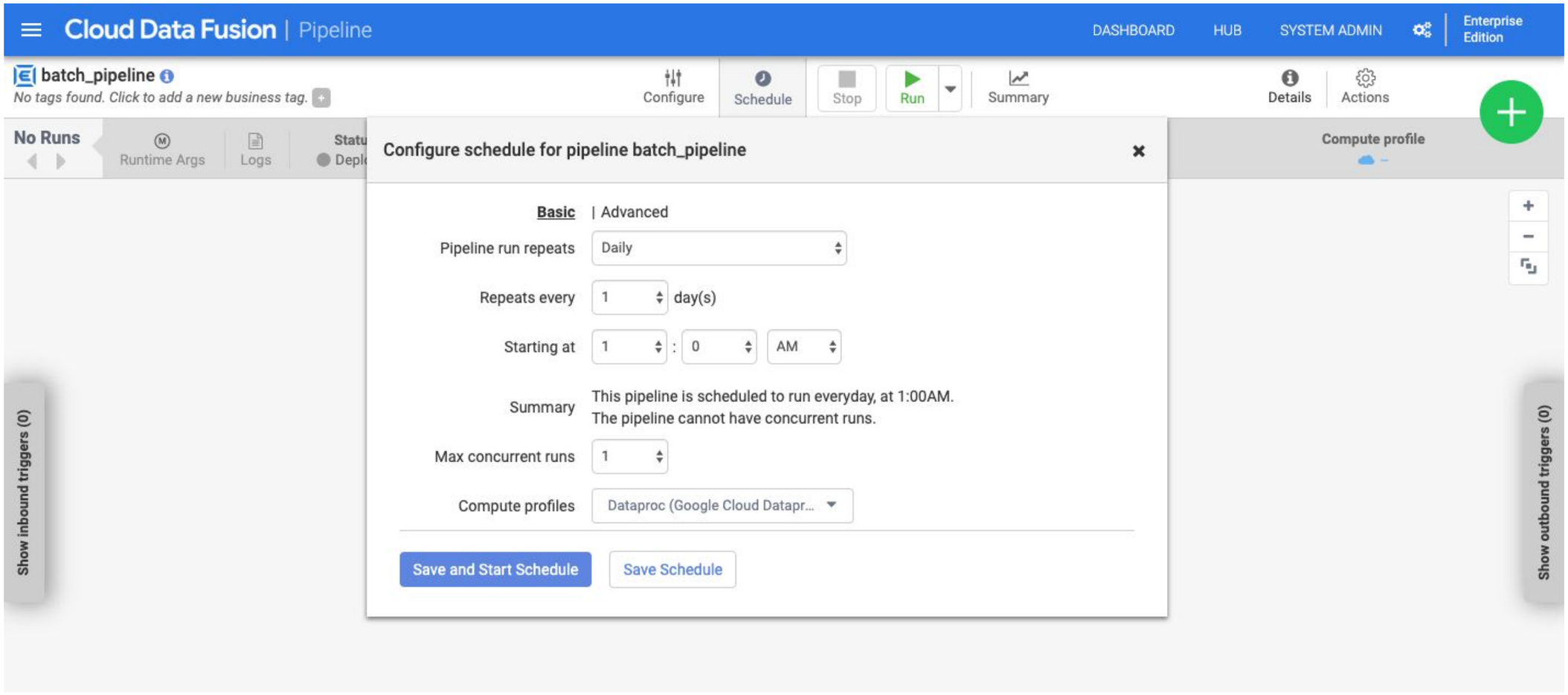
Outgoing records



Processing Statistics at each node

Google Cloud

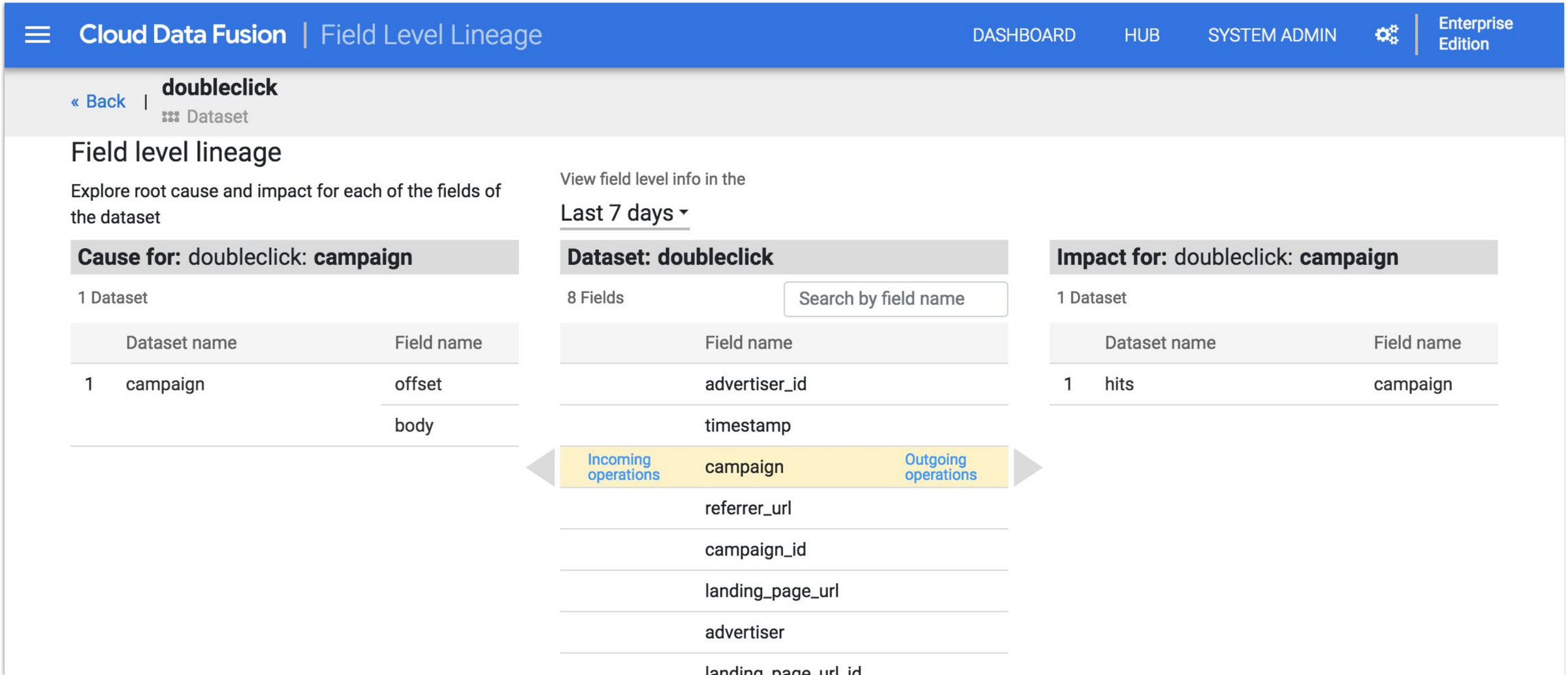
You can schedule batch pipelines



Google Cloud

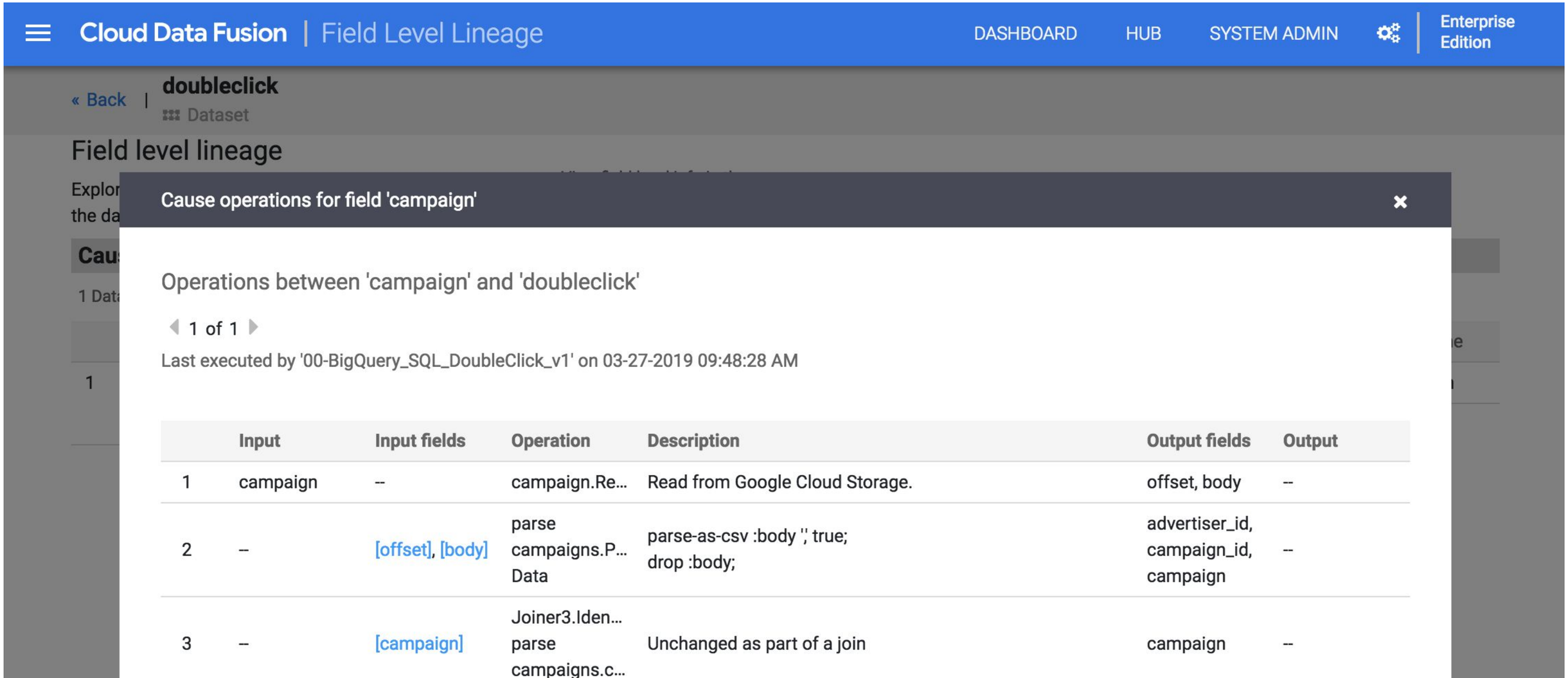
After data is transformed, you can track field-level lineage

Relationship between fields of datasets: Provenance, Impact



See every operation that is made on a field

Operations applied to a field



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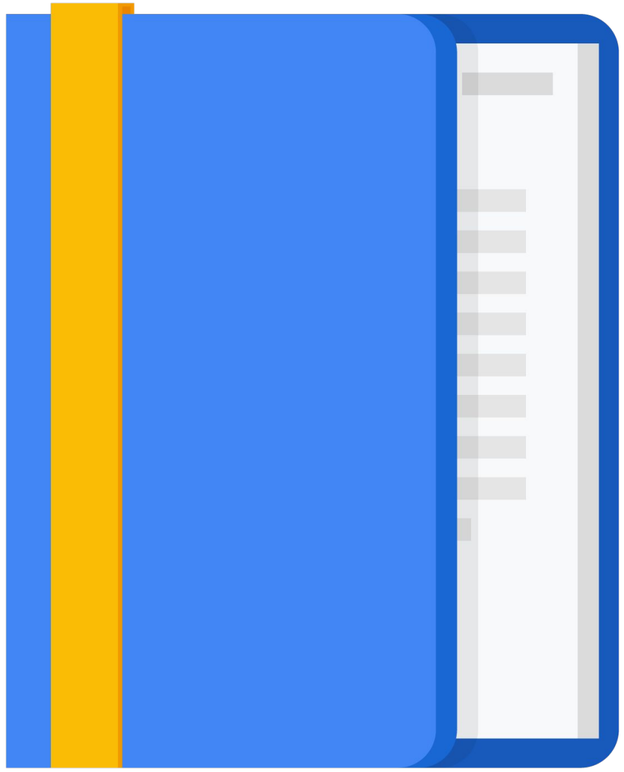
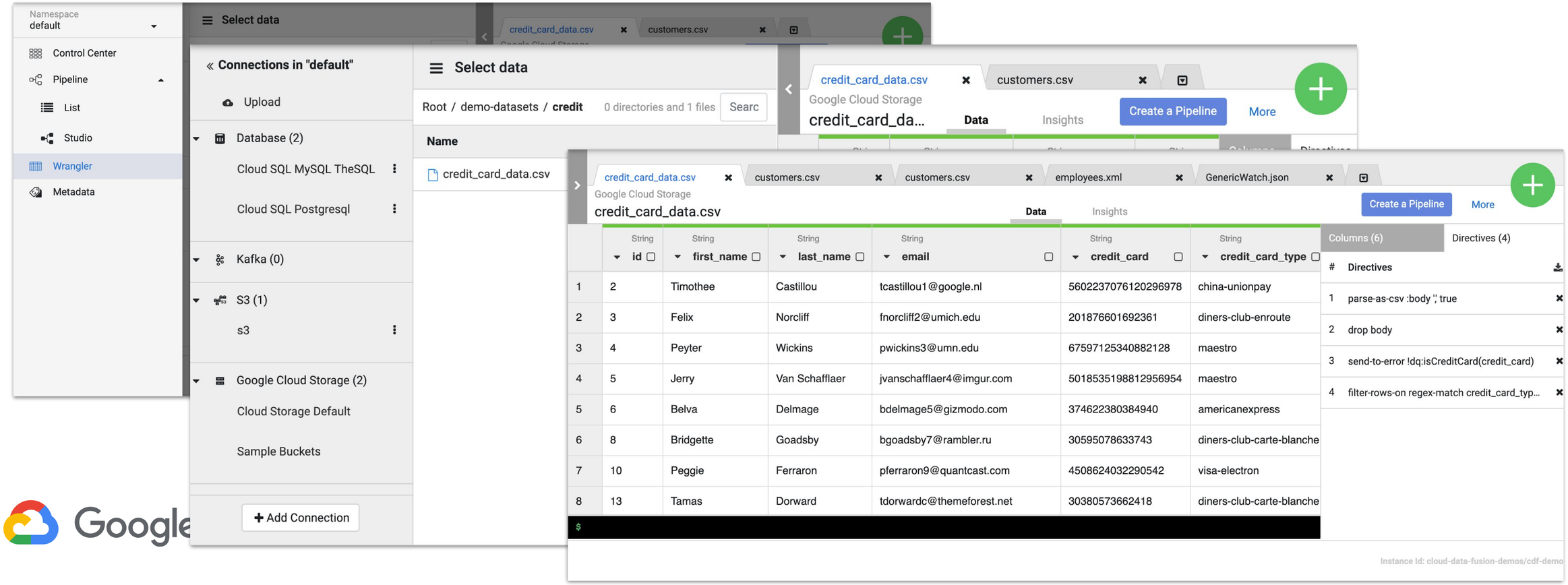
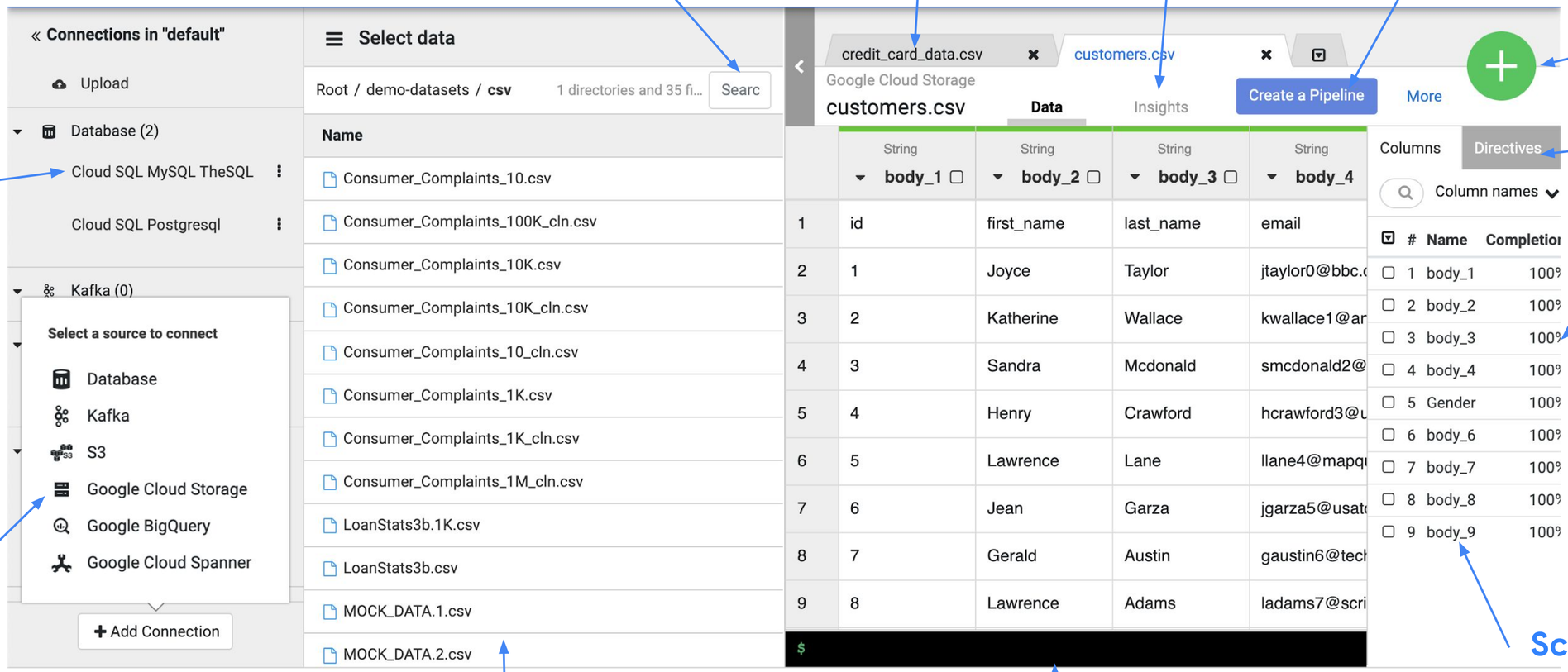


Data analysts can explore datasets in the Wrangler

Wrangler is a code-free, visual environment for transforming data in data pipelines



Wrangler UI Overview for exploring datasets



Google Cloud

Lab

Building and executing a pipeline graph in Cloud Data Fusion

Objectives

- Connect Cloud Data Fusion to a couple of data sources
- Apply basic transformations
- Join two data sources
- Write data to a sink

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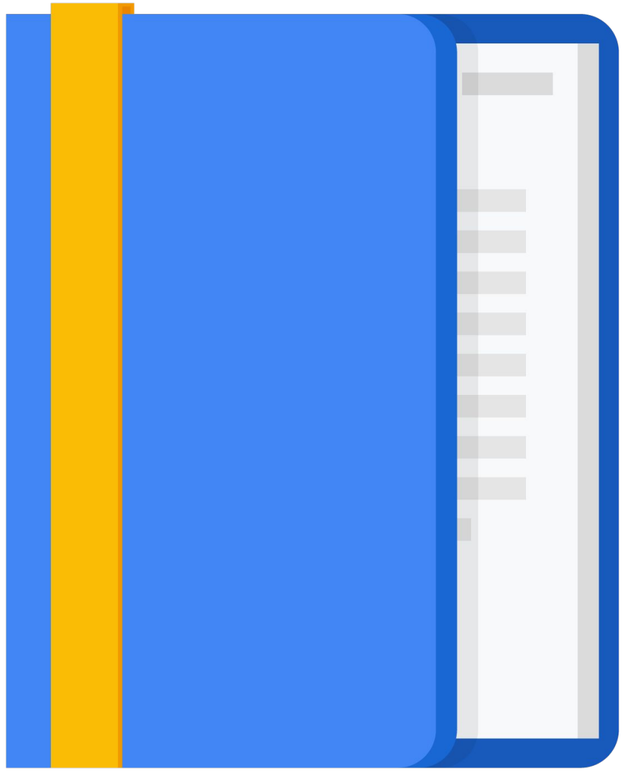
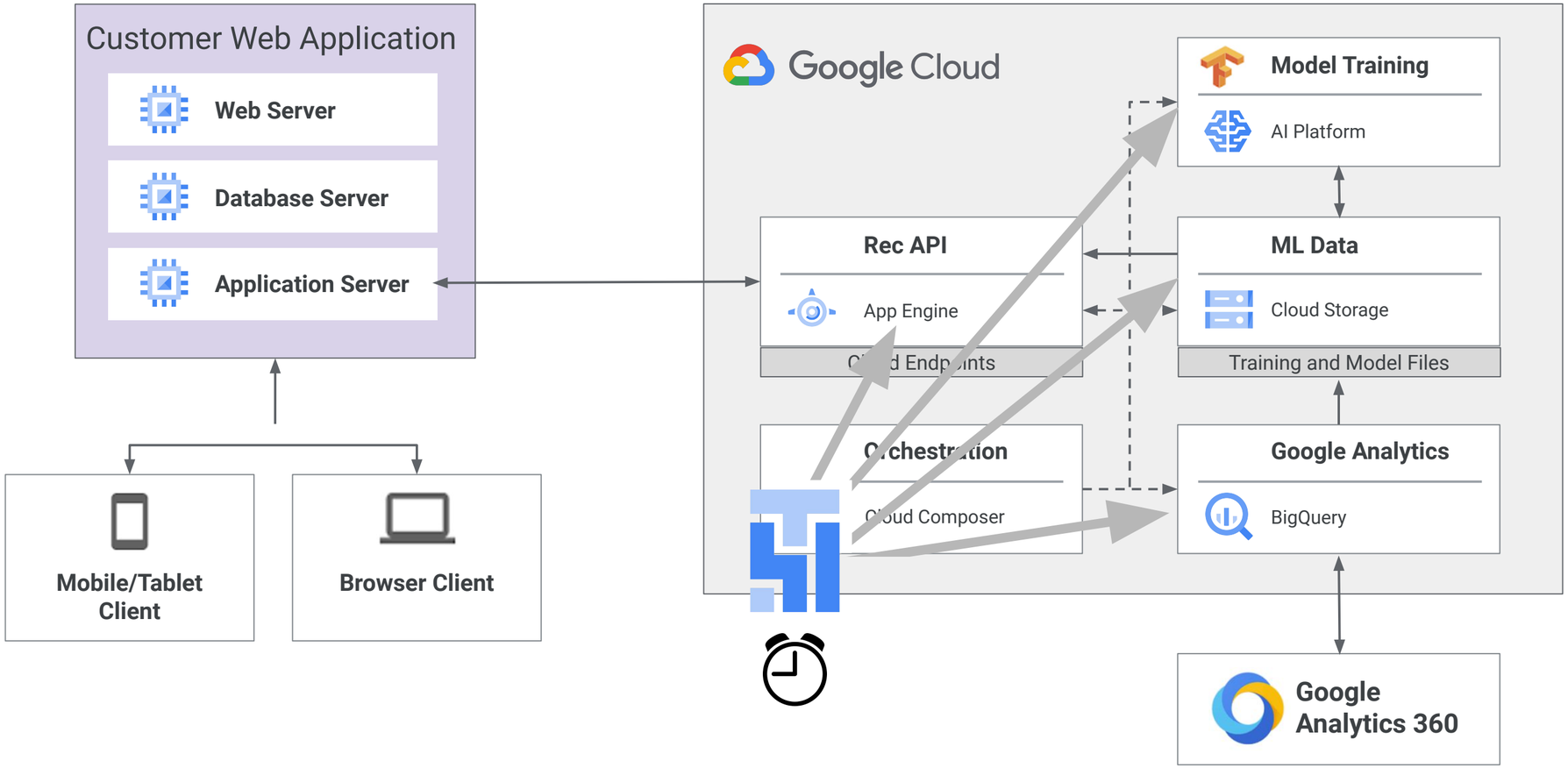
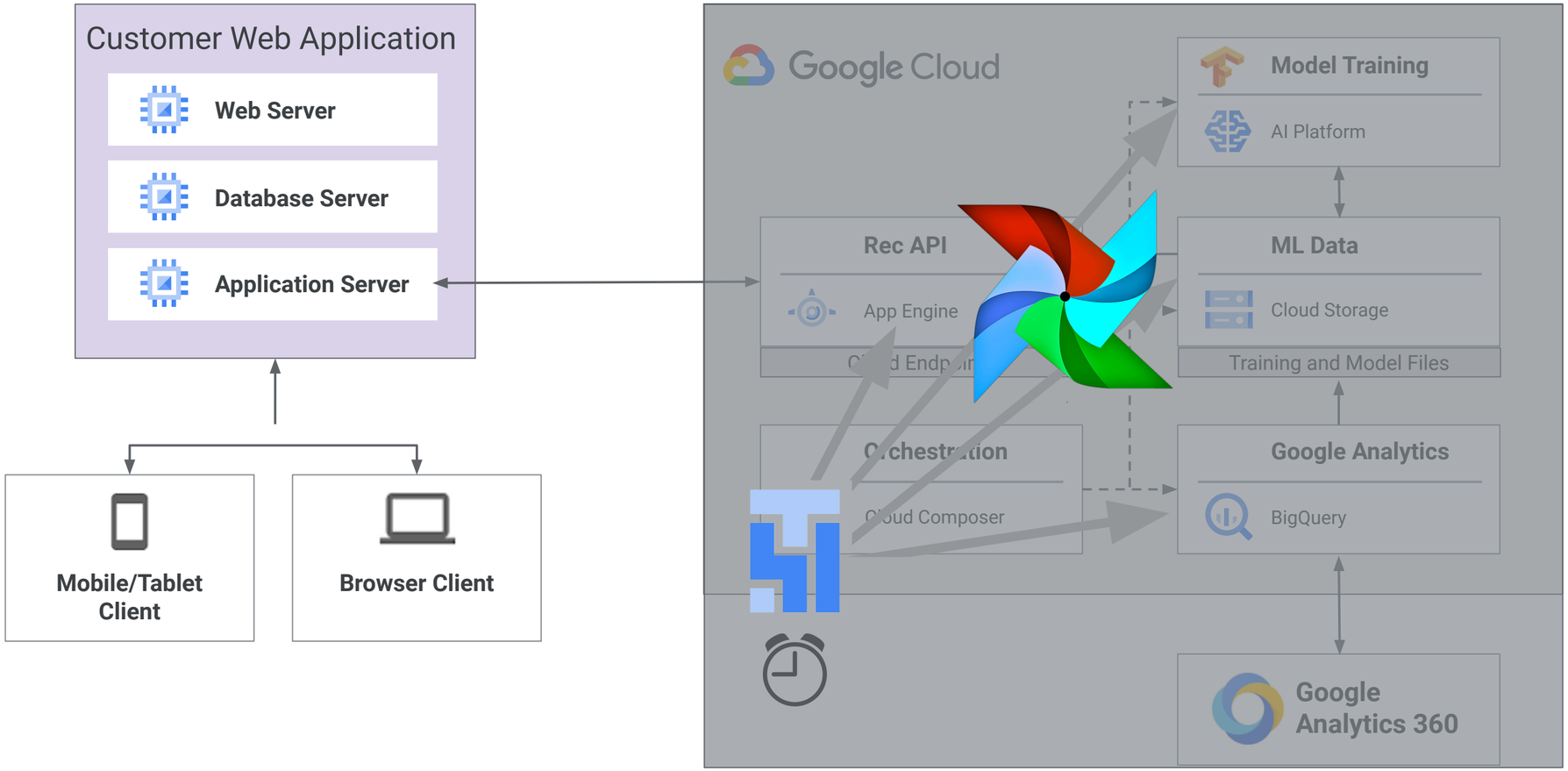


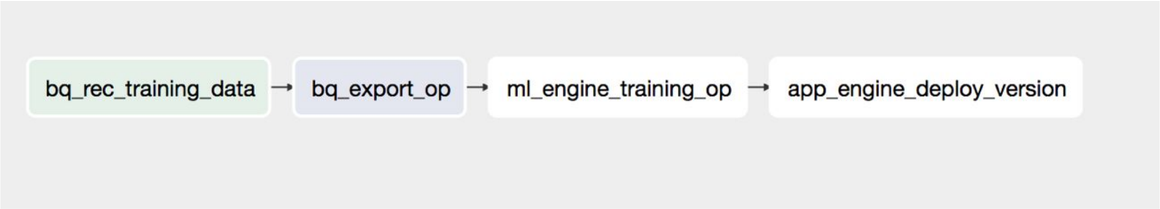
Cloud Composer orchestrates automatic workflows



Cloud Composer is managed Apache Airflow



Use Apache Airflow DAGs to orchestrate GCP services



DAG = Directed Acyclic Graph

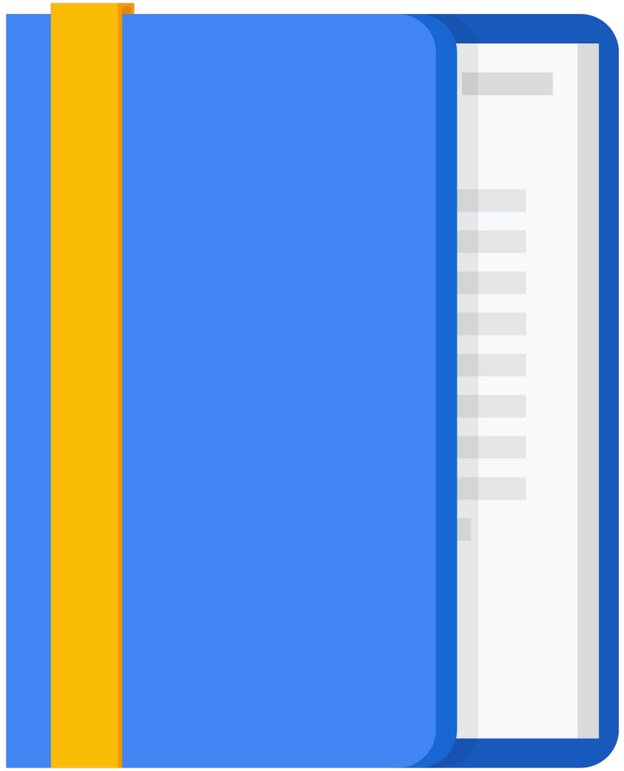
Agenda

Building Batch Data Pipelines visually with Cloud Data Fusion

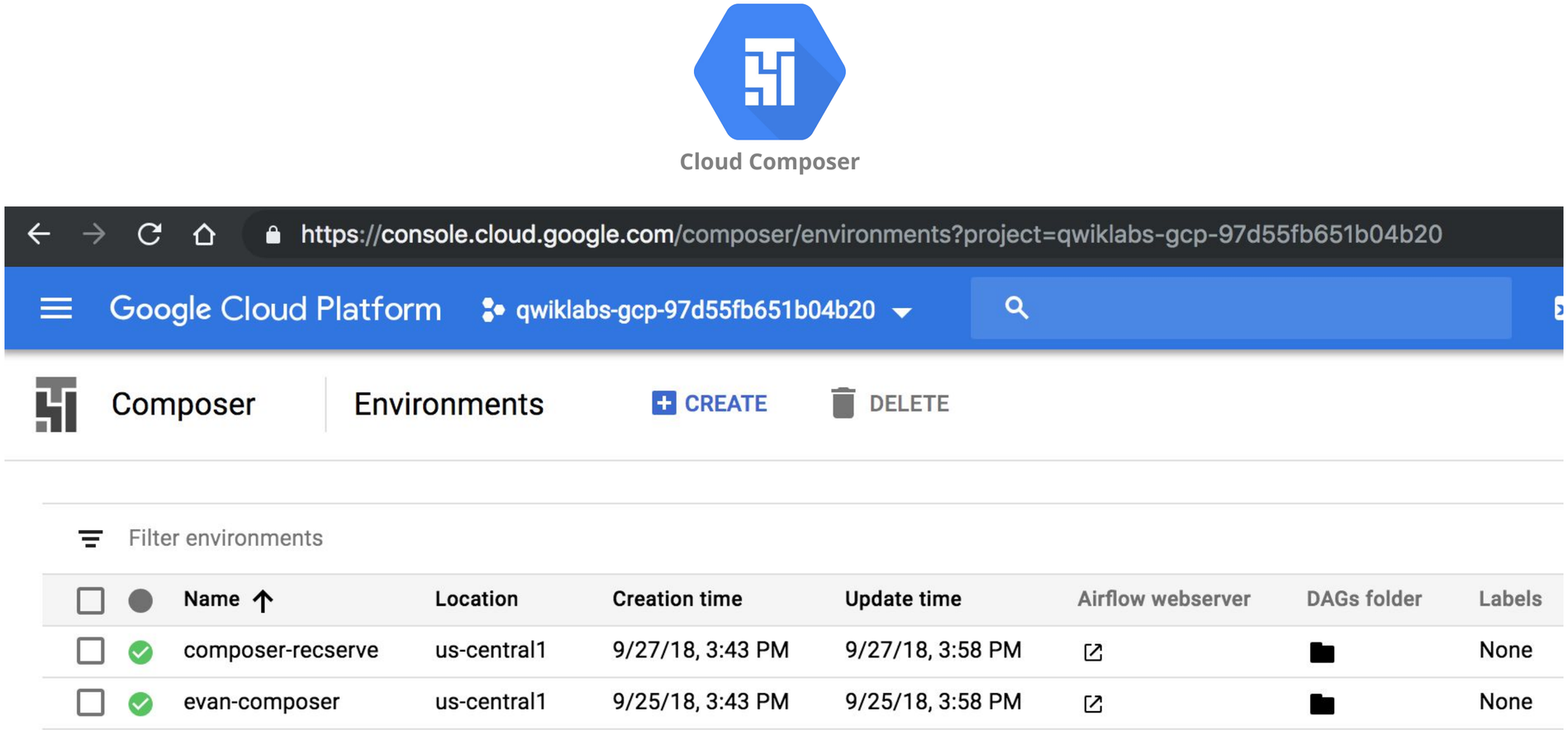
- Components
- UI Overview
- Building a Pipeline
- Exploring Data using Wrangler

Orchestrating work between GCP services with Cloud Composer

- **Apache Airflow Environment**
- DAGs and Operators
- Workflow Scheduling
- Monitoring and Logging

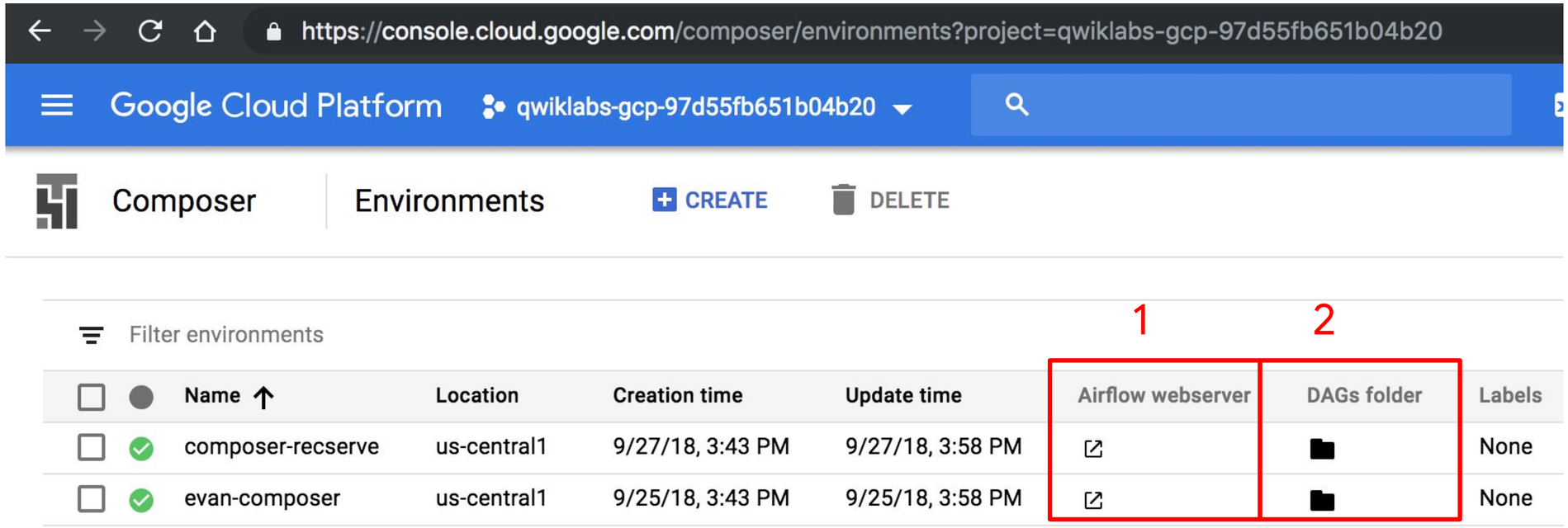


Cloud Composer creates managed Apache Airflow environments



Each Airflow environment has a separate webserver and folder in GCS for pipeline DAGs

Cloud Composer



Google Cloud

The DAGs folder is simply a GCS bucket where you will load your pipeline code

Cloud Composer

Buckets / us-central1-evan-composer-0e85530c-bucket / dags

Name	Size	Type	Storage class	Last modified	Public access	Encryption
dataflow/	–	Folder	–	–	Per object	–
simple_load_dag.py	6.79 KB	text/x-python-script	Multi-Regional	10/1/18, 1:11 PM	Not public	Google-managed key
simple.py	2.51 KB	text/x-python-script	Multi-Regional	10/1/18, 1:10 PM	Not public	Google-managed key

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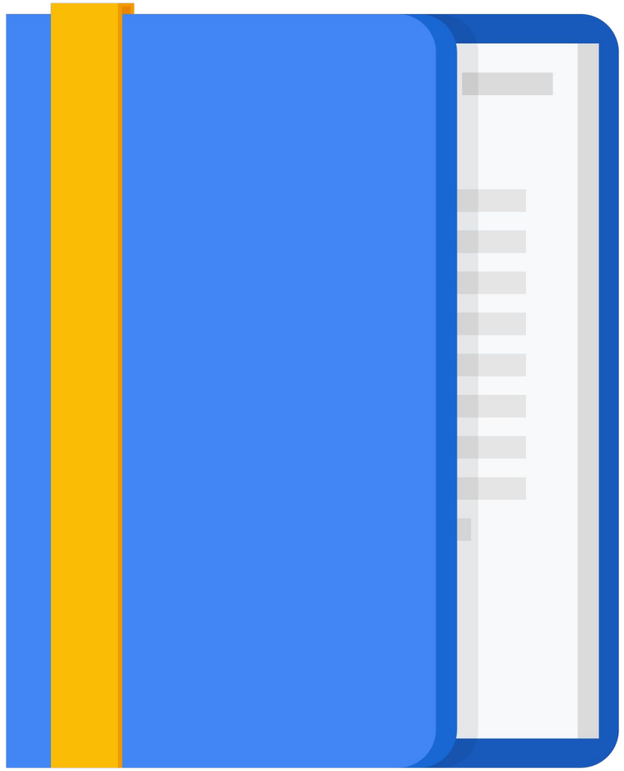
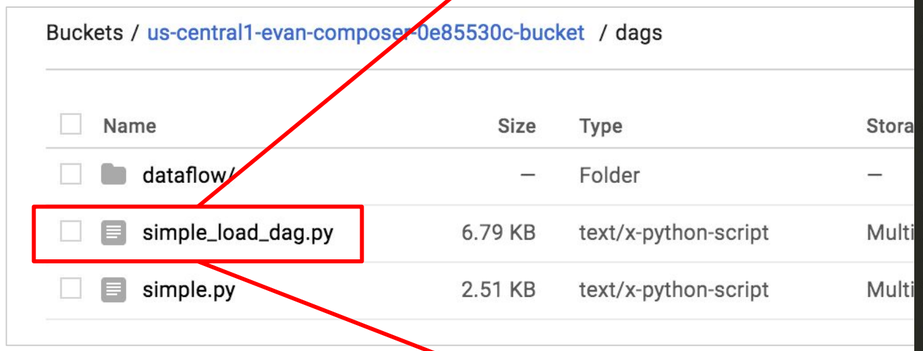


Airflow workflows are written in Python




```
#                   e.g. state,gender,year,name,number,created_date
with models.DAG(dag_id='GcsToBigQueryTriggered',
                description='A DAG triggered by an external Cloud Function',
                schedule_interval=None, default_args=DEFAULT_DAG_ARGS) as dag:
    # Args required for the Dataflow job.
    job_args = {
        'input': 'gs://{{ dag_run.conf["bucket"] }}/{{ dag_run.conf["name"] }}',
        'output': models.Variable.get('bq_output_table'),
        'fields': models.Variable.get('input_field_names'),
        'load_dt': DS_TAG
    }

    # Main Dataflow task that will process and load the input delimited file.
    dataflow_task = dataflow_operator.DataFlowPythonOperator(
        task_id="process-delimited-and-push",
        py_file=DATAFLOW_FILE,
        options=job_args)

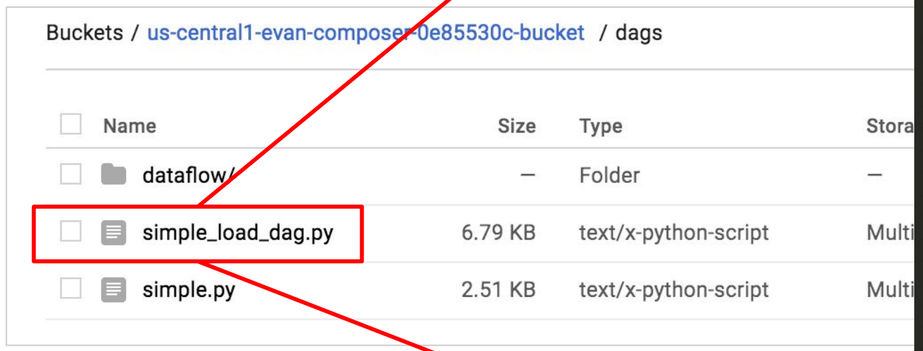
    # Here we create two conditional tasks, one of which will be executed
    # based on whether the dataflow_task was a success or a failure.
    success_move_task = python_operator.PythonOperator(task_id='success-move-to-completion',
                                                       python_callable=move_to_completion_bucket,
                                                       # A success_tag is used to move
                                                       # the input file to a success
                                                       # prefixed folder.
                                                       op_args=[COMPLETION_BUCKET, SUCCESS_TAG],
                                                       provide_context=True,
                                                       trigger_rule=TriggerRule.ALL_SUCCESS)

    failure_move_task = python_operator.PythonOperator(task_id='failure-move-to-completion',
                                                       python_callable=move_to_completion_bucket,
                                                       # A failure_tag is used to move
                                                       # the input file to a failure
                                                       # prefixed folder.
                                                       op_args=[COMPLETION_BUCKET, FAILURE_TAG],
                                                       provide_context=True,
                                                       trigger_rule=TriggerRule.ALL_FAILED)

    # The success_move_task and failure_move_task are both downstream from the
    # dataflow_task.
    dataflow_task >> success_move_task
    dataflow_task >> failure_move_task
```

Google Cloud

Airflow workflows are written in Python




```
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    job_args = {
        'input': 'gs://{{ dag_run.conf["bucket"] }}/{{ dag_run.conf["name"] }}',
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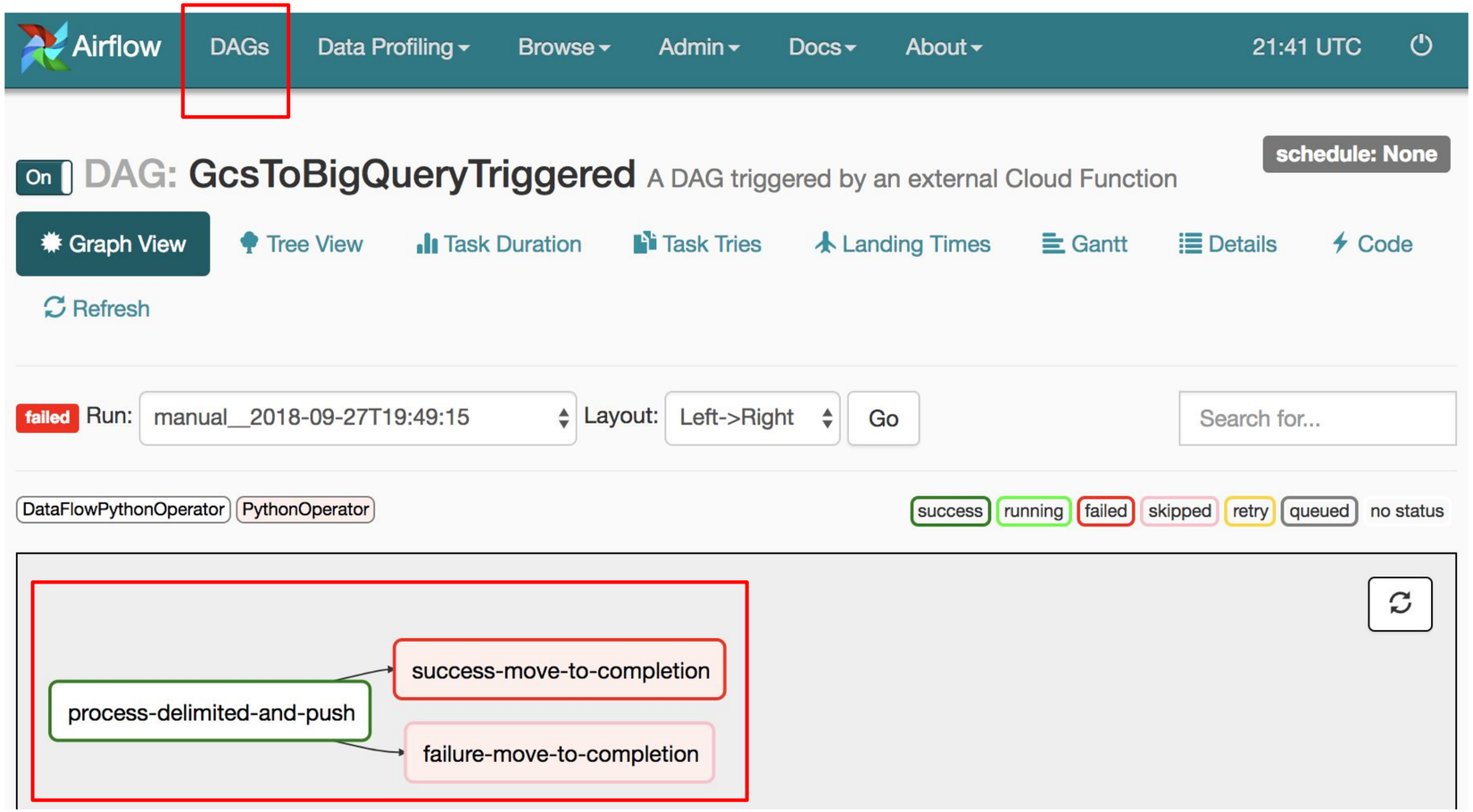
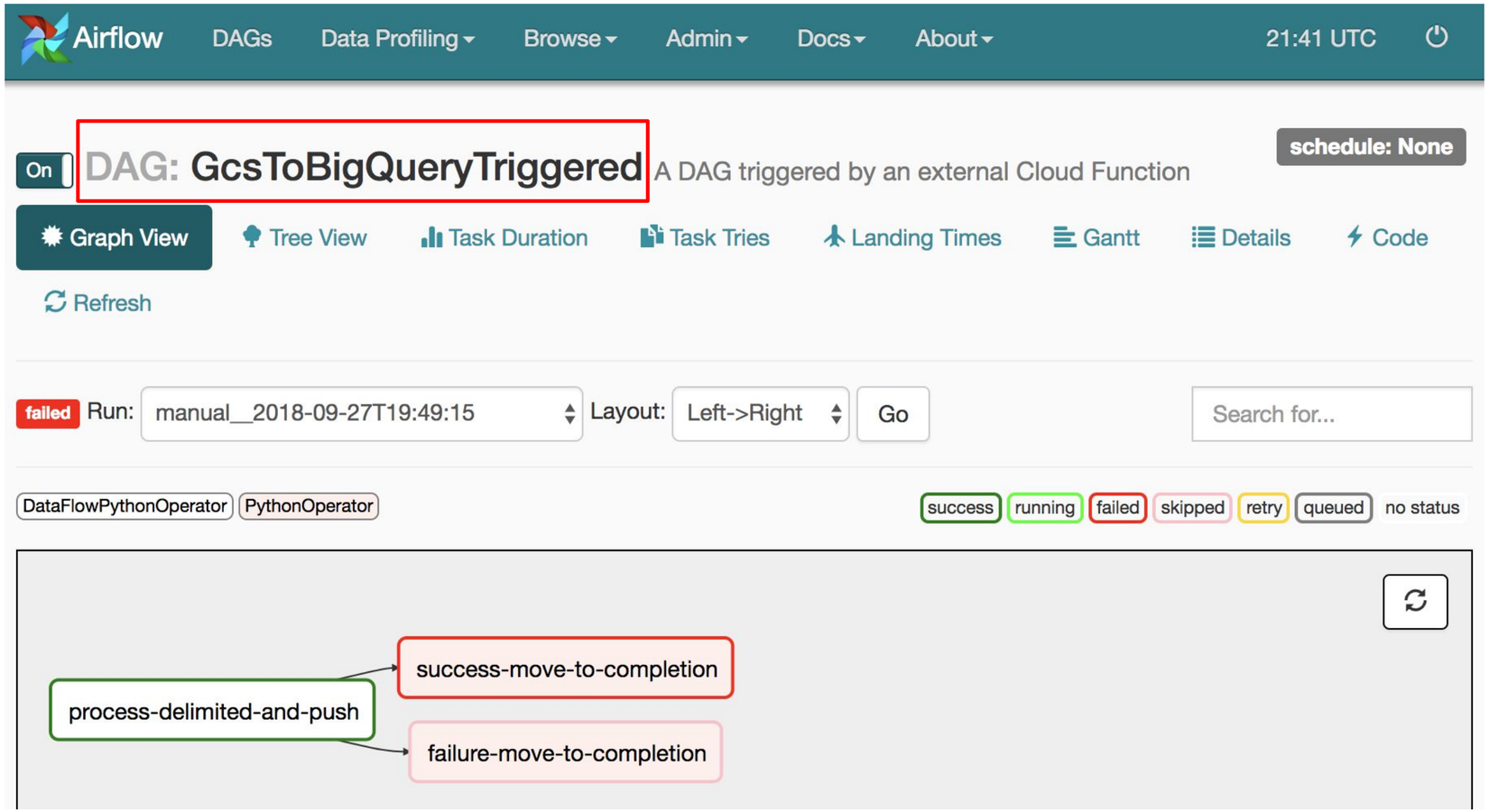
Google Cloud

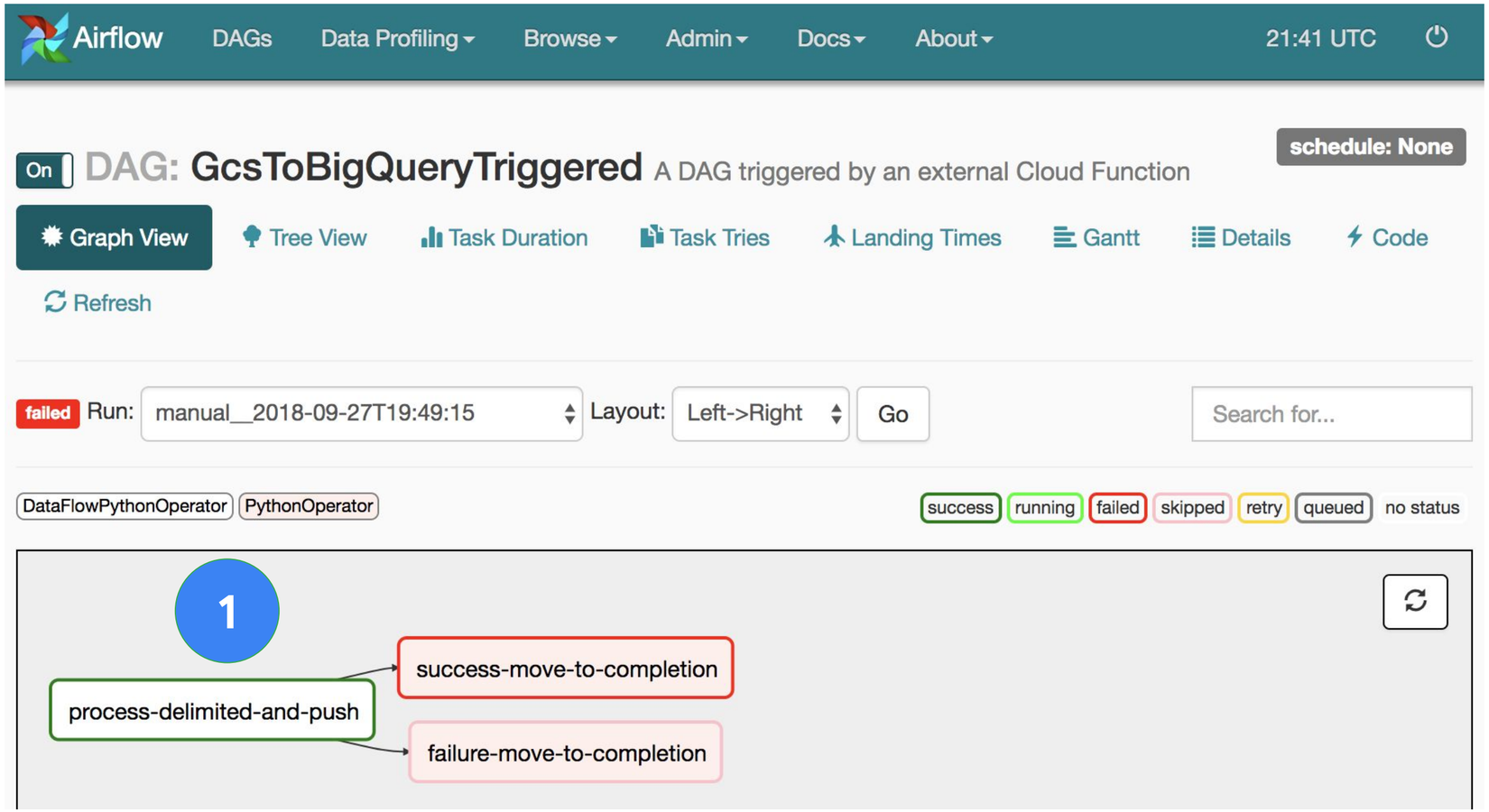
The python file creates a DAG



Airflow webserver UI overview



The python file creates a DAG (Directed Acyclic Graph)



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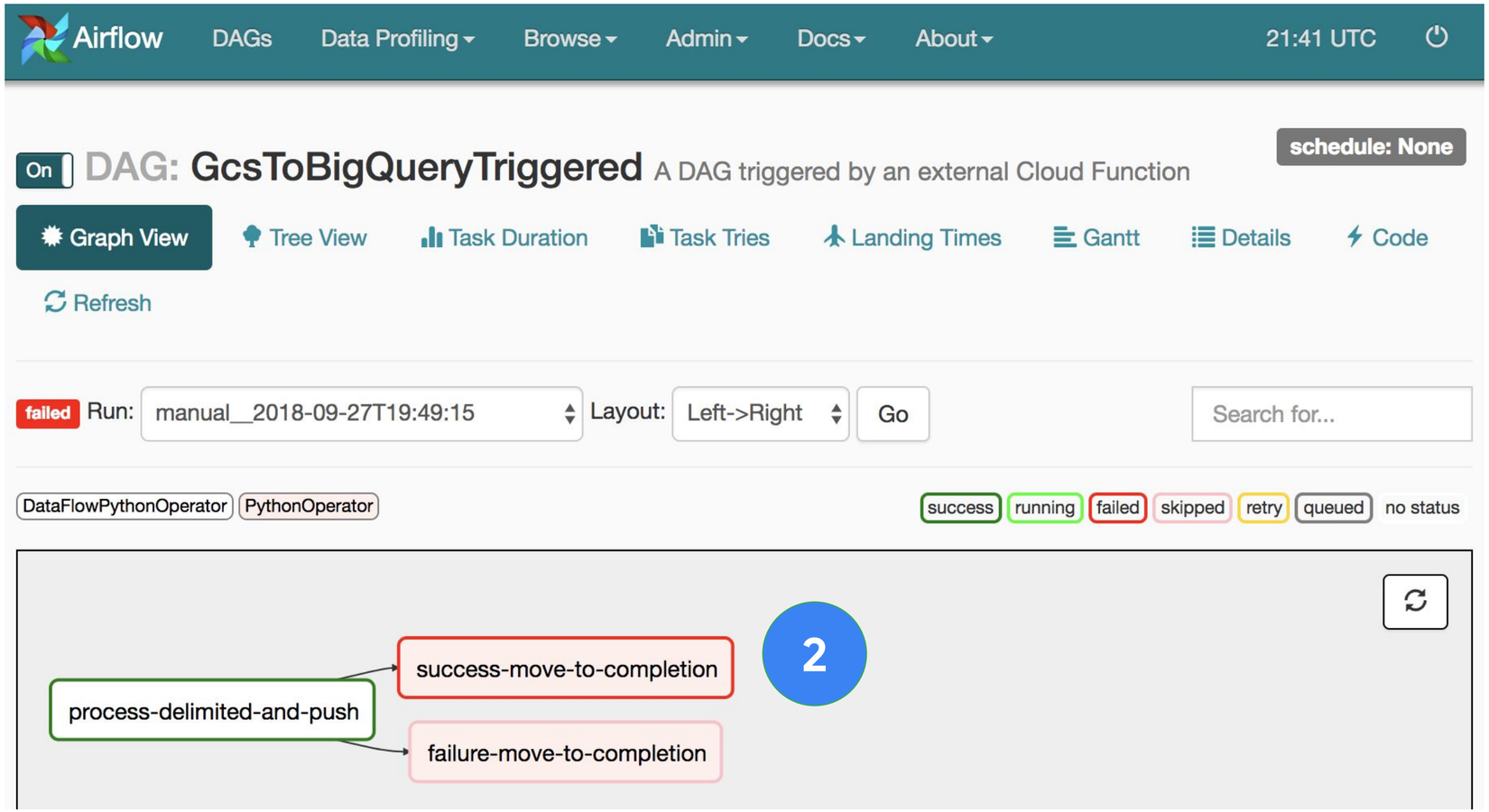

Google Cloud

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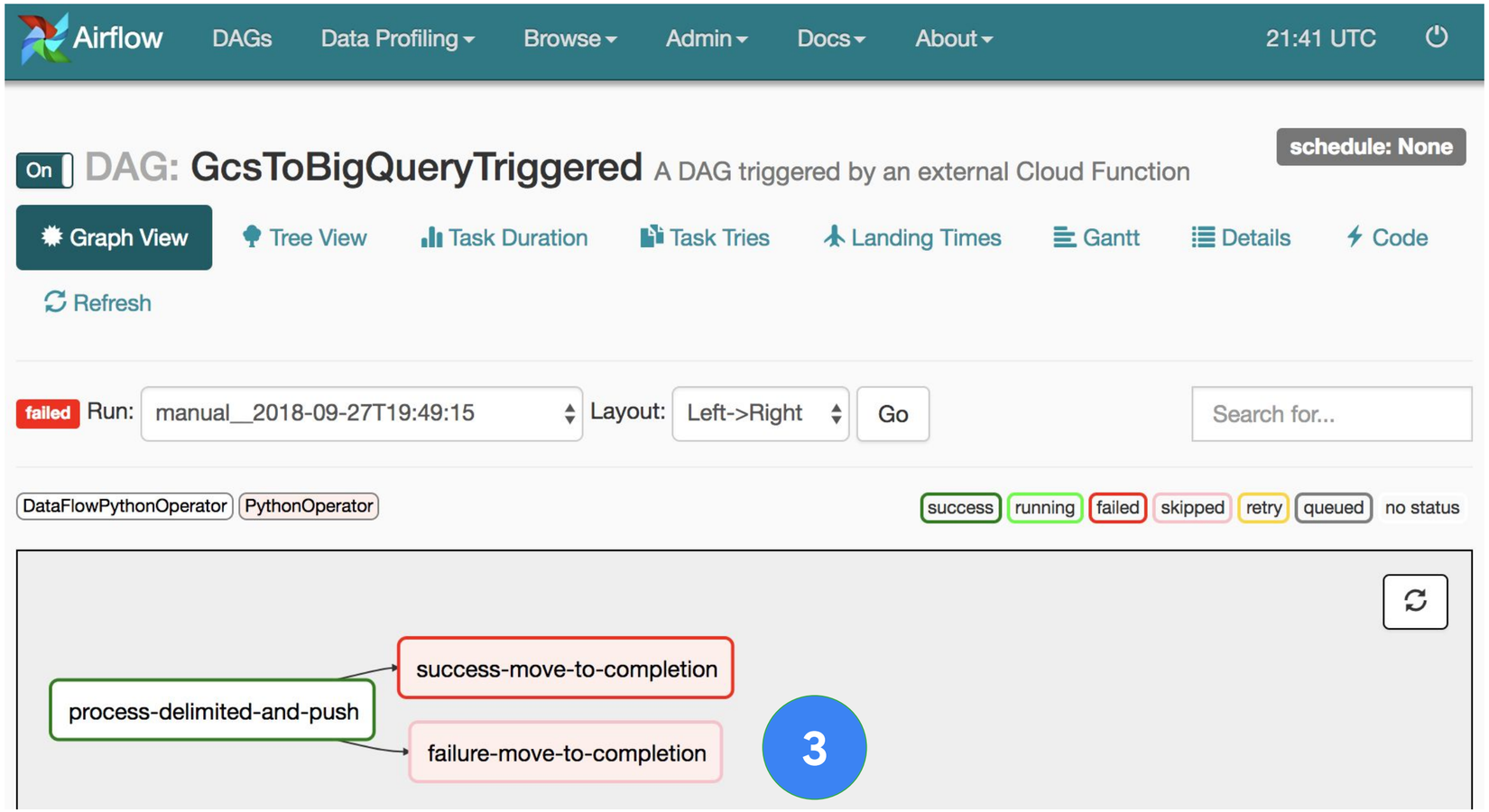
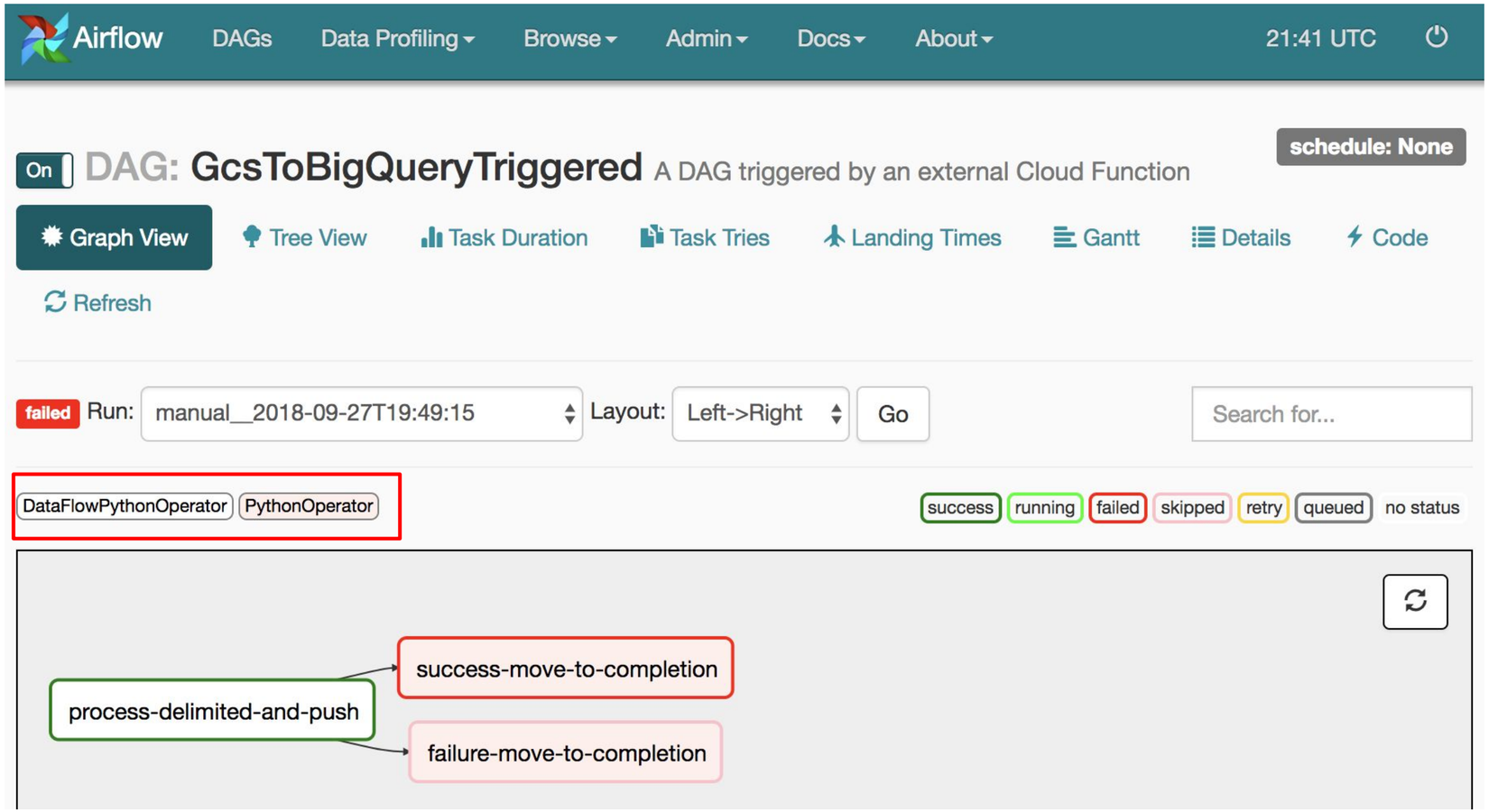
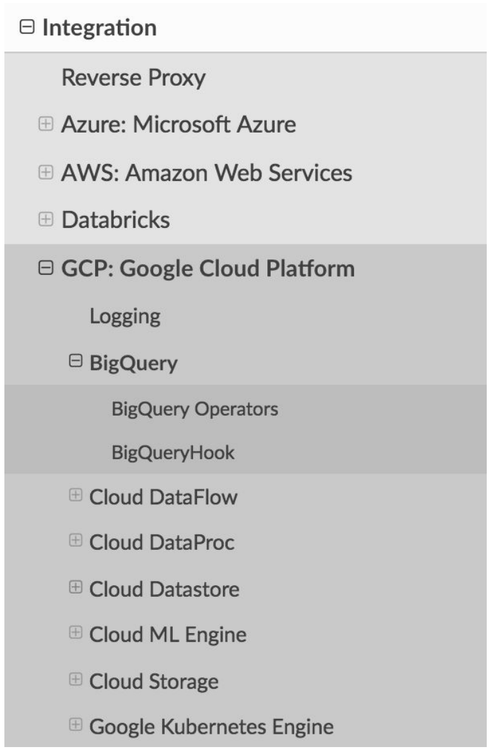


Google Cloud

The python file creates a DAG (Directed Acyclic Graph)



Airflow uses operators in your DAG to orchestrate other GCP services

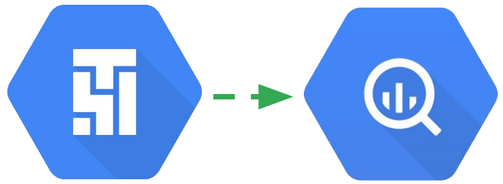


View all GCP services that Airflow can orchestrate:
http://airflow.apache.org/integration.html#gcp

\+ sample code

BigQuery Operators are popular for updating your ML training dataset

- Integration
  - Reverse Proxy
  - Azure: Microsoft Azure
  - AWS: Amazon Web Services
  - Databricks
  - GCP: Google Cloud Platform
    - Logging
    - BigQuery
      - BigQuery Operators
      - BigQueryHook
    - Cloud DataFlow
    - Cloud DataProc
    - Cloud Datastore
    - Cloud ML Engine
    - Cloud Storage
    - Google Kubernetes Engine

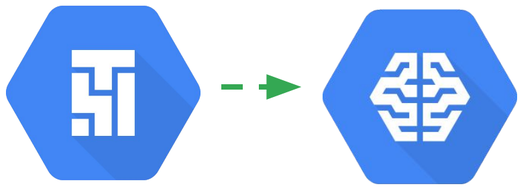


```
BigQueryOperator
BigQueryCheckOperator
BigQueryIntervalCheckOperator
BigQueryCreateEmptyTableOperator
BigQueryCreateExternalTableOperator
BigQueryDeleteDatasetOperator
BigQueryToBigQueryOperator
BigQueryToCloudStorageOperator
```

https://airflow.apache.org/integration.html#gcp

Cloud AI Platform (formerly Cloud ML Engine) operators can launch training and deployment jobs

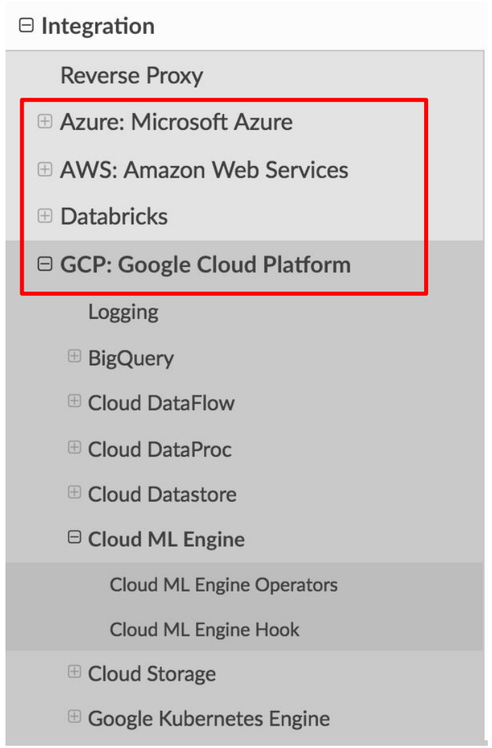
- Integration
  - Reverse Proxy
  - Azure: Microsoft Azure
  - AWS: Amazon Web Services
  - Databricks
  - GCP: Google Cloud Platform
    - Logging
    - BigQuery
    - Cloud DataFlow
    - Cloud DataProc
    - Cloud Datastore
    - Cloud ML Engine
      - Cloud ML Engine Operators
      - Cloud ML Engine Hook
    - Cloud Storage
    - Google Kubernetes Engine



```
MLEngineBatchPredictionOperator
MLEngineModelOperator
MLEngineTrainingOperator
MLEngineVersionOperator
```

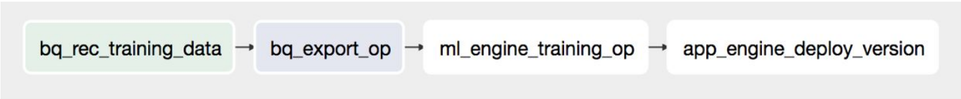
https://airflow.apache.org/integration.html#cloud-ml-engine-operators

Apache Airflow is open source and cross-platform for hybrid pipelines



https://airflow.apache.org/integration.html#cloud-ml-engine-operators

Example: Common Machine Learning workflow DAG Operators




```
# update training data
t1 = BigQueryOperator(
)

# BigQuery training data export to GCS
t2 = BigQueryToCloudStorageOperator(
)

# AI Platform training job
t3 = MLEngineTrainingOperator(
)

# App Engine deploy new version
t4 = AppEngineVersionOperator(
)

# DAG dependencies
t2.set_upstream(t1)
t3.set_upstream(t2)
t4.set_upstream(t3)
```

1

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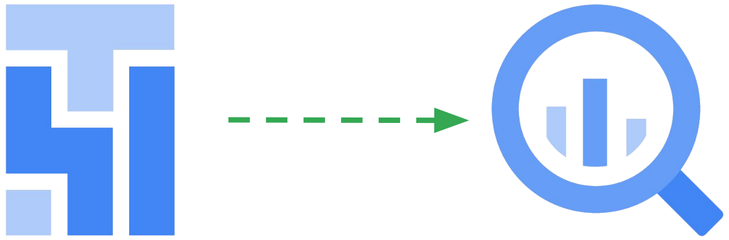
3

4

BigQuery and Cloud Storage operators get us fresh training data



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```

1

2

3

4

Use the BigQueryOperator to run SQL

```
from airflow.contrib.operators import bigquery_operator

# constants or can be dynamic based on Airflow macros
max_query_date = '2018-02-01'
min_query_date = '2018-01-01'

    # Query recent StackOverflow questions.
    bq_recent_questions_query = bigquery_operator.BigQueryOperator(

        task_id='bq_recent_questions_query',

        bql="""
        SELECT owner_display_name, title, view_count
        FROM `bigquery-public-data.stackoverflow.posts_questions`
        WHERE creation_date < CAST('{max_date}' AS TIMESTAMP)
            AND creation_date >= CAST('{min_date}' AS TIMESTAMP)
        ORDER BY view_count DESC
        LIMIT 100
        """.format(max_date=max_query_date, min_date=min_query_date),

        use_legacy_sql=False,

        destination_dataset_table=bq_recent_questions_table_id)
```

SQL commands can hold parameters (from Python)

```
from airflow.contrib.operators import bigquery_operator

# constants or can be dynamic based on Airflow macros
max_query_date = '2018-02-01'
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            AND creation_date >= CAST('{min_date}' AS TIMESTAMP)
        ORDER BY view_count DESC
        LIMIT 100
        """.format(max_date=max_query_date, min_date=min_query_date),

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```

Note the Python constants for a date range here

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            AND creation_date >= CAST('{min_date}' AS TIMESTAMP)
        ORDER BY view_count DESC
        LIMIT 100
        """.format(max_date=max_query_date, min_date=min_query_date),

        use_legacy_sql=False,

        destination_dataset_table=bq_recent_questions_table_id)
```

You could even set a rolling window with macros

```
from airflow.contrib.operators import bigquery_operator

# constants or can be dynamic based on Airflow macros
max_query_date = {{ macros.ds_add(ds, -1) }}  # one day prior
min_query_date = {{ macros.ds_add(ds, -7) }}  # seven days prior

    # Query recent StackOverflow questions.
    bq_recent_questions_query = bigquery_operator.BigQueryOperator(

        task_id='bq_recent_questions_query',

        bql="""
        SELECT owner_display_name, title, view_count
        FROM `bigquery-public-data.stackoverflow.posts_questions`
        WHERE creation_date < CAST('{max_date}' AS TIMESTAMP)
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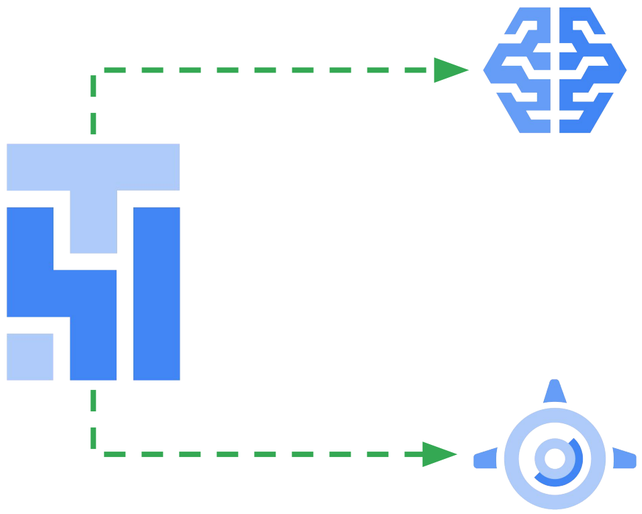
        ORDER BY view_count DESC
        LIMIT 100
        """.format(max_date=max_query_date, min_date=min_query_date),

        use_legacy_sql=False,

        destination_dataset_table=bq_recent_questions_table_id)
```

Google Cloud

AI Platform and App Engine operators retrain and redeploy our model



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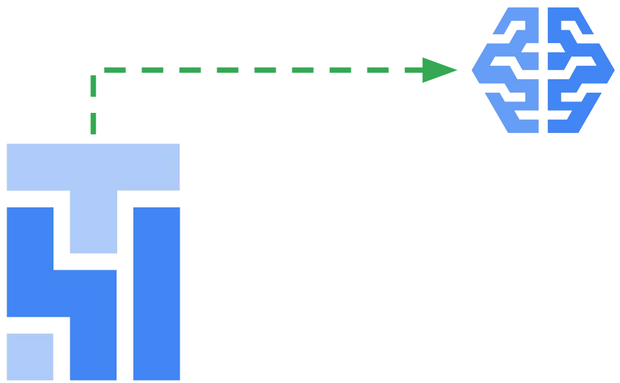
1

2

3

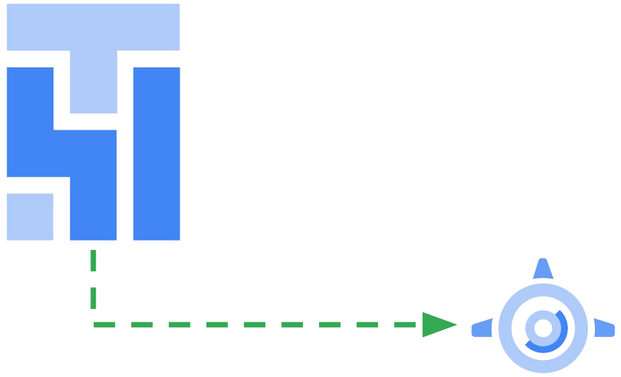
4

Use Cloud ML Engine operators to periodically submit new training jobs



```
t3 = MLEngineTrainingOperator(
    task_id='ml_engine_training_op',
    project_id=PROJECT_ID,
    job_id=job_id,
    package_uris=[PACKAGE_URI],
    training_python_module='trainer.task',
    training_args=training_args,
    region=REGION,
    scale_tier='CUSTOM',
    master_type='complex_model_m_gpu',
    dag=dag
)
```

Use App Engine operators to periodically deploy and redeploy models



```
t4 = AppEngineVersionOperator(
    task_id='app_engine_deploy_version',
    project_id=PROJECT_ID,
    service_id='default',
    region=REGION,
    service_spec=None,
    dag=dag
)
```

Manage pipelines and dependencies as code

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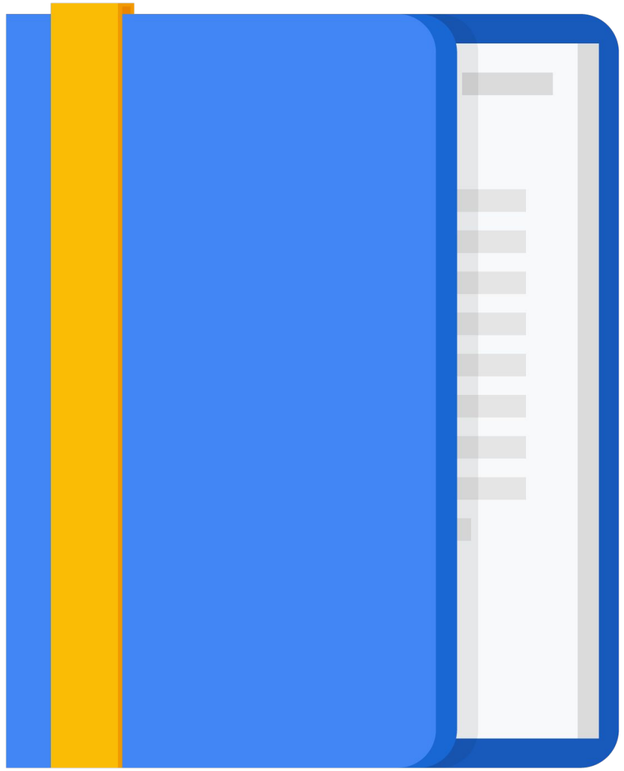
- **Workflow Scheduling**
- Monitoring and Logging

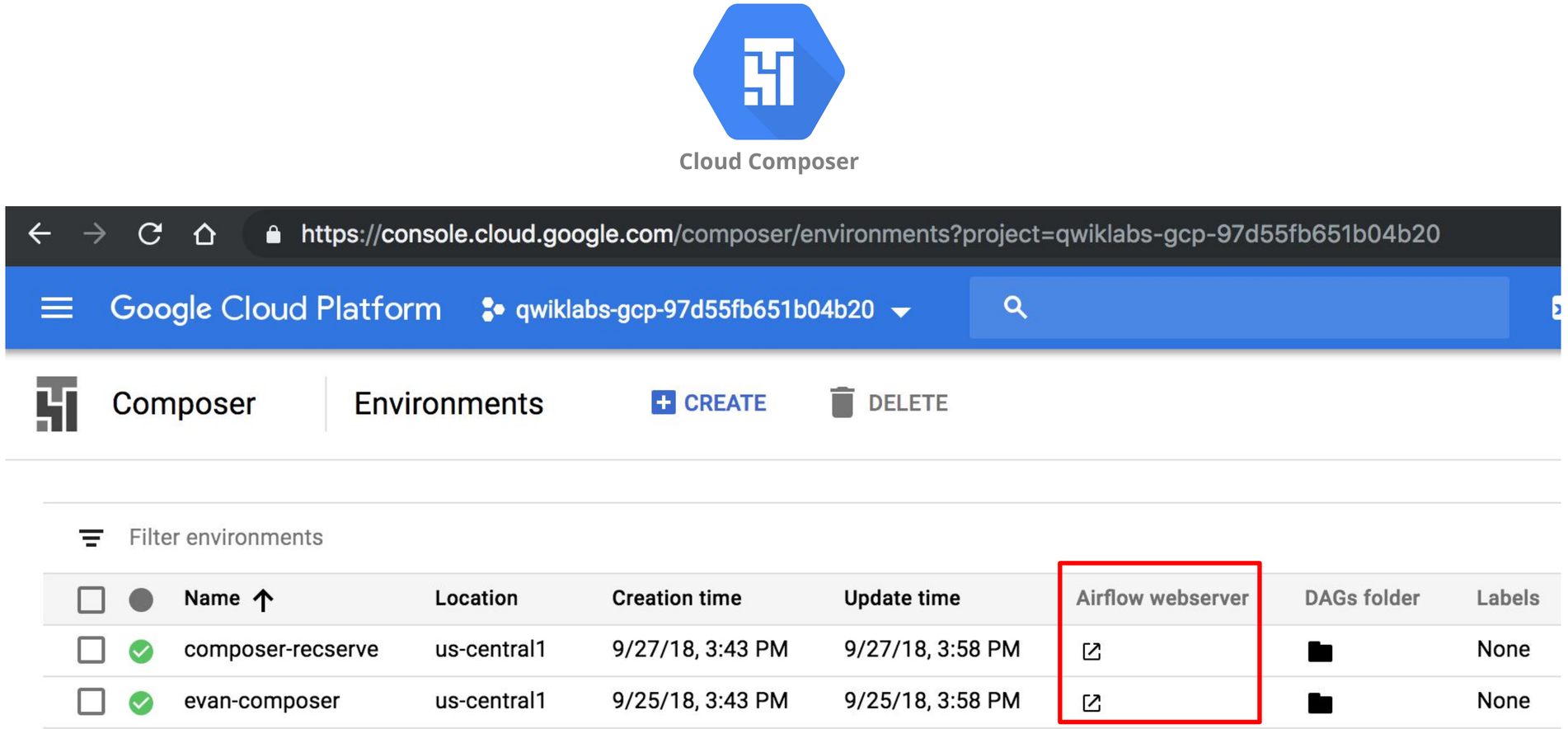


Two scheduling options for Cloud Composer workflows

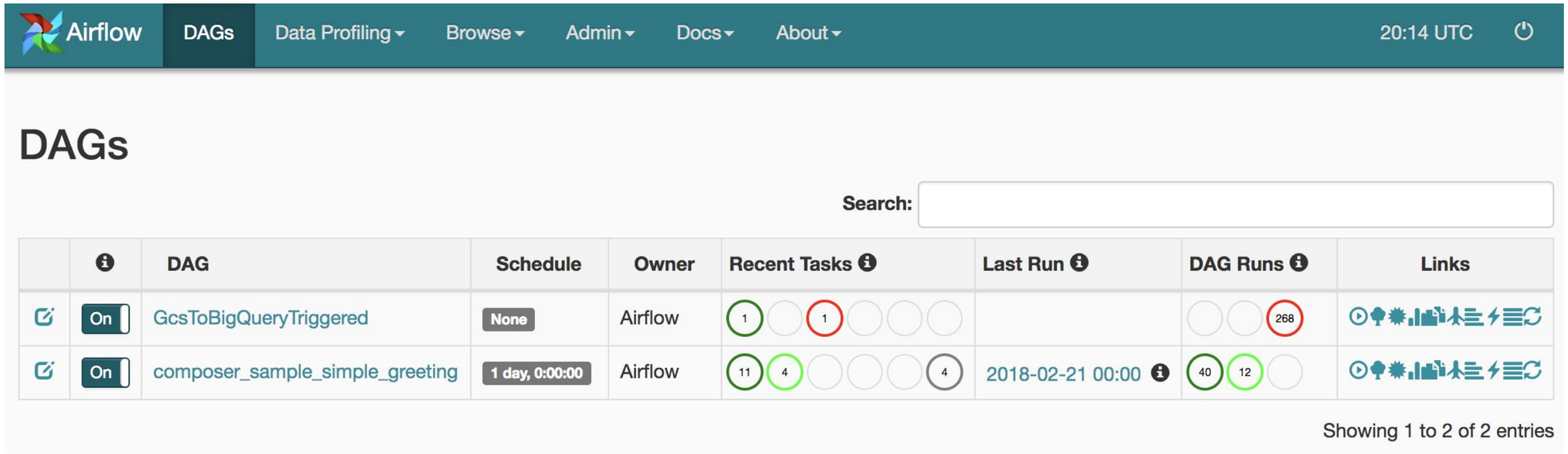
Periodic

Event-driven

Launch the Airflow webserver to interact with your DAGs

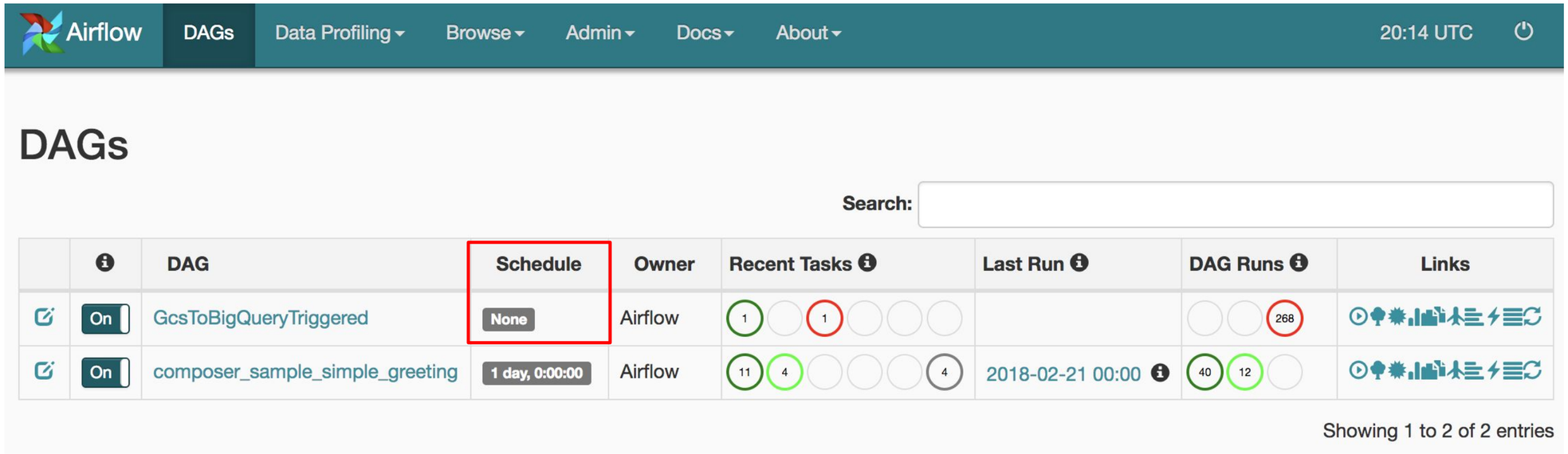


Airflow scheduling basics



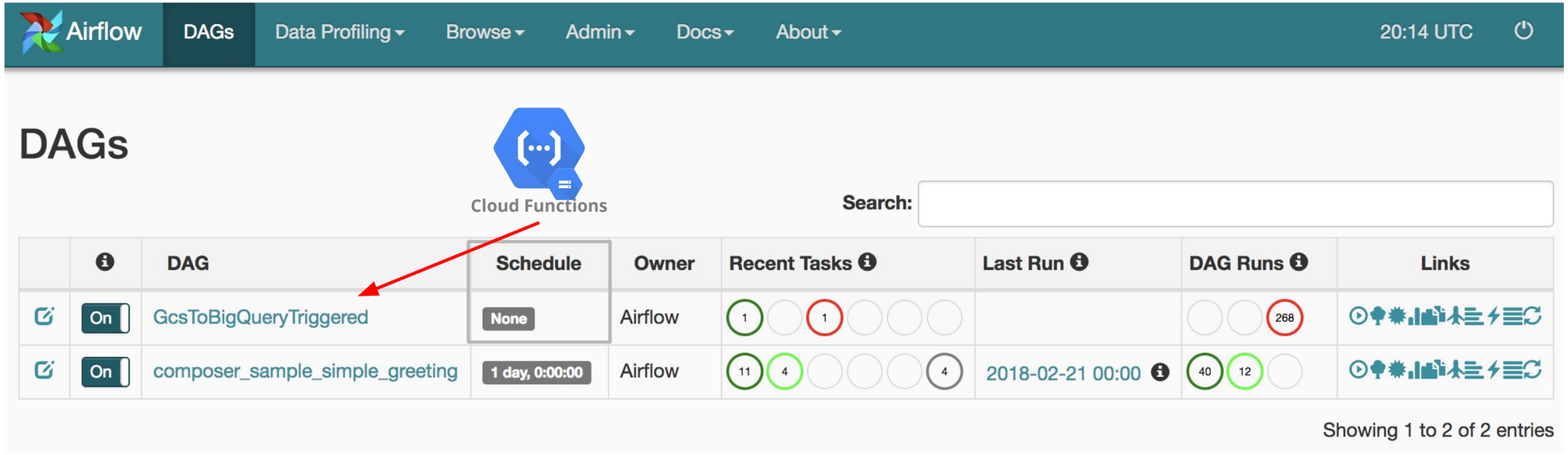
Google Cloud

Why is this DAG missing a schedule?

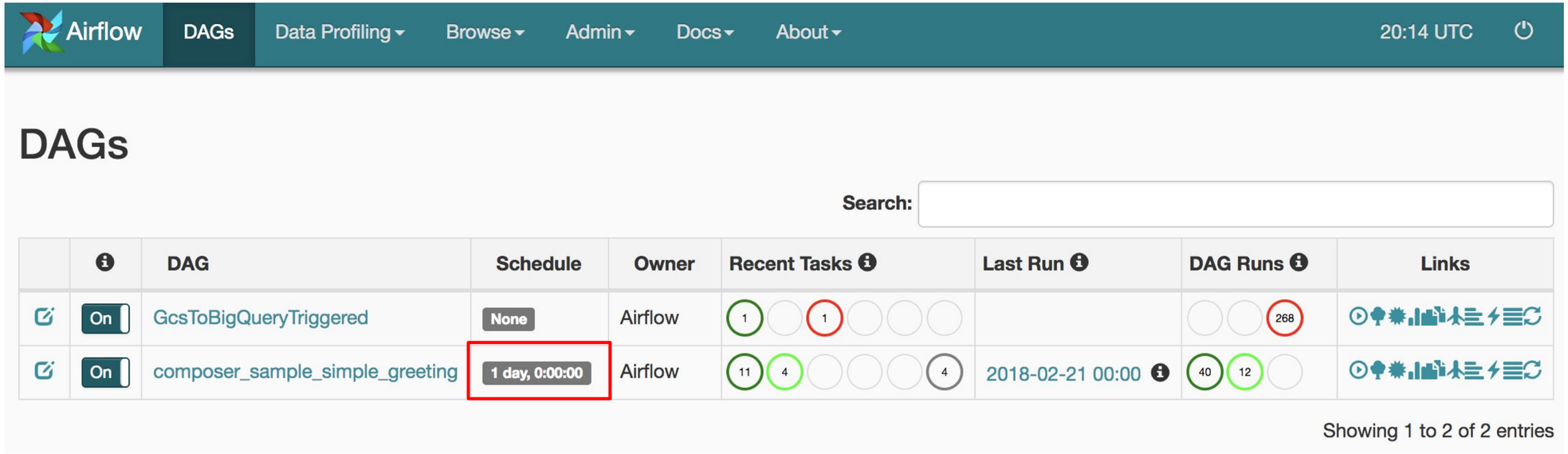


Google Cloud

Option 1: Event-driven scheduling with Cloud Functions



Option 2: Specify pipeline schedule_interval in your DAG

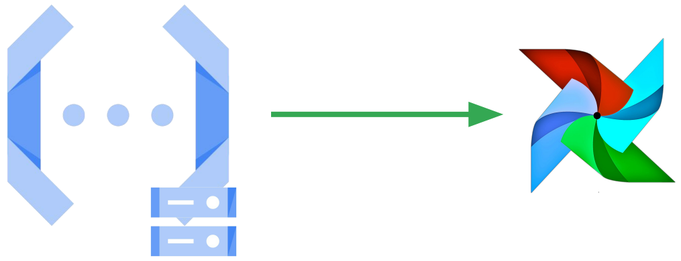



```
with models.DAG(
        'composer_sample_simple_greeting',
        schedule_interval=datetime.timedelta(days=1),
        default_args=default_dag_args) as dag:
```

Google Cloud

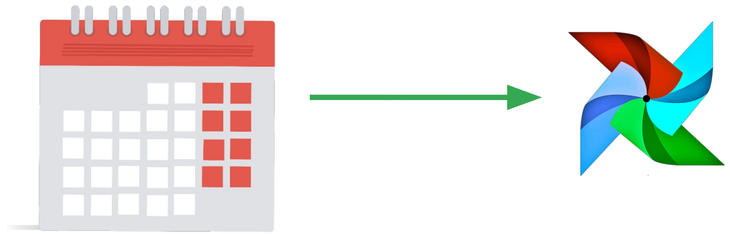
Two types of workflow ETL patterns

Push (event-triggered)

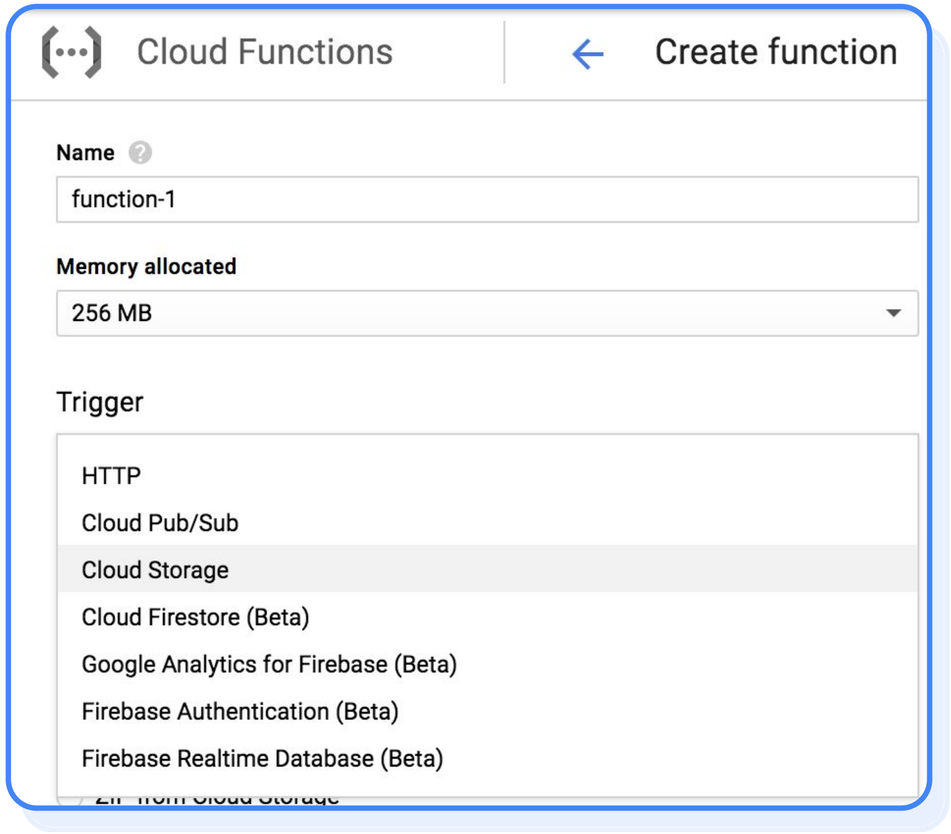


Cloud Functions

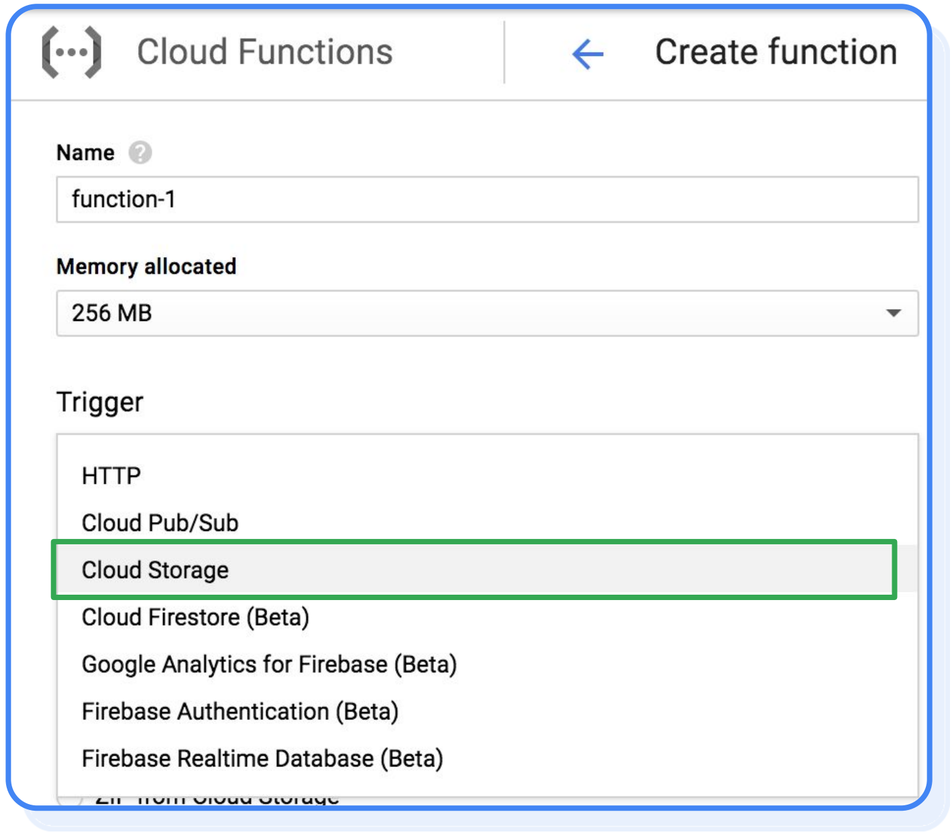
Pull (scheduled workflow run)



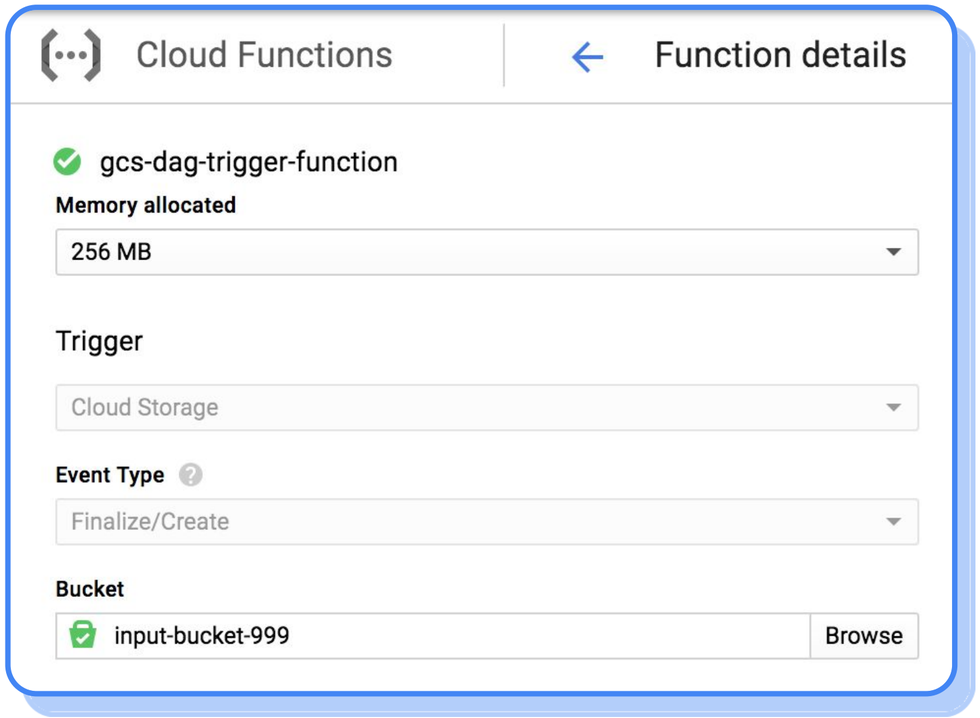
Use Cloud Functions to create an event-based push architecture



Example: Trigger an event when new data is loaded to Cloud Storage



Creating a Cloud Function to trigger an Airflow DAG



Google Cloud

Creating a Cloud Function GCS trigger an Airflow DAG

index.js package.json

```
 * @param {!Object} event The Cloud Functions event.
 * @param {!Function} callback The callback function.
 */
exports.triggerDag = function triggerDag (event, callback) {
  // Fill in your Composer environment information here.

  // The project that holds your function
  const PROJECT_ID = 'qwiklabs-gcp-                    ';
  // Navigate to your webserver's login page and get this from the URL
  const CLIENT_ID = '                                                    .apps.googleusercontent.com';
  // This should be part of your webserver's URL:
  // {tenant-project-id}.appspot.com
  const WEBSERVER_ID = 'b9                    -tp';
  // The name of the DAG you wish to trigger
  const DAG_NAME = 'GcsToBigQueryTriggered';

  // Other constants
  const WEBSERVER_URL = `https://${WEBSERVER_ID}.appspot.com/api/experimental/dags/${DAG_NAME}/dag
  const USER_AGENT = 'gcf-event-trigger';
  const BODY = {'conf': JSON.stringify(event.data)};

  // Make the request
  authorizeIap(CLIENT_ID, PROJECT_ID, USER_AGENT)
    .then(function iapAuthorizationCallback (iap) {
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```

Google Cloud

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Google Cloud

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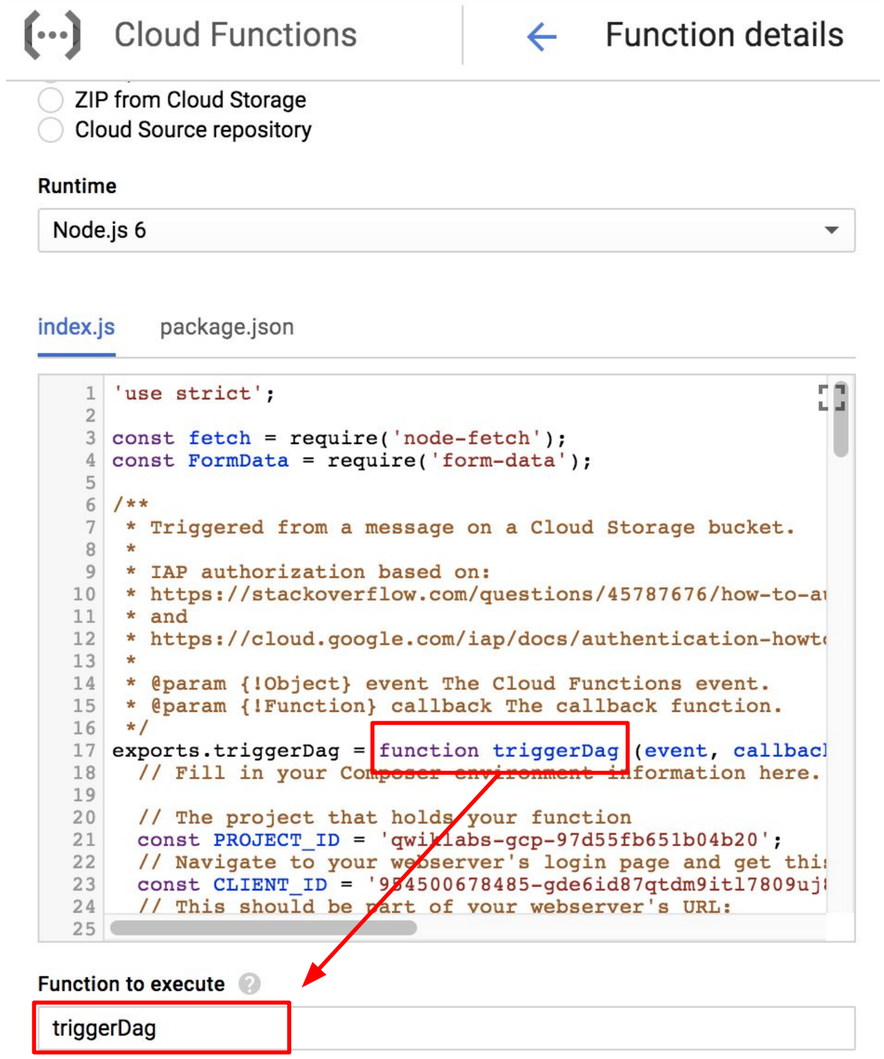
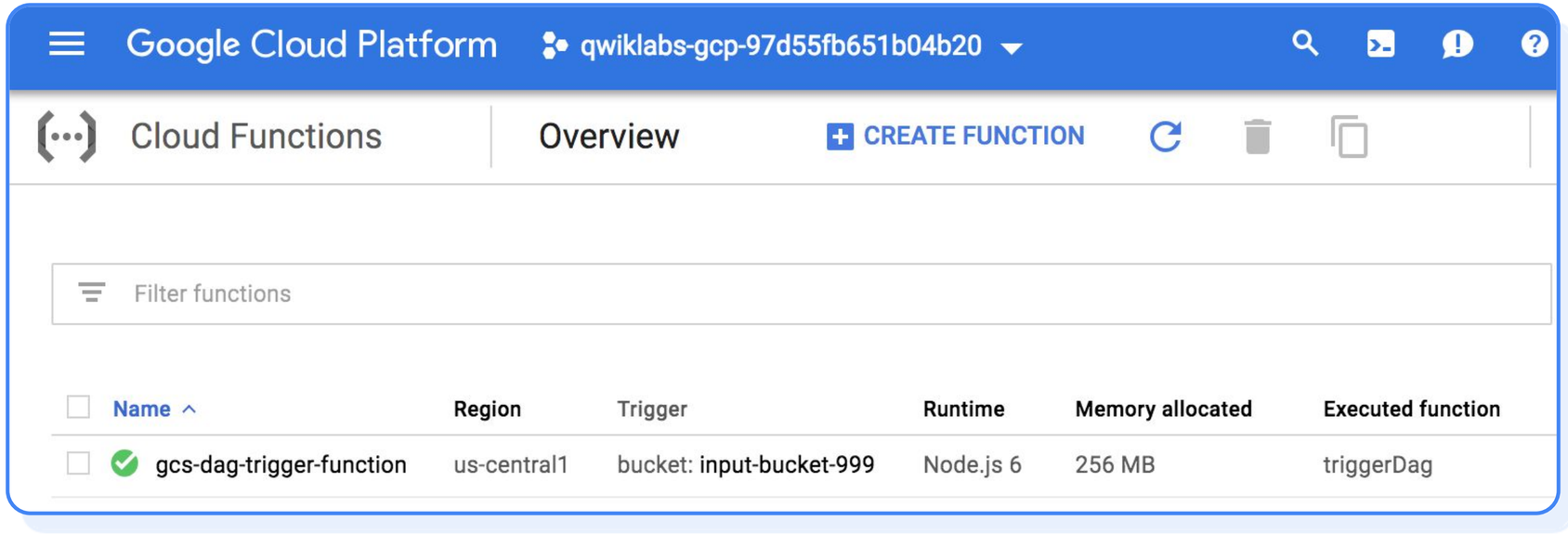
Google Cloud



Be sure to specify the function you want Cloud Functions to call in your script

Cloud Function is triggered whenever a new file is loaded to a specific Cloud Storage bucket



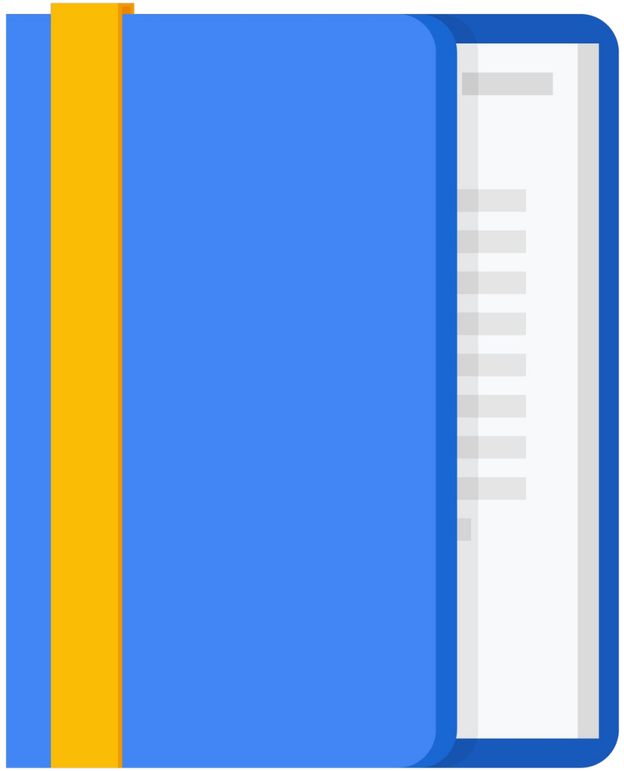
Agenda

Building Batch Data Pipelines visually with Cloud Data Fusion

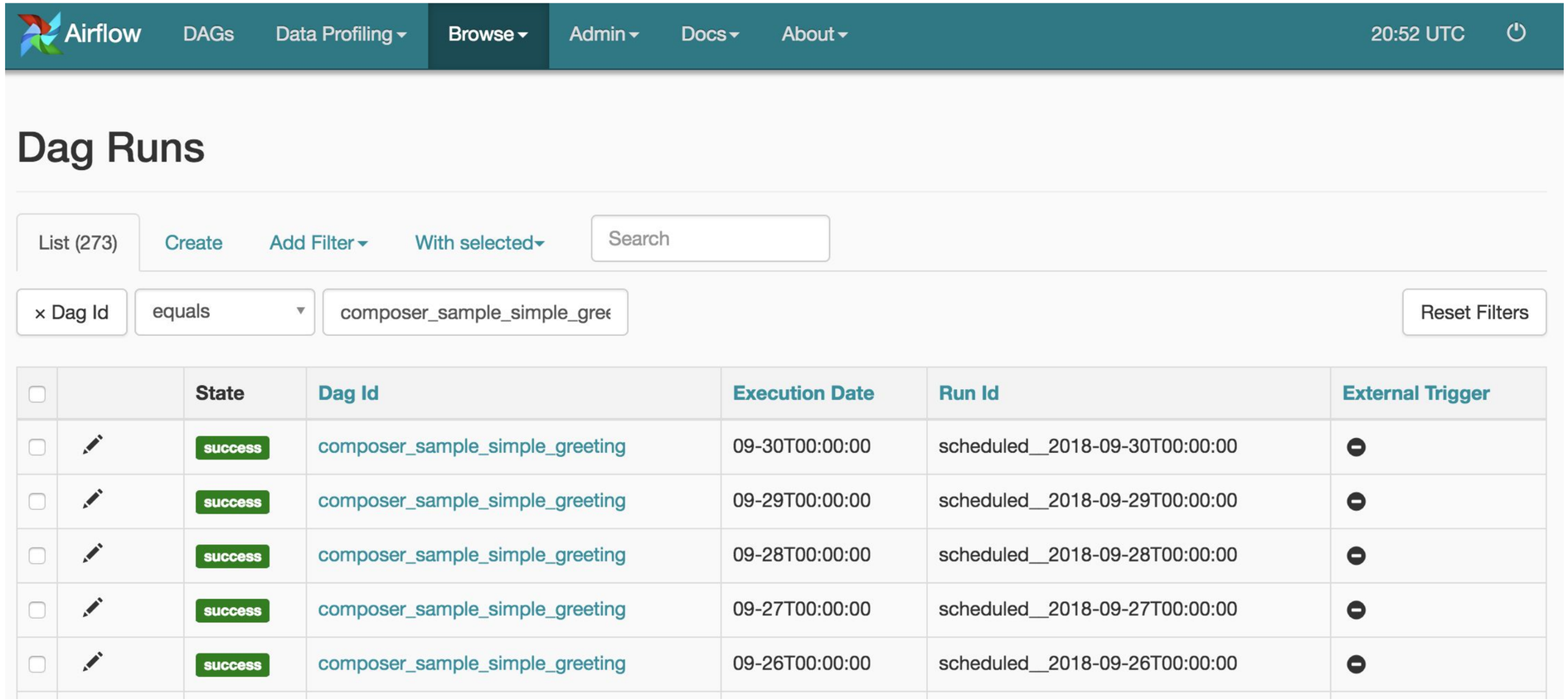
- Components
- UI Overview
- Building a Pipeline
- Exploring Data using Wrangler

Orchestrating work between GCP services with Cloud Composer

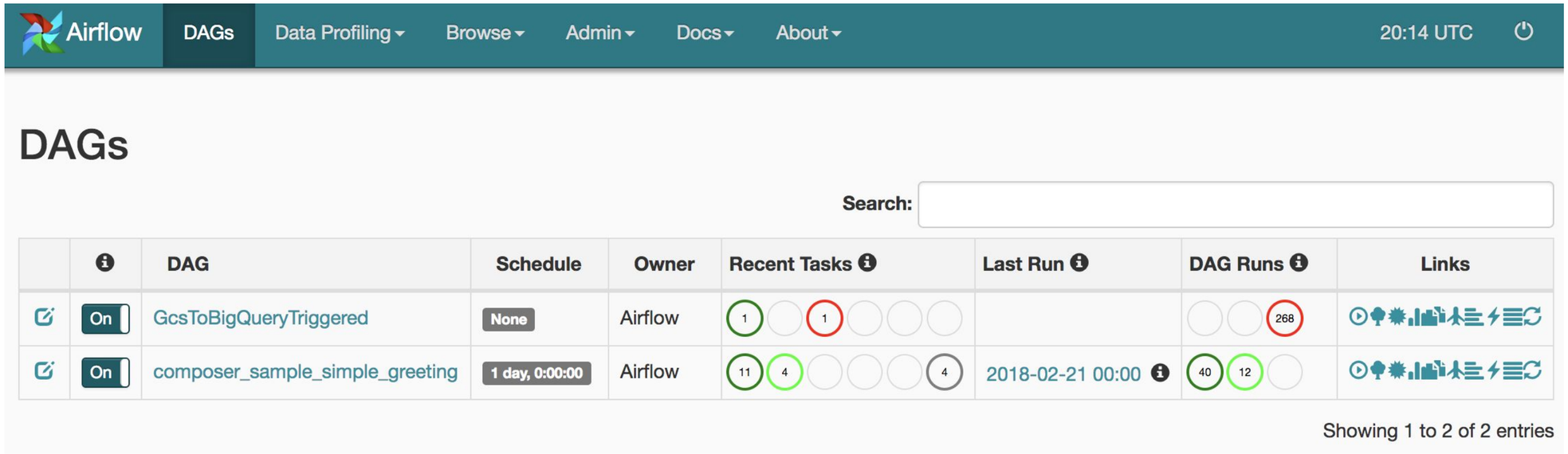
- Apache Airflow Environment
- DAGs and Operators
- Workflow Scheduling
- **Monitoring and Logging**



Monitor current and historical workflow progress



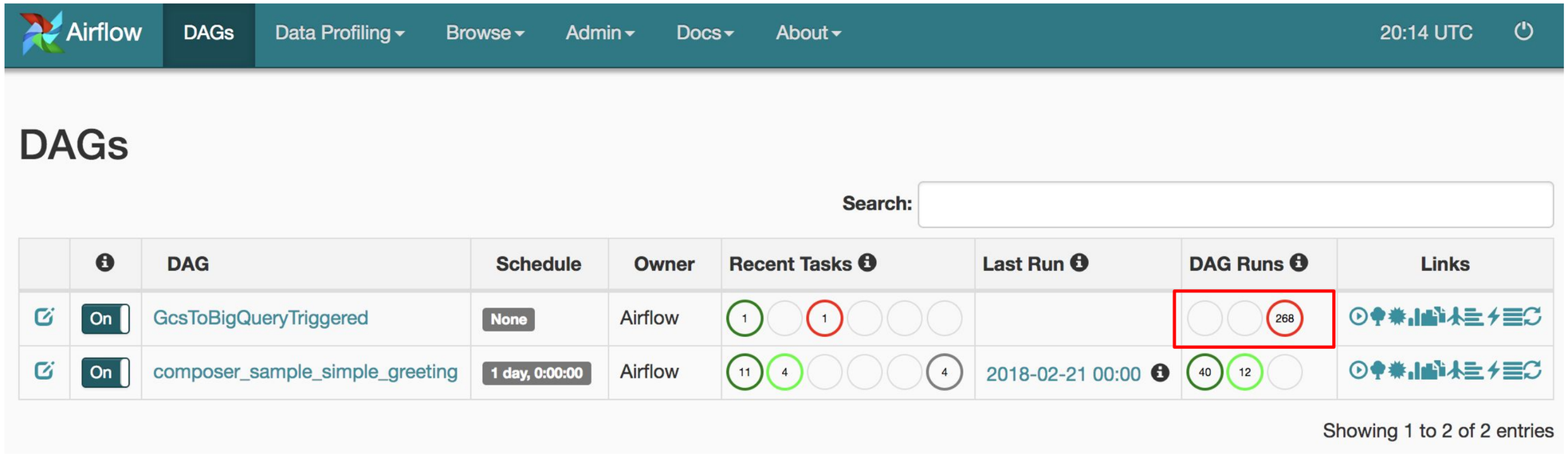
Quickly gauge pipeline health of DAG Runs



Which pipeline is healthier?

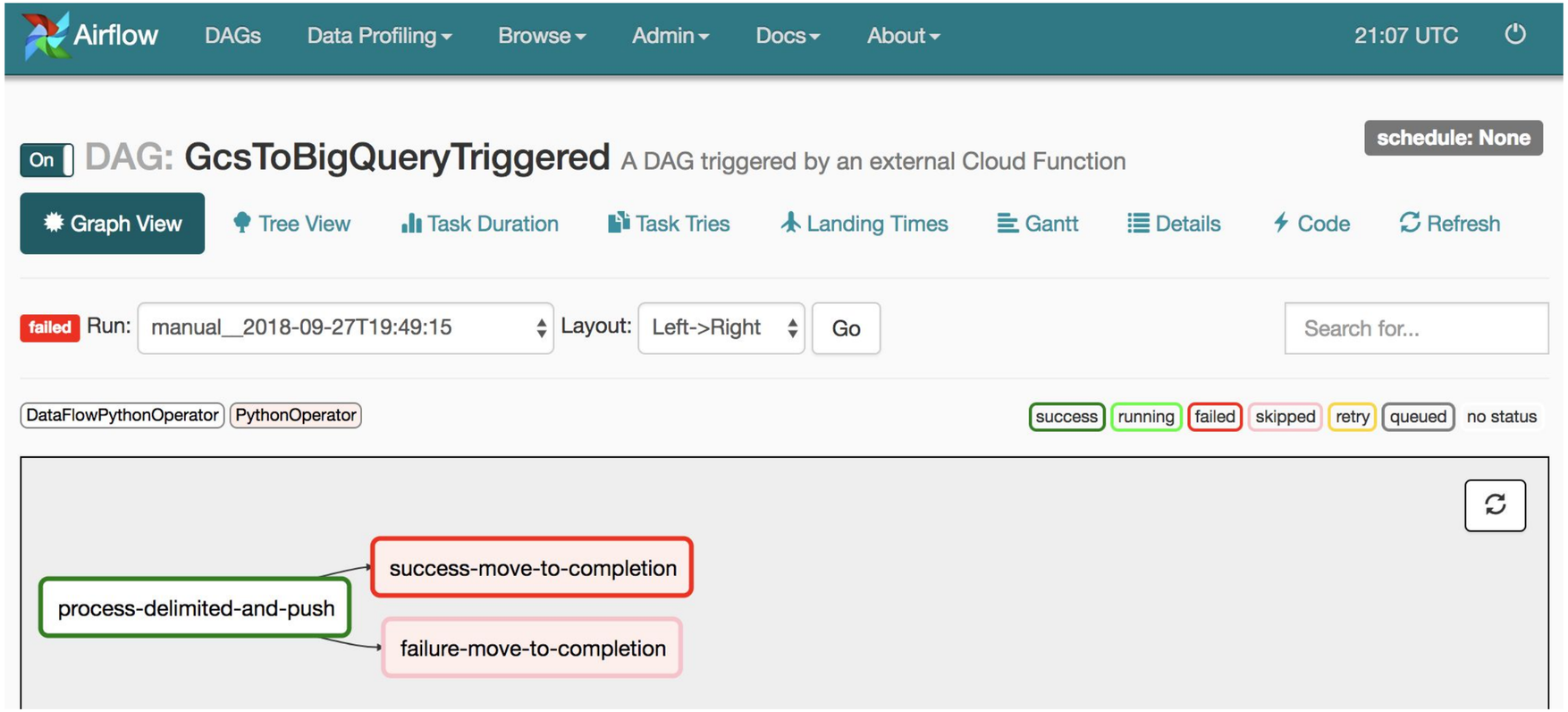
Google Cloud

Quickly gauge pipeline health of DAG Runs



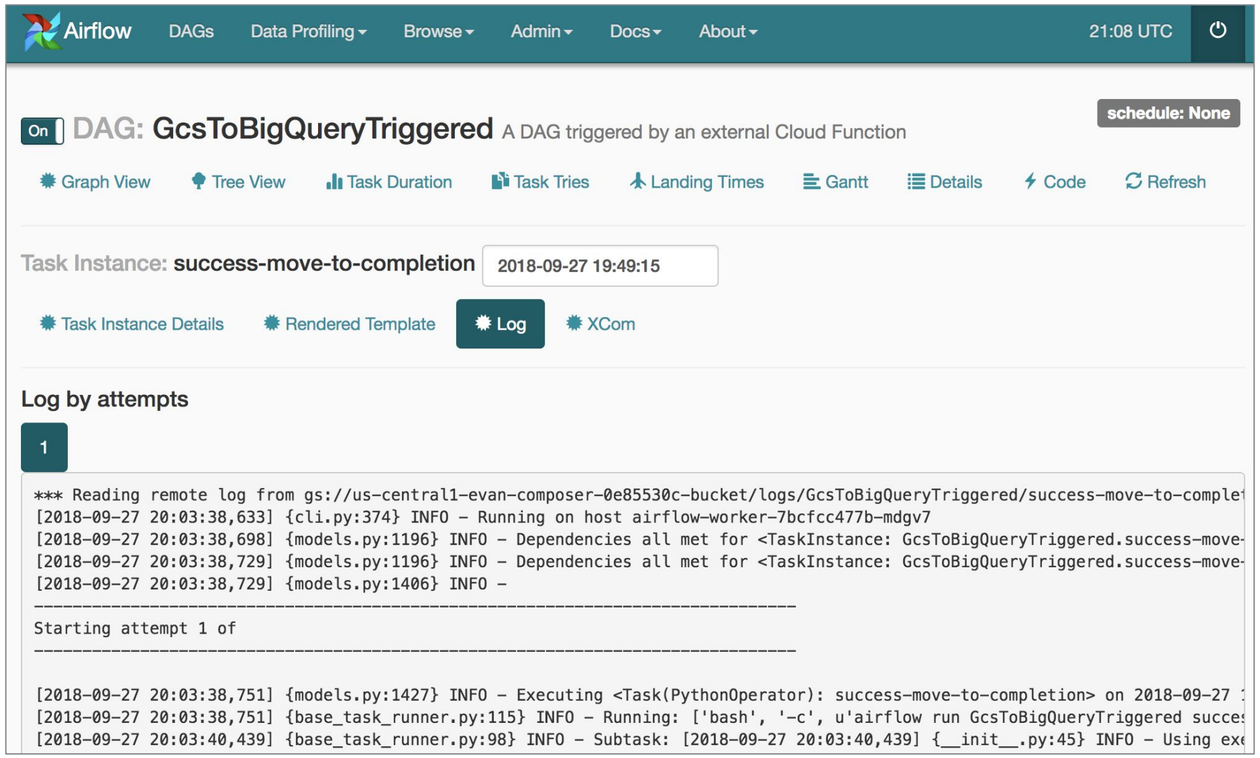
Google Cloud

Quickly gauge pipeline health of DAG Runs



Google Cloud

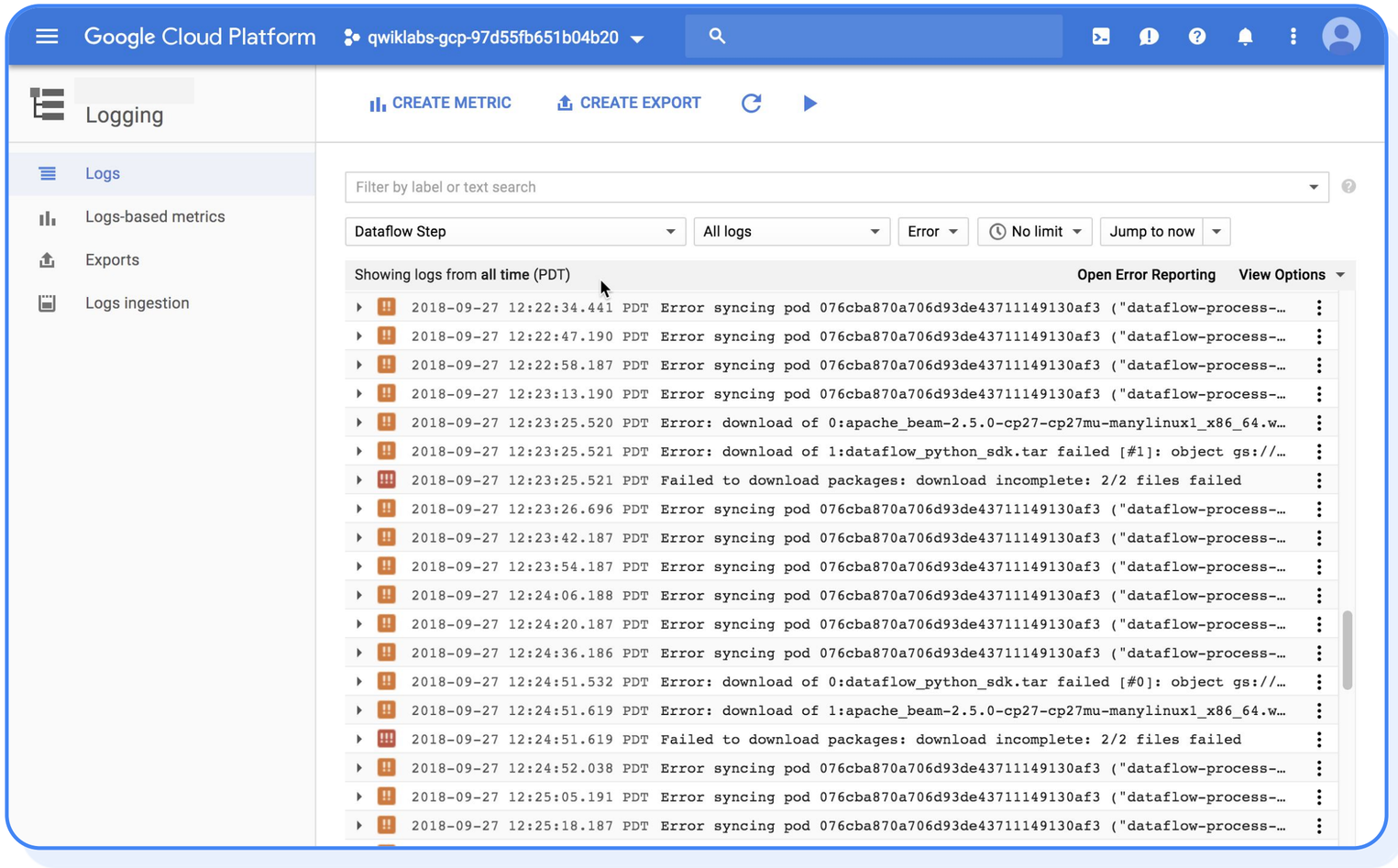
Monitor and troubleshoot Airflow step errors in logs



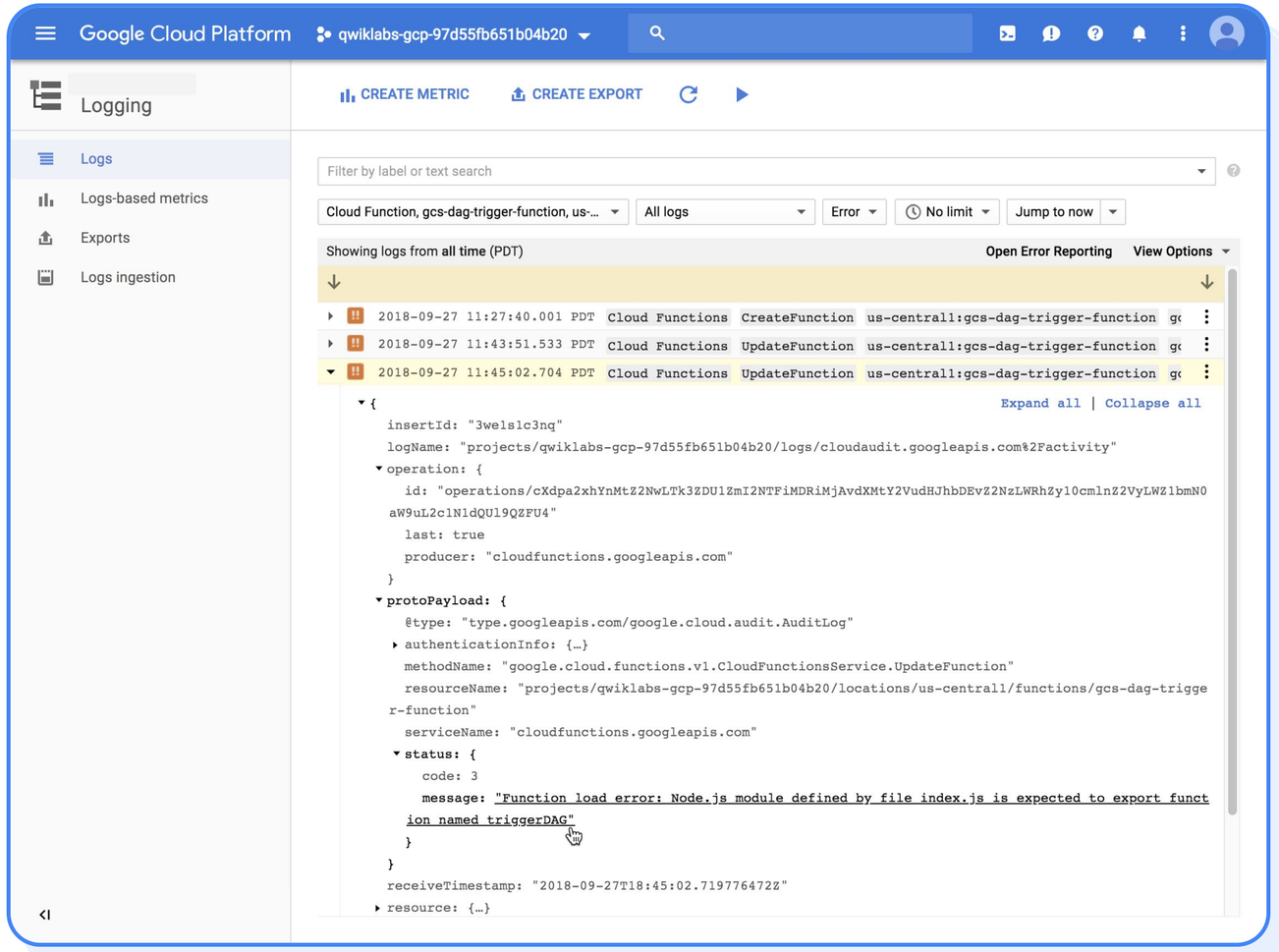

```
errors.HttpError: <HttpError 400 when requesting
https://www.googleapis.com/storage/v1/b/input-bucket-999/o/usa_names.csv/copyTo/b/gs%3A%2F%2Foutput-bucket-999
%2F/o/success%2F2018-09-27%2Fusa_names.csv?alt=json returned "Invalid bucket name: 'gs://output-bucket-999/'">
```

Google Cloud

Monitor Dataflow health in Cloud Logging



Monitor Cloud Function health in Cloud Logging



Google Cloud

Lab

An Introduction to Cloud Composer

Objectives

- Use GCP Console to create a Cloud Composer environment
- View and run a DAG in the Airflow web interface
- View the results of the wordcount job in storage

Module Summary

Cloud Data Fusion for building data pipelines.

Cloud Composer, Cloud Functions and Cloud Scheduler are the glue for your data pipelines.