

Improving the Airflow User Experience



Speakers



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Founder/CTO at Astronomer



@rywalker



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Head of Field Engineering
at Astronomer



@vmpvmp94



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Founder/CEO of Preset, Creator of
Apache Airflow and Apache Superset



@mistercrunch

About Astronomer



Astronomer is focused on helping organizations adopt Apache Airflow, the open-source standard for data pipeline orchestration.

Products



Locations

San Francisco

London

New York

Cincinnati

Hyderabad

100+

Enterprise customers around the world

4 of top 7

Airflow committers are Astronomer advisors or employees

Investors



Frontline



7 Stages of Airflow User Experience





Current

LDAP authentication

Kerberos (w/ some operators)

Fernet key encryption

External secrets backend

CVE Mitigations

RBAC

- Astronomer has multi-tenant RBAC solution built in





astronomer-fab-securitymanager

A custom Flask-AppBuilder security manager for use with [Apache Airflow](#) inside the [Astronomer Platform](#).

Data Science

← Users

User Details

Name

Email

Joined

07/08/20

Workspace Role

Viewer

Editor

Admin

Update User

Cancel

Remove User

will be removed from the workspace.

Remove User



Current

LDAP authentication

Kerberos (w/ some operators)

Fernet key encryption

External secrets backend

CVE Mitigations

RBAC

- Astronomer has multi-tenant RBAC solution built in

Future

Data lineage

Audit logs

Integration with external identity providers (Auth0, Okta, Ping, SAML)



Current

Your Text Editor + Python
environment

Astronomer CLI

Community Projects

- [DagFactory](#) (DevotedHealth)
- [Airflow DAG Creation Manager Plugin](#)
- [Kedro](#)

git pull

code .

```
with DAG('covid_data_to_s3',
        start_date=datetime(2020, 3, 1),
        max_active_runs=1,
        schedule_interval='@daily',
        default_args=default_args,
        catchup=False # enable if you don't want historic
    ) as dag:
```

```
t0 = DummyOperator(task_id='start')
```

```
for endpoint in endpoints:
    generate_files = PythonOperator(
        task_id='generate_file_{0}'.format(endpoint),
        python_callable=upload_to_s3,
        op_kwargs={'endpoint': endpoint, 'date': date}
    )
```

```
t0 >> generate_files
```



virajparekh@orbiter:~/Code/Astronomer/airflow-covid-data\$



I

dag-factory



dag-factory is a library for dynamically generating [Apache Airflow](#) DAGs from YAML configuration files.

<https://github.com/ajbosco/dag-factory>



dag-factory



dag-factory is a library for dynamically generating [Apache Airflow](#) DAGs from YAML configuration files.

Define a DAG with YAML

```
example_dag1:
  default_args:
    owner: 'example_owner'
    start_date: 2018-01-01 # or '2 days'
    end_date: 2018-01-05
    retries: 1
    retry_delay_sec: 300
  schedule_interval: '0 3 * * *'
  concurrency: 1
  max_active_runs: 1
  dagrun_timeout_sec: 60
  default_view: 'tree' # or 'graph', 'duration', 'gantt', 'landing_times'
  orientation: 'LR' # or 'TB', 'RL', 'BT'
  description: 'this is an example dag!'
  on_success_callback_name: print_hello
  on_success_callback_file: /usr/local/airflow/dags/print_hello.py
  on_failure_callback_name: print_hello
  on_failure_callback_file: /usr/local/airflow/dags/print_hello.py
  tasks:
```

dag-factory



dag-factory is a library for dynamically generating [Apache Airflow](#) DAGs from YAML configuration files.

Parse the YAML

```
from airflow import DAG
import dagfactory
```

```
dag_factory = dagfactory.DagFactory("/path/to/dags/config_file.yml")
```


```
dag_factory.clean_dags(globals())
dag_factory.generate_dags(globals())
```

Define a DAG with YAML

```
example_dag1:
  default_args:
    owner: 'example_owner'
    start_date: 2018-01-01 # or '2 days'
    end_date: 2018-01-05
    retries: 1
    retry_delay_sec: 300
  schedule_interval: '0 3 * * *'
  concurrency: 1
  max_active_runs: 1
  dagrun_timeout_sec: 60
  default_view: 'tree' # or 'graph', 'duration', 'gantt', 'landing_times'
  orientation: 'LR' # or 'TB', 'RL', 'BT'
  description: 'this is an example dag!'
  on_success_callback_name: print_hello
  on_success_callback_file: /usr/local/airflow/dags/print_hello.py
  on_failure_callback_name: print_hello
  on_failure_callback_file: /usr/local/airflow/dags/print_hello.py
```

....and you have a DAG!



 Airflow

[DAGs](#) [Data Profiling](#) [Browse](#) [Admin](#) [Docs](#) [About](#)

☐ Off

DAG: example_dag this is an example dag

 Graph View

 Tree View

 Task Duration

 Task Tries

 Landing Times

 Gantt

 Details

 Code

 Refresh

None

Base date: Number of runs: Run: Layout:

BashOperator



```
graph LR; task_1 --> task_2; task_1 --> task_3;
```



Airflow DAG Creation Manager Plugin

Description

A plugin for [Apache Airflow](#) that create and manage your DAG with web UI.

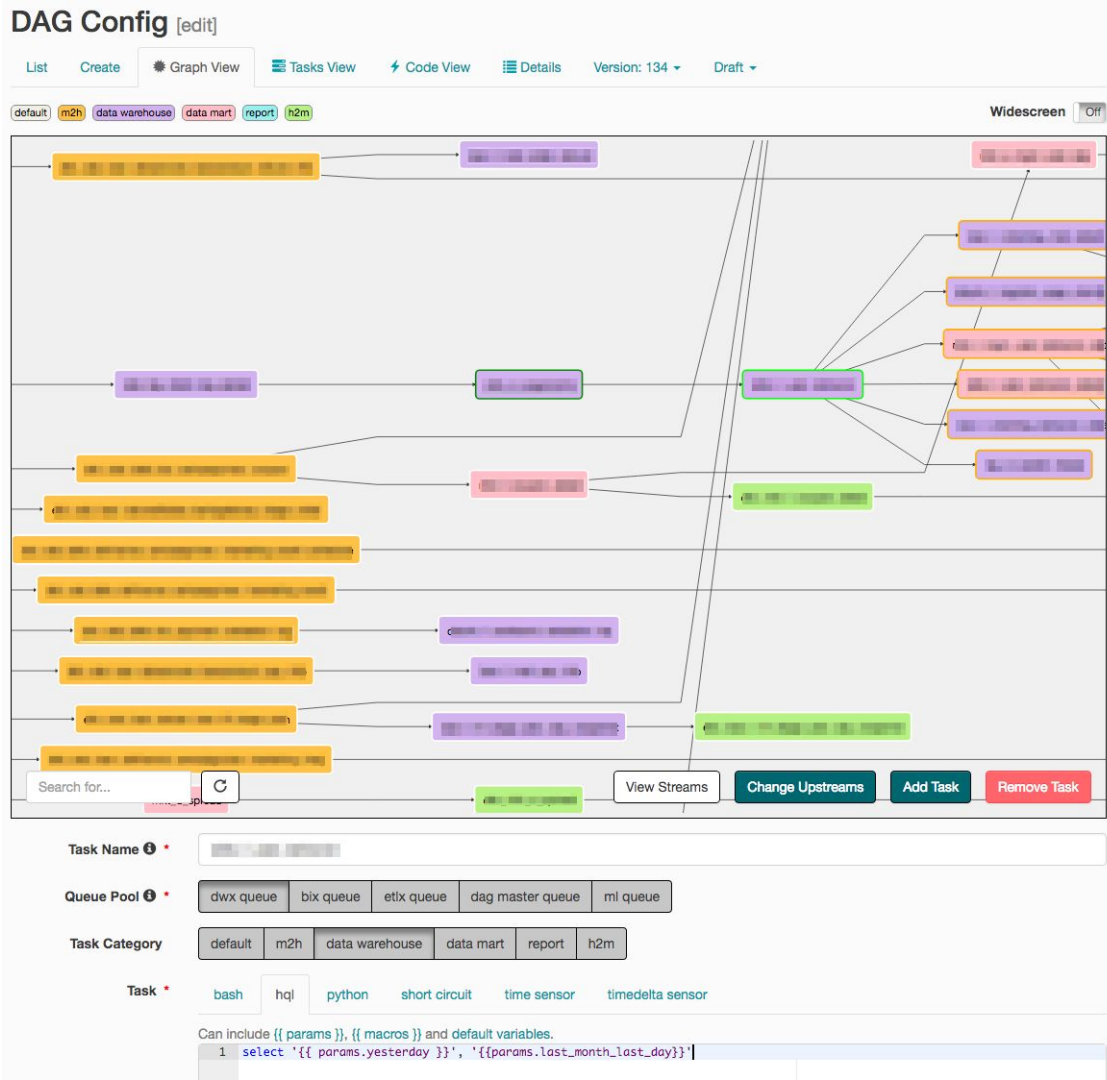
<https://github.com/lattebank/airflow-dag-creation-manager-plugin>

Airflow DAG Creation Manager Plugin

Description

A plugin for [Apache Airflow](#) that create and manage your DAG with web UI.

Create and
manage DAGS
directly from
the UI





Author

Build

Test

Deploy

Run

Monitor

Security /
Governance

Current

Your Text Editor + Python
environment

Astronomer CLI

Community Projects

- DagFactory (DevotedHealth)
- Airflow DAG Creation Manager
Plugin
- Kedro

Future

DAGs from Notebooks

Scheduling SQL query from UI

DAG Generator from standard
templates



Current

Most users git-sync DAGs, add prod dependencies manually

Official Community Docker Image

Astronomer is Docker-centric

- Define dependencies (both (Python packages + system-level packages) directly in your code project
- Run the image locally with Docker
- Reduces devOps workload, since data engineers trial and error dependencies locally
- Can run the whole image through CVE testing

```
virajparekh@orbiter:~/Code/Astronomer/airflow-covid-data$
```





Current

No standardization around DAG unit testing

Adhoc testing for different data scenarios

Community Projects:

- [Raybeam Status Plugin](#)
- [Great Expectations Pipeline Tutorial](#)

Raybeam Status Plugin



Data confidence plugin for Airflow.


The Status Airflow plugin makes it easy to communicate confidence about your data system to manager, executives and other stakeholders in your organization. It improves trust in underlying data by increasing transparency.

https://github.com/Raybeam/rb_status_plugin








Is the data ready?


 Airflow


DAGs

 Security ▾

 Browse ▾


 Admin ▾

 Docs ▾

 About ▾

Status ▾

2020-05-29, 22:52:19 UTC


 admin user ▾

No reports have run yet!

Don't worry, here's some steps for creating a new report:

- Create a new **report**.
- Turn on the new report on the **reports** page.
- Run the new report **manually** or let it run naturally on the schedule you provided.
- Wait for the report to finish running.
- This status page will now be populated with a new report.

Schedule data quality tasks as reports

Airflow

DAGs

Security

Browse

Admin

Docs

About

Status

2020-05-29, 22:53:30 UTC

admin user

New Report

General

Title

Social channels

Title will be used as the report's name

Description

Data status for social dashboards and marketing optimization model

Owner Name

Anne A. List

Owner Email


analyst@example.com

Owner email will be added to the subscribers list

Subscribers

manager@example.com

List of comma separated emails that should receive email notifications. Automatically adds owner email to this list.

Airflow

DAGs

Security

Browse

Admin

Docs

About









Status

2020-06-04, 17:17:32 UTC

admin user

Reports

[Create New Report](#)

		Report	Schedule	Tests	Owner	Subscribers	Links
		Data loading report	None	social_channels_dag.load_facebook, social_channels_dag.load_pinterest, social_channels_dag.load_twitter	Data	data@starship-enterprise.com	 
		Social channels	None	social_channels_dag.test_correlations, social_channels_dag.test_model_boundaries, social_channels_dag.test_new_records	Anne A. List	bbriski@raybeam.com	 

Some Tests Are Failing

Updated Jun 04 at 17:27

Reports



Failed / Updated Jun 04 at 17:27

Data loading report

Details ^

Report Owner: Data bbriski@raybeam.com

Description: Status of all data loads from external partners

Subscribers: bbriski@raybeam.com

Failed:

- * test_social_channels_dag.load_facebook



Passed / Updated May 29 at 23:08

Social channels

Details v

Keep stakeholders
aware of data
quality



Some Tests Are Failing

Updated Jun 04 at 17:27

Reports



Failed / Updated Jun 04 at 17:27

Data loading report

Details ^

Report Owner: Data bbriski@raybeam.com

Description: Status of all data loads from external partners

Subscribers: bbriski@raybeam.com

Failed:

- test_social_channels_dag.load_facebook



Passed / Updated May 29 at 23:08

Social channels

Details v

Hooks into existing Airflow functionality

Keep stakeholders aware of data quality

[Failed] Data loading report

Inbox x



via sendgrid.net

10:27 AM (0 minutes ago)



to me v

New status update on the "Data loading report" report you subscribed to



Failed / Updated Jun 04 at 17:27

Data loading report

Details

This report was generated by rb status
© 1997 - 2020 Raybeam, Inc. All Rights Reserved

Reply

Forward



Current

No standardization around DAG unit testing

Adhoc testing for different data scenarios

Community Projects:

- [Raybeam Status Plugin](#)
- [Great Expectations Pipeline Tutorial](#)

Future

Data awareness?

Standardized best practices for DAG unit testing

Additional automated testing of Hooks and Operators



Current

Most Airflow deployments are pets,
not cattle — manually deployed

“Guess and check” for configurations

The Astronomer Way

- Use Kubernetes!
- Airflow now has an official Helm chart
- Astronomer platform makes it easy to CRUD Airflow deployments



github.com/apache/airflow/tree/master/chart

Official Helm Chart for Apache Airflow

This chart will bootstrap an [Airflow](#) deployment on a [Kubernetes](#) cluster using the [Helm](#) package manager.

Prerequisites

- Kubernetes 1.12+ cluster
- Helm 2.11+ or Helm 3.0+
- PV provisioner support in the underlying infrastructure

```
## from the chart directory of the airflow repo
kubectl create namespace airflow
helm repo add stable https://kubernetes-charts.storage.googleapis.com
helm dep update
helm install airflow . --namespace airflow
```

uid
gid
nodeSelector
affinity
tolerations
labels
privateRegistry.enabled
privateRegistry.repository
networkPolicies.enabled
airflowHome
rbacEnabled
executor
allowPodLaunching
defaultAirflowRepository
defaultAirflowTag
images.airflow.repository
images.airflow.tag
images.airflow.pullPolicy
images.flower.repository
images.flower.tag
images.flower.pullPolicy
images.statsd.repository
images.statsd.tag
images.statsd.pullPolicy
images.redis.repository
images.redis.tag

images.redis.pullPolicy
images.pgouncer.repository
images.pgouncer.tag
images.pgouncer.pullPolicy
images.pgouncerExporter.repository
images.pgouncerExporter.tag
images.pgouncerExporter.pullPolicy
env
secret
data.metadataSecretName
data.resultBackendSecretName
data.metadataConnection
data.resultBackendConnection
fernetKey
fernetKeySecretName
workers.replicas
workers.keda.enabled
workers.keda.pollingInterval
workers.keda.cooldownPeriod
workers.keda.maxReplicaCount
workers.persistence.enabled
workers.persistence.size
workers.persistence.storageClassName
workers.resources.limits.cpu
workers.resources.limits.memory
workers.resources.requests.cpu
workers.resources.requests.memory

workers.terminationGracePeriodSeconds
workers.safeToEvict
scheduler.podDisruptionBudget.enabled
scheduler.podDisruptionBudget.config.maxUnavailable
scheduler.resources.limits.cpu
scheduler.resources.limits.memory
scheduler.resources.requests.cpu
scheduler.resources.requests.memory
scheduler.airflowLocalSettings
scheduler.safeToEvict
webserver.livenessProbe.initialDelaySeconds
webserver.livenessProbe.timeoutSeconds
webserver.livenessProbe.failureThreshold
webserver.livenessProbe.periodSeconds
webserver.readinessProbe.initialDelaySeconds
webserver.readinessProbe.timeoutSeconds
webserver.readinessProbe.failureThreshold
webserver.readinessProbe.periodSeconds
webserver.replicas
webserver.resources.limits.cpu
webserver.resources.limits.memory
webserver.resources.requests.cpu
webserver.resources.requests.memory
webserver.defaultUser
dags.persistence.*
dags.gitSync.*





```
helm install airflow-ry . --namespace airflow-ry
```

```
NAME: airflow-ry
LAST DEPLOYED: Wed Jul  8 20:10:29 2020
NAMESPACE: airflow-ry
STATUS: deployed
REVISION: 1
```

You can now access your dashboard(s) by executing the following command(s) and visiting the corresponding port at localhost in your browser:

Airflow dashboard: `kubectl port-forward svc/airflow-ry-webserver 8080:8080 --namespace airflow`

```
kubectl get pods --namespace airflow-ry
```

NAME	READY	STATUS	RESTARTS	AGE
airflow-ry-postgresql-0	1/1	Running	0	6m45s
airflow-ry-scheduler-78757cd557-t8zdn	2/2	Running	0	6m45s
airflow-ry-statsd-5c889cc6b6-jxhzw	1/1	Running	0	6m45s
airflow-ry-webserver-59d79b9955-7sgp5	1/1	Running	0	6m45s



```
astro deployment create test-deployment --executor celery
```

NAME	DEPLOYMENT NAME	ASTRO	DEPLOYMENT ID
test-deployment	theoretical-element-5806	0.15.2	ckce1ssco4uf90j16a5adkel7

Successfully created deployment with Celery executor. Deployment can be accessed at the following URLs

Airflow Dashboard: <https://deployments.astronomer.io/theoretical-element-5806/airflow>

Flower Dashboard: <https://deployments.astronomer.io/theoretical-element-5806/flower>

```
astro deployment delete ckce1ssco4uf90j16a5adkel7
```

Successfully deleted deployment

Execution Environment

Executor ⓘ

Kubernetes

Celery

Local

Worker Count ⓘ

1

Worker Resources ⓘ

20

AU

2 CPU

7.5 GB memory

\$200/mo

Worker Termination Grace Period ⓘ

10

min

Extra Capacity ⓘ

0

AU

0 CPU

0 memory

Only necessary to run the KubernetesPodOperator (minimum 10AU).

Core Resources

Webserver ⓘ

9

AU

0.9 CPU

3.38 GB memory

\$90/mo

Scheduler ⓘ

9

AU

0.9 CPU

3.38 GB memory

\$90/mo



airflow.cfg name	Environment Variable	Default Value
parallelism	AIRFLOW__CORE__PARALLELISM	32
dag_concurrency	AIRFLOW__CORE__DAG_CONCURRENCY	16
worker_concurrency	AIRFLOW__CELERY__WORKER_CONCURRENCY	16
max_threads	AIRFLOW__SCHEDULER__MAX_THREADS	2

parallelism is the max number of task instances that can run concurrently on airflow. This means that across all running DAGs, no more than 32 tasks will run at one time.

dag_concurrency is the number of task instances allowed to run concurrently within a *specific dag*. In other words, you could have 2 DAGs running 16 tasks each in parallel, but a single DAG with 50 tasks would also only run 16 tasks - not 32

These are the main two settings that can be tweaked to fix the common "Why are more tasks not running even after I add workers?"

worker_concurrency is related, but it determines how many tasks a single worker can process. So, if you have 4 workers running at a worker concurrency of 16, you could process up to 64 tasks at once. Configured with the defaults above, however, only 32 would actually run in parallel. (and only 16 if all tasks are in the same DAG)

Pro tip: If you increase worker_concurrency, make sure your worker has enough resources to handle the load. You may need to increase CPU and/or memory on your workers. Note: This setting only impacts the CeleryExecutor



Current

Most Airflow deployments are pets,
not cattle — manually deployed
“Guess and check” for configurations

The Astronomer Way

- Use Kubernetes!
- Airflow now has an official Helm chart
- Astronomer platform makes it easy to CRUD Airflow deployments

Future

Infrastructure and configuration
recommendations to optimize
performance and identify bottlenecks



Current

Most Airflow deployments running on virtual machines

Running in K8s enhances stability, observability, and ability to scale









System Admin

[Open Kibana ↗](#)[Open Grafana ↗](#)**Deployments** 205

Users 1512

← on a single k8s cluster!

 REDACTED celestial-wormhole-4369	Tag: deploy-28 Celery executor	Last updated 06/09/20 Created 09/25/19 >
 REDACTED barren-albedo-0965	Tag: ci-fa3b117570ffadca4f07963a6ac96b0890001d3c Local executor	Last updated 06/09/20 Created 10/15/19 >
 REDACTED boreal-terminator-6336	Tag: ci-0.1.949 Celery executor	Last updated 07/08/20 Created 10/16/19 >
 REDACTED asteroidal-phases-3062	Tag: deploy-21 Celery executor	Last updated 07/06/20 Created 10/21/19 >
 REDACTED planetoidal-perigee-4306	Tag: ci-6b00ab4 Celery executor	Last updated 06/19/20 Created 10/21/19 >
 REDACTED geosynchronous-telescope-1859	Tag: ci-6b00ab4 Celery executor	Last updated 06/22/20 Created 10/21/19 >

Cloud Metrics – Production

[Open Airflow ↗](#)[Open Celery ↗](#)[Settings](#)[Variables 11](#)[Metrics](#)[Logs](#)[Service Accounts 4](#)

Core Container Status ⓘ

flower	celestial-wormhole-4369-flower-dbfd99bb4-8svl5	HEALTHY
metrics-exporter	celestial-wormhole-4369-pgbouncer-5bb5f8b799-khh4l	HEALTHY
pgbouncer	celestial-wormhole-4369-pgbouncer-5bb5f8b799-khh4l	HEALTHY
redis	celestial-wormhole-4369-redis-0	HEALTHY
scheduler	celestial-wormhole-4369-scheduler-697c95478d-4j6d2	HEALTHY
scheduler-gc	celestial-wormhole-4369-scheduler-697c95478d-4j6d2	HEALTHY
statsd	celestial-wormhole-4369-statsd-666dd67fb-d2ljx	HEALTHY
webserver	celestial-wormhole-4369-webserver-855995c54c-fhzfw	HEALTHY
worker	celestial-wormhole-4369-worker-cf77888ff-tbkkf9	HEALTHY

← All this for one celery worker. But it's ready to scale.

Usage Quotas

Pods Usage ⓘ



Using **50%** of 14 pods

CPU Usage ⓘ



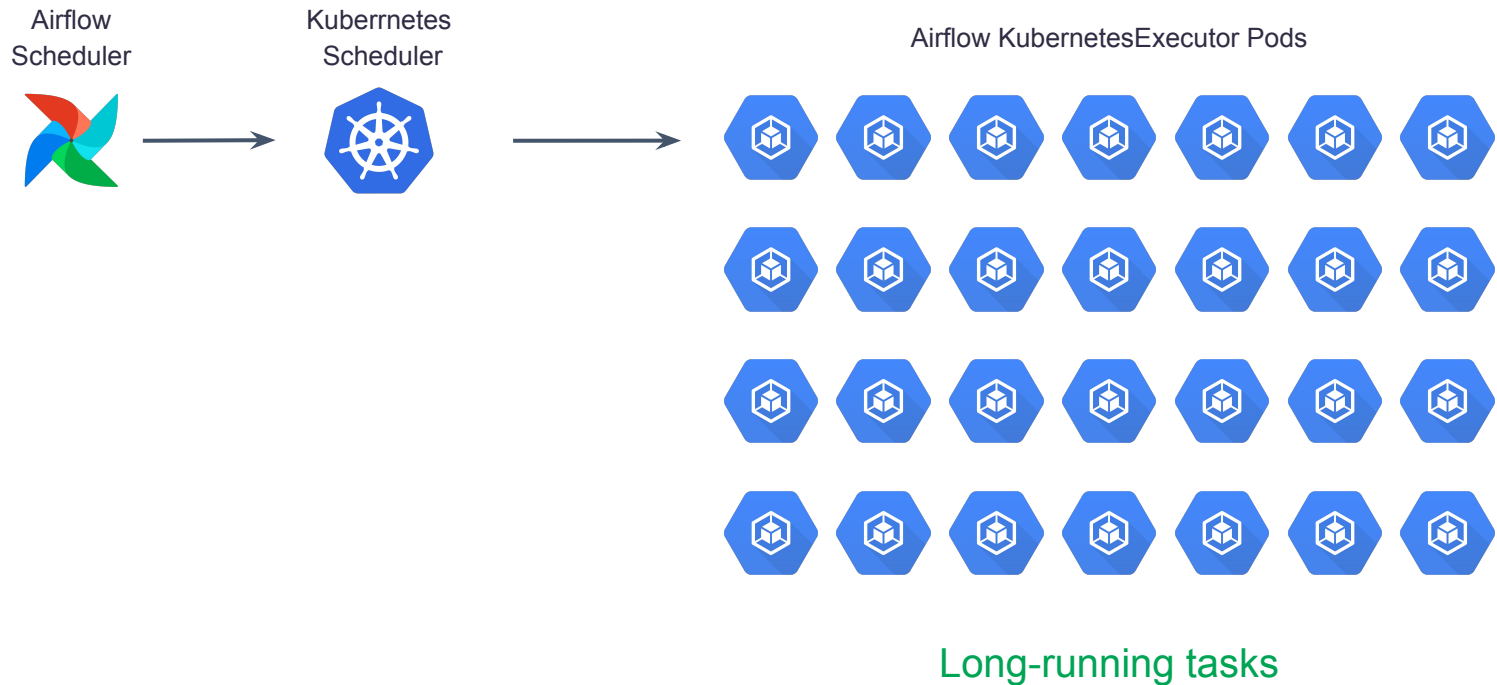
Using **50%** of 15.2 cores

Memory Usage ⓘ

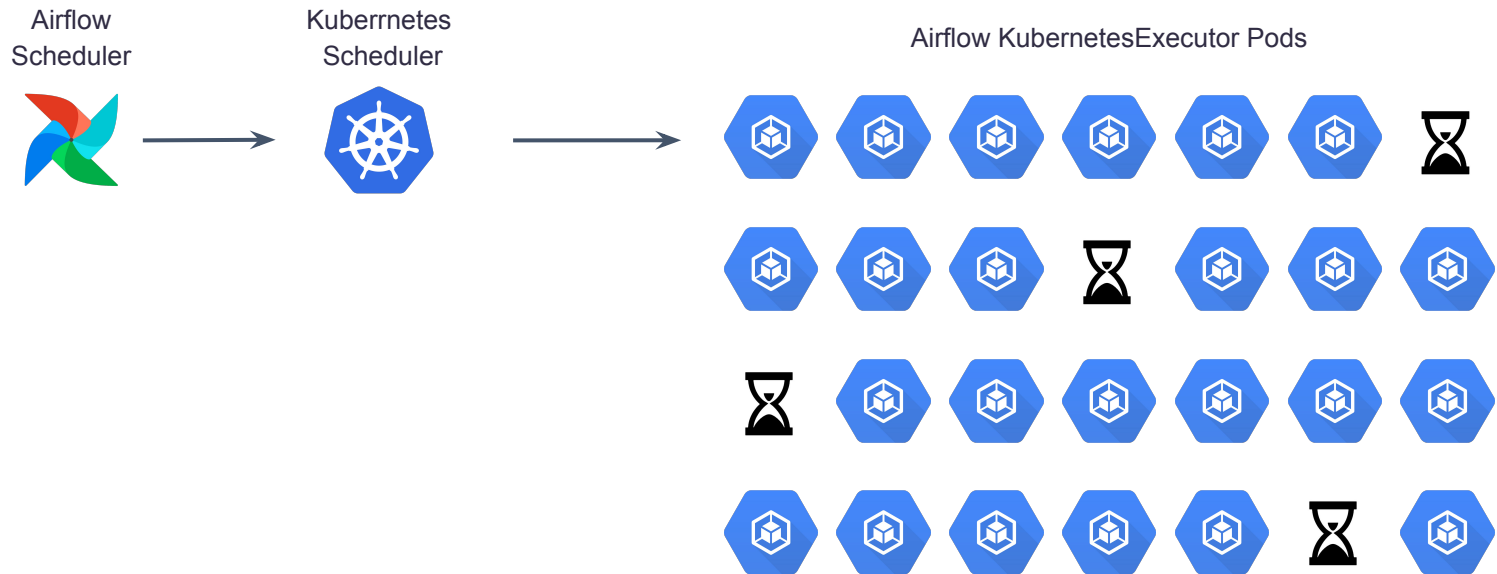


Using **50%** of 39.39 GB

The challenge w/ KubernetesExecutor

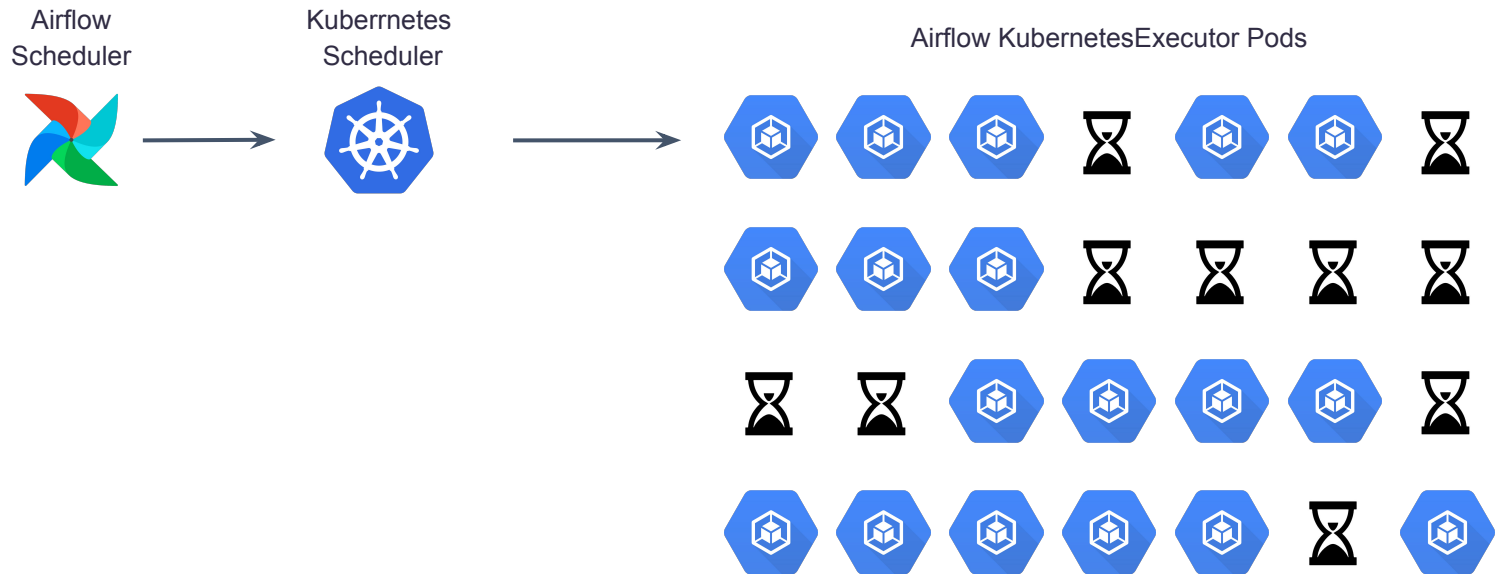


The challenge w/ KubernetesExecutor



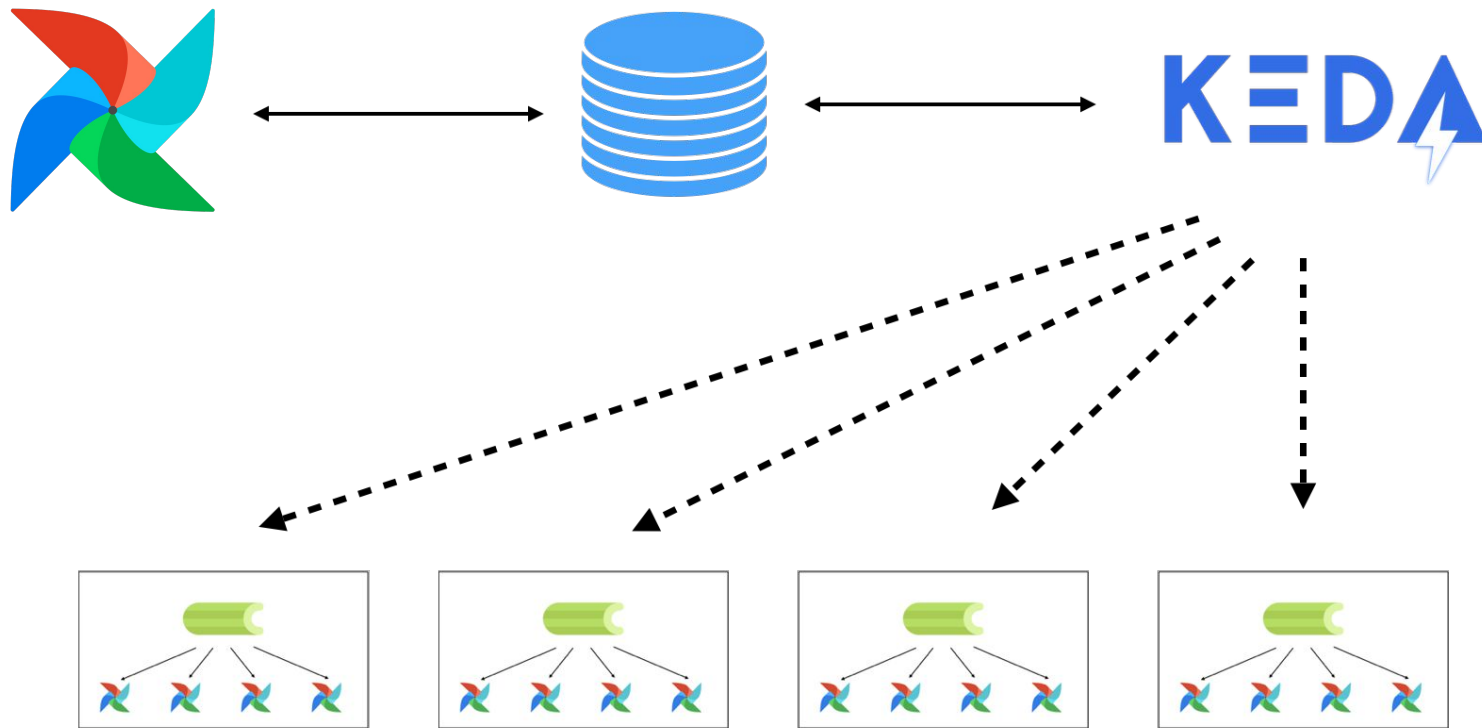
Medium-running tasks

The challenge w/ KubernetesExecutor



Short-running tasks

Celery with KEDA



$\text{CEIL}((20 \text{ RUNNING} + 20 \text{ QUEUED})/16) = 4 \text{ workers}$



Current

Most Airflow deployments running on virtual machines

Running in K8s enhances stability, observability, and ability to scale

Future

Highly Available Scheduler

“Fastfollow” task scheduling





Airflow
Scheduler

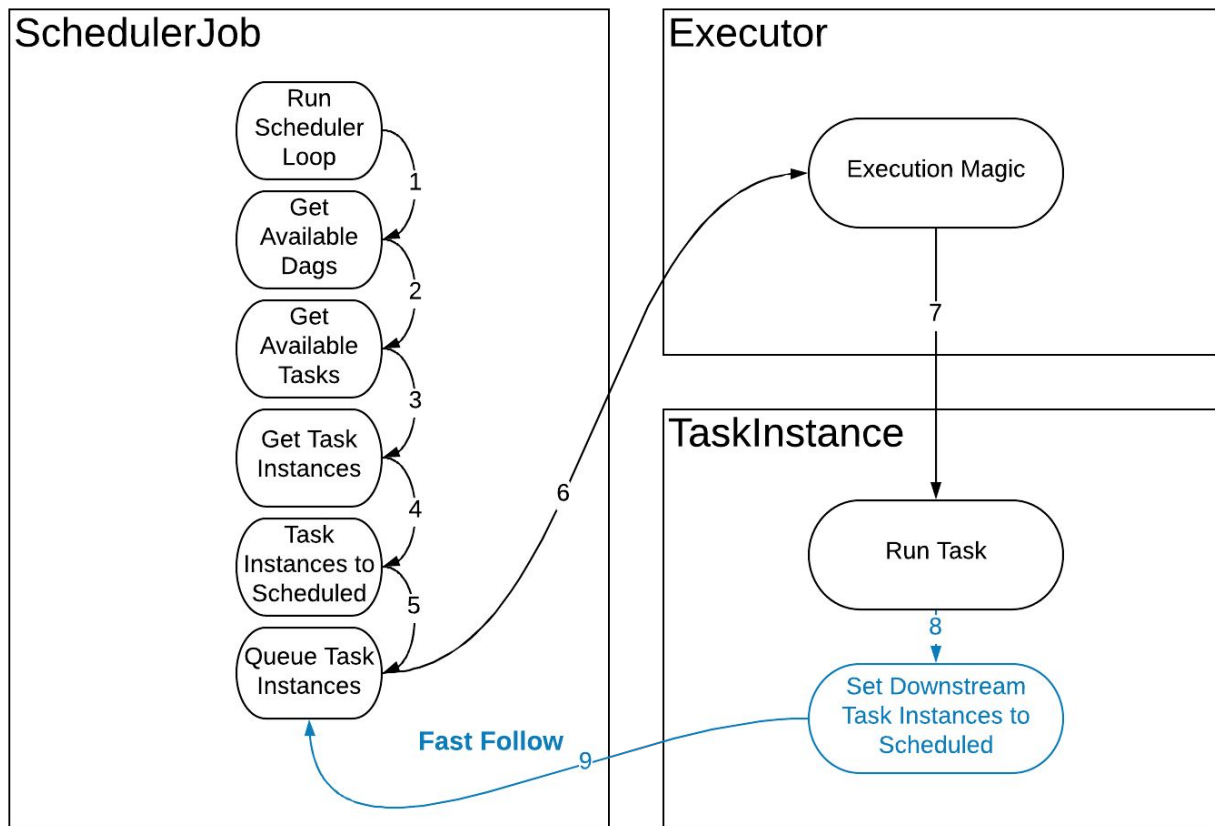


Airflow
Scheduler



...

Fast follow





Current

Airflow built-in dashboards based on task metadata

Airflow native statsd exporter offers deeper metrics



Cumulative Duration ☐

Base date:

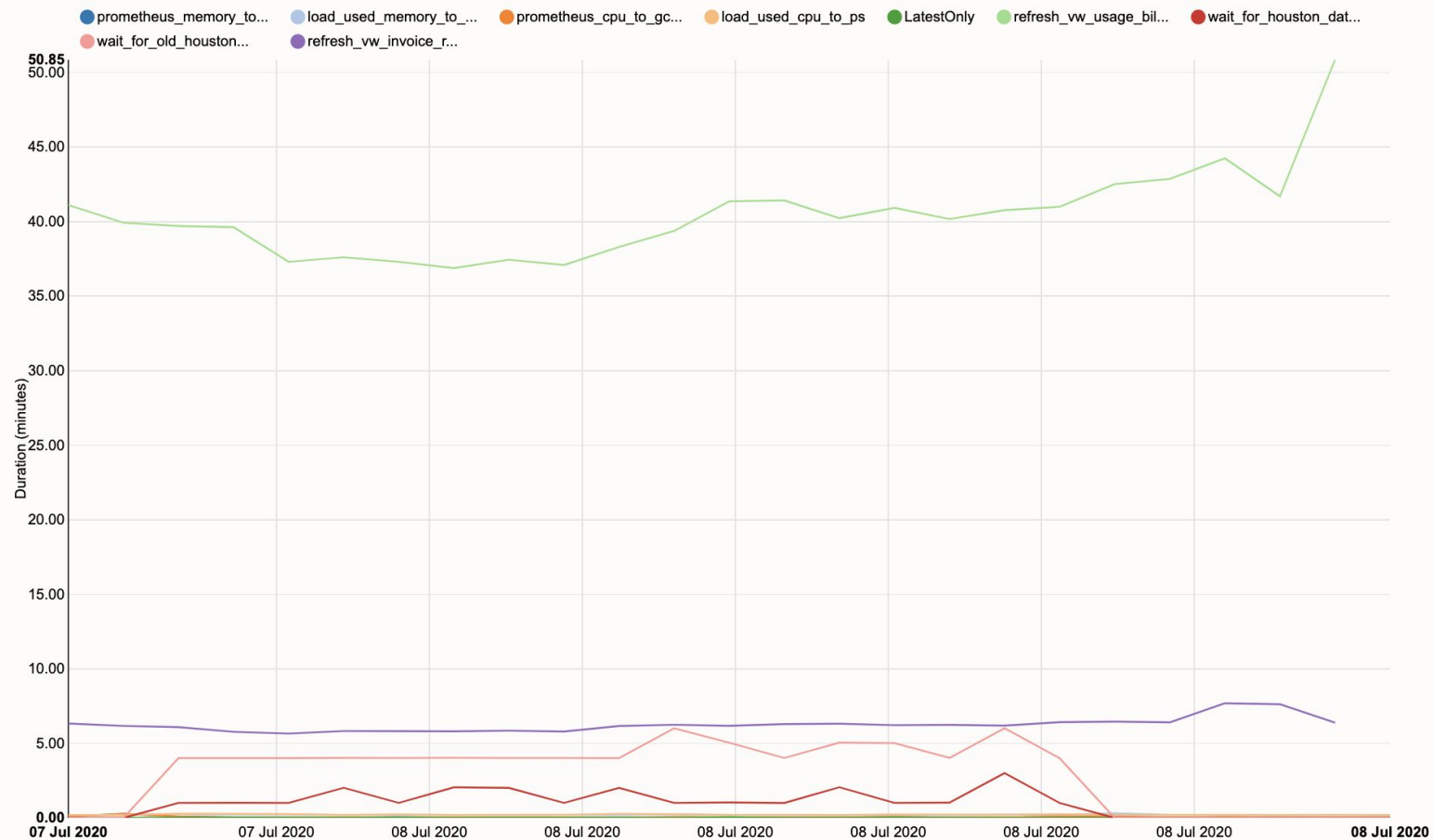


2020-07-09 00:00:00

Number of runs:

25

Go





Counters

<job_name>_start
<job_name>_end
operator_failures_<operator_name>
operator_successes_<operator_name>
ti_failures
ti_successes
zombies_killed
scheduler_heartbeat
dag_processing.processes
scheduler.tasks.killed_externally

Timers

dagrun.dependency-check.<dag_id>
dag.<dag_id>.<task_id>.duration
dag_processing.last_duration.<dag_file>
dagrun.duration.success.<dag_id>
dagrun.duration.failed.<dag_id>
dagrun.schedule_delay.<dag_id>

Gauges

dagbag_size
dag_processing.import_errors
dag_processing.total_parse_time
dag_processing.last_runtime.<dag_file>
dag_processing.last_run.seconds_ago.<dag_file>
dag_processing.processor_timeouts
executor.open_slots
executor.queued_tasks
executor.running_tasks
pool.open_slots.<pool_name>
pool.used_slots.<pool_name>
pool.starving_tasks.<pool_name>

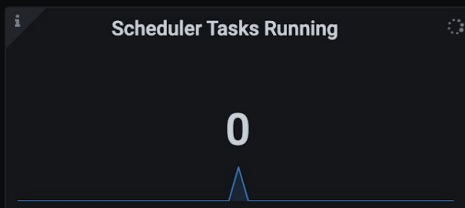
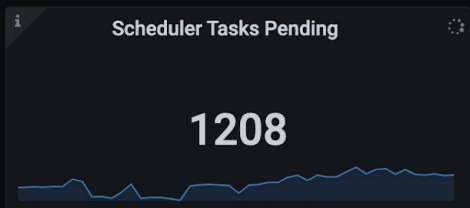
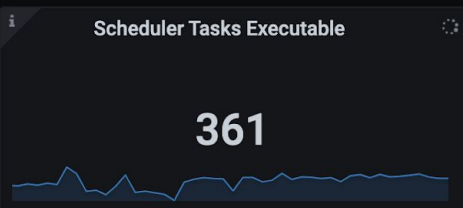
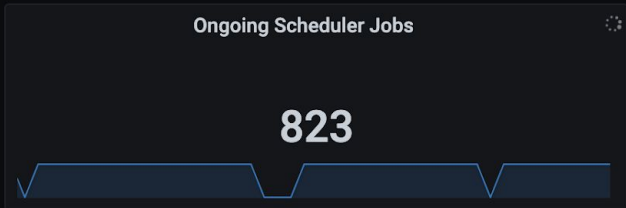
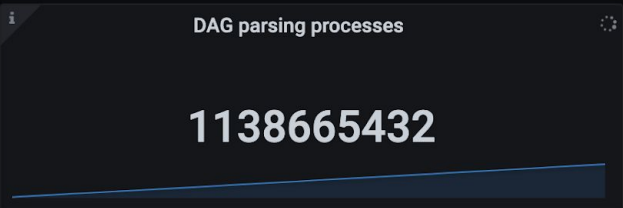
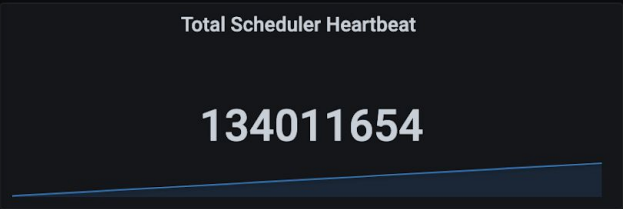


STATSD

Airflow Database Activity	airflow	Fluentd	fluentd	platform
Airflow Deployment Overview	airflow	Istio Dashboard		
Airflow Resource Utilization	airflow	Istio Performance Dashboard		
Airflow Scheduler	airflow	Kubernetes All Nodes		prometheus
Airflow State	airflow	Kubernetes Pods	airflow	platform
Availability		NGINX Ingress Controller	nginx	platform
Blackbox Exporter Overview	blackbox	Prometheus	platform	prometheus
Docker Registry	platform	registry		
Elasticsearch	elasticsearch	platform		
		Velero		velero



Deployment All





Airflow Overview

Edit Widgets +

1h The Past Hour



Saved Views Scope Shost

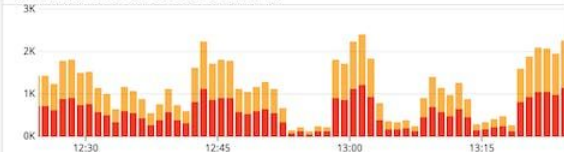


Can Connect

1

Tasks

Task Instances Successes & Failures

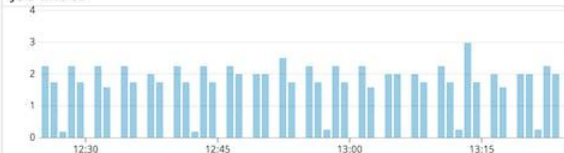


Jobs

Job Started

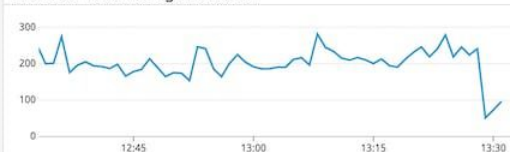


Job Ended

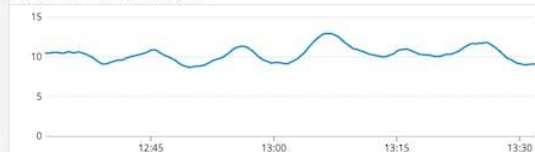


DAGs

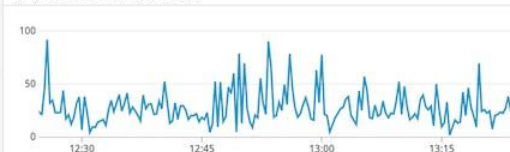
DAG Run Task Average Duration



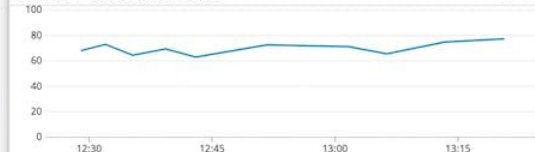
DAG Run Failed Duration



DAG Run Failed Duration



DAG Run Success Duration

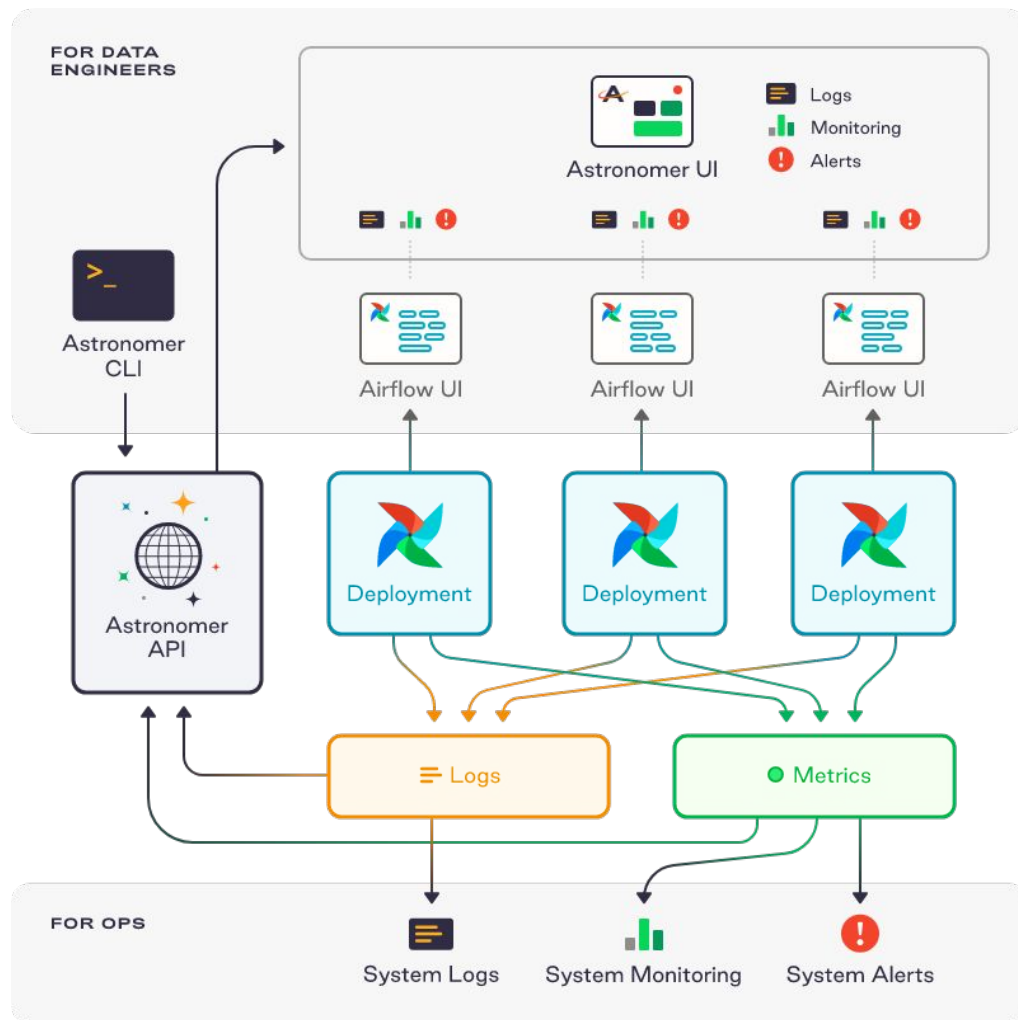


Scheduler

Job Scheduler Heatbeat



Time	_source
> Jul 8, 2020 @ 22:27:13.892	<pre> component: webserver workspace: ck1r2rf4g0ec70902zf5qseb1 release: descriptive-gyroscope-6510 message: 10.0.0.171 - - [09/Jul/2020:02:27:13 +0000] "GET /descriptive-gyroscope-6510/airflow/health HTTP/1.1" 200 187 "-" "kube-probe/1.14+" @timestamp: Jul 8, 2020 @ 22:27:13.892 _id: zqllMXMBjXxTYBj___N9 _type: _doc _index: fluentd.descriptive-gyroscope- 6510.2020.07.09 _score: - </pre>
> Jul 8, 2020 @ 22:27:13.677	<pre> component: webserver workspace: ck1r1hys70cpk0902v6b5qgob release: asteroidal-crater-4871 message: 127.0.0.1 - - [09/Jul/2020:02:27:13 +0000] "GET /asteroidal-crater-4871/airflow/health HTTP/1.1" 200 187 "-" "kube-probe/1.14+" @timestamp: Jul 8, 2020 @ 22:27:13.677 _id: yallMXMBjXxTYBj___N9 _type: _doc _index: fluentd.asteroidal-crater- 4871.2020.07.09 _score: - </pre>
> Jul 8, 2020 @ 22:27:13.393	<pre> component: webserver workspace: ck34r7f052l2i0a19ncavdl6y release: dynamical-ecliptic-0474 message: 10.0.0.128 - - [09/Jul/2020:02:27:13 +0000] "GET /dynamical-ecliptic-0474/airflow/health HTTP/1.1" 200 187 "-" "kube-probe/1.14+" @timestamp: Jul 8, 2020 @ 22:27:13.393 _id: VWJlMXMBWer-zt3w_-b2 _type: _doc _index: fluentd.dynamical-ecliptic- </pre>





Current

Airflow built-in dashboards based on task metadata

Airflow native statsd exporter offers deeper metrics

Future

Enhance integration options with third party services (Sumologic, Splunk, etc)

Task progress API



Airflow



Task Start



Task Progress



+ “subdag” view

Task Complete



DAG-Based
Execution Engines



DAGSTER

...





Thank You!

Now Q&A