DevotedHealth

From Cron to Apache Airflow

A Startup Story

Adam Boscarino, 2020-07-13

Who am I?

- Data Engineer at Devoted Health
- Previously worked at DigitalOcean, Fitbit, Carbonite
- Airflow user for ~4 years
- GitHub & Twitter: ajbosco

What is Devoted Health?

- A next generation Medicare Advantage health insurer in the United States
- Founded in 2018, first enrolled members in 2019
- Offers a Clinical Services solution (Devoted Medical Group)
- Built on homegrown Devoted Tech Platform

“ TO DRAMATICALLY IMPROVE HEALTHCARE FOR SENIORS IN THE UNITED STATES -- CARING FOR EVERYONE LIKE THEY ARE MEMBERS OF OUR OWN FAMILY ”

Devoted Health Data Platform, January 2019

Source Data	Workflows	Storage/Data Lake	Data Warehouse	Reporting/BI
	`[~]$ crontab`	Amazon S3	amazon REDSHIFT	Periscope Data by Sisense

Devoted Health Data Platform - Successes

- It did its job
- Successfully launched new health plan
- Supported key business operations and workstreams
- Powered all internal reporting

Devoted Health Data Platform - Problems

- No task dependencies
- Undetected system downtime
- Onboarding new developers
- Environment parity
- Unsure of data quality

Devoted Health Data Platform, May 2019

Source Data	Workflows	Storage/Data Lake	Data Warehouse	Reporting/BI
		Amazon S3	snowflake®	Periscope Data by Sisense
	NEW!		NEW!	

Devoted Health Data Platform - Problems

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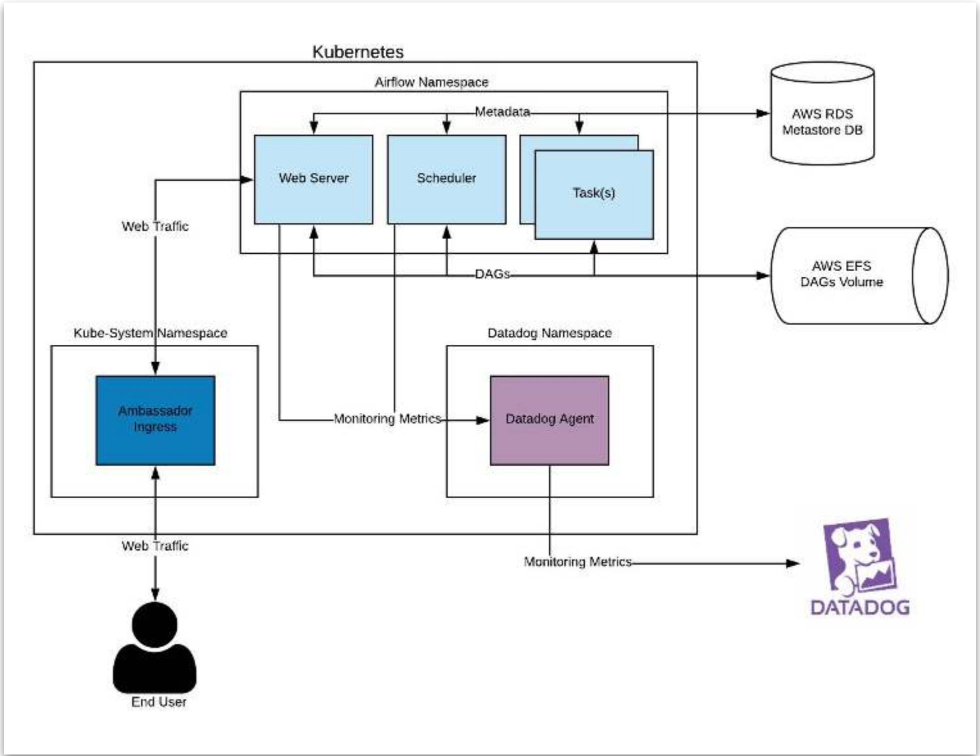
Solution: Deploying Airflow

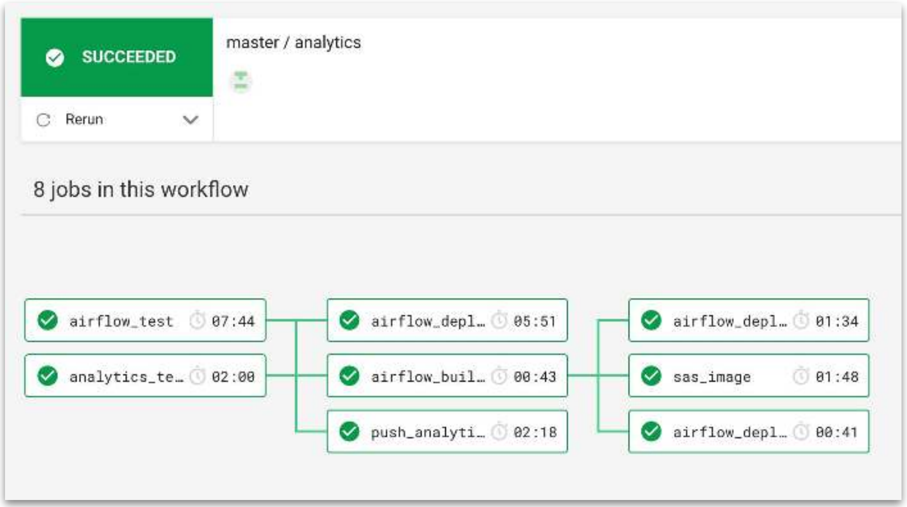
Apache Airflow Deployment

- Kubernetes
  - Orchestrates Airflow services
  - Kubernetes Executor
- Helm
  - Kubernetes Package Manager
  - Describes Kubernetes resources
  - Official Helm Chart
- Terraform
  - Infrastructure as Code
  - Used to deploy Helm chart to Kubernetes clusters



DAG Deployment

- DAGs are stored on AWS EFS
  - Mounted to each Airflow pod in Kubernetes
- DAGs are pushed from GitHub to AWS EFS via CircleCI
  - No manual intervention
  - Many deployments every single day



SUCCEEDED

master / analytics

Rerun

8 jobs in this workflow

Devoted Health Data Platform - Problems

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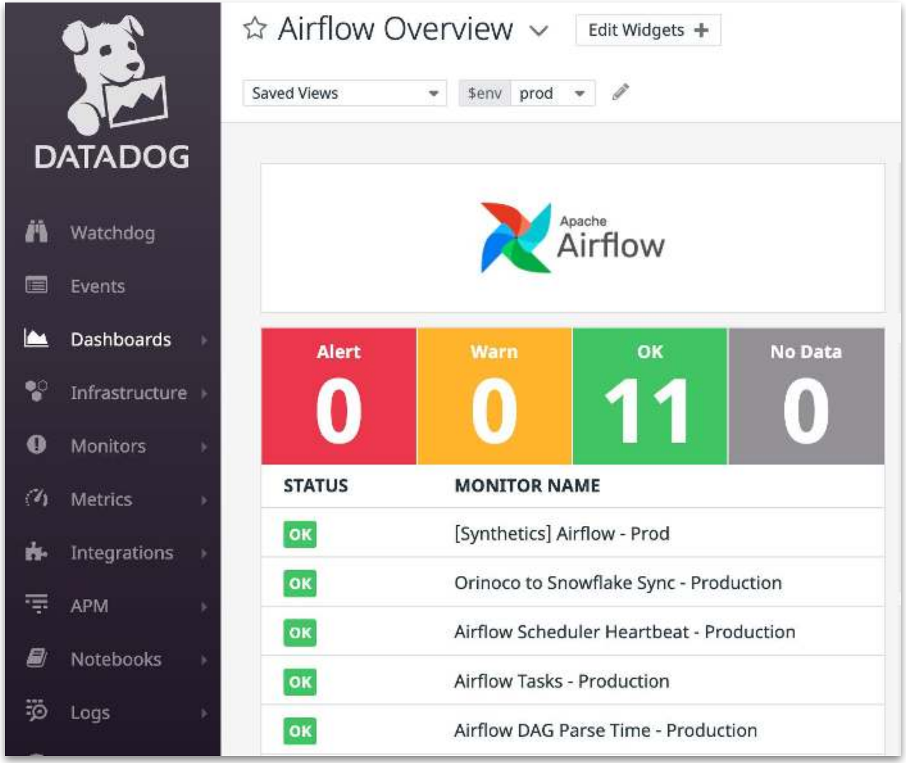
Solution: Monitoring Airflow

Monitoring Airflow

- Kubernetes Liveness & Health Checks
  - Monitor /health endpoint
  - Monitor Scheduler health
  - Restart services if in bad state
- Datadog Monitors
  - Alert on-call engineer via OpsGenie and Slack
  - Airflow is not running
  - No DAGs have completed in last 2 hours
  - CPU/Memory Usage has spiked

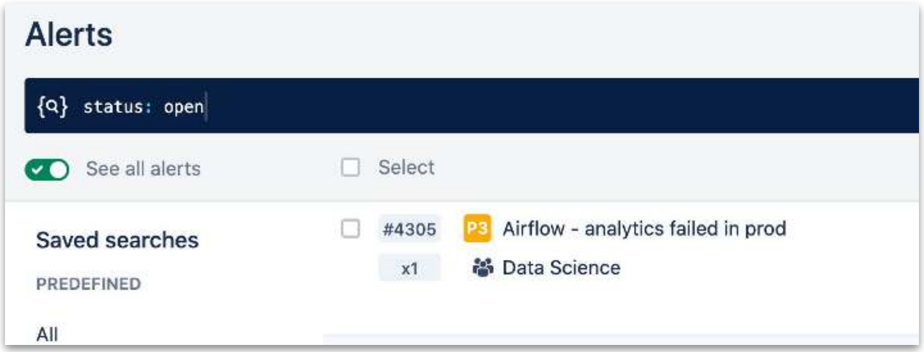


Alert	Warn	OK	No Data
0	0	11	0

STATUS	MONITOR NAME
OK	[Synthetics] Airflow - Prod
OK	Orinoco to Snowflake Sync - Production
OK	Airflow Scheduler Heartbeat - Production
OK	Airflow Tasks - Production
OK	Airflow DAG Parse Time - Production

Monitoring DAGs

- OpsGenie alerts sent to DAG Owner (and Slack)
- DAG owners are responsible for resolving non-infrastructure failures
- Alerting is “built-in” to every DAG



Alerts

{Q} status: open

See all alerts | Select

Saved searches

PREDEFINED

All

#4305 P3 Airflow - analytics failed in prod

x1 Data Science

Devoted Health Data Platform - Problems

- No dependency management
- Undetected system downtime
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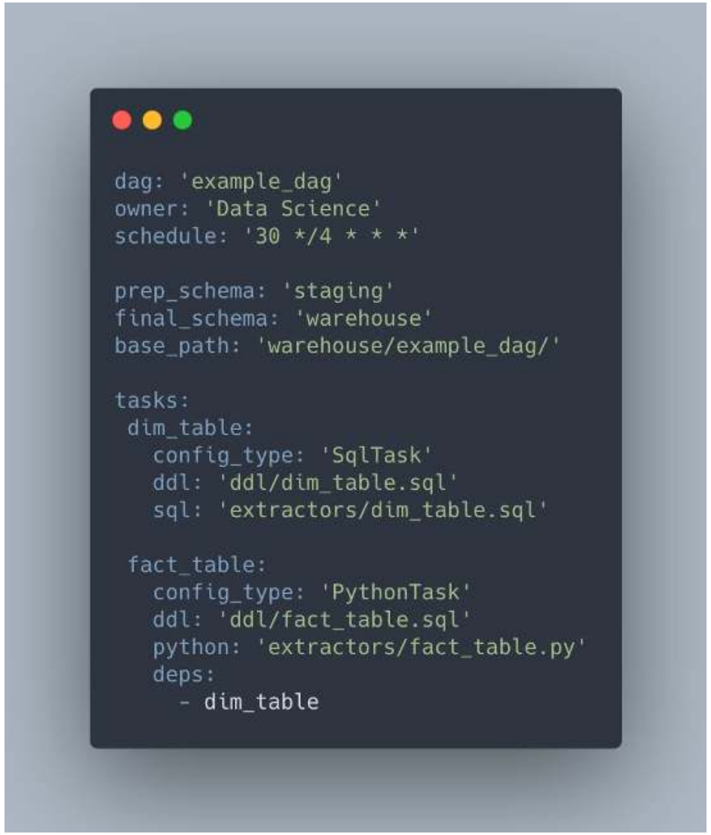
Solution: YAML DAG Builder

YAML DAG Builder

- Internal library to simplify and standardize DAG development.
- Abstraction on top of Airflow.
- Developers only write a DDL query and transformation in SQL or Python.
- No prior Airflow knowledge required.
- Similar structure in all DAGs makes switching teams less painful and simplifies debugging DAGs.
- Data Engineer team can bolt on additional features (alerting, monitoring, testing, etc.)



```yaml
dag: 'example_dag'
owner: 'Data Science'
schedule: '30 */4 * * *'

prep_schema: 'staging'
final_schema: 'warehouse'
base_path: 'warehouse/example_dag/'

tasks:
 dim_table:
   config_type: 'SqlTask'
   ddl: 'ddl/dim_table.sql'
   sql: 'extractors/dim_table.sql'

 fact_table:
   config_type: 'PythonTask'
   ddl: 'ddl/fact_table.sql'
   python: 'extractors/fact_table.py'
   deps:
     - dim_table
```

Devoted Health Data Platform - Problems

- No task dependencies
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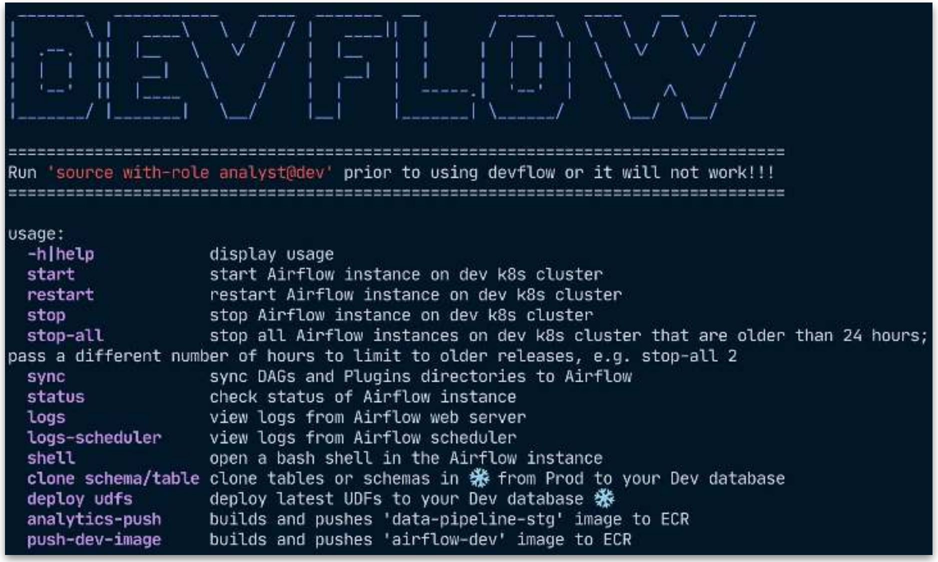
Solution: devflow

devflow

- Internal tool that wraps kubectl, Helm, and Terraform.
- Every developer gets their own Airflow deployment on Kubernetes.
- We develop on the same stack that we run production.
- Developers do not need to know anything about the infrastructure being used.



```
==================================================================================
Run 'source with-role analyst@dev' prior to using devflow or it will not work!!!
==================================================================================

usage:
  -h|help             display usage
  start               start Airflow instance on dev k8s cluster
  restart             restart Airflow instance on dev k8s cluster
  stop                stop Airflow instance on dev k8s cluster
  stop-all            stop all Airflow instances on dev k8s cluster that are older than 24 hours;
pass a different number of hours to limit to older releases, e.g. stop-all 2
  sync                sync DAGs and Plugins directories to Airflow
  status              check status of Airflow instance
  logs                view logs from Airflow web server
  logs-scheduler      view logs from Airflow scheduler
  shell               open a bash shell in the Airflow instance
  clone schema/table  clone tables or schemas in ❄ from Prod to your Dev database
  deploy udfs         deploy latest UDFs to your Dev database ❄
  analytics-push      builds and pushes 'data-pipeline-stg' image to ECR
  push-dev-image      builds and pushes 'airflow-dev' image to ECR
```

Devoted Health Data Platform - Problems

- No task dependencies
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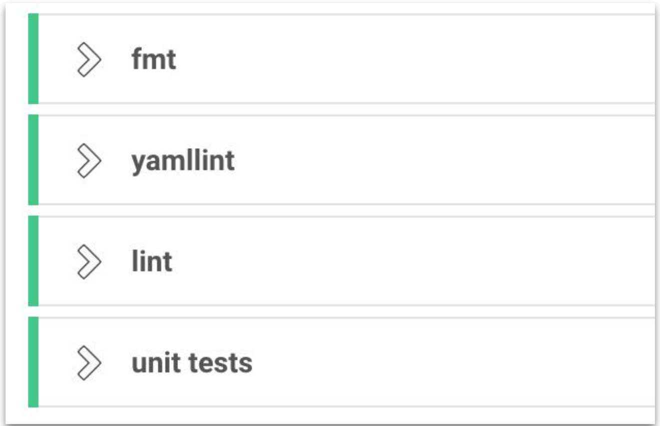
- **Unsure of data quality**

Solution: Testing & Validation

Testing DAGs

- Unit Tests
  - Used on Python transformations and core library code
- Integration Tests
  - Used for SQL tasks
  - Internal framework built on pytest
  - Executed against Snowflake using a test database
  - Mock tables are created and populated

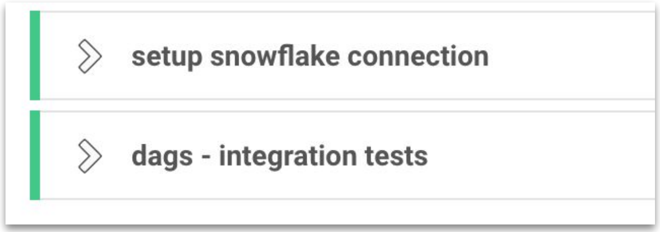


fmt

yamllint

lint

unit tests

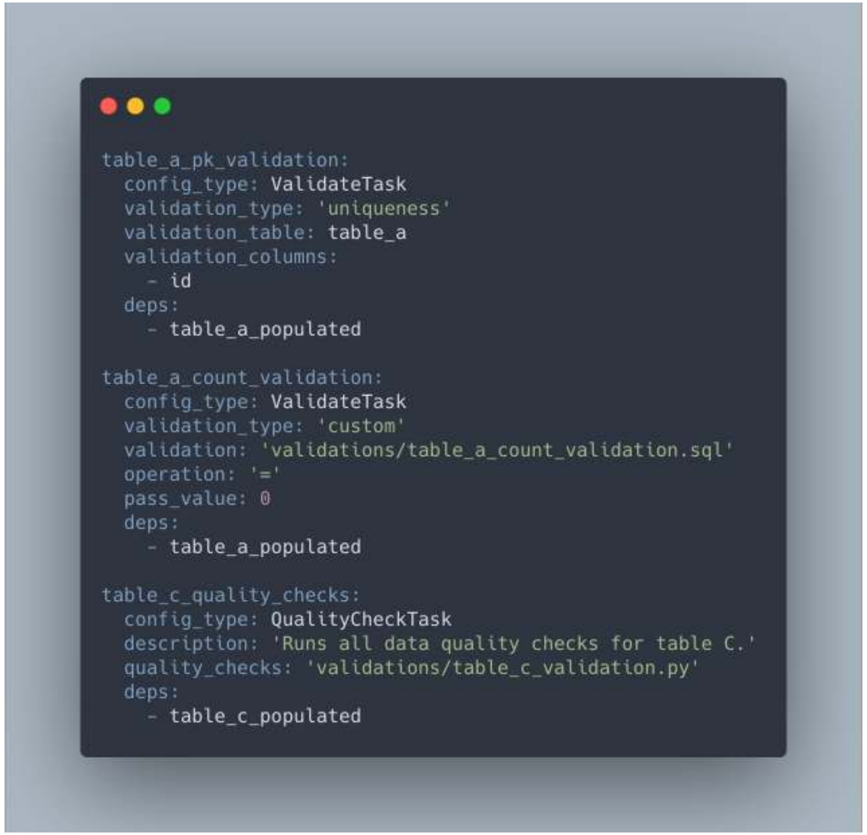


setup snowflake connection

dags - integration tests

Data Validation Framework

- Data validation is executed at DAG run-time
- DAGs are stopped if validation fails to prevent reporting on bad data
- Started with Check Operator
- Added internal Operators
  - Runs multiple checks with one task
  - Save invalid records to table
  - Send check values to Datadog
- Checks range from primary key validation to custom business logic



```
table_a_pk_validation:
  config_type: ValidateTask
  validation_type: 'uniqueness'
  validation_table: table_a
  validation_columns:
    - id
  deps:
    - table_a_populated

table_a_count_validation:
  config_type: ValidateTask
  validation_type: 'custom'
  validation: 'validations/table_a_count_validation.sql'
  operation: '='
  pass_value: 0
  deps:
    - table_a_populated

table_c_quality_checks:
  config_type: QualityCheckTask
  description: 'Runs all data quality checks for table C.'
  quality_checks: 'validations/table_c_validation.py'
  deps:
    - table_c_populated
```

Mission Accomplished!

Current Issues & Future Work

- Improve SQL testing!
  - Explore tools like dbt and dataform
  - Remove need for end user to know pytest
- Improve DAG Builder
  - Make standard use cases easier
- SQL Linting/Formatting
  - Enforce best practices programmatically
- KEDA Autoscaler
  - Improve task spin-up speed

Questions?