Kubernetes-Native Workflows with Argo

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Agenda

Context & Problem

Tool Selection

Argo: Details and Experiences

Context & Problem

Context

Small team (3 data scientists, 1 data engineer) within a larger online learning startup. Smallish data (XX TBs) but a few use cases:

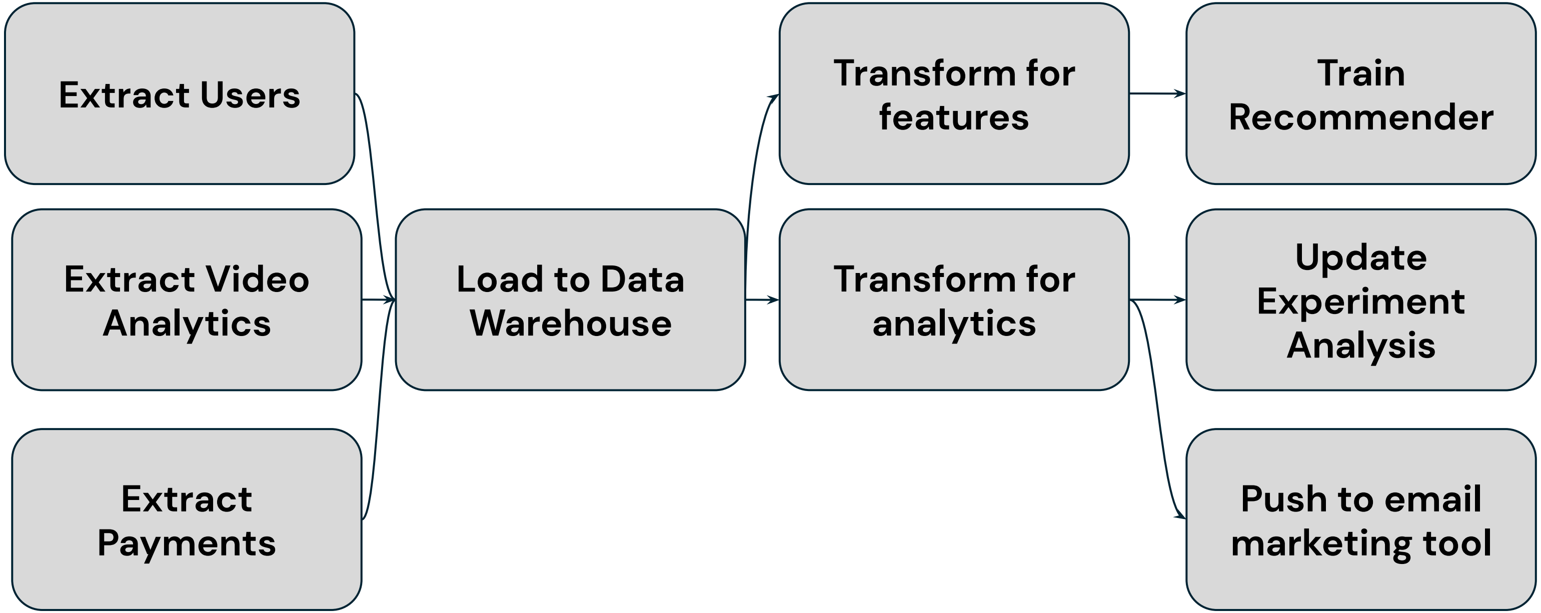
- **Data analytics:** Extracting & transforming user analytics, dashboards, re/running analyses on behavior, experiments
- **ML:** Have a recommender, want more models
- **Integrations**: Moving analytics to biz tools (Blueshift, Zendesk)

Problem

At start of project, we had some standalone pieces + lots of scripts being run on laptops and That One Server. What we needed…

- A place to run ETL/ML/integration tasks
- A tool to orchestrate those tasks into workflows

Example Workflow



Extract Users

Extract Video Analytics

Extract Payments

Load to Data Warehouse

Transform for features

Transform for analytics

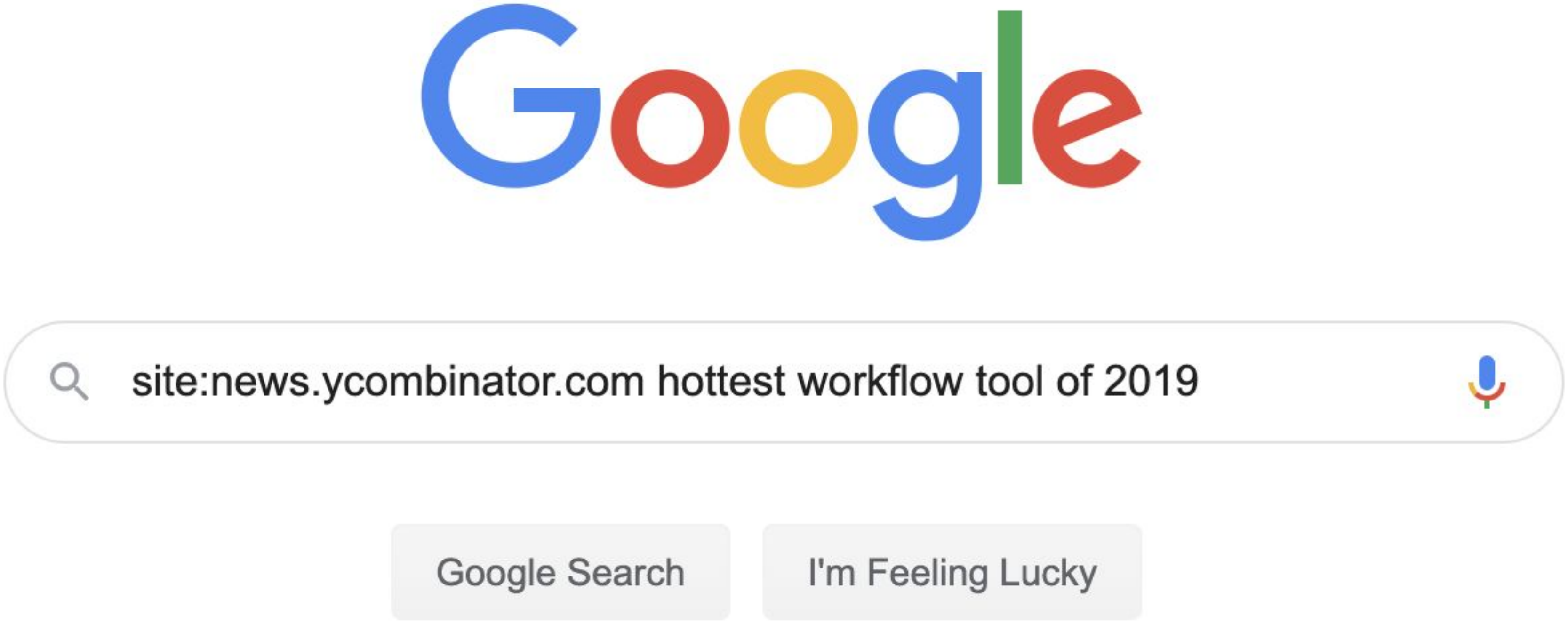
Train Recommender

Update Experiment Analysis

Push to email marketing tool

Tool Selection

How Not To Do Tool Selection



site:news.ycombinator.com hottest workflow tool of 2019

First Guiding Principle: Operability

Can less than one or more than one person operate it?

- Low conceptual complexity
- Sane development and deployment of workflows
- Logs, metrics, secrets management

Guiding Principle Two: Reliability

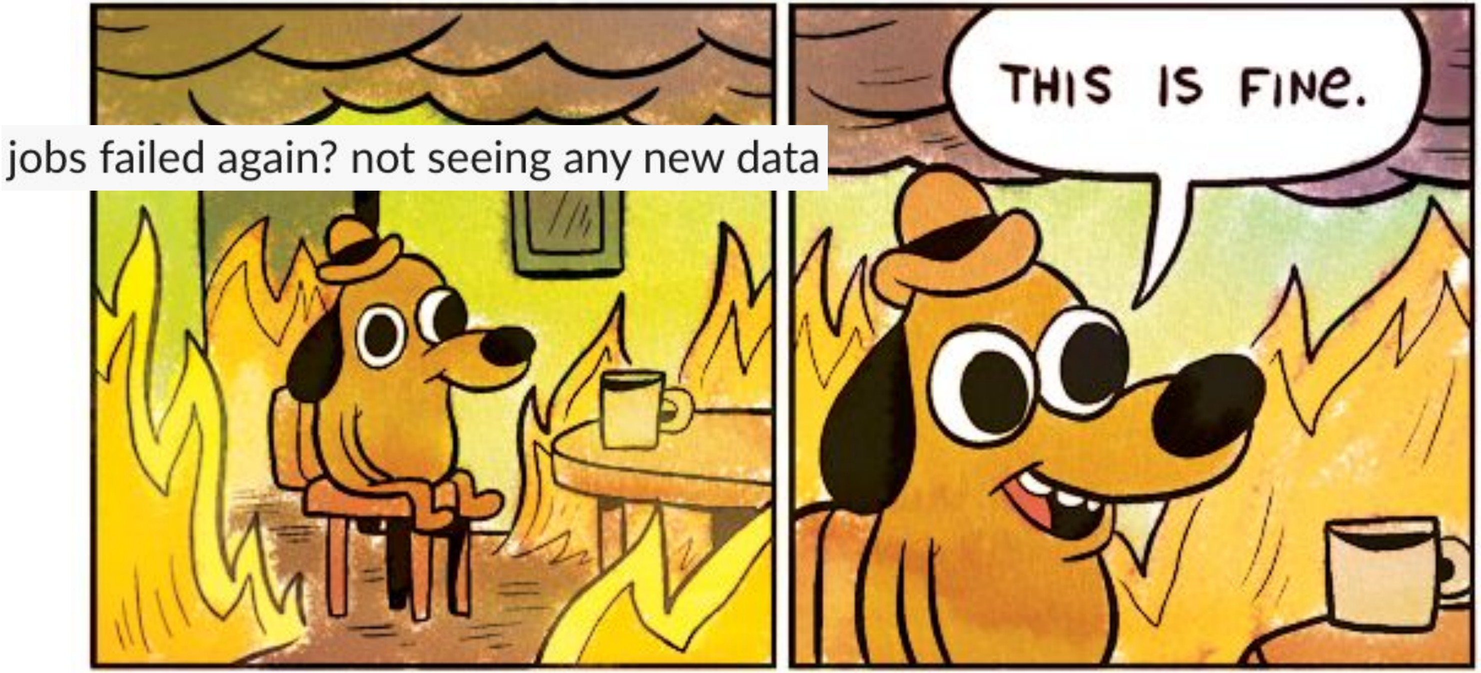
Does workflows run how they're supposed to run?

- Explicit dependencies between steps
- Decouple execution logic and orchestration logic
- Can scale as volume of data increases 10x (more customers *x* more instrumentation *x* more users)

Things We Don’t Care About (Right Now)

- Graphical creation of DAGs
- Programmatically generated DAGs
- Permissioning & security

What We Definitely Don't Want



Build or buy?

Looked at vendor tools for ETL/ML/integrations, but...

- No single vendor did everything we wanted, and orchestrating one or more vendors + internal tools is hard to do reliably.

- Also development and deployment can be tricky

- We felt comfortable using open source or writing code for all of our workflow tasks. (Some was already written.)

Containers and Kubernetes

We built containers for a small set of initial tasks, but needed a place to run them.

SRE team is already using K8s for our application platform and offered to provision and help maintain a cluster.

Lots of benefits: scaling, secrets management, dev/QA/prod parity, integration with Datadog.

K8s Orchestration: Airflow?

Could use Airflow with KubernetesExecutor, but we weren’t enthusiastic for a few reasons:

- Airflow is complex and full of footguns
- We’re not going to be using most of the features
- We found a simpler alternative…

Argo

Argo: Kubernetes-Native Workflows

Open source Kubernetes workflow engine built by Intuit.

Active project. 100+ contributors, releases every couple of months.

Two components: **Argo Workflows** and **Argo Events**

What Does Kubernatives-Native Mean?

Workflows and Events are defined as Custom-Resource Definitions.

Workflows can interface with other K8s resources: Secrets, ConfigMaps, Volume Mounts.

Workflows take full advantage of K8s: scheduling affinity, tolerations, resource limits.

Anatomy of a Workflow

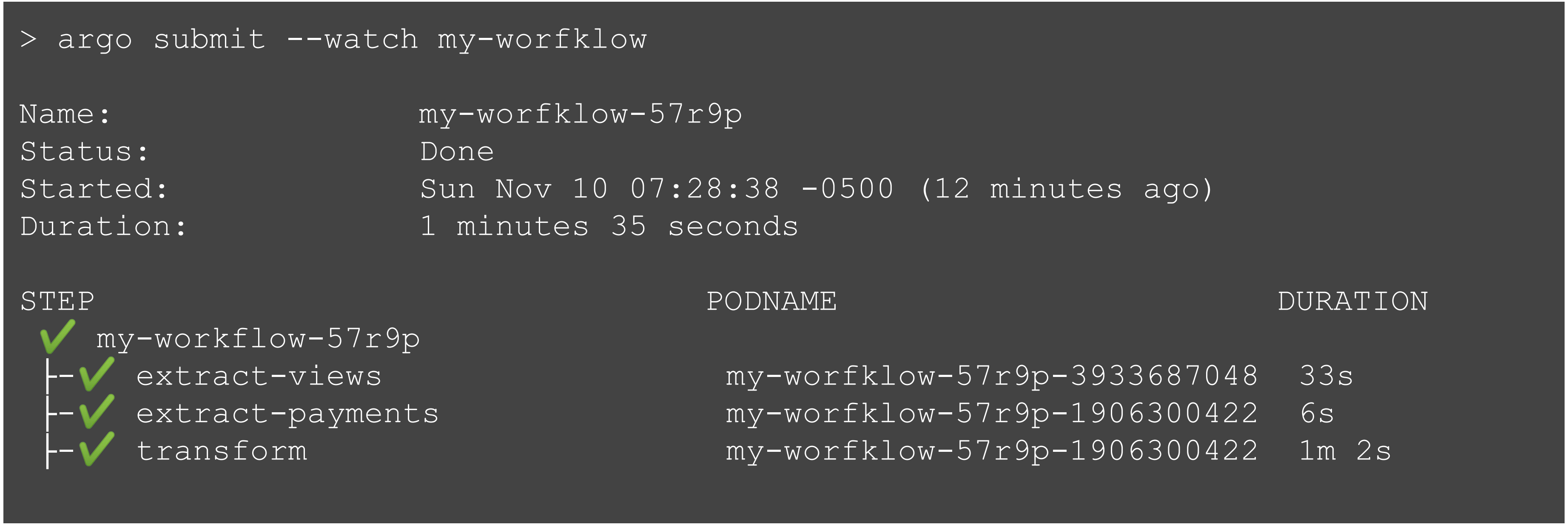
Defined in YAML (like everything else in K8s)

“Templates” = workflow steps, Just container images

Declarative DAG. Just tell it dependencies and it does the rest.

```
kind: Workflow
spec:
  templates:
  - name: extractor
    image: extractor:v3
  - name: transformer
    image: transformer:v1
  dag:
    tasks:
     - name: get-views
       template: extractor
       parameters: [{table: views}]
     - name: get-payments
       template: extractor
       parameters: [{table: payments}]
     - name: transform
       template: transformer
       dependencies: [get-views,
get-payments]
```

Running a worfklow



```
> argo submit --watch my-worfklow

Name:                     my-worfklow-57r9p
Status:                   Done
Started:                  Sun Nov 10 07:28:38 -0500 (12 minutes ago)
Duration:                 1 minutes 35 seconds

STEP                                    PODNAME                          DURATION
 ✔ my-workflow-57r9p
 ├-✔ extract-views                       my-worfklow-57r9p-3933687048   33s
 ├-✔ extract-payments                    my-worfklow-57r9p-1906300422   6s
 ├-✔ transform                           my-worfklow-57r9p-1906300422   1m 2s
```

Some Advanced Features

Parameter Passing

```
container:
  args: {{tasks.extract.manifest_location}}
```

Artifacts

```
output:
 artifacts:
 - name: results
   path: /results.csv
```

```
input:
 artifacts:
 - name: training_results
   from: {{tasks.training.results}
   path: /results.csv
```

...More Advanced Features...

Memoized Resubmit

```
argo resubmit --memoized my-worfklow-57r9p
```

Suspend & Resume (Including in DAG)

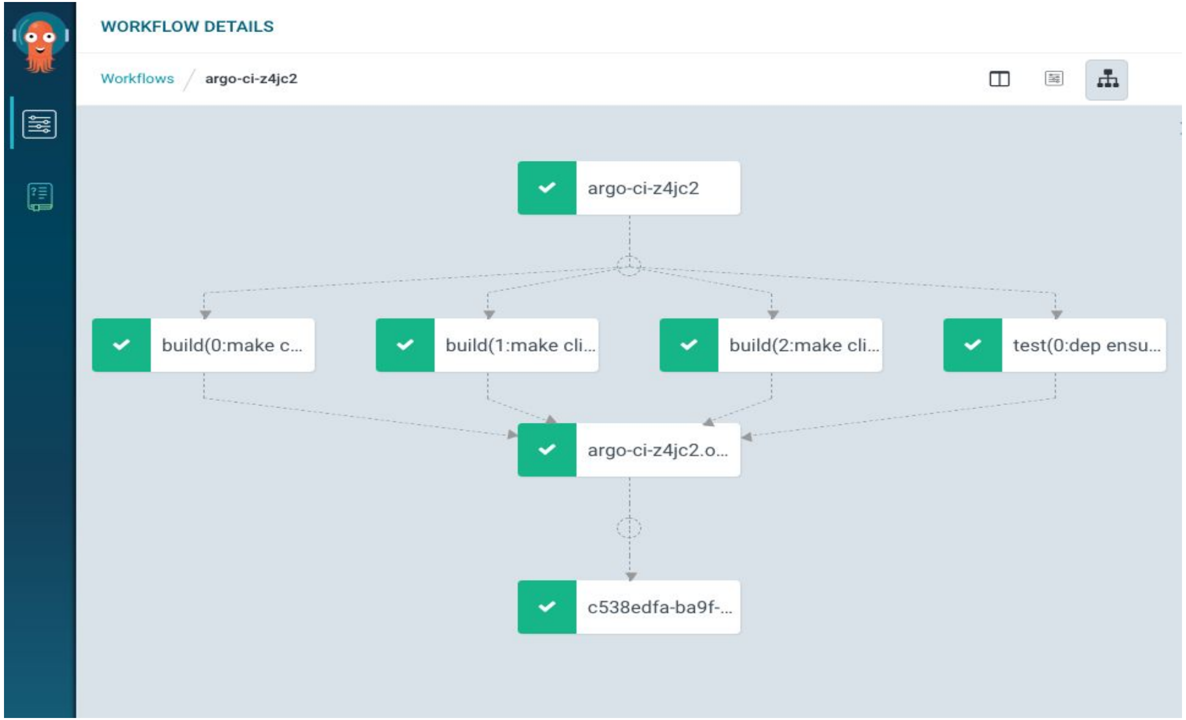
```
argo suspend my-worfklow-57r9p
argo resume my-worfklow-57r9p
```

```
task:
  suspend: {}
```

...So Many Features

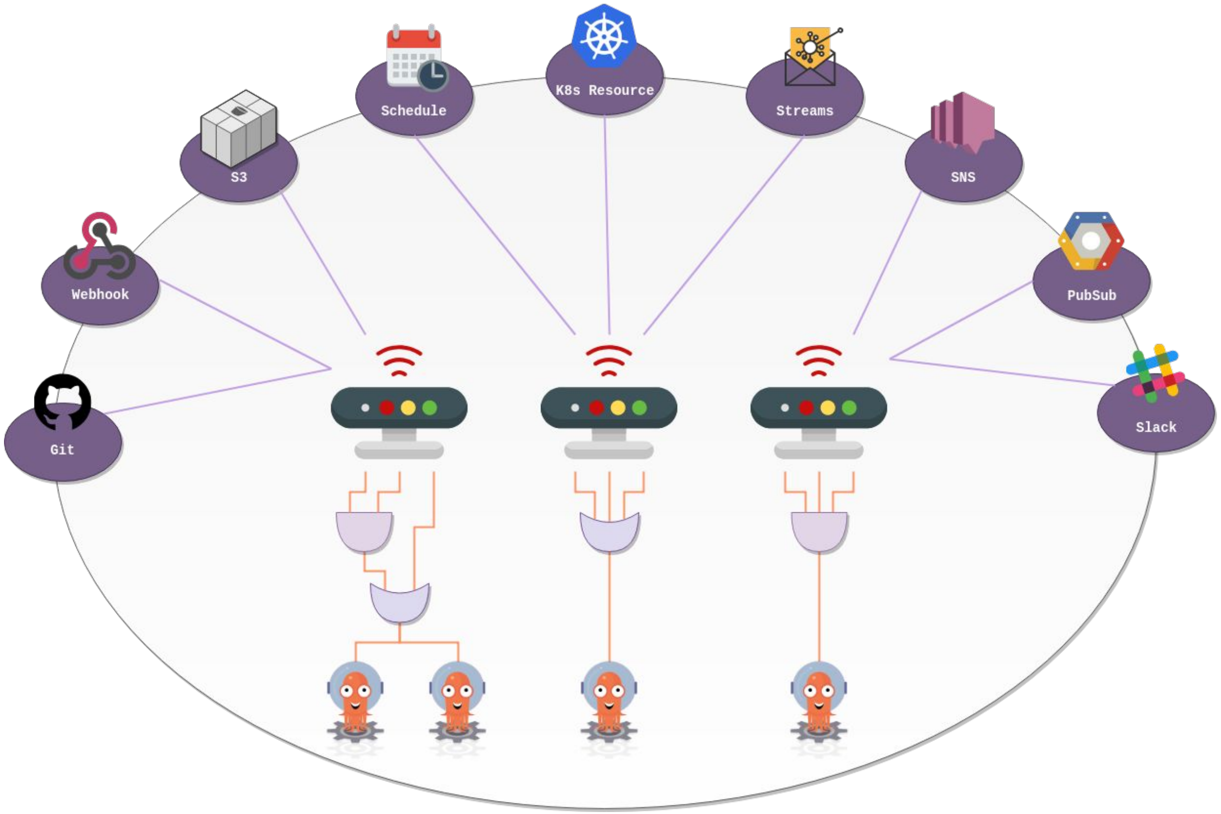
- Sidecars and daemon containers
- All sorts of DAG shenanigans (conditional tasks, sub-DAGs, generated DAGs, loops, recursive DAGs)
- Post-run hooks
- Create K8s resources as a task

Argo UI



WORKFLOW DETAILS
Workflows / argo-ci-z4jc2
argo-ci-z4jc2
build(0:make c...
build(1:make cli...
build(2:make cli...
test(0:dep ensu...
argo-ci-z4jc2.o...
c538edfa-ba9f-...

Triggering with Argo Events



Packaging & Deployment

Because Workflows and Events are K8s resources, we can use helm (package manager) to deploy and upgrade workflows:

```
> helm secrets upgrade --namespace prod -f secrets.prod.yaml .

Release "my-workflow" has been upgraded.
LAST DEPLOYED: Sun Nov 10 07:55:12 2019
NAMESPACE: prod
STATUS: DEPLOYED
```

Makes dev -> QA -> prod deployments very seamless.

Implementation Experience

Took about a week to set up Argo. (Caveat: not including Kubernetes set up time.)

Using DataDog for log aggregation.

Have been running two production DAGs with ~20 tasks for the past six months.

One production outage (fixed by a restart).

Wishlist & Future Considerations

Currently no way to limit DAG concurrency — can be an issue with time-triggered workflows.

Argo Events is a little complex (Events, Gateways, Sensors). We toughed it out but you can run workflows through an API if you want.

Any Questions?

Also, we're hiring: two Data Scientists (Analytics, ML) and a Data Engineer

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