

Managing Scalable Data Workflows on HPC Clusters



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Outline

- Time-based job schedulers
- Smart scheduling and scalability
- Workflow management systems and big data pipelines
- Introducing Apache Airflow
- Airflow components
- UI walk-through
- Airflow and HPC

Time-based job schedulers

CRON



Smart scheduling and scalability

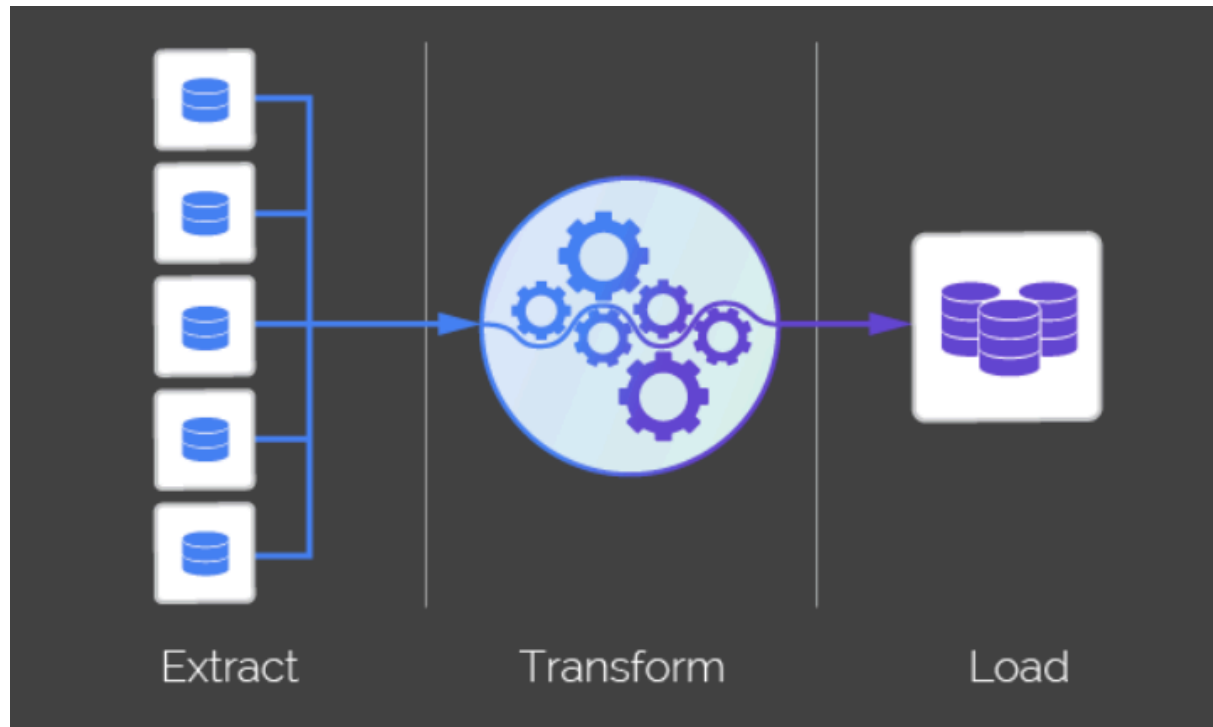
- **Smart Scheduling**

- Scheduling task execution minimal criterion for a WMS
- We want task execution to be more “data-aware”

- **Scalability**

- Not only address our current data processing needs, but also scale with our future growth
- This should be without requiring substantial engineering time and infrastructure changes

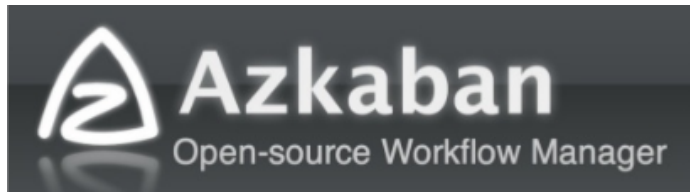
Workflow management systems and big data pipelines



Workflow management systems and big data pipelines

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Uigi



Apache Airflow



- Airflow is a platform to programmatically author, schedule and monitor workflows.
- Developed at Airbnb in 2014
- Joined the Apache Software Foundation's incubation program in 2016
- It has been built to scale
- Python script (configuration as code)
- Active development on GitHub (835 contributors, 6,534 commits)
- Rich web UI
- Officially used by about 300 companies (Tesla, Twitter, Yahoo!, PayPal, United Airlines etc.)

Airflow Components



Airflow

Run your pipelines in style
<https://airflow.apache.org/>



Directed Acyclic Graph – DAG

The DAG defines the blueprint of your analysis . It is an instructional format to tell airflow which tasks are executed in what order.



Operators

Your task blueprint identifying the top level instructions to execute your task . Is your task a bash command, python function, sql query, spark operation, etc.

Airflow Components



Sensors

Sensors are operators that wait for some event to occur, such as a file on appearing or an http request to occur, before executing a task.



Tasks

The actual execution instructions. Your python function to execute, bash command to run, spark pipeline ,etc.

<sources>

Airflow Docs - <https://airflow.apache.org/>
Airflow Github - <https://github.com/apache/airflow>
Some Icons made by "<https://www.freepik.com/>"

</visit <https://dabble-of-devops.com> for more
information>

```
1 from airflow import DAG
2 from airflow.operators import BashOperator
3 from datetime import datetime, timedelta
```

Importing modules

DAG File

```
6 default_args = {
7     'owner': 'mils',
8     'start_date': datetime(2017, 6, 13),
9     'retries': 1,
10    'retry_delay': timedelta(minutes=1),
11 }
```

Default Arguments

```
13 dag = DAG('Time_splitter',
14            schedule_interval='*/30 * * * *',
15            default_args=default_args,
16            catchup=False)
```

DAG

```
19 t1 = BashOperator(
20     task_id='task1',
21     bash_command='date > /home/ubuntu/airflow/utils/data.txt',
22     dag=dag
23 )
```

```
25 t2 = BashOperator(
26     task_id='task_2_split_time',
27     bash_command='python /home/ubuntu/airflow/utils/split_into_time.py',
28     dag=dag)
```


```
30 t3 = BashOperator(
31     task_id='task_3_split_into_mins',
32     bash_command='python /home/ubuntu/airflow/utils/split_into_min.py',
33     dag=dag)
```

tasks

```
35 t1.set_downstream(t2)
36 t2.set_downstream(t3)
```

dependencies

UI Walk-through

 Airflow

DAGs


Data Profiling ▾

Browse ▾

Admin ▾

Docs ▾



















































































21:04 UTC



DAGs

Show entries

Search:

		DAG	Schedule	Owner	Recent Statuses 	Links
	<input checked="" type="checkbox"/>	db_backup_v1	0 4 ***	aflury	<div><div>3</div><div></div><div></div><div></div><div></div><div></div><div></div></div>	      
	<input checked="" type="checkbox"/>	db_report_v4	* / 10 ***	scattaneo	<div><div></div><div>1</div><div></div><div></div><div></div><div></div><div></div></div>	      
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	<input checked="" type="checkbox"/>	emr_model_building	0 1 ***	kmandich	<div><div>5</div><div></div><div>3</div><div>2</div><div></div><div></div><div></div></div>	      
	<input type="checkbox"/>	ep_model_building_v1	0 1 ***	sanand	<div><div>7</div><div></div><div></div><div></div><div></div><div></div><div></div></div>	      
	<input type="checkbox"/>	ep_reload_data	None	sanand	<div><div>14</div><div></div><div></div><div></div><div></div><div></div><div></div></div>	      
	<input type="checkbox"/>	ep_summary_alert	@hourly	wforrester	<div><div>1</div><div></div><div></div><div></div><div></div><div></div><div></div></div>	      
	<input checked="" type="checkbox"/>	ep_telemetry_v2	@hourly	sanand	<div><div></div><div>1</div><div></div><div></div><div></div><div></div><div></div></div>	      
	<input type="checkbox"/>	feedback_report_v1	1 day, 0:00:00	kmandich	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	      

Showing 1 to 10 of 20 entries

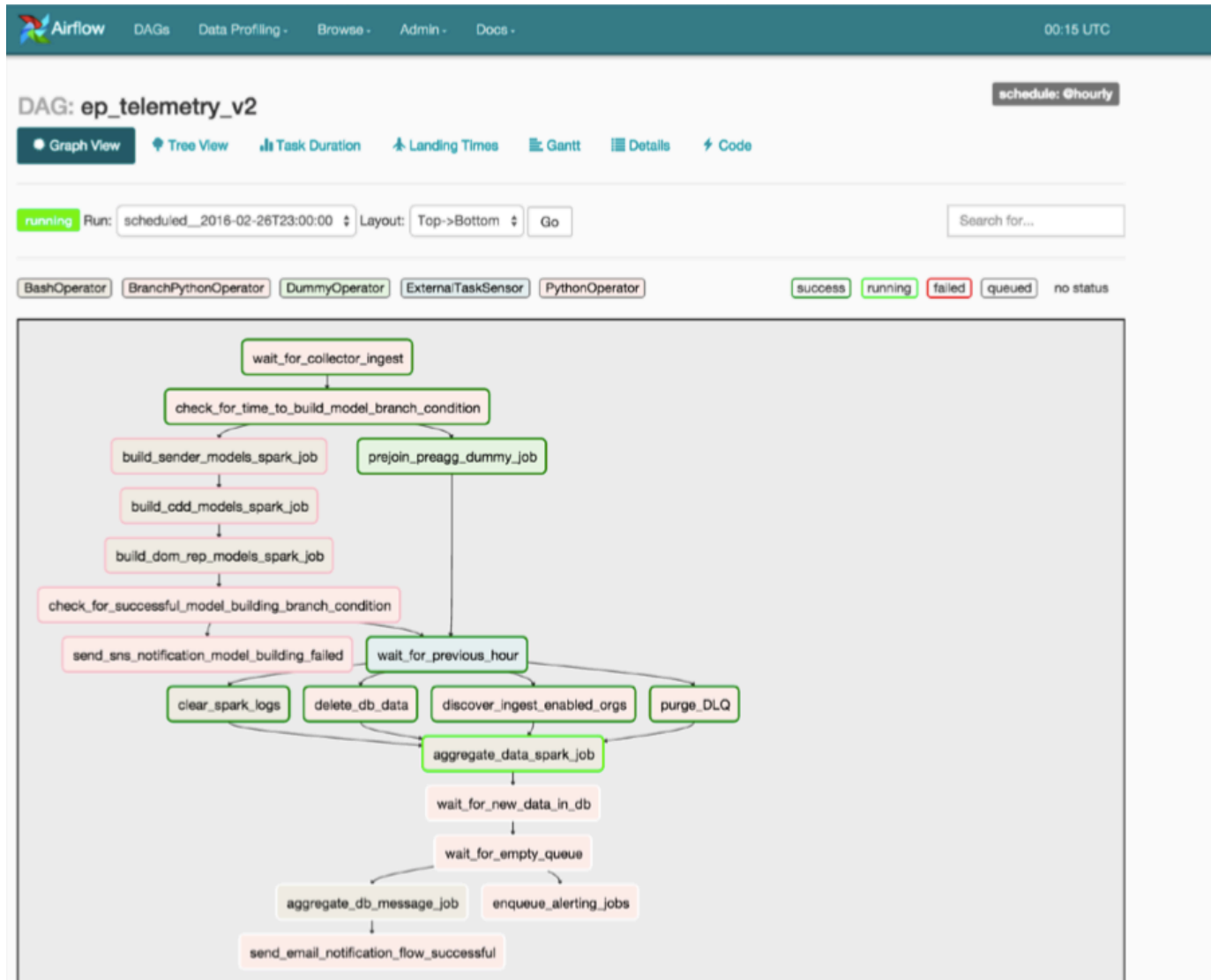
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1

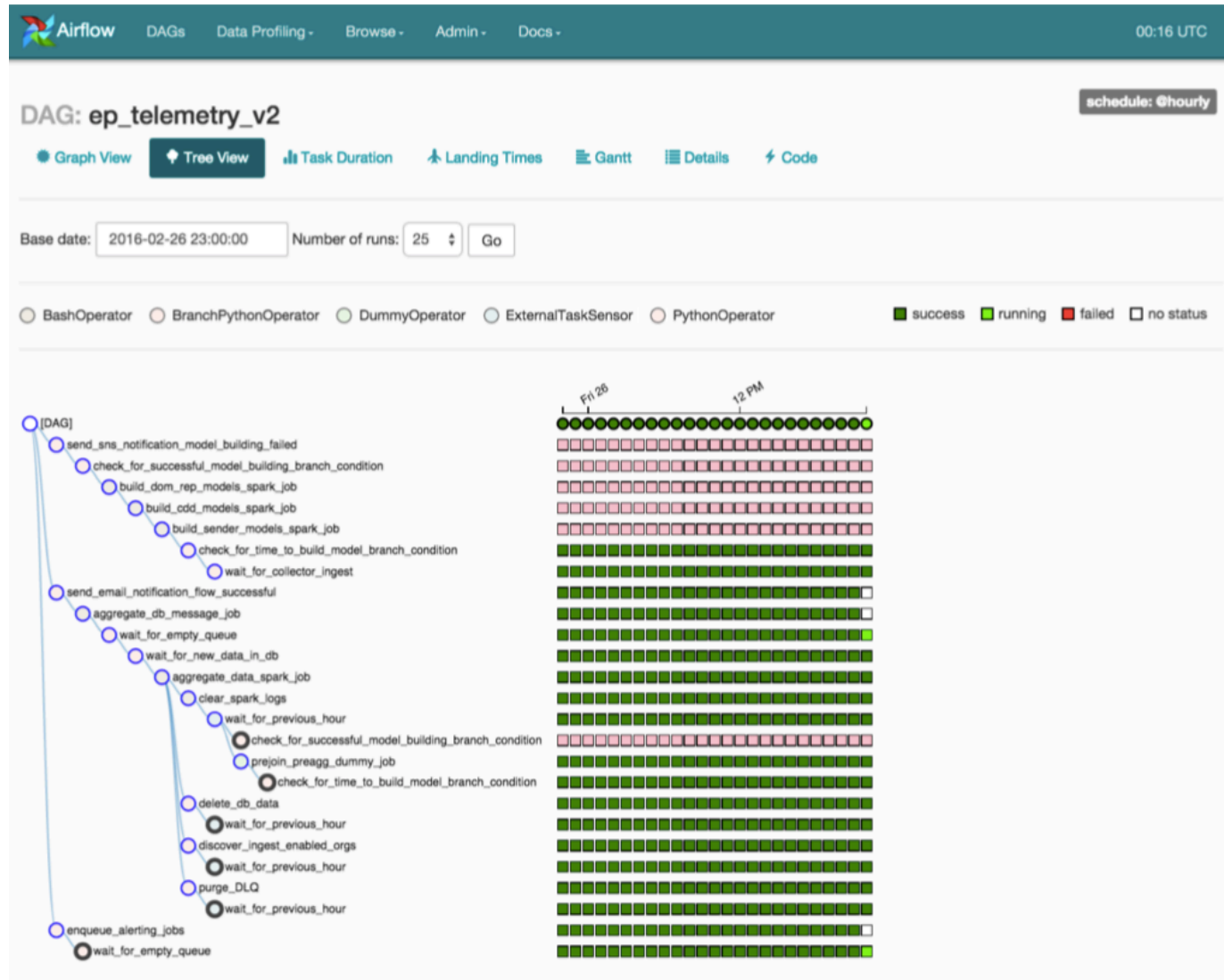
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Next

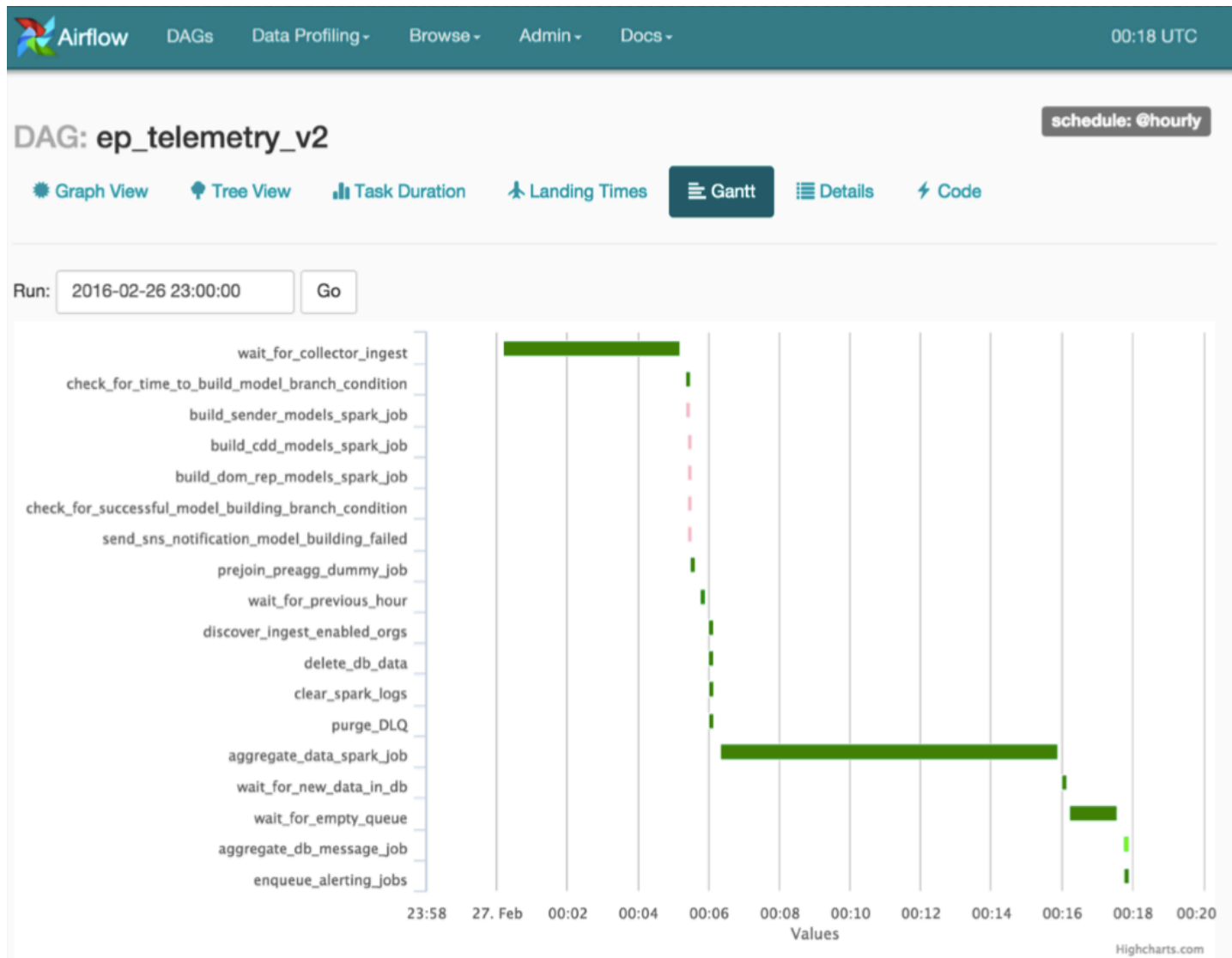
UI Walk-through



UI Walk-through



UI Walk-through



Airflow and HPC

- Apache Spark Integration
- MPI with Slurm Integration (not natively supported)



Slurm Output

```

Airflow  DAGs  Data Profiling ▼  Browse ▼  Admin ▼  Docs ▼  About ▼  2019-06-26 17:52:49 UTC

Authentication (password) successful!

<< ssh connection starts here ...

Submitted batch job 23678561
Tue May 28 03:00:25 PDT 2019 - job in RUNNING state
Tue May 28 03:00:25 PDT 2019 - job in RUNNING state after pending for about 00h 00m 10s

#####
# <START> the content of stdout: out.txt #
#####

hello, world

Your job output...

#####
# <END> the content of stdout: out.txt #
#####

job finished with the status: COMPLETED, success!
... ssh connection ends here >>

Job 1225: Subtask test_ssh_operator /Users/erfan/anaconda/envs/py36/lib/python3.6/site-packages/psycopg2/__init__.p
Job 1225: Subtask test_ssh_operator  "")
State of this instance has been externally set to success. Taking the poison pill.
Sending Signals.SIGTERM to GPID 58632
Process psutil.Process(pid=58632 (terminated)) (58632) terminated with exit code -15
Task exited with return code 0

```


Conclusion

Try Airflow and apply
it to your work

Thank you!

Sources

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<https://www.alooma.com/answers/what-is-apache-airflow>

<https://sonra.io/2018/01/01/using-apache-airflow-to-build-a-data-pipeline-on-aws/>

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https://qcon.ai/system/files/presentation-slides/sid_anand_qcon_ai_2018_v2.pdf

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<https://towardsdatascience.com/why-quizlet-chose-apache-airflow-for-executing-data-workflows-3f97d40e9571>