Flow is in the Air: Best Practices of Building Analytical Data Pipelines with Apache Airflow

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PyConDe Karlsruhe, 27.10.2017

Diving deep in the analytical data lake?

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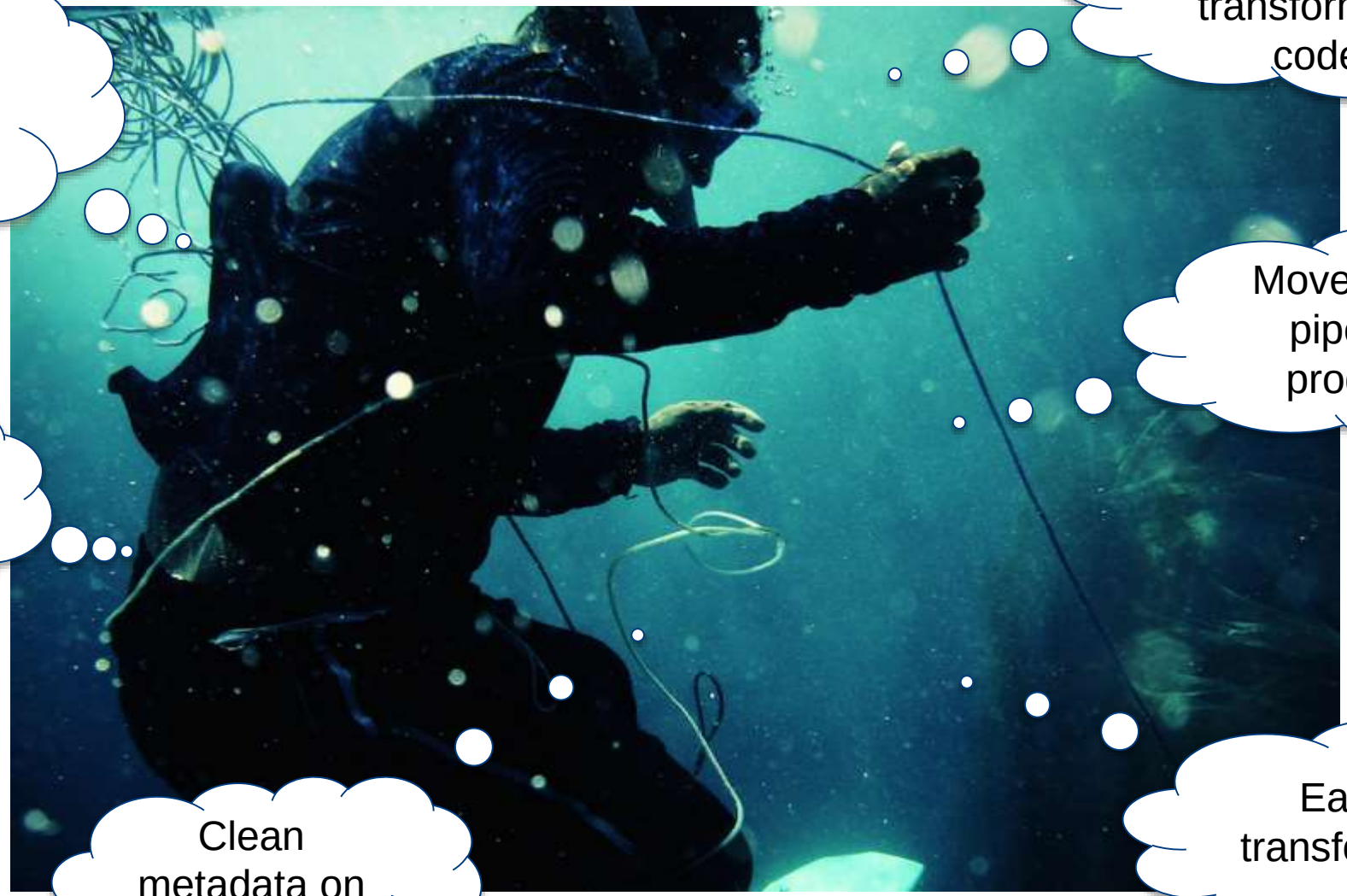


Dependencies between jobs?

Avoid boilerplate data transformation code?

Move analytical pipelines to production?

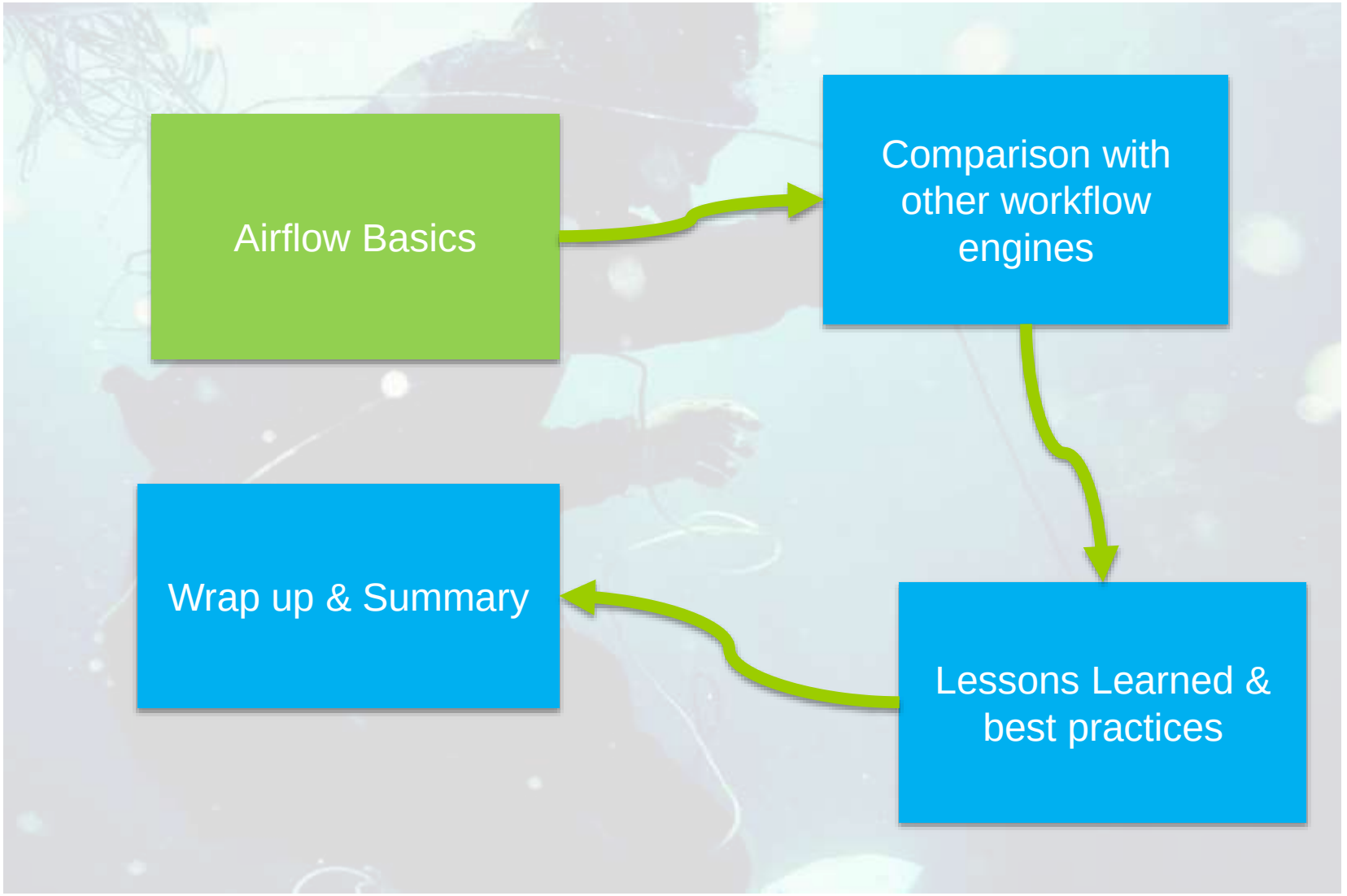
Overview of failed jobs?

Clean metadata on job runs?

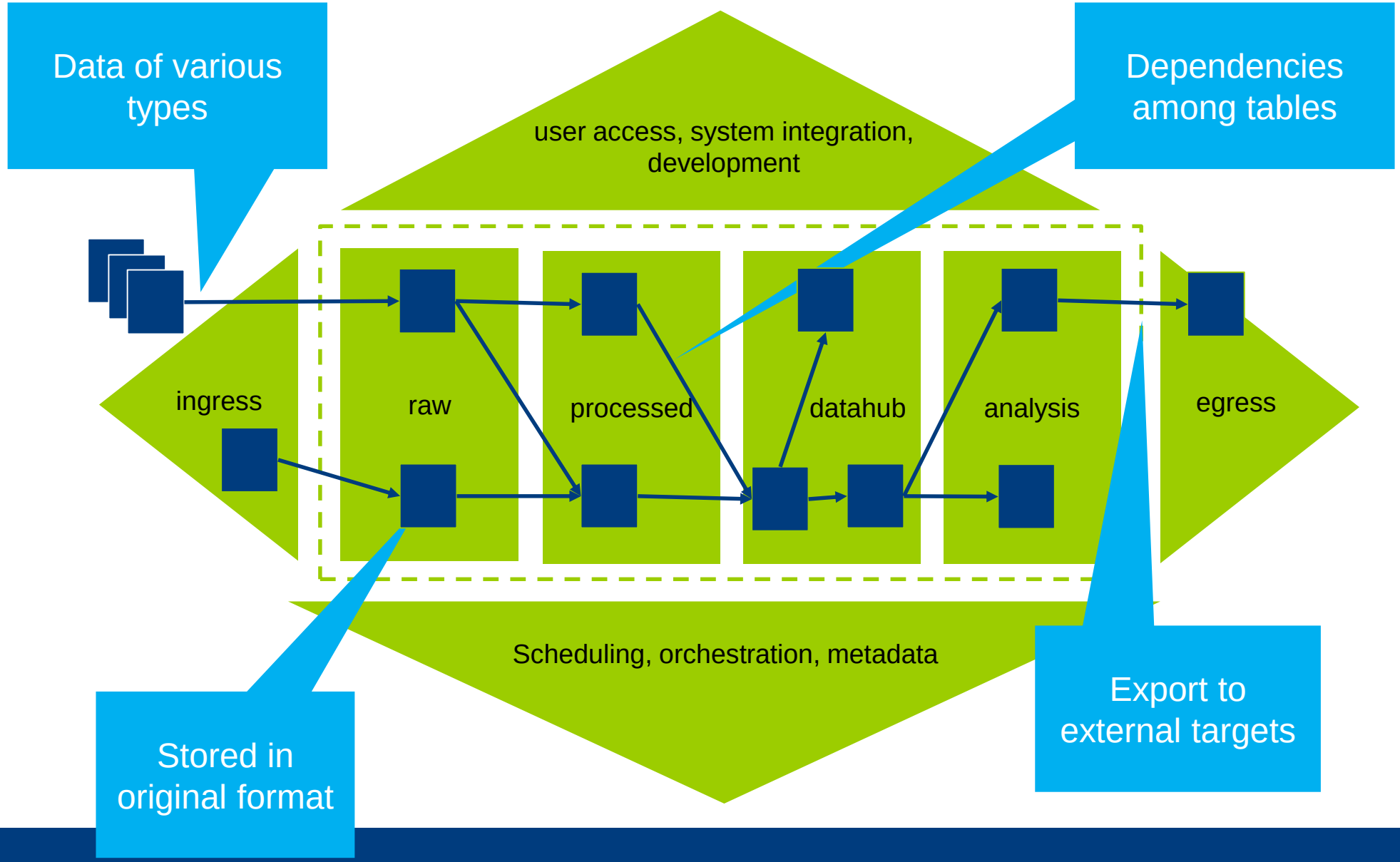
Easily test transformations?

https://flic.kr/p/64gmbY

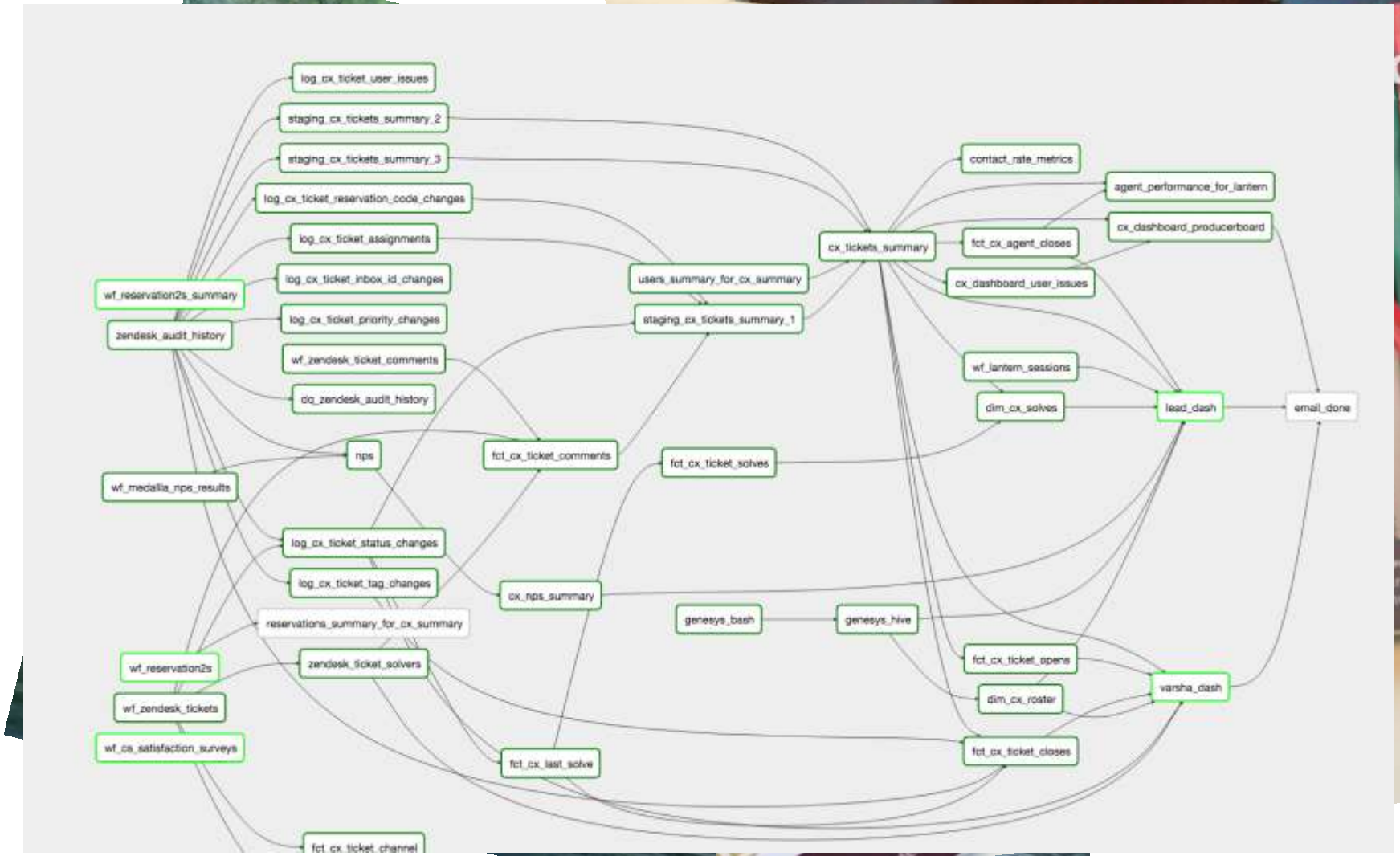
The Flow in Airflow



A typical data lake



Airflow: let‘s DAG!



- Workflow is (python) code
- Specify tasks & dependencies programmatically
- Manages workflow metadata
- Nice GUI ☺

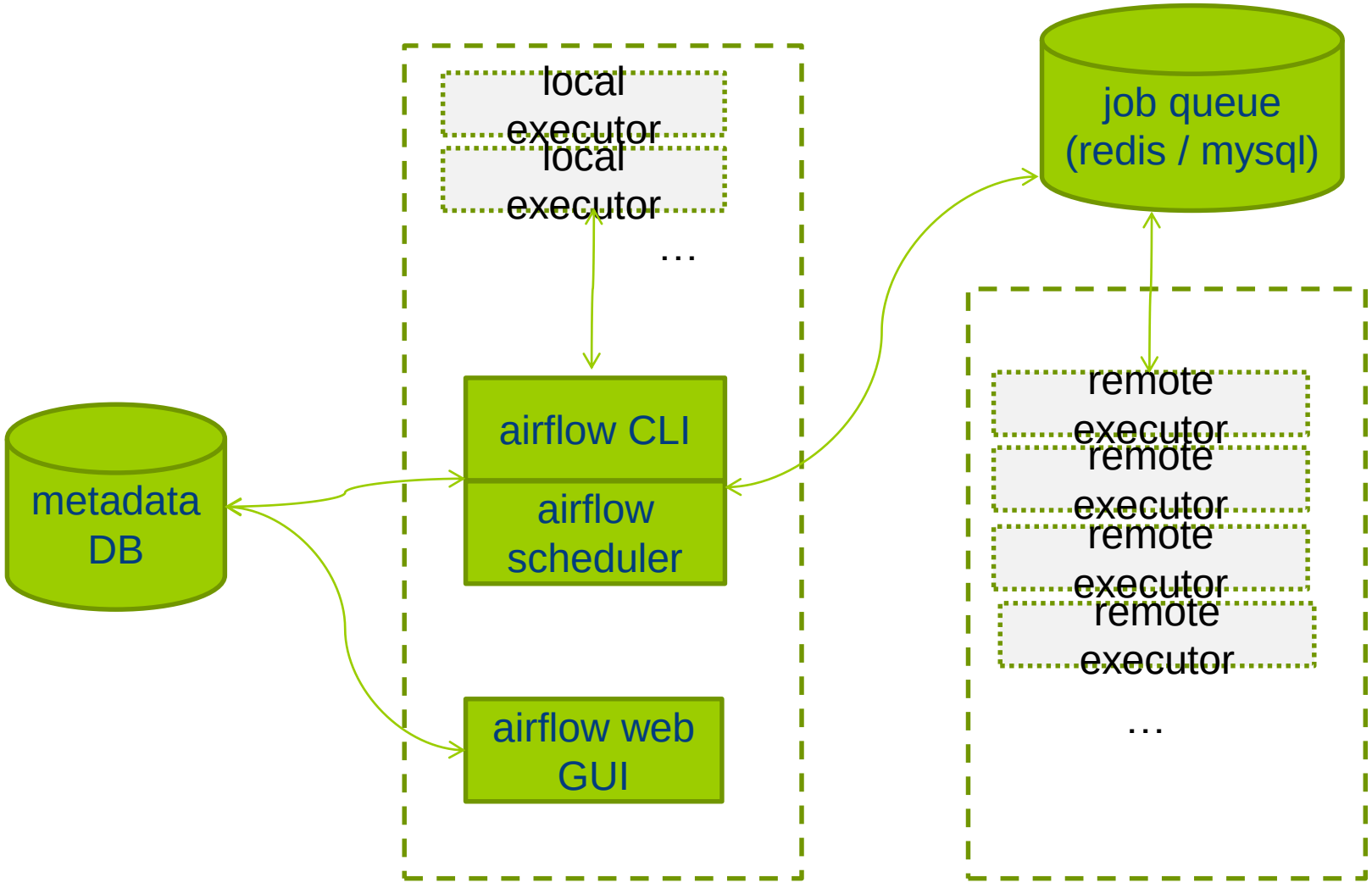
Brief History

- developed at AirBnB by Maxime Beauchemin (former Yahoo / Facebook)
- open-sourced June 2015
- ~4200 commits, 81 releases, 332 contributors
- in Apache Incubator starting 2016/05
- used in several projects since 09/2015 ☺

Gimme some code ..

```
from airflow import DAG

default_args = { 'owner': 'airflow',
  'retries': 2,
  ...
}

dag = DAG('tutorial', default_args=default_args)

t1 = BashOperator( task_id='print_date',
  bash_command='date',
  dag=dag)

t2 = HiveOperator( task_id='make_query',
  sql='select x from y where z group by k',
  dag=dag)

t2.set_upstream(t1)
```

Airflow: Architectural components



Basic Concepts

- **DAG**: graph of operator usages (=tasks)
- **Operator**: "Transformation" step
  - **Sensor**: Operator which polls with frequency / timeout (e.g. LocalFileSensor)
  - **Executor**: Trigger operation (e.g. HiveOperator, BashOperator, PigOperator, …)
- **Task**: Usage of Operator in DAG
  - **Task Instance**: run of a Task at a point in time
- **Hook**: Interface to external System (JDBCHook, HTTPHook, …)

Most popular airflow CLI commands

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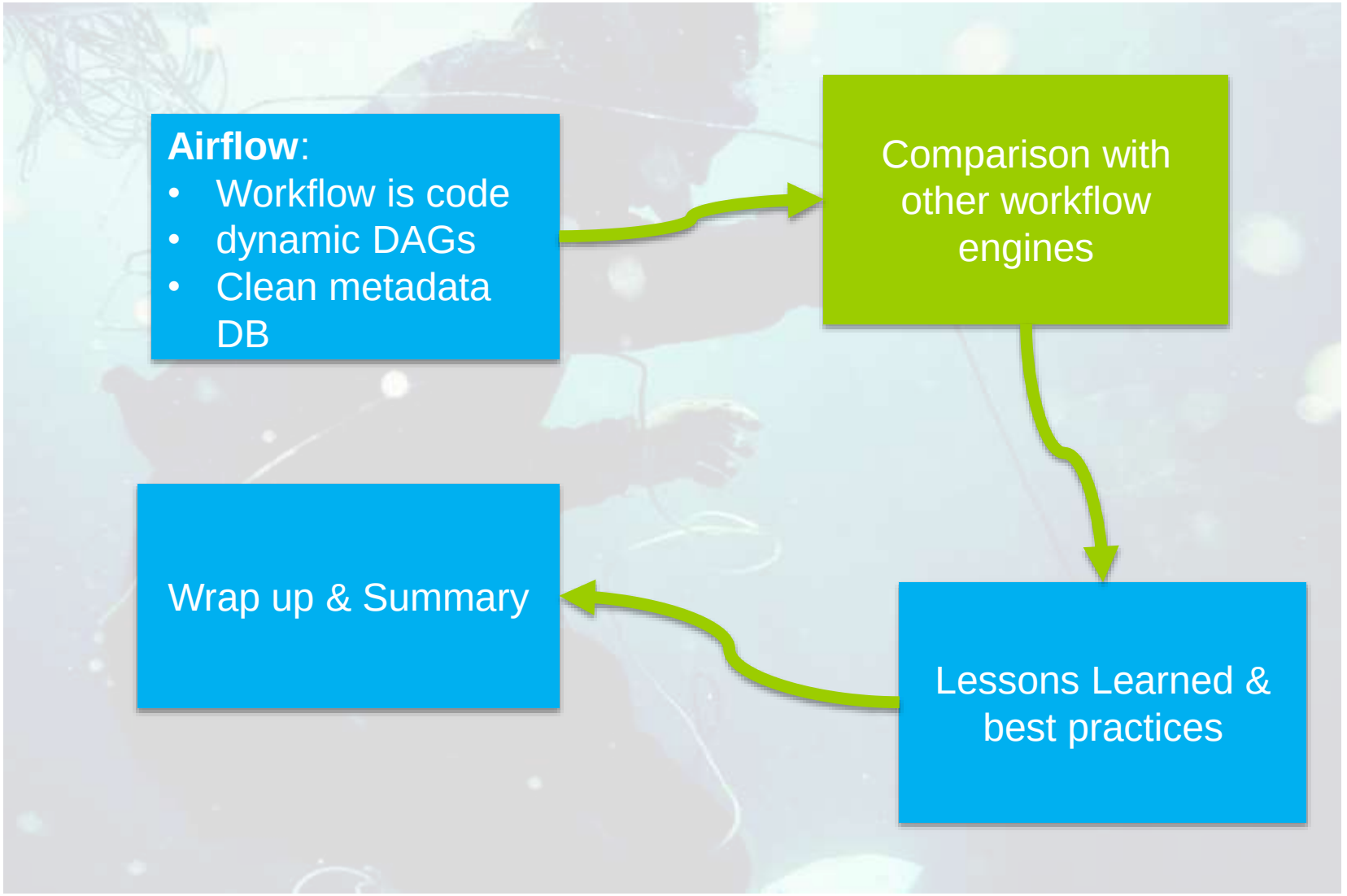
command	does
`airflow initdb`	initialize metadata DB schema
`airflow test <dag> <task> <date>`	test task of a dag (shows command only)
`airflow run <dag> <task> <date>`	run task of a dag
`airflow backfill <dag> -s <start_date> -e <end_date>`	reload / backfill dag
`airflow clear <dag> -s <start_date> -e <end_date> -t <task_regex>`	clear state of dag / tasks
`airflow backfill <dag> -s <start_date> -e <end_date> -m true`	mark dag runs as success without running

Advanced Concepts

- **XCom**: send „messages“ between tasks
- **Trigger Rules**: specify handling for multiple upstream dependencies (e.g. all_success, one_success, ..)
- **Variables**: define key/value mappings in airflow metadata DB (value can be nested JSON as well)
- **Branching**: Define python function to choose which downstream path to follow
- **SubDAGs**: encapsulate repeating functionality

The Flow in Airflow



What else is out there?

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	Oozie	Azkaban	Luigi	Airflow	Schedoscope
Language	Java	Java	Python	Python	Scala
WF specification	static (XML)	static (.job file)	static (task = extend class)	dynamic (task = instantiate operator)	dynamic
Schema / Change Management	no	no	no	no	yes
Test Framework	no	no	no	no	yes
WF trigger	data, time	time	data, time	data (sensors), time	goal

Other voices ..

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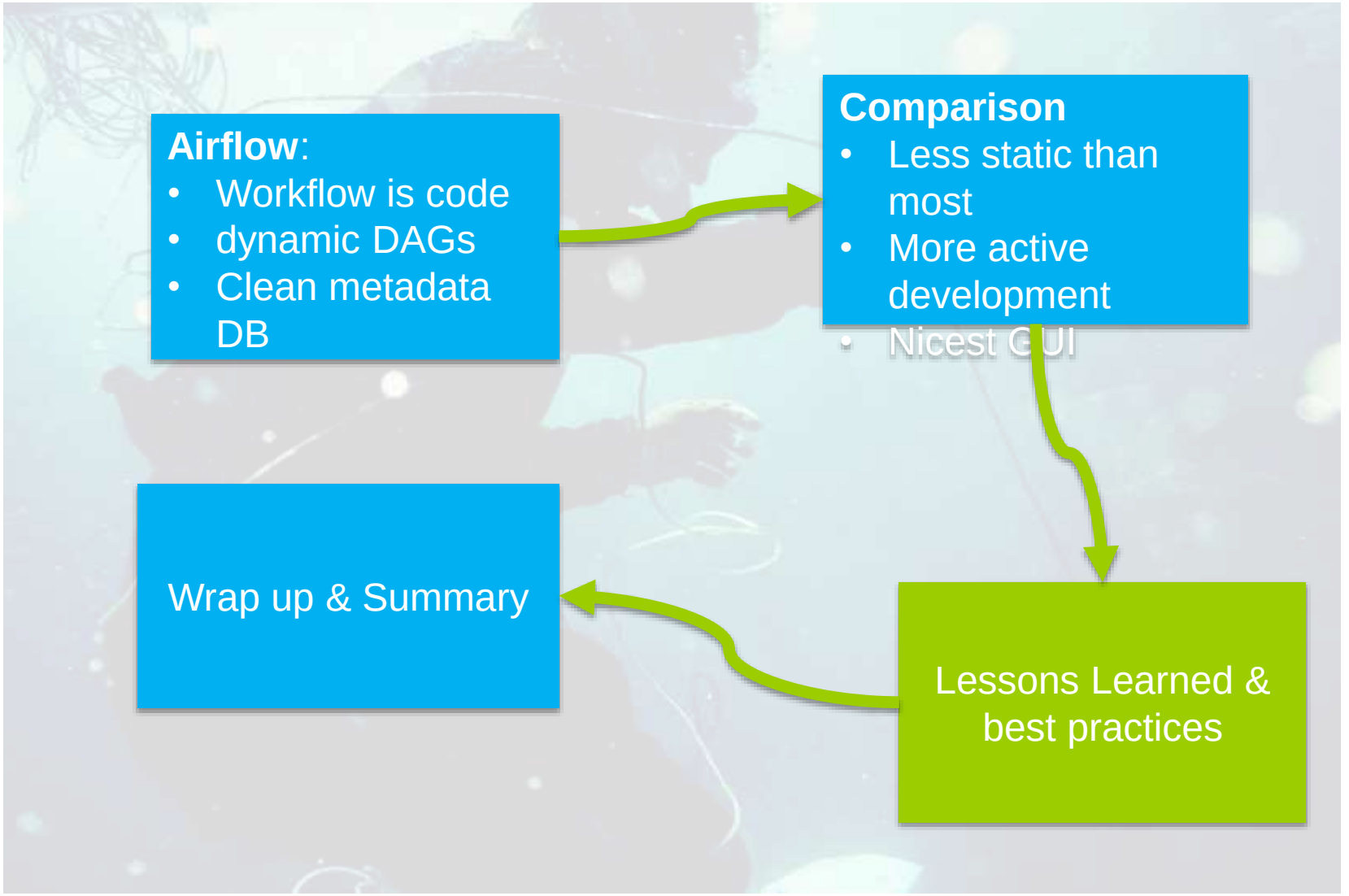
› Comparison (2016) of Airflow, Luigi, Pinball by Marton Trencseni (data science manager at Facebook) http://bytepawn.com/luigi-airflow-pinball.html :

*„If I had to build a new ETL system today from scratch, **I would use Airflow**“*

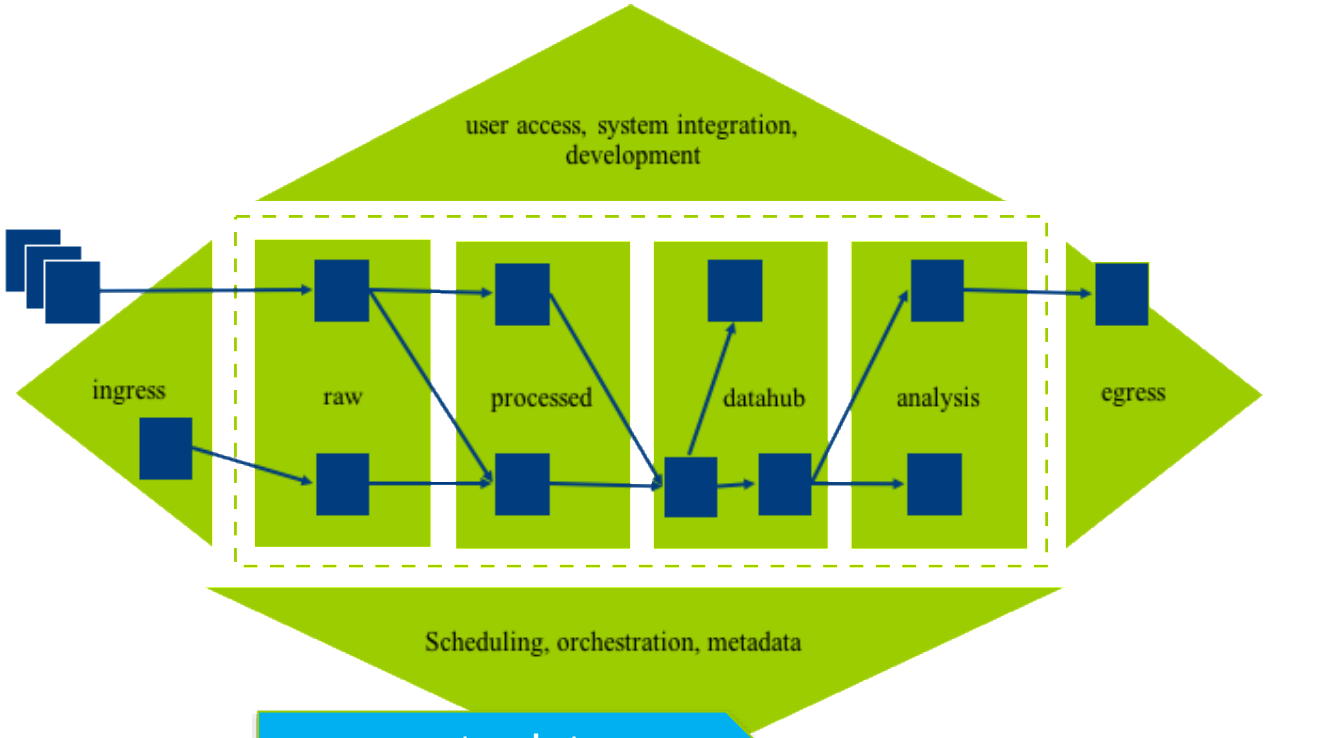
› Databricks Airflow integration https://databricks.com/blog/2017/07/19/integrating-apache-airflow-with-databricks.html :

“We implemented an Airflow operator called DatabricksSubmitRunOperator, enabling a smoother integration between Airflow and Databricks“

The Flow in Airflow



Structuring / Cutting DAGs



src_masterdata

src_pos

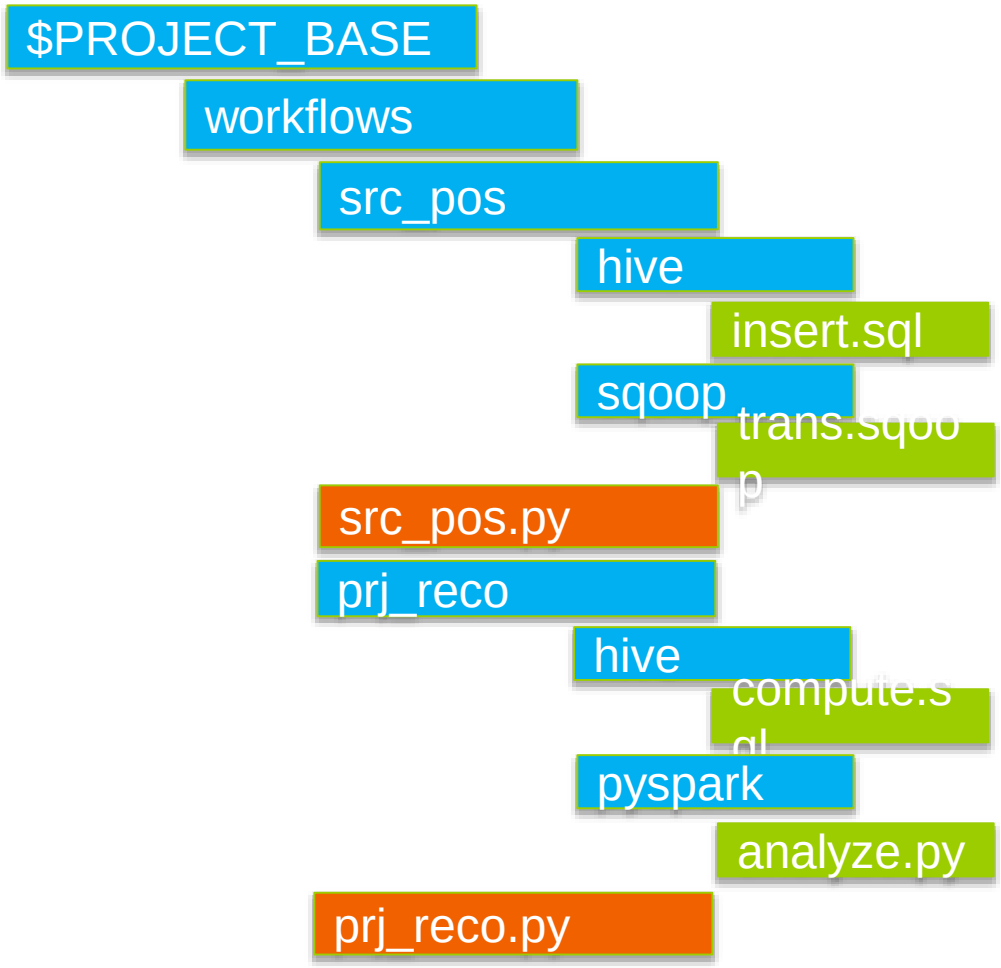
exp_reco

prj_reco

prj_analysis

- one DAG per **data source**
- one DAG per „**project**“
- one DAG per **data sink**

Structuring DAG resources



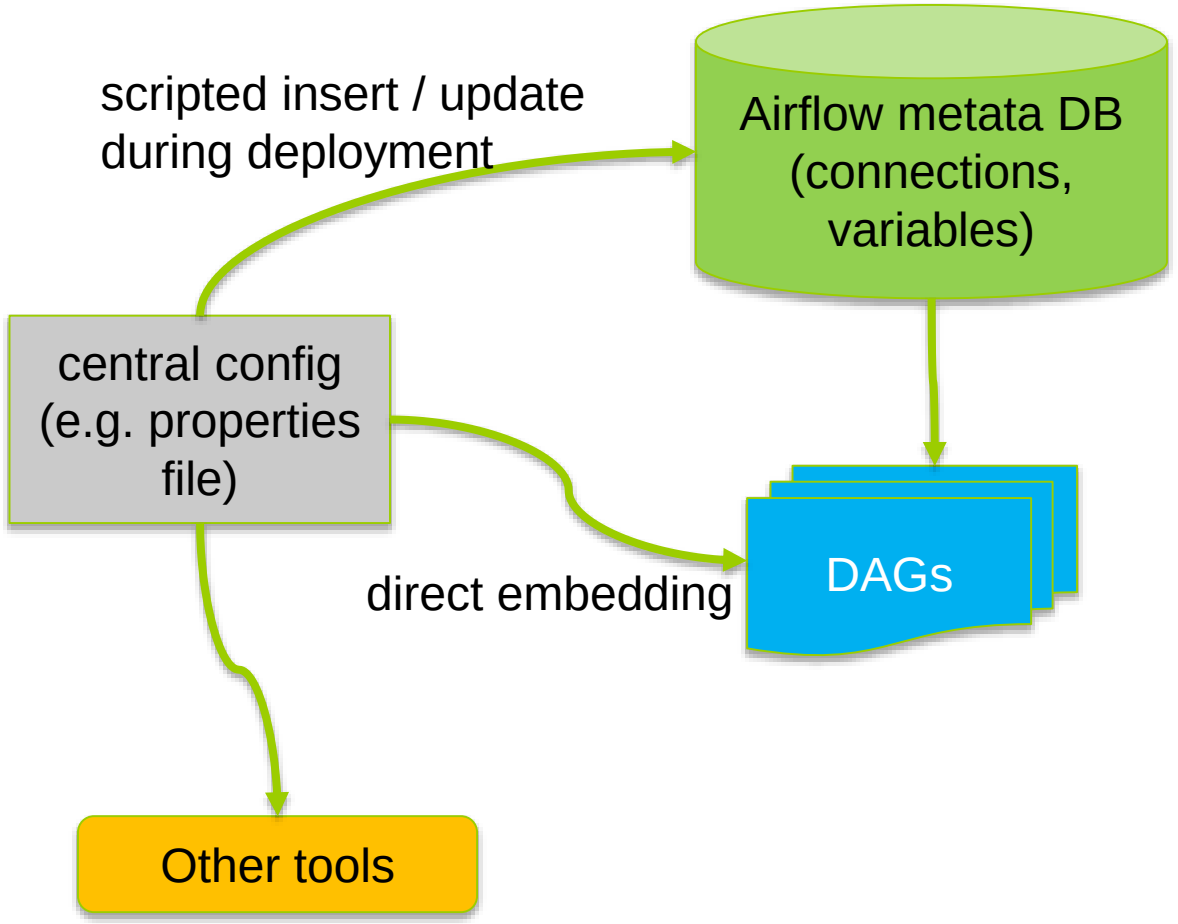
- keep code in template files
- for hive templates: use `hiveconf_jinja_translate`
- use template searchpath (see next slide)
- keep template files „airflow agnostic“ (if possible)

Structuring DAG resources (ctd.)

```
from airflow import DAG

default_args = { 'owner': 'airflow',
  'retries': 2,
  ...
}

dag = DAG('src_pos', default_args=default_args,
 template_searchpath=(
    '/base/workflows/src_pos/hive',
    '/base/workflows/src_pos/sqoop'))


insert = HiveOperator( task_id='insert',
  sql='insert.sql',
  dag=dag)

...
```

Configuration Management

- Built-in: definition of
  - Connections (e.g. to Hive, DBs, ..)
  - Variables (key/value)
- Often other (non-python) tools present
  - e.g. Realtime tools, ..
- Goal: **single source** of configuration
  - inject e.g. via “user_defined_macros“



Configuration Management (ctd.)

conf.py

```
ENV_NAME="prod"
PRJ_NAME="myprj"
...
```

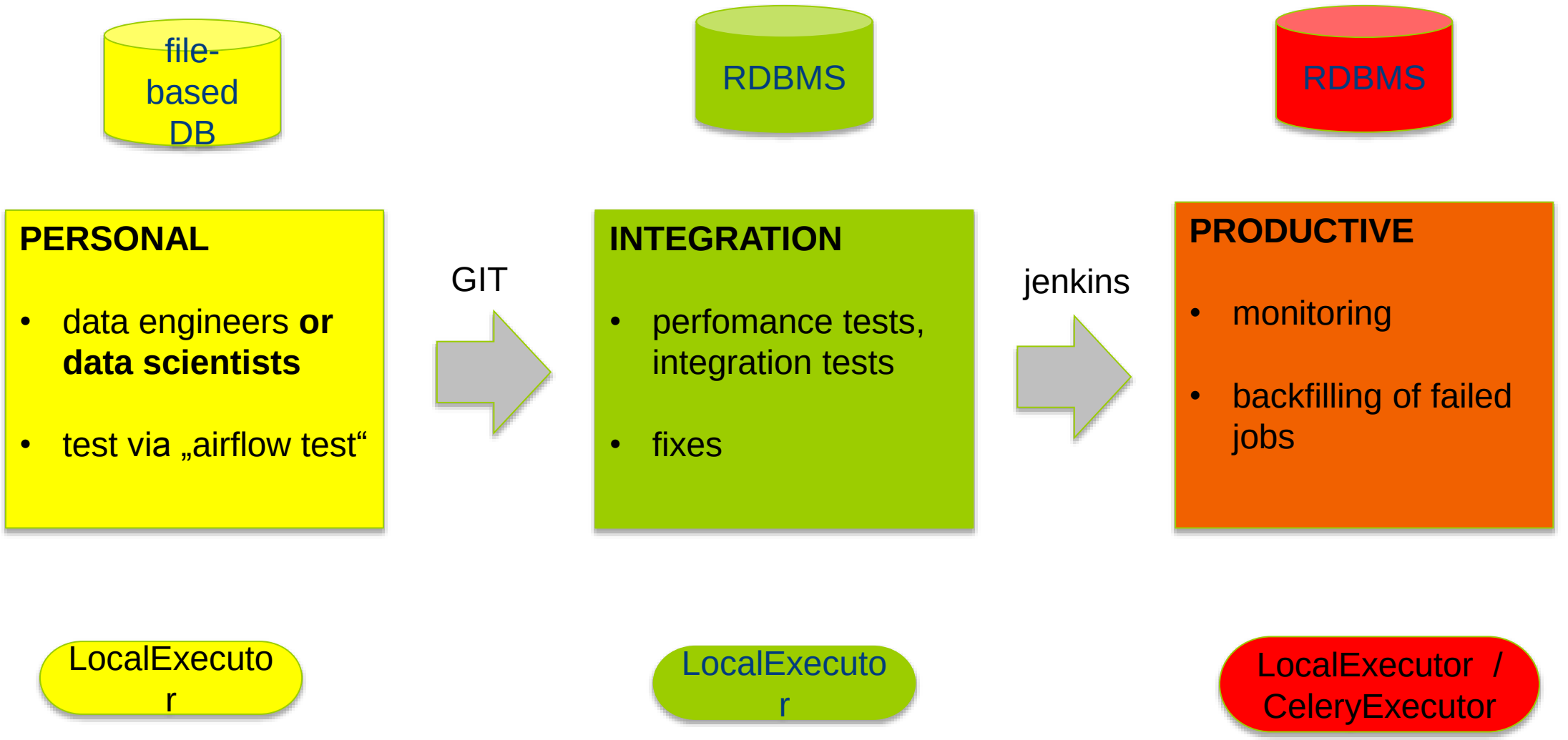
insert.sql

```
INSERT INTO TABLE
${ENV_NAME}_${PRJ_NAME}_target
SELECT .. FROM ..
```

dag definition

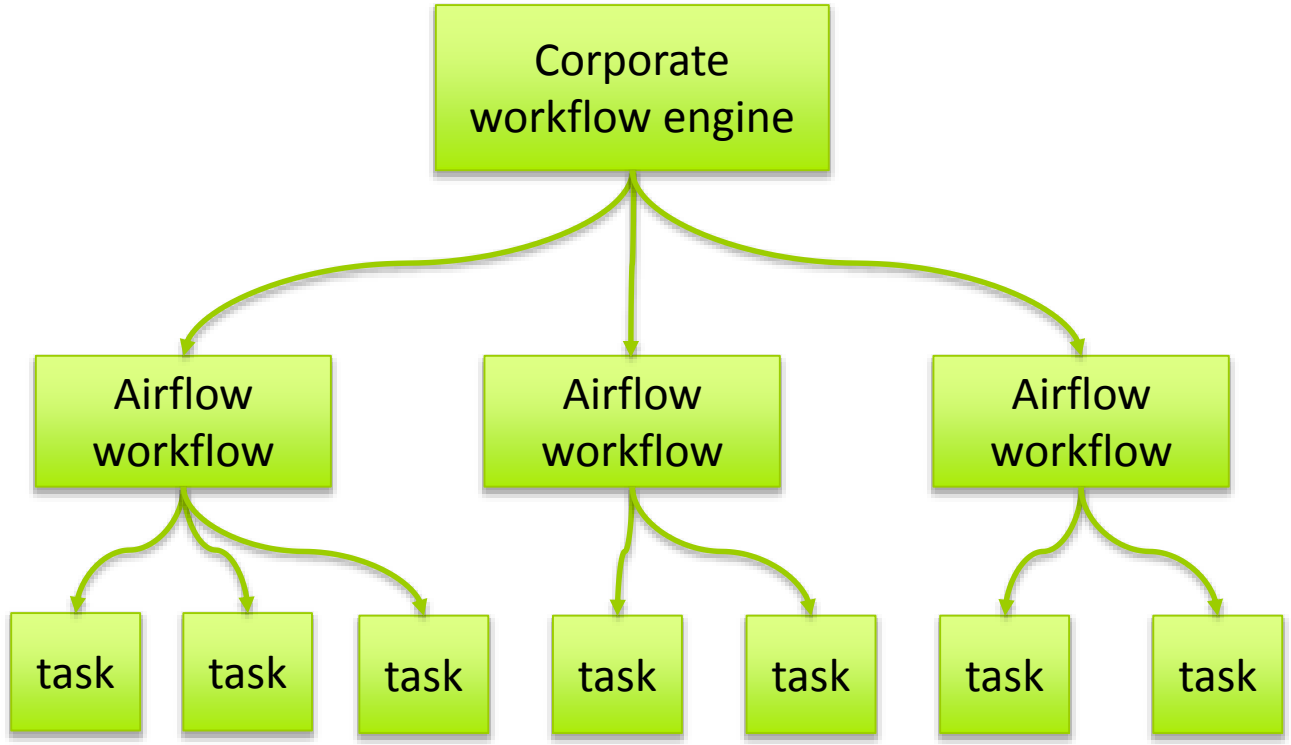
```
from airflow import DAG
import conf
...

dag = DAG('src_pos',
default_args=default_args,
 user_defined_macros=conf.__dict__)


insert = HiveOperator(
task_id='insert',
  sql='insert.sql',
  dag=dag)
...
```

Develop & Deploy Workflows



Integrating with the Enterprise

- Often existing workflow / scheduling tools present (e.g. control M, ...)
- Existing integration in e.g. ticketing systems
- Idea: “Hierarchy“ of engines:
  - Enterprise engine: scheduling, coarse-grained
  - Airflow: workflow, fine-grained



Writing Plugins & Extensions

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- Extension points:
  - **operators**
  - **hooks**
  - executors
  - macros
  - UI adaption (views, links)
- Easy – but also needed ☺
- Start from existing classes, adapt

- Developed so far:
  - SSHFileSensor
  - HiveServer2Operator (you have to!)
  - SparkSQLOperator
  - SparkOperator
  - ...
- integrate via **`airflow_plugin_directory`**

Configs, Gotchas, ..

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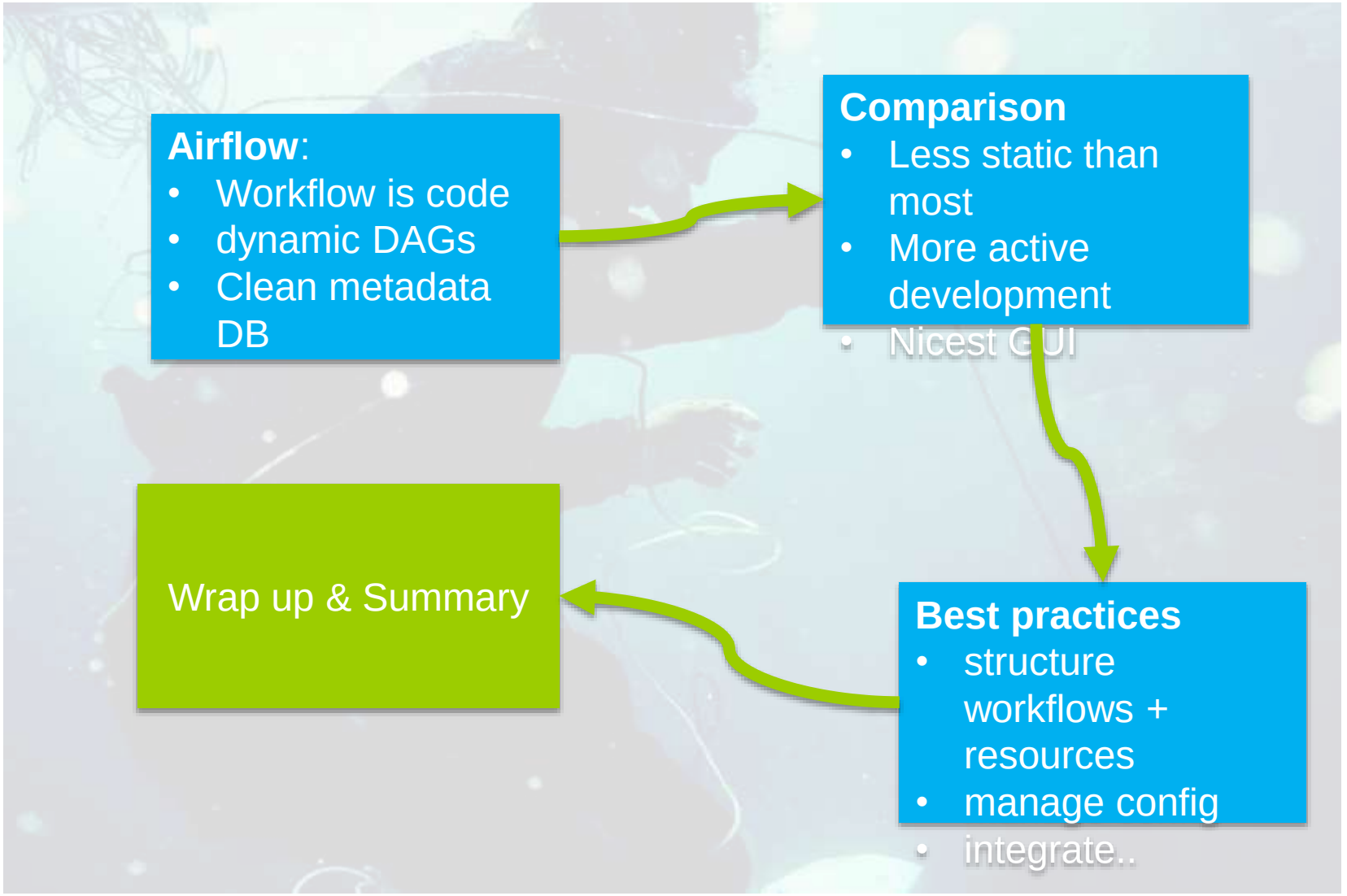
config, topic	explanation
airflow.cfg: **`parallelism`**	max nr. of task instances to run in parallel (per metadata DB / installation)
airflow.cfg: **`dag_concurrency`**	how many parallel tasks are allowed **per dag** (attention: further tasks will **not be scheduled**!)
LDAP integration	works, but problems with LDAPs who implement another „memberOf“ attribute (fixed in 1.9, see AIRFLOW-1095)
Kerberos	kerberos relogin process („airflow kerberos“) broken; workaround = own BashOperator who does kinit with a keytab
Hive integration via impyla	Problems with 1.8.2 (thrift-sasl version mismatch); solution = downgrade thrift_sasl to 0.2.1 (instead of 0.3.0)
...	fore sure more to come ☺

The Flow in Airflow



Summary

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What‘s the flow ..

- Airflow = workflow is code
- Programmatically define DAGs of Operators
- Integrates seamlessly into “pythonic“ data science stack
- Easily extensible (which is needed)
- Lowers the gap between data science + engineering
- Clean management of workflow metadata (state, runs, ...)
- Under active development
- Fun to use, & real-world project proven ☺

Vielen Dank

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