How to balance power and control when using Dataflow with an OLTP SQL Database ?

> By Florian Bastin & Léo Babonnaud



About us

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The Use Case

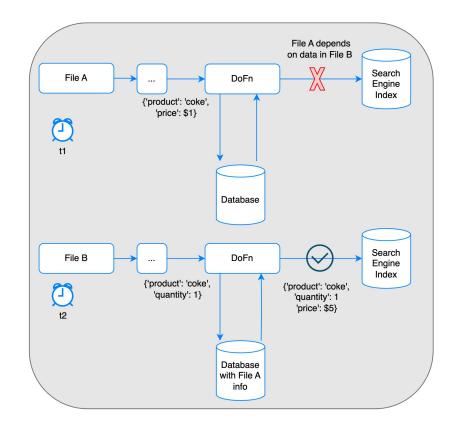
- A Retail Customer use case
- Products information pipeline to serve a search engine index





Requirements.txt

- Dependency between file rows
- No order in files reception
- Random time interval between files reception
- Most updated data in the search engine
- File B may never arrive





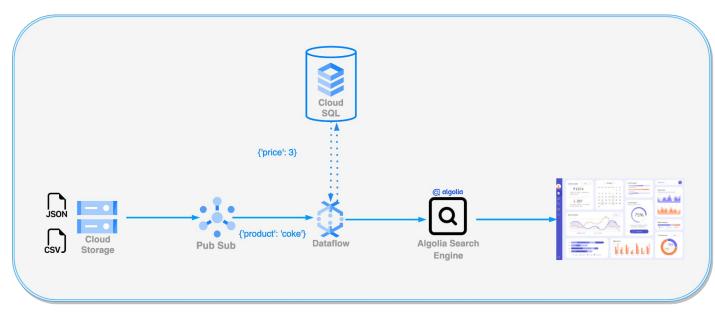
What kind of storage ?

- BigQuery storage, as an OLAP database is used for large storage and fast analytics request
- Cloud SQL is a transactional database good for fast interactions and modifications at the row level.



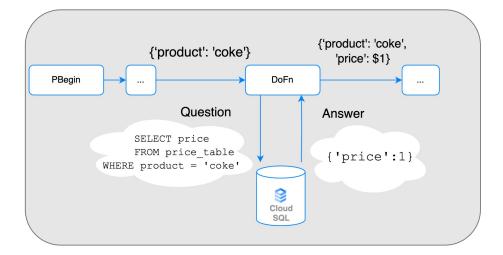
Our Architecture

- Streaming pipeline
- Near real time
- Mini batches
- CRUD operations





An I/O Cloud SQL connector ?



class apache_beam.io.jdbc.ReadFromJdbc(driver_class_name, jdbc_url, username, password, query, output_parallelization=None, fetch_size=None, connection_properties=None, connection_init_sqls=None, expansion_service=None) [source] %

class apache_beam.io.jdbc.WriteToJdbc(driver_class_name, jdbc_url, username, password, statement, connection_properties=None, connection_init_sqls=None, expansion_service=None) [source]



Developing our own connectors: No easy way

How to develop your own I/O connectors using ParDo & GroupByKey operators?

- Connector type
- Pool / Connections control
- Failed worker retry
- Dataflow autoscaling
- Idempotency

The Cloud Sql connector

The Cloud SQL Python Connector provides the following benefits:

- Uses IAM permissions to control who/what can connect to your Cloud SQL instances
- Improved Security between the client connector and the server-side proxy.
- Removes the requirement to use and distribute SSL certificates, as well as manage firewalls or source/destination IP addresses.

```
from google.cloud.sql.connector import Connector
import sqlalchemy
```

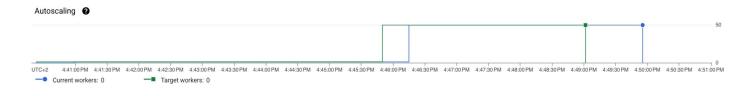
initialize Connector object
connector = Connector()

```
# function to return the database connection
def getconn() -> pymysql.connections.Connection:
    conn: pymysql.connections.Connection = connector.connect(
        "project:region:instance",
        "pymysql",
        user="my-user",
        password="my-password",
        db="my-db-name"
    )
    return conn
# create connection pool
pool = sqlalchemy.create_engine(
        "mysql+pymysql://",
        creator=getconn,
    )
```

DoFn.setup(): Called whenever the DoFn instance is deserialized on the worker. This means it can be called more than once per worker because multiple instances of a given DoFn subclass may be created (e.g., due to parallelization, or due to garbage collection after a period of disuse). This is a good place to connect to database instances, open network connections or other resources.



The Limit of the Cloud SQL Connector

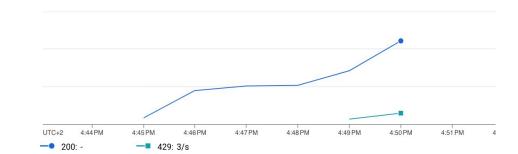


File "/usr/local/lib/python3.9/site-packages/aiohttp/client_reqrep.py", line 1
 raise ClientResponseError(
 aiohttp.client_exceptions.ClientResponseError: 429, message='Too Many Requests',

Traffic by response code

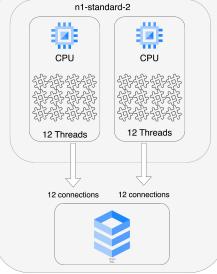
- 2 Cloud SQL Admin API calls/connection
- 600 Cloud SQL Admin API calls/minute

 \rightarrow 300 new connections/minute maximum





How many concurrent operations in



Apache Beam?

- Default 2 vCPUs
- Default 12 threads
- Max 1 DoFn per thread
- 24 Do Fns/n1-standard-2

Beam Python SDK Beam Java/Go SDK			
	Batch	Streaming without Streaming Engine	Streaming Engine
Parallelism	1 process per vCPU 1 thread per	1 process per vCPU 12 threads per process	1 process per vCPU 12 threads per
	process	12 threads per vCPU	process
	1 thread per vCPU		12 threads per vCPU
	1 DoFn per	1 DoFn per thread	1 DoFn per
Maximum number of concurrent DoFn instances (All of these	thread	12 DoFn per vCPU	thread
numbers are subject to change at any time.)	1 DoFn per vCPU		12 DoFn per vCPU

max(connections) = # workers x vCPUs/worker x # threads x # SQLDoFns steps



Leverage the beam.shared module

- Pool of connections shared at the worker level
- apache_beam.utils.Shared module

eline	«Serializable» DoFn Runner		
	can have non-transient instance variable state that will be deserialized		
	do not include enclosing class serializable state; use static nested DoFn or define as anonymous class in static method		
	no shared (global) static variable access (no sync mechanism) but a beam state (based on engine mechanisms) can be injected to processElement		
	keep as pure function as possible or idempotent side effects because DoFns can be retried on failed bundles		
create DoFn	passed instance or descrialized on workers		
initialize state variables by	at pipeline construction step constructor		
	call setup		
	reused instance to process other bundles on the same worker If state variables do not depend on the main pipeline program and are the same for all DoPin instances initialize them in setup		
	For each bundle		
	call startBundle		
	For each element		
	call processElement		
	If state variables are computed by the pipeline pass it in a PcollectionView as a side input		
	output		
	< call onTimer		
	< call finishBundle		
	If DoFn is no more needed: call tearDown		
	Call of teardown is best effort; do not use for side effects		

Use

max(connections) = # workers x # vCPUs/worker x pool size



Failure handling

- Side effects of the DoFn setup
- Exponential backoff algorithm

Jser pipeline	<i>«Serializable»</i> DoFn	Runner
ereate DoFn	variable s do not in nested D no shared state (bas keep as p because l	non-transient instance tate that will be descrialized offen orchosing class serializable state; use static offen or define as anonymous class in static method It (global) static variable access (no syne mechanism) but a beam de on engine mechanisms) can be injected to processElement ourre function as possible or idempotent side effects DoPns can be retried on failed bundles
If state variables are known initialize state variables by		tion step
D	oFn Lifecycle	
	call set	up
	If state v same for For each bundle	nstance to process other bundles on the same worker variables do not depend on the main pipeline program and are the all DoP's instances initialize them in setup rtBundle
	For each element	
		ocessElement
	If state v pass it in	variables are computed by the pipeline a Peollection/New as a side input
	call on?	Fimer
	<	ishBundle
	If DoFn i	is no more needed: call tearDown
	Call of t	eardown is best effort; do not use for side effects

max(connections) = # workers x # vCPUs/worker x pool size



A focus on idempotency

How to deal with "the not exactly" once execution?

- 'SQL' Definition : An operation that produces the same results no matter how many times it is performed
- INSERT and UPDATE statements have to be done carefully
- Check the state of a row before applying a statement

```
CREATE TABLE my_schema.product_table (

id VARCHAR(32) NOT NULL,

product VARCHAR(32) NOT NULL,

quantity NUMERIC(9) NOT NULL

PRIMARY KEY(id)

);

-- KO
```

```
INSERT INTO my_schema.product_table ('id', 'product')
VALUES ('coke_id', 'coke', 1000)
-- ERROR: duplicate key value violates unique constraint...
```

```
-- OK
INSERT INTO my_schema.product_table ('id', 'product')
VALUES ('coke_id', 'coke', 1000)
ON CONFLICT DO NOTHING
```



Our solution

```
pipeline(pipeline_options, data_size: int, max_num_workers: int, pool_size: int):
def
   with beam.Pipeline(options=pipeline_options) as p:
       shared handle = shared.Shared()
       data = p | beam.Create(range(data_size)) | beam.Reshuffle()
       prepared_data = data | beam.ParDo(PreprocessData())
       enriched_data = (prepared_data
                         | "Reduce parallelism" >> beam.Reshuffle(num_buckets=max_num_workers)
                          "Cloud SQL Do Fn" >> beam.ParDo(EnrichSQLDoFn(shared_handle=shared_handle, pool_size=pool_size))
                          "Maximize parallelism" >> beam.Reshuffle()
```

enriched_data | beam.ParDo(AnotherPreprocessData())



Key takeaways

- The available Apache Beam Cloud SQL connectors are useful as an input or output of a pipeline
- Configuring your own Cloud SQL connector using DoFns requires:
 - The use of the Setup method for instantiation
 - The use of beam Shared module to share a connection pool
 - A well defined connector object if the workload is heavy
 - A retry mechanism in case of failed requests (Exponential Backoff Algorithm for instance)
 - Carefully chosen idempotent SQL statements



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QUESTIONS?

Florian Bastin: Linkedin Léo Babonnaud: Linkedin

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