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Delta Lake

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What is Delta Lake?

What is Delta Lake?

What is Delta Lake?

https://delta.io

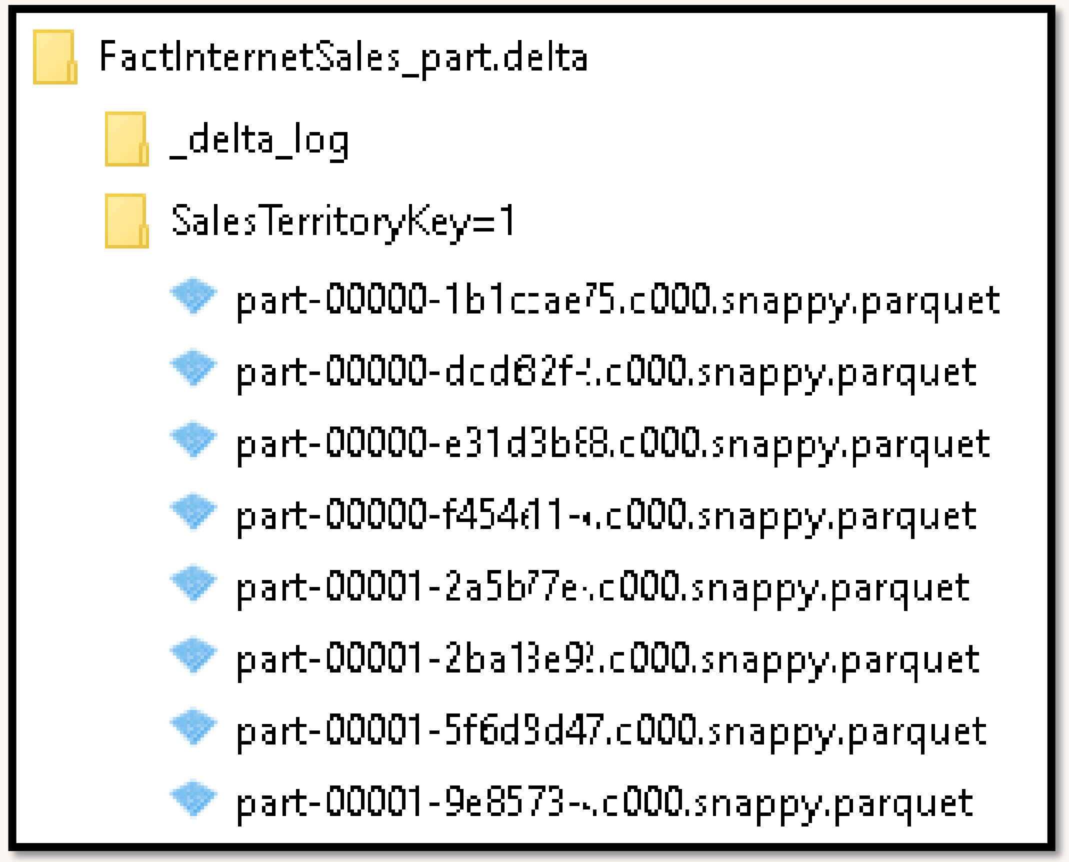
Delta Lake is an open-source storage framework that enables building a Lakehouse architecture with compute engines including Spark, PrestoDB, Flink, Trino, and Hive and APIs for Scala, Java, Rust, Ruby, and Python.

- ACID compliant transactions
    - Optimistic Concurrency Control
- Support for UPDATE / MERGE
- Time-Travel
- Schema enforcement and evolution
- Batch & Streaming
- 100% compatible with Spark

What is Delta Lake?

https://delta.io

- Built for Cloud Object stores
- Everything is stored in one folder
  - Meta-data
  - Transaction log / **Delta Log**
  - Data
- Could basically Copy & Paste whole Delta table
- Supports any storage sub-system
- Consumer only needs location



```
FactInternetSales_part.delta
    _delta_log
    SalesTerritoryKey=1
        part-00000-1b1c:ae75.c000.snappy.parquet
        part-00000-dcd82f-.c000.snappy.parquet
        part-00000-e31d3b88.c000.snappy.parquet
        part-00000-f454d11-.c000.snappy.parquet
        part-00001-2a5b77e-.c000.snappy.parquet
        part-00001-2ba13e9.c000.snappy.parquet
        part-00001-5f6d9d47.c000.snappy.parquet
        part-00001-9e8573-.c000.snappy.parquet
```

Delta Lake is the default for all tables created in Databricks

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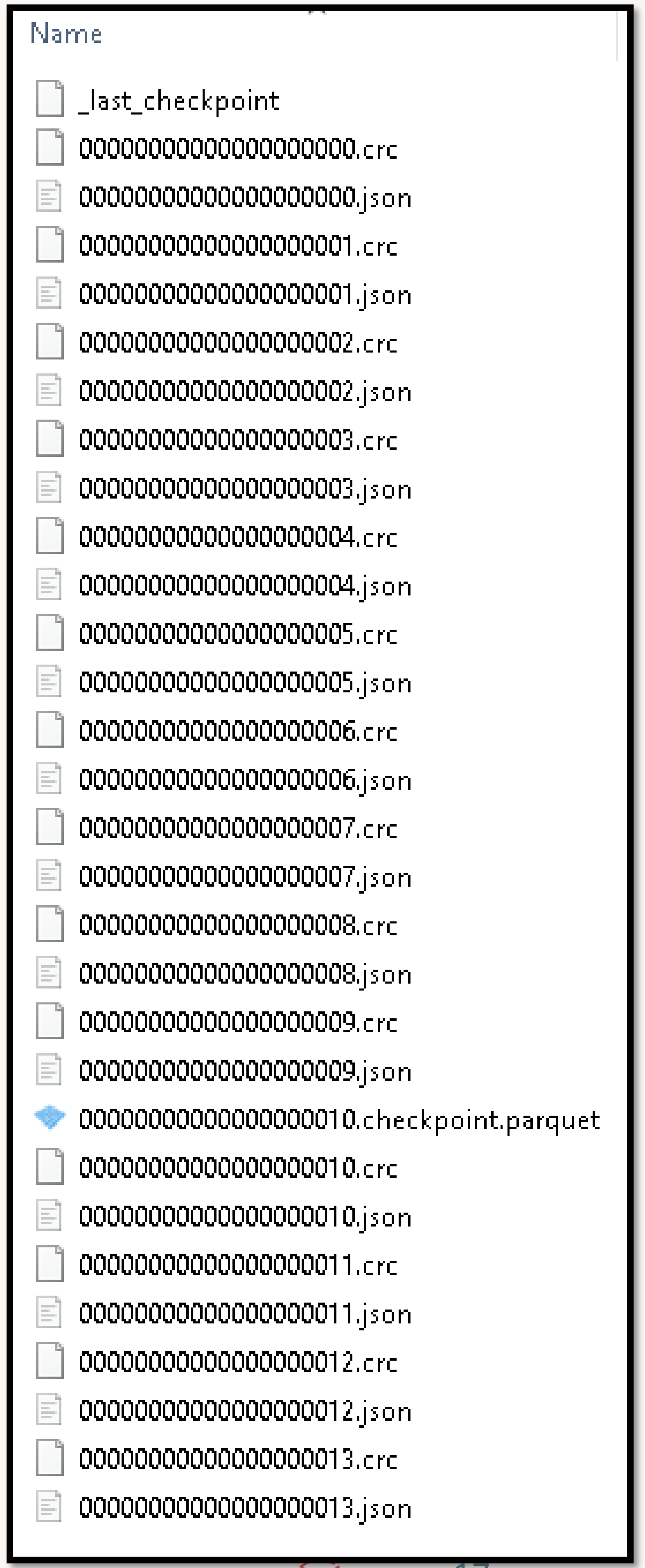
What is the Delta Log?

What is the Delta Log?

The Transactional Layer

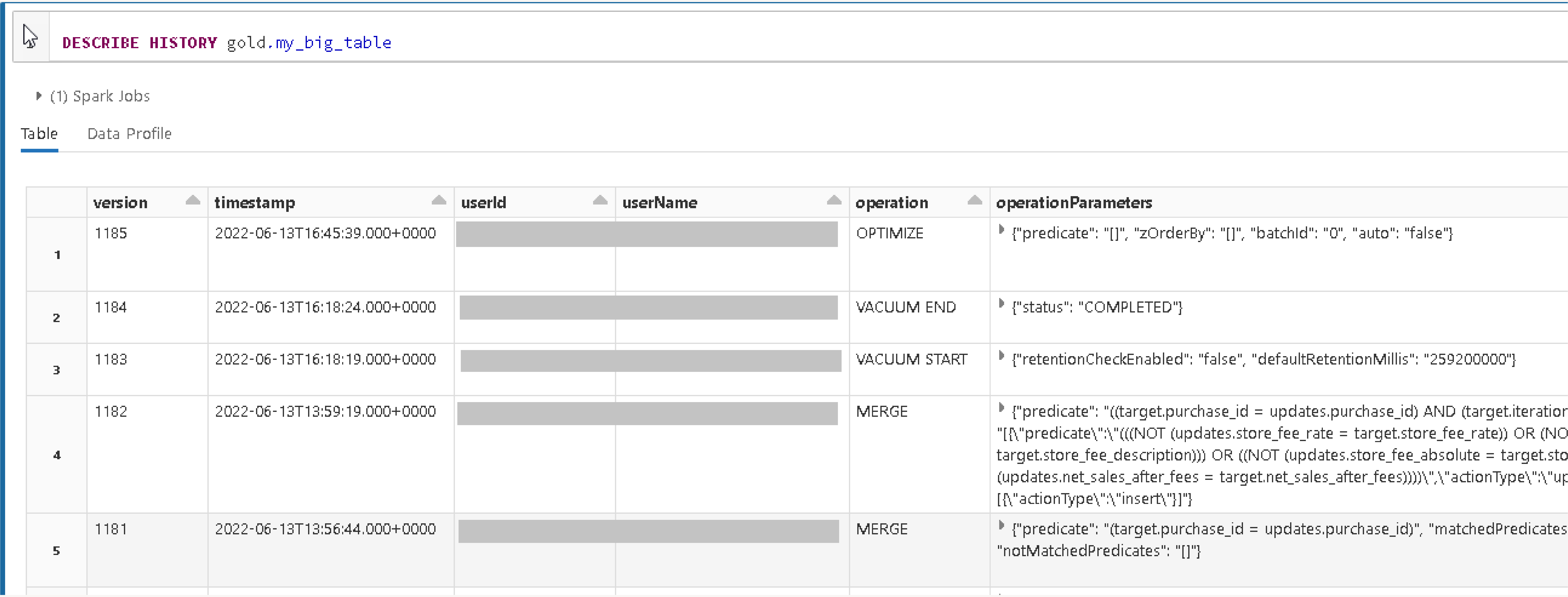
- Contains
  - Table schema + changes
  - References to files
  - Metadata and metrics
- Stored as JSON and Parquet
- One file/version per transaction
- Allows [optimistic] concurrency control
- Used for time-travel, streaming, …



```
Name
_last_checkpoint
00000000000000000000.crc
00000000000000000000.json
00000000000000000001.crc
00000000000000000001.json
00000000000000000002.crc
00000000000000000002.json
00000000000000000003.crc
00000000000000000003.json
00000000000000000004.crc
00000000000000000004.json
00000000000000000005.crc
00000000000000000005.json
00000000000000000006.crc
00000000000000000006.json
00000000000000000007.crc
00000000000000000007.json
00000000000000000008.crc
00000000000000000008.json
00000000000000000009.crc
00000000000000000009.json
00000000000000000010.checkpoint.parquet
00000000000000000010.crc
00000000000000000010.json
00000000000000000011.crc
00000000000000000011.json
00000000000000000012.crc
00000000000000000012.json
00000000000000000013.crc
00000000000000000013.json
```

What is the Delta Log?

DESCRIBE HISTORY



```
DESCRIBE HISTORY gold.my_big_table
```

(1) Spark Jobs

Table   Data Profile

	version	timestamp	userId	userName	operation	operationParameters
1	1185	2022-06-13T16:45:39.000+0000	[redacted]	[redacted]	OPTIMIZE	{"predicate": "[]", "zOrderBy": "[]", "batchId": "0", "auto": "false"}
2	1184	2022-06-13T16:18:24.000+0000	[redacted]	[redacted]	VACUUM END	{"status": "COMPLETED"}
3	1183	2022-06-13T16:18:19.000+0000	[redacted]	[redacted]	VACUUM START	{"retentionCheckEnabled": "false", "defaultRetentionMillis": "259200000"}
4	1182	2022-06-13T13:59:19.000+0000	[redacted]	[redacted]	MERGE	{"predicate": "((target.purchase_id = updates.purchase_id) AND (target.iteratior "[{\"predicate\":\"(((NOT (updates.store_fee_rate = target.store_fee_rate)) OR (NO target.store_fee_description))) OR ((NOT (updates.store_fee_absolute = target.sto (updates.net_sales_after_fees = target.net_sales_after_fees))))\",\"actionType\":\"up [{\"actionType\":\"insert\"}]"}
5	1181	2022-06-13T13:56:44.000+0000	[redacted]	[redacted]	MERGE	{"predicate": "(target.purchase_id = updates.purchase_id)", "matchedPredicates "notMatchedPredicates": "[]"}

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How does Delta Lake work?

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DML Operations – UPDATE

User

Product	Price
Notebook	900 €
PC	1,500 €
Tablet	500 €

```
UPDATE DimProduct
SET Price = 1300
WHERE Product = 'PC'
```

Product	Price
Notebook	900 €
PC	1,300 €
Tablet	500 €

_delta_log

0000.json

"add": { "part-01.parquet", … }

0001.json

"remove": { "path": "part-01.parquet", … },
"add": { "path": "part-02.parquet", … }

Storage

part-01
(3 rows)

part-01
(3 rows)

part-02
(3 rows)

DML Operations – DELETE

User

Product	Price
Notebook	900 €
PC	1,300 €
Tablet	500 €

```sql
DELETE FROM DimProduct
WHERE Product = 'PC'
```

Product	Price
Notebook	900 €
Tablet	500 €

_delta_log

0000.json

0001.json

"remove": { "path": "part-01.parquet", … },
"add": { "path": "part-02.parquet", … }

0002.json

"remove": { "path": "part-02.parquet", … },
"add": { "path": "part-03.parquet", … }

Storage

Parquet
part-01
(3 rows)

Parquet
part-02
(3 rows)

Parquet
part-01
(3 rows)

Parquet
part-02
(3 rows)

Parquet
part-03
(2 rows)

DML Operations – INSERT

User

Product	Price
Notebook	900 €
Tablet	500 €

```
INSERT INTO DimProduct
VALUES ('Monitor', 200)
```

Product	Price
Notebook	900 €
Tablet	500 €
Monitor	200 €

_delta_log

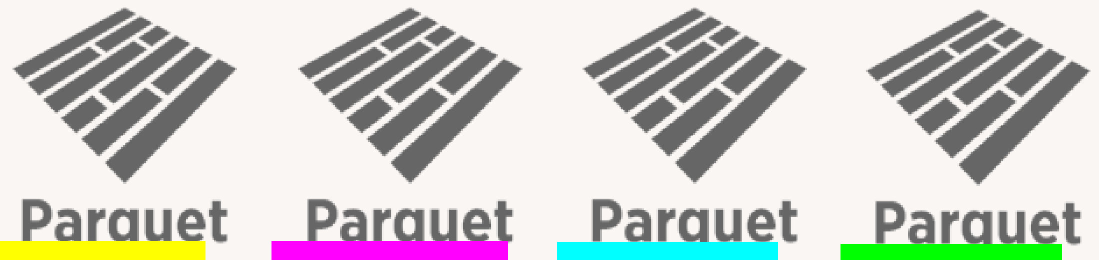
0000.json
0001.json

0002.json
"remove": { "path": "part-02.parquet", … },
"add": { "path": "part-03.parquet", … }

0003.json
"add": { "path": "part-04.parquet", … }

Storage

part-01 (3 rows)
part-02 (3 rows)
part-03 (2 rows)



part-01 (3 rows)
part-02 (3 rows)
part-03 (2 rows)
part-04 (1 row)

DML Operations

- Operations are logged in **`_delta_log`**
  - Old files are **logically(!)** removed
  - New files are added

- Most operations create new files! Even a **`DELETE can`**!

Can create A LOT of files!

File & Storage Management

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Data Management – VACUUM

User

Product	Price
Notebook	900 €
Tablet	500 €
Monitor	200 €

```
VACUUM DimProduct
```

Product	Price
Notebook	900 €
Tablet	500 €
Monitor	200 €

_delta_log

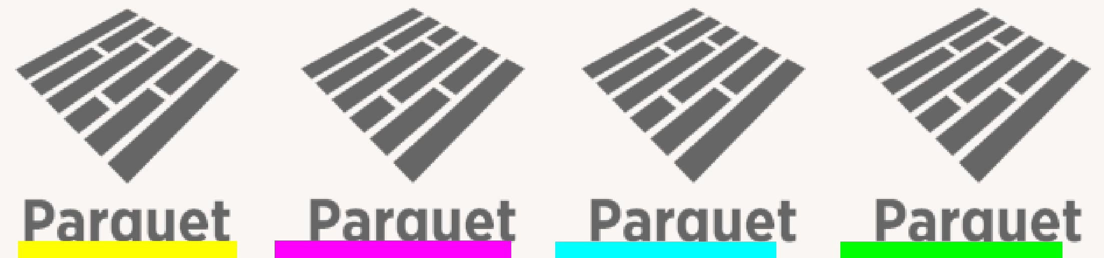
0000.json … **0003.json**

0004.json
"add": { "path": "part-04.parquet", … }

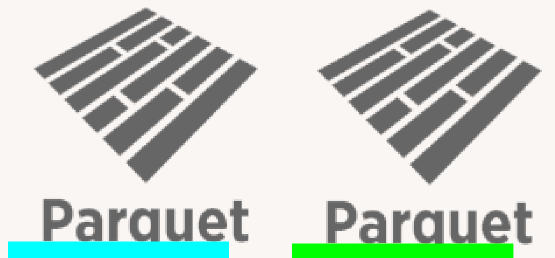
0005.json
{"VACUUM START ", … "numFilesToDelete": 2, … }

0006.json
{"VACUUM END ", … "numDeletedFiles": 2, … }

Storage



part-01 (3 rows)
part-02 (3 rows)
part-03 (2 rows)
part-04 (1 row)



part-03 (2 rows)
part-04 (1 row)

Data Management – OPTIMIZE

User

Product	Price
Notebook	900 €
Tablet	500 €
Monitor	200 €

```
OPTIMIZE DimProduct
```

Product	Price
Notebook	900 €
Tablet	500 €
Monitor	200 €

_delta_log

0000.json … **0005.json**

0006.json

{"VACUUM END ", … "numDeletedFiles": 2, … }

0007.json

"remove": { "path": "part-03.parquet", … }
"remove": { "path": "part-04.parquet", … }
"add": { "path": "part-05.parquet", … }

Storage

part-03
(2 rows)

part-04
(1 row)

part-03
(2 rows)

part-04
(1 row)

part-05
(3 rows)

Data Management

VACUUM

- Physically removes unreferenced files older than X days
- Never touches files of latest version of Delta table!

```
VACUUM events
[RETAIN num HOURS]
[DRY RUN]
```

OPTIMIZE

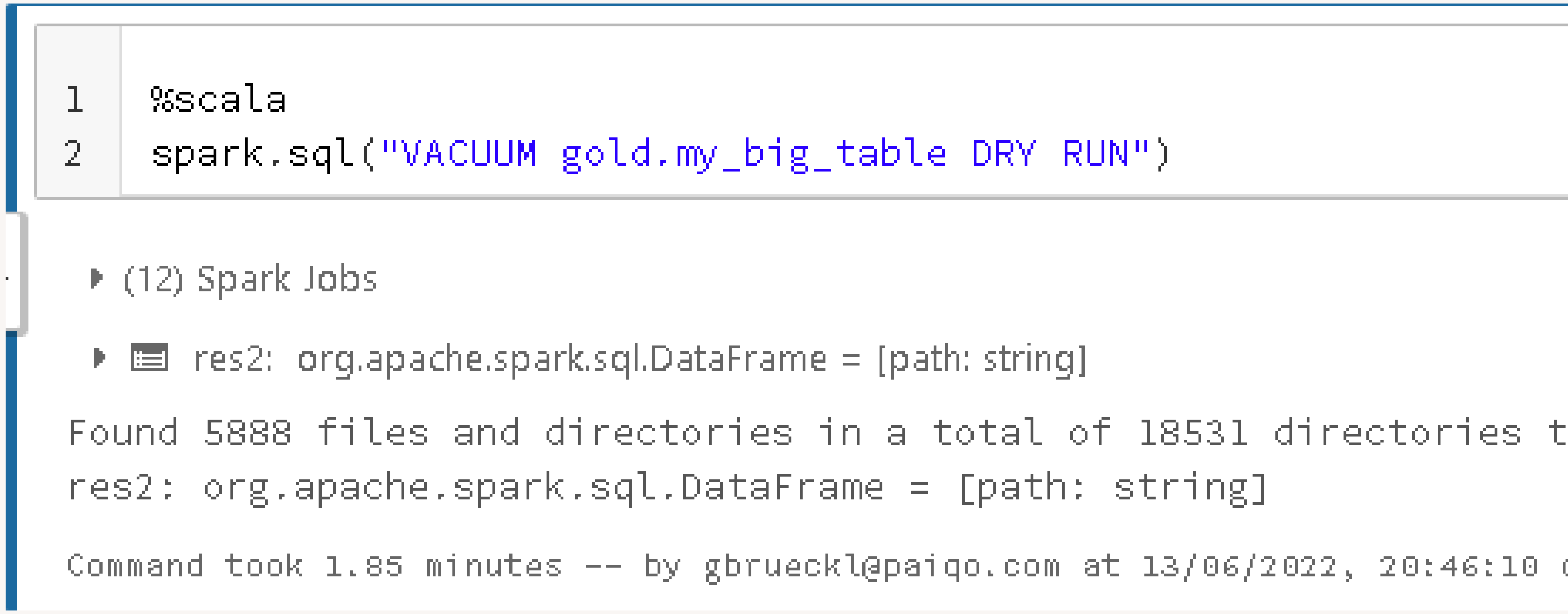
- Collapse small files into bigger files
- Clustering / Ordering
- Improve query performance

```
OPTIMIZE events
[WHERE date = 20200101]
[ZORDER BY (eventType)]
```

Data Management

VACUUM and OPTIMIZE

- VACUUM DRY RUN
  - Only shows first 1000 files to be deleted
  - Use SCALA to get the actual number of files to be removed!
- Can take a long time!
- OPTIMIZE
  - works per partition level



```
%scala
spark.sql("VACUUM gold.my_big_table DRY RUN")
```

▸ (12) Spark Jobs

▸ res2: org.apache.spark.sql.DataFrame = [path: string]

```
Found 5888 files and directories in a total of 18531 directories t
res2: org.apache.spark.sql.DataFrame = [path: string]
```

Command took 1.85 minutes -- by gbrueckl@paiqo.com at 13/06/2022, 20:46:10 o

Data Management

RESTORE

- Restores a previous state of the Delta table
- At **`version`** or **`timestamp`**
- Meta-data only operation
- Creates a new version

```
RESTORE events
TO TIMESTAMP AS OF
'2022-05-03'
```

CLONE

- **`SHALLOW`** or **`DEEP`**
- Forks Delta Log
  - **`DEEP`**: copies data files
  - **`SHALLOW`**: references data files
- Ideal for testing

```
CREATE TABLE
events_clone
SHALLOW CLONE events;
```

Data Management

`RESTORE and CLONE`

- You can RESTORE as often as you want
  - To rollback another RESTORE
- RESTORE does not create any new [data] files
- DEEP Clones are incremental and can be used for Backup

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Demo

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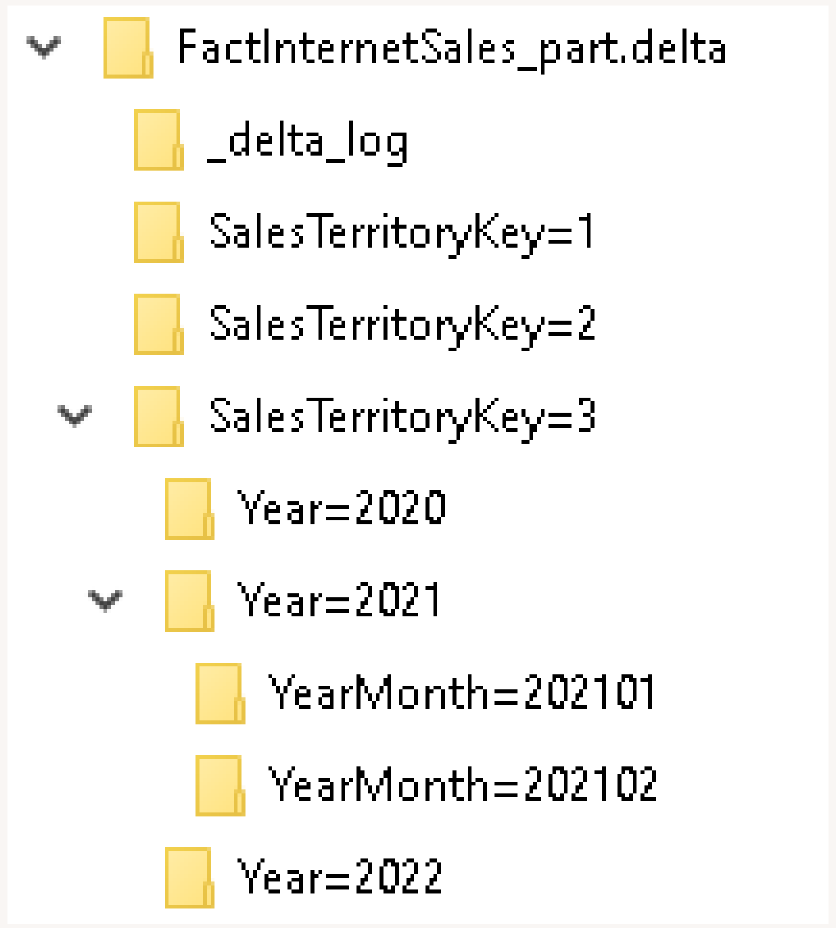
Partitioning

Partitioning

Basics

- Delta Tables can be partitioned
  - For ETL performance (usually on Bronze, Silver)
  - For query performance (usually on Gold)
- **Goal:** touch as few partitions as possible/necessary
  - ETL and Query performance can conflict
  - Explicitly specify Partitioning columns

- Partition by Time [and ?]



```
FactInternetSales_part.delta
  _delta_log
  SalesTerritoryKey=1
  SalesTerritoryKey=2
  SalesTerritoryKey=3
    Year=2020
    Year=2021
      YearMonth=202101
      YearMonth=202102
    Year=2022
```

Partitioning

Advanced

- Avoid over-partitioning!
  - < few 1000s partitions
  - Single partition should be > 1 GB
- Use generated columns
  - `EventTimestamp` -> partition by `CAST(EventTimestamp AS DATE)`
  - Delta engine will [try to] push filters on `EventTimestamp` down to partition
- Used to separate transactions and processing jobs
  - Explicitly specify partitions you touch (e.g. `MERGE` target)!
  - Check Delta Log history for query predicates!

Partitioning

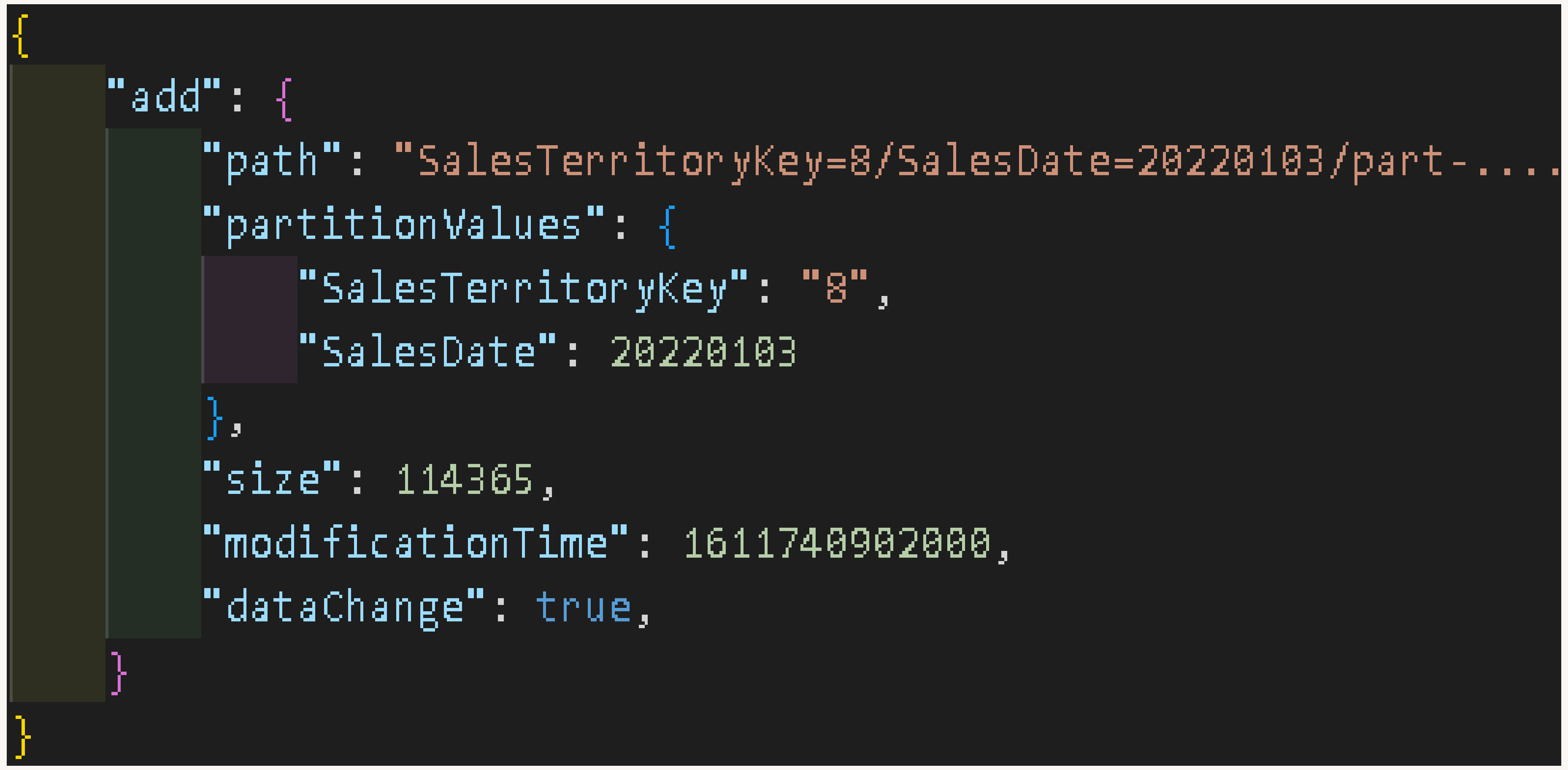
Advanced

- Physical .parquet file does not contain the partitioning-columns!

- `path` could point anywhere!

- You do not need to specify all partitioning columns sequentially!

`_delta_log Entry`



```
{
    "add": {
        "path": "SalesTerritoryKey=8/SalesDate=20220103/part-....
        "partitionValues": {
            "SalesTerritoryKey": "8",
            "SalesDate": 20220103
        },
        "size": 114365,
        "modificationTime": 1611740982000,
        "dataChange": true,
    }
}
```

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Streaming

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Streaming

Basics

- Delta Lake can be used as source and target for streaming
- It’s technically still [micro-]batches
  - As is Spark Streaming
- Streaming works on a file-level
- Files are processed in order of
  - Version/Transaction number
  - File index (**`part-XXXXX…snappy.parquet`**)

Streaming

Advanced

- Checkpoints
  - Track state of what has already been processed from source
  - One checkpoint per source
  - Could stream from same source multiple times using different checkpoints
- **`MERGE`** only with **`foreachBatch()`**
- Control the Trigger/Batch size!
- Avoid **`Trigger.Once`**
- Can stop/resume stream at any time

Delta Lake TableProperties

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Delta Lake Table Properties

- Can be defined on different levels
- Table Properties
    - `delta.autoOptimize.optimizeWrite`
    - `spark.databricks.delta.properties.defaults.optimizeWrite` (default for new tables)
- Configured Settings during Execution
    - `spark.databricks.delta.optimizeWrite.enabled`
- Execution settings have priority over table properties!

Delta Lake Table Properties

Important Table Properties to know

- delta.appendOnly
- delta.autoOptimize.autoCompact
- delta.autoOptimize.optimizeWrite
- delta.deletedFileRetentionDuration
- delta.logRetentionDuration
- delta.dataSkippingNumIndexedCol

Delta Lake Table Properties

- Use defaults for commands
- Define exceptions on table level

→ No need to use individual commands per table

- Changing table properties are also a Delta transaction

Conclusion

Take Aways

- Delta Lake can solve a lot of problems for you
- File management is crucial
- Data maintenance jobs are mandatory
- Use table properties