Exploring Apache Iceberg - A Modern Data Lake Stack

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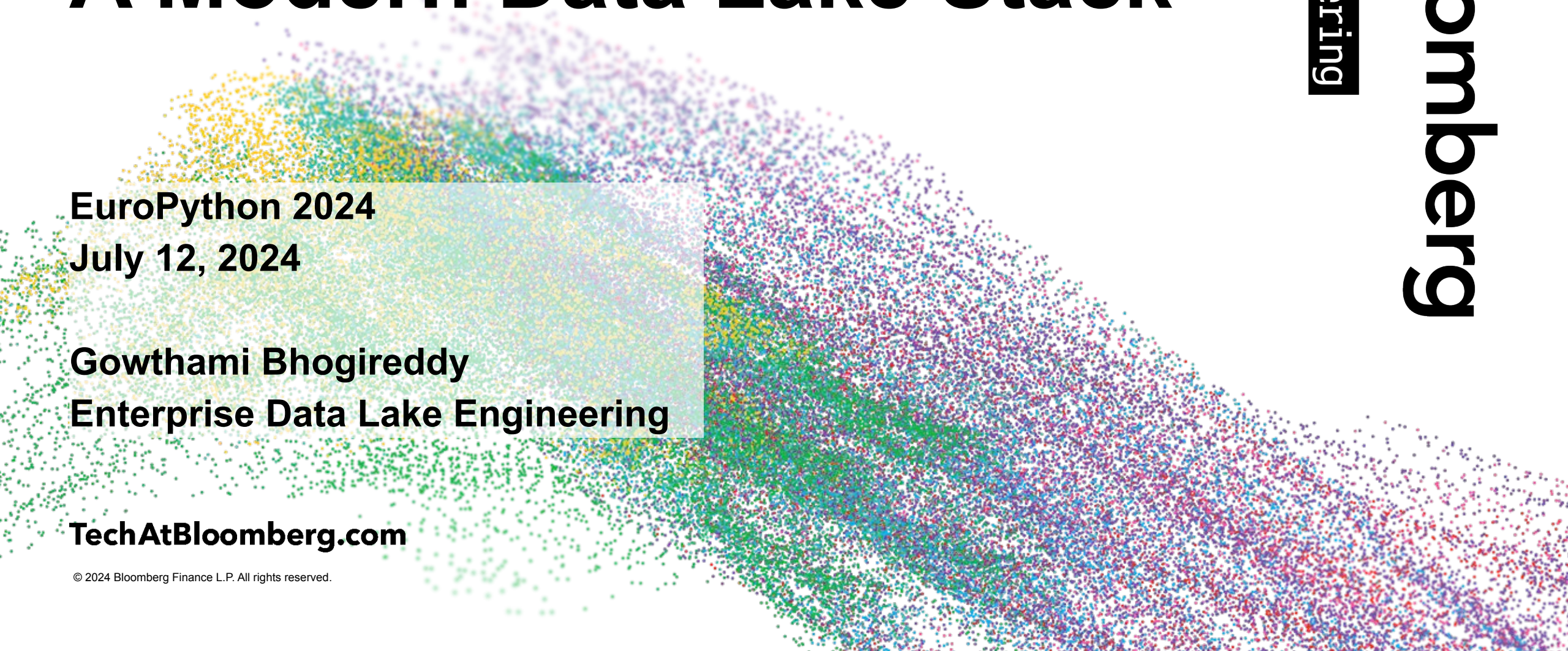

EuroPython 2024
July 12, 2024

Gowthami Bhogireddy
Enterprise Data Lake Engineering

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Who Am I?

Software Engineer at Bloomberg

👉https://www.linkedin.com/in/gowthami-bhogireddy-7335427b/

👉 PyIceberg Open Source Contributor

👉 First time EuroPython speaker, yay!

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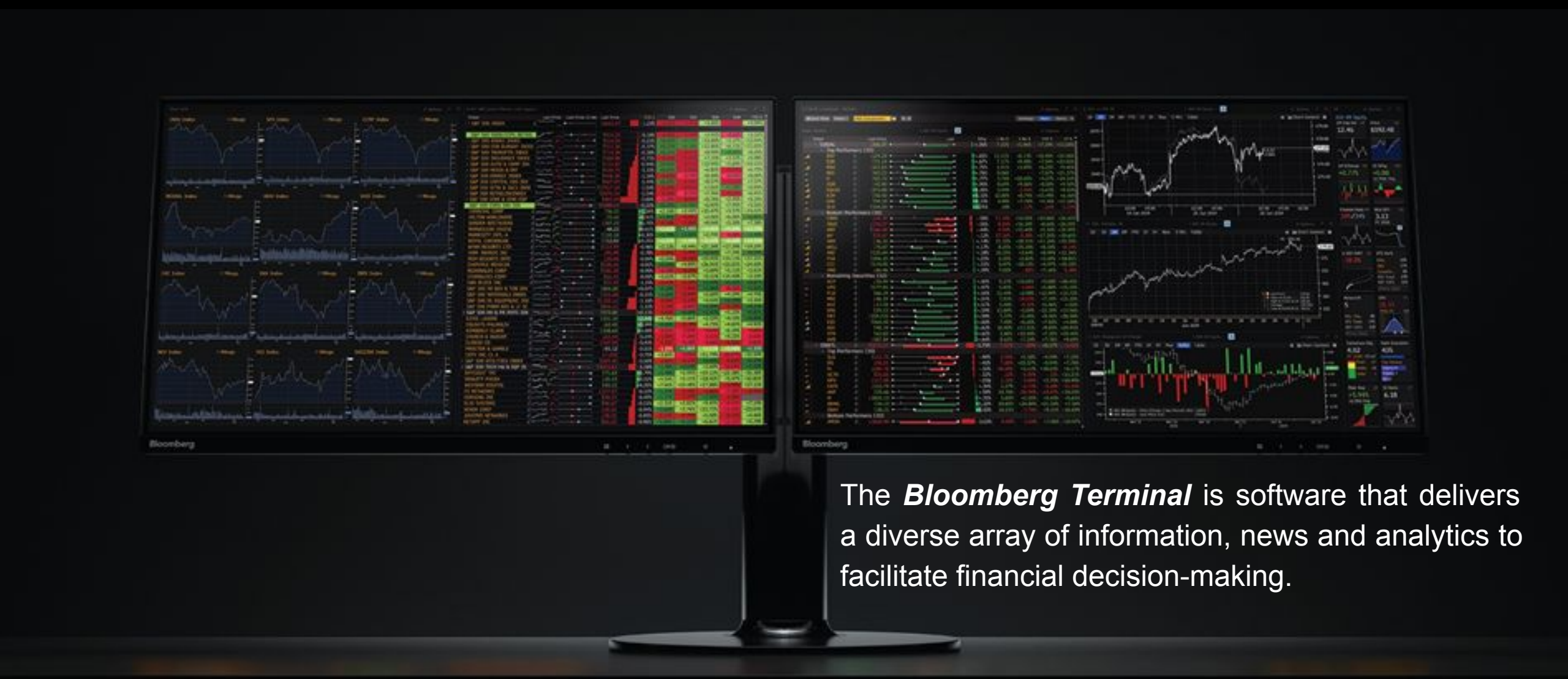

The ***Bloomberg Terminal*** is software that delivers a diverse array of information, news and analytics to facilitate financial decision-making.

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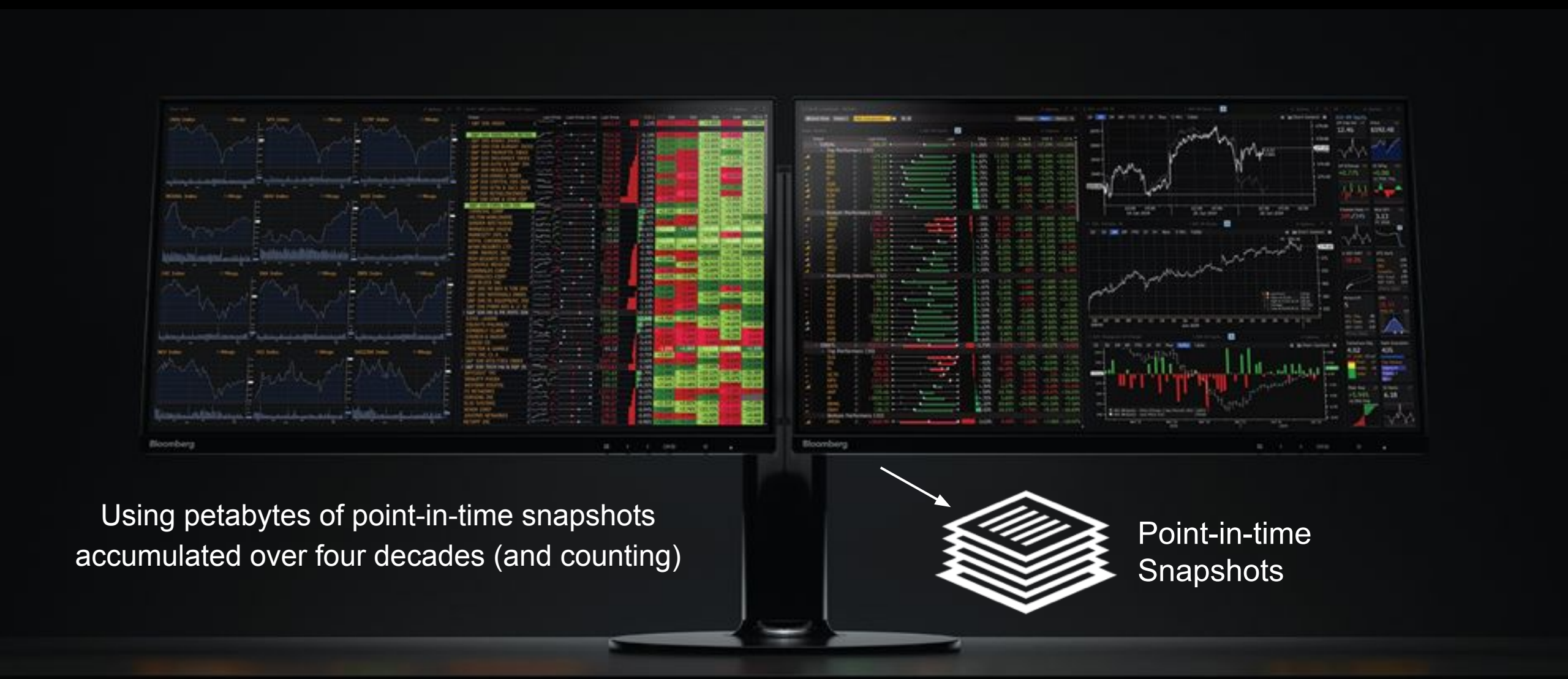

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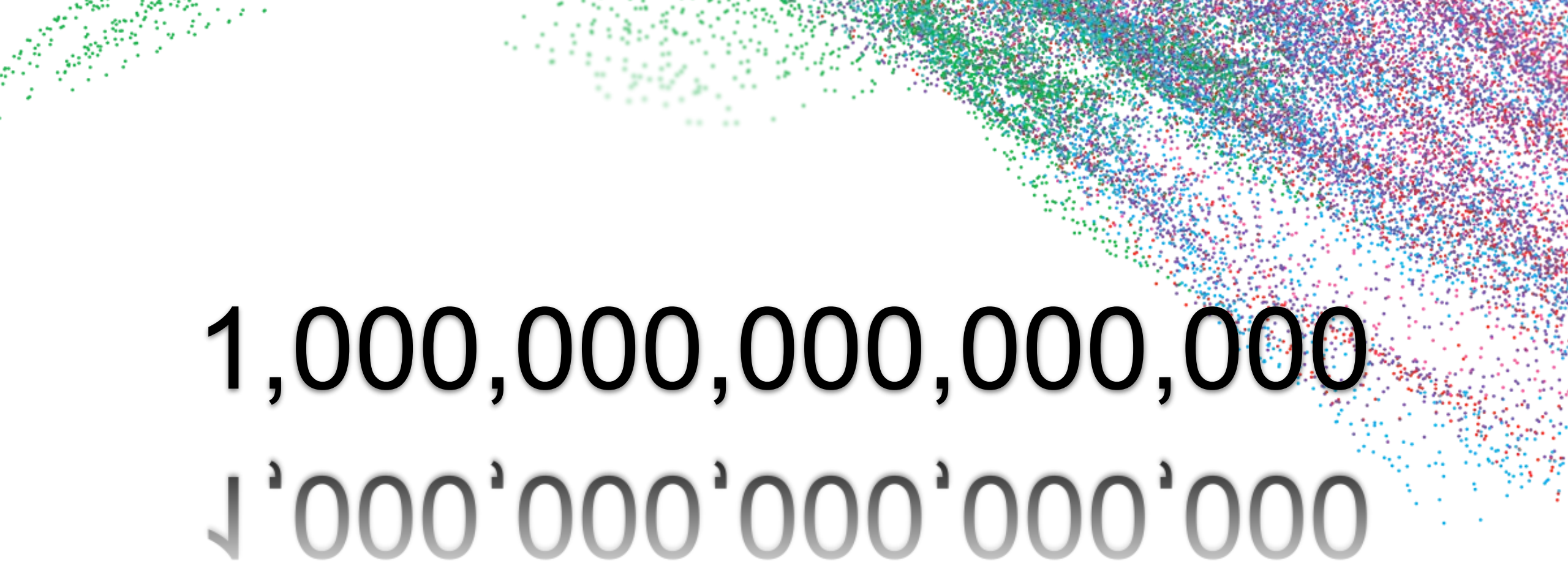

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Agenda

1. Building a historical data lake using Apache Iceberg
2. Demo - Ways to interact with Apache Iceberg

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Building a historical data lake using Apache Iceberg

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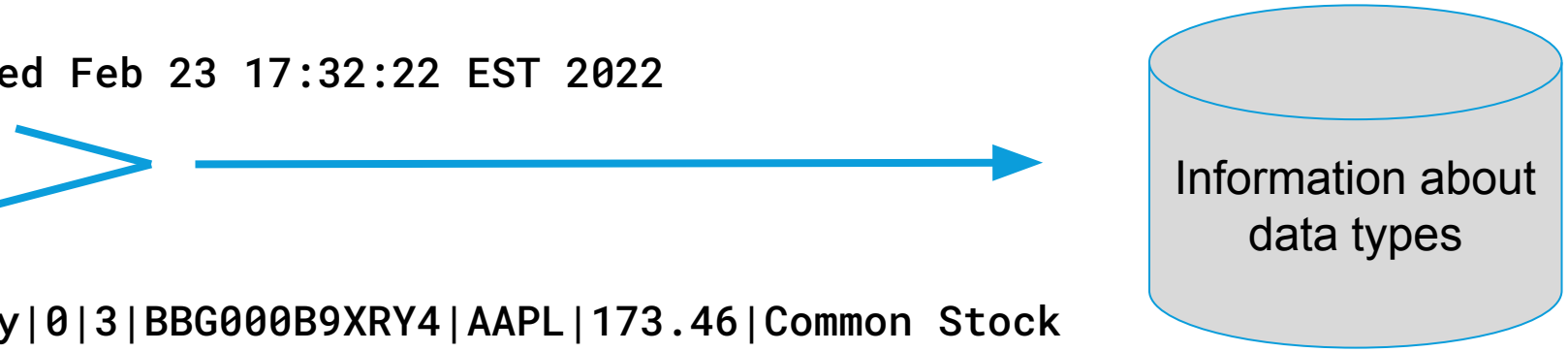
Example data

```
TIMESTARTED=Wed Feb 23 17:32:22 EST 2022
COMPANY_ID
TICKER
PRICE
START-OF-DATA
AAPL US Equity|0|3|BBG000B9XRY4|AAPL|173.46|Common Stock
IBM US Equity|0|3|BBG000BLNNH6|IBM|129.43|Common Stock
…
END-OF-DATA
DATARECORDS=2
TIMEFINISHED=Wed Feb 23 17:41:32 EST 2022
```




```
COMPANY_ID: string
TICKER: string
PRICE: double
```

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Summary of Problems

- **Data Format** - Text files
- **Data Volume** - PBs of data
- **Scale** - Tens of millions of files (and only growing)

Data Lake Requirements

Golden copy of data

Audit trail

Schema Evolution

ACID guarantees

Data Analysis

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What is Iceberg?

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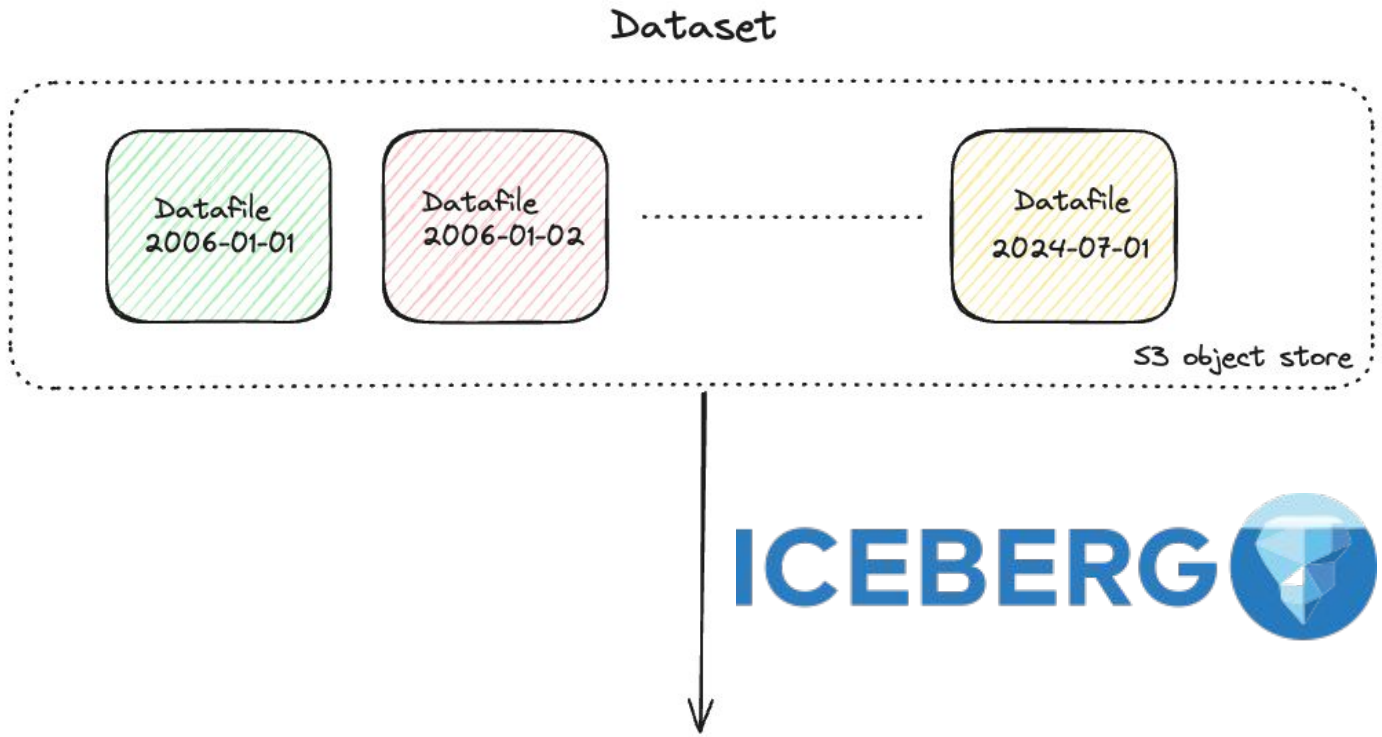

SQL
LIKE
BEHAVIOR

DATE_PUBLISHED	SECURITY	PRICE
2006-01-02	APPL	34.4
2024-07-01	APPL	200.08

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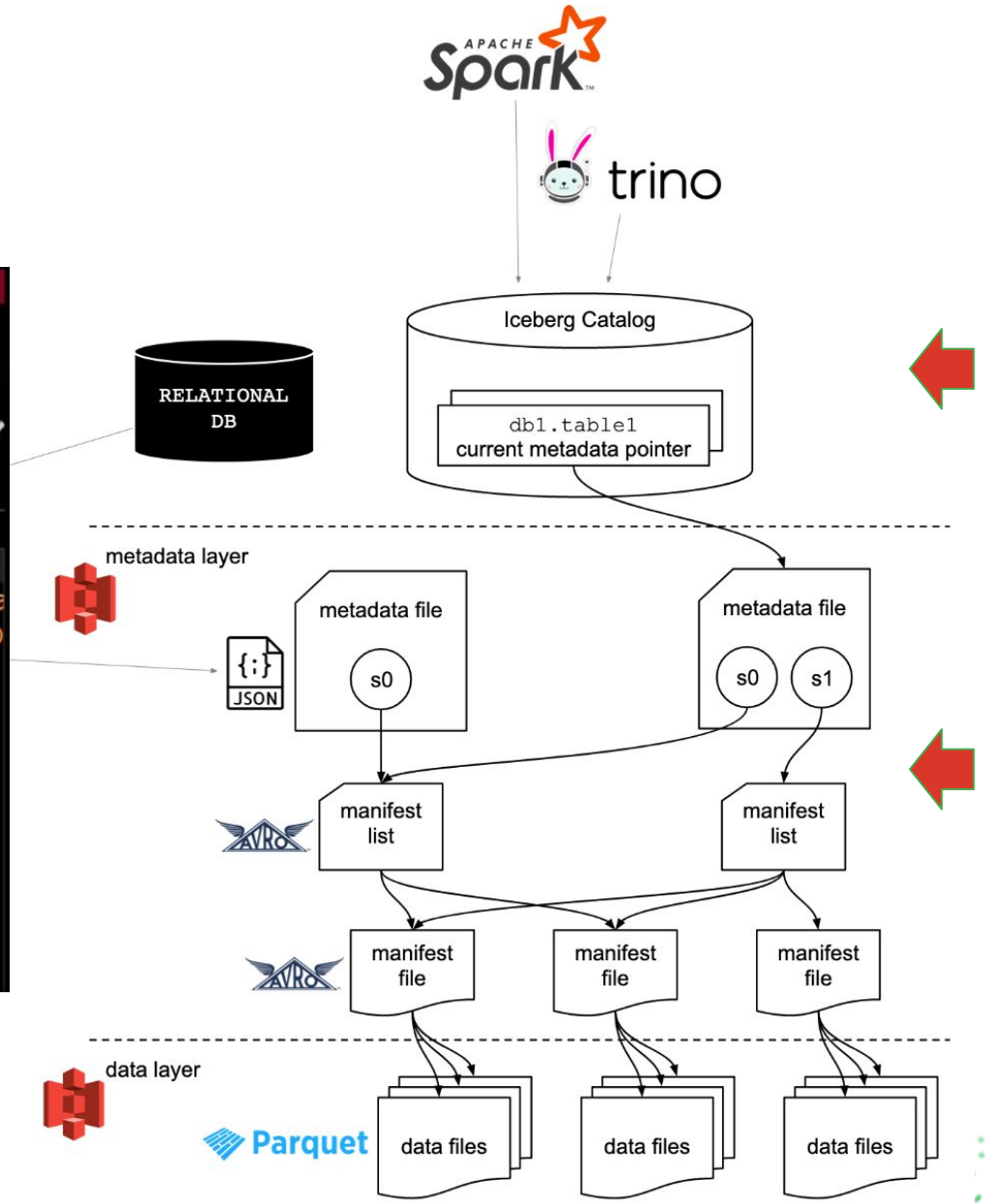
✅ Open table format

❌ Storage layer

❌ Compute Engine

Iceberg Internals

Bloomberg Database UI



Why Iceberg?

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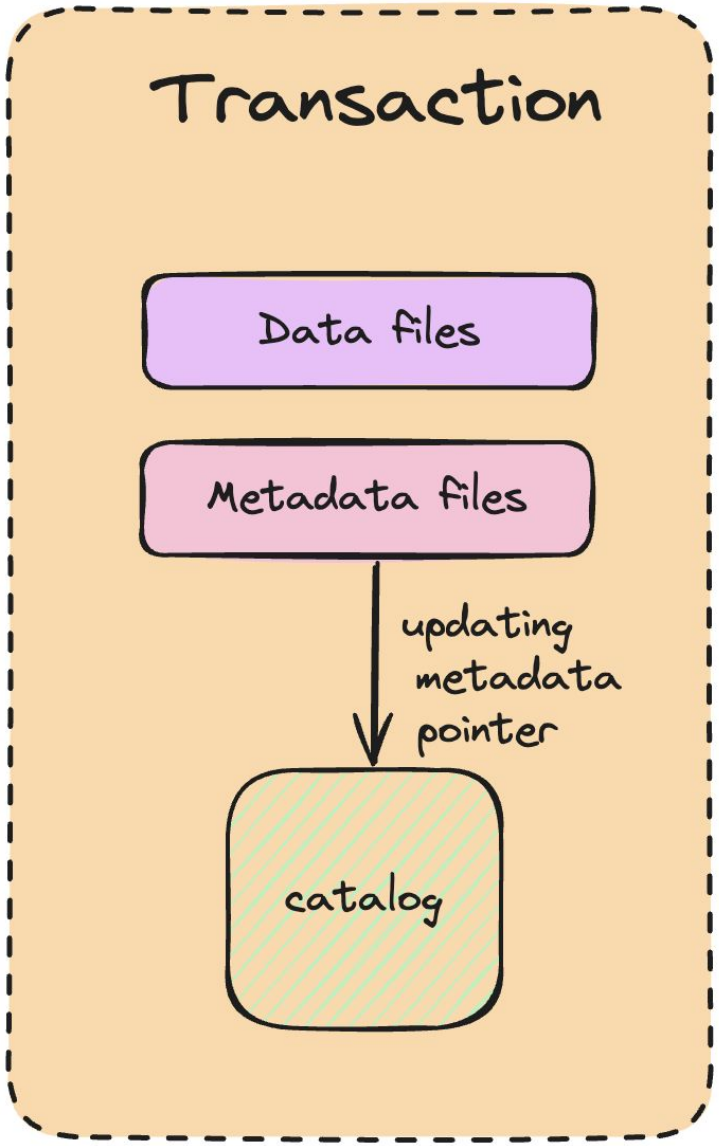
ALL OR NOTHING



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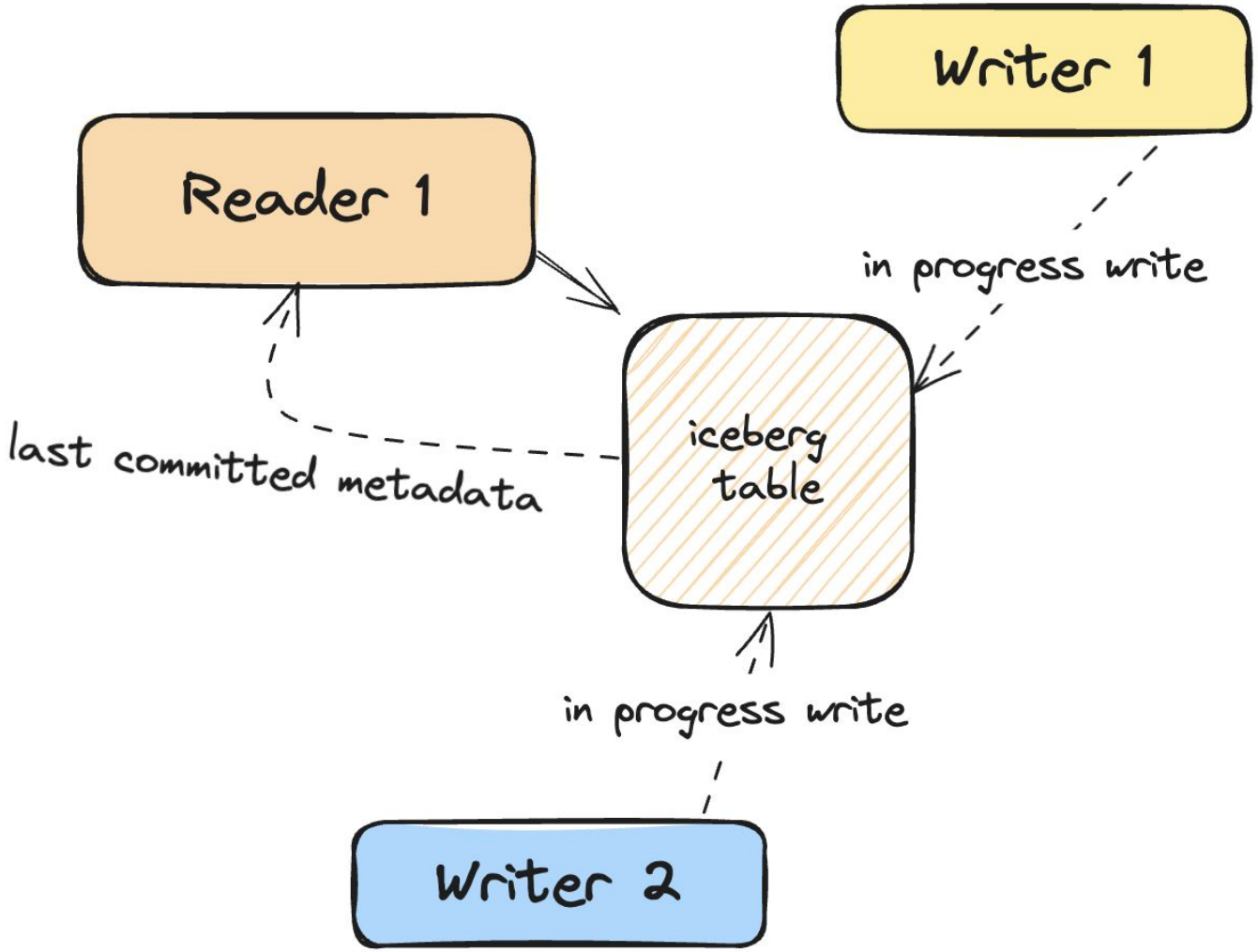
OPTIMISTIC CONCURRENCY

ISOLATION



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Schema Evolution

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Europython

SESSION_ID
SESSION_NAME
SESSION_TYPE

\+ SESSION_DURATION

Europython

SESSION_ID
SESSION_NAME
SESSION_TYPE
SESSION_DURATION

Metadata Only!!

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Partition Evolution

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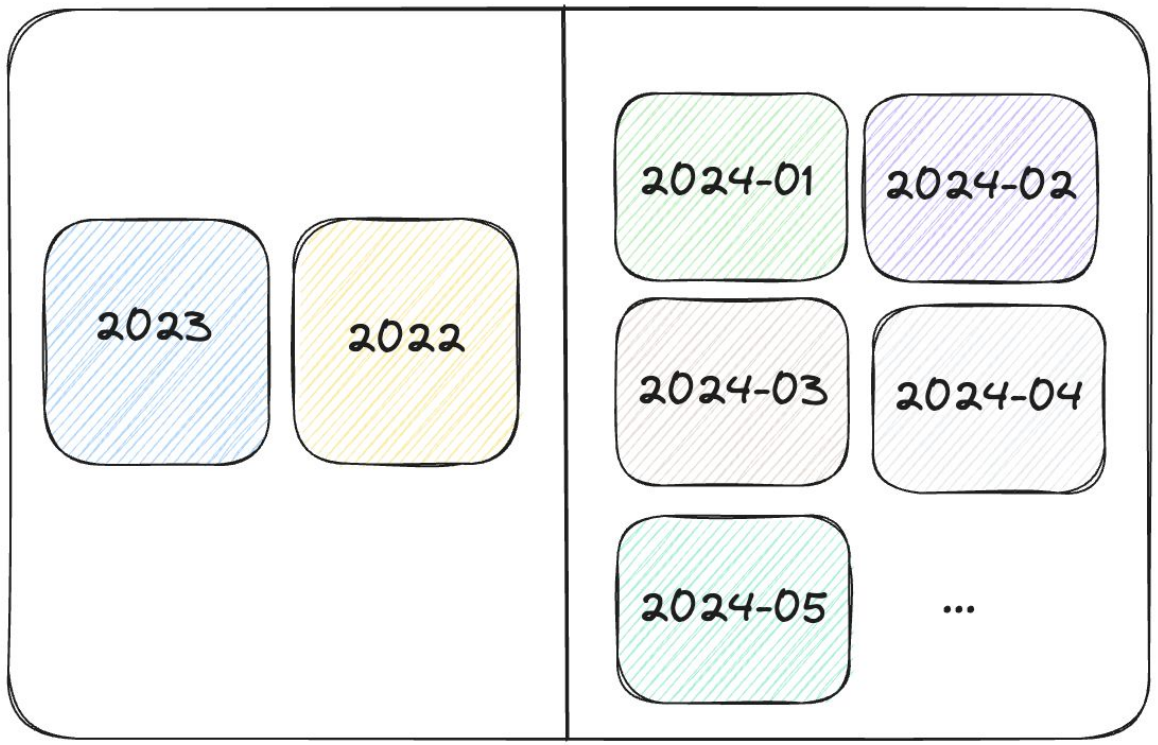

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Query Planning

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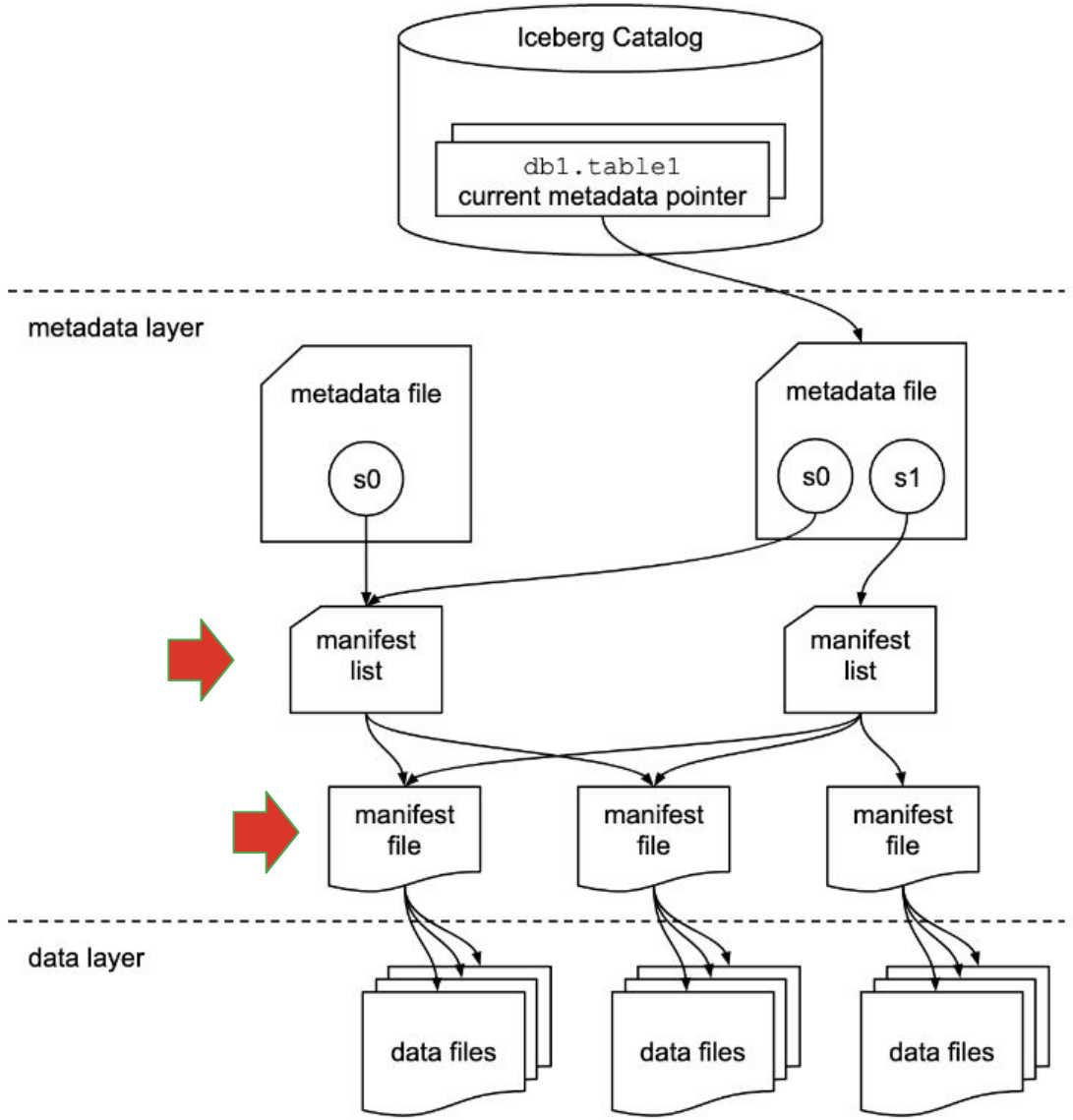

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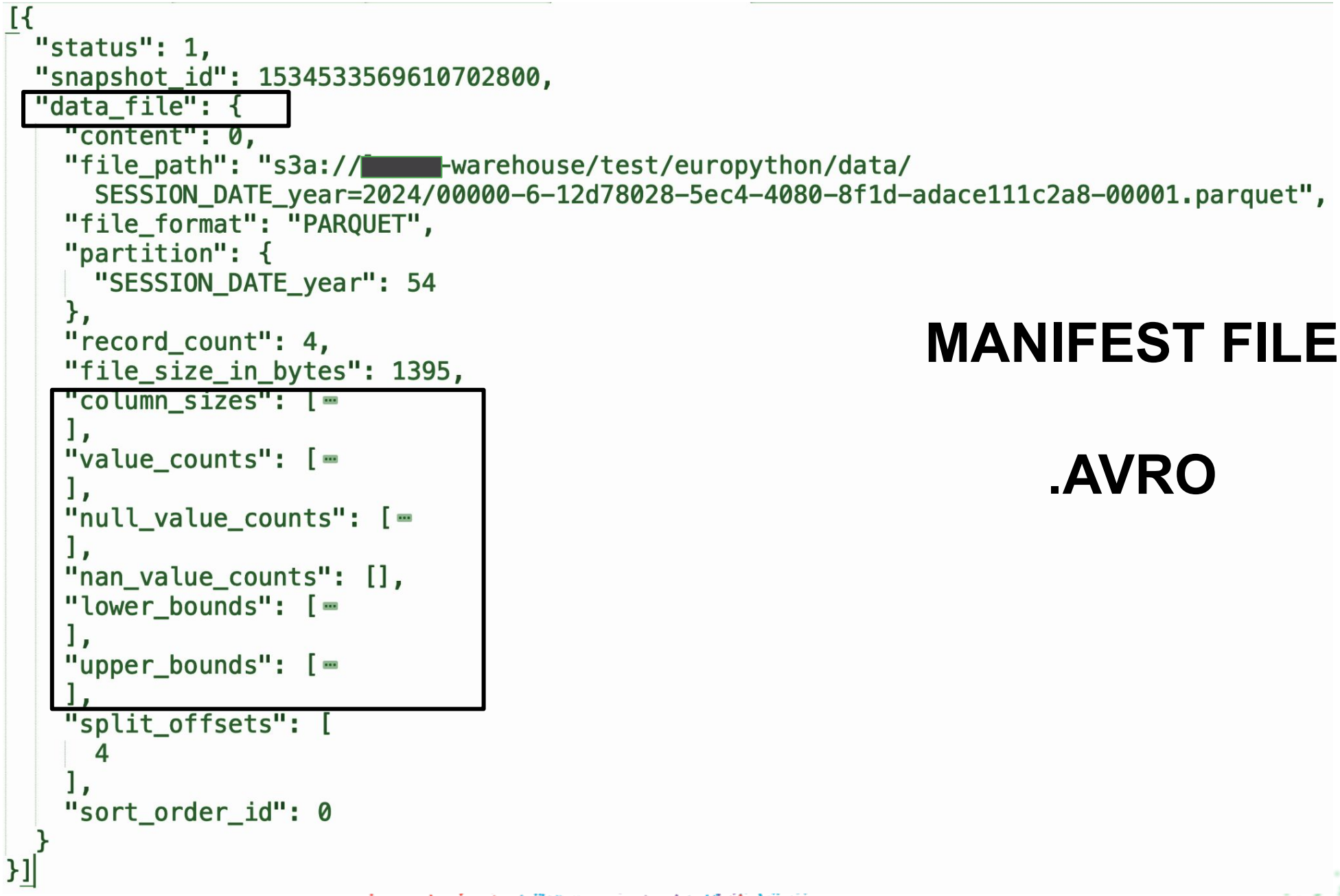
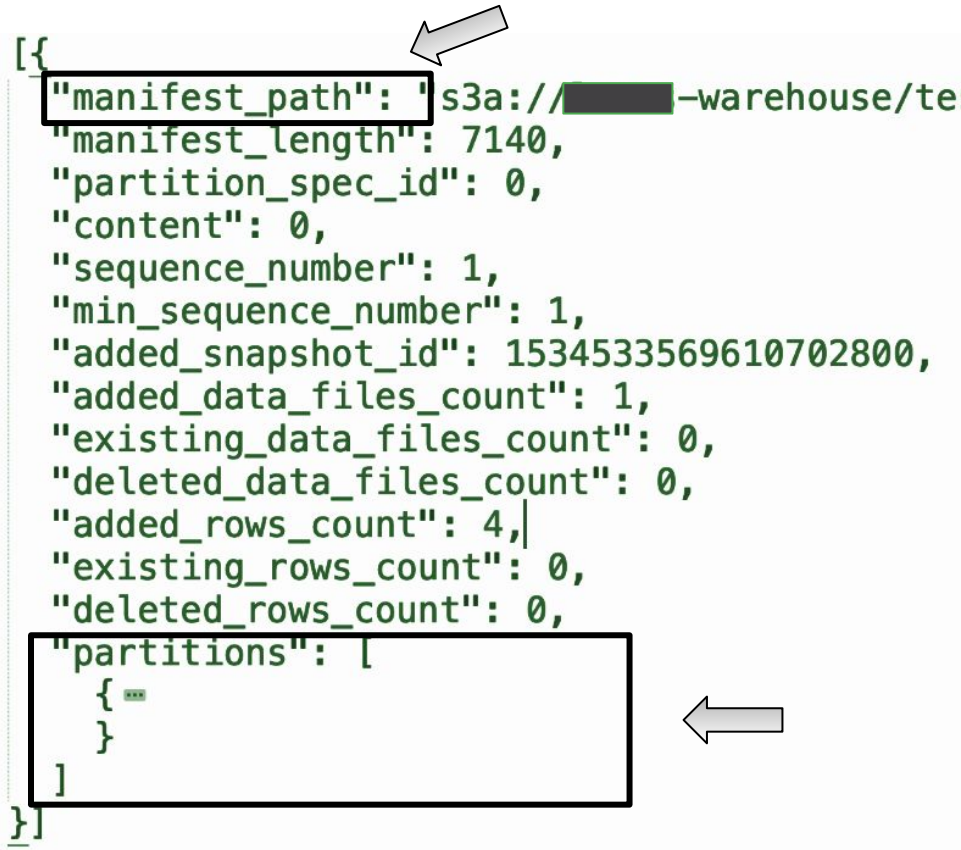


MANIFEST FILE

.AVRO



MANIFEST LIST

.AVRO

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Time Travel

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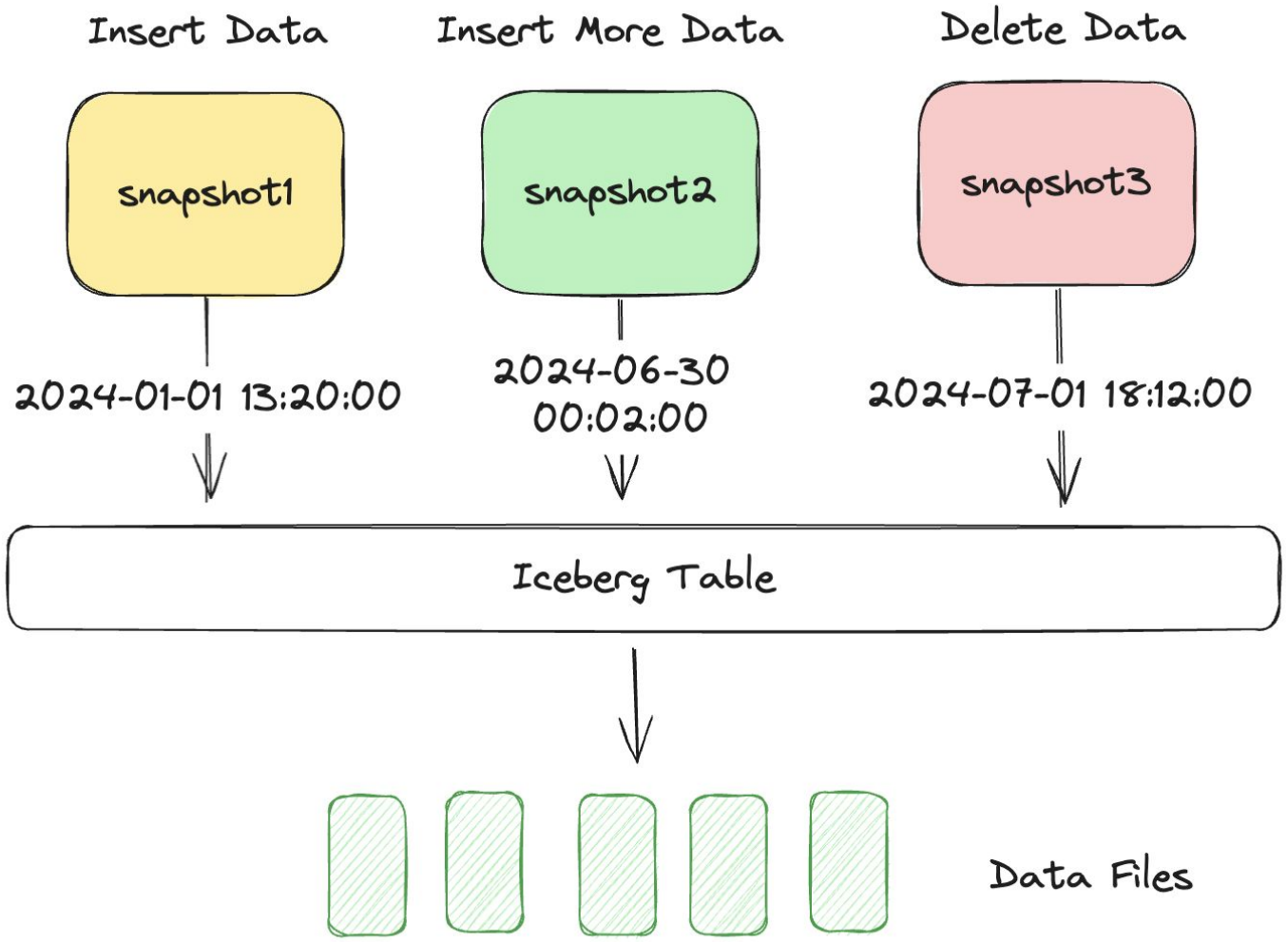
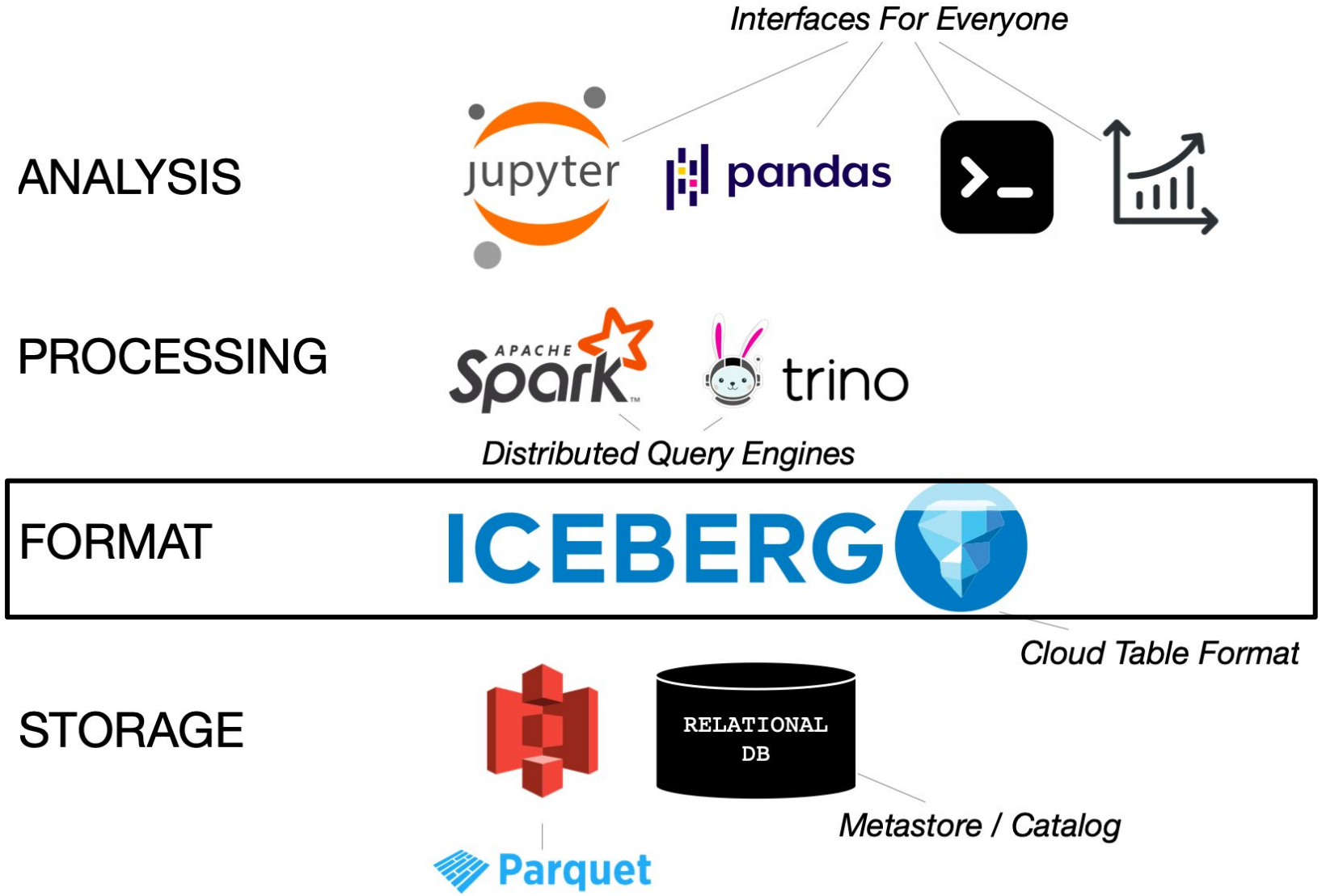



```
SELECT * FROM TABLE
WHERE VERSION AS OF
SNAPSHOT1;
```



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Using Python with Apache Iceberg

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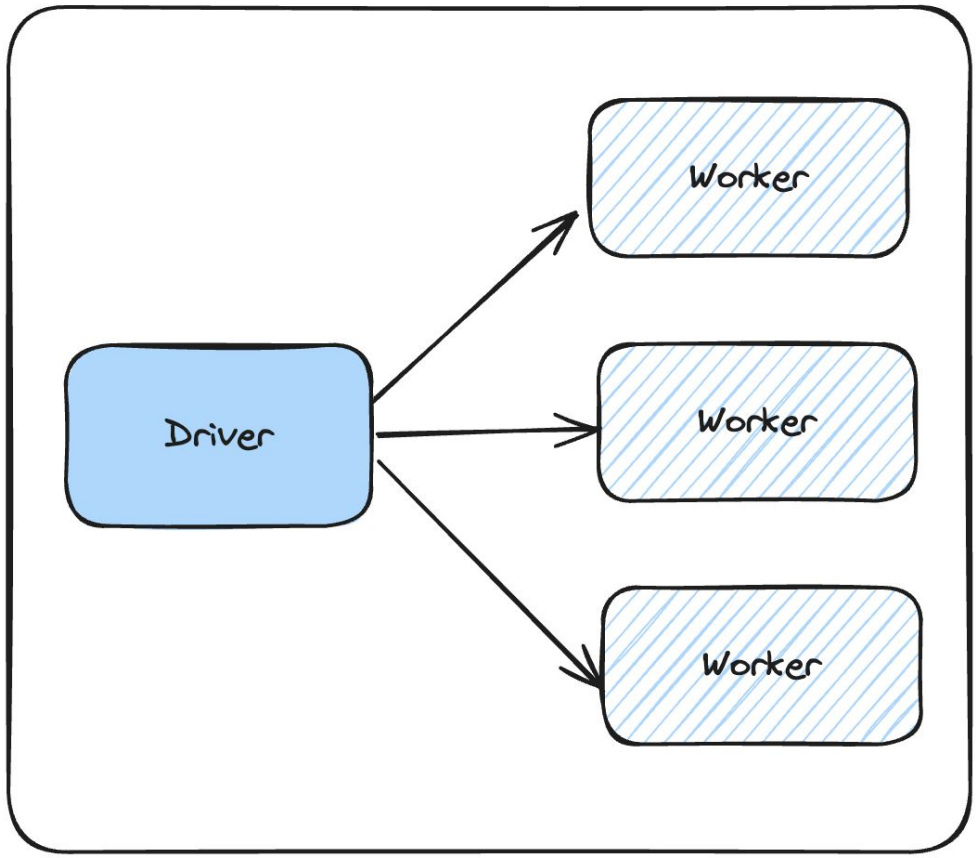
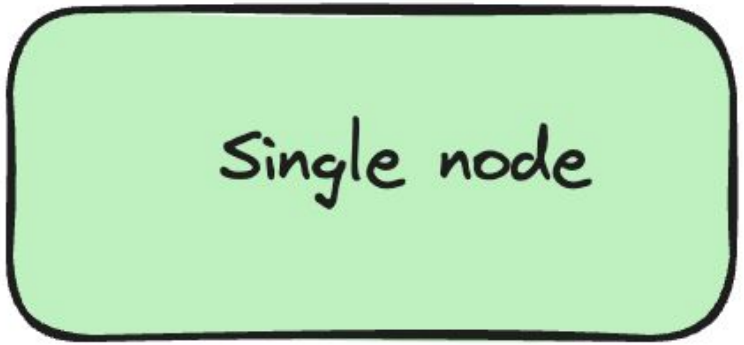
#1: PySpark



#2: Pylceberg



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PySpark

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```
JARS = [
"https://xxxxx/root-repos/org/apache/iceberg/iceberg-spark-runtime-3.5_X.XX/X.X.X/iceb
erg-spark-runtime-3.5_X.XX-X.X.X.jar"]


spark = (
   SparkSession.builder.config(
       "spark.sql.extensions",
       "org.apache.iceberg.spark.extensions.IcebergSparkSessionExtensions",
   )
.config("spark.sql.catalog.XXX", "org.apache.iceberg.spark.SparkCatalog")
.config("spark.sql.catalog.XXX.warehouse", "s3a://data-warehouse")
.config("spark.sql.catalog.XXX.catalog-impl","org.apache.iceberg.jdbc.JdbcCatalog”)
.config("spark.sql.catalog.XXX.uri","jdbc://mydb://localhost:3306/iceberg",)
.config("spark.jars", ",".join(JARS)))
spark = SparkSession.builder.getOrCreate()
```

catalog namespace table

```
spark.sql("""
        CREATE TABLE IF NOT EXISTS XXX.test.europython USING iceberg
        TBLPROPERTIES (
            'format-version' = '2'
        )
        PARTITIONED BY (year(SESSION_DATE))
        AS SELECT * FROM df
""")
```

```
df.show()
```

Last executed at 2024-06-26 15:02:29 in 227ms

SESSION_ID	SESSION_NAME	SESSION_TYPE	SESSION_DATE
1	ICEBERG WALKTHROUGH	TUTORIAL	2024-07-08
2	KEY NOTE	ANNOUNCEMENTS	2024-07-09
3	PYICEBERG	TALK (LONG SESSION)	2024-07-08
4	PYTEST	TALK	2024-07-09

```
spark.sql("""select * from [redacted].test.europython""")
```

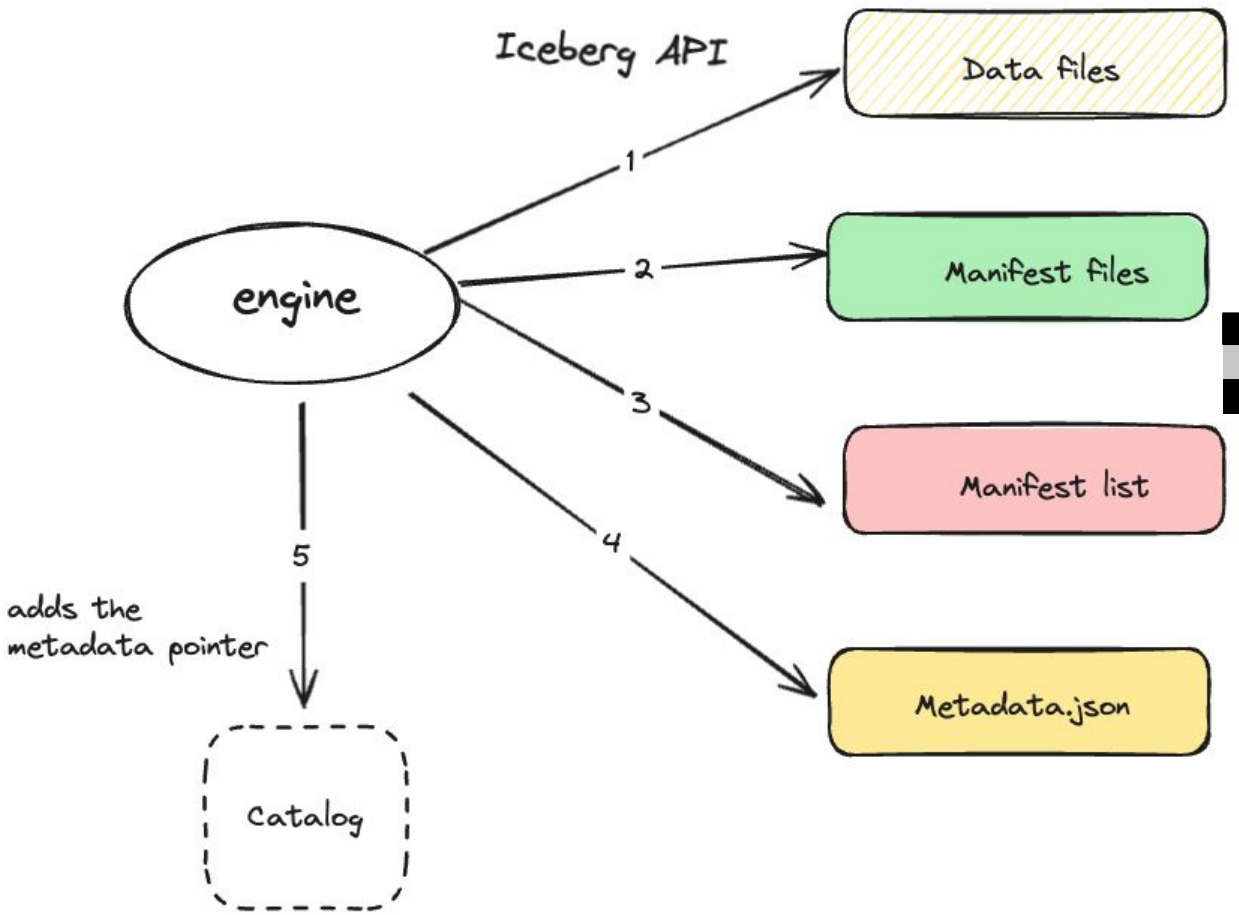
Last executed at 2024-06-27 16:58:01 in 4.53s

SESSION_ID	SESSION_NAME	SESSION_TYPE	SESSION_DATE
1	ICEBERG WALKTHROUGH	TUTORIAL	2024-07-08
2	KEY NOTE	ANNOUNCEMENTS	2024-07-09
3	PYICEBERG	TALK (LONG SESSION)	2024-07-08
4	PYTEST	TALK	2024-07-09

{"metadata-location":"s3a://XXX-warehouse/test/europython/metadata/00000-a1249670-2ddf-4734-8620-f3d6d6977c78.metadata.json","metadata":{"location":"s3a://XXX-warehouse/test/europython","table-uuid":"f0a46b3c-4be7-4394-891a-e131d919a249","last-updated-ms":1719428590109,"last-column-id":4,"schemas":[{"type":"struct","fields":[{"id":1,"name":"SESSION_ID","type":"int","required":false},{"id":2,"name":"SESSION_NAME","type":"string","required":false},{"id":3,"name":"SESSION_TYPE","type":"string","required":false},{"id":4,"name":"SESSION_DATE","type":"date","required":false}],"schema-id":0,"identifier-field-ids":[]}],"current-schema-id":0,"partition-specs":[{"spec-id":0,"fields":[{"source-id":4,"field-id":1000,"transform":"year","name":"SESSION_DATE_year"}]}],"default-spec-id":0,"last-partition-id":1000,"properties":{"owner":"job","write.metadata.delete-after-commit.enabled":"true","commit.manifest.target-size-bytes":"8388608","write.metadata.metrics.default":"full","write.parquet.compression-codec":"zstd"},"current-snapshot-id":1534533569610702955,"snapshots":[{"snapshot-id":1534533569610702955,"sequence-number":1,"timestamp-ms":1719428590109,"manifest-list":"s3a://XXX-warehouse/test/europython/metadata/snap-1534533569610702955-1-8261a1ce-3376-4126-a200-4dbd0e028690.avro","summary":{"operation":"append","spark.app.id":"spark-application-1719426812731","added-data-files":"1","added-records":"4","added-files-size":"1395","changed-partition-count":"1","total-records":"4","total-files-size":"1395","total-data-files":"1","total-delete-files":"0","total-position-deletes":"0","total-equality-deletes":"0"},"schema-id":0}],"snapshot-log":[{"snapshot-id":1534533569610702955,"timestamp-ms":1719428590109}],"metadata-log":[],"sort-orders":[{"order-id":0,"fields":[]}],"default-sort-order-id":0,"refs":{"main":{"snapshot-id":1534533569610702955,"type":"branch"}},"format-version":2,"last-sequence-number":1},"config":{}}

```
{
  "metadata-location": "s3a://[redacted]-warehouse/test/europython/metadata/
      00000-a1249670-2ddf-4734-8620-f3d6d6977c78.metadata.json",
  "metadata": {
    "location": "s3a://[redacted]-warehouse/test/europython",
    "table-uuid": "f0a46b3c-4be7-4394-891a-e131d919a249",
    "last-updated-ms": 1719428590109,
    "last-column-id": 4,
    "schemas": [ ...
    ],
    "current-schema-id": 0,
    "partition-specs": [ ...
    ],
    "default-spec-id": 0,
    "last-partition-id": 1000,
    "properties": {
      "owner": "job",
      "write.metadata.delete-after-commit.enabled": "true",
      "commit.manifest.target-size-bytes": "8388608",
      "write.metadata.metrics.default": "full",
      "write.parquet.compression-codec": "zstd"
    },
    "current-snapshot-id": 1534533569610702800,
    "snapshots": [ ...
    ],
    "snapshot-log": [ ...
    ],
    "metadata-log": [],
    "sort-orders": [ ...
    ],
    "default-sort-order-id": 0,
    "refs": { ...
    },
    "format-version": 2,
    "last-sequence-number": 1
  },
  "config": {}
}
```

```
                -warehouse/test/europython --------
  20.435Ki [##########] /metadata
   1.362Ki [#          ] /data
```



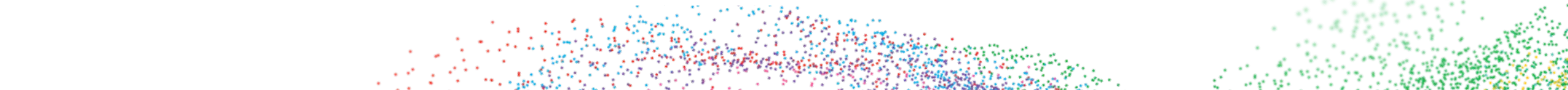

```
                    -warehouse/test/europython/data ------------
   1.362Ki [##########] /SESSION_DATE_year=2024
```

```
          :lacus-warehouse/test/europython/data/SESSION_DATE_year=2024 ----------------
1.362Ki [##########]  00000-6-12d78028-5ec4-4080-8f1d-adace111c2a8-00001.parquet
```

```
                -warehouse/test/europython/metadata ----------------------------------------
6.973Ki [#########]  8261a1ce-3376-4126-a200-4dbd0e028690-m0.avro
4.170Ki [######    ]  snap-1534533569610702955-1-8261a1ce-3376-4126-a200-4dbd0e028690.avro
```

00000-a1249670-2ddf-4734-8620-f3d6d6977c78.metadata.json

snapshot_id - 1534533569610702955



```
|-- status: integer (nullable = true)
 |-- snapshot_id: long (nullable = true)
 |-- sequence_number: long (nullable = true)
 |-- file_sequence_number: long (nullable = true)
 |-- data_file: struct (nullable = true)
 |    |-- content: integer (nullable = true)
 |    |-- file_path: string (nullable = true)
 |    |-- file_format: string (nullable = true)
 |    |-- partition: struct (nullable = true)
 |    |    |-- SESSION_DATE_year: integer (nullable = true)
 |    |-- record_count: long (nullable = true)
 |    |-- file_size_in_bytes: long (nullable = true)
 |    |-- column_sizes: array (nullable = true)
 |    |    |-- element: struct (containsNull = true)
 |    |    |    |-- key: integer (nullable = true)
 |    |    |    |-- value: long (nullable = true)
 |    |-- value_counts: array (nullable = true)
 |    |    |-- element: struct (containsNull = true)
 |    |    |    |-- key: integer (nullable = true)
 |    |    |    |-- value: long (nullable = true)
 |    |-- null_value_counts: array (nullable = true)
 |    |    |-- element: struct (containsNull = true)
 |    |    |    |-- key: integer (nullable = true)
 |    |    |    |-- value: long (nullable = true)
 |    |-- nan_value_counts: array (nullable = true)
 |    |    |-- element: struct (containsNull = true)
 |    |    |    |-- key: integer (nullable = true)
 |    |    |    |-- value: long (nullable = true)
 |    |-- lower_bounds: array (nullable = true)
 |    |    |-- element: struct (containsNull = true)
 |    |    |    |-- key: integer (nullable = true)
 |    |    |    |-- value: binary (nullable = true)
 |    |-- upper_bounds: array (nullable = true)
 |    |    |-- element: struct (containsNull = true)
 |    |    |    |-- key: integer (nullable = true)
 |    |    |    |-- value: binary (nullable = true)
 |    |-- key_metadata: binary (nullable = true)
 |    |-- split_offsets: array (nullable = true)
 |    |    |-- element: long (containsNull = true)
 |    |-- equality_ids: array (nullable = true)
 |    |    |-- element: integer (containsNull = true)
 |    |-- sort_order_id: integer (nullable = true)
```

```
root
 |-- manifest_path: string (nullable = true)
 |-- manifest_length: long (nullable = true)
 |-- partition_spec_id: integer (nullable = true)
 |-- content: integer (nullable = true)
 |-- sequence_number: long (nullable = true)
 |-- min_sequence_number: long (nullable = true)
 |-- added_snapshot_id: long (nullable = true)
 |-- added_data_files_count: integer (nullable = true)
 |-- existing_data_files_count: integer (nullable = true)
 |-- deleted_data_files_count: integer (nullable = true)
 |-- added_rows_count: long (nullable = true)
 |-- existing_rows_count: long (nullable = true)
 |-- deleted_rows_count: long (nullable = true)
 |-- partitions: array (nullable = true)
 |    |-- element: struct (containsNull = true)
 |    |    |-- contains_null: boolean (nullable = true)
 |    |    |-- contains_nan: boolean (nullable = true)
 |    |    |-- lower_bound: binary (nullable = true)
 |    |    |-- upper_bound: binary (nullable = true)
```

Schema evolution - metadata only!!!

```
spark.sql("ALTER TABLE XXX.test.europython ADD COLUMNS (SESSION_DURATION_MINS int)")
```

```
spark.sql("""select * from [redacted]test.europython""")
```

Last executed at 2024-06-27 16:58:01 in 4.53s

SESSION_ID	SESSION_NAME	SESSION_TYPE	SESSION_DATE	SESSION_DURATION_MINS
1	ICEBERG WALKTHROUGH	TUTORIAL	2024-07-08	NULL
2	KEY NOTE	ANNOUNCEMENTS	2024-07-09	NULL
3	PYICEBERG	TALK (LONG SESSION)	2024-07-08	NULL
4	PYTEST	TALK	2024-07-09	NULL

Updated Schema in metadata.json


```
"schemas":[{"type":"struct","fields":[{"id":1,"name":"SESSION_ID","type":"int","required":
false},{"id":2,"name":"SESSION_NAME","type":"string","required":false},{"id":3,"name":"SES
SION_TYPE","type":"string","required":false},{"id":4,"name":"SESSION_DATE","type":"date","
required":false}],"schema-id":0,"identifier-field-ids":[]},
```

```
{"type":"struct","fields":[{"id":1,"name":"SESSION_ID","type":"int","required":false},{"id
":2,"name":"SESSION_NAME","type":"string","required":false},{"id":3,"name":"SESSION_TYPE",
"type":"string","required":false},{"id":4,"name":"SESSION_DATE","type":"date","required":f
alse},{"id":5,"name":"SESSION_DURATION_MINS","type":"int","required":false}],"schema-id":1
,"identifier-field-ids":[]}],
```

```
"current-schema-id":1
```


```
"schemas": [
    {
      "type": "struct",
      "fields": [
        {
          "id": 1,
          "name": "SESSION_ID",
          "type": "int",
          "required": false
        },
        {
          "id": 2,
          "name": "SESSION_NAME",
          "type": "string",
          "required": false
        },
        {
          "id": 3,
          "name": "SESSION_TYPE",
          "type": "string",
          "required": false
        },
        {
          "id": 4,
          "name": "SESSION_DATE",
          "type": "date",
          "required": false
        }
      ],
```

```
spark.sql("SELECT SESSION_ID, SESSION_NAME FROM
XXX.TEST.EUROPYTHON;")
```

Columns are selected from data files using field IDs

PyIceberg API

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```
>>> pip install “pyiceberg[sql-sqlite]”
```

```python
from pyiceberg.catalog.sql import SqlCatalog

warehouse_path = "/tmp/warehouse"
catalog = SqlCatalog(
    "default",
    **{
        "uri": f"sqlite:///{warehouse_path}/pyiceberg_catalog.db",
        "warehouse": f"file://{warehouse_path}",
    },
)
catalog.create_namespace("test")
```

```
>>> pip install pyarrow
```

```python
import pyarrow.parquet as pq
data = pq.read_table("s3://test/insert_europython.parquet")
```

```
pyarrow.Table
SESSION_ID: int64
SESSION_NAME: string
SESSION_TYPE: string
SESSION_DATE: string
DURATION_MINS: int64
----
SESSION_ID: [[5,6]]
SESSION_NAME: [["Airflow and Python","Python modules in Rust"]]
SESSION_TYPE: [["TALK","TALK"]]
SESSION_DATE: [["2023-07-07","2023-07-08"]]
DURATION_MINS: [[30,45]]
```

```python
tbl = catalog.create_table("test.europython_pyiceberg", schema=data.schema)
tbl.append(data)
```

```
/tmp/warehouse/
/tmp/warehouse//pyiceberg_catalog.db
/tmp/warehouse//test.db
/tmp/warehouse//test.db/europython_pyiceberg
/tmp/warehouse//test.db/europython_pyiceberg/data
/tmp/warehouse//test.db/europython_pyiceberg/data/00000-0-ee45bb2f-6c80-4272-a2e9-0dc45a826b
1c.parquet
/tmp/warehouse//test.db/europython_pyiceberg/metadata
/tmp/warehouse//test.db/europython_pyiceberg/metadata/00001-384de88c-d052-4148-9e43-d77a4630
3de1.metadata.json
/tmp/warehouse//test.db/europython_pyiceberg/metadata/e95cd1f9-5fc6-4535-991c-ee90212ba3a2-m
0.avro
/tmp/warehouse//test.db/europython_pyiceberg/metadata/00000-356f91ad-6777-409f-a4fb-0f052f31
fa1f.metadata.json
/tmp/warehouse//test.db/europython_pyiceberg/metadata/snap-1181746681384757451-0-e95cd1f9-5f
c6-4535-991c-ee90212ba3a2.avro
```

```python
from pyiceberg.expressions import GreaterThanOrEqual

scan = tbl.scan(
    row_filter=GreaterThanOrEqual("DURATION_MINS", 35),
    selected_fields=("SESSION_NAME", "SESSION_DATE"),
    limit=10,
)

file_paths = [task.file.file_path for task in scan.plan_files()]
```

['file:///tmp/warehouse/test.db/europython_pyiceberg/data/00000-0-ee45bb2f-6c80-4272-a2e9-0dc45a826b1c.parquet']

```
scan.to_arrow()
scan.to_pandas()
```

```
pyarrow.Table
SESSION_NAME: string
SESSION_DATE: string
----
SESSION_NAME: [["Python modules in Rust"]]
SESSION_DATE: [["2023-07-08"]]
```

Pylceberg 0.7.0

The main objective of 0.7.0 is to have partitioned writes (non-exhaustive list :)

- [ ] Support for merge-into / upsert: Merge into / Upsert #402
  - [x] Support partitioned appends: Support Appends with TimeTransform Partitions #784
  - [ ] Support partial deletes: Support partial deletes #569
- [x] Support for parallelizing writes: Parallel Table.append #428 Faster ingestion from Parquet #346
  - [x] Support parallelized writes: Bin-pack Writes Operation into multiple parquet files, and parallelize writing `WriteTask`s #444
- [x] Support `table_exists` on catalog: check if table exist #406 Add `table_exists` method to the Catalog #507, fixed in Add `table_exists` method to Catalog #512
- [ ] Metadata tables: Add metadata tables #511
  - [ ] *Files* assigned to **@Gowthami03B**, PR in Add Files metadata table #614
  - [x] *Snapshots* assigned to **@Fokko** in Add Snapshots table metadata #524
  - [x] *History* assigned to **@ndrluis** in Add history inspect table #828
  - [x] *Metadata log entries* **@kevinjqliu** (issue in [feat request] Add `metadata_log_entries` metadata table #594): Metadata Log Entries metadata table #667
  - [x] *Manifests* **@geruh**: PR in Add manifests metadata table #717
  - [x] *Partitions* assigned to **@syun64** (issue in Support get partition table with filter #24): Add Partitions Metadata Table #603
  - [x] *References* assigned to **@geruh** in Add Refs metadata table #602
  - [x] *Entries* assigned to **@Fokko** in Add entries metadata table #551
- [ ] Manifest read/write improvements:
  - [ ] Implement rolling writes: Implement rolling manifest-writers #596 feat: add `RollingManifestWriter` #650
  - [ ] Caching of manifests: Implement caching of manifest-files #595
- [ ] Incremental append scan: Incremental Append Scan #533

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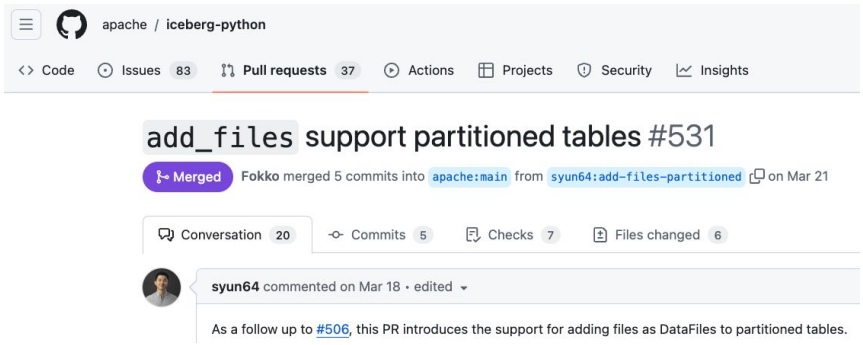
Contributions to the Pylceberg community

Support partitioned writes #208

Open · 4 tasks · **Fokko** opened this issue on Dec 12, 2023 · 26 comments



Partitioned Append on Identity Transform #555

Merged · **Fokko** merged 20 commits into `apache:main` from `jqin61:identity-partitioned-append` on Apr 5

Conversation 42 · Commits 20 · Checks 7 · Files changed 11

jqin61 commented on Mar 28 • edited

Change Append/Overwrite API to accept snapshot properties #419

Merged · **Fokko** merged 13 commits into `apache:main` from `Gowthami03B:snapshot-properties` on Mar 19

Conversation 15 · Commits 13 · Checks 7 · Files changed 3

Gowthami03B commented on Feb 12 · Contributor

No description provided.

allow override env-variables in load_catalog #45

Merged · **Fokko** merged 2 commits into `apache:main` from `bdilday:bf-config-rhs-override` on Oct 13, 2023

Conversation 3 · Commits 2 · Checks 6 · Files changed 4

bdilday commented on Oct 6, 2023 · Contributor

Retry with new Access Token on 419 response #340

Merged · **Fokko** merged 10 commits into `apache:main` from `anupam-saini:as-token-refresh` on Feb 20

Conversation 6 · Commits 10 · Checks 6 · Files changed 4

anupam-saini commented on Jan 31 · Contributor

Closes #234

- Attempts to retry 2 more times if the initial call fails.
- The retry is only triggered for `AuthorizationExpiredError` response.

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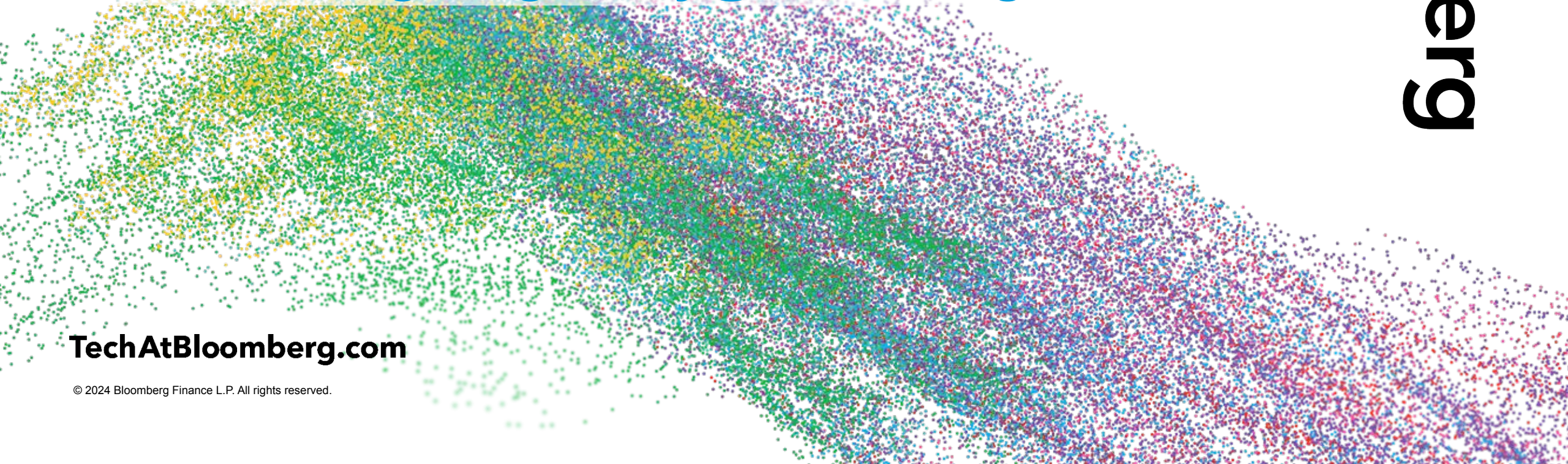

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Q&A

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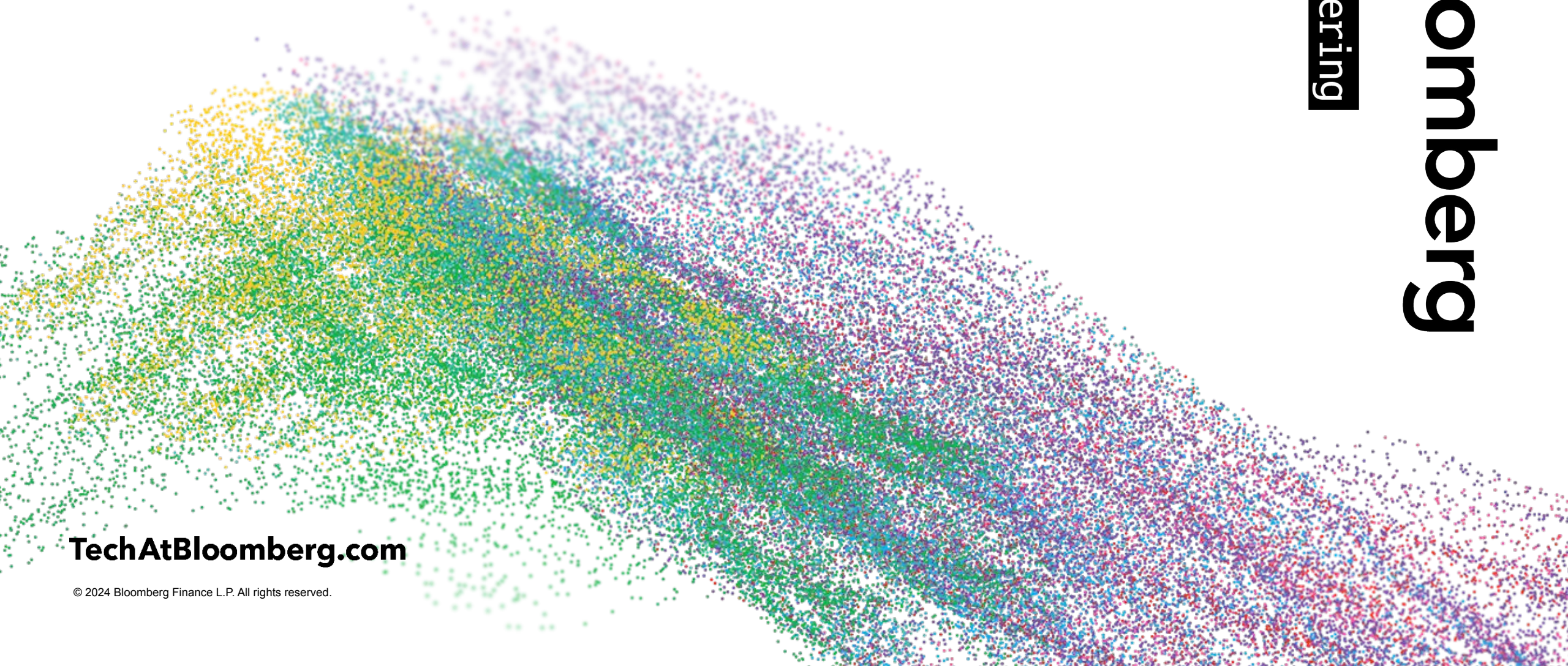
Engineering



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