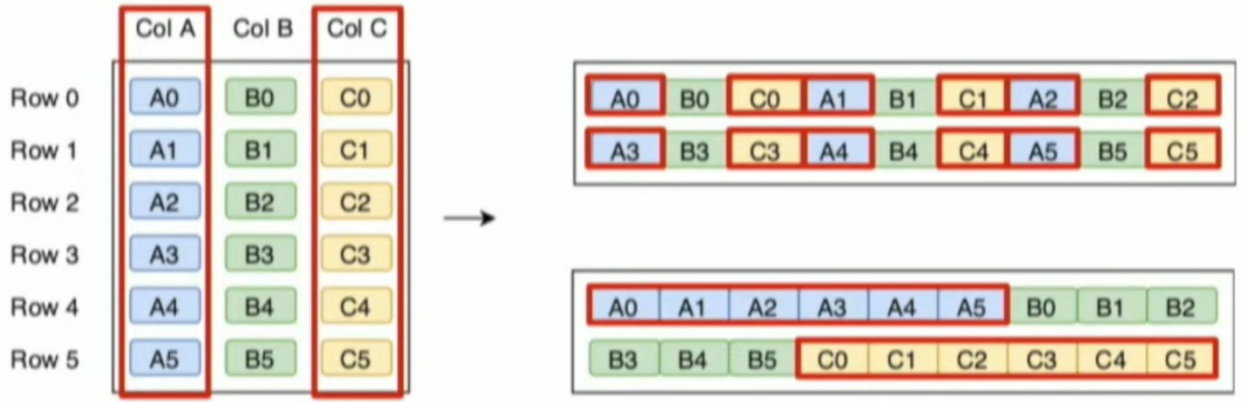
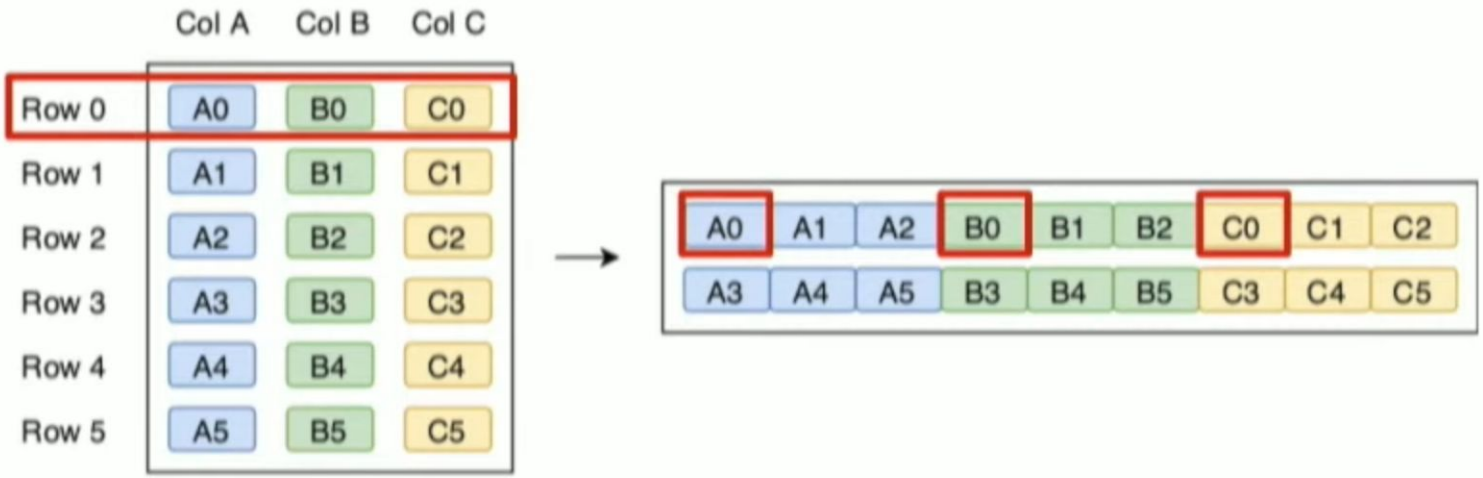
INTRO TO Apache Iceberg

Recap Parquet

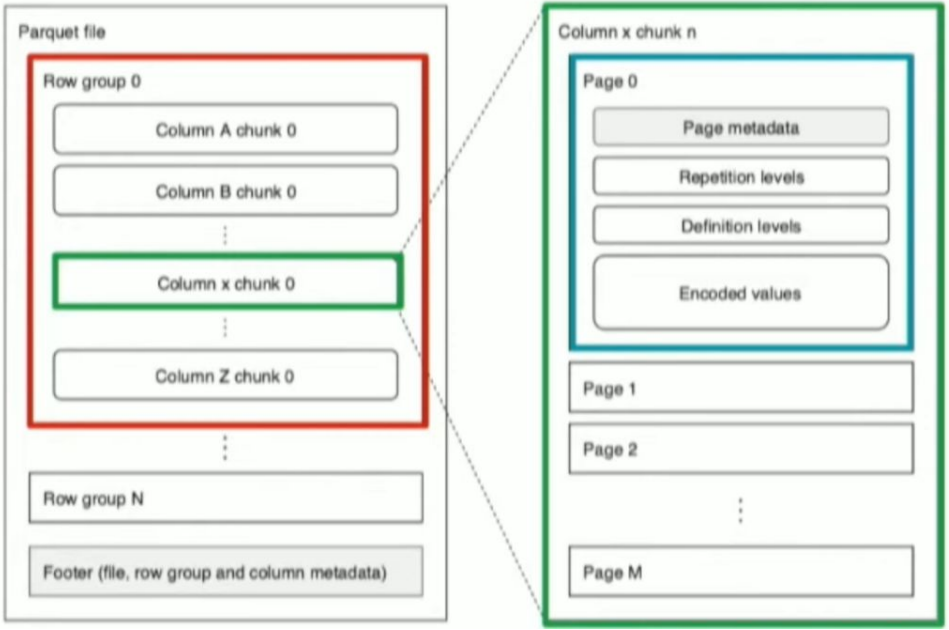
Row-wise vs Columnar




Col A
Col B
Col C
Row 0
Row 1
Row 2
Row 3
Row 4
Row 5
A0
B0
C0
A1
B1
C1
A2
B2
C2
A3
B3
C3
A4
B4
C4
A5
B5
C5
A0
A1
A2
B0
B1
B2
C0
C1
C2
A3
A4
A5
B3
B4
B5
C3
C4
C5

Parquet: data organization

- Data organization
  - Row-groups (*default 128MB*)
  - Column chunks
  - Pages (*default 1MB*)
    - Metadata
      - Min
      - Max
      - Count
    - Rep/def levels
    - Encoded values



How Parquet “Knows” Which Row Group to Scan?

- **Parquet contains metadata**
  - Data about data
- **Min and max values**
- **Footer**
  - Format version
  - Schema information
  - Column metadata

Parquet Storage

	Column 1	Column 2	Column 3	Column 4	Column 5
	Product	Customer	Country	Date	Sales Amount
Row group 1	Ball	John Doe	USA	2023-01-01	100
	T-Shirt	John Doe	USA	2023-01-02	200
Row group 2	Socks	Maria Adams	UK	2023-01-01	300
	Socks	Antonio Grant	USA	2023-01-03	100
Row group 3	T-Shirt	Maria Adams	UK	2023-01-02	500
	Socks	John Doe	USA	2023-01-05	200

Projection and Predicate(s)

Projection = SELECT

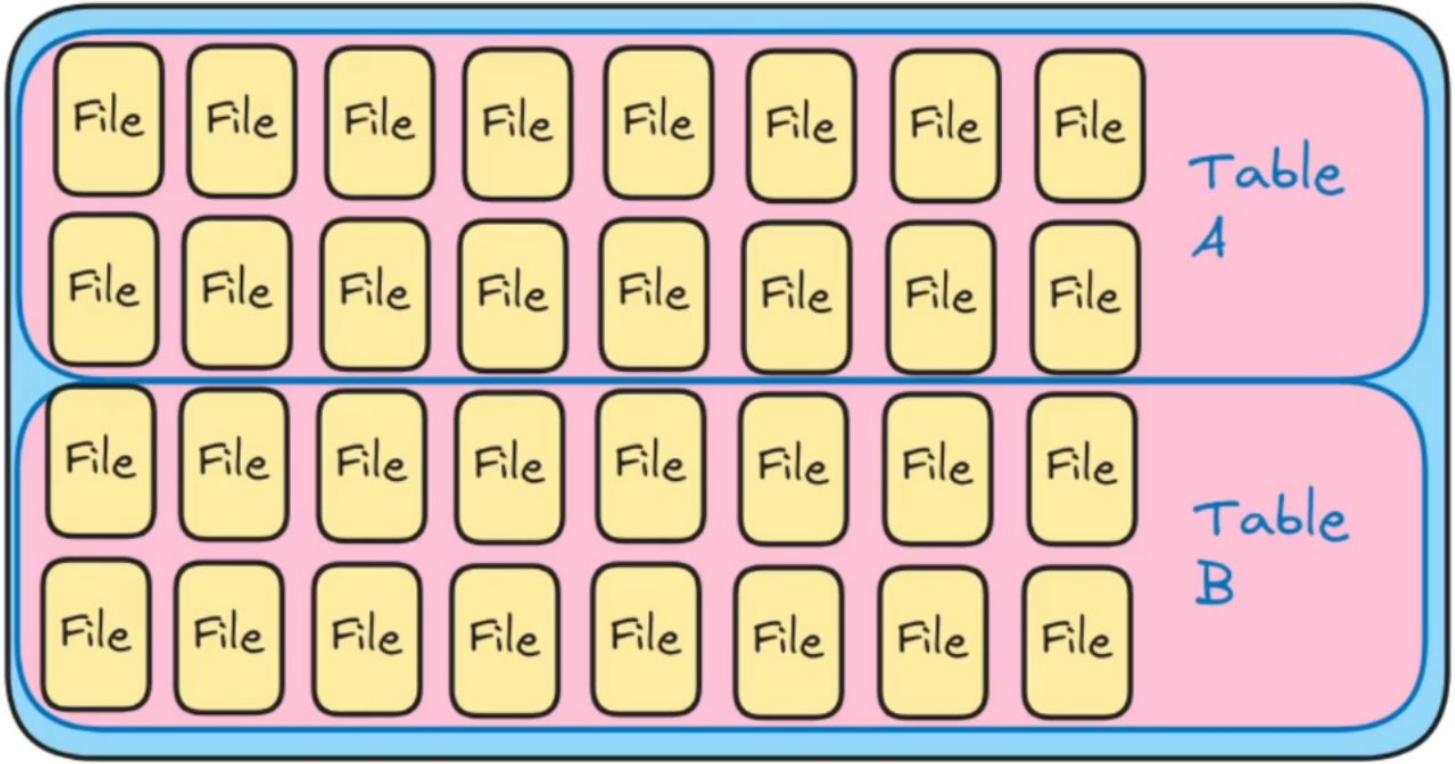
Predicate(s) = WHERE

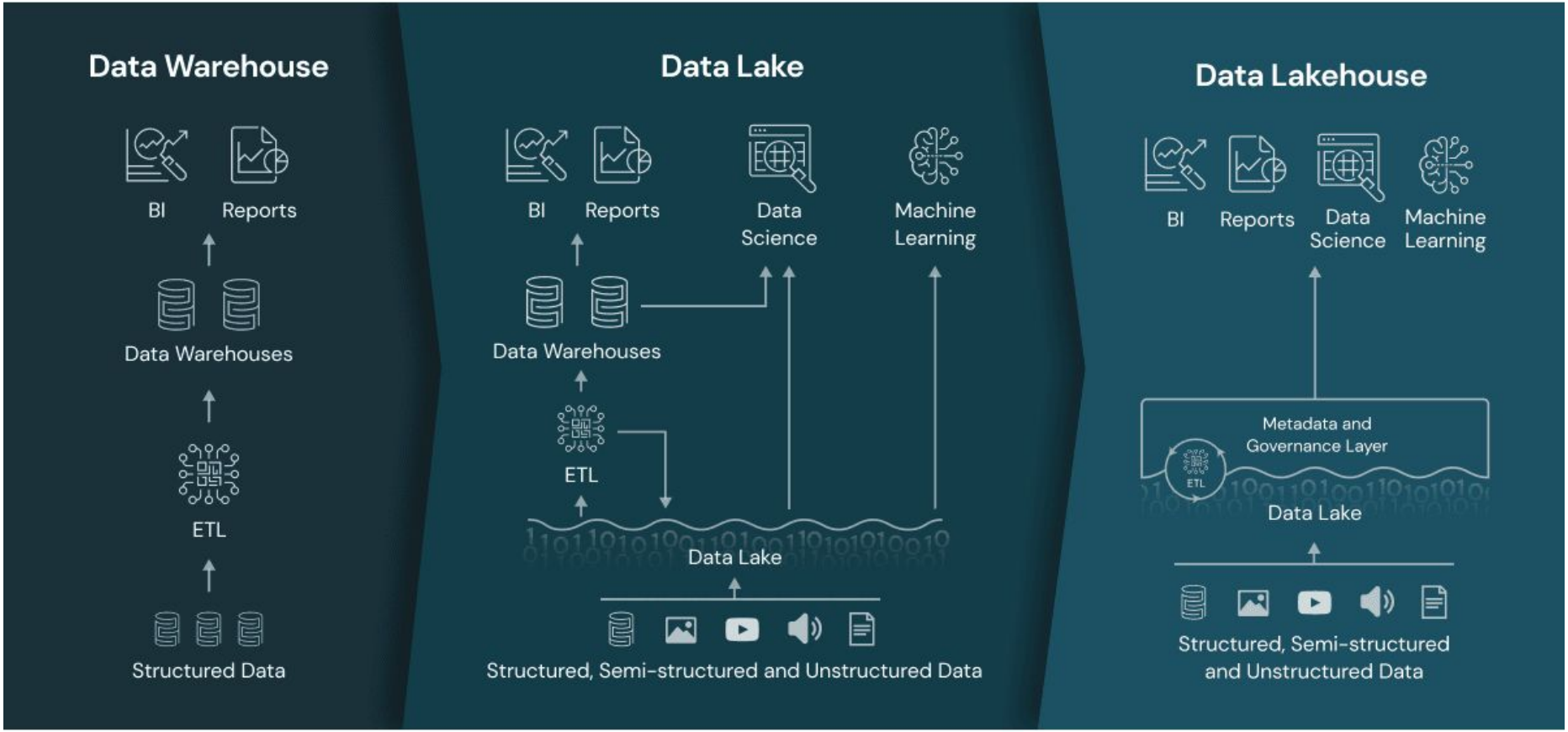
	Column 1	Column 2	Column 3	Column 4	Column 5
	Product	Customer	Country	Date	Sales Amount
Row group 1	Ball	John Doe	USA	2023-01-01	100
	T-Shirt	John Doe	USA	2023-01-02	200
Row group 2	Socks		UK		
	Socks		USA		
Row group 3	T-Shirt	Maria Adams	UK	2023-01-02	500
	Socks	John Doe	USA	2023-01-05	200

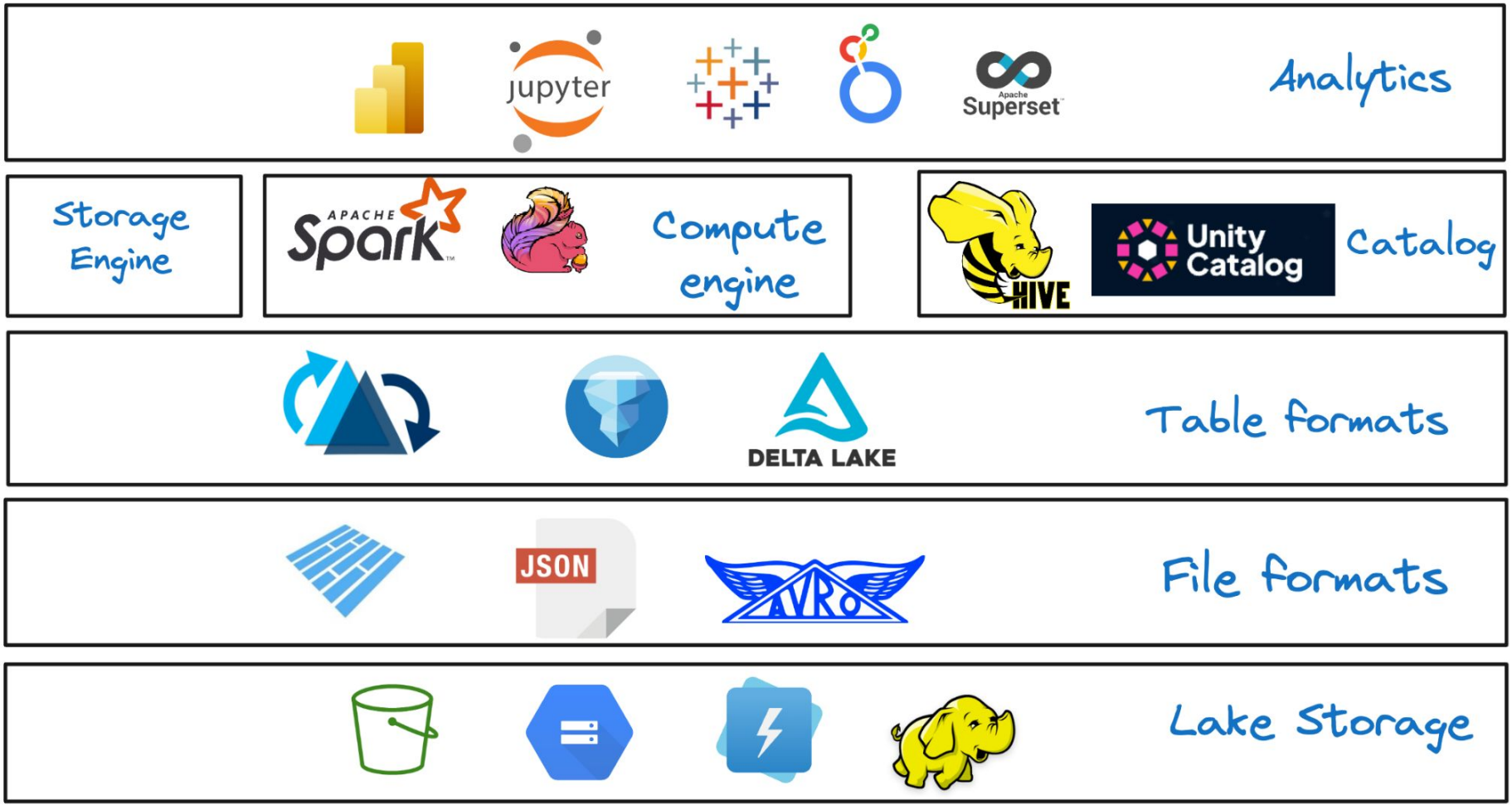
The engine will skip scanning these records!

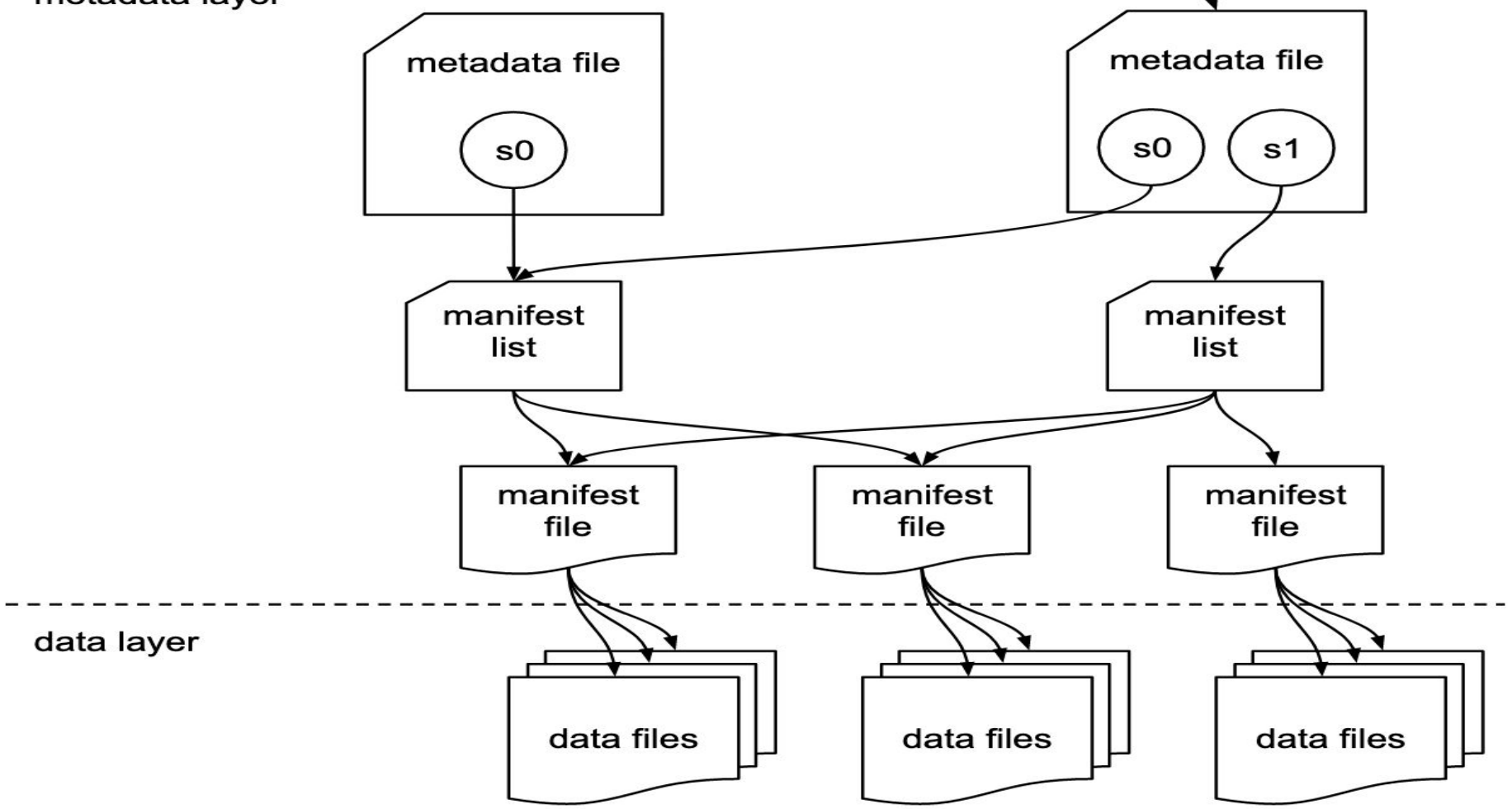
What is a Table Format?

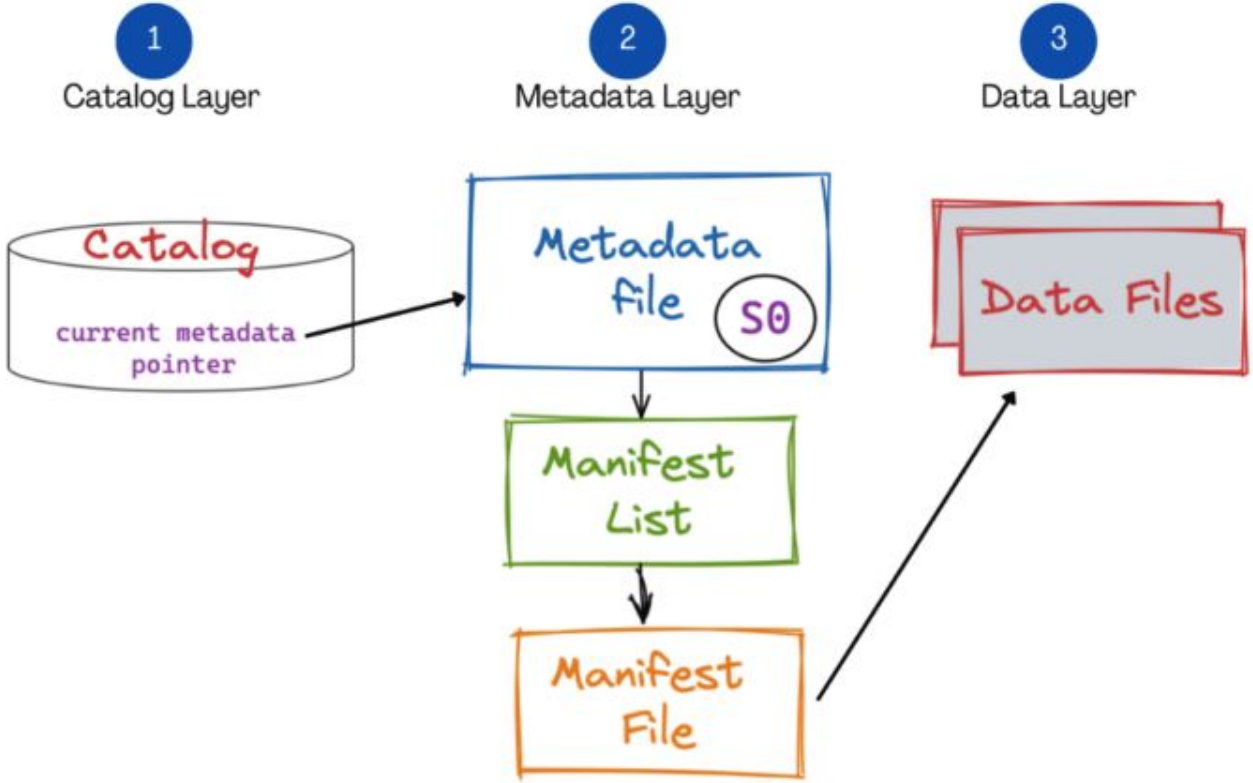
An abstraction to allow multiple files on the lake to be seen as a single table.




Data Warehouse
BI
Reports
Data Warehouses
ETL
Structured Data
Data Lake
BI
Reports
Data Science
Machine Learning
Data Warehouses
ETL
Data Lake
Structured, Semi-structured and Unstructured Data
Data Lakehouse
BI
Reports
Data Science
Machine Learning
Metadata and Governance Layer
ETL
Data Lake
Structured, Semi-structured and Unstructured Data


jupyter
Apache Superset
Analytics
Storage Engine
APACHE Spark
Compute engine
HIVE
Unity Catalog
Catalog
DELTA LAKE
Table formats
JSON
AVRO
File formats
Lake Storage


metadata file
s0
metadata file
s0
s1
manifest list
manifest list
manifest file
manifest file
manifest file
data layer
data files
data files
data files


1
Catalog Layer
2
Metadata Layer
3
Data Layer
Catalog
current metadata pointer
Metadata file
S0
Manifest List
Manifest File
Data Files

Iceberg Table Metadata File (metadata.json)

```
{
  "format-version": 2,
  "table-uuid": "b3d6d8b8-62f1-4fa6-9a8d-08a9f7d4aa31",
  "location": "s3://my-bucket/warehouse/db/sales",
  "current-snapshot-id": 3055729220031123456,
  "snapshots": [
    {
      "snapshot-id": 3055729220031123456,
      "timestamp-ms": 1736940000123,
      "operation": "append",
      "manifest-list": "…/metadata/snap-3055729220031123456-1.avro"
    }
  ],
  "schemas": [
    { "schema-id": 0, "fields": [ … ] }
  ],
  "partition-specs": [
    { "spec-id": 0, "fields": [ { "transform": "day(order_ts)" } ] }
  ]
}
```

Iceberg Manifest List (Avro)

Manifest List (decoded view) — one record per manifest file

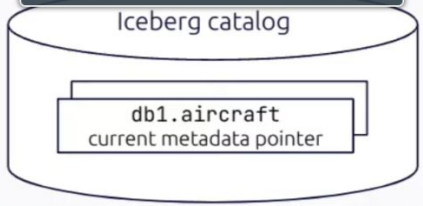

```
[
  {
    "manifest_path": "…/metadata/0d3c2b2f-….-m0.avro",
    "content": "DATA",
    "partition_spec_id": 0,
    "sequence_number": 17,
    "added_snapshot_id": 3055729220031123456,
    "added_files_count": 2,
    "existing_files_count": 0,
    "deleted_files_count": 0,
    "partitions": [
      { "lower_bound": "2026-01-15", "upper_bound": "2026-01-16" }
    ]
  }
]
```

Iceberg Manifest File (Avro)

Manifest File (decoded view) — entries point to data/delete files


```
[
  {
    "status": "ADDED",
    "snapshot_id": 3055729220031123456,
    "sequence_number": 17,
    "data_file": {
      "content": "DATA",
      "file_path": "…/data/order_day=2026-01-15/00000-0-….parquet",
      "file_format": "PARQUET",
      "partition": { "order_day": "2026-01-15" },
      "record_count": 60000,
      "file_size_in_bytes": 134217728,
      "lower_bounds": { "order_id": "100000" },
      "upper_bounds": { "order_id": "159999" }
    }
  },
  {
    "status": "ADDED",
    "data_file": {
      "file_path": "…/data/order_day=2026-01-16/00001-0-….parquet",
      "record_count": 60000
    }
  }
]
```

```
CREATE TABLE aircraft (
   tail_number varchar(15),
   description varchar(150),
   class varchar(50),
   year integer
)
WITH
   (type = 'iceberg');
```



metadata layer

data layer

Objects | Properties

Objects (1) Info

Copy S3 URI | Copy URL | Download | Open | Delete | Actions | Create folder

Upload

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

Find objects by prefix

1

Name	Type	Last modified	Size	Storage class
metadata/	Folder	-	-	-

metadata/

Copy S3 URI

Objects | Properties

Objects (2) Info

Copy S3 URI | Copy URL | Download | Open | Delete | Actions | Create folder

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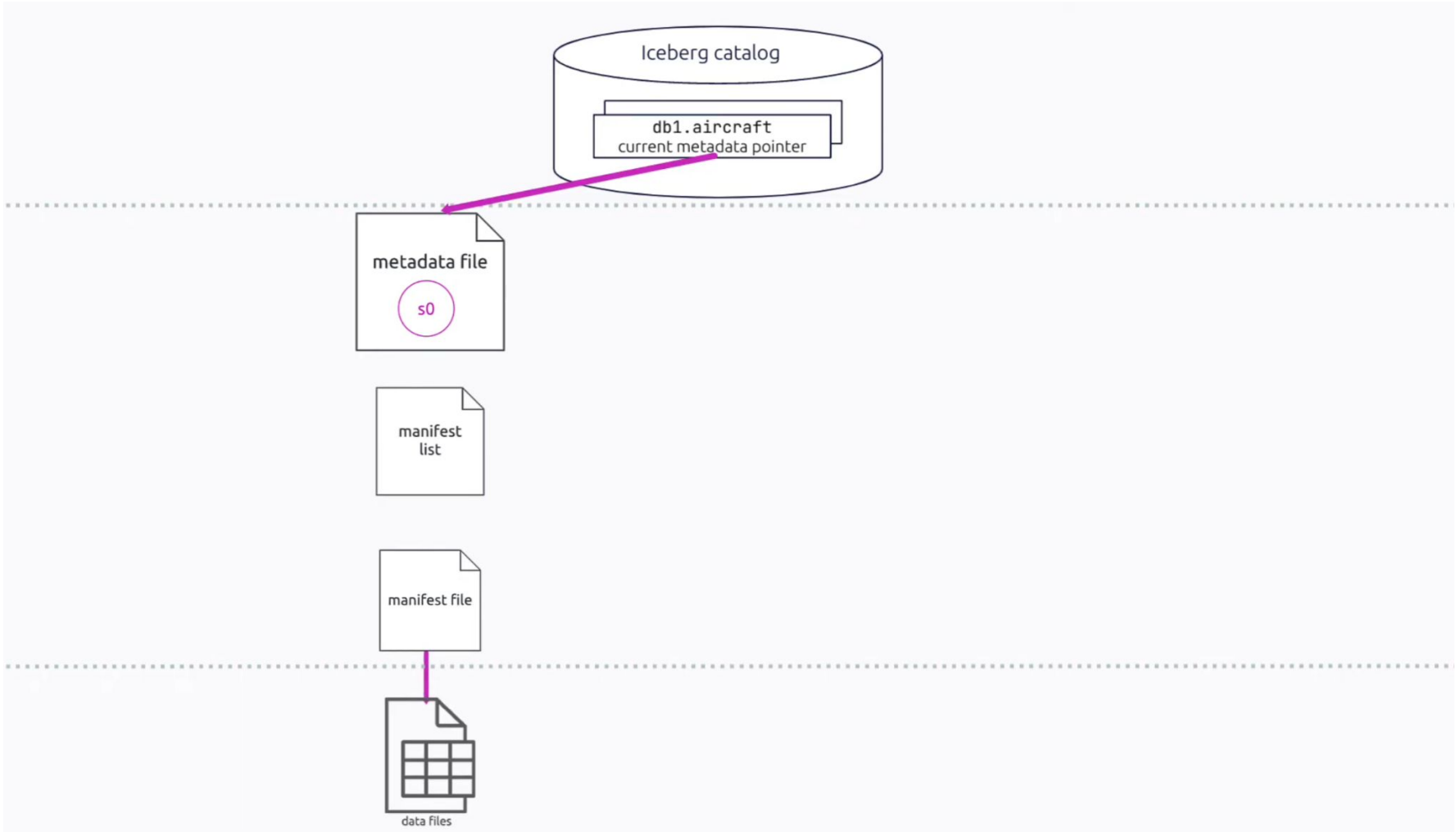
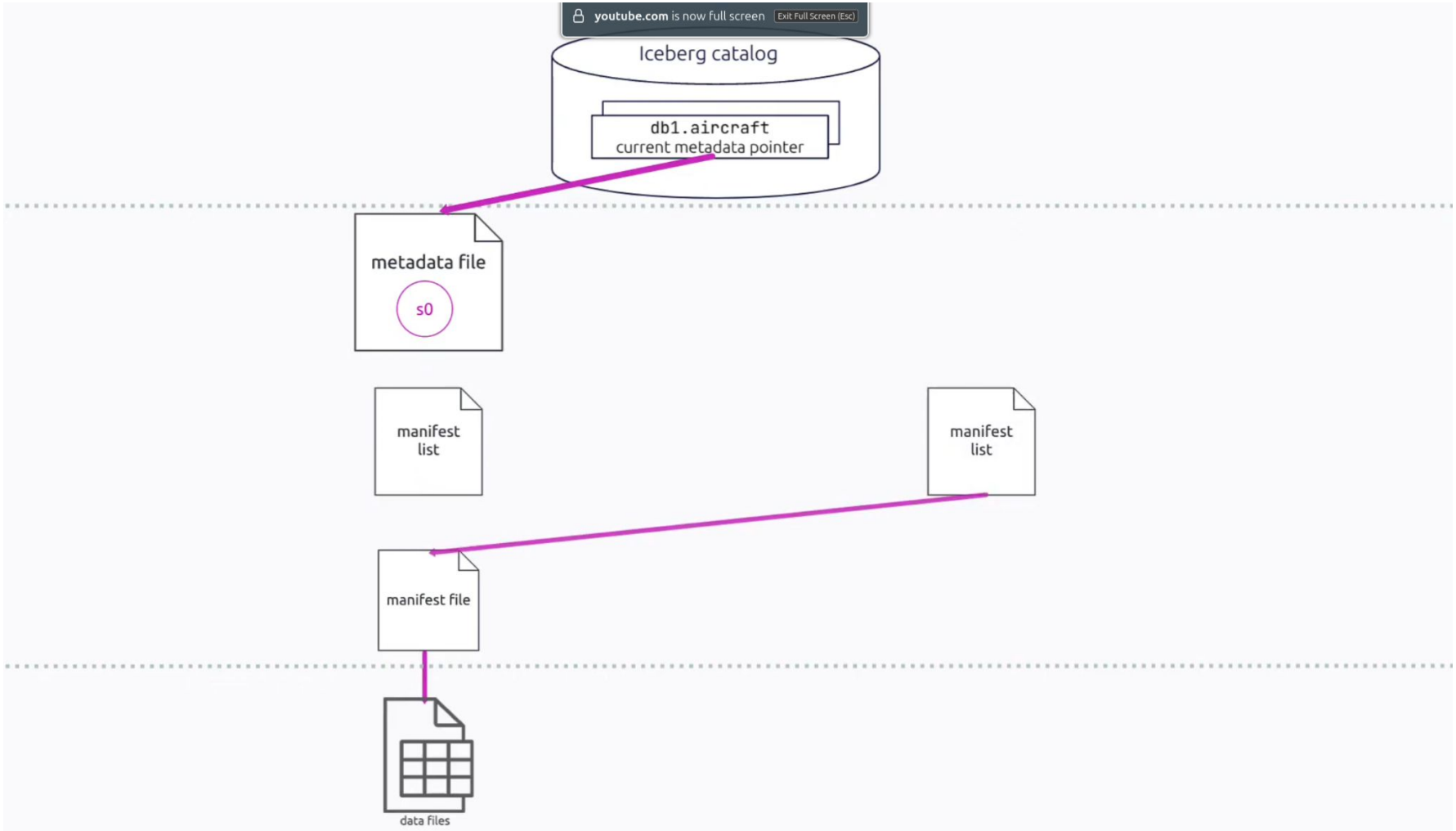
1

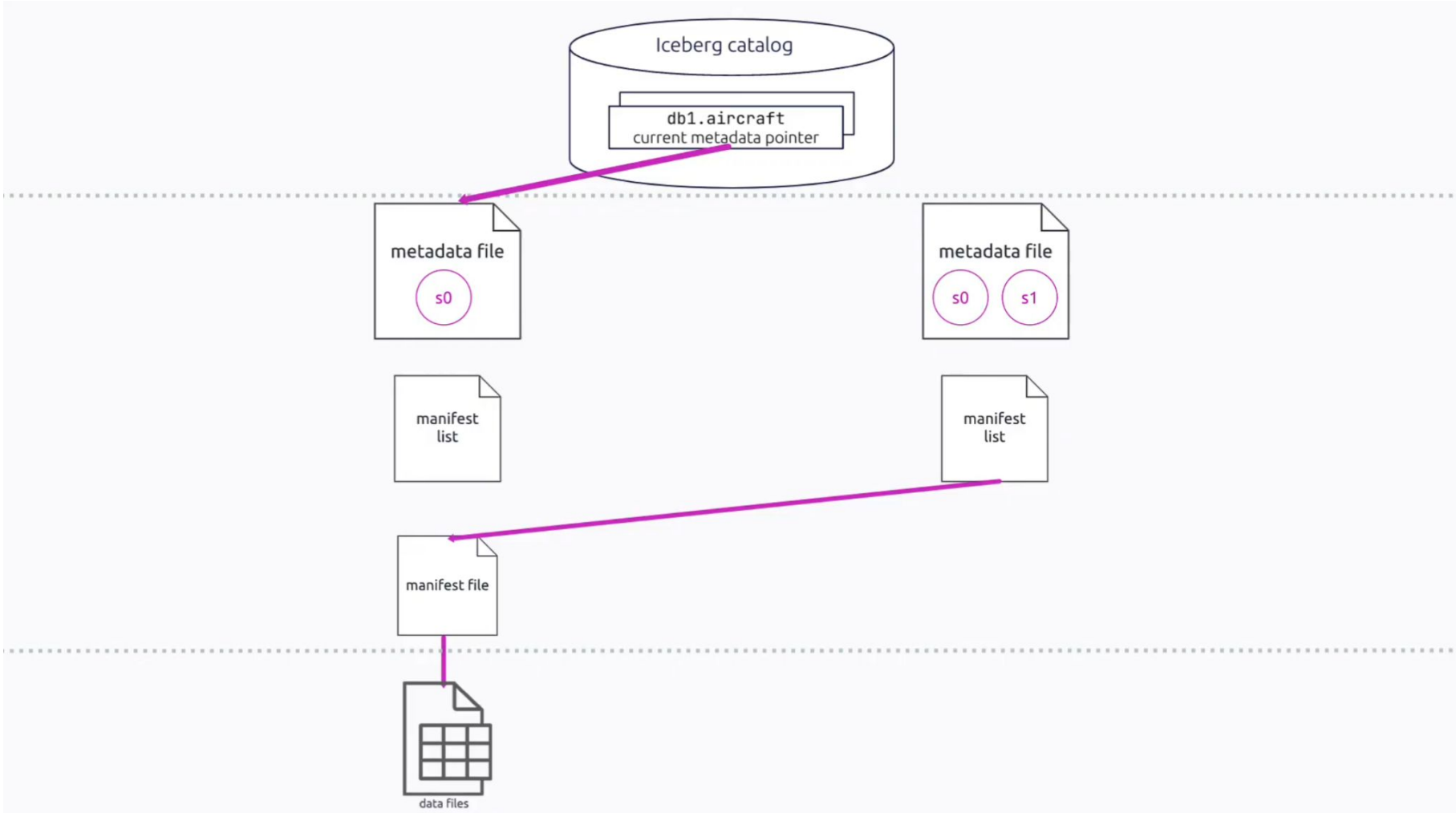
Name	Type	Last modified	Size	Storage class
00000-e6b05edc-87c5-44c0-91ed-504767cd1107.metadata.json	json	May 28, 2024, 15:06:23 (UTC-04:00)	2.1 KB	Standard
snap-425416382669527773-1-189af56b-cb7a-40b0-a0d1-6a94c3796ca0.avro	avro	May 28, 2024, 15:06:23 (UTC-04:00)	4.0 KB	Standard

```
INSERT INTO
  aircraft (tail_number, description, class, year)
VALUES
  ('N535NA', 'NASA', 'Helicopter', 1969),
  ('N611TV', 'COOL', 'Jet', 1983);
```


Iceberg catalog
db1.aircraft
current metadata pointer
metadata file
s0
manifest list
manifest file
data files

youtube.com is now full screen Exit Full Screen (Esc)

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db1.aircraft
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s0
metadata file
s0
s1
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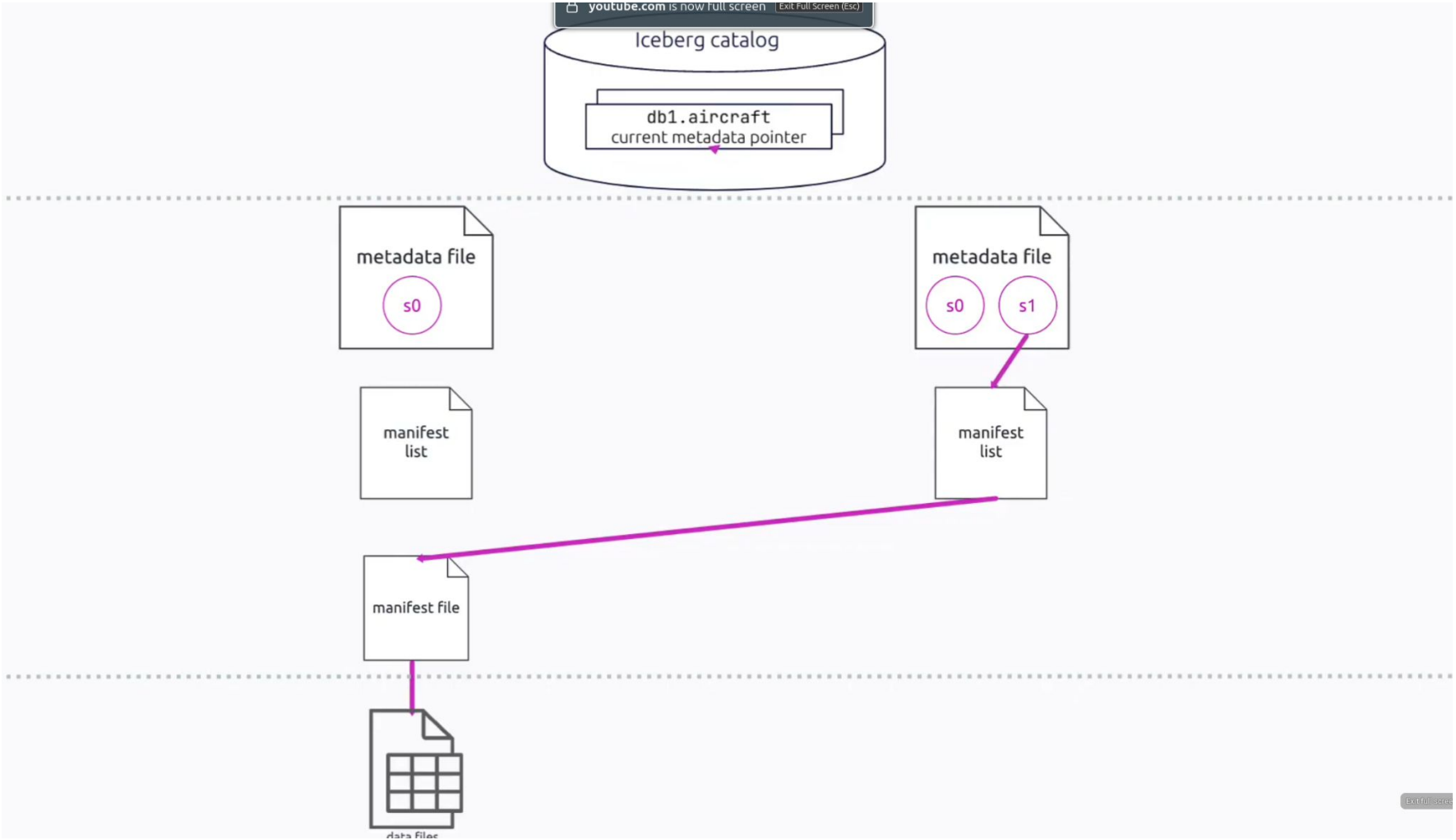
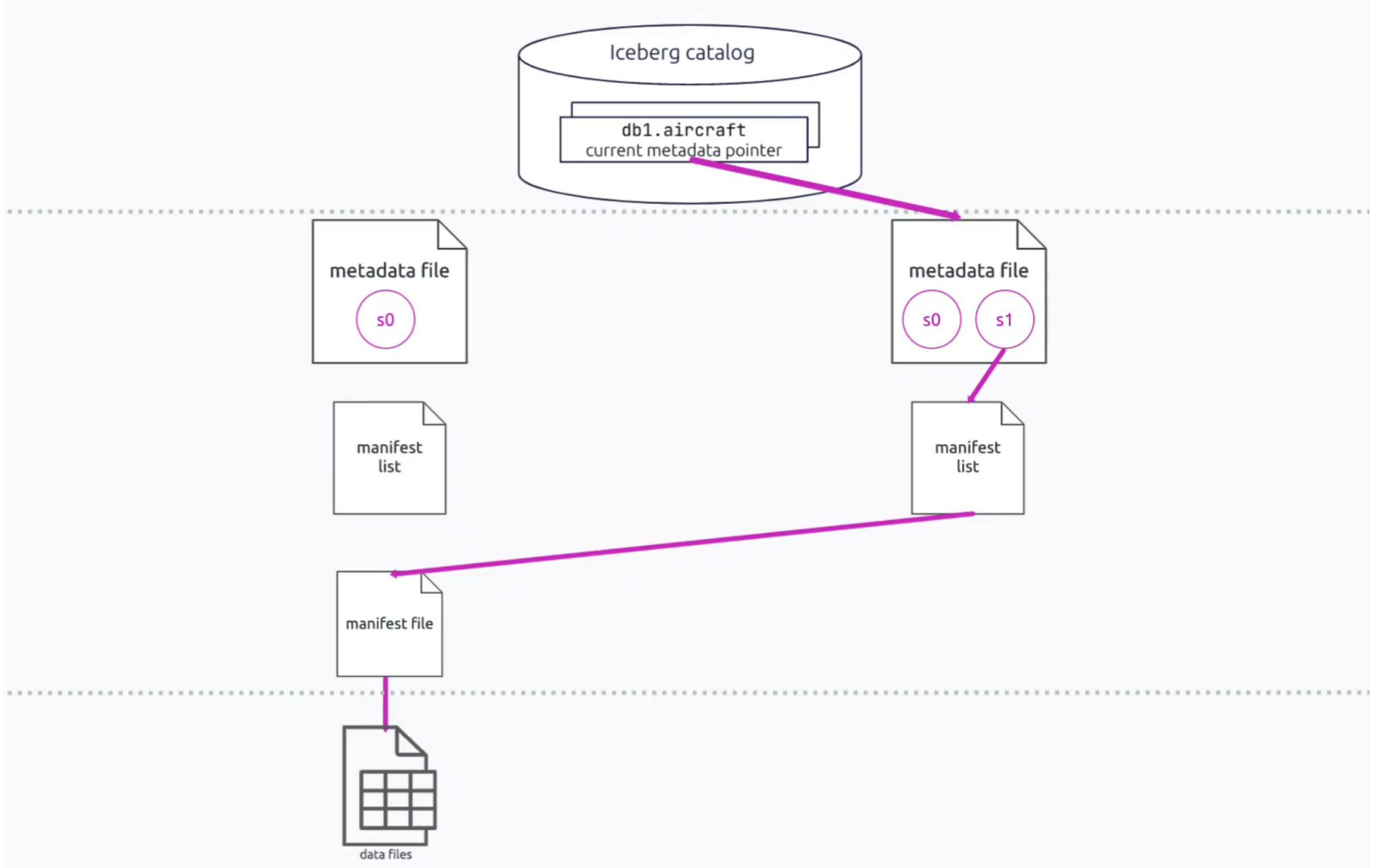
manifest list
manifest file
data files




Iceberg catalog
db1.aircraft
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s0
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s1
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Objects | Properties

Objects (2) Info

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Find objects by prefix

1

Name	Type	Last modified	Size	Storage class
data/	Folder	-	-	-
metadata/	Folder	-	-	-

data/

Copy S3 URI

Objects | Properties

Objects (1) Info

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1

Name	Type	Last modified	Size	Storage class
20[illegible]0529_152110_21982_9r62a-588d9021-5556-437f-a2f0-d0f00600f748.parquet	parquet	May 29, 2024, 11:22:37 (UTC-04:00)	658.0 B	Standard

Objects (7) Info

Copy S3 URI | Copy URL | Download | Open | Delete | Actions | Create folder

Upload

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Find objects by prefix

1

Name	Type	Last modified	Size	Storage class
20240529_152110_21982_9r62a-740c70f1-774b-4b49-9067-03e1771f37a8.stats	stats	May 29, 2024, 11:22:38 (UTC-04:00)	1017.0 B	Standard
29fa1a6e-e0aa-4aab-b9c3-58fa79dcfa44-m0.avro	avro	May 29, 2024, 11:22:38 (UTC-04:00)	6.7 KB	Standard
snap-272458280946650479 3-1-29fa1a6e-e0aa-4aab-b9c3-58fa79dcfa44.avro	avro	May 29, 2024, 11:22:38 (UTC-04:00)	4.2 KB	Standard
snap-425416382669527773-1-189af56b-cb7a-40b0-a0d1-6a94c3796ca0.avro	avro	May 28, 2024, 15:06:23 (UTC-04:00)	4.0 KB	Standard

Objects (7) Info

Copy S3 URI | Copy URL | Download | Open | Delete | Actions | Create folder

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Find objects by prefix

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Name	Type	Last modified	Size	Storage class
20240529_152110_21982_9r62a-740c70f1-774b-4b49-9067-03e1771f37a8.stats	stats	May 29, 2024, 11:22:38 (UTC-04:00)	1017.0 B	Standard
29fa1a6e-e0aa-4aab-b9c3-58fa79dcfa44-m0.avro	avro	May 29, 2024, 11:22:38 (UTC-04:00)	6.7 KB	Standard
snap-2724582809466504793-1-29fa1a6e-e0aa-4aab-b9c3-58fa79dcfa44.avro	avro	May 29, 2024, 11:22:38 (UTC-04:00)	4.2 KB	Standard
snap-425416382669527773-1-189af56b-cb7a-40b0-a0d1-6a94c3796ca0.avro	avro	May 28, 2024, 15:06:23 (UTC-04:00)	4.0 KB	Standard

Apache iceberg advantages

1) Reliable schema evolution

- add/drop/rename columns safely
- type promotion (where supported)

2) ACID-like consistency for the lake

With “just Parquet”, you typically don’t have atomic commits: readers can see partial writes, and concurrent writers can stomp on each other.
Iceberg uses **atomic snapshots**:

- writes commit as a new snapshot or not at all
- readers always see a consistent version
- concurrent writes are coordinated via metadata + catalog

3) Time travel and reproducibility

Iceberg keeps table history (snapshots), so you can:

- query “as of” a timestamp/snapshot
- rollback to a previous version
- reproduce ML features / reports exactly

4) Upserts, deletes, and MERGE that actually work

Parquet files are immutable; “updates” usually mean rewriting partitions and hoping you don’t break consistency.
Iceberg supports:

- row-level deletes (delete files / position deletes)
- MERGE INTO / UPDATE / DELETE patterns (engine support varies but the table format enables it)

5) Faster reads via metadata-driven pruning

Parquet has row-group stats, but without a table layer you still often end up listing tons of files and guessing what to scan.
Iceberg maintains metadata that enables:

- **partition pruning** without directory conventions
- **file pruning** via stats (min/max, null counts, etc.)
- less expensive “list” operations on object stores

8) Multi-engine interoperability (more predictable)

A Parquet directory structure might “work” in Spark but not in Trino/Presto the same way, especially with schema evolution and partition inference.
Iceberg’s spec makes behavior more consistent across engines that support it (Spark, Flink, Trino, Dremio, Athena, etc.).

When “pure Parquet” can be enough

- append-only pipelines with no updates/deletes
- single writer, low concurrency
- you don’t need time travel, rollback, or evolving partition strategies