

# Build Data Pipelines with Delta Live Tables

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Module 04



# Agenda

## Build Data Pipelines with Delta Live Tables

The Medallion Architecture

Introduction to Delta Live Tables

DE 4.1 – DLT UI Walkthrough

DE 4.2 – Python vs SQL

DE 4.1A – SQL Pipelines

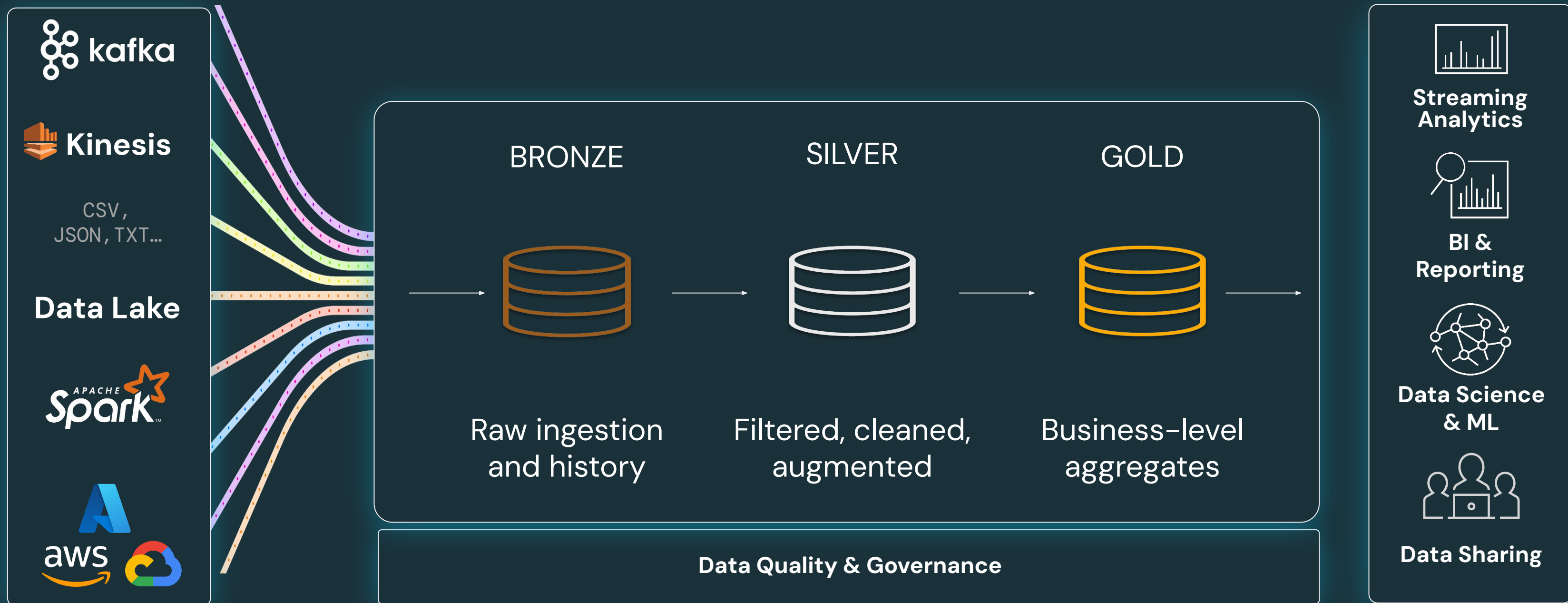
DE 4.1B – Python Pipelines

DE 4.3 – Pipeline Results

DE 4.4 – Pipeline Event Logs

# The Medallion Architecture

# Medallion Architecture in the Lakehouse



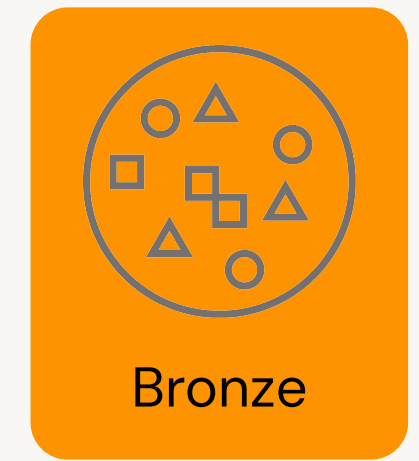
# Multi-Hop in the Lakehouse

## Bronze Layer

Typically just a raw copy of ingested data

Replaces traditional data lake

Provides efficient storage and querying of full, unprocessed history of data



# Multi-Hop in the Lakehouse

## Silver Layer

Reduces data storage complexity, latency, and redundancy

Optimizes ETL throughput and analytic query performance

Preserves grain of original data (without aggregations)

Eliminates duplicate records

Production schema enforced

Data quality checks, corrupt data quarantined



# Multi-Hop in the Lakehouse

## Gold Layer

Powers ML applications, reporting, dashboards, ad hoc analytics

Refined views of data, typically with aggregations

Reduces strain on production systems

Optimizes query performance for business-critical data



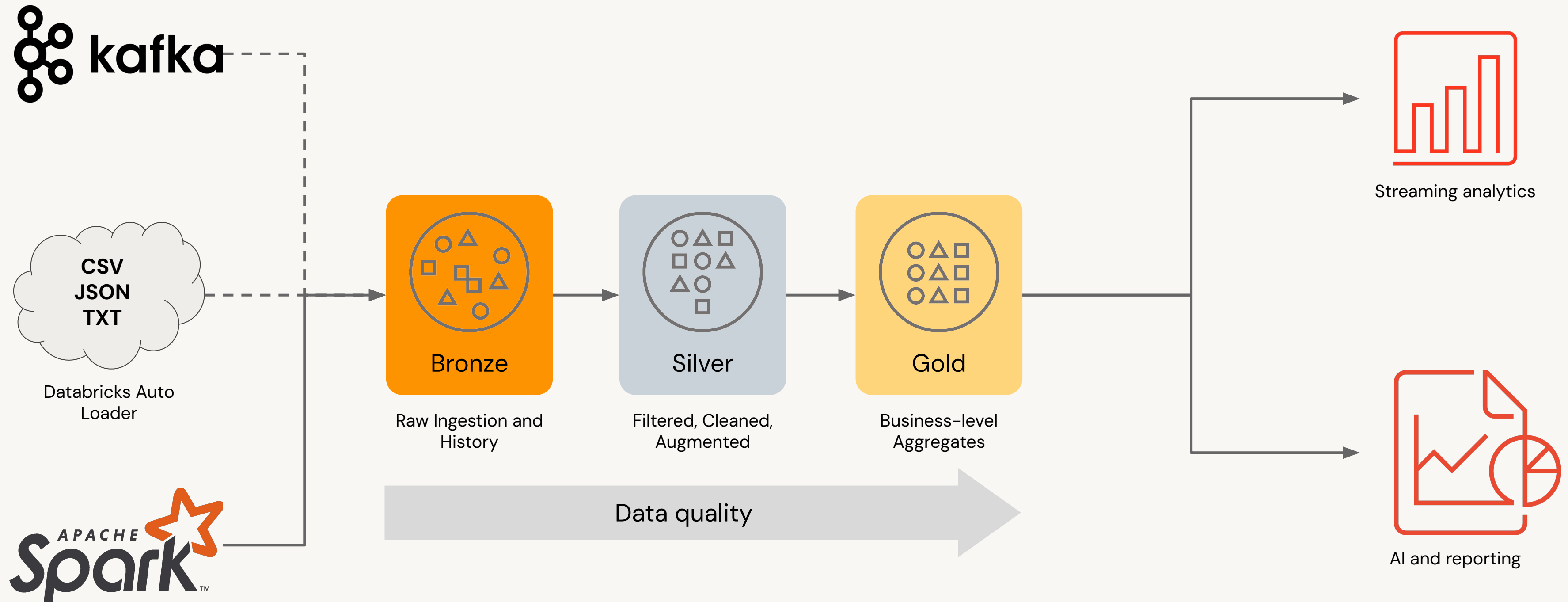


# Introduction to Delta Live Tables

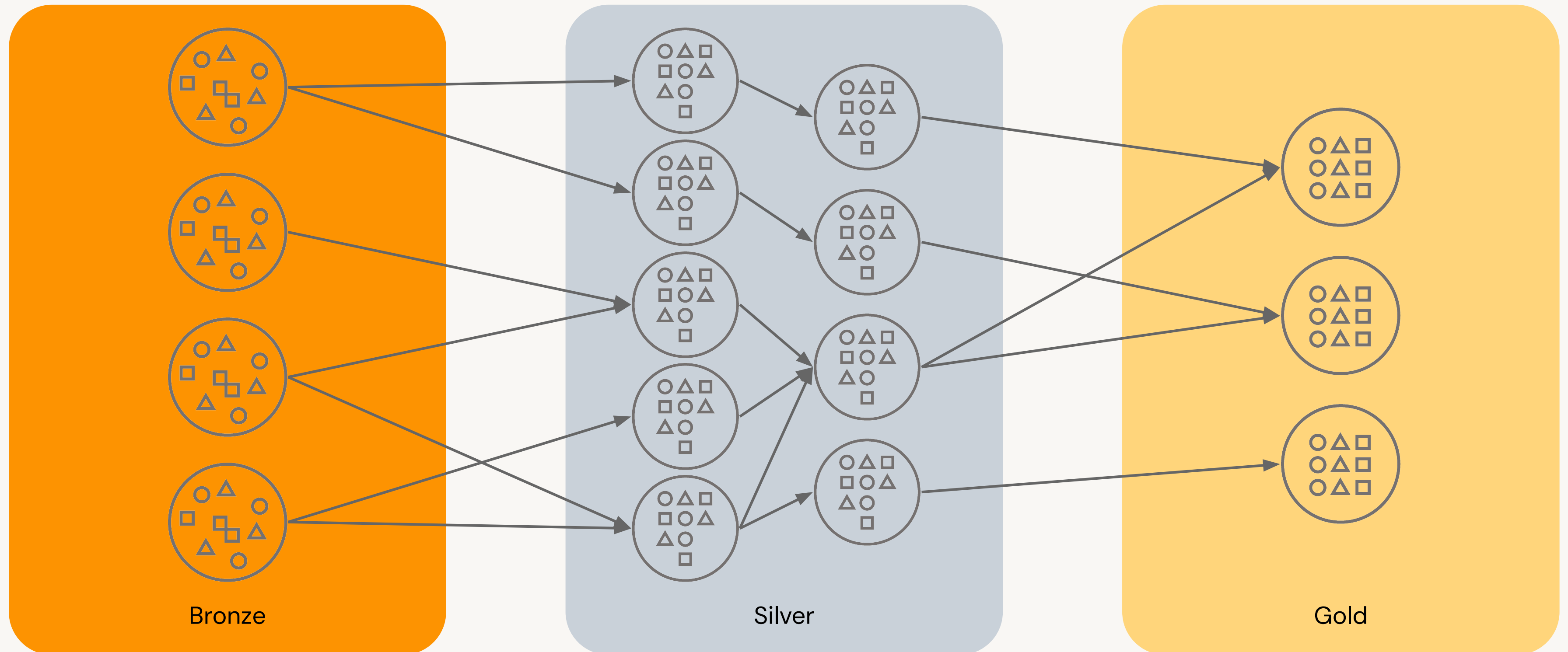




# Multi-Hop in the Lakehouse



# The Reality is Not so Simple



# Large scale ETL is complex and brittle

## Complex pipeline development

Hard to build and maintain table **dependencies**

Difficult to switch between **batch** and **stream** processing

## Data quality and governance

Difficult to monitor and enforce **data quality**

Impossible to trace data **lineage**

## Difficult pipeline operations

Poor **observability** at granular, data level

Error handling and **recovery** is laborious

# Introducing Delta Live Tables

Make reliable ETL easy on Delta Lake

## Operate with agility

Declarative tools to  
build batch and  
streaming data  
pipelines



## Trust your data

DLT has built-in  
declarative quality  
controls

Declare quality  
expectations and  
actions to take



## Scale with reliability

Easily scale  
infrastructure  
alongside your data



# What is a LIVE TABLE?

# What is a Live Table?

Live Tables are materialized views for the lakehouse.

A live table is:

- Defined by a SQL query
- Created and kept up-to-date by a pipeline

```
CREATE OR REFRESH LIVE TABLE report
AS SELECT sum(profit)
FROM prod.sales
```

Live tables provides tools to:

- Manage dependencies
- Control quality
- Automate operations
- Simplify collaboration
- Save costs
- Reduce latency

# What is a Streaming Live Table?

Based on Spark™ Structured Streaming

A **streaming live table** is “stateful”:

- Ensures exactly–once processing of input rows
- Inputs are only read once

```
CREATE STREAMING LIVE TABLE report  
AS SELECT sum(profit)  
FROM cloud_files(prod.sales)
```

- **Streaming Live tables** compute results over append–only streams such as Kafka, Kinesis, or Auto Loader (files on cloud storage)
- Streaming live tables allow you to **reduce costs and latency** by avoiding reprocessing of old data.

# What is a Streaming Table?

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# When should I use streaming?

# Using Spark Structured Streaming for ingestion

Easily ingest files from cloud storage as they are uploaded

```
CREATE STREAMING LIVE TABLE raw_data
AS SELECT *
FROM cloud_files("/data", "json")
```

This example creates a table with all the json data stored in “/data”:

- `cloud_files` keeps track of which files have been read to avoid duplication and wasted work
- Supports both listing and notifications for arbitrary scale
- Configurable schema inference and schema evolution

# Using the SQL `STREAM()` function

Stream data from any Delta table

```
CREATE STREAMING LIVE TABLE mystream  
  AS SELECT *  
  FROM STREAM(my_table)
```

Pitfall: `my_table` must be an append-only source.

e.g. it may not:

- be the target of `APPLY CHANGES INTO`
- define an aggregate function
- be a table on which you've executed DML to delete/update a row (see GDPR section)

- `STREAM(my_table)` reads a stream of new records, instead of a snapshot
- Streaming tables must be an append-only table
- Any append-only delta table can be read as a stream (i.e. from the live schema, from the catalog, or just from a path).

# Using the SQL `STREAM()` function

Stream data from any Delta table

```
CREATE STREAMING TABLE mystream  
  AS SELECT *  
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# How do I use DLT?

# Creating Your First Live Table Pipeline

SQL to DLT in three easy steps...

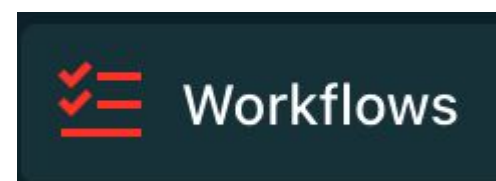
## Write create live table

- Table definitions are written (but not run) in notebooks
- Databricks Repos allow you to version control your table definitions.

```
1 CREATE LIVE TABLE daily_stats
2 AS SELECT sum(rev) - sum(costs) AS profits
3 FROM prod_data.transactions
4 GROUP BY day
```

## Create a pipeline

- A Pipeline picks one or more notebooks of table definitions, as well as any configuration required.



Delta Live Tables

## Click start

- DLT will create or update all the tables in the pipelines.



# Development vs Production

Fast iteration or enterprise grade reliability

## Development Mode

- Reuses a **long-running cluster** running for **fast iteration**.
- **No retries** on errors enabling **faster debugging**.


## Production Mode

- **Cuts costs** by **turning off clusters** as soon as they are done (within 5 minutes)
- **Escalating retries**, including cluster restarts, **ensure reliability** in the face of transient issues.

In the Pipelines UI:

Development

Production



# What if I have dependent tables?

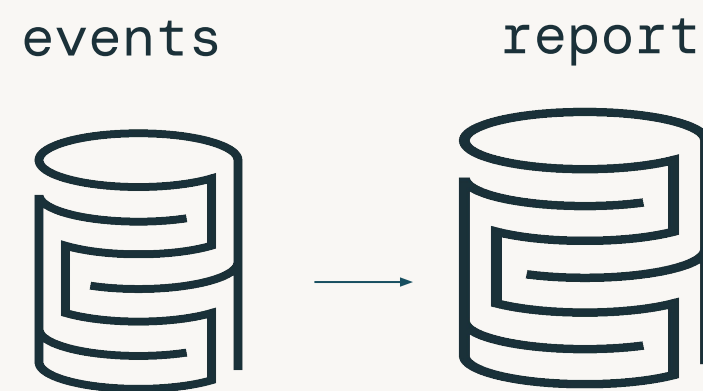


# Declare **LIVE** Dependencies

Using the **LIVE** virtual schema.

```
CREATE LIVE TABLE events  
AS SELECT ... FROM prod.raw_data
```

```
CREATE LIVE TABLE report  
AS SELECT ... FROM LIVE.events
```



- Dependencies owned by **other producers** are just read from the **catalog or spark data source as normal**.
- **LIVE dependencies**, from the **same pipeline**, are read from the **LIVE** schema.
- DLT **detects LIVE dependencies** and executes all operations in **correct order**.
- DLT handles **parallelism** and captures the **lineage** of the data.

# How do I ensure Data Quality?

# Ensure **correctness** with Expectations

Expectations are tests that ensure data quality in production

```
CONSTRAINT valid_timestamp  
EXPECT (timestamp > '2012-01-01')  
ON VIOLATION DROP
```

```
@dlt.expect_or_drop(  
    "valid_timestamp",  
    col("timestamp") > '2012-01-01')
```

Expectations are true/false expressions that are used to **validate each row** during processing.

DLT offers **flexible policies** on how to handle records that violate expectations:

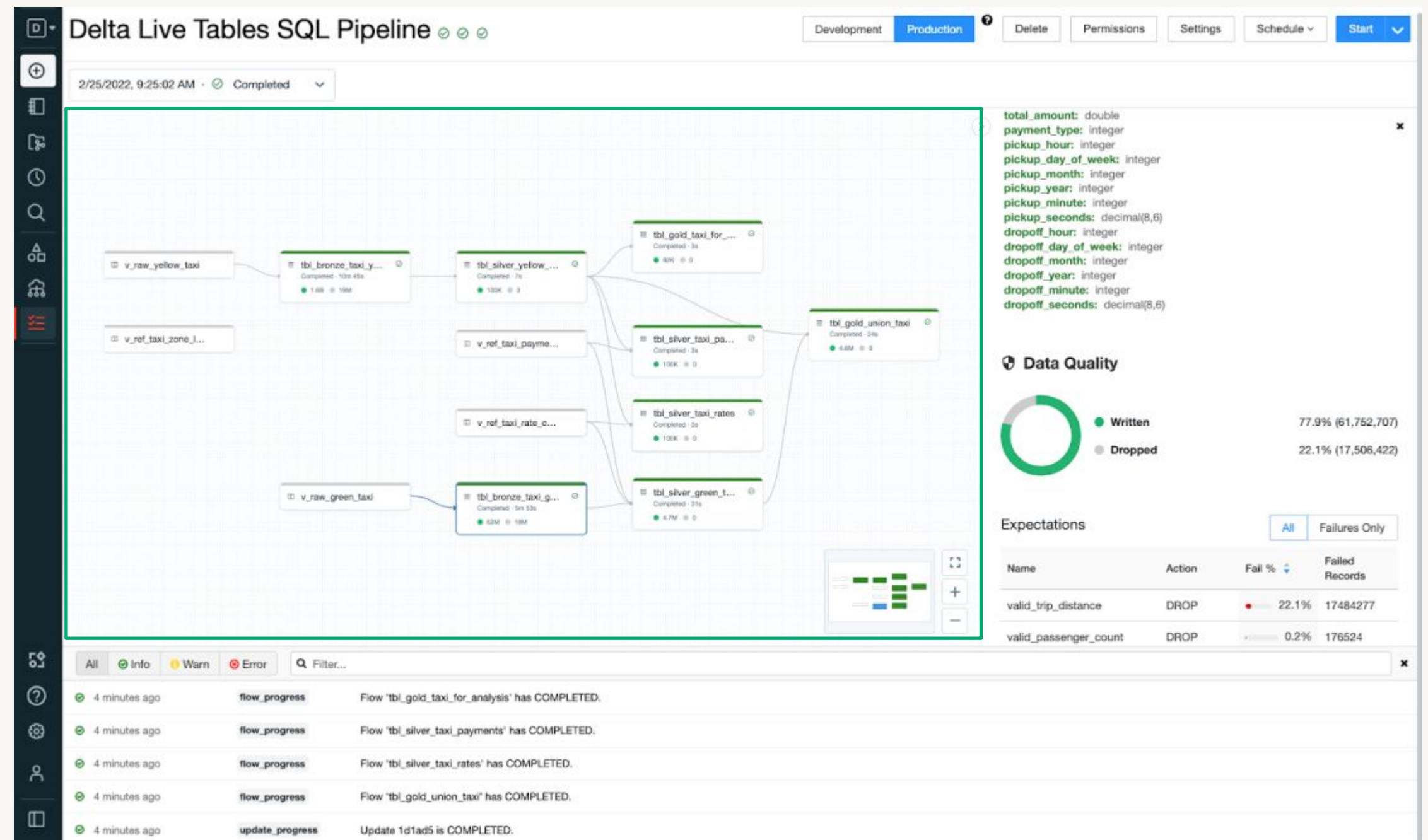
- **Track** number of bad records
- **Drop** bad records
- **Abort** processing for a single bad record

# What about operations?

# Pipelines UI (1 of 5)

A one stop shop for ETL debugging and operations

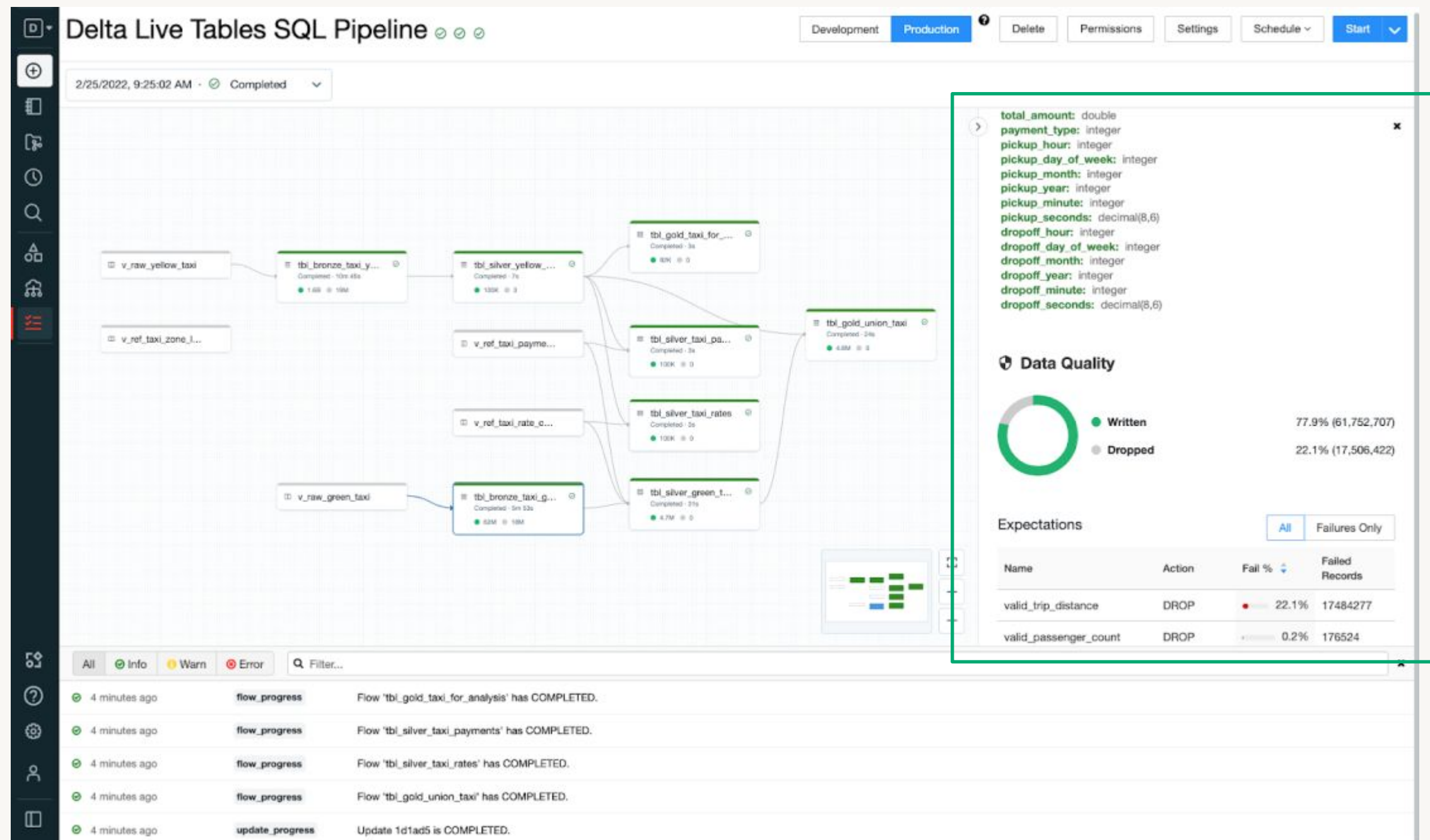
- Visualize data flows between tables



# Pipelines UI (2 of 5)

A one stop shop for ETL debugging and operations

- **Visualize** data flows between tables
- **Discover** metadata and quality of each table

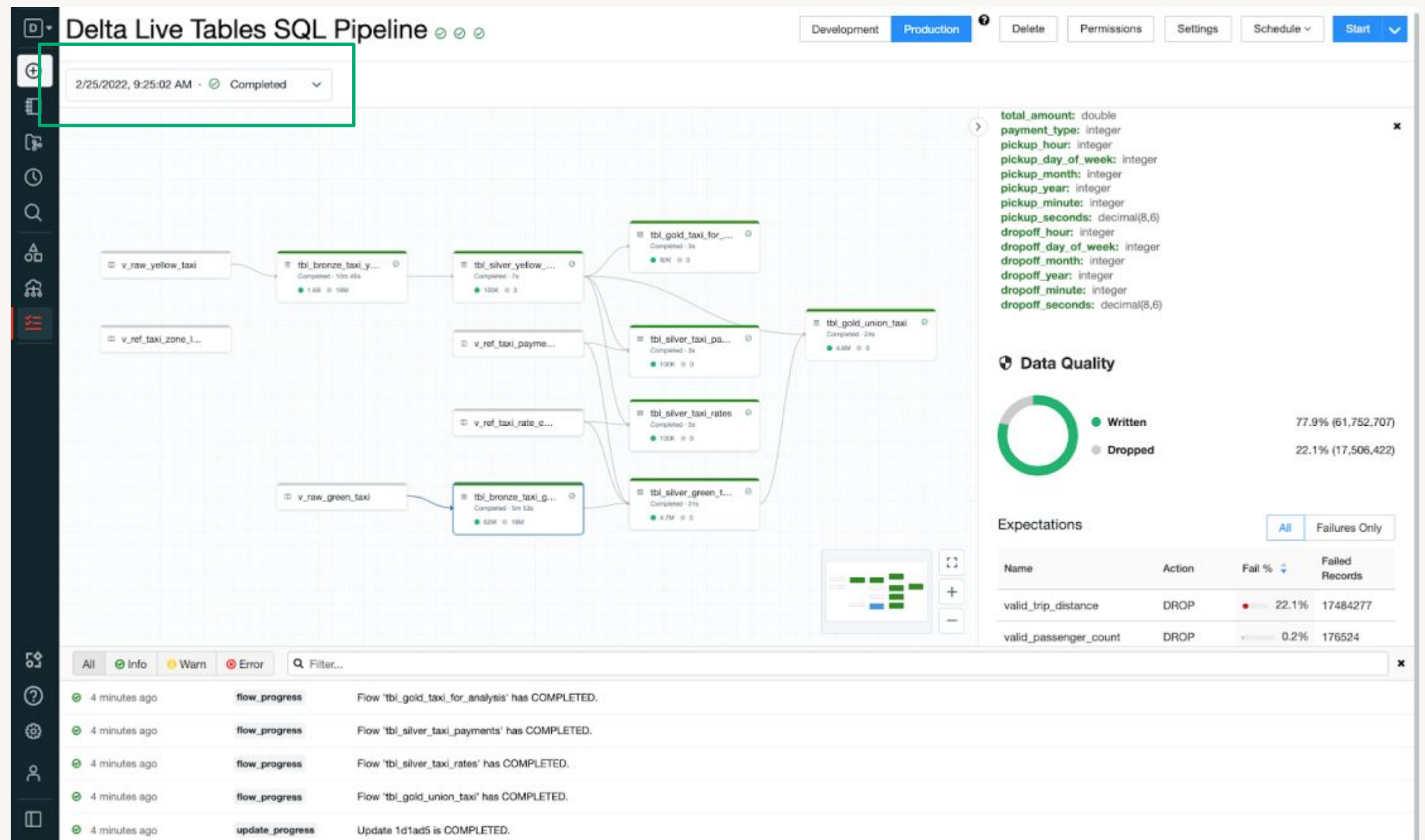




# Pipelines UI (3 of 5)

A one stop shop for ETL debugging and operations

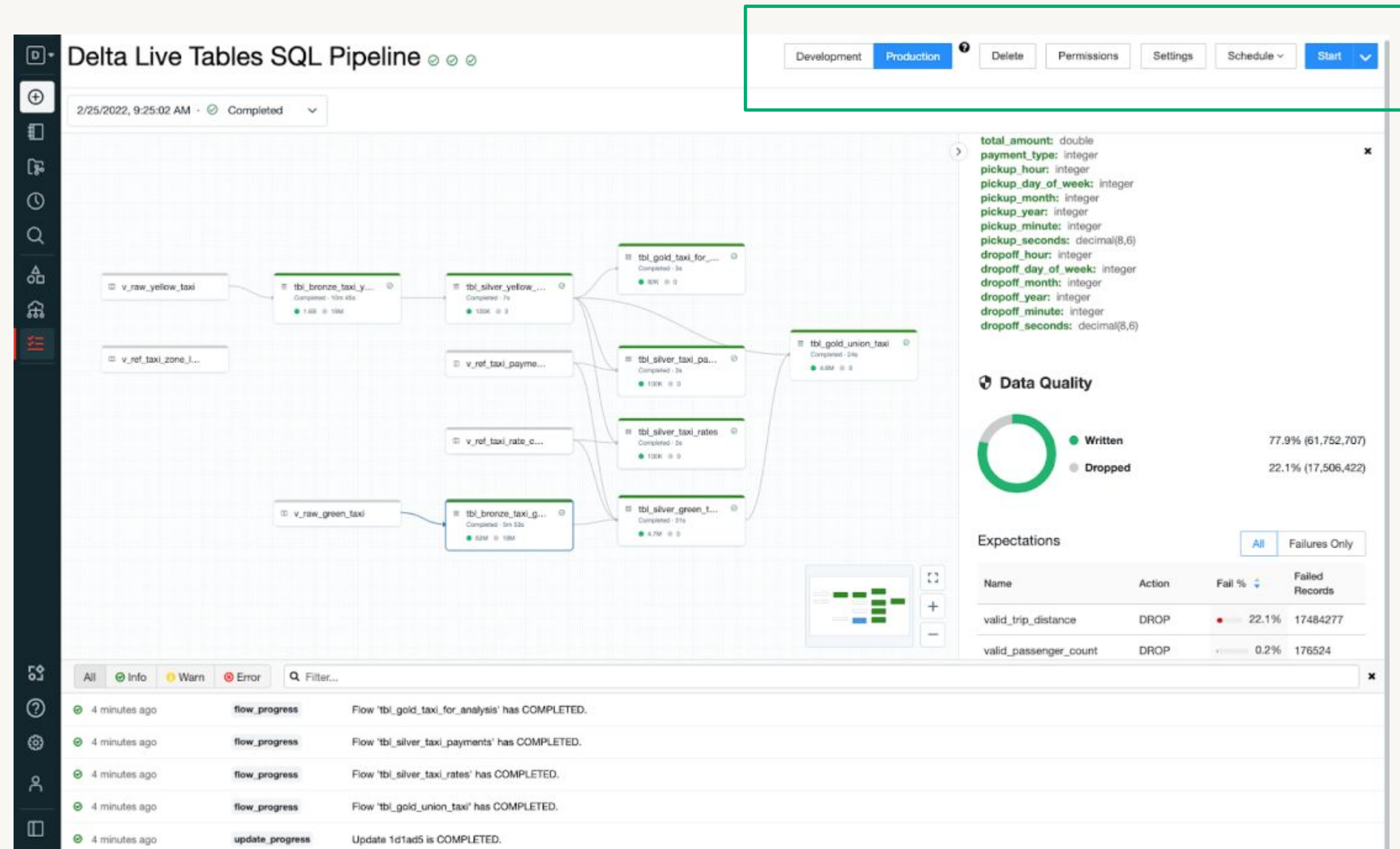
- Visualize data flows between tables
- Discover metadata and quality of each table
- Access to historical updates



# Pipelines UI (4 of 5)

A one stop shop for ETL debugging and operations

- **Visualize** data flows between tables
- **Discover** metadata and quality of each table
- **Access** to historical updates
- **Control** operations





# Pipelines UI (4 of 5)

## Full refresh all

- Optional: Full refresh all tables
- Accessed from the Start dropdown
- Important!! Performing a full refresh on bronze tables can introduce errors or loss of data
- `pipelines.reset.allowed`

`es.reset.allowed`

Delta Live Tables SQL Pipeline

2/25/2022, 9:25:02 AM - Completed

Development Production Delete Permissions Settings Schedule Start

total\_amount: double  
payment\_type: integer  
pickup\_hour: integer  
pickup\_day\_of\_week: integer  
pickup\_month: integer  
pickup\_year: integer  
pickup\_minute: integer  
pickup\_seconds: decimal(8,6)  
dropoff\_hour: integer  
dropoff\_day\_of\_week: integer  
dropoff\_month: integer  
dropoff\_year: integer  
dropoff\_minute: integer  
dropoff\_seconds: decimal(8,6)

Data Quality

77.9% (61,752,707) Written  
22.1% (17,506,422) Dropped

Expectations

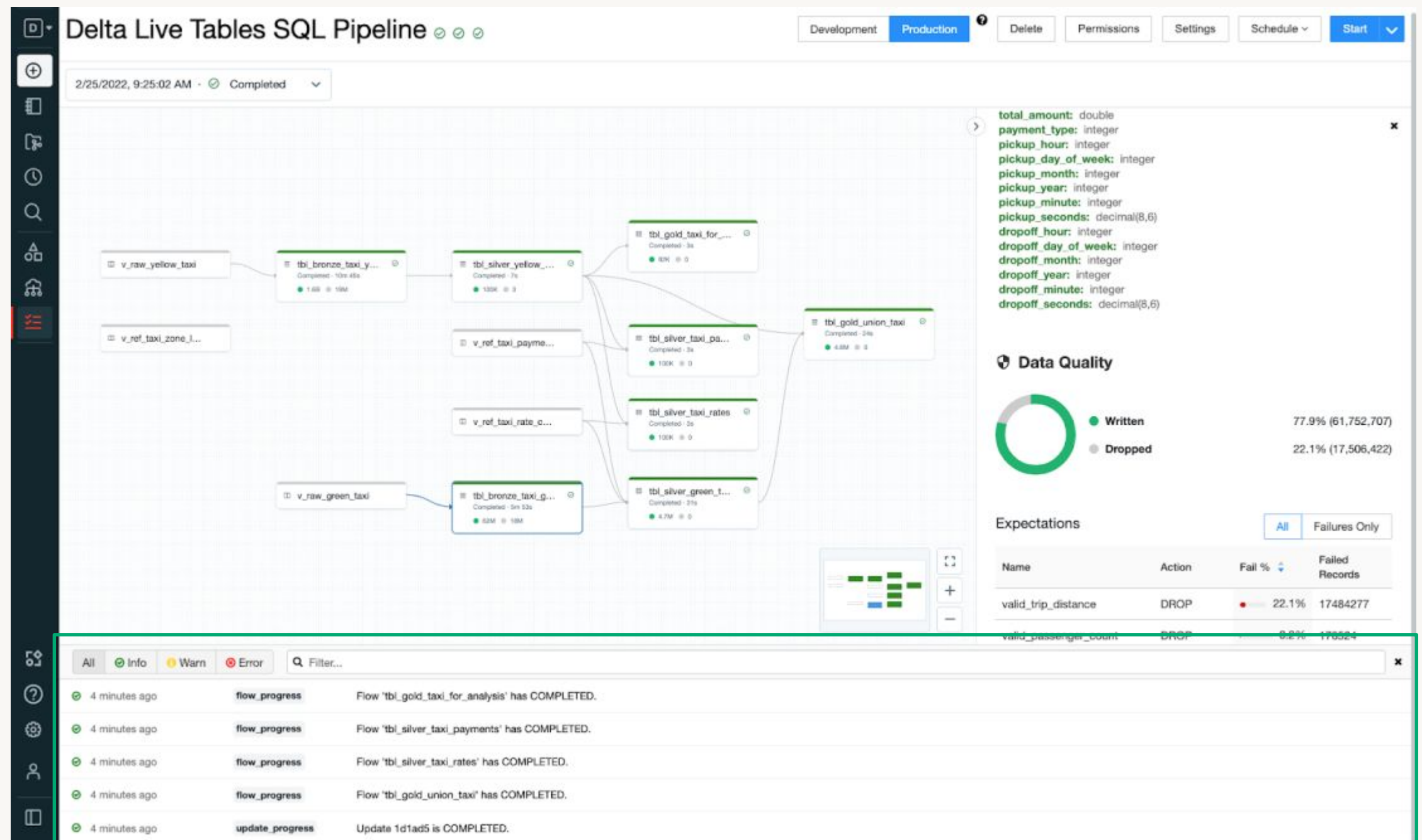
Name	Action	Fail %	Failed Records
valid_trip_distance	DROP	22.1%	17484277
valid_passenger_count	DROP	0.2%	176524

Flow 'tbl\_gold\_taxi\_for\_analysis' has COMPLETED.  
Flow 'tbl\_silver\_taxi\_payments' has COMPLETED.  
Flow 'tbl\_silver\_taxi\_rates' has COMPLETED.  
Flow 'tbl\_gold\_union\_taxi' has COMPLETED.  
Update 1d1ad5 is COMPLETED.

# Pipelines UI (5 of 5)

A one stop shop for ETL debugging and operations

- **Visualize** data flows between tables
- **Discover** metadata and quality of each table
- **Access** to historical updates
- **Control** operations
- **Dive deep** into events



# The Event Log

The event log automatically records all pipelines operations.

## Operational Statistics

Time and current status, for all operations

Pipeline and cluster configurations

Row counts

## Provenance

Table schemas, definitions, and declared properties

Table-level lineage

Query plans used to update tables

## Data Quality

Expectation pass / failure / drop statistics

Input/Output rows that caused expectation failures

# How can I use parameters?

# Modularize your code with configuration

Avoid hard coding paths, topic names, and other constants in your code.

A pipeline's configuration is a **map of key value pairs** that can be used to parameterize your code:


- Improve code readability/maintainability
- Reuse code in multiple pipelines for different data

Configuration

my_etl.input_path	s3://my-data/json/	
<button>Add configuration</button>		

```
CREATE STREAMING LIVE TABLE data AS  
SELECT * FROM cloud_files("${my_etl.input_path}", "json")
```

```
@dlt.table  
def data():  
    input_path = spark.conf.get("my_etl.input_path")  
    spark.readStream.format("cloud_files").load(input_path)
```



# How can I do change data capture (CDC)?

# APPLY CHANGES INTO for CDC

Maintain an up-to-date replica of a table stored elsewhere

```
APPLY CHANGES INTO LIVE.cities  
FROM STREAM(LIVE.city_updates)  
KEYS (id)  
SEQUENCE BY ts
```

{UPDATE}  
{DELETE}  
{INSERT}



Up-to-date Snapshot



# APPLY CHANGES INTO for CDC

Maintain an up-to-date replica of a table stored elsewhere

```
APPLY CHANGES INTO LIVE.cities
FROM STREAM(LIVE.city_updates)
KEYS (id)
SEQUENCE BY ts
```

A **target** for the changes to be applied to.

## city\_updates

```
{"id": 1, "ts": 1, "city": "Bekerly, CA"}
```

## cities

id	city
----	------



# APPLY CHANGES INTO for CDC

Maintain an up-to-date replica of a table stored elsewhere

```
APPLY CHANGES INTO LIVE.cities  
FROM STREAM(LIVE.city_updates)  
KEYS (id)  
SEQUENCE BY ts
```

A **source** of changes,  
currently this has to be a  
stream.

**city\_updates**

```
{"id": 1, "ts": 1, "city": "Bekerly, CA"}
```

# APPLY CHANGES INTO for CDC

Maintain an up-to-date replica of a table stored elsewhere

```
APPLY CHANGES INTO LIVE.cities
FROM STREAM(LIVE.city_updates)
KEYS (id)
SEQUENCE BY ts
```

A unique **key** that can be used to identify a given row.

## city\_updates

```
{"id": 1, "ts": 1, "city": "Bekerly, CA"}
```

## cities

id	city
----	------

# APPLY CHANGES INTO for CDC

Maintain an up-to-date replica of a table stored elsewhere

```
APPLY CHANGES INTO LIVE.cities
FROM STREAM(LIVE.city_updates)
KEYS (id)
SEQUENCE BY ts
```

A **sequence** that can be used to order changes:

- Log sequence number (lsn)
- Timestamp
- Ingestion time

## city\_updates

```
{"id": 1, "ts": 100, "city": "Bekerly, CA"}
```

## cities

id	city
----	------

# APPLY CHANGES INTO for CDC

Maintain an up-to-date replica of a table stored elsewhere

```
APPLY CHANGES INTO LIVE.cities
FROM STREAM(LIVE.city_updates)
KEYS (id)
SEQUENCE BY ts
```

## city\_updates

```
{"id": 1, "ts": 100, "city": "Bekerly, CA"}
{"id": 1, "ts": 200, "city": "Berkeley, CA"}
```

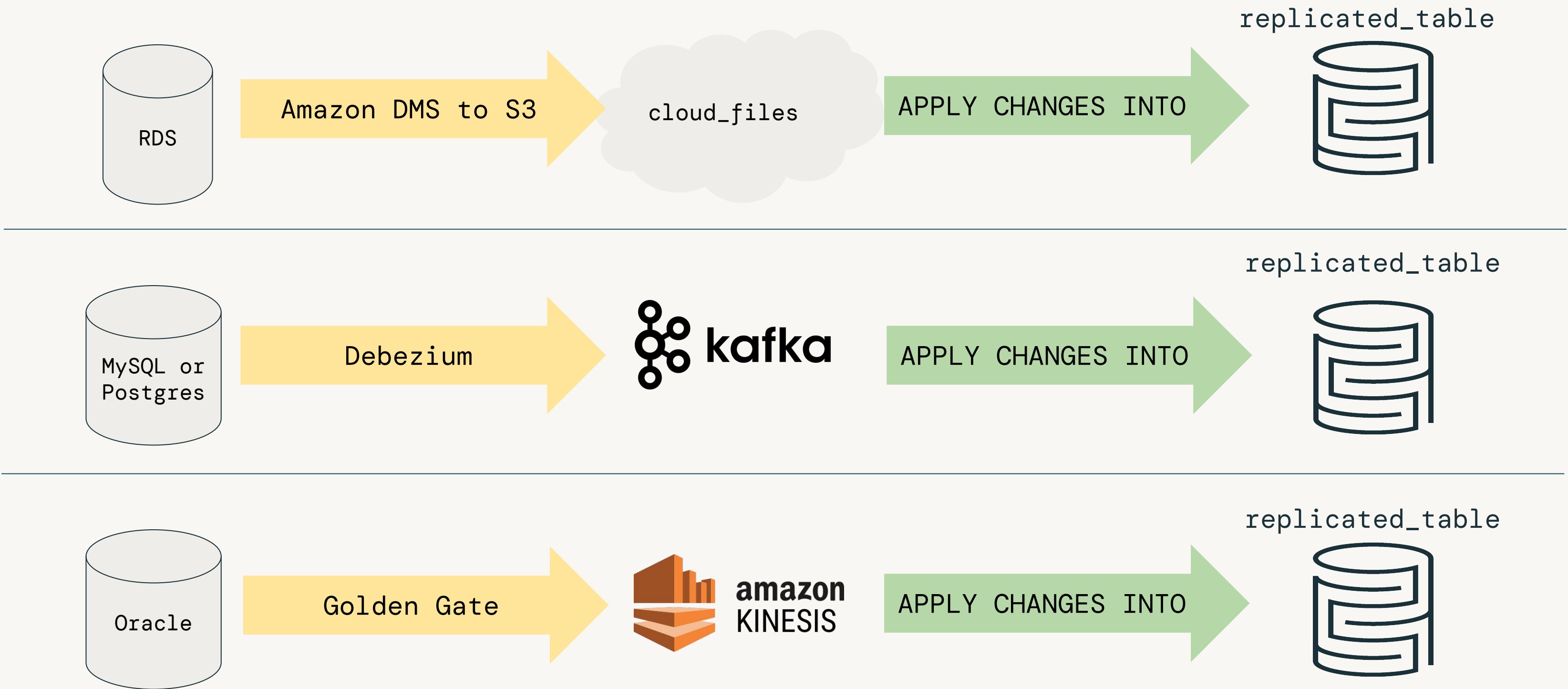
## cities

id	city
1	<del>Bekerly, CA</del>

Berkeley, CA

# Change Data Capture (CDC) from RDBMS

A variety of 3<sup>rd</sup> party tools can provide a streaming change feed



What do I no longer  
need to manage **with**  
**DLT?**

# Automated Data Management

DLT automatically optimizes data for performance & ease-of-use

## Best Practices

### What:

DLT encodes Delta best practices automatically when creating DLT tables.

### How:

DLT sets the following properties:

- `optimizeWrite`
- `autoCompact`
- `tuneFileSizesForRewrites`

## Physical Data

### What:

DLT automatically manages your physical data to minimize cost and optimize performance.

### How:

- runs vacuum daily
- runs optimize daily

**You still can tell us how you want it organized (ie ZORDER)**

## Schema Evolution

### What:

Schema evolution is handled for you

### How:

Modifying a **live table** transformation to add/remove/rename a column will automatically do the right thing.

When removing a column **in a streaming live table**, old values are preserved.

# DE 4.1 – Using the Delta Live Tables UI

Deploy a DLT pipeline

Explore the resultant DAG

Execute an update of the pipeline



# DE 4.1.1 – Fundamentals of DLT Syntax

Declaring Delta Live Tables

Ingesting data with Auto Loader

Using parameters in DLT Pipelines

Enforcing data quality with constraints

Adding comments to tables

Describing differences in syntax and execution of live tables and streaming live tables

# DE 4.1.2 – More DLT SQL Syntax

Processing CDC data with APPLY CHANGES INTO

Declaring live views

Joining live tables

Describing how DLT library notebooks work together in a pipeline

Scheduling multiple notebooks in a DLT pipeline

# DE 4.2 – Delta Live Tables: Python vs SQL

Identify key differences between the Python and SQL implementations of Delta Live Tables

# DE 4.3 – Exploring the Results of a DLT Pipeline

# DE 4.4 – Exploring the Pipeline Events Logs

# DE 4.1.3 – Troubleshooting DLT Syntax Lab

Identifying and troubleshooting DLT syntax  
Iteratively developing DLT pipelines with notebooks

