2 Hours to Data Innovation with Cloudera Data Warehouse

October 11th, 2023

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Cloudera Data Warehouse Workshop

Self Service Hands On Lab

Index:

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Business Use Case

The following Labs will take you through a Self-Service Analytics example. We will use a fictitious company named, Special Marketing Group (SMG). A little company background on **SMG is that they are a marketing data aggregator company** that is currently working closely **with Duty-Free Shops in many airports throughout the U.S. and 20+ countries. SMG is working with the Duty-Free Shop owners on an initiative to drive additional revenue into the shops**. The **duty-free shop owners** want to partner with specific airlines to offer **discounts through the airlines** to their **passengers who spend more time in an international terminal** than warranted for their flight.

SMG believes that it can help drive more revenue by driving more traffic to the duty-free shops. SMG realizes that they have **some questions that need to be answered**, such as:

- Which airlines have the most passengers who have long layovers built into their tickets?
- Which airlines have the most passengers who have delayed international legs in their itinerary causing an extended layover in their flight itinerary?
- Which airlines have the most passengers who are displaced by a missed international connection, caused by a delay in their previous leg?

By answering these burning business questions SMG will be able to work with duty-free shop owners to develop campaigns that they can run to drive additional revenue. Since, SMG also does quite a bit of business with many of the major airlines and believes that the analytics used to drive more revenue for duty-free shops could also help the airlines improve customer satisfaction during extended wait times, and duty-free shops can increase sales.

Our Labs today will walk through the steps to learn how SMG uses the power of Cloudera's Data Warehouse Data Service to leverage the Self-Service capabilities to build out this new solution. If/when the Business Analyst proves that this new data will work to solve the need, they can turn it over to the admin team to "productionalize" it.

Introduction to the Lab Data

For the following Workshop Hands On Labs, we will dive into this Scenario to show Cloudera Data Warehouse (CDW) is used to enable SMG to gain a competitive advantage - and at the same time, it highlights the performance and automation capabilities that help ensure performance is maintained while controlling costs.

The Hands On Labs will take you through how to use the Cloudera Data Warehouse service to quickly explore raw data, create curated versions of the data for simple reporting and dashboarding, and then scale up usage of the curated data by exposing it to more users.

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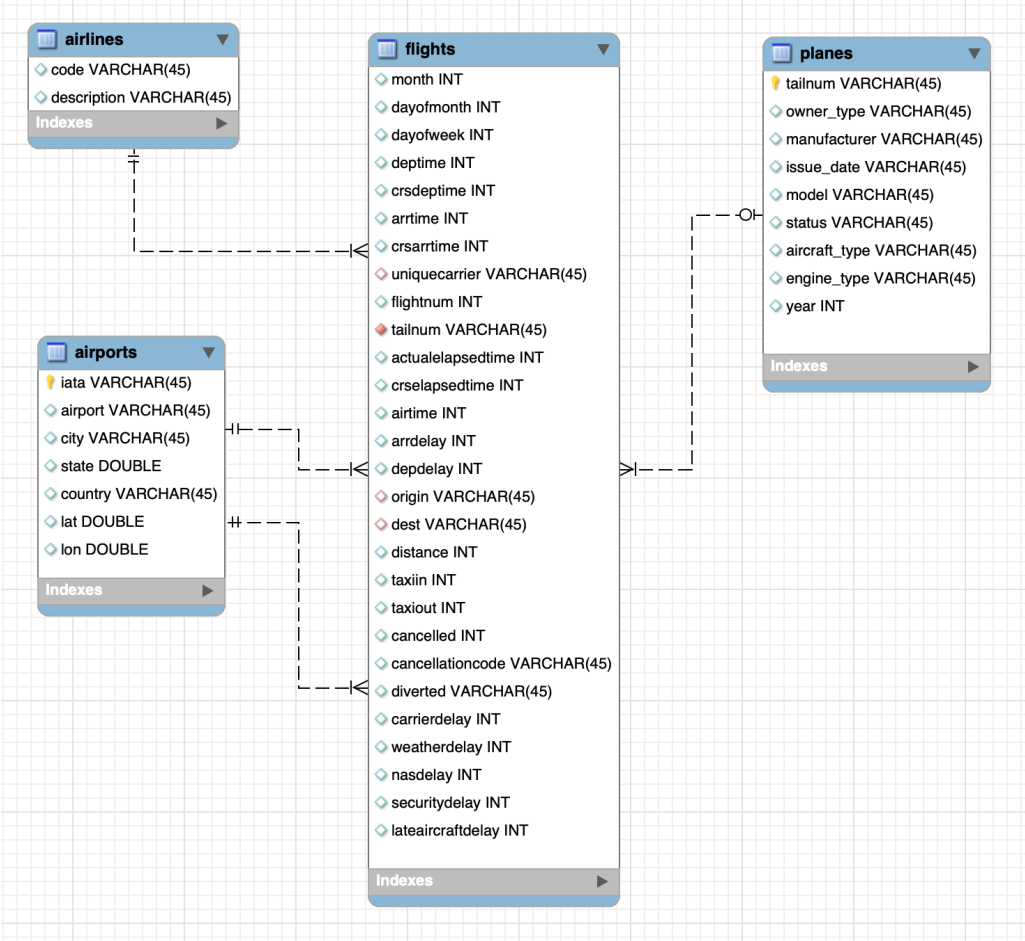
ER - Diagram of the demo Data Lakehouse:

- **Fact table:** flights (86M rows)
- **Dimension tables:** airlines (1.5k rows), airports (3.3k rows) and planes (5k rows)



Self Service data file - Passenger Ticket manifest:

- This is a CSV file with 1,000 records
- Each record represents a unique Passenger Ticket with 2 Flight Legs
- It contains the following schema
  ticketnumber BIGINT
  leg1flightnum BIGINT
  leg1uniquecarrier STRING
  leg1origin STRING
  leg1dest STRING
  leg1month BIGINT
  leg1dayofmonth BIGINT
  leg1dayofweek BIGINT
  leg1deptime BIGINT
  leg1arrtime BIGINT
  leg2flightnum BIGINT

leg2uniquecarrier STRING
leg2origin STRING
leg2dest STRING
leg2month BIGINT
leg2dayofmonth BIGINT
leg2dayofweek BIGINT
leg2deptime BIGINT
leg2arrtime BIGINT

Lab Setup

Workshop Attendees will be provided with a Login. Please enter your details below for reference throughout these lab exercises.

- URL: https://rb.gy/wx75l
  - Use Incognito Browser window
- Login:
  - **User:** _____
  - **Password:** _____

In the labs when you see:

- ${user_id} or <user_id> - this will indicate to use your User (Workload User) provided for you to login to CDP

Zoom Link:

https://cloudera.zoom.us/j/94846291323

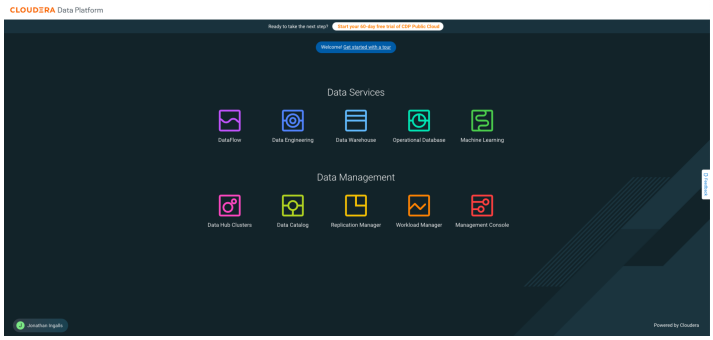
Get Started - Log into CDP

GET STARTED

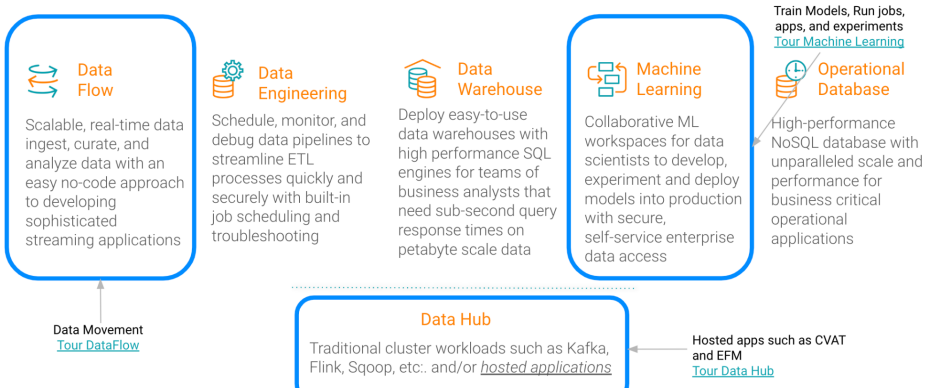
- Preparatory work for us to get ourselves oriented in CDW and ready to build out the use case
- Login to CDP
- Learn a little about Cloudera Data Warehouse (CDW) Data Service

In this Lab you will login to CDP and complete your user setup.

1. Log in to CDP - open a browser and open the URL from the Lab Setup section
   - When prompted use the Login details from the Lab Setup section for the User/PW
2. On the HOME page of CDP you will see all of the Services available to you



- Multi-function analytics - Data Services; today we'll just focus on the Cloudera Data Warehouse Data Service
- There are other Data Services that usually are part of an Analytic use case
  - Data Flow - for data ingestion needs
  - Data Engineering - for ELT/ETL, transformations, data wrangling, etc.
  - Machine Learning - for Data Science teams to collaboratively build and productionalize ML/AI applications and models for the Enterprise
- However, Cloudera provides other services such as Data Catalog, Replication Manager, Workload Manager, and Management Console provide continuity and functionality throughout the platform.



Note: The platform removes the necessity to spend unnecessarily on integration tax, where other solutions combine various pieces together in the ability to provide continuity and functionality throughout an end-to-end use case but this is difficult because it introduces many moving parts.

Lab 1 - Business Analyst: Explore Completed Dashboard

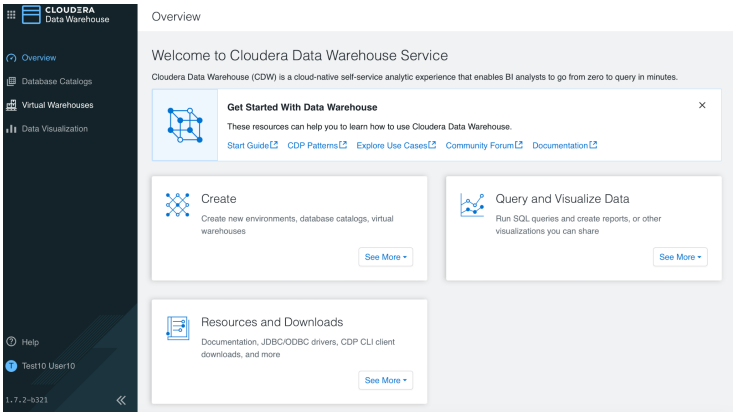
SEE THE END RESULT (WHAT IS CREATED) (LAB 1)

- Explore the created Dashboard after it has been “productionalized”
    - Analyst first validates that the combination of data answers questions & builds initial Dashboard to start gaining insights on the data
    - Administrator picks up and formalizes the data ingestion for the new data, incorporates it into the Data Lakehouse, adds security, & completes the Dashboard

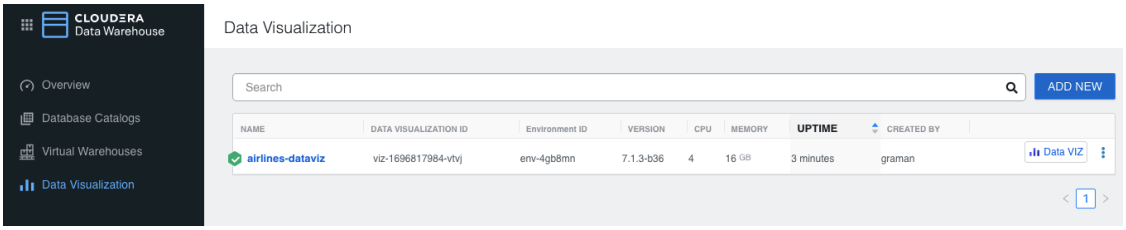
In this Lab you will explore the Dashboard that will be created as the result of the Self-Service Labs you will complete shortly.

3. Open Cloudera Data Visualization, which is part of the Cloudera Data Warehouse Data Service
    - First let’s open Cloudera Data Warehouse (CDW) -
        - Click on the Cloudera Data Warehouse (CDW) tile

        - We’ll come back to this screen in Lab 2 for more details

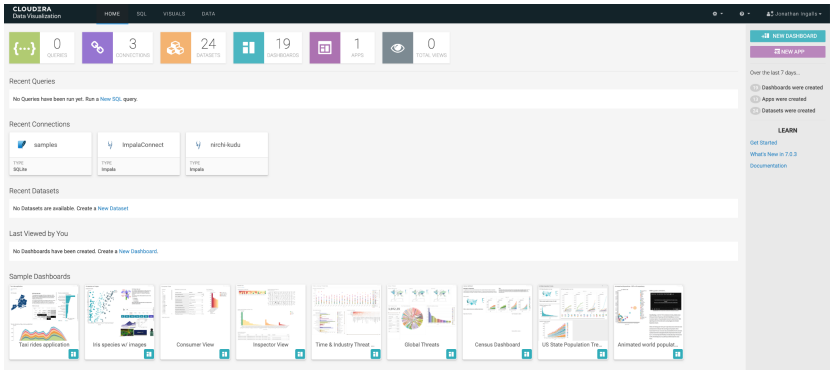


    - Now let’s open Cloudera Data Visualization (CDV) - to explore the finished product
        - Open Cloudera Data Visualization (CDV or Data Viz)
            - On the left navigation panel click “Data Visualization” - this will open a new browser tab
            - On the row with **airlines-dataviz-#**, to the right, click the Data VIZ button

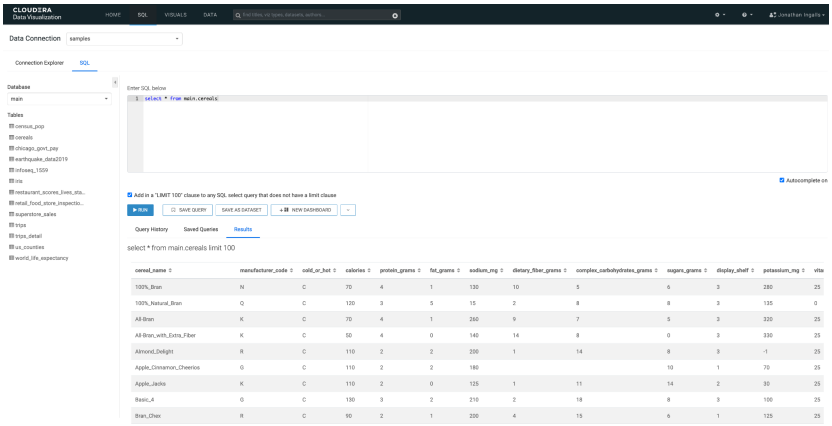


            - If you see the “What’s New” page, you can read it, or click on the GOT IT button

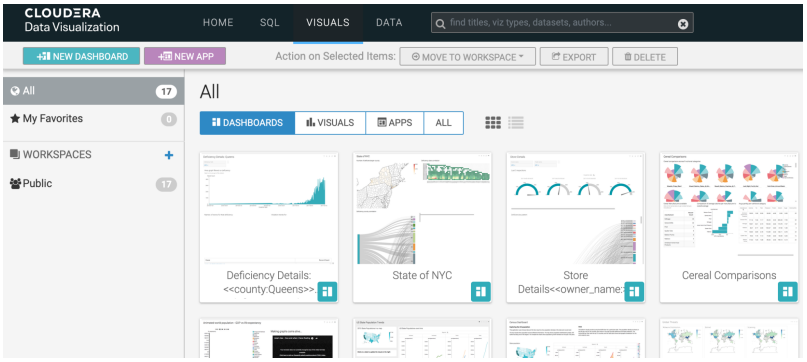
        - Cloudera Data Visualization (CDV) Home page



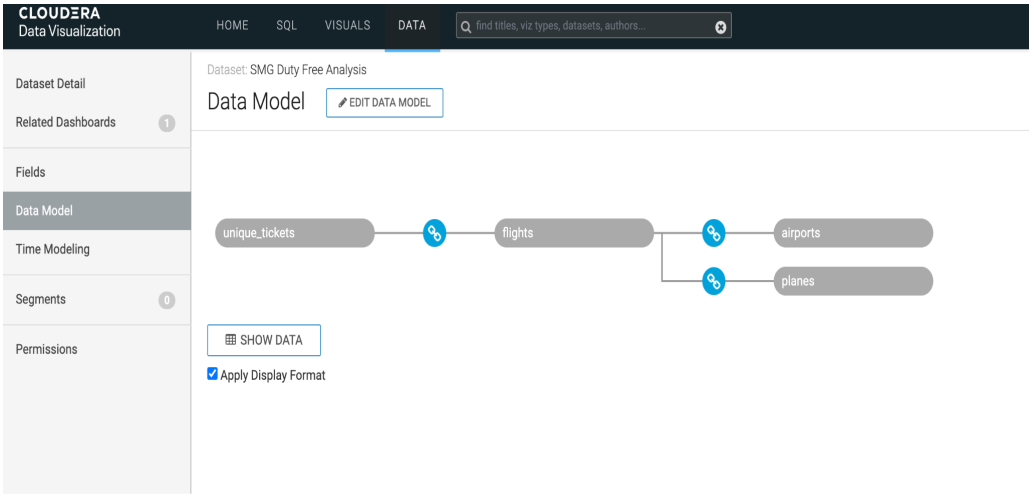
- There are 4 areas of CDV - HOME, SQL, VISUALS, DATA - these are the tabs at the top of the screen in the black bar to the right of the Cloudera Data Visualization banner
    - HOME - this is the starting point; it shows some statistics at the top, followed by some quick access details to recent content - Queries, Connections, Datasets, and Dashboards
    - SQL - allows you to manually build queries against data to perform quick discovery against the data. Below is an example of a query that was built and Run



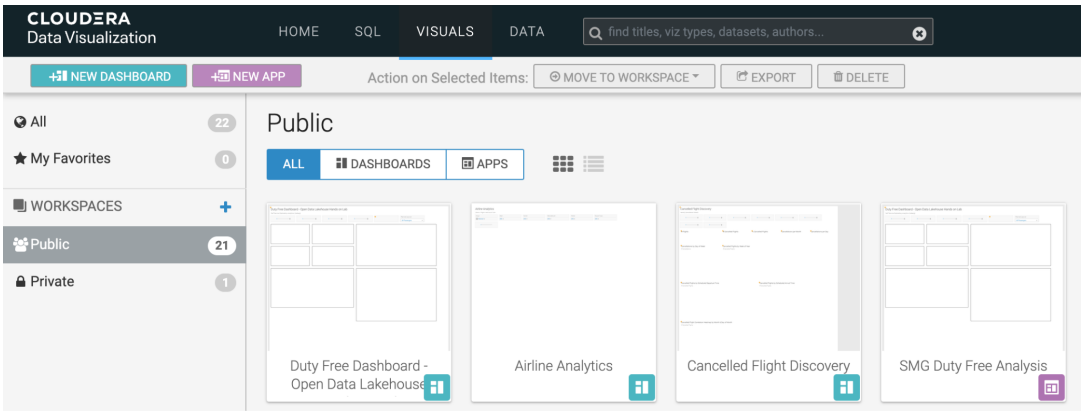
    - VISUALS - an area for viewing/building/modifying visuals, dashboards, and applications



    - DATA - interface for access to datasets (aka: metadata model) image below, connections, and the Connection Explorer. Explore the Data model for SMG Duty Free Analysis



- Click on the VISUALS tab at the top of the screen (in black banner)



Lab 2 - Business Analyst: Self Service (in CDW)

BUSINESS ANALYST - SELF SERVICE TO VALIDATE NEW DATA ANSWERS QUESTIONS (LAB 2)

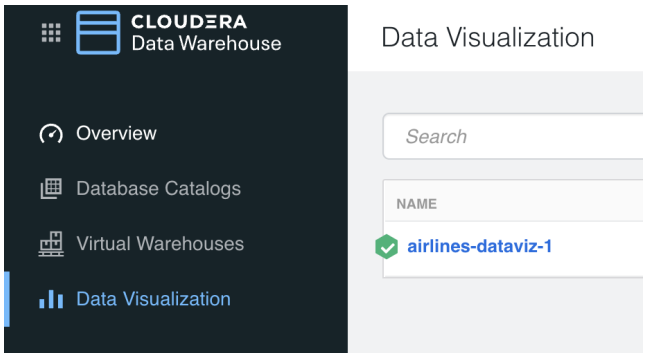
- Upload new data - passenger ticket manifest**(already preloaded data)**
  - See if new data can help to answer questions prior to undertaking a complete project
  - See how to upload data
- **Answer burning business questions to see if the new passenger data**
  - Combine uploaded data with existing data warehouse
  - Start digging into the data - running a few queries to see if the new dataset can help with answering the burning questions
  - Visualize the data - modify existing Dashboard to add new content with the data just added

In this Lab you will take advantage of the **Self Service capabilities within CDW** to upload a data file and combine it with an existing Data Lakehouse. You will then perform analytics (SQL & Visualizations) on the combined data to ensure that the burning business questions can first be answered before “productionalizing” the new data source.

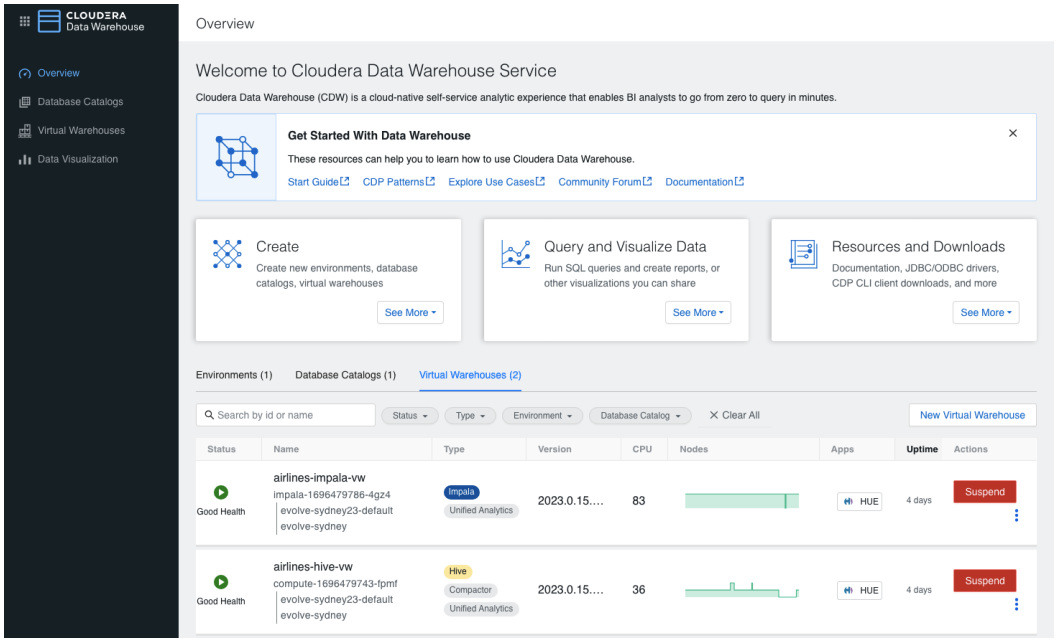
4. Navigate back to **CDW Overview**

- Click on the browser tab where CDW is open - 

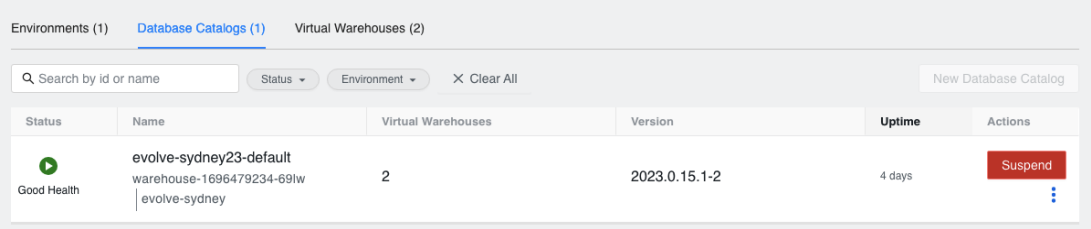
- Click on Overview in the left navigation



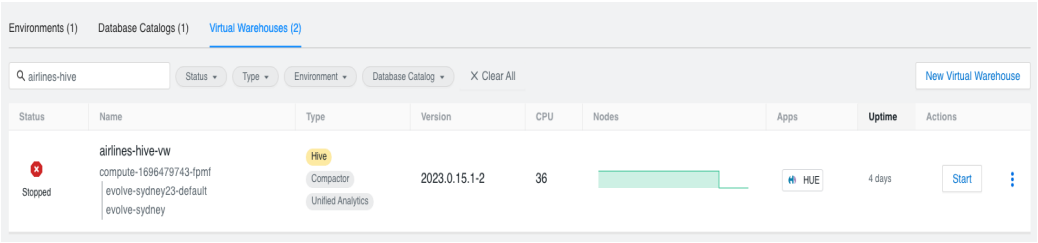
5. The following is a quick explanation of the CDW User Experience so that you have a basic knowledge of the data service. The **CDW Data Service allows you to create independent, self-service data warehouses and data marts that autoscale up and down to meet your varying workload demands**. It provides isolated compute instances for each data warehouse/mart, has built-in automatic optimization, and ultimately enables you to meet SLAs - at the same time save costs.



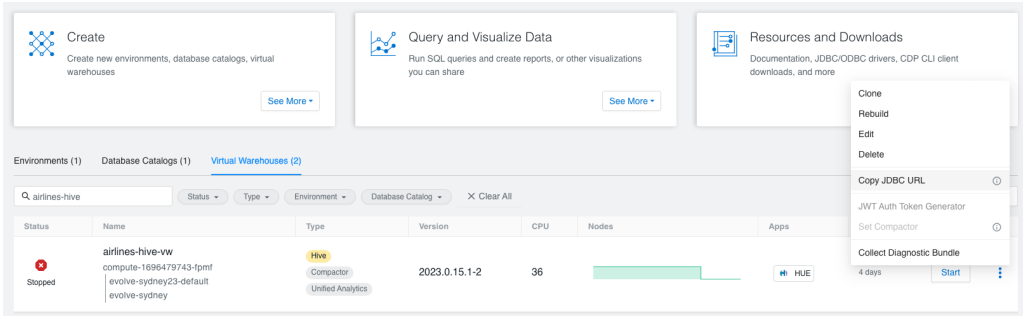
- There are 2 areas on this screen - **Database Catalogs (DBC), and Virtual Warehouses (VW)**, for today's lab, we will just concentrate on Virtual Warehouses or VW for short
  - **Database Catalogs (DBC) - is a logical collection of table and view metadata, security permissions, and other information.** As you create databases, tables, views, etc. in the Data Warehouse, it collects the metadata. When you activate an Environment for CDW, the CDW service will automatically create a default DBC associated with this Environment.
    - DBCs are in the middle column



- **Virtual Warehouses (VW) - is a set of compute resources running in Kubernetes to execute the queries.** This is something that can allow for Self Service capabilities or can be controlled by Administrators. A VW binds compute and storage to execute secured queries that access tables and views of your data via the DBC. A VW can scale automatically to ensure performance even with high concurrency, and can auto-scale down in situations of low demand. Tools that access data via JDBC/ODBC can connect to VWs to run queries

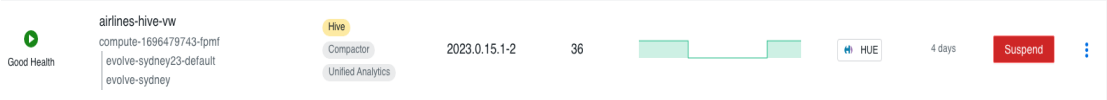


  - See options available for a VW - click on the ⋮ button on the bottom right corner of tile airlines-hive-vw-#



    The list of options will vary slightly depending on whether this is a Hive or Impala VW. This is also where you would go to get the JDBC URL and Driver to use to connect your Business Intelligence software to this VW, and when a new version is released you could Upgrade this VW to the latest release without having to upgrade all VWs at the same time.

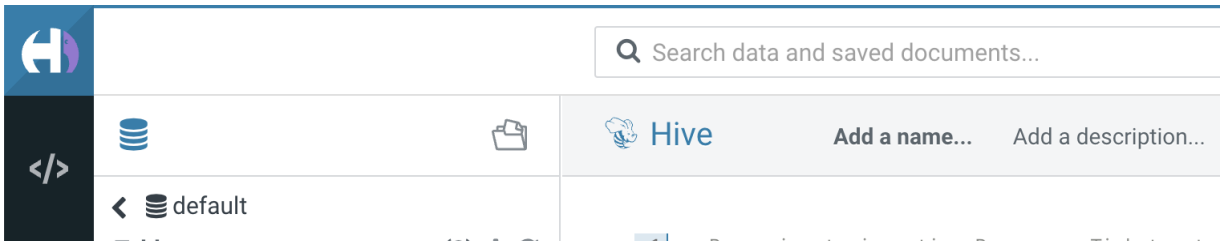
- ***The airlines-hive-vw-#*** - this will highlight the Environment and DBCs that are associated with this VW.
  - These tiles will display information about current workload on a VW. Below you will see items indicating when a VW is idle and has auto scaled so nothing is running for this VW; and where the VW needed to auto-scale up to handle incoming SQL requests handling concurrency



  - ***On the airlines-hive-vw-# tile*** - In the upper right corner click on the HUE button to enter into the SQL Editor

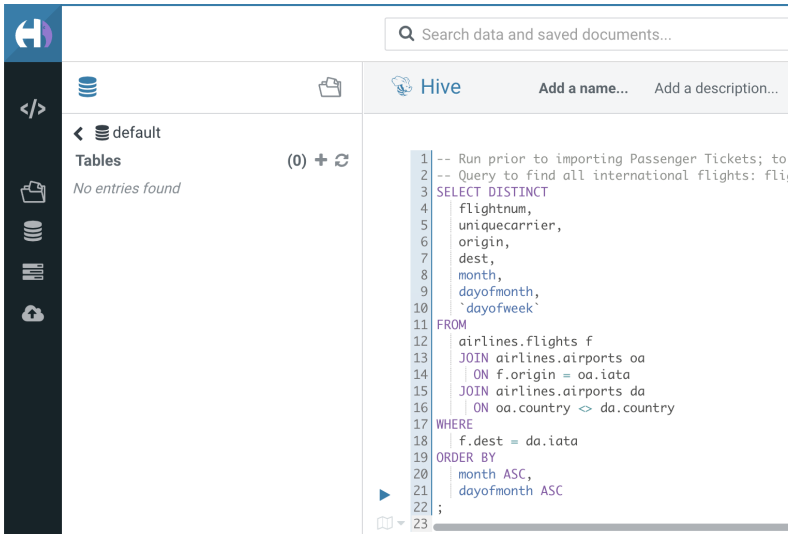
6. Explore the Data Lakehouse

- You will be using HUE for the ***airlines-hive-vw-# Virtual Warehouse*** until you get to Step 13

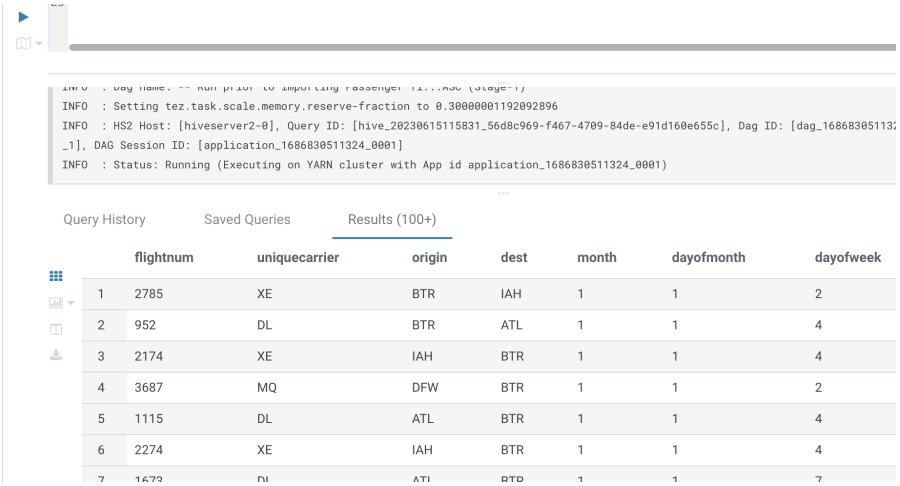


- Copy & paste the following SQL into the query Editor window

```
-- Run prior to importing Passenger Tickets; to ensure correct access and that everything is good to go
-- Query to find all international flights: flights where destination airport country is not the same as origin airport country
SELECT DISTINCT
  flightnum,
  uniquecarrier,
  origin,
  dest,
  month,
  dayofmonth,
  `dayofweek`
FROM
  airlines.flights f
  JOIN airlines.airports oa ON f.origin = oa.iata
  JOIN airlines.airports da ON oa.country <> da.country
WHERE f.dest = da.iata
ORDER BY
  month ASC, dayofmonth ASC
;
```



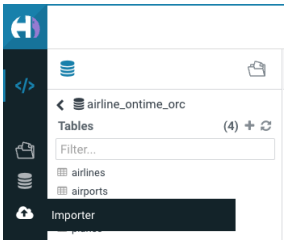
- Click on the ▶ to the bottom left of the SQL window to run this SQL command to test and ensure you have access to the Data Lakehouse
  - You should see the something similar to the following in the Results tab

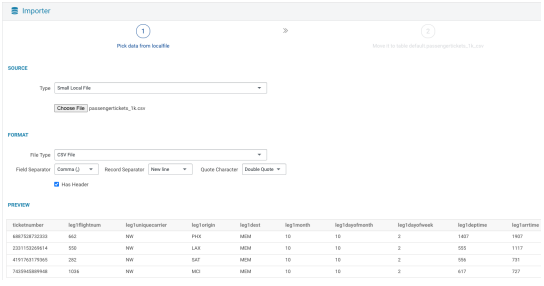


	flightnum	uniquecarrier	origin	dest	month	dayofmonth	dayofweek
1	2785	XE	BTR	IAH	1	1	2
2	952	DL	BTR	ATL	1	1	4
3	2174	XE	IAH	BTR	1	1	4
4	3687	MQ	DFW	BTR	1	1	2
5	1115	DL	ATL	BTR	1	1	4
6	2274	XE	IAH	BTR	1	1	4

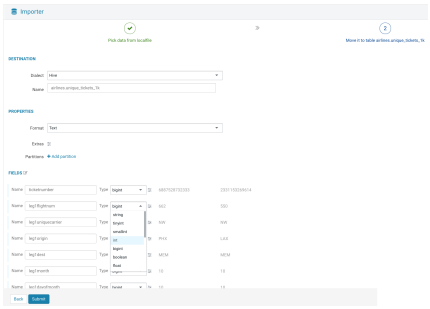
  - This validates that you have the correct permissions via the SDX security to access the Data Lakehouse

7. Upload Passenger Ticket data file - ***already completed*** for you and shown as part of the main presentation
   - Below are some images that highlight the 3 steps to upload this file: 1) Open the **Importer**, 2) Pick a file & options for the file upload, 3) Name the table, specify table options, and provide the table metadata (column names, data types, etc.) **(NOT FOR LAB EXECUTION)**

1) 

2) 

3)

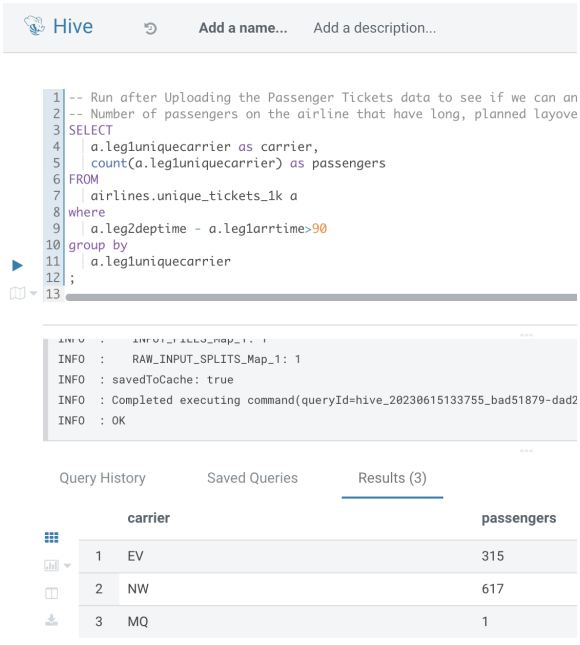


- Since the data is already uploaded we will use the table **airlines.unique_tickets**

8. **Explore the Data Lakehouse and Passenger Tickets (unique_tickets) data** to see if it can answer the **burning questions**. The Data Analyst can use a SQL Editor to perform this task by executing queries against this data.
   - Delete the current query from the SQL Window
   - Copy & paste the following SQL into the SQL Editor window

```
-- Run after Uploading the Passenger Tickets data to see if we can answer the "burning questions" to support Duty Free Stores
-- Number of passengers on the airline that have long, planned layovers for a flight (good target to send promotion to)
SELECT
   a.leg1uniquecarrier as carrier,
   count(a.leg1uniquecarrier) as passengers
FROM
   airlines.unique_tickets a
where
   a.leg2deptime - a.leg1arrtime > 90
group by
   a.leg1uniquecarrier
;
```

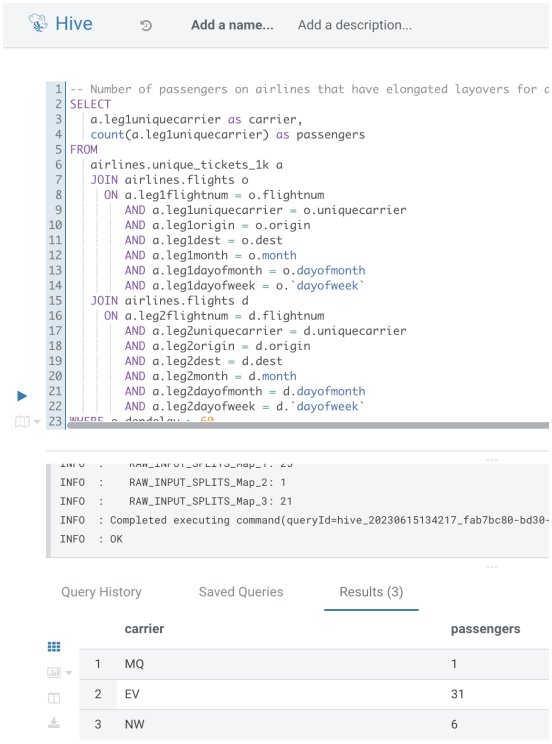
   - Execute the Query by clicking on the ▶ button
     - Review the output to see the number of passenger with a long planned layover (> 90 minutes) by Airline Carrier - one of the questions we wanted to answer



- Delete the current query from the SQL Window
- Copy & paste the following SQL into the SQL Editor window

```
-- Number of passengers on airlines that have elongated layovers for a flight caused by
delayed connection (potential customer satisfaction issue)
SELECT
   a.leg1uniquecarrier as carrier,
   count(a.leg1uniquecarrier) as passengers
FROM
   airlines.unique_tickets a
   JOIN airlines.flights o
     ON a.leg1flightnum = o.flightnum
        AND a.leg1uniquecarrier = o.uniquecarrier
        AND a.leg1origin = o.origin
        AND a.leg1dest = o.dest
        AND a.leg1month = o.month
        AND a.leg1dayofmonth = o.dayofmonth
        AND a.leg1dayofweek = o.`dayofweek`
   JOIN airlines.flights d
     ON a.leg2flightnum = d.flightnum
        AND a.leg2uniquecarrier = d.uniquecarrier
        AND a.leg2origin = d.origin
        AND a.leg2dest = d.dest
        AND a.leg2month = d.month
        AND a.leg2dayofmonth = d.dayofmonth
        AND a.leg2dayofweek = d.`dayofweek`
WHERE o.depdelay > 60
group by
   a.leg1uniquecarrier
;
```

- Execute the Query by clicking on the ▶ button
  - Review the output to see that we can answer another burning question



  - Now that we've validated that we can answer the business questions, it's time to visualize the data to see the insights we can gain from combining this data

Lab 3 - Administrator: “Productionalize” the Open Data Lakehouse

ADMINISTRATOR - “PRODUCTIONALIZE” INTO OPEN DATA LAKEHOUSE (LAB 3)

- **See “how the sausage was made” - how to take advantage of Apache Iceberg from end to end to deliver a modern Open Data Lakehouse solution**
  - **Migrate existing tables to Iceberg Table Format**
  - **Create a new Iceberg table**
  - **Load data**
  - **Some Key Features of Iceberg**
    - **Partition evolution**
    - **Time Travel**
- **Monitor the Virtual Warehouses (compute) and watch as it scales up and down, suspends, etc.**
- **Security & Governance before launching to the masses**

In this Lab you will be an Administrator and will use CDW to create and build an Open Data Lakehouse and take advantage of some of the key features with this approach.

Execute the following SQL/DDL/DML statements.

9. Stay in HUE for the CDW **Hive** Virtual Warehouse - **airlines-hive-vw-#**
   - There should be an open CDW Browser tab, open the 

browser tab
   - Create a user Database to store all of the tables you will create in the following lab steps
     - In the SQL Editor window create a database for the remaining lab exercises, execute the following.
       - Delete the current query from the SQL Window
       - Copy & paste the SQL below

```
CREATE DATABASE ${user_id}_airlines;
```

       - The “${...}” notation is a hint to HUE to create a parameter. As you copy/paste in this you will see that HUE determined that there is a parameter that needs to be entered.
       - In the “user_id” parameter box, enter your user id (see Lab Setup section)

       - Execute the Query by clicking on the ▶ button
     - Check to see if the Database was created
       - Delete the current query from the SQL Window
       - Copy & paste the SQL below

```
SHOW DATABASES;
```

- Execute the Query by clicking on the ▶ button to see that the database was created

Results

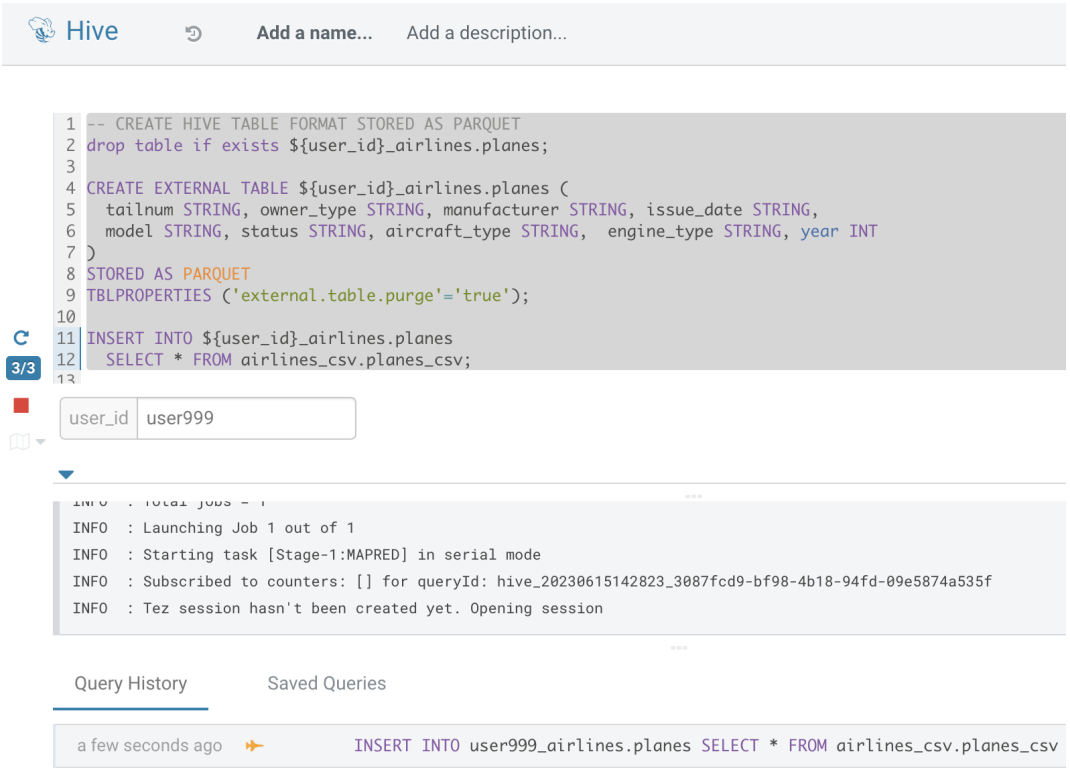
```
DATABASE_NAME
…
user001_airlines
…
<user_id>_airlines
…
user100_airlines
…
```

There may be many databases, scroll & look for the one that starts with your <user_id>

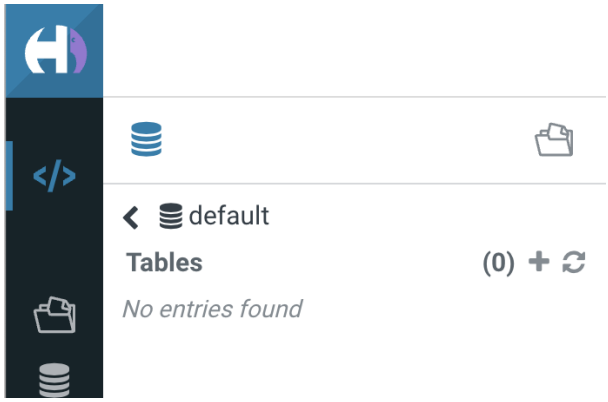
- **Let's simulate existing tables in our Data Lakehouse**
  - Create planes table in *Hive Table Format*, stored in Parquet file format
    - Delete the current query from the SQL Window
    - Copy & paste the SQL below

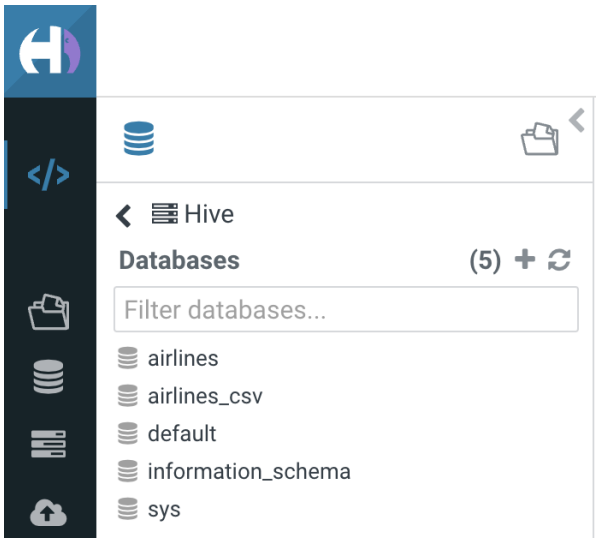
```
-- CREATE HIVE TABLE FORMAT STORED AS PARQUET
-- drop table if exists ${user_id}_airlines.planes;

CREATE EXTERNAL TABLE ${user_id}_airlines.planes (
  tailnum STRING, owner_type STRING, manufacturer STRING, issue_date STRING,
  model STRING, status STRING, aircraft_type STRING,  engine_type STRING, year INT
)
STORED AS PARQUET
TBLPROPERTIES ('external.table.purge'='true');

INSERT INTO ${user_id}_airlines.planes
  SELECT * FROM airlines_csv.planes_csv;
```

- Select all of the content in the SQL Editor
- Execute the Query by clicking on the ▶ button

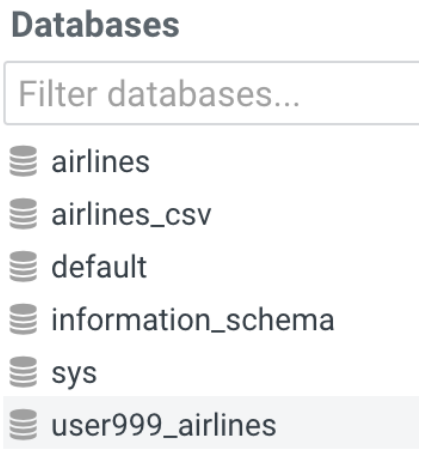


- Switch Database to the user Database
  - On the left side of the SQL Editor, click on the < arrow next to default

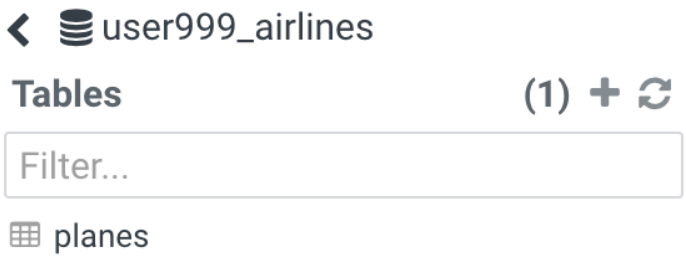




- To the right of Databases click on the button to refresh the list of Databases



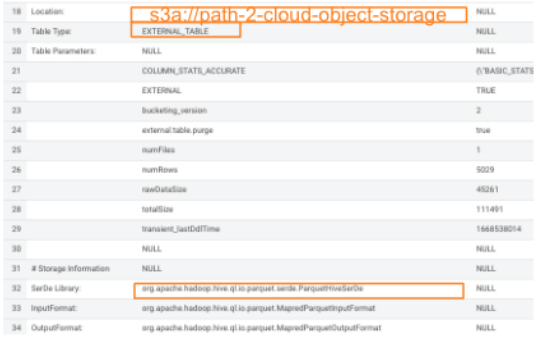
- Click on your <user-id>_airlines Database - this will allow you to track what has been created in your database through the next steps



- Delete the current query from the SQL Window
- Copy & paste the SQL below

```
DESCRIBE FORMATTED ${user_id}_airlines.planes;
```

- Execute the Query by clicking on the ▶ button
  - In the output look for the following fields - scroll down to look for the following properties: Location, Table Type, and SerDe Library (this value should reflect the ParquetHiveSerDe, indicating this is a Hive Table Format)



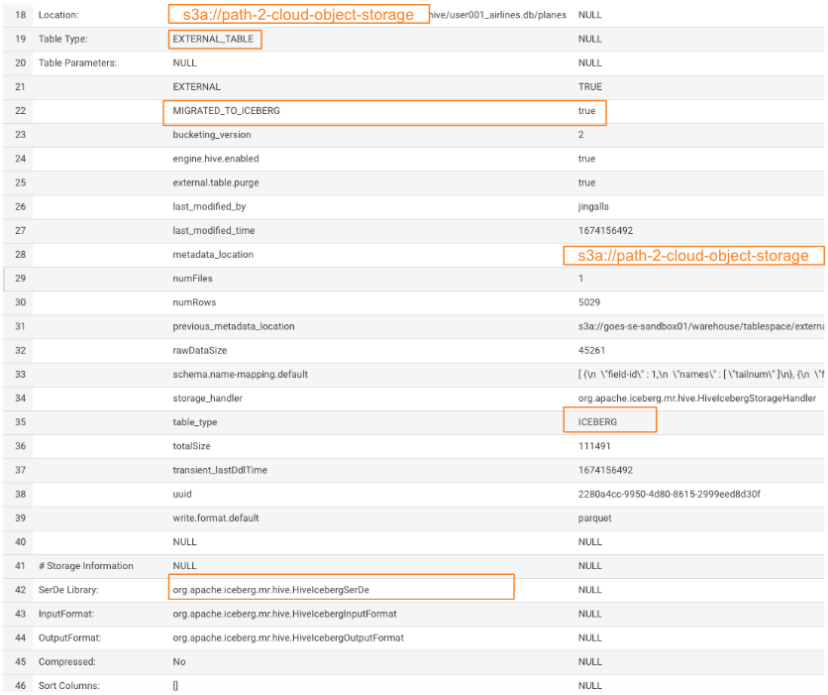
10. Build the Data Lakehouse
    - Stay in HUE for the CDW Hive Virtual Warehouse - airlines-hive-vw.
    - **Migrating Hive Table Format to Iceberg Table format** - If you already have created a Data Warehouse using the Hive Table Format, but would like to take advantage of the features offered in the Iceberg Table Format, **you have two (2) options: 1) Utilize the in-place table Migration feature; or 2) Use Create Table as Select (CTAS)**
      - **Option 1: Migrate the planes table in our Data Lakehouse from Hive Table Format to Iceberg Table Format using the Migration Utility.**
        - Delete the current query from the SQL Window
        - Copy & paste the SQL below

```
ALTER TABLE ${user_id}_airlines.planes
SET TBLPROPERTIES
('storage_handler'='org.apache.iceberg.mr.hive.HiveIcebergStorageHandler');

DESCRIBE FORMATTED ${user_id}_airlines.planes;
```

        - Select all of the content in the SQL Editor
        - Execute the Query by clicking on the ▶ button
        - This migration to Iceberg happened in-place, there was **no** rewriting of data that occurred as part of this process. It retained the File Format of Parquet for the Iceberg table as well. There was a Metadata file that is created, which you can see when you run the DESCRIBE FORMATTED.
        - In the output look for the following fields - scroll down to look for the following properties: look for the following (see image with highlighted fields) key values: Table Type, Location (location of where table data is stored), SerDe Library, and in Table Parameters look for properties MIGRATE_TO_ICEBERG, storage_handler, metadata_location, and table_type
          - Location - Data is stored in cloud storage in this case S3 in the same location as the Hive Table Format
          - Metadata_location - Since there is no need to regenerate data files

with in-place table migration, you save time generating Iceberg tables. Only metadata is regenerated, which points to source data files. Removes Hive Metastore as bottleneck.

- Table_type - indicates "ICEBERG" table format
- Storage_handler & SerDe Library - indicate what Serializer/Desearializer to use when reading/writing data in this case the "HiveIcebergSerDe"



18	Location:	s3a://path-2-cloud-object-storage	NULL
19	Table Type:	EXTERNAL_TABLE	NULL
20	Table Parameters:	NULL	NULL
21		EXTERNAL	TRUE
22		MIGRATED_TO_ICEBERG	true
23		bucketing_version	2
24		engine.hive.enabled	true
25		external.table.purge	true
26		last_modified_by	jingalls
27		last_modified_time	1674156492
28		metadata_location	s3a://path-2-cloud-object-storage
29		numFiles	1
30		numRows	5029
31		previous_metadata_location	s3a://goes-se-sandbox01/warehouse/tablespace/extern
32		rawDataSize	45261
33		schema.name-mapping.default	[{\n \"field-id\" : 1,\n \"names\" : [\"tailnum\"]\n}, {\n \"f
34		storage_handler	org.apache.iceberg.mr.hive.HiveIcebergStorageHandler
35		table_type	ICEBERG
36		totalSize	111491
37		transient_lastDdlTime	1674156492
38		uuid	2280a4cc-9950-4d80-8615-2999eed8d30f
39		write.format.default	parquet
40		NULL	NULL
41	# Storage Information	NULL	NULL
42	SerDe Library:	org.apache.iceberg.mr.hive.HiveIcebergSerDe	NULL
43	InputFormat:	org.apache.iceberg.mr.hive.HiveIcebergInputFormat	NULL
44	OutputFormat:	org.apache.iceberg.mr.hive.HiveIcebergOutputFormat	NULL
45	Compressed:	No	NULL
46	Sort Columns:	[]	NULL

- **Option 2: Create airports table in *Iceberg Table Format*, using Create Table As Select (CTAS). Notice the syntax to create an Iceberg Table within Hive is "*Stored by Iceberg*"**
  - Delete the current query from the SQL Window
  - Copy & paste the SQL below

```
-- drop table if exists ${user_id}_airlines.airports;
CREATE EXTERNAL TABLE ${user_id}_airlines.airports
STORED BY ICEBERG AS
  SELECT * FROM airlines_csv.airports_csv;

DESCRIBE FORMATTED ${user_id}_airlines.airports;
```

  - Select all of the content in the SQL Editor
  - Execute the Query by clicking on the ▶ button
    - In the output - look for the following key values (just like previously): Table Type, Location (location of where table data is stored), SerDe Library, and in Table Parameters look for properties MIGRATE_TO_ICEBERG, storage_handler, metadata_location, and table_type
    - On the left you should see the airports table added to the list of Tables for your user Database

- Slowly changing dimension table airlines
  - **Iceberg is fully ACID compliant and can execute Insert, Update, Delete, and Merge Into statements**
  - Delete the current query from the SQL Window
  - Copy & paste the SQL below

```
-- SLOWLY CHANGING DIMENSION TABLE USE ACID CAPABILTIES OF ICEBERG
drop table if exists ${user_id}_airlines.airlines;

CREATE EXTERNAL TABLE ${user_id}_airlines.airlines (
code string,
description string
)
 STORED BY ICEBERG
 STORED AS PARQUET
 tblproperties('format-version'='2');

-- LOAD DATA
INSERT INTO ${user_id}_airlines.airlines
 SELECT * FROM airlines_csv.airlines_csv;

-- Check data to see a few records
SELECT *
FROM ${user_id}_airlines.airlines
WHERE code IN ("04Q", "05Q");
```

  - Select all of the content in the SQL Editor
  - Execute the Query by clicking on the ▶ button
    - This will create the Iceberg Table, load initial data, and display a few rows that will be modified in the next step
  - Delete the current query from the SQL Window
  - Copy & paste the SQL below

```
-- SLOWLY CHANGING DIMENSION TABLE USE ACID CAPABILITIES OF ICEBERG
MERGE INTO ${user_id}_airlines.airlines AS t
  USING airlines_csv.airlines_csv s ON t.code = s.code
WHEN MATCHED AND t.code = "04Q" THEN DELETE
WHEN MATCHED AND t.code = "05Q" THEN UPDATE SET description = "Comlux Aviation"
WHEN NOT MATCHED THEN INSERT VALUES (s.code, s.description);

-- Check data to see records were deleted or updated
SELECT *
FROM ${user_id}_airlines.airlines
WHERE code IN ("04Q", "05Q");
```

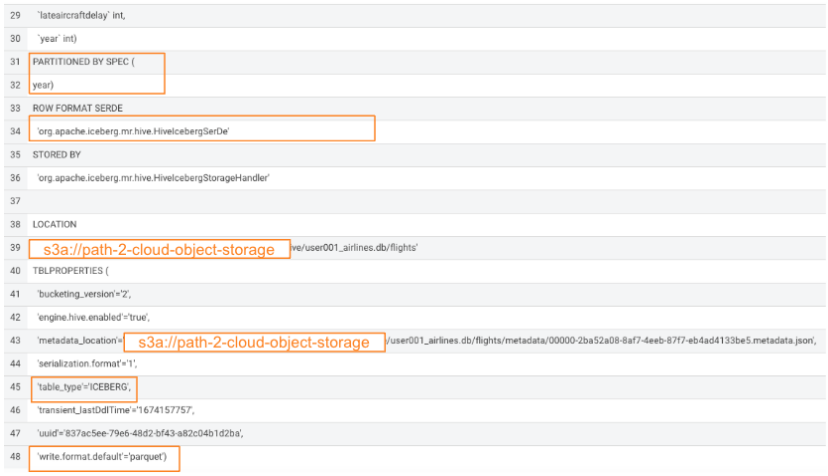
  - Select all of the content in the SQL Editor
  - Execute the Query by clicking on the ▶ button
    - The Merge Into statement will check to see if a record needs to be Deleted (when the record key matches and the code = 04Q), when a new record needs to be Inserted (key doesn't match), and when an Update is needed (when the key matches and the code = 05Q
    - Compare the output to see that only one record is returned with the description set to "Comlux Aviation"

- **Creating an Iceberg Table - for this step create a partitioned table, in Iceberg Table Format, stored in Parquet File Format**. Optionally, you could specify other File Formats, the supported formats for Iceberg are: Parquet, ORC, and Avro.
  - Delete the current query from the SQL Window
  - Copy & paste the SQL below

```
drop table if exists ${user_id}_airlines.flights;
CREATE EXTERNAL TABLE ${user_id}_airlines.flights (
 month int, dayofmonth int,
 dayofweek int, deptime int, crsdeptime int, arrtime int,
 crsarrtime int, uniquecarrier string, flightnum int, tailnum string,
 actualelapsedtime int, crselapsedtime int, airtime int, arrdelay int,
 depdelay int, origin string, dest string, distance int, taxiin int,
 taxiout int, cancelled int, cancellationcode string, diverted string,
 carrierdelay int, weatherdelay int, nasdelay int, securitydelay int,
 lateaircraftdelay int
)
PARTITIONED BY (year int)
STORED BY ICEBERG
STORED AS PARQUET
tblproperties ('format-version'='2');

SHOW CREATE TABLE ${user_id}_airlines.flights;
```

  - Select all of the content in the SQL Editor
  - Execute the Query by clicking on the ▶ button

    - Looking at the SHOW CREATE TABLE output, scroll down and notice the output is the unformatted version of the Describe Formatted as we would expect. The main item to pay attention to here is the PARTITIONED BY SPEC, currently we've partitioned by just the "year" column

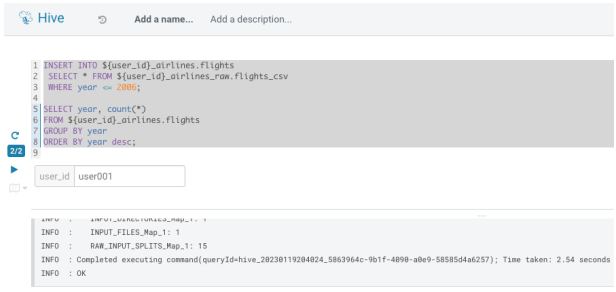


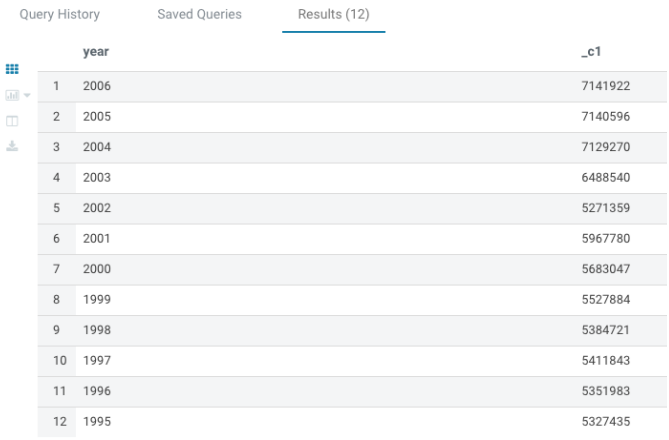
- When we insert data into this table it will write data together within the same partition (ie. all 2006 data is written to the same location, all 2005 data is written to the same location, etc.)
  - Delete the current query from the SQL Window
  - Copy & paste the SQL below

```
INSERT INTO ${user_id}_airlines.flights
 SELECT * FROM airlines_csv.flights_csv
 WHERE year <= 2006;
```

```
SELECT year, count(*)
FROM ${user_id}_airlines.flights
GROUP BY year
ORDER BY year desc;
```

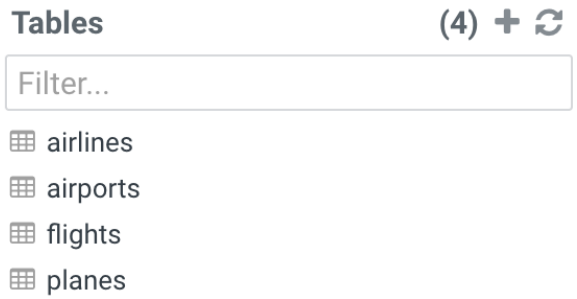
- Select all of the content in the SQL Editor
- Execute the Query by clicking on the ▶ button
  - The Insert will insert data from years 1995 to 2006
  - Notice that each of the years have a range of data within a few million flights (each record in the flights table counts as a flight)





	year	_c1
1	2006	7141922
2	2005	7140596
3	2004	7129270
4	2003	6488540
5	2002	5271359
6	2001	5967780
7	2000	5683047
8	1999	5527884
9	1998	5384721
10	1997	5411843
11	1996	5351983
12	1995	5327435

11. Performance improvements
    - Check that you created the tables for the Data Lakehouse - on the list of tables to the left of the Editor window you should see the following tables



    - **Iceberg in-place Partition Evolution [Performance Optimization]**
      - One of the key features for Iceberg tables is the ability to evolve the partition that is being used over time
        - Delete the current query from the SQL Window
        - Copy & paste the SQL below

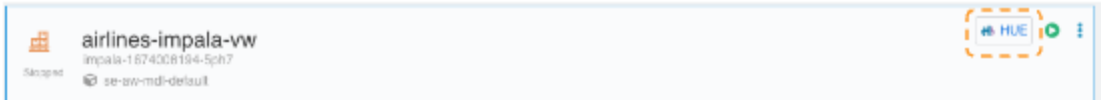
```
ALTER TABLE ${user_id}_airlines.flights
SET PARTITION spec ( year, month );

SHOW CREATE TABLE ${user_id}_airlines.flights;
```

        - Select all of the content in the SQL Editor
        - Execute the Query by clicking on the ▶ button

- This was an in-place Partition Evolution, meaning that the existing data is not rewritten as part of the ALTER TABLE execution. What will happen is the next data that is loaded will use the new Partition definition.
- In the output scroll to see the PARTITIONED BY SPEC to see that it is now both year and month

```
30   `year` int)
31   PARTITIONED BY SPEC (
32   year,
33   month)
```

12. Performance Improvements - Open HUE for the CDW **Impala** Virtual Warehouse - airlines-impala-vw.
    - There should be an open CDW Browser tab, open the CDW × browser tab
    - Click on the airlines-impala-vw-# tile
      - In the upper right corner click on the HUE button to enter into the SQL Editor



    - Load new data into the flights table using the NEW partition definition - this will load new data to take advantage of the new partition specification. This also shows how Iceberg also supports multiple engines by allowing both Hive & Impala to create, load, query, and or modify Iceberg tables.
    - Copy & Paste the following in the SQL Editor window

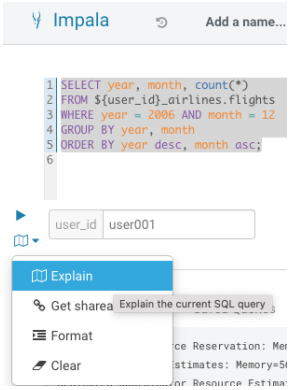
```
INSERT INTO ${user_id}_airlines.flights
SELECT * FROM airlines_csv.flights_csv
WHERE year = 2007;
```

    - Execute the Query by clicking on the ▶ button
    - Run Explain Plans against some typical analytic queries we might run to see what happens with this new Partition definition.
      - In Impala we are in another engine which is another key feature of Iceberg - multi-function (or multiple engine) analytics. No need to copy the data or do more work to allow access to the same data.
      - Copy/paste the following in the Editor, but do not execute the query

```
SELECT year, month, count(*)
FROM ${user_id}_airlines.flights
WHERE year = 2006 AND month = 12
GROUP BY year, month
ORDER BY year desc, month asc;
```

      - In the “user_id” parameter box, enter your user id (see Lab Setup section)

- Instead select (highlight) the statement click the  button, which is right below the Execute (▶) button and select Explain



  - In the output notice the amount of data that needs to be scanned for this query (it would represent the volume of 1 years worth of data - about 139MB). Up to this point the data was loaded using the Partition of just a year.

  - Copy/paste the following in the Editor, but do not execute the query

```
SELECT year, month, count(*)
FROM ${user_id}_airlines.flights
WHERE year = 2007 AND month = 12
GROUP BY year, month
ORDER BY year desc, month asc;
```

- Instead select (highlight) the statement click the  button, which is right below the Execute (▶) button and select Explain

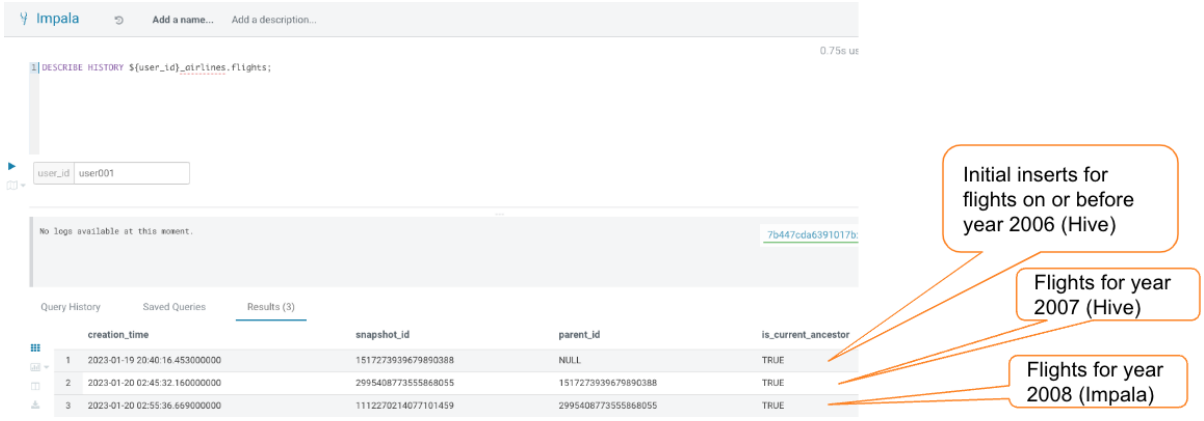
- In the output notice the amount of data that needs to be scanned for this query, about 10MB, is significantly less than that of the first, 138MB. This shows an important capability, Partition Pruning. Meaning that much less data is being scanned for this query and only the selected month of data is being scanned vs scanning the entire year of data. This should result in much faster query execution times.

- **Iceberg Snapshots Time Travel** - in the previous steps we have been loading data into the flights Iceberg table.
  - Each time data was changed in our Iceberg tables, a Snapshot is automatically captured. This is important for many reasons but the main point of the Snapshot is to ensure eventual consistency and allow for multiple reads/writes concurrently (from various engines or the same engine).
  - Show snapshots
    - Delete the current query from the SQL Window
    - Copy & paste the SQL below

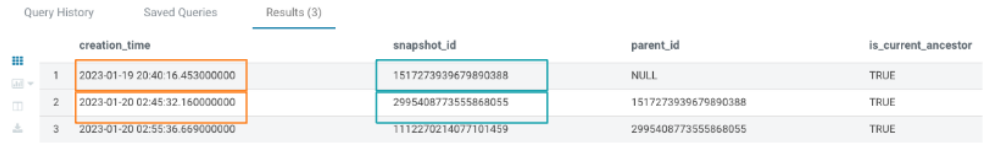
```
DESCRIBE HISTORY ${user_id}_airlines.flights;
```

    - Execute the Query by clicking on the ▶ button

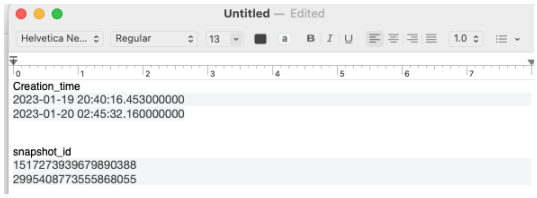
In the output there should be 2 Snapshots, in the example below there are 3 snapshots as this example shows that data was also loaded vie Impala and not just Hive. Also, keep in mind we have been reading/writing data from/to the Iceberg table from both Hive & Impala which is indicated by the () in the callouts below. This is important aspect of Iceberg Tables is that they support multi-function analytics - ie. many engines can work with Iceberg tables (Cloudera Data Warehouse [Hive & Impala], Cloudera Data Engineering [Spark], Cloudera Machine Learning [Spark], Cloudera DataFlow [NiFi], and DataHub Clusters)



- Get Details for Snapshots - open a text editor/notepad



Text Editor - copy in a couple creation_time's and snapshot_id's

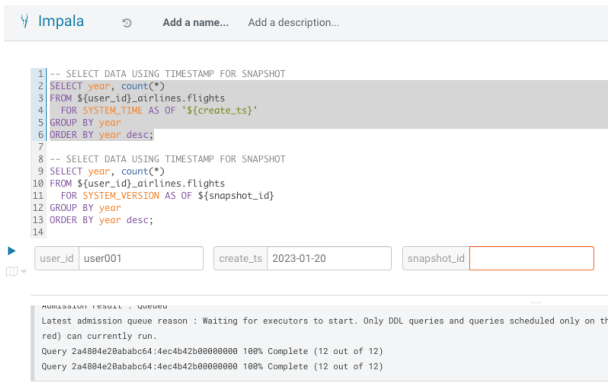


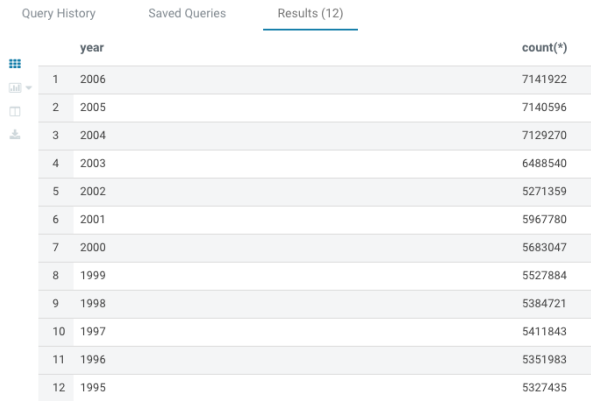
- **Iceberg Time Travel [Table Maintenance]** - copy/paste the following data into the Impala Editor, but do not execute.
  - Delete the current query from the SQL Window
  - Copy & paste the SQL below

```
-- SELECT DATA USING TIMESTAMP FOR SNAPSHOT
SELECT year, count(*)
FROM ${user_id}_airlines.flights
  FOR SYSTEM_TIME AS OF '${create_ts}'
GROUP BY year
ORDER BY year desc;

-- SELECT DATA USING TIMESTAMP FOR SNAPSHOT
SELECT year, count(*)
FROM ${user_id}_airlines.flights
  FOR SYSTEM_VERSION AS OF ${snapshot_id}
GROUP BY year
ORDER BY year desc;
```

- Once you copy this SQL into the Editor you will see 2 new parameters - create_ts and snapshot_id

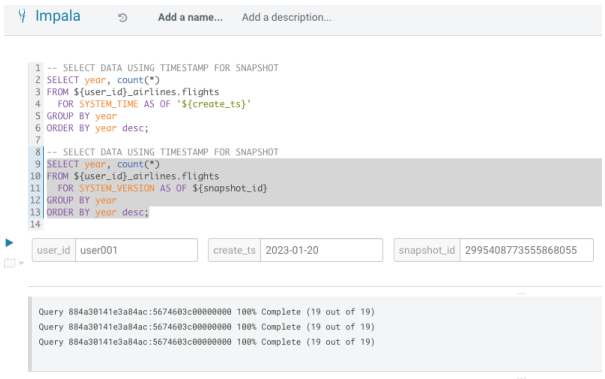
- The first SELECT statement will use the create_ts
  - In the create_ts parameter box enter a date/time (this can be relative or specific timestamp). From your Text Editor copy the second entry under creation_time, paste it into the create_ts parameter. For this Time Travel you can use relative time periods and don't have to enter the specific timestamp for the Snapshot.
  - Highlight the first SELECT statement, and execute it

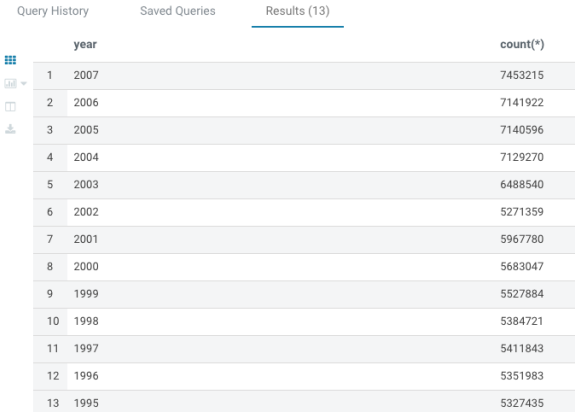




	year	count(*)
1	2006	7141922
2	2005	7140596
3	2004	7129270
4	2003	6488540
5	2002	5271359
6	2001	5967780
7	2000	5683047
8	1999	5527884
9	1998	5384721
10	1997	5411843
11	1996	5351983
12	1995	5327435

  - This returned the the data as it was in our initial load
- The second SELECT statement will use the snapshot_id
  - From your Text Editor copy the second entry under snapshot_id, paste it into the snapshot_id parameter box
    - Highlight the second SELECT statement, and execute it

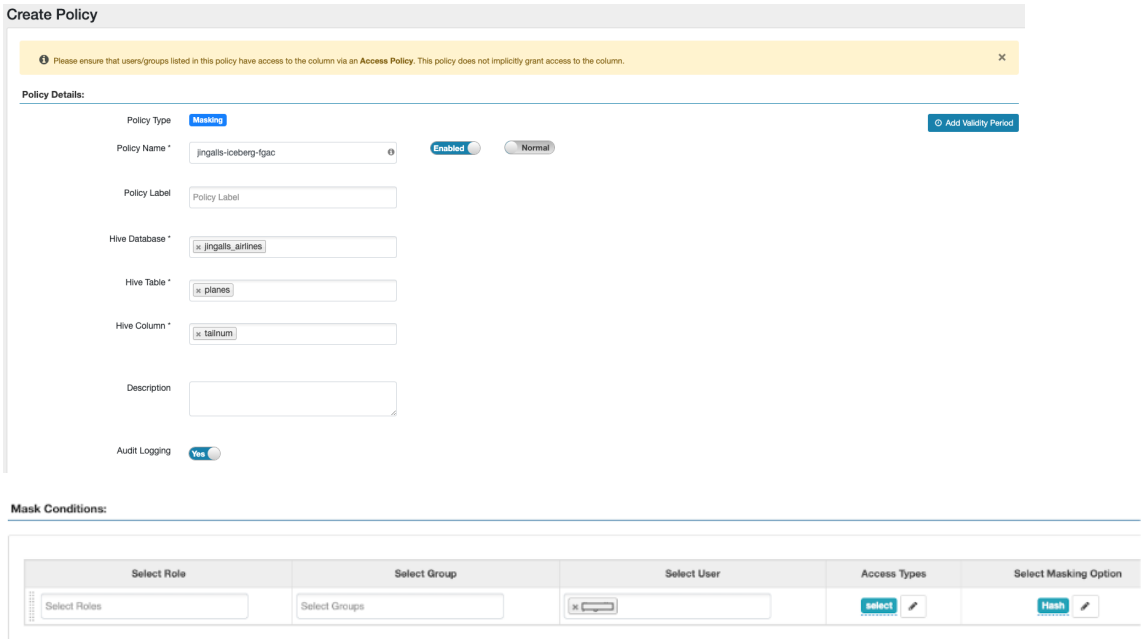




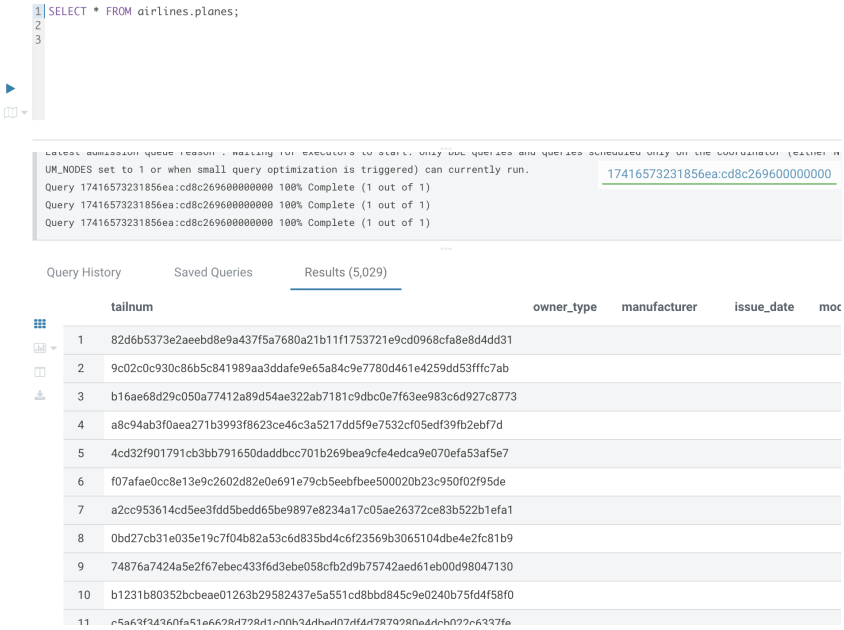
	year	count(*)
1	2007	7453215
2	2006	7141922
3	2005	7140596
4	2004	7129270
5	2003	6488540
6	2002	5271359
7	2001	5967780
8	2000	5683047
9	1999	5527884
10	1998	5384721
11	1997	5411843
12	1996	5351983
13	1995	5327435

  - This returns the data for the specific Snapshot ID that was specified in the query which was the data for the initial insert for data up to year 2006 and the insert for data for year 2007

- **Security & Governance** - Now that performance has been optimized, we are almost ready to release this to the users. Before we do that we need to apply security - Security is always on and can be defined with fine grained access control. A security policy has already been created. This is how it is defined



- Delete the current query from the SQL Window
- Copy & paste the SQL below Select all of the content in the SQL Editor
- Execute the Query by clicking on the ▶ button



- You will see that the “tailnum” column is masked so you are unable to see the actual plane’s tail number, instead you see the Hashed value of the tailnum

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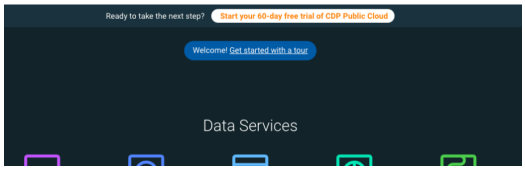
(Optional Bonus Material)

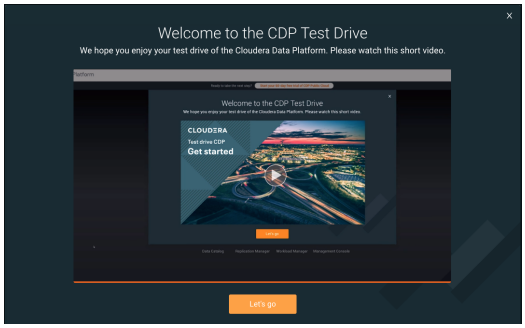
Optional Lab 1 - CDW Tour

In this Lab you will explore how to take advantage of CDW.

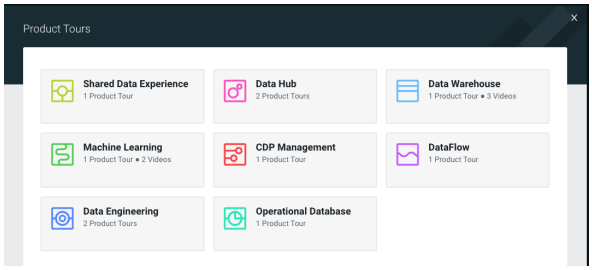
13. Click on the “Get Started with a Tour” at the top of the CDP Home screen



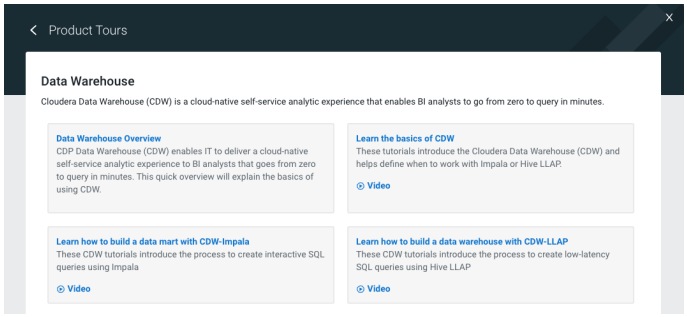
14. [Optional] Watch the “Test Drive” Video on the CDP Home screen (video is ~3 minutes)



15. Click on the “Let’s go” button at the bottom of the video, you can take tours of any of the Data Services
16. Click on the Data Warehouse tour tile



- Here you see the content you can take advantage of - there are 3 tiles where you can watch videos on an area of interest, you will see a “> Video” link on the tile if this is a video, and there is also a tour.



- Click on the “Data Warehouse Overview” tile, this is a click through tour of CDW
  - Perform all of the actions for this click through tour (~5 minutes)
  - Once completed click on the “X” in the top right corner to close the window

17. On the Product Tours screen, explore the various topics to learn mover about Cloudera Data Warehouse

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Optional Lab 2 - Data Security & Governance

In this lab you will experience the combination of what the Data Warehouse and the Shared Data Experience (SDX) offers. SDX enables you to provide Security and Governance tooling to ensure that you will be able to manage what is in the CDP Platform without having to stitch together multiple tools.

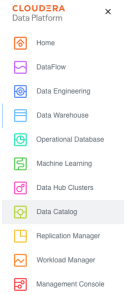
Robust Data Catalog (Governance) capability that:

- Enables you to understand, manage, secure, and govern data assets across
- Provides a 360 degree view of Assets - Lineage, Metadata, Security Policy applied to the asset
  - There are many assets - everything created in CDP is captured as an Asset
  - For this Workshop we have been working with Assets, like - databases, views, tables, etc.

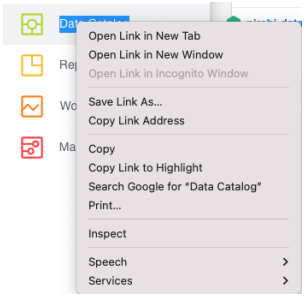
Powerful Security features like:

- Rule-based masking columns based on a user’s role
- Group association or rule-based row filters
- Attribute-Based Access Control a.k.a. Tag-based security policies

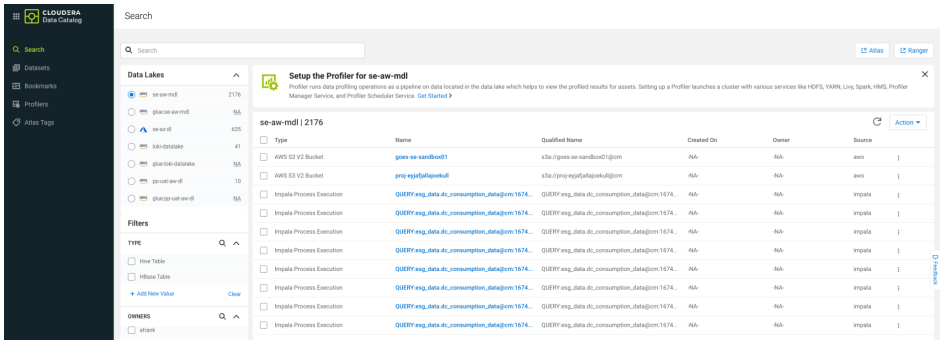
18. Data Catalog - Governance (Lineage, Metadata, etc.)
    - On the left navigation menu click the next to Data Warehouse



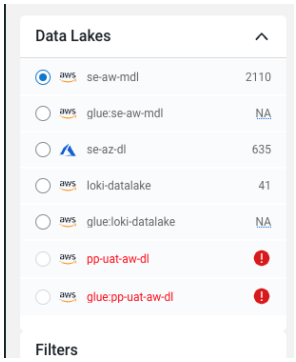
- Right click on the Data Catalog and select “Open Link in New Tab” option



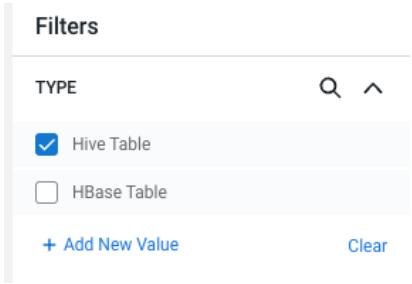
- Open browser tab that just opened, should have Data Catalog in the tab title



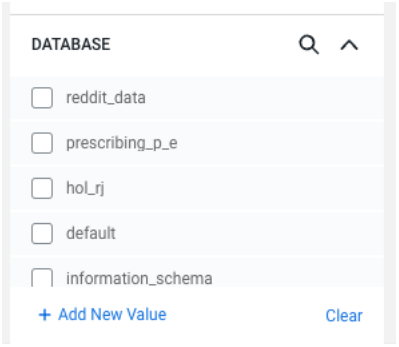
- To the left, under Data Lakes, ensure the Data Lake provided in Lab Setup radio button is selected

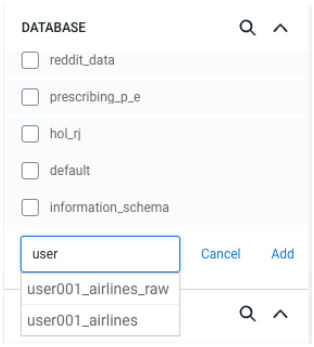


- Filter for Assets we created - below the Data Lakes on the left of the screen under Filters, select TYPE of Hive Table. The right side of the screen will update to reflect this selection

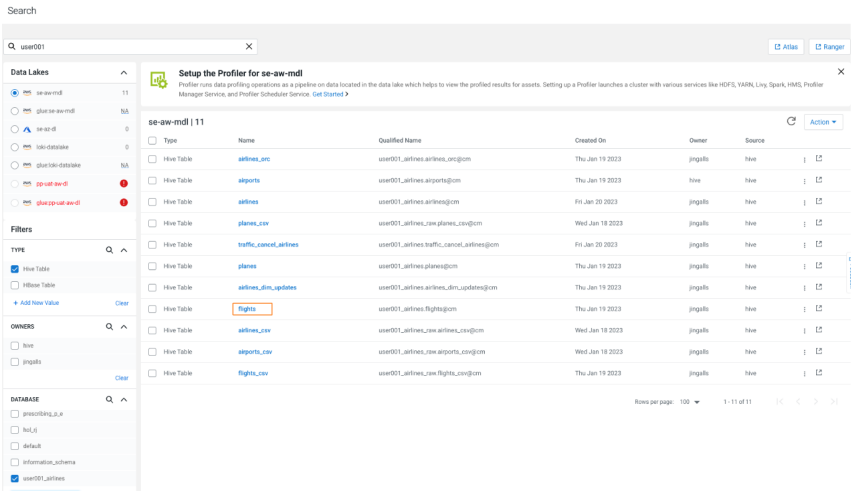


- Under DATABASE, click +Add new Value. In the box that appears start typing your **<user_id>** when you see the **<user_id>**_airlines database pop up select it

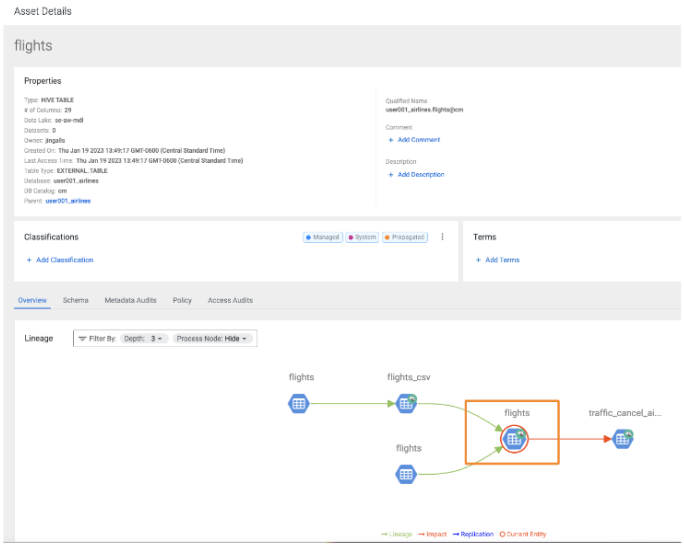




- You should now see the tables and materialized views that have been created in the **<user_id>**_airlines database. Click on flights in the Name column to view more details on the flights table.

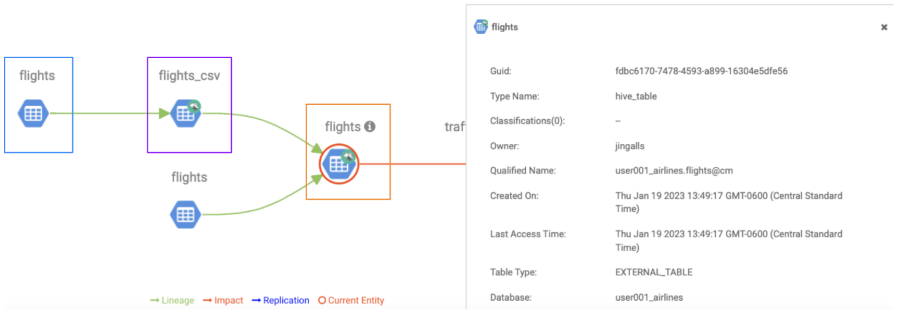


- This page shows information about the flights table such as the table owner, when the table was created, when it was last accessed, and other properties. Below the summary details is the Overview tab which shows the lineage - hoover over the flights click on the “i” icon that appears to see more detail on this table

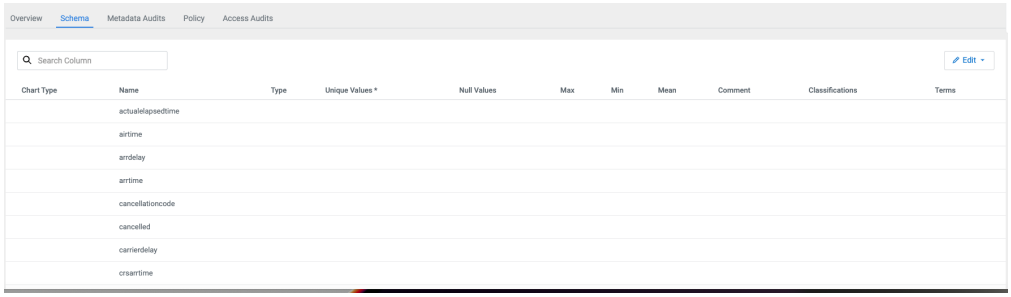


- The lineage shows
  - [blue box] flights data file residing in an s3 folder

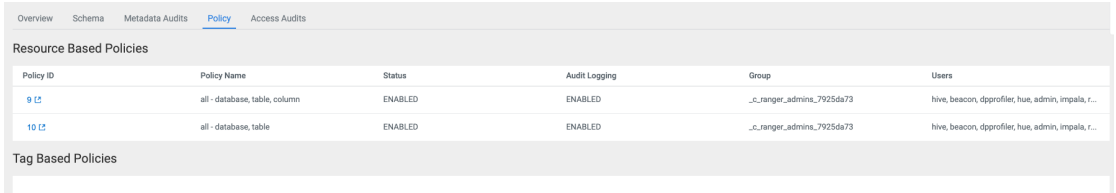
- [purple box] is showing how the flights_csv Hive table is created, this table was created and points to the data location of flights' (blue box) s3 folder
- [orange box] is showing the flights Iceberg table and how it is created, it uses data from flights_csv Hive table (CTAS)
- Traffic_cancel_airlines is a Materialized View that uses data from the flights Iceberg table.



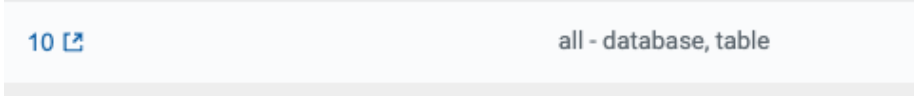
- Click on the Schema Tab to see Metadata on this table. The Metadata includes basic information from the table such as: column names and data types for the columns. You can also run Profilers that come as part of CDP:
  - Hive Table Profiler - allows you to gather additional information from the table including Min/Max values in the column, # records with Null Values in a column, etc.
  - Sensitivity Profiler - identifies columns that may contain sensitive information such as PII data, SSN, credit card numbers, ID numbers, etc. These items will be "Tagged" in the Classification column of the Schema page.



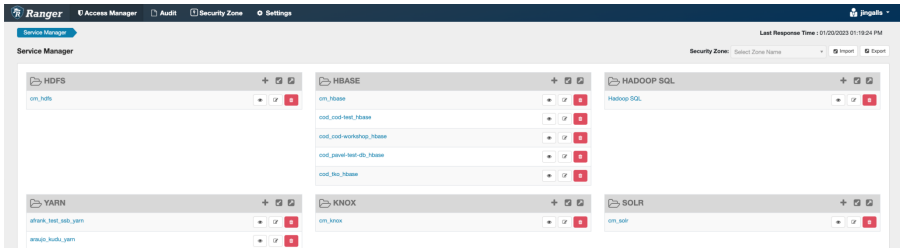
- Click on the Policy tab to see what security policies have been applied on this table. There are 2 policies that have been defined to allow some users & groups access via policy "all - database, table, column" and another policy "all - database, table" access.
  - The Access Audits tab allows Administrators to be able to see who, when, where, why either accessed this table or was denied access to this table. Feel free to switch to this tab to take a look and switch back to the Policy tab.



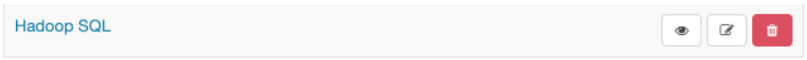
- Click on the next to the "all - database, table" - to modify this policy or create a new policy



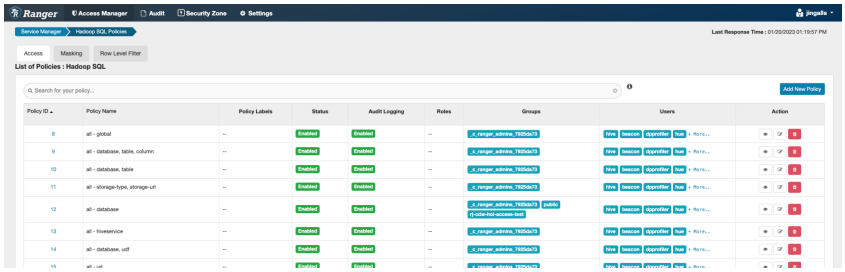
19. Security (Ranger) - modify and create security policies for the various CDP Data Services.
    - View the Policy details and click the CANCEL button at the bottom.
    - For this portion of the Lab let's restrict your access to a subset of data available in the "flights" table.



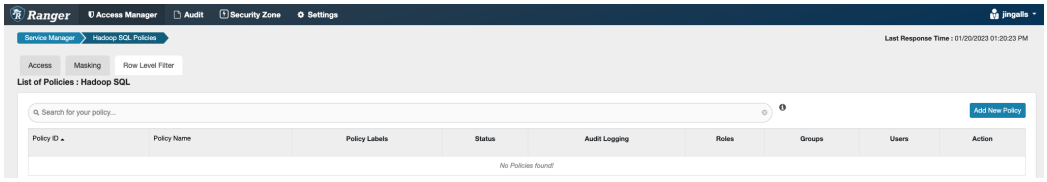
    - Click on the Hadoop SQL link in the upper left corner - to view the security policies in place for CDW. For this Workshop we will stick to the CDW related security features



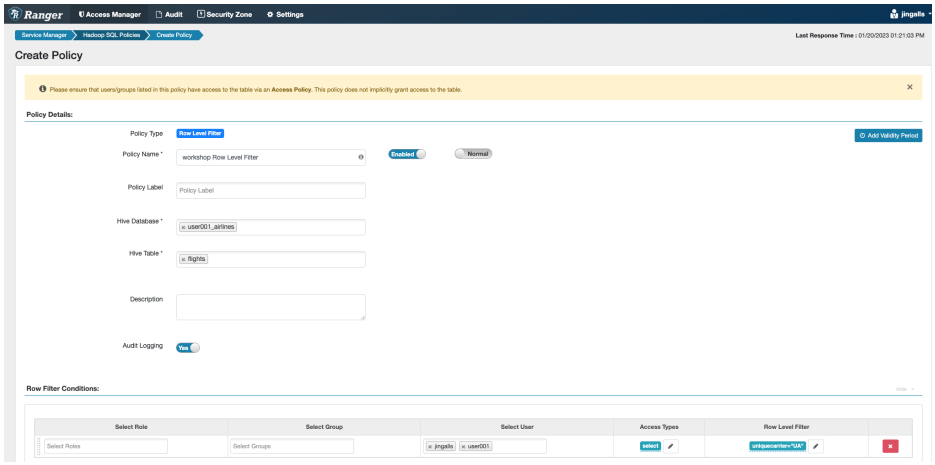
    - This screen shows the general Access related security policies - who has access to which Data Lakehouse databases, tables, views, etc. Click on the "Row Level Filter" tab to see the policies to restrict access to portions of data



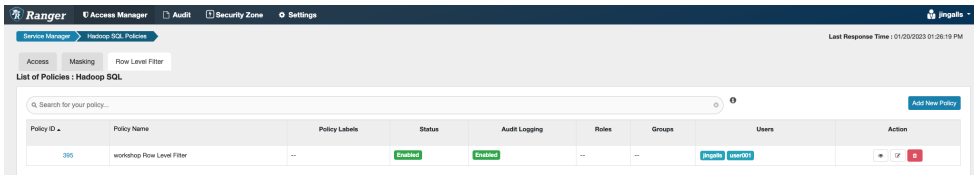
    - There are currently no policies defined. Click on the Add New Policy button



    - Fill out the form as follows. For this policy let's say you are an Gate Agent for United Airlines and should not be able to see data for any other Airline. To setup the policy we need to apply a filter that is applied to any query that is run for your **<user_id>** so you only see rows for flights run by United Airlines.
        - Policy Name: **<user_id>** Workshop Row Level Filter
        - Hive Database: **<user_id>**_airlines (start typing, once you see this database in the list, select it)
        - Hive Table: flights (start typing, once you see this table in the list, select it)
        - Row Level Filtering Conditions
            - Select User - **<user_id>** (start typing, once you see this user in the list, select it)
            - Row Level Filter - **uniquecarrier="UA"**
            - For this you could have any number of filter conditions (for this Lab we will only create 1) with many different filter configurations
        - Click Add button to accept this Policy



- The new policy is added to the “Row Level Filter” policies (as below)



- Test the policy is working - Open HUE for the CDW **Impala** Virtual Warehouse - airlines-impala-vw and execute the following query

```
SELECT uniquecarrier, count(*)
FROM ${user_id}_airlines.flights
GROUP BY uniquecarrier;
```

You should now only see 1 row returned for this query - after the policy was applied you will only be able to access uniquecarrier = “UA” and no other carriers: