CS598 PDF Report - Task 1

Task 1 Overview

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1) Overview - Data Extract and Cleaning

I copied the snapshot, renamed as "CS598 CCC - Copied Snapshot - Transportation Databases (Linux)", to retrieve the dataset. I created a new EBS volume from the snapshot, and a new EC2 instance to be attached to the EBS volume. After mounting EBS to your EC2 instance, I copied files from EBS to my local machine.

Once I had the entire airline_ontime directory on my local, I unzipped all the CSV files, expecting and finding 240 files, ignoring 2008_11 and 2008_12 zips. I then moved all CSV to one directory and converted them to utf-8. From here, I used Jupyter for a data cleaning script. This was a two-part optimization because a) smaller file sizes needed to be uploaded to S3, saving on storage costs, and b) before doing this, I ran into issues with many of the columns were null even though they were in the CSVs in S3. It seems that these were float integers, and I had to go back to convert those columns.

After the script completed, I compressed each cleaned csv into their .gz, and upserted all the .gz to S3. From there, I used AWS Glue to clean, organize, and view the data by creating and running a crawler in AWS Glue. After the crawler completed, I cleaned and updated the table schema to confirm the wanted columns and data types. Using AWS Athena, I validated my cleaned data in S3. I expected and found 116,753,952 rows and also validated the data by querying a few rows and seeing that the stored data looked correct.

2) Overview - System Integration

Used AWS EMR with Hive and DynamoDB. I launched an EMR cluster with the default, 3 nodes (2 master and 1 slave). My SSH first timed out when I tried SSHing directly into the master node after it was up and running. I resolved this by adding SSH to port 22 in the AWS Security Group.From there I set up a Hive external table using S3 as the location from which I would import the airline data into DynamoDB. S3 initially imported 116,754,192 records, vs 116,753,952 rows found from Athena before. This is a 240 row difference, for the CSV headers. I then created the DynamoDB tables for Group 2 and Group 3.2. I did spent some time tinkering with the partition and sort keys and learning how they worked for Dy.namoDB, but eventually went back to approaching the problems and optimizing my queries

3) Approaches and Algorithms

I started by testing out my queries in Athena and validating I got the expected solution there. From there, I could copy and paste those queries into the HIVE CLI to run on the EMR Hive cluster when they were ready. From there, it was a simple matter of adopting the query to create an external table and insert the data into DynamoDB. For each question, I created separate DynamoDB tables and ran the HIVE queries to insert data in their respective tables.

For Question 3.1, I ran the Hive query needed for the data points, then added those results to a Hive table which was subsequent exported to a file in S3. I then converted that file from S3 to a CSV file. From there, I created the distribution graphs needed to answer 3.1. For 3.2, it took some time to figure out how I wanted to do this. I first approached this from the perspective where I would have just one table and do one massive query with JOIN/UNION/WHERE/GROUPBY/etc. However, that would be time and performance intensive. Thus, I decided to break the problem up by using three tables: one for the first leg, one for the second leg, and one for the complete flight that selected the necessary fields from the first two tables. For importing the result for this question, I only imported results from the third table.

4) Results

Only results are included here. Full Hive Queries & image proof is provided in Section 8).

Group 1

1.1) Rank the top 10 most popular airports by numbers of flights to/from the airport. ORD: 12449354 ATL: 11540422 DFW: 10799303 LAX: 7723596 PHX: 6585534 DEN: 6273787 DTW: 5636622 IAH: 5480734 MSP: 5199213 SFO: 5171023	1.2) Rank the top 10 airlines by on-time arrival performance. Airline: Average delay in minutes *Rounded to the hundredths place to mirror the example solutions HA: -1.01 AQ: 1.16 PS: 1.45 ML (1): 4.75 PA (1): 5.32 F9: 5.47 NW: 5.56 WN: 5.56 OO: 5.74

	9E: 5.87
1.3) Weekday: Average delay in minutes *Rounded to the hundredths place to mirror the example solutions Saturday / 6: 4.30 Tuesday / 2: 5.99 Sunday /7 : 6.61 Monday / 1: 6.72 Wednesday / 3: 7.20 Thursday / 4: 9.09 Friday / 5: 9.72	

Group 2

2.1) For each airport X, rank the top-10 carriers in decreasing order of on-time departure performance from X.
*Rounded to the hundredths place to mirror the example solutions

CMI (University of Illinois Willard Airport) (OH, 0.61) (US, 2.03) (TW, 4.12) (PI, 4.46) (DH, 6.03) (EV, 6.67) (MQ, 8.02)	BWI (Baltimore-Washington International Airport) (F9, 0.76) (PA (1), 4.76) (CO, 5.18) (YV, 5.50) (NW, 5.71) (AA, 6.00) (9E, 7.24) (US, 7.49) (DL, 7.68) (UA, 7.74)	MIA (Miami International Airport) (9E, -3.0) (EV, 1.20) (TZ, 1.78) (XE, 1.87) (PA (1), 4.20) (NW, 4.50) (US, 6.09) (UA, 6.87) (ML (1), 7.50) (FL, 8.57)
LAX (Los Angeles International Airport) (MQ, 2.41) (OO, 4.22) (FL, 4.73) (TZ, 4.76) (PS, 4.86) (NW, 5.12) (F9, 5.73) (HA, 5.81) (YV, 6.02) (US, 6.75)	IAH (George Bush Intercontinental Airport) (NW, 3.56) (PA (1), 3.98) (PI, 3.99) (US, 5.06) (F9, 5.55) (AA, 5.70) (TW, 6.05) (WN, 6.23) (OO, 6.59) (MQ, 6.71)	SFO (San Francisco International Airport) (TZ, 3.95) (MQ, 4.85) (F9, 5.16) (PA (1), 5.29) (NW, 5.76) (PS, 6.30) (DL, 6.56) (CO, 7.08) (US, 7.53) (TW, 7.79)

2.2) For each source airport X, rank the top-10 destination airports in decreasing order of on-time departure performance from X.
*Rounded to the hundredths place to mirror the example solutions

CMI (University of Illinois Willard Airport) (ABI, -7.0) (PIT, 1.10) (CVG, 1.89) (DAY, 3.12) (STL, 3.98) (PIA, 4.59) (DFW, 5.94) (ATL, 6.67) (ORD, 8.19)	BWI (Baltimore-Washington International Airport) (SAV, -7.0) (MLB, 1.16) (DAB, 1.47) (SRQ, 1.59) (IAD, 1.79) (UCA, 3.65) (CHO, 3.74) (GSP, 4.20) (SJU, 4.44) (OAJ, 4.47)	MIA (Miami International Airport) (SHV, 0.0) (BUF, 1.0) (SAN, 1.71) (SLC, 2.5) (HOU, 2.91) (ISP, 3.65) (MEM, 3.75) (PSE, 3.98) (TLH, 4.26) (MCI, 4.61)
LAX (Los Angeles International Airport) (SDF, -16.0) (IDA, -7.0), DRO, -6.0) (RSW, -3.0) (LAX, -2.0) (BZN, -0.73) (MAF, 0.0) (PIH, 0.0) (IYK, 1.27) (MFE, 1.38)	IAH (George Bush Intercontinental Airport) (MSN, -2.0) (AGS, -0.62) (MLI, -0.5) (EFD, 1.89) (HOU, 2.17) (JAC, 2.57) (MTJ, 2.95) (RNO, 3.22) (BPT, 3.60) (VCT, 3.61)	SFO (San Francisco International Airport) (SDF, -10.0) (MSO, -4.0) (PIH, -3.0) (LGA, -1.76) (PIE, -1.34) (OAK, -0.81) (FAR, 0.0) (BNA, 2.43) (MEM, 3.30) (SCK, 4.0)

2.3) For each source-destination pair X-Y, rank the top-10 carriers in decreasing order of on-time arrival performance at Y from X
*Rounded to the hundredths place to mirror the example solutions

CMI → ORD (MQ, 10.14)	IND → CMH (CO, -2.55) (AA, 5.5) (HP, 5.70) (NW, 5.76) (US, 6.88) (DL, 10.69) (EA, 10.81)	DFW → IAH PA (1), -1.60) (EV, 5.09) (UA, 5.41) (CO, 6.49) (OO, 7.56) (XE, 8.09) (AA, 8.38) (DL, 8.60) (MQ, 9.10)
LAX → SFO (TZ, -7.62) (PS, -2.15) (F9, -2.03) (EV, 6.96)	JFK → LAX (UA, 3.31) (HP, 6.68) (AA, 6.90) (DL, 7.93)	ATL → PHX (FL, 4.55) (US, 6.29) (HP, 8.48) (EA, 8.95)

(AA, 7.39) (MQ, 7.81) (US, 7.96) (WN, 8.79) (CO, 9.35) (NW, 9.85)	(PA (1), 11.02) (TW, 11.70)	(DL, 9.81)

2.4) For each source-destination pair X-Y, determine the mean arrival delay (in minutes) for a flight from X to Y.

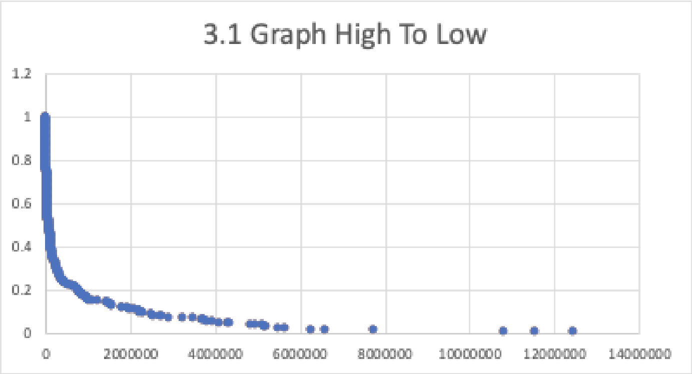
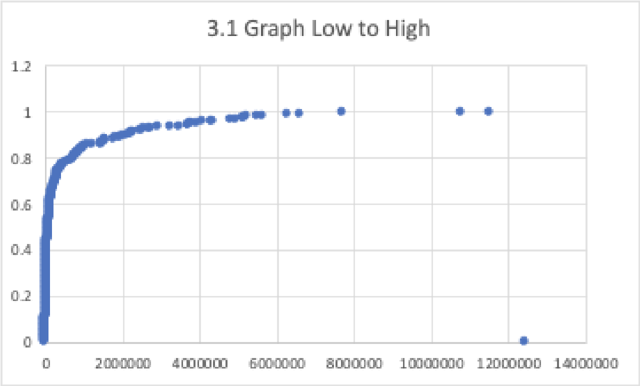
- CMI → ORD: 10.14
- IND → CMH: 2.90
- DFW → IAH: 7.65
- LAX → SFO: 9.59
- JFK → LAX: 6.64
- ATL → PHX: 9.02

Group 3

3.1) Does the popularity distribution of airports follow a Zipf distribution? If not, what distribution does it follow?

No, when plotting the result of the above query, we can see the overall shape follows a log-normal distribution, and not more of a straight line, which a power-law (Zipfian) distribution would be more similar to. In the attached images, we have the frequency distribution on the y-axis and the popularity/number of flights on the x-axis. One was plotted with popularity from highest to lowest while the other is plotted from lowest to highest.

Discrepancy Explanation: This is expected to differ from the provided example solution because I plotted my popularity distribution as a classic CDF in excel, not CCDF as the example solution does. This means that the “CCDF illustrates the fraction of airports with popularity above a given value.” while the CDF illustrates the fraction of airports with popularity below a given value. Thus, the chart is similar to the provided example solution in its curvature and distribution, but different in how the distribution is calculated and thus plotted. You may notice the graph could be seen as a mirror of the provided sample solution.

3.2) I factored in departure and arrival delay, not just arrival delay, because while the passenger may have an arrival delay of X, this does not include any departure delays of Y.

While the example solutions are using arrival delay, the prompt itself for Question 3.2 does not specify arrival delay as the only measure of delay, so using total delay would still fall within the requirements (Capstone Project Overview) for “as little delay as possible”.

Most of the queries aligned with the example solutions, except in 1 and 5, where the optimal flight found was not the same as the one provided in the query sample solutions, although they were very close in total delay as the sample solutions. Optimal flights are boxed in red; total_delay is the name of the last column (it’s cut off in the images).

Reference for Requirement + Explanation for allowed solution discrepancy

- c) Tom wants to arrive at each destination with as little delay as possible. You can assume you know the actual delay of each flight.
- Instructors on #45: “we tolerate inconsistencies of results (within 10%) comparing to the example solutions.”

1. CMI → ORD → LAX, 04/03/2008 First Leg Origin: CMI Destination: ORD Airline/Flight Number: MQ 4278 Sched Depart: 7:10 04/03/2008 Flight total delay: -14.0	Total Delay: -39 (2 routes possible) Second Leg: Origin: ORD Destination: LAX Airline/Flight Number: AA 1345 Sched Depart: 14:01 06/03/2008 Flight total delay: -25.0
2. JAX → DFW → CRP, 09/09/2008 Origin: JAX Destination: DFW Airline/Flight Number: AA 845 Sched Depart: 7:22 09/09/2008 Flight total delay: -2.0	Total Delay: -6 Origin: DFW Destination: CRP Airline/Flight Number: MQ 3627 Sched Depart: 16:48 11/09/2008 Flight total delay: -4.0
3. SLC → BFL → LAX, 01/04/2008 Origin: SLC Destination: BFL Airline/Flight Number: OO 3755 Sched Depart: 11:01 01/04/2008 Flight total delay: 13.0	Total Delay: 33 Origin: BFL Destination: LAX Airline/Flight Number: OO 5429 Sched Depart: 15:09 03/04/2008 Flight total delay: 20.0
4. LAX → SFO → PHX, 12/07/2008 Origin: LAX Destination: SFO Airline/Flight Number: WN 3534 Sched Depart: 6:50 12/07/2008 Flight total delay: -13.0	Total Delay: -41 Origin: SFO Destination: PHX Airline/Flight Number: US 412 Sched Depart: 19:16 14/07/2008 Flight total delay: -28.0
5. DFW → ORD → DFW, 10/06/2008 Origin: DFW Destination: ORD Airline/Flight Number: UA 1104 Sched Depart: 6:58 10/06/2008 Flight total delay: -23.0	Total Delay: -31 Origin: ORD Destination: DFW Airline/Flight Number: OO6199 Sched Depart: 16:46 12/06/2008 Flight total delay: -8.0

6. LAX → ORD → JFK, 01/01/2008 Origin: LAX Destination: ORD Airline/Flight Number: UA 944 Sched Depart: 7:00 01/01/2008 Flight total delay: -4.0	Total Delay: -18 Origin: ORD Destination: JFK Airline/Flight Number: B6 918 Sched Depart: 18:53 03/01/2008 Flight total delay: -14.0

5) Optimizations

- Cleaning: Removed unused columns in data and cleaned via Python/Jupyter. This, along with gzipping, lowers the amount to be transferred, storage needed, and storage costs.
- DynamoDB: Maintained ordered and sorted results when inserting into DynamoDB using partition and sort keys. When I did not use a sort key, data ingestion took about an hour longer and was incomplete. By adding a sortkey, this optimizes the data integration process for DynamoDB to process the dataset faster and allow for sorting.
    - Partition: origin
    - Sort: averagedeparturedelay
- Data Architecture Optimization. Prior to the updated requirement to not require all the rows for Group 3.2, I was optimizing the data integration process by increasing the write throughput and increasing the EMR cluster size to speed up the data ingestion process.
    - SET dynamodb.throughput.write.percent=1.5;
    - SET mapreduce.job.maps = 20;
    - EMR Resize to 5 instead of default 3.

6) Opinion and Notes

- This was a great project, frustrating and challenging at times, having spent numerous hours figuring out how to do this and put it all together for the first time. Other technical opinions are in line with their response in their respective sections/queries/results.
- Youtube
    - For the Youtube video, it is recorded at 2x speed to fit in the original sub-5 minute requirement. You can use Youtube's playback speed to watch it at a slower pace.
    - There is no sound and that is expected. You can follow the Notes outline to understand what is being shown and more quickly than me speaking.
- Page Count: This page concludes my report, ending at 7 pages including table of contents and answers to all questions, not just minimum requirement.
    - Because the requirement for having a limit of 4-5 pages without query results was lifted, I added the table of contents + two dozen pages to add: expected grading of my Task 1 Submission according to the rubric, queries & proof of results, quick commands, and resources.
    - For the peer reviewers, you can skip the rest of the report, but I recommend you lightly review the rubric / expected grading section (next page) to see how I fulfilled all the requirements of the projects under the Excellent box.

7) Rubric/Expected Grading

Adding PDF, Video Prompts, and Rubric here & adding notes to indicate how they are fulfilled.

Document Length: 33 pages

- Length of Report: 7 pages, includes all problems and a half page table of contents
    - Target: No more than 4-5 pages excluding the results: Not fulfilled but
        - a) not a requirement
        - b) results section condensed to results only.
    - Assuming you will not include the "Resources + Addendum" section after the results and do not consider this Rubric/Expected Grading page as part of the report
    - Source: https://piazza.com/class/ka8oxw9bygm2e9?cid=78
- Addendum
    - Rubric/Expected Grading: Page 8
    - Results (Queries and Proof (Pages 9-31)
    - Queries & Quick Commands: Pages 31+
- 11 Point Font: Fulfilled

Rubric:

- Project Report: 10 points
    - Fulfilled; 1) See Section 1, 2) See Section 3, 3) see Results section 4.
- Project Video: 10 points
    - Fulfilled; 1) Shows data ingestion + data analysis 2) results are queried
    - Youtube Link: https://youtu.be/wqOQvRAVE7M
    - Watch at HD quality since SD quality is too poor and everything is blurry.
- Speed/Efficiency: 10 points
    - Optimization 1: Improve data cleaning before and during ingestion
    - Optimization 2: Maintained ordered and sorted records in DynamoDB, including partition and sort keys.
- System Integration: 10 points
    - Fulfilled - Uses 1) Hadoop or Spark, and 2) Cassandra or DynamoDB.
        - See section 2) for more details
- Quality of Results: 10 points
    - Fulfilled: See results addendum + video. Also did all queries, not just minimum.
- Total: 10+10+10+10+10 = 50/50

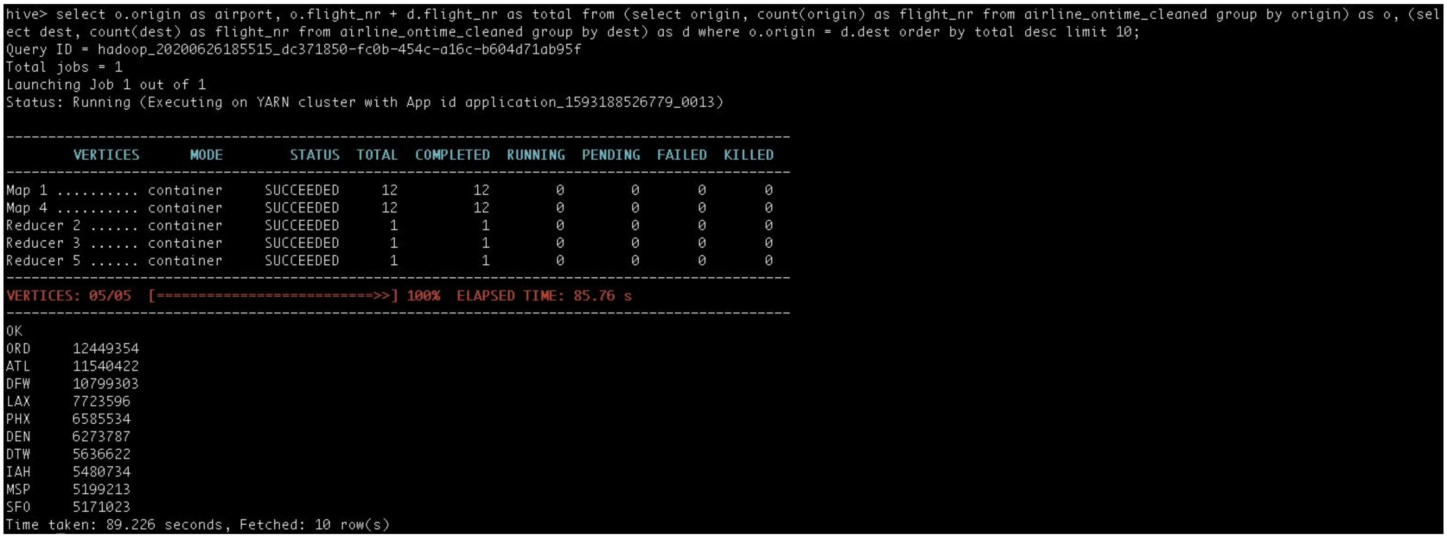
8) Results (Queries and Proof)

*Includes HiveQL Query and screenshot of the result

Group 1

1.1) Rank the top 10 most popular airports by numbers of flights to/from the airport.

- SELECT o.origin as airport, o.flight_nr + d.flight_nr as total from (SELECT origin, count(origin) as flight_nr from airline_ontime_cleaned group by origin) as o, (SELECT dest, count(dest) as flight_nr from airline_ontime_cleaned group by dest) as d where o.origin = d.dest order by total DESC LIMIT 10;

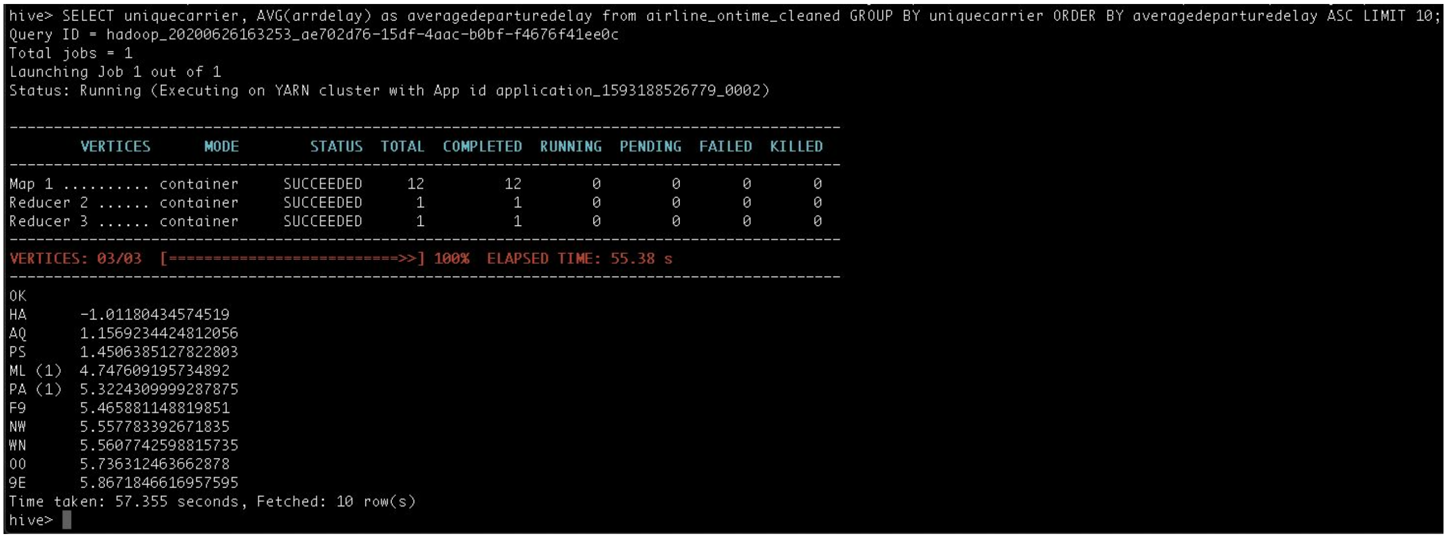


```
hive> select o.origin as airport, o.flight_nr + d.flight_nr as total from (select origin, count(origin) as flight_nr from airline_ontime_cleaned group by origin) as o, (sel
ect dest, count(dest) as flight_nr from airline_ontime_cleaned group by dest) as d where o.origin = d.dest order by total desc limit 10;
Query ID = hadoop_20200626185515_dc371850-fc0b-454c-a16c-b604d71ab95f
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0013)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Map 4 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 5 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 05/05  [==========================>>] 100%  ELAPSED TIME: 85.76 s
----------------------------------------------------------------------------------------------
OK
ORD     12449354
ATL     11540422
DFW     10799303
LAX     7723596
PHX     6585534
DEN     6273787
DTW     5636622
IAH     5480734
MSP     5199213
SFO     5171023
Time taken: 89.226 seconds, Fetched: 10 row(s)
```

1.2) Rank the top 10 airlines by on-time arrival performance.

Airline: Average delay in minutes

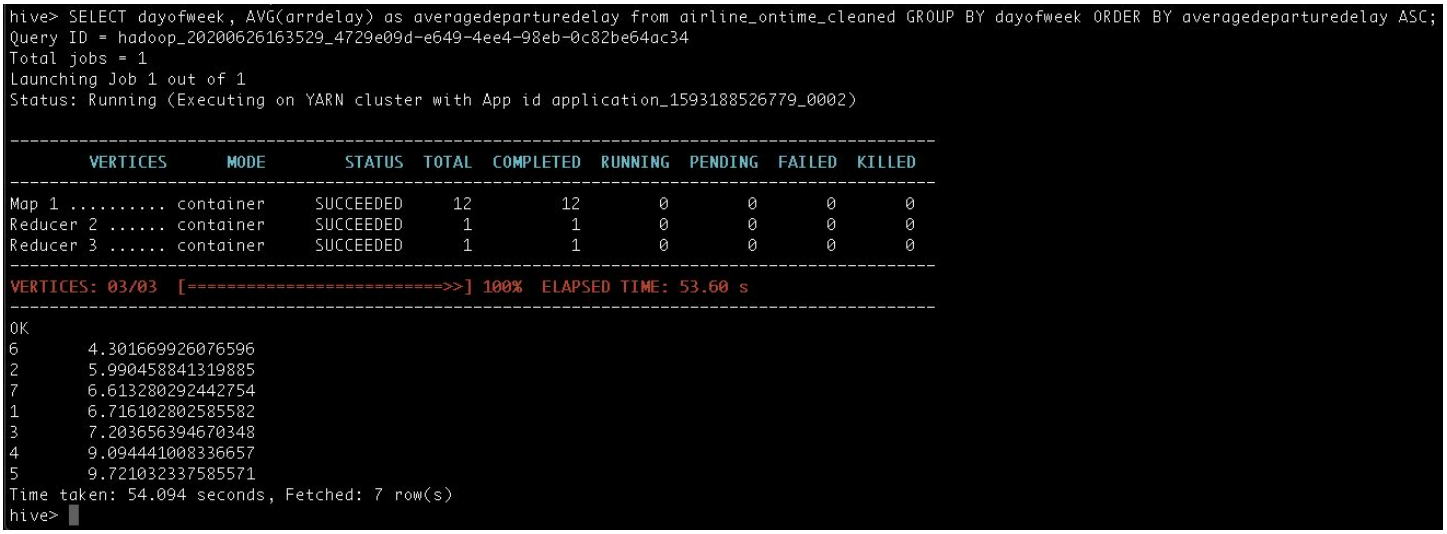
- SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626163253_ae702d76-15df-4aac-b0bf-f4676f41ee0c
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 55.38 s
----------------------------------------------------------------------------------------------
OK
HA      -1.01180434574519
AQ      1.1569234424812056
PS      1.4506385127822803
ML (1)  4.747609195734892
PA (1)  5.3224309999287875
F9      5.465881148819851
NW      5.557783392671835
WN      5.5607742598815735
OO      5.736312463662878
9E      5.8671846616957595
Time taken: 57.355 seconds, Fetched: 10 row(s)
hive>
```

1.3) Weekday: Average delay in minutes

- SELECT dayofweek, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned GROUP BY dayofweek ORDER BY averagedeparturedelay ASC;



```
hive> SELECT dayofweek, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned GROUP BY dayofweek ORDER BY averagedeparturedelay ASC;
Query ID = hadoop_20200626163529_4729e09d-e649-4ee4-98eb-0c82be64ac34
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 53.60 s
----------------------------------------------------------------------------------------------
OK
6       4.301669926076596
2       5.990458841319885
7       6.613280292442754
1       6.716102802585582
3       7.203656394670348
4       9.094441008336657
5       9.721032337585571
Time taken: 54.094 seconds, Fetched: 7 row(s)
hive>
```

For Group 2 + 3.2 Results Below, I have "overall" queries along with Hive queries to save the results into DynamoDB, and screenshots of individual queries and their results required for submission.

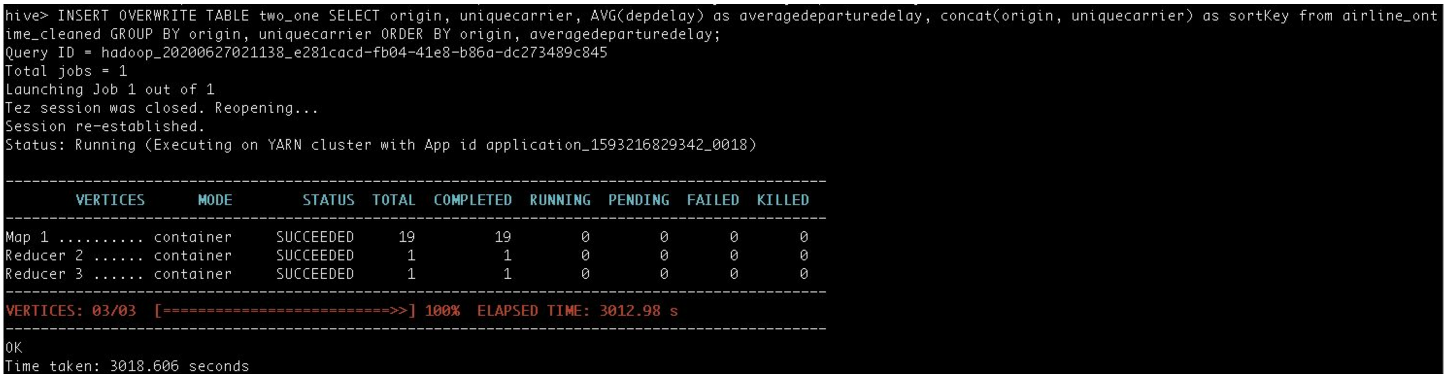
Group 2

2.1) For each airport X, rank the top-10 carriers in decreasing order of on-time departure performance from X.

General Hive Query + Adding Data to DDB (Query Result Shown in Video)

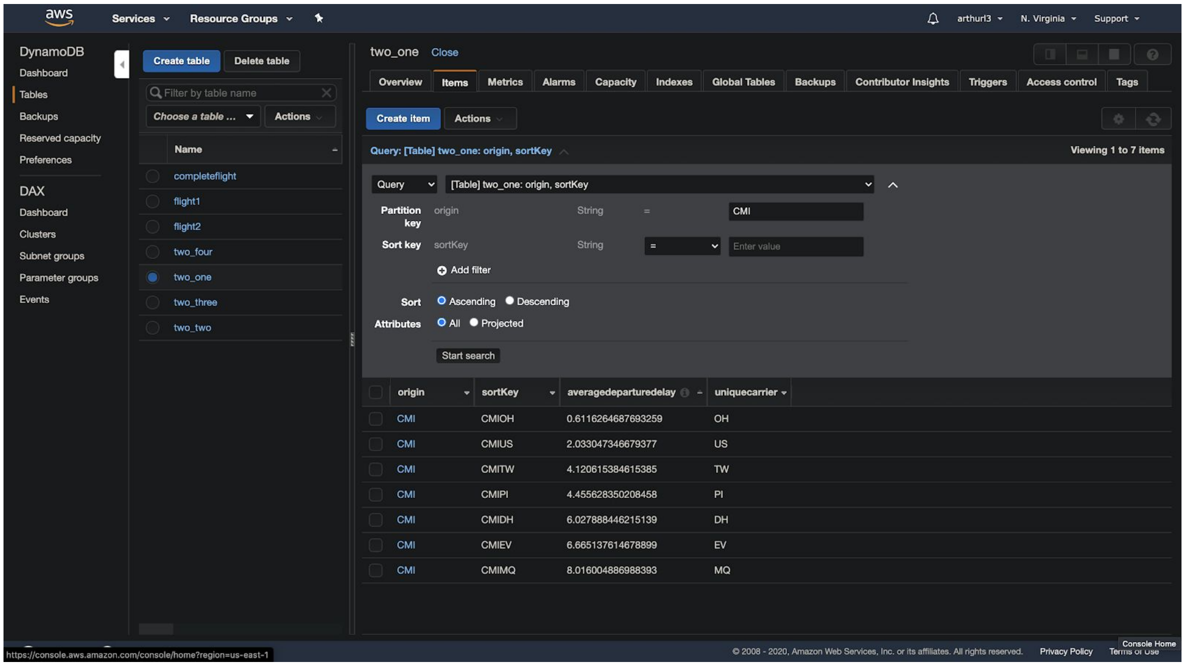
- SELECT origin, uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned GROUP BY origin, uniquecarrier ORDER BY origin, averagedeparturedelay;
- CREATE EXTERNAL TABLE two_one(origin STRING, uniquecarrier STRING, averagedeparturedelay DOUBLE, sortKey STRING) STORED BY 'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler' TBLPROPERTIES ("dynamodb.table.name" = "two_one", "dynamodb.column.mapping" = "origin:origin,uniquecarrier:uniquecarrier,averagedeparturedelay:averagedeparturedelay,sortKey:sortKey");
- INSERT OVERWRITE TABLE two_one SELECT origin, uniquecarrier, AVG(depdelay) as averagedeparturedelay, concat(origin, uniquecarrier) as sortKey from airline_ontime_cleaned GROUP BY origin, uniquecarrier ORDER BY origin, averagedeparturedelay;

Hive Query to Import from S3 to DynamoDB



```
hive> INSERT OVERWRITE TABLE two_one SELECT origin, uniquecarrier, AVG(depdelay) as averagedeparturedelay, concat(origin, uniquecarrier) as sortKey from airline_ont
ime_cleaned GROUP BY origin, uniquecarrier ORDER BY origin, averagedeparturedelay;
Query ID = hadoop_20200627021138_e281cacd-fb04-41e8-b86a-dc273489c845
Total jobs = 1
Launching Job 1 out of 1
Tez session was closed. Reopening...
Session re-established.
Status: Running (Executing on YARN cluster with App id application_1593216829342_0018)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     19         19        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 3012.98 s
----------------------------------------------------------------------------------------------
OK
Time taken: 3018.606 seconds
```

Sample DynamoDB Query - CMI



Query: [Table] two_one: origin, sortKey

Viewing 1 to 7 items

Query [Table] two_one: origin, sortKey

Partition key origin String = CMI

Sort key sortKey String = Enter value

Add filter

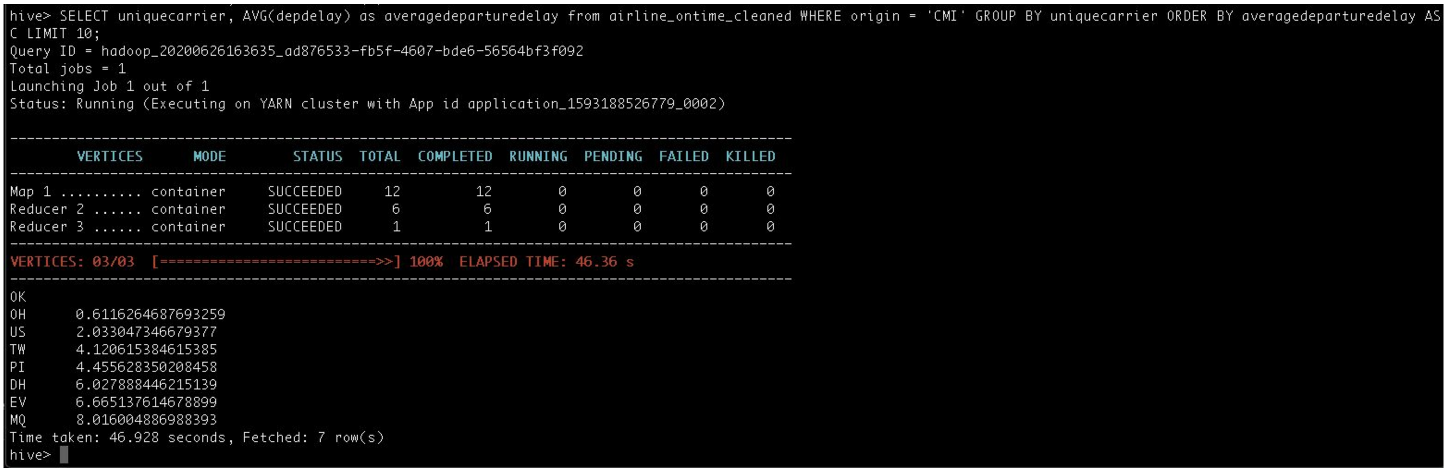
Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

origin	sortKey	averagedeparturedelay	uniquecarrier
CMI	CMIOH	0.6116264687693259	OH
CMI	CMIUS	2.033047346679377	US
CMI	CMITW	4.120615384615385	TW
CMI	CMIPI	4.455628350208458	PI
CMI	CMIDH	6.027888446215139	DH
CMI	CMIEV	6.665137614678899	EV
CMI	CMIMQ	8.016004886988393	MQ

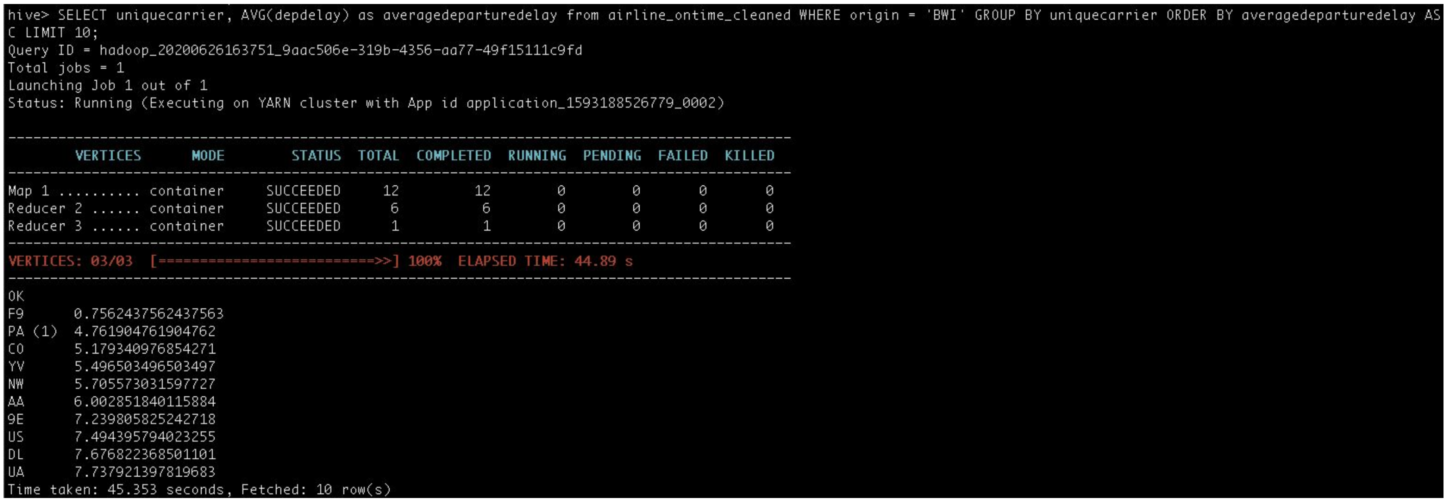
Targeted Queries (HIVE)

- CMI (University of Illinois Willard Airport)
  - SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'CMI' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



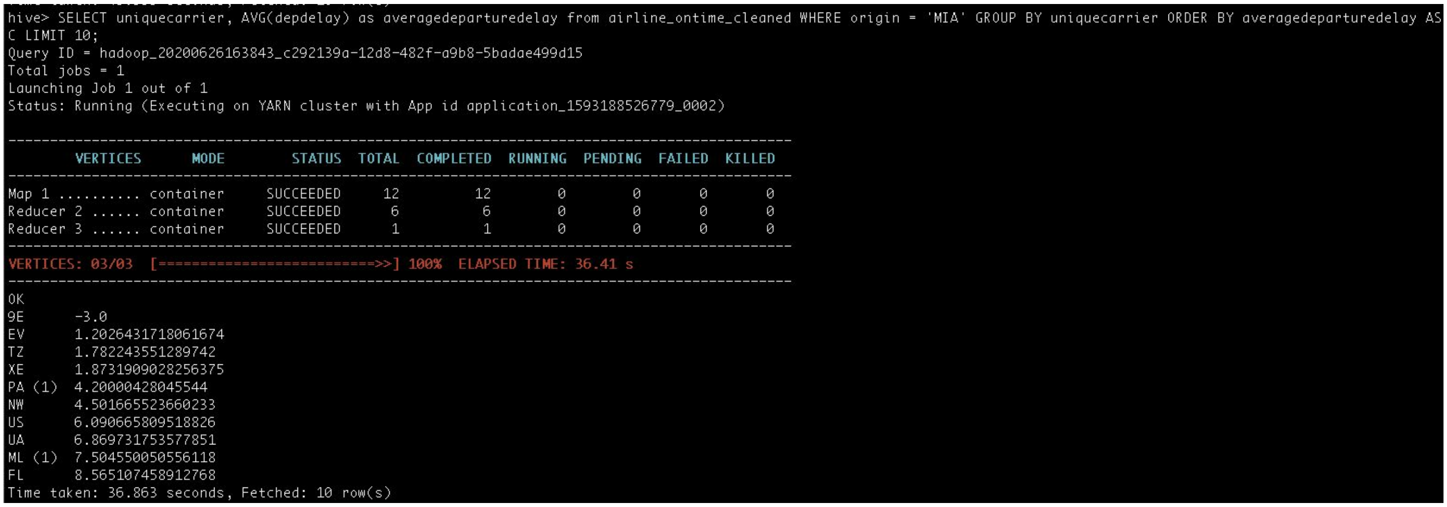
```
hive> SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'CMI' GROUP BY uniquecarrier ORDER BY averagedeparturedelay AS
C LIMIT 10;
Query ID = hadoop_20200626163635_ad876533-fb5f-4607-bde6-56564bf3f092
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 46.36 s
----------------------------------------------------------------------------------------------
OK
OH      0.6116264687693259
US      2.033047346679377
TW      4.120615384615385
PI      4.455628350208458
DH      6.027888446215139
EV      6.665137614678899
MQ      8.016004886988393
Time taken: 46.928 seconds, Fetched: 7 row(s)
hive>
```

- BWI (Baltimore-Washington International Airport)
  - SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'BWI' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



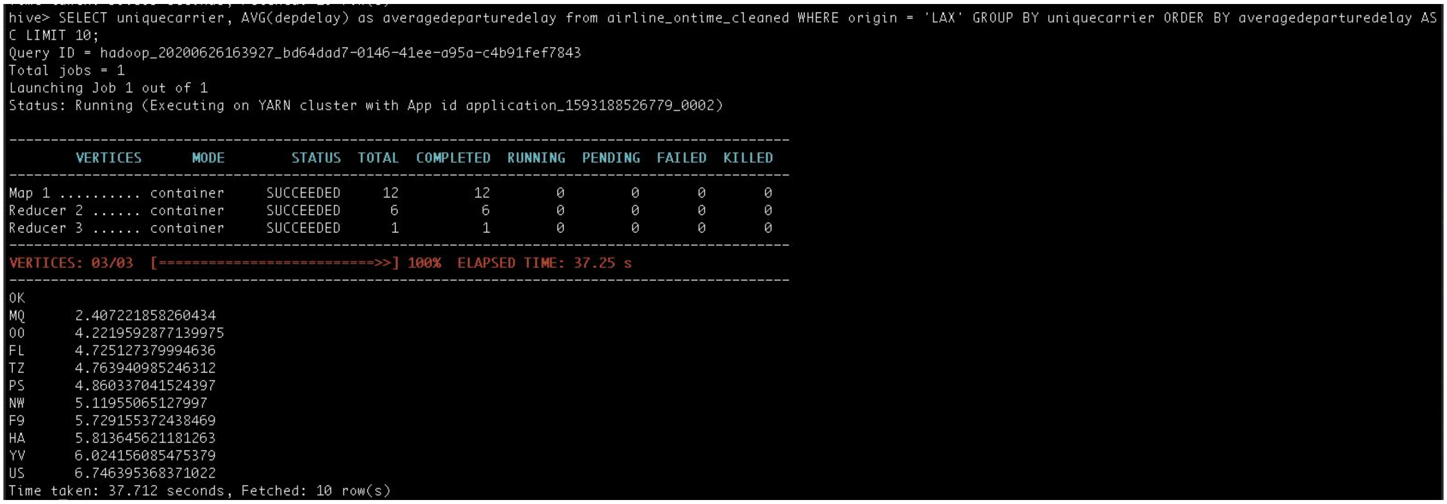
```
hive> SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'BWI' GROUP BY uniquecarrier ORDER BY averagedeparturedelay AS
C LIMIT 10;
Query ID = hadoop_20200626163751_9aac506e-319b-4356-aa77-49f15111c9fd
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 44.89 s
----------------------------------------------------------------------------------------------
OK
F9      0.7562437562437563
PA (1)  4.761904761904762
CO      5.179340976854271
YV      5.496503496503497
NW      5.705573031597727
AA      6.002851840115884
9E      7.239805825242718
US      7.494395794023255
DL      7.676822368501101
UA      7.737921397819683
Time taken: 45.353 seconds, Fetched: 10 row(s)
```

- MIA (Miami International Airport)
    - SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'MIA' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



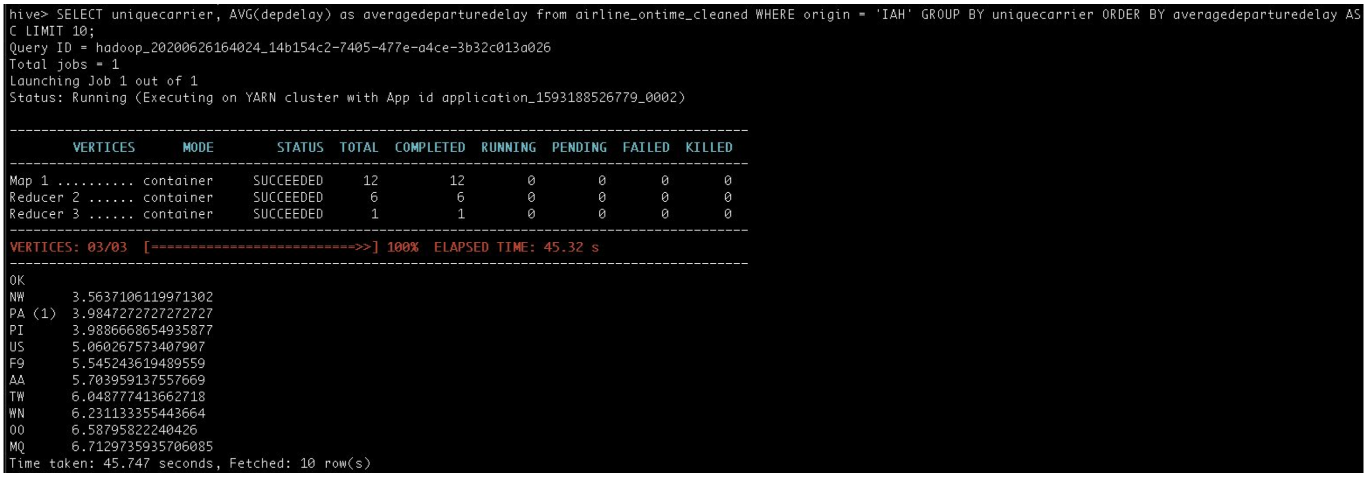
```
hive> SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'MIA' GROUP BY uniquecarrier ORDER BY averagedeparturedelay AS
C LIMIT 10;
Query ID = hadoop_20200626163843_c292139a-12d8-482f-a9b8-5badae499d15
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 36.41 s
----------------------------------------------------------------------------------------------
OK
9E      -3.0
EV      1.2026431718061674
TZ      1.782243551289742
XE      1.8731909028256375
PA (1)  4.20000428045544
NW      4.501665523660233
US      6.090665809518826
UA      6.869731753577851
ML (1)  7.504550050556118
FL      8.565107458912768
Time taken: 36.863 seconds, Fetched: 10 row(s)
```

- LAX (Los Angeles International Airport)
    - SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'LAX' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



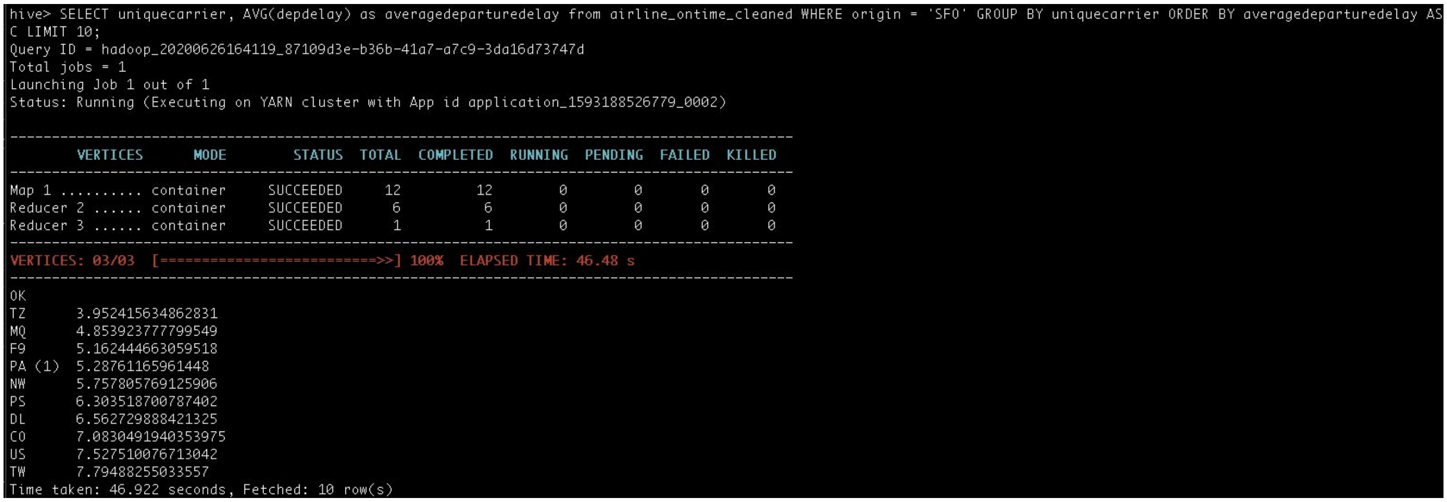
```
hive> SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'LAX' GROUP BY uniquecarrier ORDER BY averagedeparturedelay AS
C LIMIT 10;
Query ID = hadoop_20200626163927_bd64dad7-0146-41ee-a95a-c4b91fef7843
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 37.25 s
----------------------------------------------------------------------------------------------
OK
MQ      2.407221858260434
OO      4.2219592877139975
FL      4.725127379994636
TZ      4.763940985246312
PS      4.860337041524397
NW      5.11955065127997
F9      5.729155372438469
HA      5.813645621181263
YV      6.024156085475379
US      6.746395368371022
Time taken: 37.712 seconds, Fetched: 10 row(s)
```

- IAH (George Bush Intercontinental Airport)
    - SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'IAH' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



```
hive> SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'IAH' GROUP BY uniquecarrier ORDER BY averagedeparturedelay AS
C LIMIT 10;
Query ID = hadoop_20200626164024_14b154c2-7405-477e-a4ce-3b32c013a026
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 45.32 s
----------------------------------------------------------------------------------------------
OK
NW      3.5637106119971302
PA (1)  3.9847272727272727
PI      3.9886668654935877
US      5.060267573407907
F9      5.545243619489559
AA      5.703959137557669
TW      6.048777413662718
WN      6.231133355443664
OO      6.58795822240426
MQ      6.7129735935706085
Time taken: 45.747 seconds, Fetched: 10 row(s)
```

- SFO (San Francisco International Airport)
    - SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'SFO' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC LIMIT 10;



```
hive> SELECT uniquecarrier, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'SFO' GROUP BY uniquecarrier ORDER BY averagedeparturedelay AS
C LIMIT 10;
Query ID = hadoop_20200626164119_87109d3e-b36b-41a7-a7c9-3da16d73747d
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 46.48 s
----------------------------------------------------------------------------------------------
OK
TZ      3.952415634862831
MQ      4.853923777799549
F9      5.162444663059518
PA (1)  5.28761165961448
NW      5.757805769125906
PS      6.303518700787402
DL      6.562729888421325
CO      7.0830491940353975
US      7.527510076713042
TW      7.79488255033557
Time taken: 46.922 seconds, Fetched: 10 row(s)
```

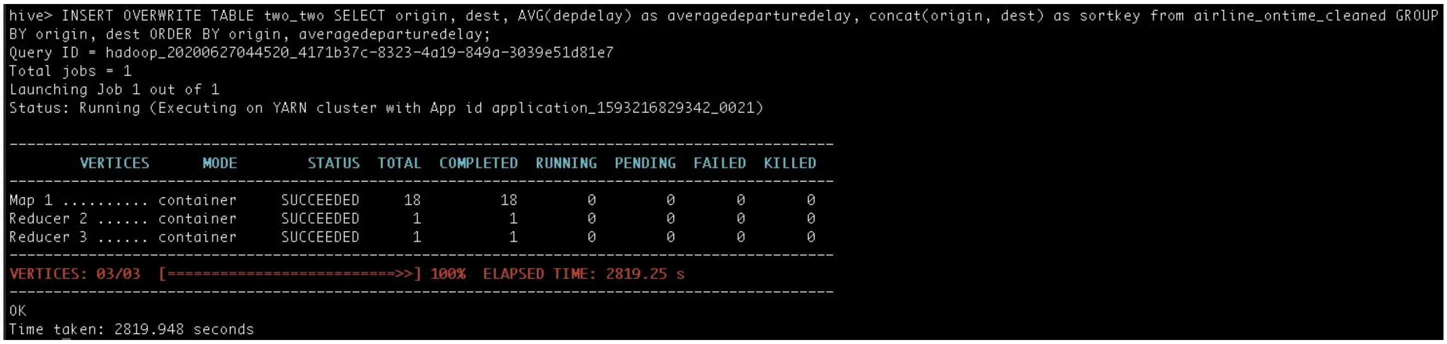
2.2) For each source airport X, rank the top-10 destination airports in decreasing order of on-time departure performance from X.

General Hive Query + Adding Data to DDB

- SELECT origin, dest, AVG(depdelay) as averagedeparturedelay, concat(origin, dest) as sortkey from airline_ontime_cleaned GROUP BY origin, dest ORDER BY origin, averagedeparturedelay;
- CREATE EXTERNAL TABLE two_two(origin STRING, dest STRING, averagedeparturedelay DOUBLE, sortkey STRING) STORED BY 'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler' TBLPROPERTIES ("dynamodb.table.name" = "two_two", "dynamodb.column.mapping" = "origin:origin,dest:dest,averagedeparturedelay:averagedeparturedelay,sortkey:sortkey");

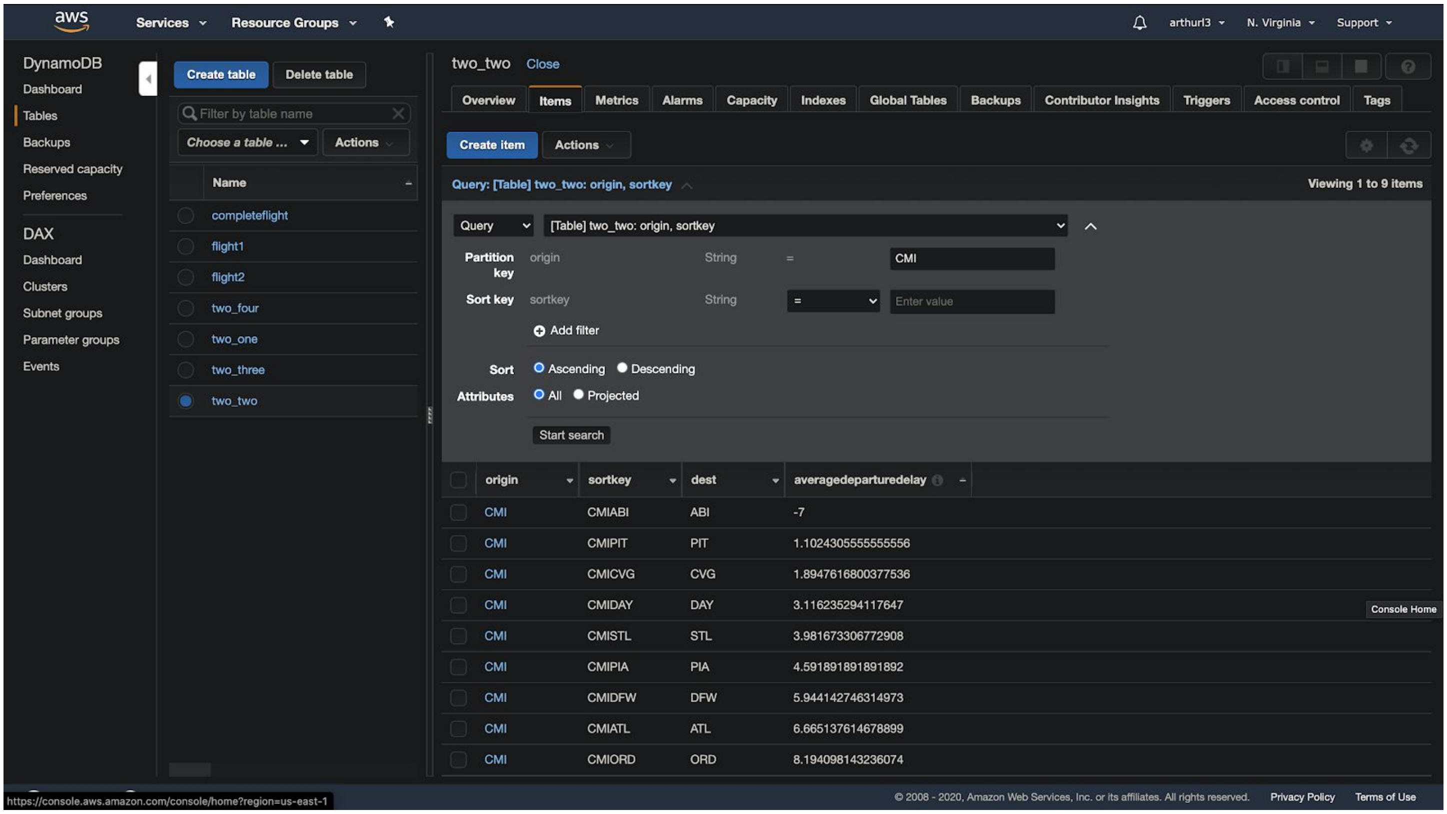
- INSERT OVERWRITE TABLE two_two SELECT origin, dest, AVG(depdelay) as averagedeparturedelay, concat(origin, dest) as sortkey from airline_ontime_cleaned GROUP BY origin, dest ORDER BY origin, averagedeparturedelay;

Hive Query to Import from S3 to DynamoDB



```
hive> INSERT OVERWRITE TABLE two_two SELECT origin, dest, AVG(depdelay) as averagedeparturedelay, concat(origin, dest) as sortkey from airline_ontime_cleaned GROUP
BY origin, dest ORDER BY origin, averagedeparturedelay;
Query ID = hadoop_20200627044520_4171b37c-8323-4a19-849a-3039e51d81e7
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593216829342_0021)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     18         18        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 2819.25 s
----------------------------------------------------------------------------------------------
OK
Time taken: 2819.948 seconds
```

Sample DynamoDB Query - CMI



Query: [Table] two_two: origin, sortkey

Viewing 1 to 9 items

Query | [Table] two_two: origin, sortkey

Partition key: origin String = CMI

Sort key: sortkey String = Enter value

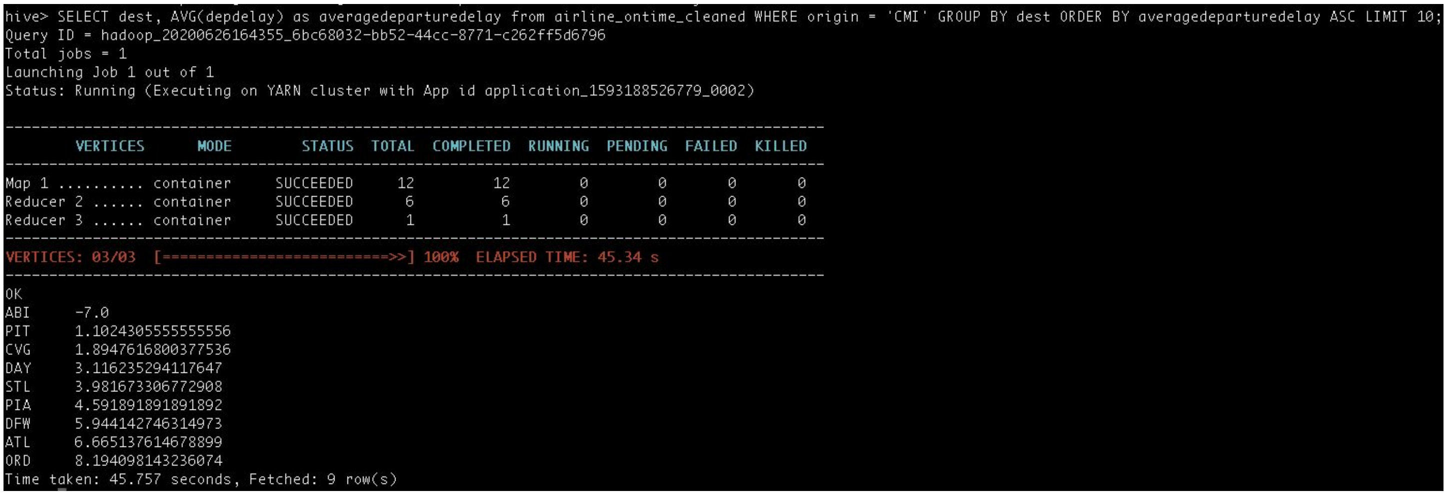
Sort: ● Ascending ○ Descending

Attributes: ● All ○ Projected

origin	sortkey	dest	averagedeparturedelay
CMI	CMIABI	ABI	-7
CMI	CMIPIT	PIT	1.1024305555555556
CMI	CMICVG	CVG	1.8947616800377536
CMI	CMIDAY	DAY	3.116235294117647
CMI	CMISTL	STL	3.981673306772908
CMI	CMIPIA	PIA	4.591891891891892
CMI	CMIDFW	DFW	5.944142746314973
CMI	CMIATL	ATL	6.665137614678899
CMI	CMIORD	ORD	8.194098143236074

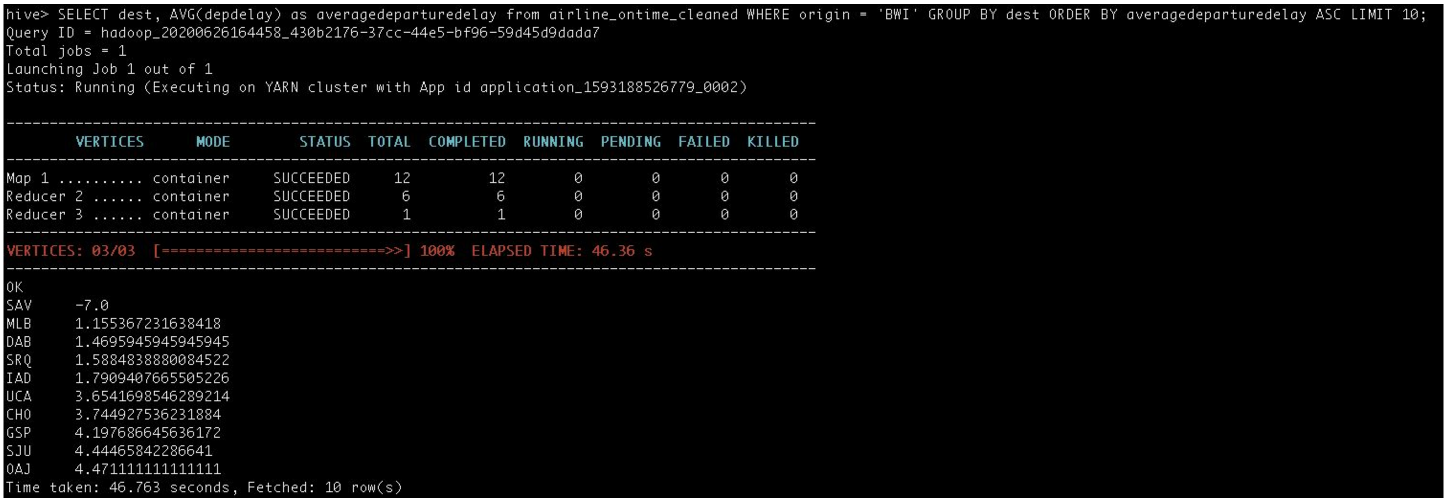
Targeted Queries (HIVE)

- CMI (University of Illinois Willard Airport)
    - SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'CMI' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;



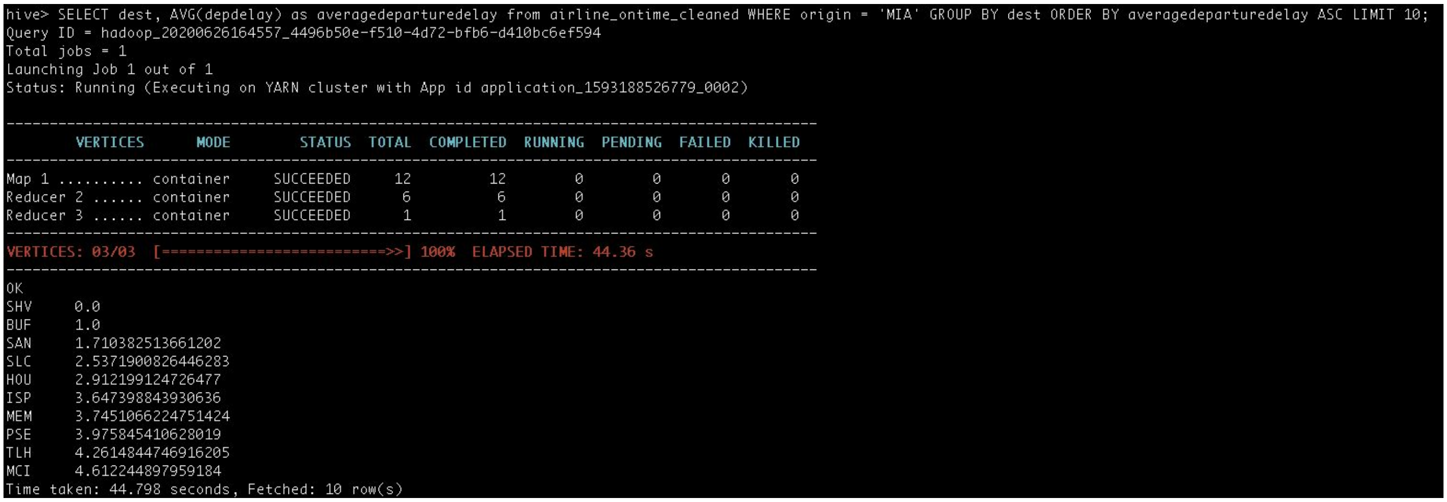
```
hive> SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'CMI' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626164355_6bc68032-bb52-44cc-8771-c262ff5d6796
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 45.34 s
----------------------------------------------------------------------------------------------
OK
ABI     -7.0
PIT     1.1024305555555556
CVG     1.8947616800377536
DAY     3.116235294117647
STL     3.981673306772908
PIA     4.591891891891892
DFW     5.944142746314973
ATL     6.665137614678899
ORD     8.194098143236074
Time taken: 45.757 seconds, Fetched: 9 row(s)
```

- BWI (Baltimore-Washington International Airport)
  - SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'BWI' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;



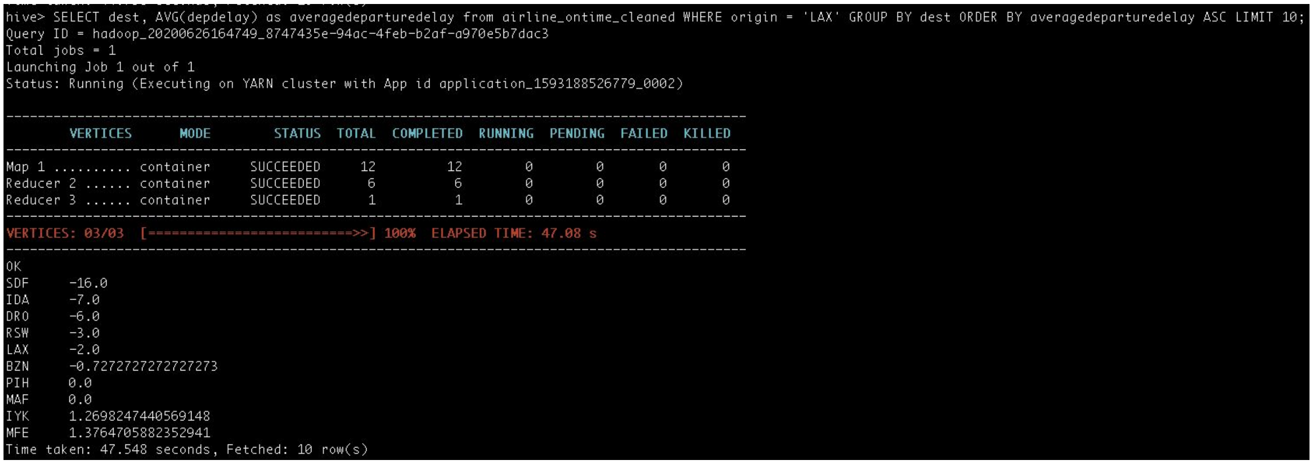
```
hive> SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'BWI' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626164458_430b2176-37cc-44e5-bf96-59d45d9dada7
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 46.36 s
----------------------------------------------------------------------------------------------
OK
SAV     -7.0
MLB     1.155367231638418
DAB     1.4695945945945945
SRQ     1.5884838880084522
IAD     1.7909407665505226
UCA     3.6541698546289214
CHO     3.744927536231884
GSP     4.197686645636172
SJU     4.44465842286641
OAJ     4.471111111111111
Time taken: 46.763 seconds, Fetched: 10 row(s)
```

- MIA (Miami International Airport)
  - SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'MIA' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;



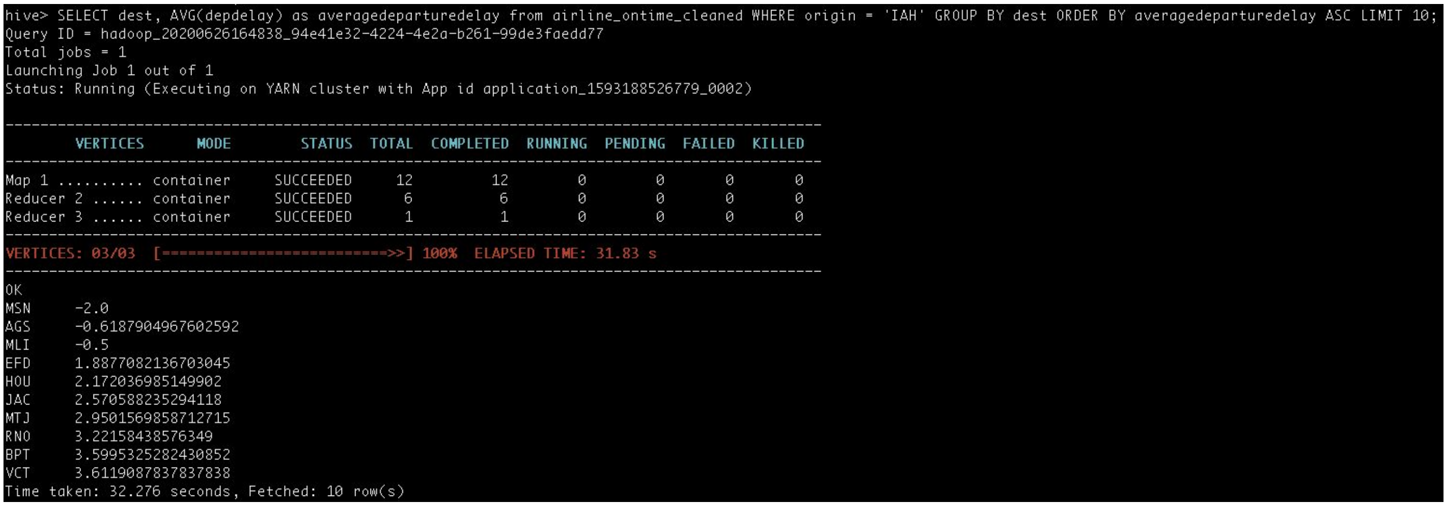
```
hive> SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'MIA' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626164557_4496b50e-f510-4d72-bfb6-d410bc6ef594
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 44.36 s
----------------------------------------------------------------------------------------------
OK
SHV     0.0
BUF     1.0
SAN     1.710382513661202
SLC     2.5371900826446283
HOU     2.912199124726477
ISP     3.647398843930636
MEM     3.7451066224751424
PSE     3.975845410628019
TLH     4.2614844746916205
MCI     4.612244897959184
Time taken: 44.798 seconds, Fetched: 10 row(s)
```

- LAX (Los Angeles International Airport)
    - SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'LAX' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;



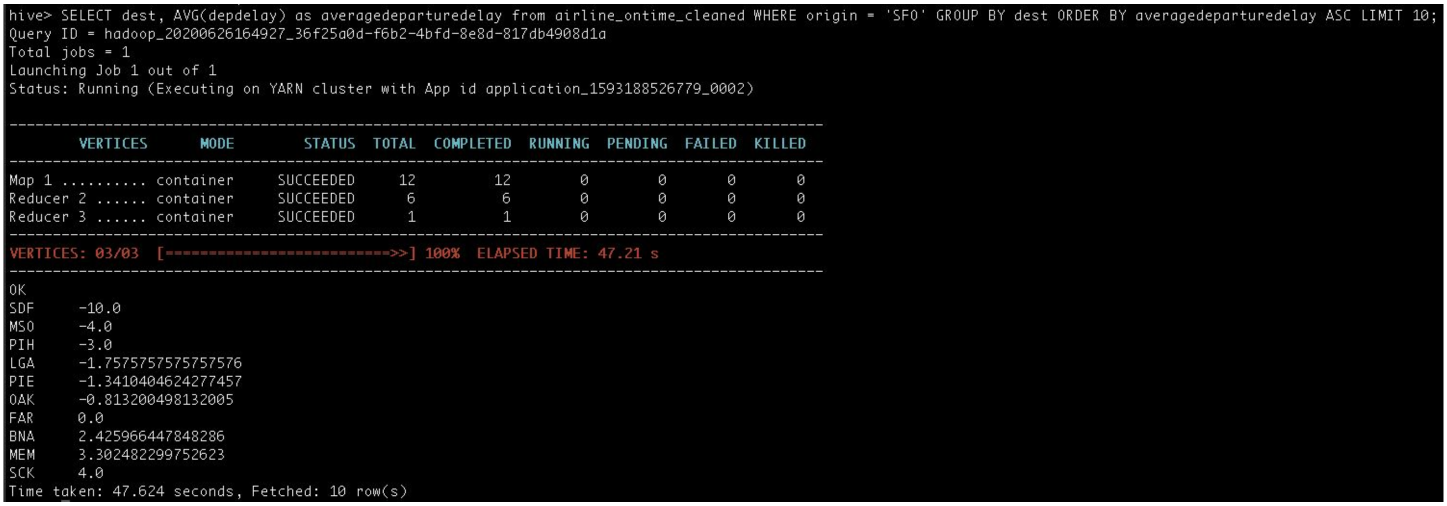
```
hive> SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'LAX' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626164749_8747435e-94ac-4feb-b2af-a970e5b7dac3
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 47.08 s
----------------------------------------------------------------------------------------------
OK
SDF     -16.0
IDA     -7.0
DRO     -6.0
RSW     -3.0
LAX     -2.0
BZN     -0.7272727272727273
PIH     0.0
MAF     0.0
IYK     1.2698247440569148
MFE     1.3764705882352941
Time taken: 47.548 seconds, Fetched: 10 row(s)
```

- IAH (George Bush Intercontinental Airport)
    - SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'IAH' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;



```
hive> SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'IAH' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626164838_94e41e32-4224-4e2a-b261-99de3faedd77
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 31.83 s
----------------------------------------------------------------------------------------------
OK
MSN     -2.0
AGS     -0.6187904967602592
MLI     -0.5
EFD     1.8877082136703045
HOU     2.172036985149902
JAC     2.570588235294118
MTJ     2.9501569858712715
RNO     3.22158438576349
BPT     3.5995325282430852
VCT     3.6119087837837838
Time taken: 32.276 seconds, Fetched: 10 row(s)
```

- SFO (San Francisco International Airport)
    - SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'SFO' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;



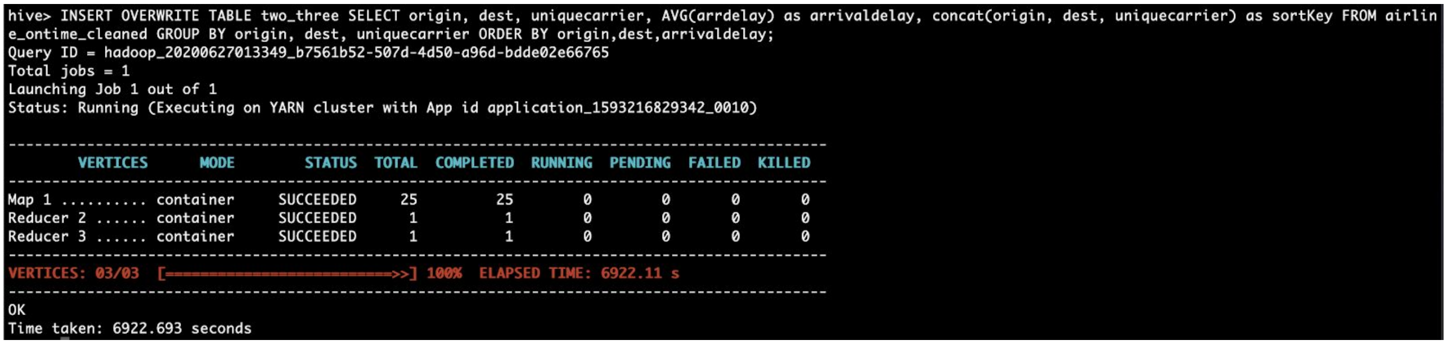
```
hive> SELECT dest, AVG(depdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'SFO' GROUP BY dest ORDER BY averagedeparturedelay ASC LIMIT 10;
Query ID = hadoop_20200626164927_36f25a0d-f6b2-4bfd-8e8d-817db4908d1a
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      6          6        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 47.21 s
----------------------------------------------------------------------------------------------
OK
SDF     -10.0
MSO     -4.0
PIH     -3.0
LGA     -1.7575757575757576
PIE     -1.3410404624277457
OAK     -0.813200498132005
FAR     0.0
BNA     2.425966447848286
MEM     3.302482299752623
SCK     4.0
Time taken: 47.624 seconds, Fetched: 10 row(s)
```

2.3) For each source-destination pair X-Y, rank the top-10 carriers in decreasing order of on-time arrival performance at Y from X

General Hive Query + Adding Data to DDB

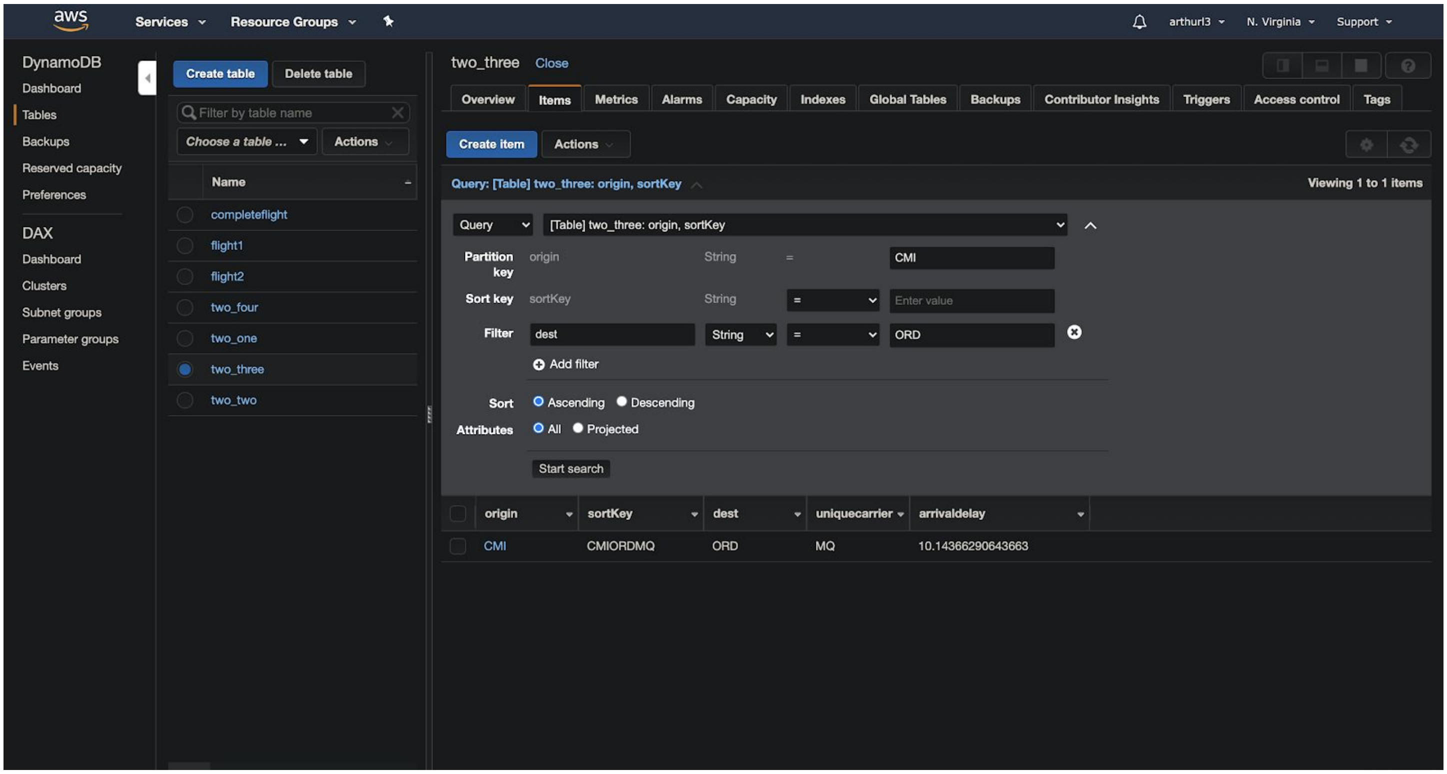
- SELECT origin, dest, uniquecarrier, AVG(arrdelay) as arrivaldelay from airline_ontime_cleaned GROUP BY origin, dest, uniquecarrier ORDER BY origin, dest, arrivaldelay;
- CREATE EXTERNAL TABLE two_three(origin STRING, dest STRING, uniquecarrier STRING, arrivaldelay DOUBLE, sortKey STRING) STORED BY 'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler' TBLPROPERTIES ("dynamodb.table.name" = "two_three", "dynamodb.column.mapping" = "origin:origin,dest:dest,uniquecarrier:uniquecarrier,arrivaldelay:arrivaldelay,sortKey:sortKey");
- INSERT OVERWRITE TABLE two_three SELECT origin, dest, uniquecarrier, AVG(arrdelay) as arrivaldelay, concat(origin, dest, uniquecarrier) as sortKey FROM airline_ontime_cleaned GROUP BY origin, dest, uniquecarrier ORDER BY origin,dest,arrivaldelay;

Hive Query to Import from S3 to DynamoDB



```
hive> INSERT OVERWRITE TABLE two_three SELECT origin, dest, uniquecarrier, AVG(arrdelay) as arrivaldelay, concat(origin, dest, uniquecarrier) as sortKey FROM airlin
e_ontime_cleaned GROUP BY origin, dest, uniquecarrier ORDER BY origin,dest,arrivaldelay;
Query ID = hadoop_20200627013349_b7561b52-507d-4d50-a96d-bdde02e66765
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593216829342_0010)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     25         25        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 6922.11 s
----------------------------------------------------------------------------------------------
OK
Time taken: 6922.693 seconds
```

Sample DynamoDB Query - CMI



Query: [Table] two_three: origin, sortKey

Viewing 1 to 1 items

Query [Table] two_three: origin, sortKey

Partition key origin String = CMI

Sort key sortKey String = Enter value

Filter dest String = ORD

Add filter

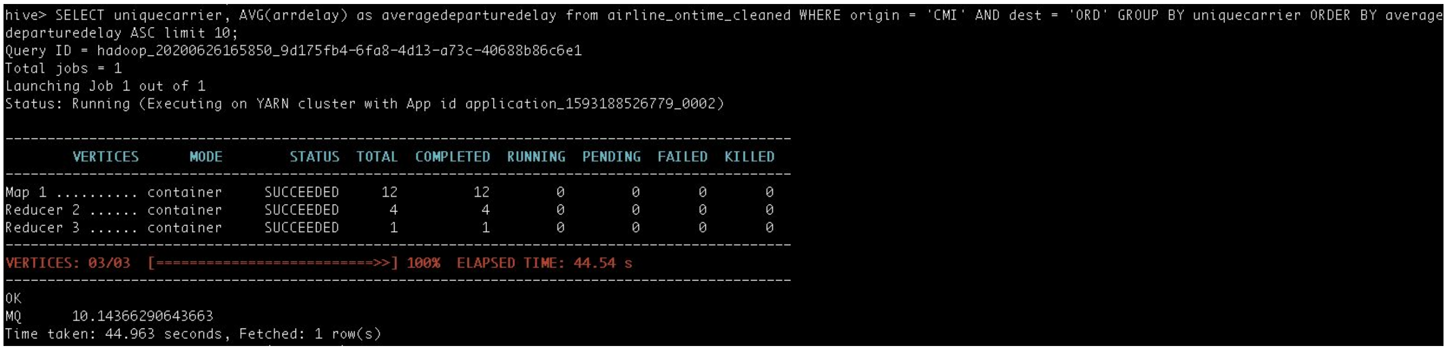
Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

origin	sortKey	dest	uniquecarrier	arrivaldelay
CMI	CMIORDMQ	ORD	MQ	10.14366290643663

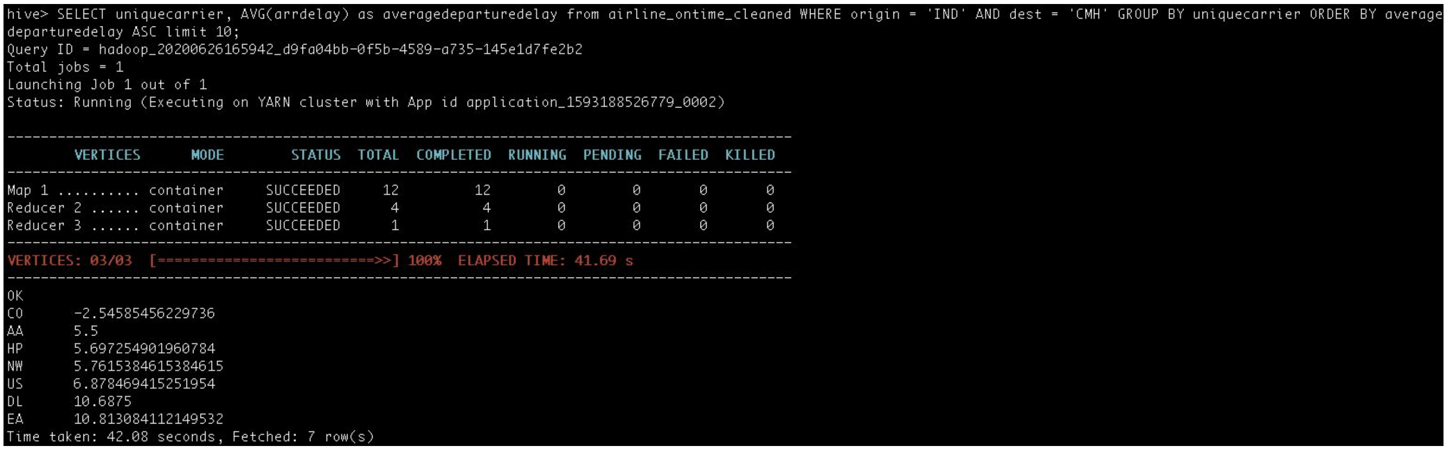
Targeted Queries (HIVE)

- CMI → ORD
  - SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'CMI' AND dest = 'ORD' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC limit 10;



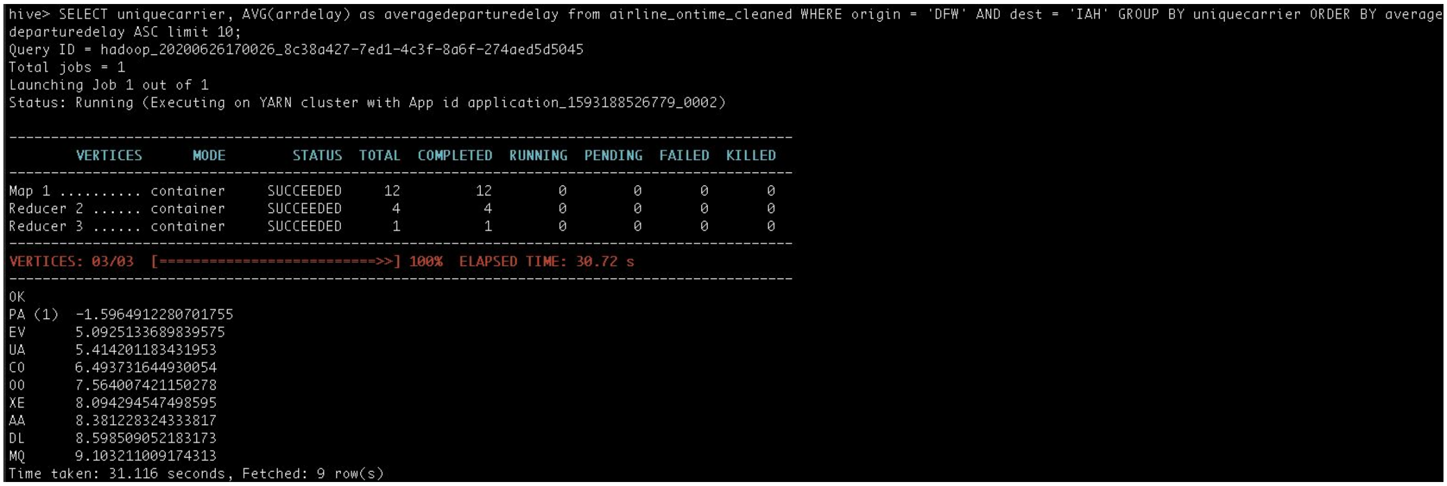
```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'CMI' AND dest = 'ORD' GROUP BY uniquecarrier ORDER BY average
departuredelay ASC limit 10;
Query ID = hadoop_20200626165850_9d175fb4-6fa8-4d13-a73c-40688b86c6e1
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      4          4        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 44.54 s
----------------------------------------------------------------------------------------------
OK
MQ      10.14366290643663
Time taken: 44.963 seconds, Fetched: 1 row(s)
```

- IND → CMH
  - SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'IND' AND dest = 'CMH' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC limit 10;



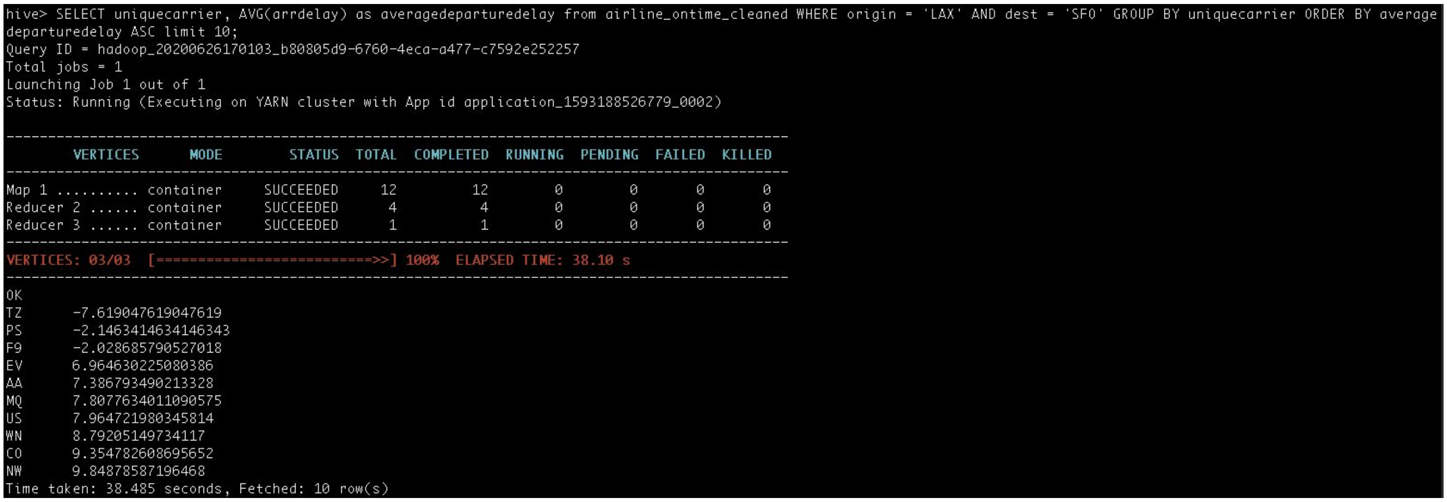
```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'IND' AND dest = 'CMH' GROUP BY uniquecarrier ORDER BY average
departuredelay ASC limit 10;
Query ID = hadoop_20200626165942_d9fa04bb-0f5b-4589-a735-145e1d7fe2b2
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      4          4        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 41.69 s
----------------------------------------------------------------------------------------------
OK
CO      -2.54585456229736
AA      5.5
HP      5.697254901960784
NW      5.7615384615384615
US      6.878469415251954
DL      10.6875
EA      10.813084112149532
Time taken: 42.08 seconds, Fetched: 7 row(s)
```

- DFW → IAH
  - SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'DFW' AND dest = 'IAH' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC limit 10;



```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'DFW' AND dest = 'IAH' GROUP BY uniquecarrier ORDER BY average
departuredelay ASC limit 10;
Query ID = hadoop_20200626170026_8c38a427-7ed1-4c3f-8a6f-274aed5d5045
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      4          4        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 30.72 s
----------------------------------------------------------------------------------------------
OK
PA (1)  -1.5964912280701755
EV      5.0925133689839575
UA      5.414201183431953
CO      6.493731644930054
OO      7.564007421150278
XE      8.094294547498595
AA      8.381228324333817
DL      8.598509052183173
MQ      9.103211009174313
Time taken: 31.116 seconds, Fetched: 9 row(s)
```

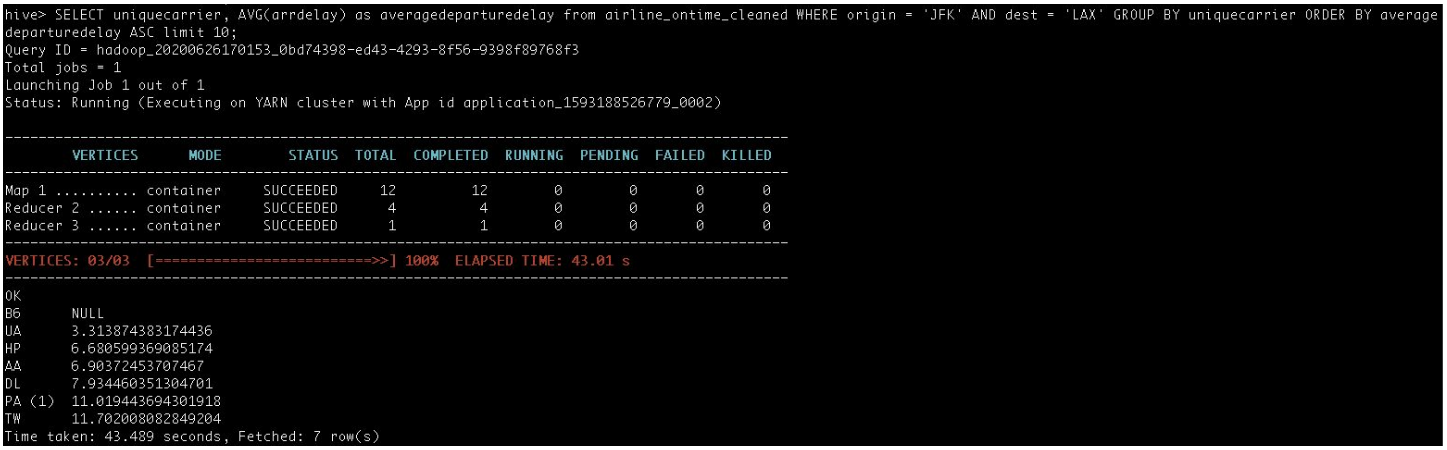
- LAX → SFO
  - SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'LAX' AND dest = 'SFO' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC limit 10;



```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'LAX' AND dest = 'SFO' GROUP BY uniquecarrier ORDER BY average
departuredelay ASC limit 10;
Query ID = hadoop_20200626170103_b80805d9-6760-4eca-a477-c7592e252257
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      4          4        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 38.10 s
----------------------------------------------------------------------------------------------
OK
TZ      -7.619047619047619
PS      -2.1463414634146343
F9      -2.028685790527018
EV      6.964630225080386
AA      7.386793490213328
MQ      7.8077634011090575
US      7.964721980345814
WN      8.79205149734117
CO      9.354782608695652
NW      9.84878587196468
Time taken: 38.485 seconds, Fetched: 10 row(s)
```

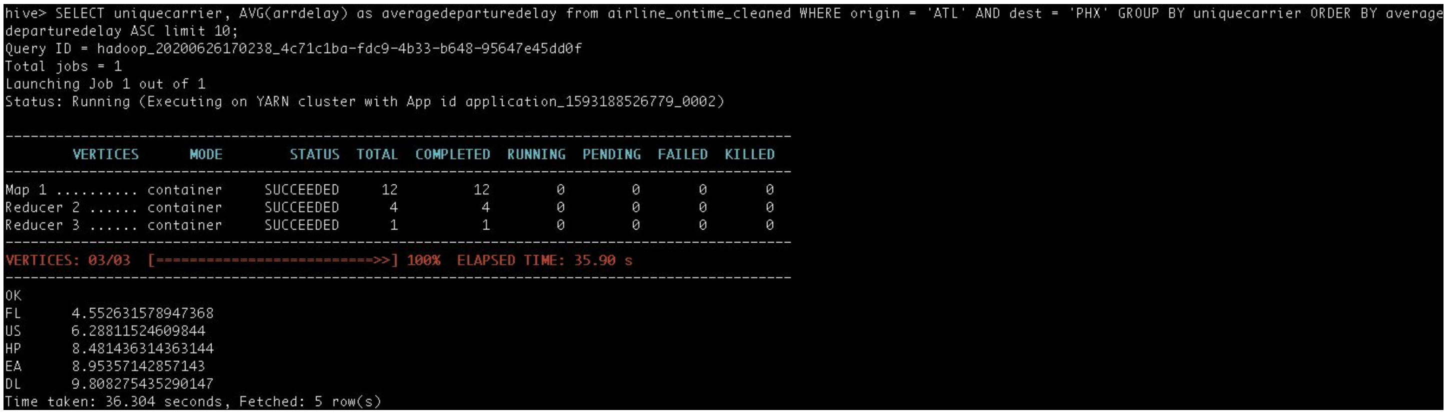
- JFK → LAX

    - SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'JFK' AND dest = 'LAX' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC limit 10;



```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'JFK' AND dest = 'LAX' GROUP BY uniquecarrier ORDER BY average
departuredelay ASC limit 10;
Query ID = hadoop_20200626170153_0bd74398-ed43-4293-8f56-9398f89768f3
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      4          4        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 43.01 s
----------------------------------------------------------------------------------------------
OK
B6      NULL
UA      3.313874383174436
HP      6.680599369085174
AA      6.90372453707467
DL      7.934460351304701
PA (1)  11.019443694301918
TW      11.702008082849204
Time taken: 43.489 seconds, Fetched: 7 row(s)
```

- ATL → PHX
    - SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'ATL' AND dest = 'PHX' GROUP BY uniquecarrier ORDER BY averagedeparturedelay ASC limit 10;

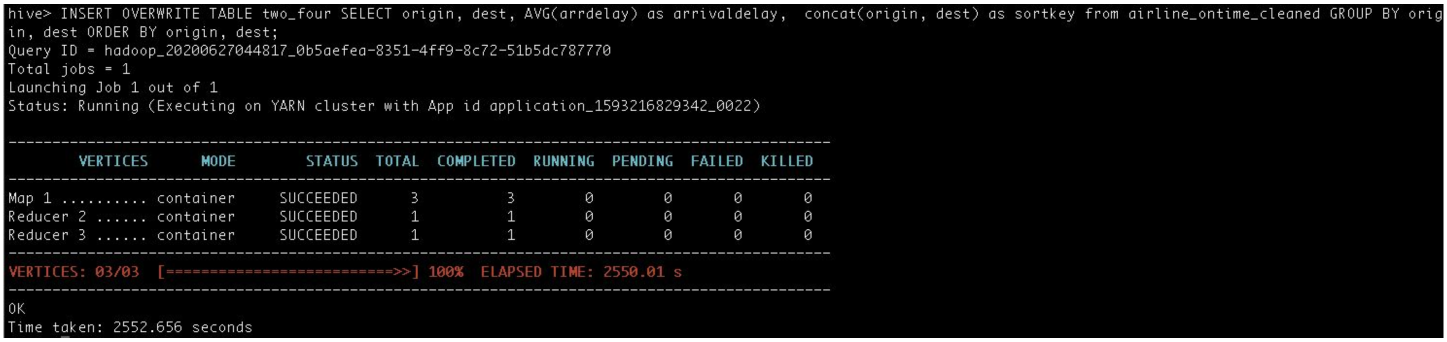


```
hive> SELECT uniquecarrier, AVG(arrdelay) as averagedeparturedelay from airline_ontime_cleaned WHERE origin = 'ATL' AND dest = 'PHX' GROUP BY uniquecarrier ORDER BY average
departuredelay ASC limit 10;
Query ID = hadoop_20200626170238_4c71c1ba-fdc9-4b33-b648-95647e45dd0f
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      4          4        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 35.90 s
----------------------------------------------------------------------------------------------
OK
FL      4.552631578947368
US      6.28811524609844
HP      8.481436314363144
EA      8.95357142857143
DL      9.808275435290147
Time taken: 36.304 seconds, Fetched: 5 row(s)
```

2.4) For each source-destination pair X-Y, determine the mean arrival delay (in minutes) for a flight from X to Y.
General Hive Query + Adding Data to DDB

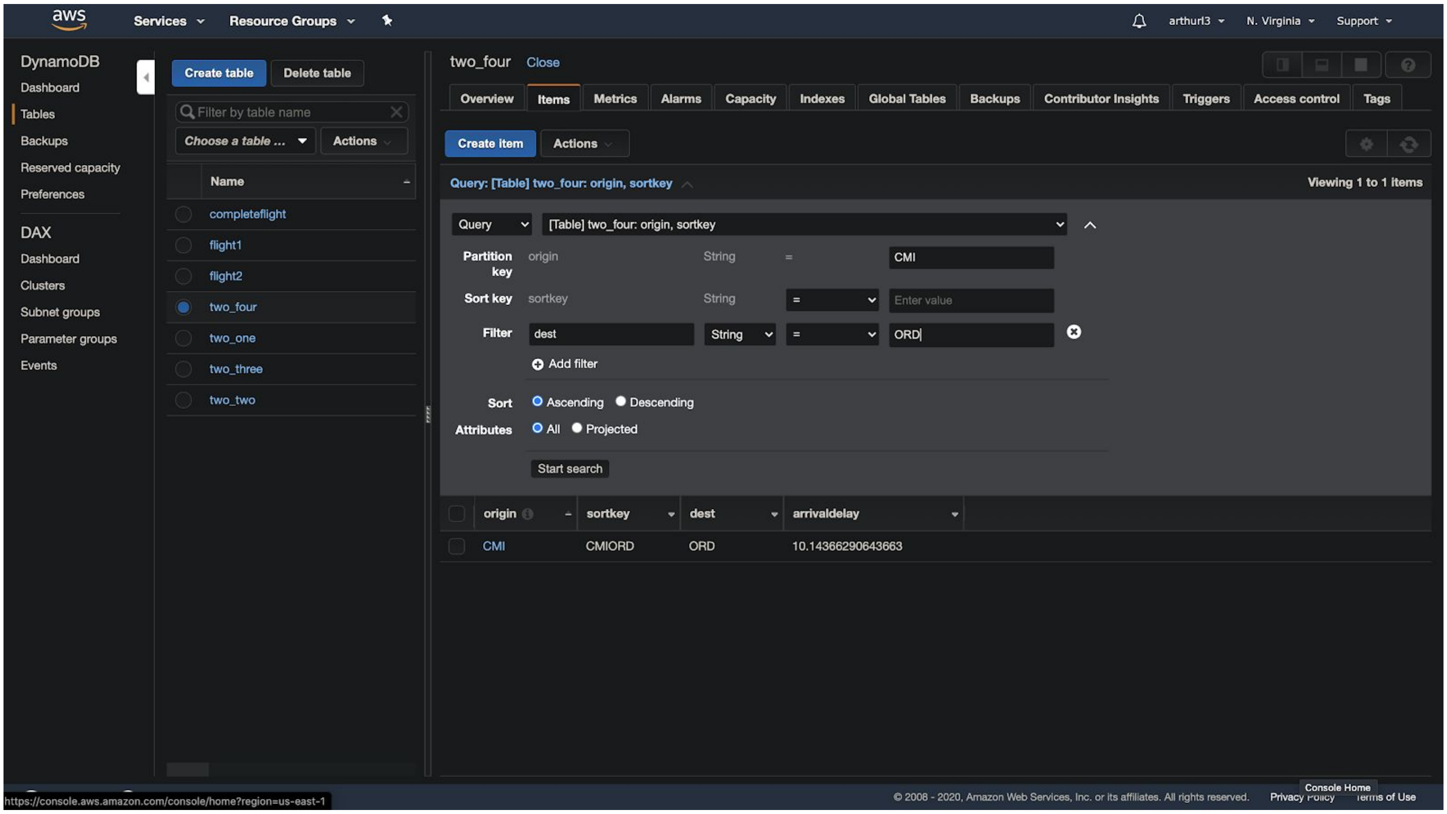
- SELECT origin, dest, AVG(arrdelay) as arrivaldelay from airline_ontime_cleaned GROUP BY origin, dest ORDER BY origin, dest;
- CREATE EXTERNAL TABLE two_four(origin STRING, dest STRING, arrivaldelay DOUBLE, sortkey STRING) STORED BY 'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler' TBLPROPERTIES ("dynamodb.table.name" = "two_four", "dynamodb.column.mapping" = "origin:origin,dest:dest,arrivaldelay:arrivaldelay,sortkey:sortkey");
- INSERT OVERWRITE TABLE two_four SELECT origin, dest, AVG(arrdelay) as arrivaldelay, concat(origin, dest) as sortkey from airline_ontime_cleaned GROUP BY origin, dest ORDER BY origin, dest;

Hive Query to Import from S3 to DynamoDB



```
hive> INSERT OVERWRITE TABLE two_four SELECT origin, dest, AVG(arrdelay) as arrivaldelay,  concat(origin, dest) as sortkey from airline_ontime_cleaned GROUP BY orig
in, dest ORDER BY origin, dest;
Query ID = hadoop_20200627044817_0b5aefea-8351-4ff9-8c72-51b5dc787770
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593216829342_0022)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED      3          3        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
Reducer 3 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 03/03  [==========================>>] 100%  ELAPSED TIME: 2550.01 s
----------------------------------------------------------------------------------------------
OK
Time taken: 2552.656 seconds
```

Sample DynamoDB Query - CMI



Query: [Table] two_four: origin, sortkey

Query | [Table] two_four: origin, sortkey

Partition key: origin String = CMI

Sort key: sortkey String = Enter value

Filter: dest String = ORD

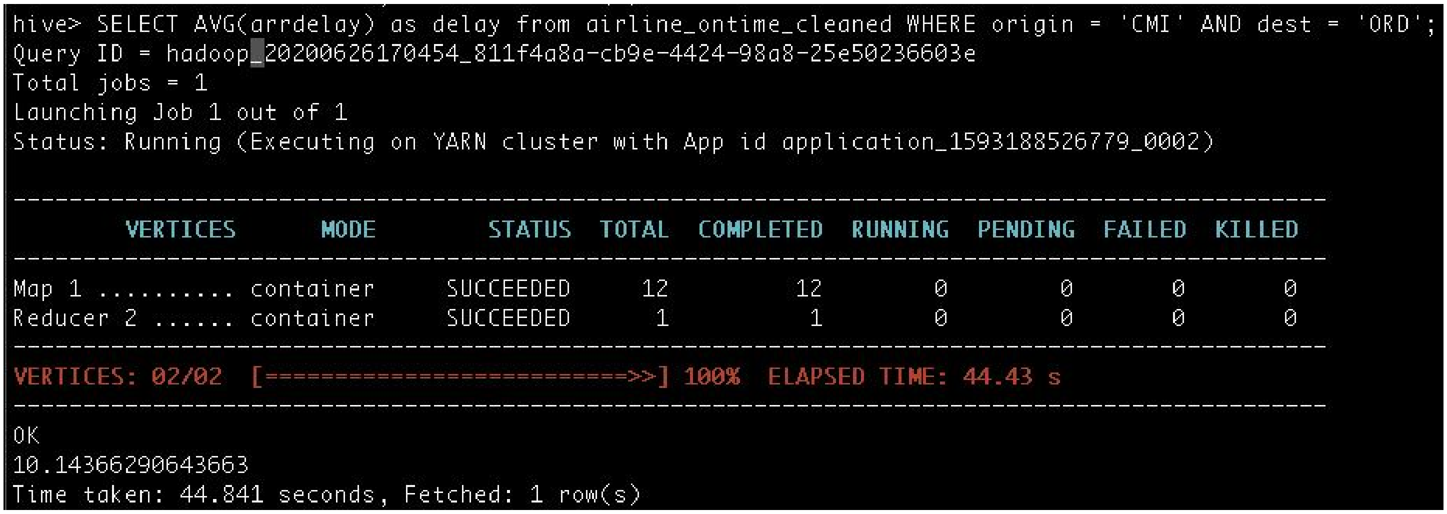
Sort: ● Ascending ○ Descending

Attributes: ● All ○ Projected

origin	sortkey	dest	arrivaldelay
CMI	CMIORD	ORD	10.14366290643663

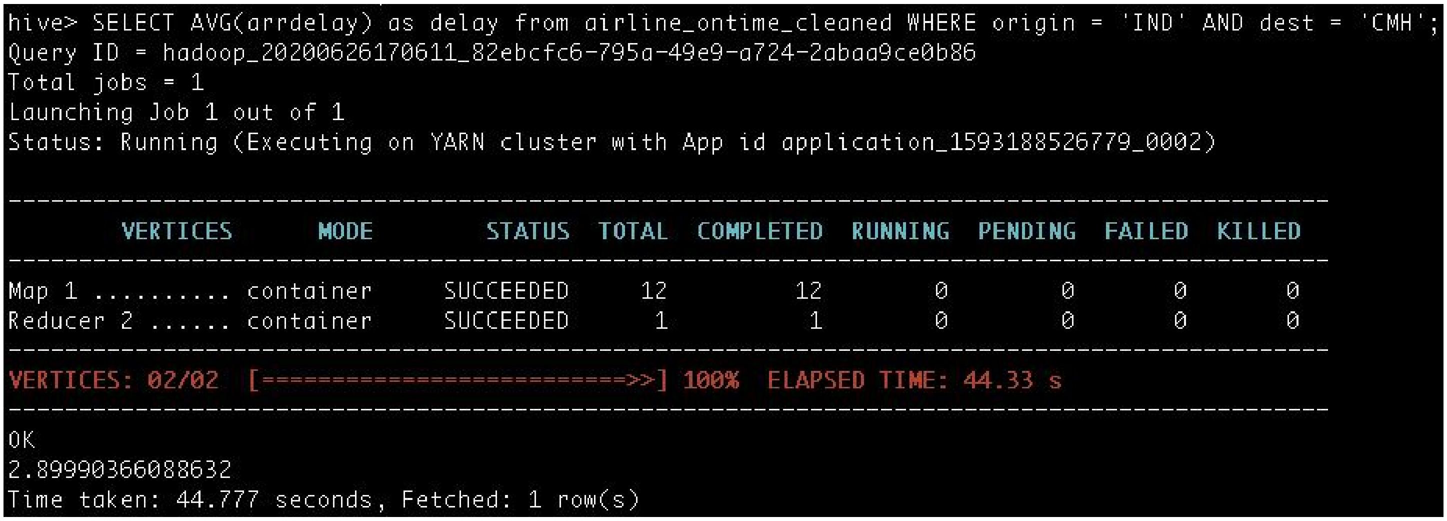
Targeted Queries (HIVE)

- CMI → ORD: 10.14
  - SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'CMI' AND dest = 'ORD';



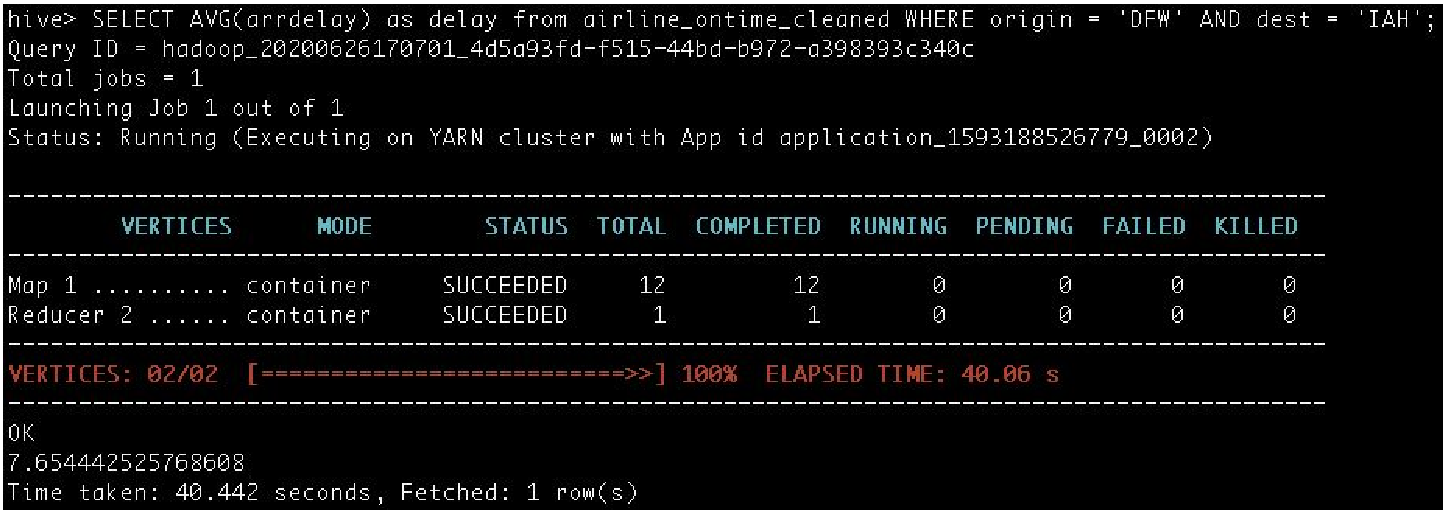
```
hive> SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'CMI' AND dest = 'ORD';
Query ID = hadoop_20200626170454_811f4a8a-cb9e-4424-98a8-25e50236603e
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 02/02  [==========================>>] 100%  ELAPSED TIME: 44.43 s
--------------------------------------------------------------------------------
OK
10.14366290643663
Time taken: 44.841 seconds, Fetched: 1 row(s)
```

- IND → CMH: 2.90
    - SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'IND' AND dest = 'CMH';



```
hive> SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'IND' AND dest = 'CMH';
Query ID = hadoop_20200626170611_82ebcfc6-795a-49e9-a724-2abaa9ce0b86
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 02/02  [==========================>>] 100%  ELAPSED TIME: 44.33 s
--------------------------------------------------------------------------------
OK
2.89990366088632
Time taken: 44.777 seconds, Fetched: 1 row(s)
```

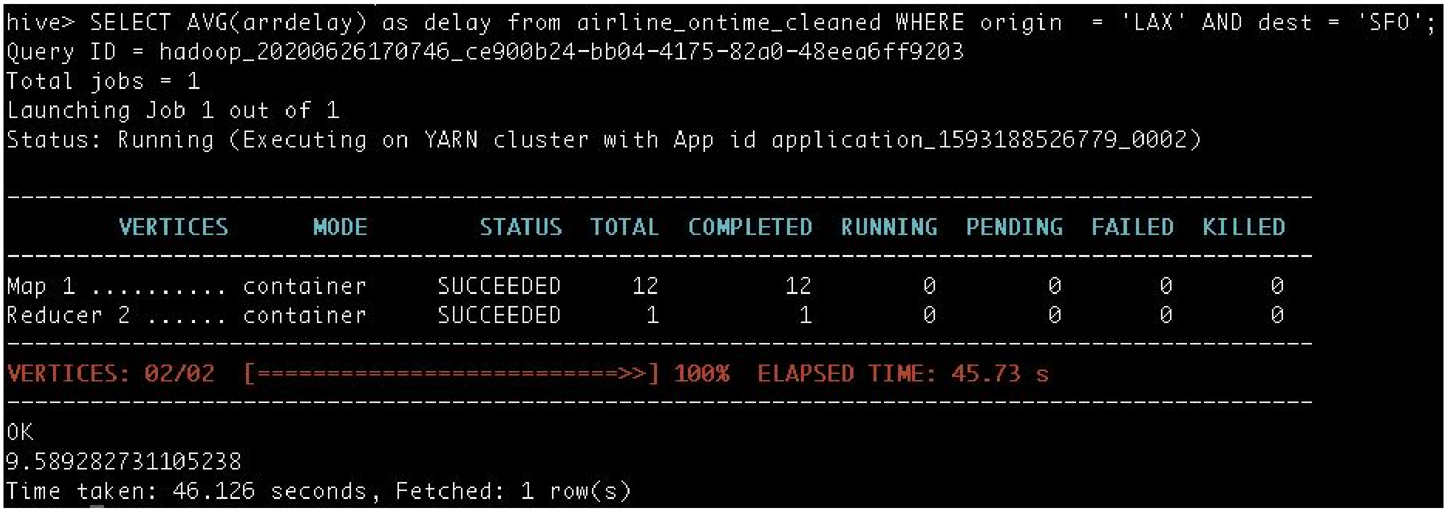
- DFW → IAH: 7.65
    - SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'DFW' AND dest = 'IAH';



```
hive> SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'DFW' AND dest = 'IAH';
Query ID = hadoop_20200626170701_4d5a93fd-f515-44bd-b972-a398393c340c
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

--------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
--------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
--------------------------------------------------------------------------------
VERTICES: 02/02  [==========================>>] 100%  ELAPSED TIME: 40.06 s
--------------------------------------------------------------------------------
OK
7.654442525768608
Time taken: 40.442 seconds, Fetched: 1 row(s)
```

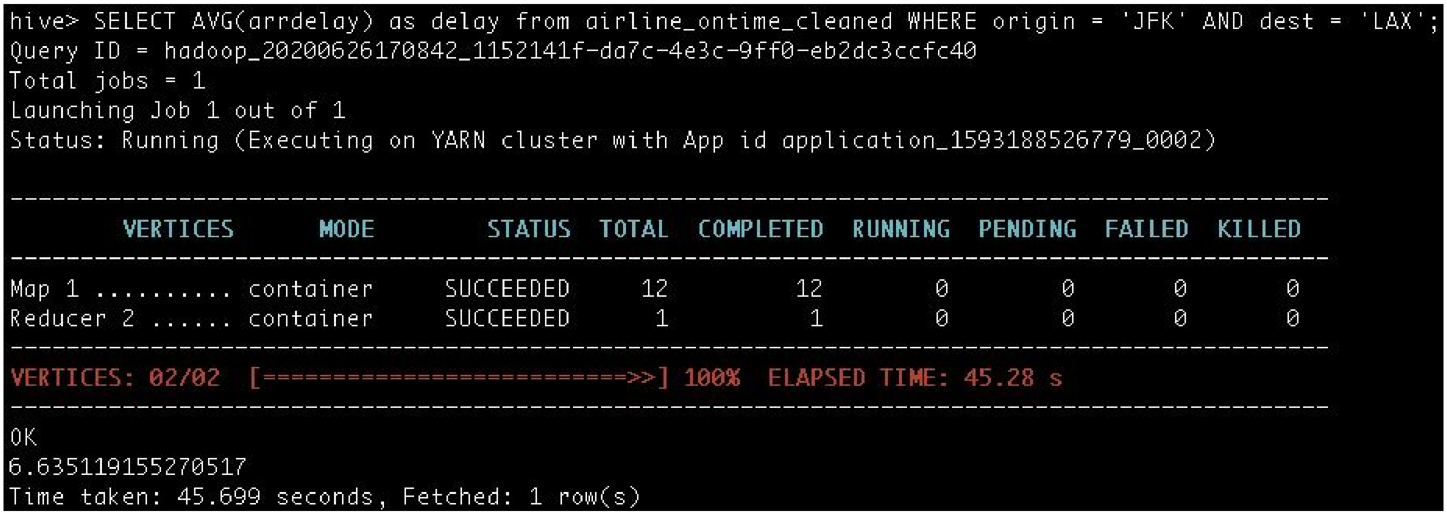
- LAX → SFO: 9.59

  - SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'LAX' AND dest = 'SFO';



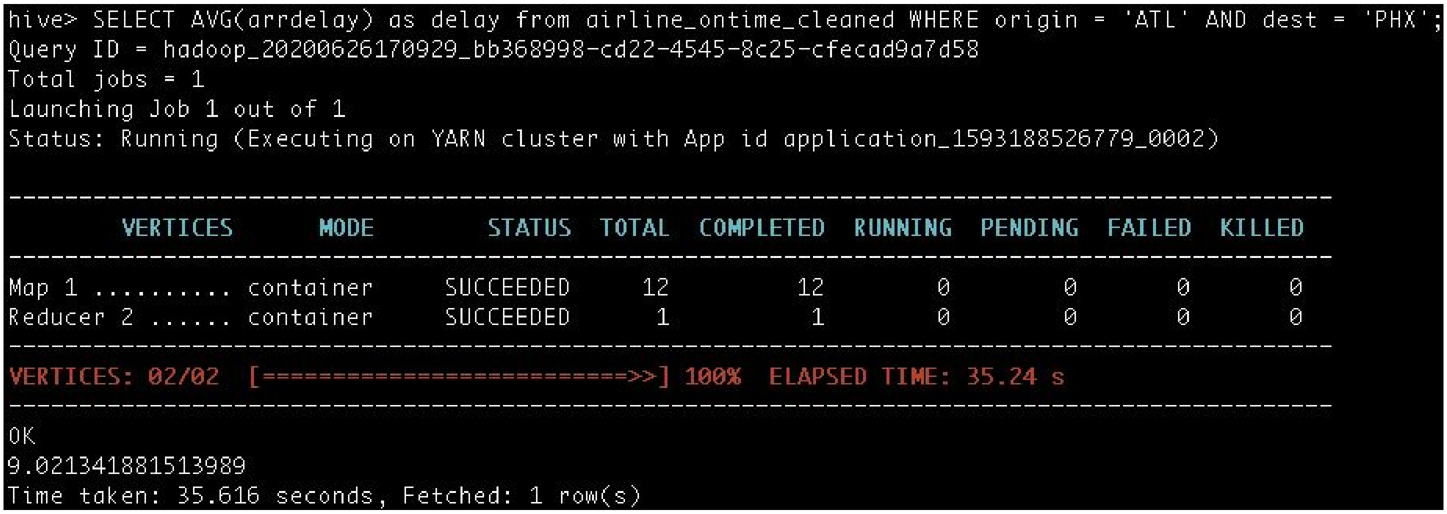
```
hive> SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin  = 'LAX' AND dest = 'SFO';
Query ID = hadoop_20200626170746_ce900b24-bb04-4175-82a0-48eea6ff9203
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 02/02  [==========================>>] 100%  ELAPSED TIME: 45.73 s
----------------------------------------------------------------------------------------------
OK
9.589282731105238
Time taken: 46.126 seconds, Fetched: 1 row(s)
```

- JFK → LAX: 6.64
  - SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'JFK' AND dest = 'LAX';



```
hive> SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'JFK' AND dest = 'LAX';
Query ID = hadoop_20200626170842_1152141f-da7c-4e3c-9ff0-eb2dc3ccfc40
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 .......... container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ...... container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 02/02  [==========================>>] 100%  ELAPSED TIME: 45.28 s
----------------------------------------------------------------------------------------------
OK
6.635119155270517
Time taken: 45.699 seconds, Fetched: 1 row(s)
```

- ATL → PHX: 9.02
  - SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'ATL' AND dest = 'PHX';



```
hive> SELECT AVG(arrdelay) as delay from airline_ontime_cleaned WHERE origin = 'ATL' AND dest = 'PHX';
Query ID = hadoop_20200626170929_bb368998-cd22-4545-8c25-cfecad9a7d58
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1593188526779_0002)

----------------------------------------------------------------------------------------------
        VERTICES      MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
----------------------------------------------------------------------------------------------
Map 1 ..........  container     SUCCEEDED     12         12        0        0       0       0
Reducer 2 ......  container     SUCCEEDED      1          1        0        0       0       0
----------------------------------------------------------------------------------------------
VERTICES: 02/02  [==========================>>] 100%  ELAPSED TIME: 35.24 s
----------------------------------------------------------------------------------------------
OK
9.021341881513989
Time taken: 35.616 seconds, Fetched: 1 row(s)
```

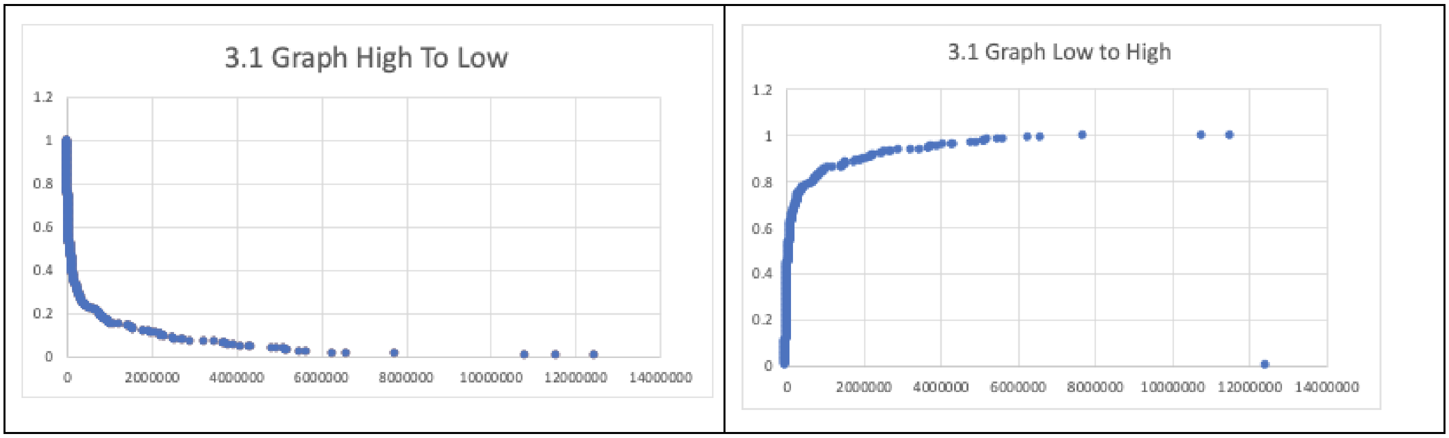
Group 3

3.1) Does the popularity distribution of airports follow a Zipf distribution? If not, what distribution does it follow?

Export to S3 as a CSV File

- CREATE EXTERNAL TABLE threeCSV(airport STRING,popularity BIGINT) row format delimited fields terminated by ',' lines terminated by '\n' STORED AS TEXTFILE LOCATION 's3n://cs598-testing/export/';
- INSERT OVERWRITE TABLE threeCSV SELECT o.origin as airport, o.flightnum + d.flightnum as popularity FROM (SELECT origin, count(origin) as flightnum FROM airline_ontime_cleaned group by origin) as o, (select dest, count(dest) as flightnum FROM airline_ontime_cleaned group by dest) as d WHERE o.origin = d.dest ORDER BY popularity DESC;

No, when plotting the result of the above query, we can see the overall shape follows a log-normal distribution, and not more of a straight line, which a power-law (Zipfian) distribution would be more similar to. In the attached images, we have the frequency distribution on the y-axis and the popularity on the x-axis. One was plotted with popularity from highest to lowest while the other is plotted from lowest to highest. The chart is similar to the provided example solution in the curvature and distribution, but different in how the scatter plot was created.



3.2) Queries provided first. Results, images of results, and analysis provided after.
Hive Table Setup

- SELECT origin, dest,flightnum,flightdate, deptime, arrdelay + depdelay as delay, uniquecarrier from airline_ontime_cleaned WHERE deptime < "1200" and flightdate like '2008-%';
    - CREATE EXTERNAL TABLE temp_export(origin STRING, dest STRING,flightnum BIGINT, flightdate STRING, deptime STRING, delay DOUBLE, uniquecarrier STRING, sortkey STRING);
    - INSERT OVERWRITE TABLE temp_export SELECT origin, dest,flightnum,flightdate, deptime, arrdelay + depdelay as delay, uniquecarrier, concat(origin, "_", dest, "_", flightdate, "_", uniquecarrier, "_", flightnum) as sortkey from airline_ontime_cleaned WHERE deptime < "1200" and flightdate like '2008-%';
- SELECT origin, dest,flightnum,flightdate, deptime, arrdelay + depdelay as delay, uniquecarrier from airline_ontime_cleaned WHERE deptime < "1200" and flightdate like '2008-%';
    - CREATE EXTERNAL TABLE temp_export2(origin STRING, dest STRING,flightnum BIGINT, flightdate STRING, deptime STRING, delay DOUBLE, uniquecarrier STRING, sortkey STRING);
    - INSERT OVERWRITE TABLE temp_export2 SELECT origin, dest,flightnum,flightdate, deptime, arrdelay + depdelay as delay, uniquecarrier, concat(origin, "_", dest, "_", flightdate, "_", uniquecarrier, "_", flightnum) as sortkey from airline_ontime_cleaned WHERE deptime > "1200" and flightdate like '2008-%';
- SELECT concat(flight1.origin, "_", flight1.dest, "_", flight2.dest) as route, flight1.flightdate as depdate, concat(flight1.uniquecarrier, flight1.flightnum) as firstflight, concat(flight2.uniquecarrier, flight2.flightnum) as secondflight, flight1.delay + flight2.delay as delay, ROW_NUMBER() over (partition by flight1.origin, flight1.dest, flight2.dest, flight1.flightdate order by flight1.delay + flight2.delay asc) as rank FROM flight1, flight2 WHERE flight1.dest = flight2.origin and flight2.flightdate = date_add(flight1.flightdate, 2);
    - CREATE EXTERNAL TABLE temp_complete(route STRING, origin STRING, layover STRING, dest STRING, depdate STRING, deptime STRING, firstflight STRING, second_depdate STRING, second_deptime STRING, secondflight STRING, first_delay STRING, second_delay STRING, total_delay DOUBLE, rank DOUBLE);
    - INSERT OVERWRITE TABLE temp_complete SELECT concat(temp_export.origin, "_", temp_export.dest, "_", temp_export2.dest) as route, temp_export.origin as origin, temp_export.dest as layover, temp_export2.dest as dest, temp_export.flightdate as depdate, temp_export.deptime as deptime, concat(temp_export.uniquecarrier, temp_export.flightnum) as firstflight, concat(temp_export2.uniquecarrier, temp_export2.flightnum) as secondflight, temp_export2.flightdate as second_depdate, temp_export2.deptime as second_deptime, temp_export.delay as first_delay, temp_export2.delay as second_delay, temp_export.delay + temp_export2.delay as total_delay, ROW_NUMBER() over (partition by temp_export.origin, temp_export.dest,temp_export2.dest, temp_export.flightdate order by temp_export.delay + temp_export.delay asc) as rank FROM temp_export, temp_export2 WHERE temp_export.dest = temp_export2.origin and temp_export2.flightdate = date_add(temp_export.flightdate, 2);

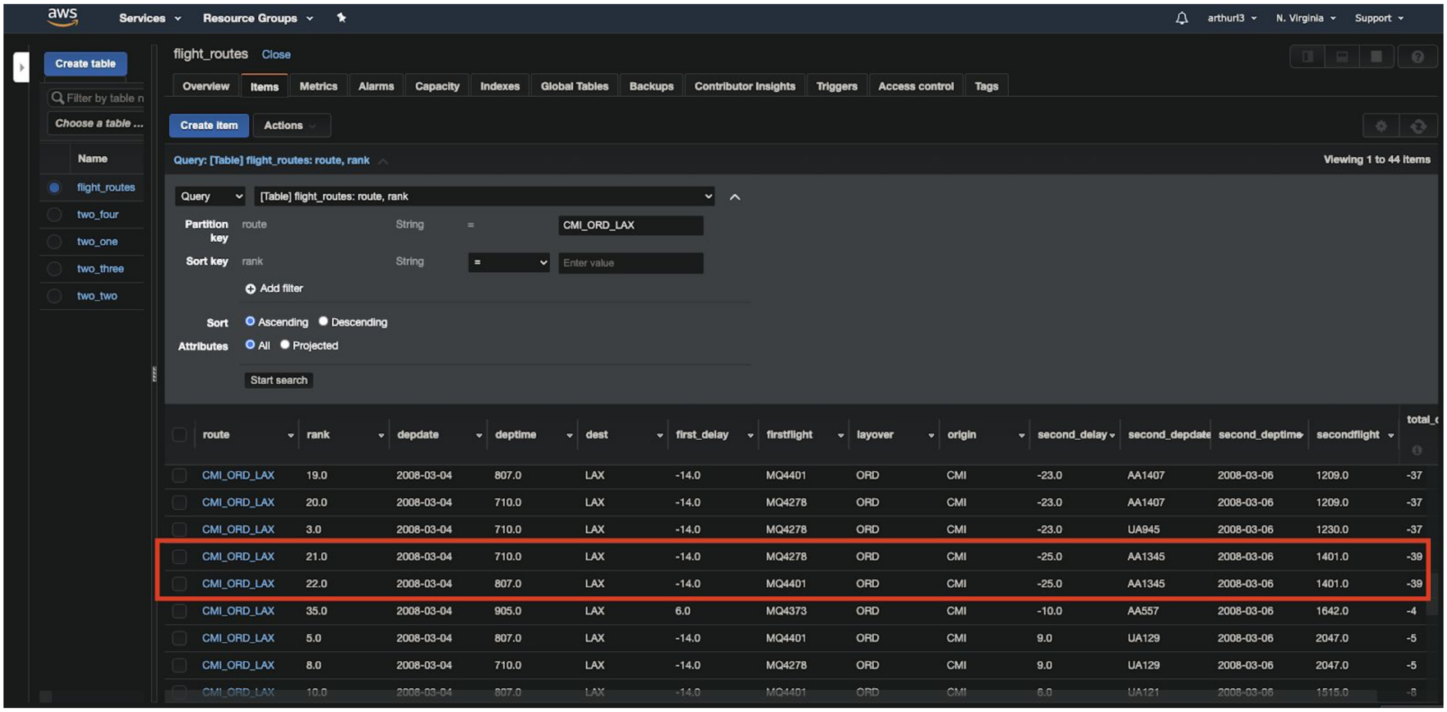
  - Note:; MRJ finished in 40m
- Generate Hive Tables to store results
  - CREATE EXTERNAL TABLE temp_complete(route STRING, origin STRING, layover STRING, dest STRING, depdate STRING, deptime STRING, firstflight STRING, second_depdate STRING, second_deptime STRING, secondflight STRING, first_delay STRING, second_delay STRING, total_delay DOUBLE, rank DOUBLE);
    - For all rows
  - CREATE EXTERNAL TABLE small_temp_complete(route STRING, origin STRING, layover STRING, dest STRING, depdate STRING, deptime STRING, firstflight STRING, second_depdate STRING, second_deptime STRING, secondflight STRING, first_delay STRING, second_delay STRING, total_delay DOUBLE, rank DOUBLE);
    - For rows to be imported into DynamoDB
- Queries for Hive Queries + Insert into DynamoDB
  - SELECT * FROM temp_complete WHERE origin = "CMI" AND layover = 'ORD' AND dest = 'LAX' AND depdate like '2008-03-04';
    - INSERT INTO TABLE small_temp_complete SELECT * FROM temp_complete WHERE origin = "CMI" AND layover = 'ORD' AND dest = 'LAX' AND depdate like '2008-03-04';
    - Route: CMI_ORD_LAX
  - SELECT * FROM temp_complete WHERE origin = "JAX" AND layover = 'DFW' AND dest = 'CRP' AND depdate like '2008-09-09';
    - INSERT INTO TABLE small_temp_complete SELECT * FROM temp_complete WHERE origin = "JAX" AND layover = 'DFW' AND dest = 'CRP' AND depdate like '2008-09-09';
    - JAX_DFE_CRP
  - SELECT * FROM temp_complete WHERE origin = "SLC" AND layover = 'BFL' AND dest = 'LAX' AND depdate like '2008-04-01';
    - INSERT INTO TABLE small_temp_complete SELECT * FROM temp_complete WHERE origin = "SLC" AND layover = 'BFL' AND dest = 'LAX' AND depdate like '2008-04-01';
    - SLC_BFL_LAX
  - SELECT * FROM temp_complete WHERE origin = "LAX" AND layover = 'SFO' AND dest = 'PHX' AND depdate like '2008-07-12';
    - INSERT INTO TABLE small_temp_complete SELECT * FROM temp_complete WHERE origin = "LAX" AND layover = 'SFO' AND dest = 'PHX' AND depdate like '2008-07-12';
    - LAX_SFO_PHX
  - SELECT * FROM temp_complete WHERE origin = "DFW" AND layover = 'ORD' AND dest = 'DFW' AND depdate like '2008-06-10';
    - INSERT INTO TABLE small_temp_complete SELECT * FROM temp_complete WHERE origin = "DFW" AND layover = 'ORD' AND dest = 'DFW' AND depdate like '2008-06-10';
    - DFW_ORD_DFW
  - SELECT * FROM temp_complete WHERE origin = "LAX" AND layover = 'ORD' AND dest = 'JFK' AND depdate like '2008-01-01';

        - INSERT INTO TABLE small_temp_complete SELECT * FROM temp_complete WHERE origin = "LAX" AND layover = 'ORD' AND dest = 'JFK' AND depdate like '2008-01-01';
        - LAX_ORD_JFK
- CREATE EXTERNAL TABLE flight_routes(route STRING, origin STRING, layover STRING, dest STRING, depdate STRING, deptime STRING, firstflight STRING, second_depdate STRING, second_deptime STRING, secondflight STRING, first_delay STRING, second_delay STRING, total_delay DOUBLE, rank STRING) STORED BY 'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler' TBLPROPERTIES ("dynamodb.table.name" = "flight_routes", "dynamodb.column.mapping" = "route:route,origin:origin,layover:layover,dest:dest,depdate:depdate,deptime:deptime,firstflight:firstflight,second_depdate:second_depdate,second_deptime:second_deptime,secondflight:secondflight,first_delay:first_delay,second_delay:second_delay,total_delay:total_delay,rank:rank");
- INSERT INTO TABLE flight_routes SELECT * from small_temp_complete;
    - DDB - Imports records for the 6 queries
    - INSERT OVERWRITE TABLE flight_routes SELECT * from small_temp_complete;

3.2 Results.

* I factored in departure and arrival delay, not just arrival delay. So in the case of query 5, the optimal flight found was not the same as the one provided in the query solutions, although they were very close in total delay. Optimal flights are boxed in red; total_delay is the name of the last column (it's cut off in the images).

7. CMI → ORD → LAX, 04/03/2008



Query: [Table] flight_routes: route, rank

Viewing 1 to 44 items

Query | [Table] flight_routes: route, rank

Partition key route String = CMI_ORD_LAX

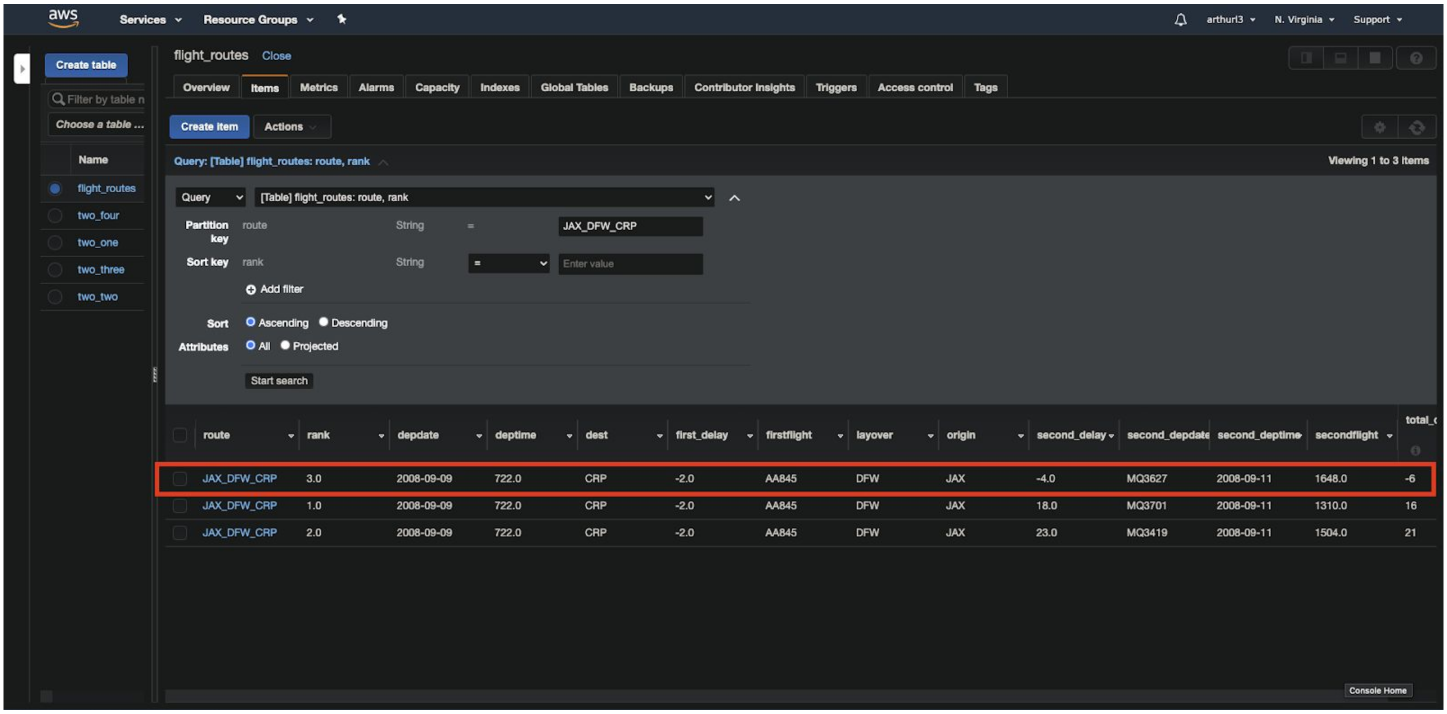
Sort key rank String = Enter value

Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

route	rank	depdate	deptime	dest	first_delay	firstflight	layover	origin	second_delay	second_depdate	second_deptime	secondflight	total_
CMI_ORD_LAX	19.0	2008-03-04	807.0	LAX	-14.0	MQ4401	ORD	CMI	-23.0	AA1407	2008-03-06	1209.0	-37
CMI_ORD_LAX	20.0	2008-03-04	710.0	LAX	-14.0	MQ4278	ORD	CMI	-23.0	AA1407	2008-03-06	1209.0	-37
CMI_ORD_LAX	3.0	2008-03-04	710.0	LAX	-14.0	MQ4278	ORD	CMI	-23.0	UA945	2008-03-06	1230.0	-37
CMI_ORD_LAX	21.0	2008-03-04	710.0	LAX	-14.0	MQ4278	ORD	CMI	-25.0	AA1345	2008-03-06	1401.0	-39
CMI_ORD_LAX	22.0	2008-03-04	807.0	LAX	-14.0	MQ4401	ORD	CMI	-25.0	AA1345	2008-03-06	1401.0	-39
CMI_ORD_LAX	35.0	2008-03-04	905.0	LAX	6.0	MQ4373	ORD	CMI	-10.0	AA557	2008-03-06	1642.0	-4
CMI_ORD_LAX	5.0	2008-03-04	807.0	LAX	-14.0	MQ4401	ORD	CMI	9.0	UA129	2008-03-06	2047.0	-5
CMI_ORD_LAX	8.0	2008-03-04	710.0	LAX	-14.0	MQ4278	ORD	CMI	9.0	UA129	2008-03-06	2047.0	-5
CMI_ORD_LAX	10.0	2008-03-04	807.0	LAX	-14.0	MQ4401	ORD	CMI	6.0	UA121	2008-03-06	1515.0	-8

8. JAX → DFW → CRP, 09/09/2008



flight_routes

Query: [Table] flight_routes: route, rank

Viewing 1 to 3 items

Query [Table] flight_routes: route, rank

Partition key route String = JAX_DFW_CRP

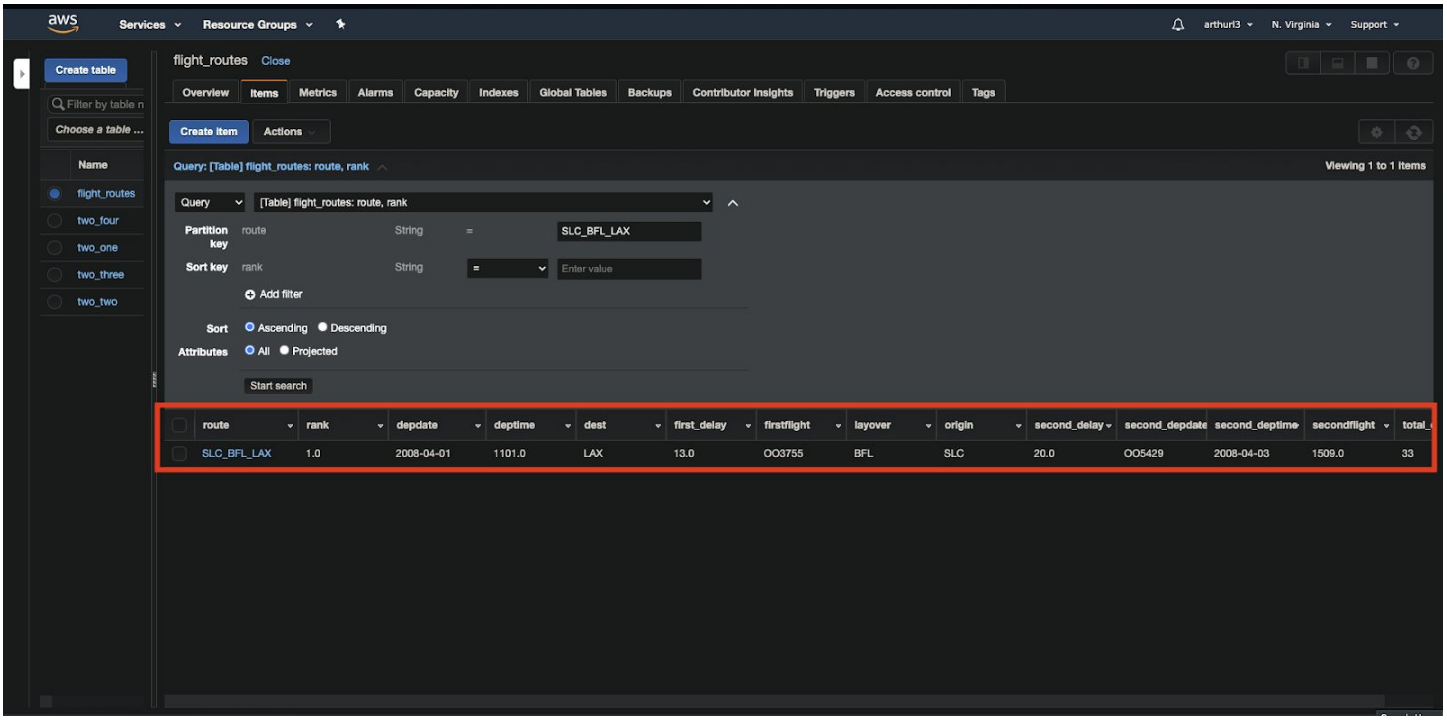
Sort key rank String = Enter value

Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

route	rank	depdate	deptime	dest	first_delay	firstflight	layover	origin	second_delay	second_depdate	second_deptime	secondflight	total_(
JAX_DFW_CRP	3.0	2008-09-09	722.0	CRP	-2.0	AA845	DFW	JAX	-4.0	MQ3627	2008-09-11	1648.0	-6
JAX_DFW_CRP	1.0	2008-09-09	722.0	CRP	-2.0	AA845	DFW	JAX	18.0	MQ3701	2008-09-11	1310.0	16
JAX_DFW_CRP	2.0	2008-09-09	722.0	CRP	-2.0	AA845	DFW	JAX	23.0	MQ3419	2008-09-11	1504.0	21

9. SLC → BFL → LAX, 01/04/2008



flight_routes

Query: [Table] flight_routes: route, rank

Viewing 1 to 1 items

Query [Table] flight_routes: route, rank

Partition key route String = SLC_BFL_LAX

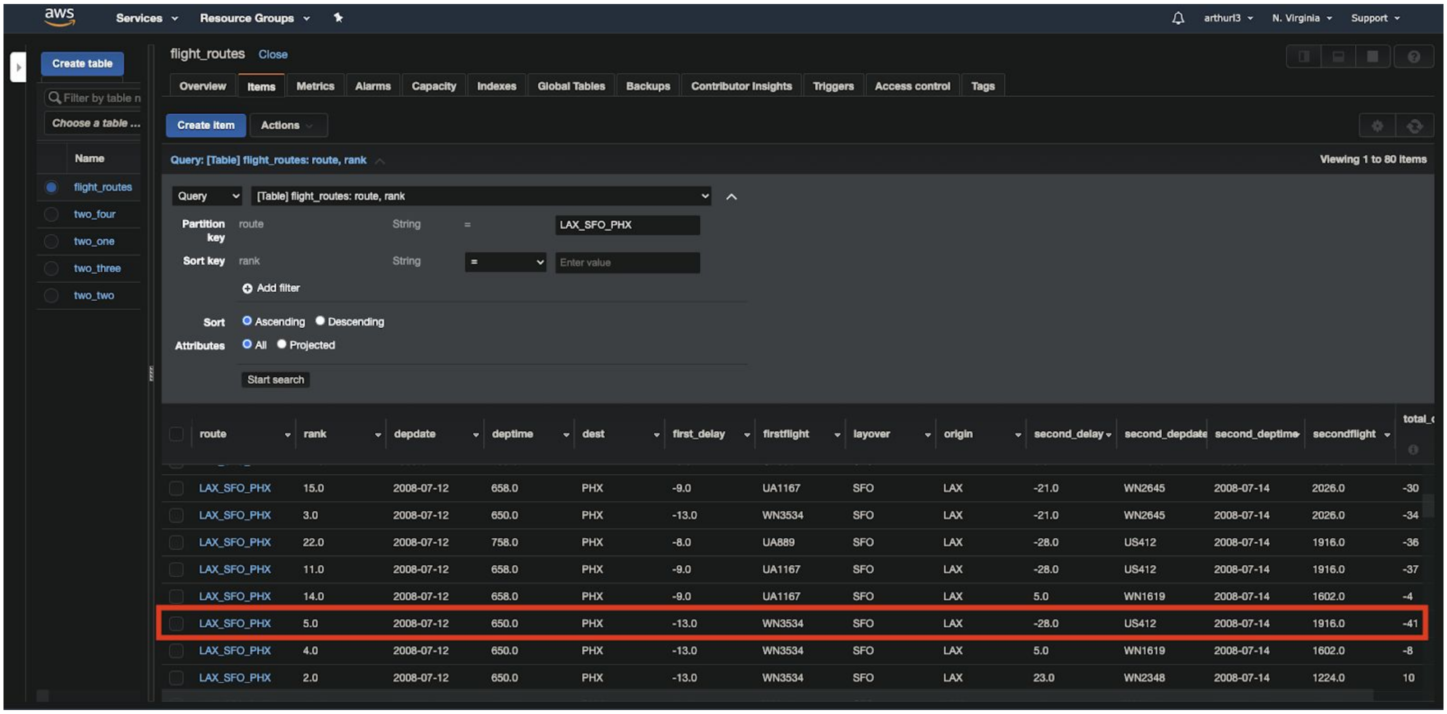
Sort key rank String = Enter value

Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

route	rank	depdate	deptime	dest	first_delay	firstflight	layover	origin	second_delay	second_depdate	second_deptime	secondflight	total_(
SLC_BFL_LAX	1.0	2008-04-01	1101.0	LAX	13.0	OO3755	BFL	SLC	20.0	OO5429	2008-04-03	1509.0	33

10. LAX → SFO → PHX, 12/07/2008



flight_routes Close

Query: [Table] flight_routes: route, rank

Viewing 1 to 80 items

Query [Table] flight_routes: route, rank

Partition key route String = LAX_SFO_PHX

Sort key rank String = Enter value

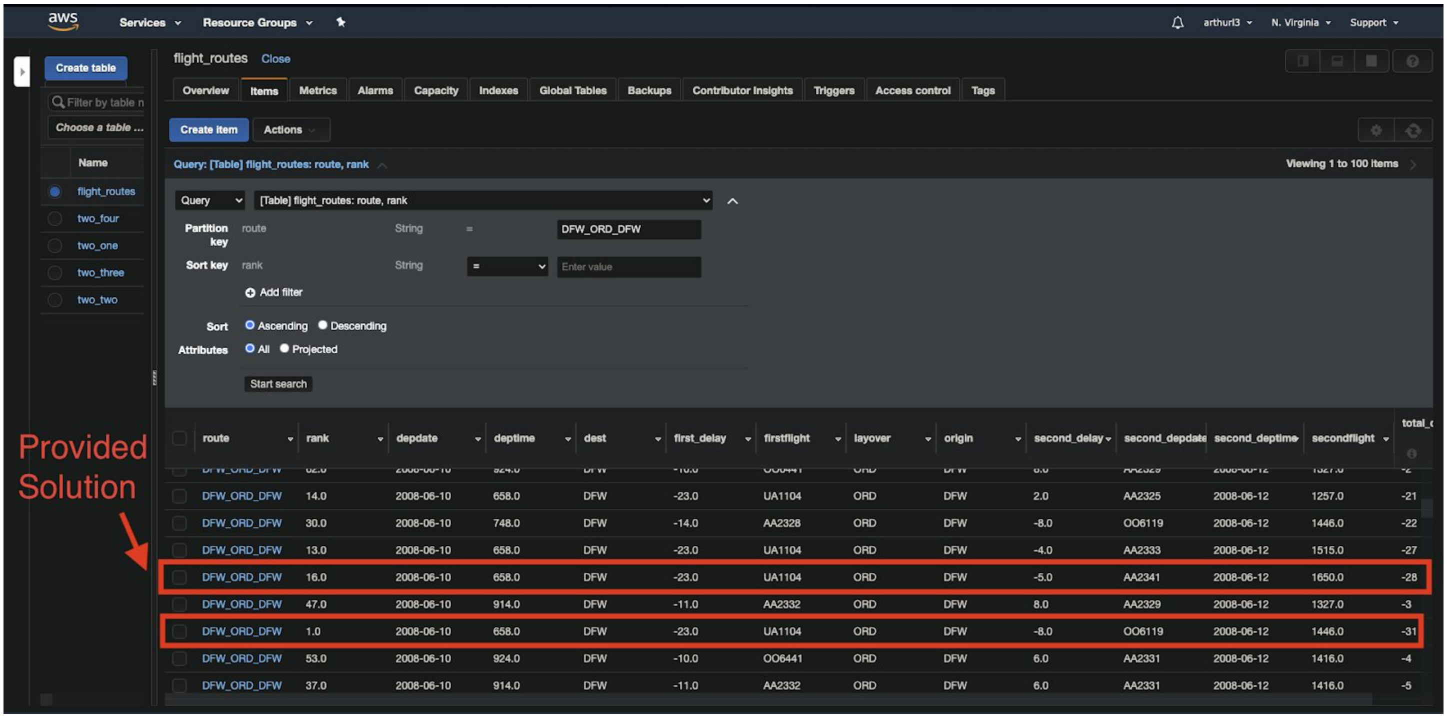
Add filter

Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

route	rank	depdate	deptime	dest	first_delay	firstflight	layover	origin	second_delay	second_depdate	second_deptime	secondflight	total_(
LAX_SFO_PHX	15.0	2008-07-12	658.0	PHX	-9.0	UA1167	SFO	LAX	-21.0	WN2645	2008-07-14	2026.0	-30
LAX_SFO_PHX	3.0	2008-07-12	650.0	PHX	-13.0	WN3534	SFO	LAX	-21.0	WN2645	2008-07-14	2026.0	-34
LAX_SFO_PHX	22.0	2008-07-12	758.0	PHX	-8.0	UA889	SFO	LAX	-28.0	US412	2008-07-14	1916.0	-36
LAX_SFO_PHX	11.0	2008-07-12	658.0	PHX	-9.0	UA1167	SFO	LAX	-28.0	US412	2008-07-14	1916.0	-37
LAX_SFO_PHX	14.0	2008-07-12	658.0	PHX	-9.0	UA1167	SFO	LAX	5.0	WN1619	2008-07-14	1602.0	-4
LAX_SFO_PHX	5.0	2008-07-12	650.0	PHX	-13.0	WN3534	SFO	LAX	-28.0	US412	2008-07-14	1916.0	-41
LAX_SFO_PHX	4.0	2008-07-12	650.0	PHX	-13.0	WN3534	SFO	LAX	5.0	WN1619	2008-07-14	1602.0	-8
LAX_SFO_PHX	2.0	2008-07-12	650.0	PHX	-13.0	WN3534	SFO	LAX	23.0	WN2348	2008-07-14	1224.0	10

11.DFW → ORD → DFW, 10/06/2008



flight_routes Close

Query: [Table] flight_routes: route, rank

Viewing 1 to 100 items

Query [Table] flight_routes: route, rank

Partition key route String = DFW_ORD_DFW

Sort key rank String = Enter value

Add filter

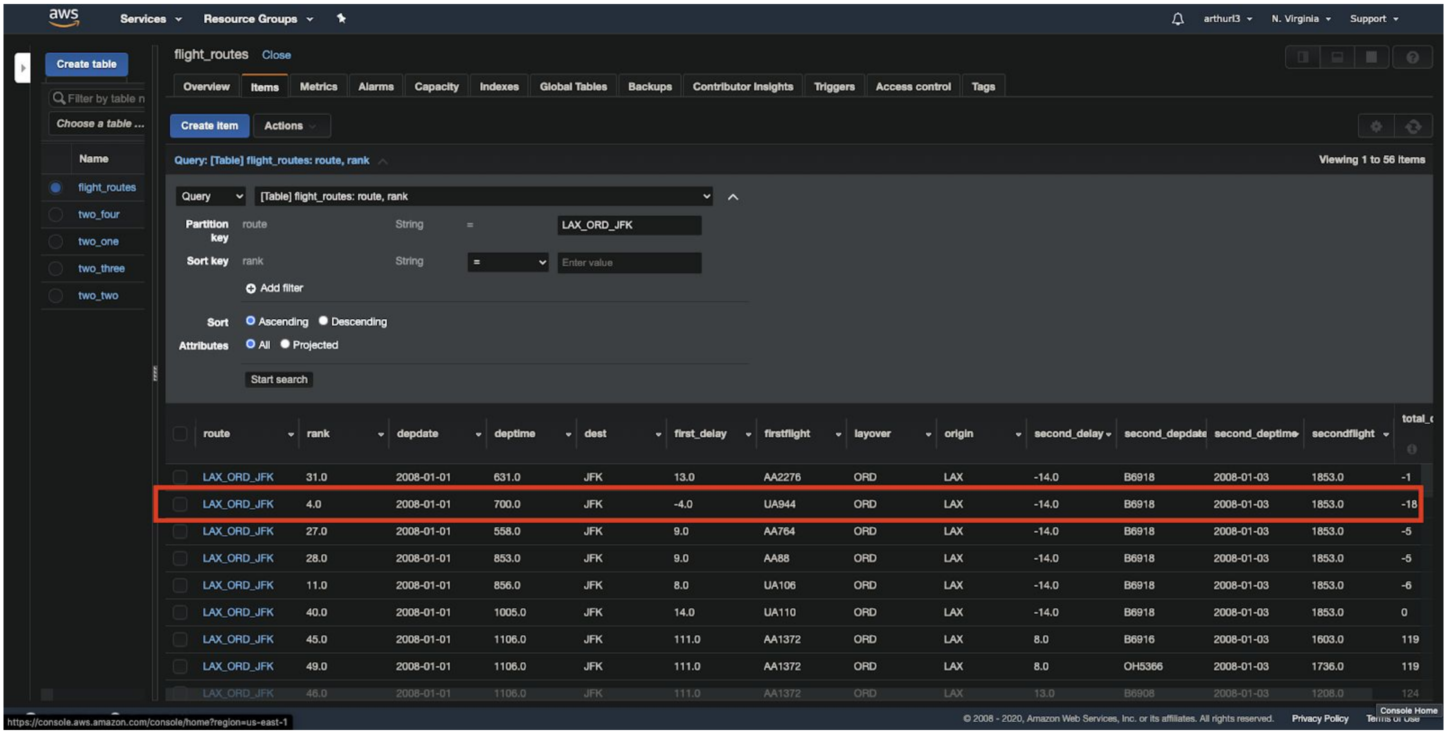
Sort ● Ascending ○ Descending

Attributes ● All ○ Projected

Provided Solution

route	rank	depdate	deptime	dest	first_delay	firstflight	layover	origin	second_delay	second_depdate	second_deptime	secondflight	total_(
DFW_ORD_DFW	14.0	2008-06-10	658.0	DFW	-23.0	UA1104	ORD	DFW	2.0	AA2325	2008-06-12	1257.0	-21
DFW_ORD_DFW	30.0	2008-06-10	748.0	DFW	-14.0	AA2328	ORD	DFW	-8.0	OO6119	2008-06-12	1446.0	-22
DFW_ORD_DFW	13.0	2008-06-10	658.0	DFW	-23.0	UA1104	ORD	DFW	-4.0	AA2333	2008-06-12	1515.0	-27
DFW_ORD_DFW	16.0	2008-06-10	658.0	DFW	-23.0	UA1104	ORD	DFW	-5.0	AA2341	2008-06-12	1650.0	-28
DFW_ORD_DFW	47.0	2008-06-10	914.0	DFW	-11.0	AA2332	ORD	DFW	8.0	AA2329	2008-06-12	1327.0	-3
DFW_ORD_DFW	1.0	2008-06-10	658.0	DFW	-23.0	UA1104	ORD	DFW	-8.0	OO6119	2008-06-12	1446.0	-31
DFW_ORD_DFW	53.0	2008-06-10	924.0	DFW	-10.0	OO6441	ORD	DFW	6.0	AA2331	2008-06-12	1416.0	-4
DFW_ORD_DFW	37.0	2008-06-10	914.0	DFW	-11.0	AA2332	ORD	DFW	6.0	AA2331	2008-06-12	1416.0	-5

LAX → ORD → JFK, 01/01/2008



Query: [Table] flight_routes: route, rank

Viewing 1 to 56 items

Query [Table] flight_routes: route, rank

Partition key: route String = LAX_ORD_JFK

Sort key: rank String = Enter value

Sort: ● Ascending ○ Descending

Attributes: ● All ○ Projected

route	rank	depdate	deptime	dest	first_delay	firstflight	layover	origin	second_delay	second_depdate	second_deptime	secondflight	total_
LAX_ORD_JFK	31.0	2008-01-01	631.0	JFK	13.0	AA2276	ORD	LAX	-14.0	B6918	2008-01-03	1853.0	-1
LAX_ORD_JFK	4.0	2008-01-01	700.0	JFK	-4.0	UA944	ORD	LAX	-14.0	B6918	2008-01-03	1853.0	-18
LAX_ORD_JFK	27.0	2008-01-01	558.0	JFK	9.0	AA764	ORD	LAX	-14.0	B6918	2008-01-03	1853.0	-5
LAX_ORD_JFK	28.0	2008-01-01	853.0	JFK	9.0	AA88	ORD	LAX	-14.0	B6918	2008-01-03	1853.0	-5
LAX_ORD_JFK	11.0	2008-01-01	856.0	JFK	8.0	UA106	ORD	LAX	-14.0	B6918	2008-01-03	1853.0	-6
LAX_ORD_JFK	40.0	2008-01-01	1005.0	JFK	14.0	UA110	ORD	LAX	-14.0	B6918	2008-01-03	1853.0	0
LAX_ORD_JFK	45.0	2008-01-01	1106.0	JFK	111.0	AA1372	ORD	LAX	8.0	B6916	2008-01-03	1603.0	119
LAX_ORD_JFK	49.0	2008-01-01	1106.0	JFK	111.0	AA1372	ORD	LAX	8.0	OH5366	2008-01-03	1736.0	119
LAX_ORD_JFK	46.0	2008-01-01	1106.0	JFK	111.0	AA1372	ORD	LAX	13.0	B6908	2008-01-03	1208.0	124

https://console.aws.amazon.com/console/home?region=us-east-1

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Quick Commands

Quick Commands

- scp -i cs598.pem ec2-user@ec2-TBD.compute-1.amazonaws.com:~/newvolume/aviation/airline_ontime /Users/arthurliou/SCP/
- lsblk
- sudo mkdir /home/ec2-user/data
- sudo mount /dev/xvdf /home/ec2-user/data
- sudo umount /home/ec2-user/data
- sudo mount -a
- scp -rp -i cs598.pem ec2-user@ec2-TBD.compute-1.amazonaws.com:~/data/aviation/airline_ontime /Users/arthurliou/SCP/
- sudo scp -r -i cs598.pem /Users/arthurliou/SCP/solution.zip ec2-user@ec2-TBD.compute-1.amazonaws.com:~/
    - Testing Uploaded Successfully
- Organization + Moving.
    - Expected 240 files
        - Ignore 2008_11 and 2008_12 zips to to unzipping issues
    - find . -name "*.zip" -exec unzip {} \;
    - Move all CSV to one directory
        - find . -name '*.csv' -exec mv {} ~/cs/uiuc/cs598/airline_ontime/move/ \;
        - find . -name '*.csv' -exec cp {} ~/cs/uiuc/cs598/airline_ontime/csv/ \;
    - Convert to utf-8
        - find . -type f -exec bash -c 'iconv -f iso-8859-1 -t utf-8 "{}" > ~/cs/uiuc/cs598/airline_ontime/converted/"{}"' \;
    - Compressed each csv into a .gz
        - gzip -r converted
    - Upsert .gz to S3
- AWS Athena Validation Query
    - s3://arthurl3-cs598/airline_ontime_raw_data/
    - s3://arthurl3-cs598/airline_ontime_cleaned/
    - select count(*) from airline_ontime_cleaned;
    - select * from airline_ontime_cleaned limit 10;
- EMR Setup
    - ssh -i cs598-ddb.pem hadoop@ec2-TBD.compute-1.amazonaws.com
    - ssh -i cs598-educate
- Validate Hive External Table Row Count
    - show tblproperties airline_ontime_cleaned;
    - describe extended airline_ontime_cleaned;
    - SELECT count(*) FROM airline_ontime_cleaned;
        - //116754192 with headers
    - SELECT count(*) FROM airline_ontime_cleaned WHERE flightnum IS NOT NULL;
    - SELECT * FROM airline_ontime_cleaned limit 10;

- Setups for Schema, Hive External Tables, DynamoDB Table (see below)

1)	year	smallint
2)	month	smallint
3)	dayofmonth	tinyint
4)	dayofweek	tinyint
5)	flightdate	string
6)	uniquecarrier	string
7)	airlineid	int
8)	carrier	string
9)	flightnum	smallint
10)	origin	string
11)	dest	string
12)	crsdeptime	double
13)	deptime	double
14)	depdelay	int
15)	depdelayminutes	int
16)	crsarrtime	double
17)	arrtime	double
18)	arrdelay	int
19)	arrdelayminutes	int

Notes

- 116754192 - 116753952 = 240
- year, month, dayofmonth, dayofweek, flightdate, uniquecarrier, airlineid, carrier, flightnum, origin, dest,crsdeptime, deptime, depdelay, depdelayminutes, crsarrtime, arrtime, arrdelay, arrdelayminutes, concat(origin, '_', dest, '_', uniquecarrier) as sortKey

Import

```
INSERT OVERWRITE TABLE airlineTimes
SELECT * FROM airline_ontime_cleaned;
```

External Table for S3 Import

```
CREATE EXTERNAL TABLE
airline_ontime_cleaned(year BIGINT, month
BIGINT, dayofmonth BIGINT, dayofweek
BIGINT, flightdate STRING, uniquecarrier
STRING, airlineid BIGINT, carrier STRING,
flightnum BIGINT, origin STRING, dest
STRING, crsdeptime DOUBLE, deptime
DOUBLE, depdelay DOUBLE, depdelayminutes
DOUBLE, crsarrtime DOUBLE, arrtime
DOUBLE, arrdelay DOUBLE, arrdelayminutes
DOUBLE) ROW FORMAT DELIMITED FIELDS
TERMINATED BY ',' LOCATION
's3://arthurl3-cs598/airline_ontime_cleaned/'
tblproperties ('skip.header.line.count'='1');
```

Create Hive-DDB Mapping

```
CREATE EXTERNAL TABLE airlineTimes(year
BIGINT, month BIGINT, dayofmonth BIGINT,
dayofweek BIGINT, flightdate STRING,
uniquecarrier STRING, airlineid BIGINT,
carrier STRING, flightnum BIGINT, origin
STRING, dest STRING,
crsdeptime DOUBLE, deptime DOUBLE,
depdelay DOUBLE, depdelayminutes DOUBLE,
crsarrtime DOUBLE, arrtime DOUBLE, arrdelay
DOUBLE, arrdelayminutes DOUBLE, sortKey
STRING)
STORED BY
'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler'
TBLPROPERTIES ("dynamodb.table.name" =
"airlineTimes",
"dynamodb.column.mapping" =
"year:year,month:month,dayofmonth:dayofmonth,dayofweek:dayofweek,flightdate:flightdate,uniquecarrier:uniquecarrier,airlineid:airlineid,carrier:carrier,flightnum:flightnum,origin:origin,dest:dest,crsdeptime:crsdeptime,deptime:deptime,depdelay:depdelay,depdelayminutes:depdelayminutes,crsarrtime:crsarrtime,arrtime:arrtime,arrdelay:arrdelay,arrdelayminutes:arrdelayminutes,sortKey:sortKey");
```

Resources

- https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-copy-snapshot.html
- https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-using-volumes.html
- https://devopscube.com/mount-ebs-volume-ec2-instance/
- https://docs.aws.amazon.com/AmazonS3/latest/user-guide/upload-objects.html
- https://aws.amazon.com/blogs/big-data/build-a-data-lake-foundation-with-aws-glue-and-amazon-s3/
- https://docs.aws.amazon.com/glue/latest/dg/populate-data-catalog.html
- https://hevodata.com/blog/dynamodb-to-s3-using-aws-glue/
- https://docs.aws.amazon.com/amazondynamodb/latest/developerguide/EMRforDynamoDB.Tutorial.html
- https://docs.aws.amazon.com/efs/latest/ug/accessing-fs-create-security-groups.html
- https://docs.aws.amazon.com/amazondynamodb/latest/developerguide/EMRforDynamoDB.ExternalTableForDDB.html
- Check Mapper to Maximize Throughput
    - https://docs.aws.amazon.com/emr/latest/ReleaseGuide/emr-hadoop-task-config.html
    - https://stackoverflow.com/questions/41454796/aws-emr-parallel-mappers
    - 12288/3072 = 4. 3x Cluster Size = 12 mappers
    - So number of write capacity units should be greater than 12
    - However, I’m unable to change the Provisioned Capacity setting, so created as is, with 5 Write Capacity Units
- https://aws.amazon.com/getting-started/hands-on/optimize-amazon-emr-clusters-with-ec2-spot/
- https://docs.aws.amazon.com/amazondynamodb/latest/developerguide/EMRforDynamoDB.html
- https://docs.aws.amazon.com/emr/latest/ReleaseGuide/EMR_Interactive_Hive.html
- https://docs.aws.amazon.com/emr/latest/ReleaseGuide/EMR_Hive_Commands.html