Master Executive di II Livello

BIG DATA ANALYSIS AND BUSINESS INTELLIGENCE

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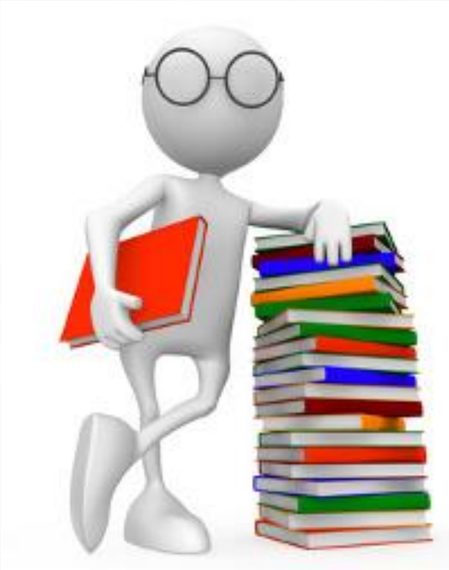
HiveQL

fondazione INUIT TORVERGATA

Topics



- What is Hive ?
- What Hive is not
- Hive features
- Hive architecture
- Limitations of Hive
- Hive QL
- Hive Datatypes
- Hive partitioning
- Basic Hive QL commands
- Hive SELECT
- Wordcount in Hive QL

What is Hive ?

- Is a SQL like Querying tool to query the data stored in HDFS and other Filesystems that integrate with Hadoop
- Developed by Facebook and later on taken by Apache
- It processes Structured data that can be stored into tables
- Efficient for Batch processing
- Is a lens between Map reduce and HDFS
- Provides us various storage file formats like Parquet, Sequence file, ORC file, Text file with significant compression.

What Hive is Not ?

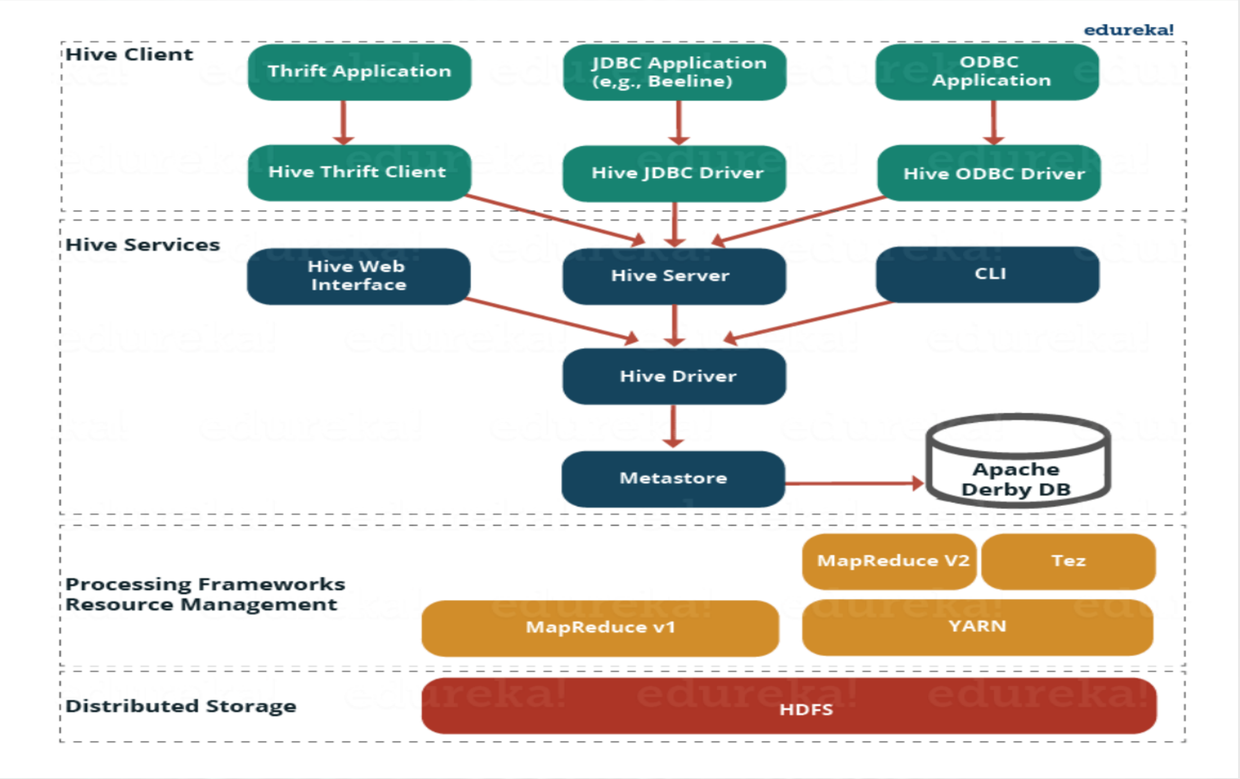
- Hive is not a Database. It just points to the data lying in HDFS.
- Hive is not a tool for OLTP. It is closer being as OLAP tool.
- It does not provide row level Insert, Update and Delete.
- Not used where fast response time is required as in RDBMS. Rather used where high latency is acceptable with batch processing.
- Does not support unstructured data like Audio, Video and Images.

Hive Features

- Indexing to provide acceleration, index type including compaction and bitmap index.
- Metadata storage in a relational database management system, significantly reducing the time to perform semantic checks during query execution.
- Built-in user-defined functions (UDFs) to manipulate dates, strings, and other data-mining tools.

Note: By default, Hive stores metadata in an embedded Apache Derby database, and other client/server databases like MySQL can optionally be used.

Hive Architecture



Hive Architecture(2)

- **Metastore**: Stores metadata for each of the tables such as their schema and location.
- **Driver**: Acts like a controller which receives the HiveQL statements. Monitors the life cycle and progress of the execution. The driver also acts as a collection point of data or query results obtained after the Reduce operation
- **Compiler**: Performs compilation of the HiveQL query, which converts the query to an execution plan. This plan contains the tasks and steps needed to be performed by the Hadoop MapReduce to get the output as translated by the query.

Hive Architecture(3)

- **Optimizer**: Performs various transformations on the execution plan to get an optimized DAG.
- **Executor**: After compilation and optimization, the executor executes the tasks. It interacts with the job tracker of Hadoop to schedule tasks to be run. It takes care of pipelining the tasks by making sure that a task with dependency gets executed only if all other prerequisites are run.
- **CLI, UI, and Thrift Server**: A command-line interface (CLI) provides a user interface for an external user to interact with Hive by submitting queries, instructions and monitoring the process status. Thrift server allows external clients to interact with Hive over a network, similar to the JDBC or ODBC protocols.

Limitations of Hive

- Hive is not designed for Online transaction processing (OLTP), it is only used for the Online Analytical Processing.(OLAP)
- Hive supports overwriting or apprehending data, but not updates and deletes.
- In Hive, sub queries are not supported.

Hive QL

- Based on SQL
- Offers basic support for indexes.
- HiveQL lacked support for transactions and materialized views, and only limited subquery support.
- Internally, a compiler translates HiveQL statements into a directed acyclic graph of MapReduce, Tez, or Spark jobs, which are submitted to Hadoop for execution.
- Support for insert, update, and delete with full ACID functionality

Hive - Datatypes

- All the data types in Hive are classified into four types:

  - Column Types

  - Literals

  - Null Values

  - Complex Types

Hive – Datatypes(2)

Column Types:

Column type are used as column data types of Hive. They are categorized further in to Integral types, String types, Time stamp, Dates and Decimals, Union types.

- **Integral**: TINYINT, SMALLINT, INT, BIGINT.
- **String**: VARCHAR(1-65355), CHAR(255).
- **Timestamp**: UNIX timestamp with optional nanosecond precision.
- **Dates**: DATE values are described in year/month/day format in the form {{YYYY-MM-DD}}.
- **Union**: Union is a collection of heterogeneous data types. Similar to dictionary in Python with key-value pairs.

Hive – Datatypes(2)

Literals:

- **Floating Point Types**: Floating point types are nothing but numbers with decimal points. Generally, this type of data is composed of DOUBLE data type.
- **Decimal Type**: Decimal type data is nothing but floating point value with higher range than DOUBLE data type. The range of decimal type is approximately -10^308 to 10^308..

Null Value:

Missing values are represented by the special value NULL.

Hive – Datatypes(3)

Complex Types:

- **Arrays:** Arrays in Hive are used the same way they are used in Java.
- **Maps:** Maps in Hive are similar to Java Maps.
- **Structs:** Structs in Hive is similar to using complex data with comment.

Hive – Partitioning

- **Partitions:** Hive organizes tables into partitions. It is a way of dividing a table into related parts based on the values of partitioned columns such as date, city, and department. Using partition, it is easy to query a portion of the data.

- **Buckets:** Tables or partitions are sub-divided into buckets, to provide extra structure to the data that may be used for more efficient querying. Bucketing works based on the value of hash function of some column of a table.

Hive – Partitioning(2)

Example:
A table named Tab1 contains employee data such as id, name, dept, and yoj (i.e., year of joining). Suppose you need to retrieve the details of all employees who joined in 2012.

Normal: A query searches the whole table for the required information.

However, if you partition the employee data with the year and store it in a separate file, it reduces the query processing time

Hive – Partitioning(3)

The following file contains employeedata table.

/tab1/employeedata/file1

```
id, name, dept, yoj
1, gopal, TP, 2012
2, kiran, HR, 2012
3, kaleel,SC, 2013
4, Prasanth, SC, 2013
```

The above data is partitioned into two files using year.

/tab1/employeedata/2012/file2

```
1, gopal, TP, 2012
2, kiran, HR, 2012
```

/tab1/employeedata/2013/file3

```
3, kaleel,SC, 2013
4, Prasanth, SC, 2013
```

Basic HiveQL Commands

- Find all the databases in HDFS –
  show databases;

- Switch to a specific database –
  use database_name; (Ex: use hive_demo;)

- Create a new table –

```
create table txnrecords( txnno INT,
                         txtdate STRING,
                         custno INT,
                         amount DOUBLE,
                         category STRING,
                         product STRING,
                         city STRING,
                         state STRING);
```

- Find the schema of a table –
  describe txnrecords;

HiveQL SELECT

- Syntax:

```
SELECT [ALL | DISTINCT] select_expr, select_expr, ...
FROM table_reference
[WHERE where_condition]
[GROUP BY col_list]
[HAVING having_condition]
[CLUSTER BY col_list | [DISTRIBUTE BY col_list]
  [SORT BY col_list] ]
[LIMIT number];
```

Example:

```
SELECT * FROM employee WHERE salary>30000;
```

Creating tables

To create a new table we use a syntax similar to SQL

Example:

```
CREATE TABLE customers
 ( id INT,
    firstname STRING,
    lastname STRING )
 ROW FORMAT DELIMITED
 FIELDS TERMINATED BY '\t'
 STORED AS TEXTFILE;
```

If no database is selected, a database with name default is used

The above CREATE statement is created in the following directory in HDFS:
/apps/hive/warehouse/customers

Hive databases

- A table can also be created on a particular database rather a default database. Below query creates a database ‘mydatabase’ and creates customers table inside it, as shown below

```
CREATE DATABASE mydatabase;
USE mydatabase;
CREATE TABLE customers
( id INT,
   firstname STRING,
   lastname STRING );
```

- This create statement created the following directory in HDFS: /apps/hive/warehouse/mydatabase/customers

- The default hive path in HDFS is /apps/hive/warehouse, but can be changed in the configuration

Hive inserting data

- To insert records in to newly created table:

  INSERT INTO customers(id, firstname, lastname) VALUES
  (1, 'John', 'Smith');

  Using INSERT is not the recommended way to insert lot of data

- LOAD INPATH is a better approach:

  LOAD DATA INPATH '/tmp/data.csv' INTO TABLE customers;

  This will move the data from the HDFS path /tmp/data.csv to /apps/hive/warehouse/customers

Hive inserting data

- An alternative way is to immediately copy data from your local disk in to HDFS –

  > hadoop fs –put data.csv /apps/hive/warehouse/customers/

  this will copy the data in to HDFS, not move it

- hadoop fs can be done from an edge node (a node with only client libraries), a datanode (a node in the cluster), or a desktop/laptop that has hadoop installed and configured (xml configuration files needs to be present)

Hive Querying

- **Output all the data** -
  SELECT * FROM CUSTOMERS; -> This query will not run a MapReduce job, because no operation needs to run on the data, data can simply be shown on the screen

- **Filter the data** -
  SELECT firstname, lastname
  FROM CUSTOMERS
  WHERE id=1; -> This query will run Map job only, to filter on id=1 and to select 2 columns instead of all 3

- **Aggregation** –
  SELECT firstname, COUNT(*)
  FROM CUSTOMERS
  GROUP BY firstname; -> This query will run Map and Reduce jobs. The aggregation(GROUP BY) will run in the reduce tasks.

Hive Partitioning

- In Hive, using HDFS, indexes will not speed up the queries like in Relational databases.
- Indexes in relational database are built and kept in memory to quickly find data on disk.
- Using HDFS, even if we know where the data would be on the disk, it would still take a long time to retrieve the full blocks, it’s not possible to do random reads on a file in HDFS.
- A better way to speeding up your queries is to use partitioning and bucketing.

Hive Partitioning(2)

- To partition a table, use the PARTITIONED BY clause in HiveQL –

```
CREATE TABLE employees
(id INT, firstname STRING, lastname  STRING)
PARTITIONED BY (department String);
```

- After inserting some data, you will see that Hive automatically creates subdirectories for every department –

```
INSERT INTO employees (id, firstname, lastname, department)
VALUES (1, 'John', 'Smith', 'hr');

INSERT INTO employees (id, firstname, lastname, department)
VALUES (1, 'Alice', 'Jones', 'operations');

INSERT INTO employees (id, firstname, lastname, department)
VALUES (1, 'Joe', 'Johnson', 'finance');
```

Hive Partitioning(3)

SELECT * from employees where department = ‘hr’;

- Anytime a query is executed on a specific department, a big portion of the data can be skipped, because Hive can go straight to the data in one of the subdirectories –

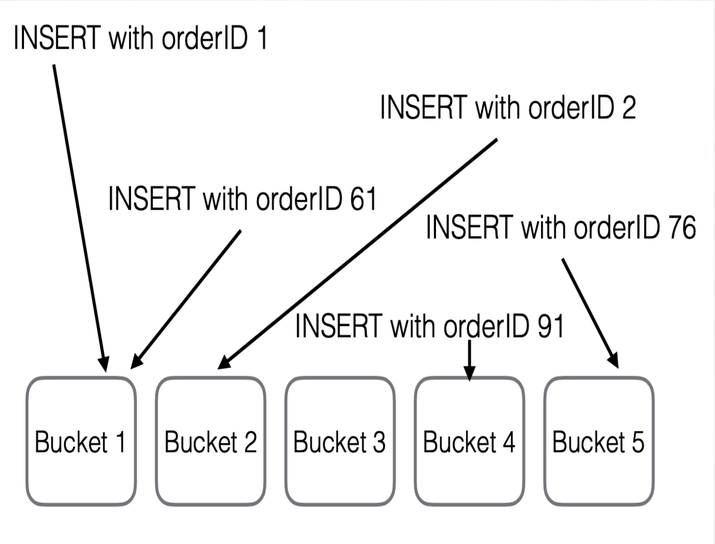
  /apps/hive/warehouse/employees/department=hr/
  /apps/hive/warehouse/employees/department=operations/
  /apps/hive/warehouse/employees/department=finance/

Hive Bucketing


```
CREATE TABLE customers
(id INT, firstname STRING, lastname STRING)
PARTITIONED BY (orderID INT)
INTO 5 BUCKETS;
```

- Often the column you want to partition on, doesn't have a one-toone relation to the amount of partitions you want to have
- In our previous example we partitioned on department, which was a good fit to use for partitioning, but let's say you want to partition an ID in exactly 5 partitions, you can't use "partitioned by" with the directory structure. Buckets are answer to this.

Hive Bucketing(2)



- Using a hashing algorithm on the orderID, the rows will be evenly divided over all 5 buckets
- When executing a query, with a WHERE-clause on orderID, Hive will run the same hashing algorithm again to know where it should look for a certain ID
- Using buckets on columns you are going to query will significantly increase performance

Hive Tables

External table:

External table is created for external use as when the data is used outside Hive. Whenever we want to delete the table's metadata and we want to keep the table's data as it is, we use an External table. **External table only deletes the schema of the table**.

Managed table:

A managed table is also called an Internal table. This is the default table in Hive. When we create a table in Hive without specifying it as external, by default we will get a Managed table.

If we create a table as a managed table, the table will be created in a specific location in HDFS.

By default, the table data will be created in /usr/hive/warehouse directory of HDFS. If we delete a Managed table, both the table data and metadata for that table will be deleted from the HDFS.

Word count in Hive QL


```
DROP TABLE IF EXISTS docs;

CREATE TABLE docs (line STRING);

LOAD DATA INPATH 'input_file' OVERWRITE INTO TABLE docs;

CREATE TABLE word_counts AS

SELECT word, count(1) AS count FROM
   (SELECT explode(split(line, '\s')) AS word FROM docs) temp

GROUP BY word

ORDER BY word;
```

Word count in Hive QL(2)

DROP TABLE IF EXISTS docs;
CREATE TABLE docs (line STRING);

Explanation: Checks if table docs exists and drops it if it does. Creates a new table called docs with a single column of type STRING called line.

LOAD DATA INPATH 'input_file' OVERWRITE INTO TABLE docs;

Explanation: Loads the specified file or directory (In this case “input_file”) into the table. OVERWRITE specifies that the target table to which the data is being loaded into is to be re-written; Otherwise the data would be appended.

Word count in Hive QL(3)


```
CREATE TABLE word_counts AS
SELECT word, count(1) AS count FROM
   (SELECT explode(split(line, '\s')) AS word FROM docs) temp
GROUP BY word
ORDER BY word;
```

Explanation: Creates a table called word_counts with two columns: word and count. This query draws its input from the inner query (SELECT explode(split(line, '\s')) AS word FROM docs) temp". This query serves to split the input words into different rows of a temporary table aliased as temp. The GROUP BY WORD groups the results based on their keys. This results in the count column holding the number of occurrences for each word of the word column. The ORDER BY WORDS sorts the words alphabetically.

Hive metastore

- Metastore is the central repository of Apache Hive metadata. It stores metadata for Hive tables (like their schema and location) and partitions in a relational database.
- It provides client access to this information by using metastore service API.
- Hive metastore consists of two fundamental units:
  A service that provides metastore access to other Apache Hive services.
  Disk storage for the Hive metadata which is separate from HDFS storage.

Hive metastore modes

There are three modes for Hive Metastore deployment:

Embedded Metastore -

In Hive by default, metastore service runs in the same JVM as the Hive service. It uses embedded derby database stored on the local file system in this mode. Thus both metastore service and hive service runs in the same JVM by using embedded Derby Database. Only single session can be open at any time.

Local Metastore -

Many users can use the metastore at the same time. We can achieve by using any JDBC compliant like MySQL which runs in a separate JVM or different machines

Remote Metastore -

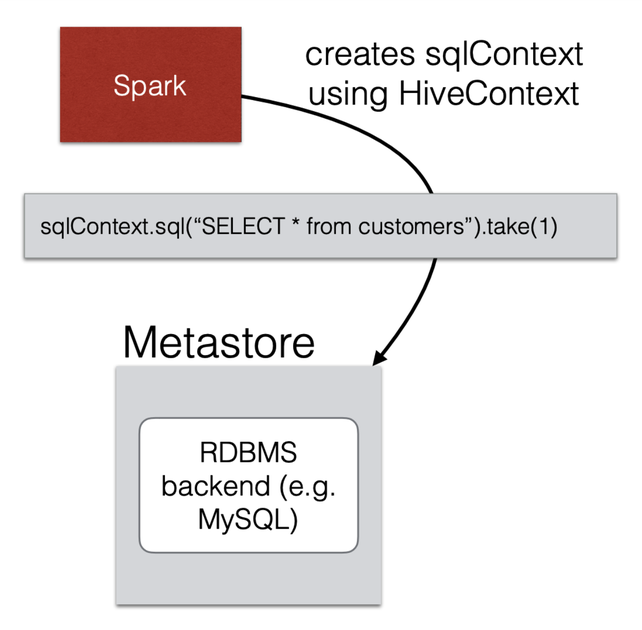
to communicate with the metastore server they can communicate using Thrift Network APIs.

Databases supported

Hive supports 5 backend databases which are as follows:

- Derby
- MySQL
- MS SQL Server
- Oracle
- Postgres

Hive in Spark



- You can use Hive in Apache Spark
- Data can be ingested into Hadoop and saved in hive-tables for easy access to Data Analysts
- Spark can use Hive to retrieve the data with the schema
- Data Frames can be used to then continue to process the data
- Results can then be stored again in Hive

Hive vs RDBMS

- RDBMS Tables are fine tuned for best of the performance for transactions (PoS, Bank Transfers etc) where as Hive is meant for heavy weight batch data processing.
- Even though one can specify constraints in Hive tables, they are only informational. The constraints might not be enforced.
- There are no Transaction based statements such as COMMIT, ROLLBACK etc. in Hive.
- Metastore and Data are decoupled in Hive. Metastore is available in RDBMS and actual business data is typically stored in HDFS.

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