Hive: SQL for Hadoop

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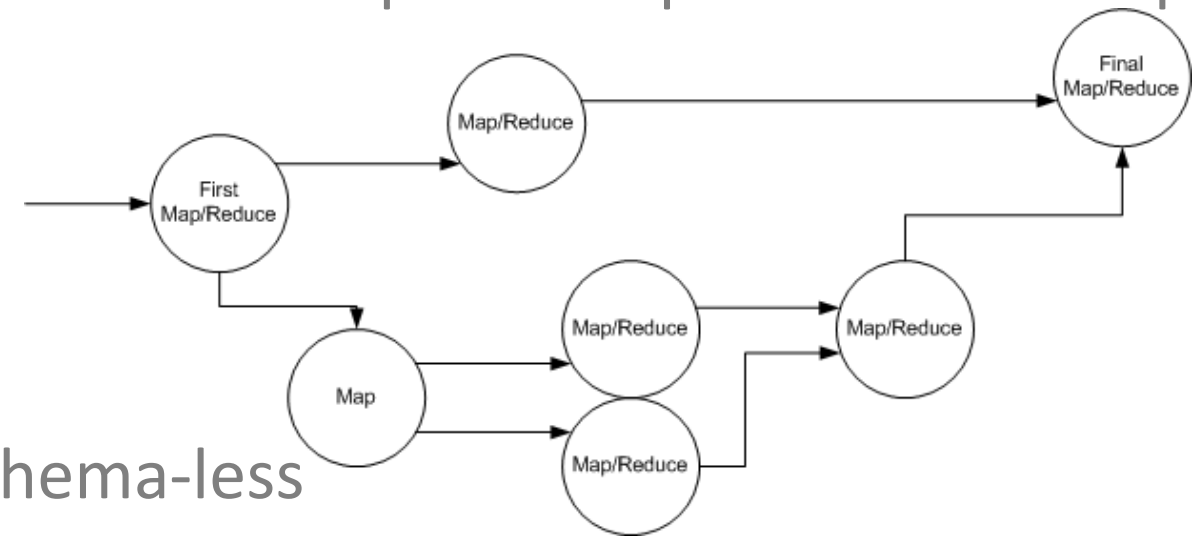
What is Hive?

- Subproject of Apache Hadoop
- Originally created at Facebook
- Provides an easier and faster way to analyze data in Hadoop (compared to MapReduce in Java, Python, C++, etc)

The problem with MapReduce

- The developer has to worry about a lot of things besides the analysis/processing logic
- Often requires several MapReduce passes to accomplish a final



- The data is schema-less
- Would be more convenient to use constructs such as "filter", "join", "aggregate"

What does Hive provide?

- A parser/optimizer/compiler that translates HiveQL to MapReduce code
- A Metastore (usually a MySQL server) that stores the "schema" information
  - Table name, column names, data types
  - Partition information
  - Storage location, row format (SerDe), storage format (Input and OutputFormat)

Despite SQL-like language, Hive is NOT an RDBMS

	RDBMS	Hive
Language	SQL-92 standard (maybe)	Subset of SQL-92 plus Hive-specific extension
Update Capabilities	INSERT, UPDATE, and DELETE	INSERT OVERWRITE; no UPDATE or DELETE
Transactions	Yes	No
Latency	Sub-second	Minutes or more
Indexes	Any number of indexes, very important for performance	No indexes, data is always scanned (in parallel)
Data size	TBs	PBs

Getting started is easy!

1. Setup Hadoop (NameNode, DataNodes, JobTracker and TaskTrackers)
2. Create Hive tables
3. Load data into Hive
4. SELECT data

Creating a table in Hive

- ```
  CREATE TABLE tablename
  (col1 INT, col2 STRING)
  ROW FORMAT DELIMITED FIELDS
  TERMINATED BY '\t'
  STORED AS TEXTFILE;
  ```

Describes the format of the file
  ```

Load data into the table

- `LOAD DATA LOCAL INPATH '/myhd/file_or_dir' INTO TABLE <tablename>`

  Copies data from the client's filesystem to HDFS

- `LOAD DATA INPATH '/hdfs/file_or_dir' INTO TABLE <tablename>`

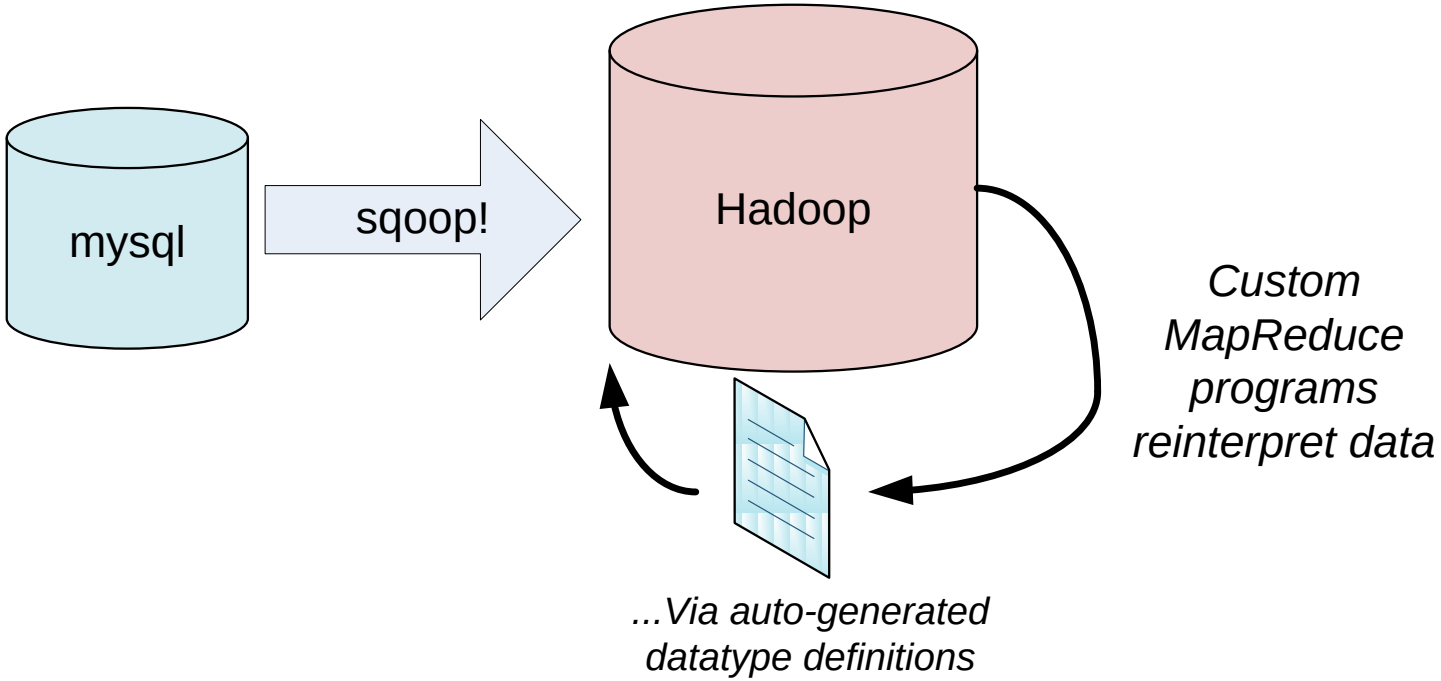
  Moves data to /user/hive/warehouse

- File format should match the CREATE TABLE definition!

Schema on read, not write

- Data is not checked during the load
  - Loads are very fast
- Parsing errors would be found at query time
- Possible to have multiple schemas for the same data (using `EXTERNAL` tables)

Sqoop: SQL to Hadoop




```
$ sqoop --connect jdbc:mysql://foo.com/corp \
    --table employees \
    --hive-import \
    --fields-terminated-by '\t' \
    --lines-terminated-by '\n'
```

Query the data with SELECT

- Similar to SQL:
  - `SELECT..`
    `FROM..`
    `WHERE..`
    `GROUP BY..`
    `ORDER BY..`
  - Inner join, outer join, full outer join
  - Subqueries (in the FROM clause)
  - Built-in functions such as `round, concat, substr, max, min, sum, count`

Hive converts to a series of MapReduce phases

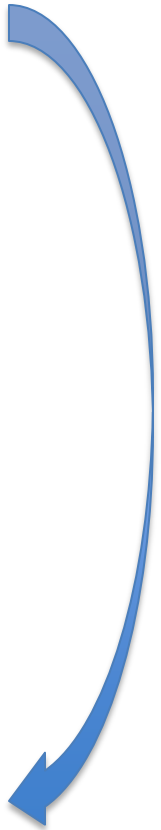
- `WHERE` => map
- `GROUP BY/ORDER BY` => reduce
- `JOIN` => map or reduce depending on optimizer
- Example:

```
SELECT * FROM purchases
WHERE cost > 40
ORDER BY order_date DESC;
```

  - Single MapReduce required:
    - WHERE clause translates to a “map”
    - Mapper outputs order_date as key
    - Single reducer collects sorted rows

EXPLAIN - the "map" (slide 1/3)

- ```
  EXPLAIN SELECT * FROM purchases
  WHERE cost > 40
  ORDER BY order_date DESC;
  ```
- ```
  …
  STAGE PLANS:
  Stage: Stage-1
    Map Reduce
      Alias -> Map Operator Tree:
        purchases
          TableScan
            alias: purchases
            Filter Operator
              predicate:
                  expr: (cost > UDFToDouble(40))
                  type: boolean
  ```

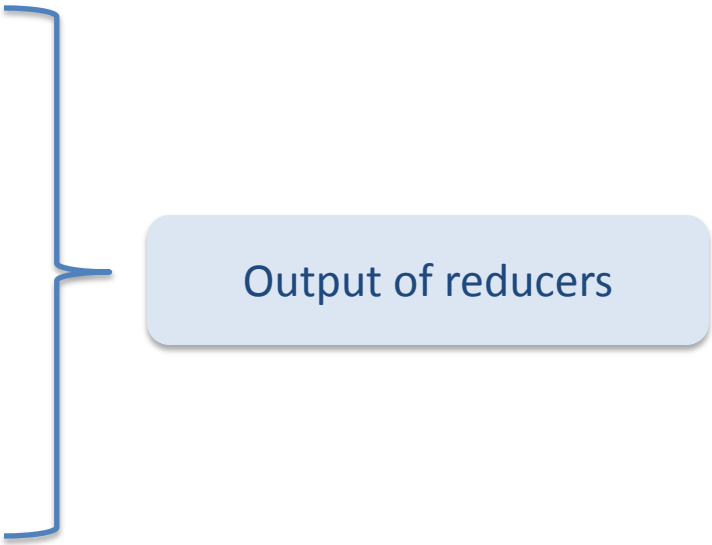


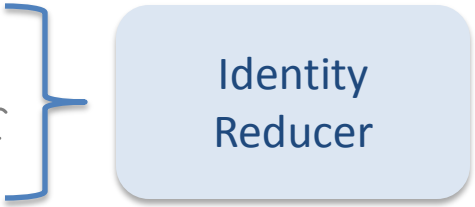
EXPLAIN - the "shuffle and sort" (slide 2/3)

- Select Operator
  expressions:
  expr: custid
  type: int
  expr: order_date
  type: string
  expr: cost
  type: double
  outputColumnNames: _col0, _col1, _col2
  Reduce Output Operator
  key expressions:
  expr: _col1
  type: string

EXPLAIN - the "reduce" (slide 3/3)

```
• value expressions:
        expr: _col0
        type: int
        expr: _col1
        type: string
        expr: _col2
        type: double
  Reduce Operator Tree:
        Extract
            File Output Operator
```





Optimizations

- Some operations use direct HDFS access
  - `SELECT * FROM table LIMIT 10;`
- Number of MapReduce phases is minimized if possible
- Map-side join via MAPJOIN hint
  - ```
    SELECT /*+ MAPJOIN(t1) */ t1.col, t2.col
    FROM t1 JOIN t2
    ON (t1.col = t2.col)
    ```
    ```

Hive extension: multi-table insert

```
FROM(
  SELECT username, accessdate
  FROM logs WHERE url LIKE '%.cloudera.com'
  ) clicks

INSERT OVERWRITE DIRECTORY 'count'
   SELECT count(1)

INSERT OVERWRITE DIRECTORY 'list_users'
   SELECT DISTINCT clicks.username;
```

Invoking custom map script

- `ADD FILE /tmp/map.py;`

- ```
  INSERT OVERWRITE TABLE results_table
    SELECT transform(logdata.*)
    USING'./map.py' as (output)
    FROM
      (SELECT *
       FROM logs) logdata;
  ```

Map.py receives the log records as tab-separated list and returns output
  ```

Partitioning and bucketing

- Divide data into subsets of rows
- Benefits:
  - Better performance
  - Easier data management (add or delete a portion of a table)
  - Sampling of data

Partitioning

- CREATE TABLE logs (url STRING, user STRING)
  PARTITIONED BY (d STRING);

- LOAD DATA LOCAL INPATH
  '/tmp/new_logs.txt'
  INTO TABLE logs
  PARTITION (d='2010-04-01');

Bucketing

- CREATE TABLE *tablename* (*columns*)

  CLUSTERED BY (*col*) INTO *N* BUCKETS;

- SET hive.enforce.bucketing = true;

- INSERT OVERWRITE TABLE *target*

  SELECT * FROM *helper*;

Sampling

- Reading a subset of the data is very efficient if the table is bucketed
- `SELECT * FROM tablename`

  `TABLESAMPLE (BUCKET 1 OUT OF 4 ON col)`

Summary of Hive

- Enables easy analysis of data without a lot of setup
- Adds features that Hadoop lacks via the metastore
- Quite full-featured with lots of development work ongoing

Thanks!

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