Welcome to Hive

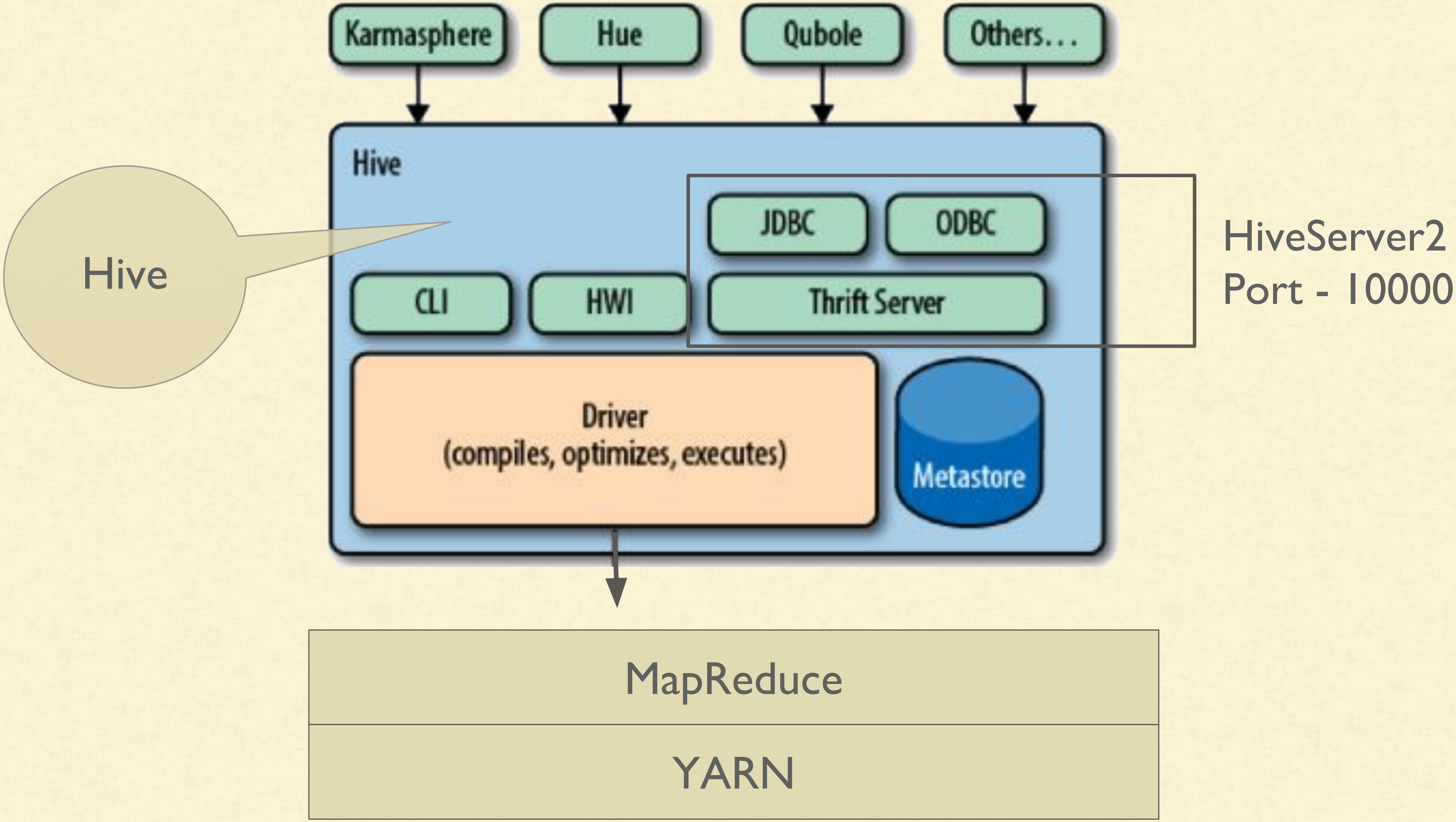
Hive - Introduction

- Data warehouse infrastructure tool
- Process structured data in Hadoop
- Resides on top of Hadoop
- Makes data churning easy
- Provides SQL like queries

Why Do We Need Hive?

- Developers face problem in writing MapReduce logic
- How to port existing
    - relational databases
    - SQL infrastructure with Hadoop?
- End users are familiar with SQL queries than MapReduce and Pig
- Hive’s SQL-like query language makes data churning easy

Hive - Components



Hive

HiveServer2
Port - 10000

MapReduce

YARN

Hive - Limitations

- Does not provide row level updates (earlier versions)
- Not suitable for OLTP
  - Queries have higher latency
  - Start-up overhead for MapReduce jobs
- Best when large dataset is maintained and mined

Hive - Data Types - Numeric

- TINYINT (1-byte signed integer)
- SMALLINT (2-byte signed integer)
- INT (4-byte signed integer)
- BIGINT (8-byte signed integer)
- FLOAT (4-byte single precision floating point number)
- DOUBLE (8-byte double precision floating point number)
- DECIMAL (User defined precisions)

Hive - Data Types - Date/Time

- TIMESTAMP (Hive version > 0.8.0)
- DATE (Hive version > 0.12.0) - YYYY-MM-DD

Hive - Data Types - String

- STRING
- VARCHAR (Hive version > 0.12.0)
- CHAR (Hive version > 0.13.0)

Hive - Data Types - Misc

- BOOLEAN
- BINARY (Hive version > 0.8.0)

Hive - Data Types - Complex

arrays: ARRAY<data_type>

maps: MAP<primitive_type, data_type>

structs: STRUCT<col_name : data_type [COMMENT col_comment], ...>

union: UNIONTYPE<data_type, data_type, ...> (Hive version > 0.7.0)

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

“John”

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

40000.00

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

[“Michael”, “Rumi”]

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

```
{
“Insurance”: 500.00,
“Charity”: 600.00
}
```

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

“street” : “2711”,
“city”: “Sydney”,
“state”: “Wales”,
“zip”: 560064

Hive - Data Types - Example

```
CREATE TABLE employees(
    name STRING,
    salary FLOAT,
    subordinates ARRAY<STRING>,
    deductions MAP<STRING, FLOAT>,
    address STRUCT<street:STRING,
        city:STRING,
        state:STRING,
        zip:INT>,
    auth UNION<fbid:INT, gid:INT, email:STRING>
)
```

“fbid”:168478292

Hive - Metastore

- Stores the metadata of tables into a relational database
- Metadata includes
  - Details of databases and tables
  - Table definitions: name of table, columns, partitions etc.

Hive - Warehouse

- Hive tables are stored in the Hive warehouse directory
- /apps/hive/warehouse on HDFS
- At the location specified in the table definition

Hive - Getting Started - Command Line

- Login to CloudxLab Linux console

- Type *“hive”* to access hive shell

- By default database named “default” will be selected as current db for the current session

- Type *“SHOW DATABASES”* to see list of all databases

Hive - Getting Started - Command Line

- *“SHOW TABLES”* will list tables in current selected database which is “default” database.
- Create your own database with your login name
- *CREATE DATABASE abhinav9884;*
- *DESCRIBE DATABASE abhinav9884;*
- *DROP DATABASE abhinav9884;*

Hive - Getting Started - Command Line

- *CREATE DATABASE abhinav9884;*
- *USE abhinav9884;*
- *CREATE TABLE x (a INT);*

Hive - Getting Started - Hue

- Login to Hue
- Click on “Query Editors” and select “Hive”
- Select your database (abhinav9984) from the list
- *SELECT * FROM x;*
- *DESCRIBE x;*
- *DESCRIBE FORMATTED x;*

Hive - Tables

- Managed tables
- External tables

Hive - Managed Tables

- Aka Internal
- Lifecycle managed by Hive
- Data is stored in the warehouse directory
- Dropping the table deletes data from warehouse

Hive - External Tables

- The lifecycle is not managed by Hive
- Hive assumes that it does not own the data
- Dropping the table does not delete the underlying data
- Metadata will be deleted

Hive - Managed Tables - Example

```
CREATE TABLE nyse(
    exchange1 STRING,
    symbol1 STRING,
    ymd STRING,
    price_open FLOAT,
    price_high FLOAT,
    price_low FLOAT,
    price_close FLOAT,
    volume INT,
    price_adj_close FLOAT
)
ROW FORMAT DELIMITED FIELDS TERMINATED BY '\t';

DESCRIBE nyse;
DESCRIBE FORMATTED nyse;
```

Hive - Loading Data - From Local Directory

- *hadoop fs -copyToLocal /data/NYSE_daily*
- Launch Hive
- *use yourdatabase;*
- *load data local inpath 'NYSE_daily' overwrite into table nyse;*
- Copies the data from local file system to warehouse

Hive - Loading Data - From HDFS

```
CREATE TABLE nyse_hdfs(
    exchange1 STRING,
    symbol1 STRING,
    ymd STRING,
    price_open FLOAT,
    price_high FLOAT,
    price_low FLOAT,
    price_close FLOAT,
    volume INT,
    price_adj_close FLOAT
)
ROW FORMAT DELIMITED FIELDS TERMINATED BY '\t';
```

Hive - Loading Data - From HDFS

- Copy /data/NYSE_daily to your home directory in HDFS
- *load data inpath 'hdfs:///user/abhinav9884/NYSE_daily' overwrite into table nyse_hdfs;*
- Moves the data from specified location to warehouse
- Check if NYSE_daily is in your home directory in HDFS

Hive - External Tables

```
CREATE EXTERNAL TABLE  nyse_external (
  exchange1 STRING,
  symbol1 STRING,
  ymd STRING,
  price_open FLOAT,
  price_high FLOAT,
  price_low FLOAT,
  price_close FLOAT,
  volume INT,
  price_adj_close FLOAT
)
ROW FORMAT DELIMITED FIELDS TERMINATED BY '\t'
LOCATION '/user/abhinav9884/NYSE_daily';

describe formatted nyse_external;
```

Hive - S3 Based External Table

```
create external table miniwikistats (
    projcode string,
    pagename string,
    pageviews int,
    bytes int)
partitioned by(dt string)
row format delimited fields terminated by ' '
lines terminated by '\n'
location 's3n://paid/default-datasets/miniwikistats/';
```

Hive - Select Statements

- Select all columns

```
SELECT * FROM nyse;
```

- Select only required columns

```
SELECT exchange1, symbol1 FROM nyse;
```

Hive - Aggregations

- Find average opening price for each stock

```
SELECT symbol1, AVG(price_open) AS avg_price FROM nyse
GROUP BY symbol1;
```

- To improve performance set top-level aggregation in map phase

```
SET hive.map.aggr=true;
```

Hive - Saving Data

- In local file system

```
insert overwrite local directory  '/home/abhinav9884/onlycmc'
select * from nyse where symbol1 = 'CMC';
```

- In HDFS

```
insert overwrite directory  'onlycmc' select * from nyse where
symbol1 = 'CMC';
```

Hive - Tables - DDL - ALTER

- Rename a table

ALTER TABLE x RENAME TO x1;

- Change datatype of column

ALTER TABLE x1 CHANGE a a FLOAT;

- Add columns in existing table

ALTER TABLE x1 ADD COLUMNS (b FLOAT, c INT);

Hive - Partitions

```
#First name, Department, Year of joining
Mark, Engineering, 2012
Jon, HR, 2012
Monica, Finance, 2015
Steve, Engineering, 2012
Michael, Marketing, 2015
```

Hive - Partitions - Hands-on

- Data is located at /data/bdhs/employees/ on HDFS

- Copy data to your home directory in HDFS

```
hadoop fs -cp /data/bdhs/employees .
```

- Create table

```
CREATE TABLE employees(
name STRING,
department STRING,
somedate DATE
)
PARTITIONED BY(year STRING)
ROW FORMAT DELIMITED FIELDS TERMINATED BY ',';
```

Hive - Partitions - Hands-on

- Load dataset 2012.csv

load data inpath 'hdfs:///user/sandeepgiri9034/employees/2012.csv' into table employees partition (year=2012);

- Load dataset 2015.csv

load data inpath 'hdfs:///user/sandeepgiri9034/employees/2015.csv' into table employees partition (year=2015);

- *SHOW PARTITIONS employees;*
- Check warehouse and metastore

Hive - Partitions - Summary

- To avoid the full table scan
- The data is stored in different files in warehouse defined by the partitions
- Define the partitions using “partition by” in “create table”
- We can also add a partition later
- Partition can happen on multiple columns (year=2012, month=10, day=12)

Hive - Views

- *SELECT * FROM employees where department='Engineering';*
- Create a view

  CREATE VIEW employees_engineering AS
  *SELECT * FROM employees where department='Engineering';*

- Now query from the view

  *SELECT * FROM employees_engineering;*

Hive - Views - Summary

- Allows a query to be saved and treated like a table
- Logical construct - does not store data
- Hides the query complexity
- Divide long and complicated query into smaller and manageable pieces
- Similar to writing a function in a programming language

Hive - Load JSON Data

- Download JSON-SERDE BINARIES
- ADD JAR

```
hdfs:///data/serde/json-serde-1.3.6-SNAPSHOT-jar-with-dependencies.jar;
```

- Create Table

```
CREATE EXTERNAL TABLE tweets_raw (

)
ROW FORMAT SERDE 'org.apache.hive.hcatalog.data.JsonSerDe'
LOCATION '/user/abhinav9884/senti/upload/data/tweets_raw';
```

Hive - Sorting & Distributing - Order By

ORDER BY x

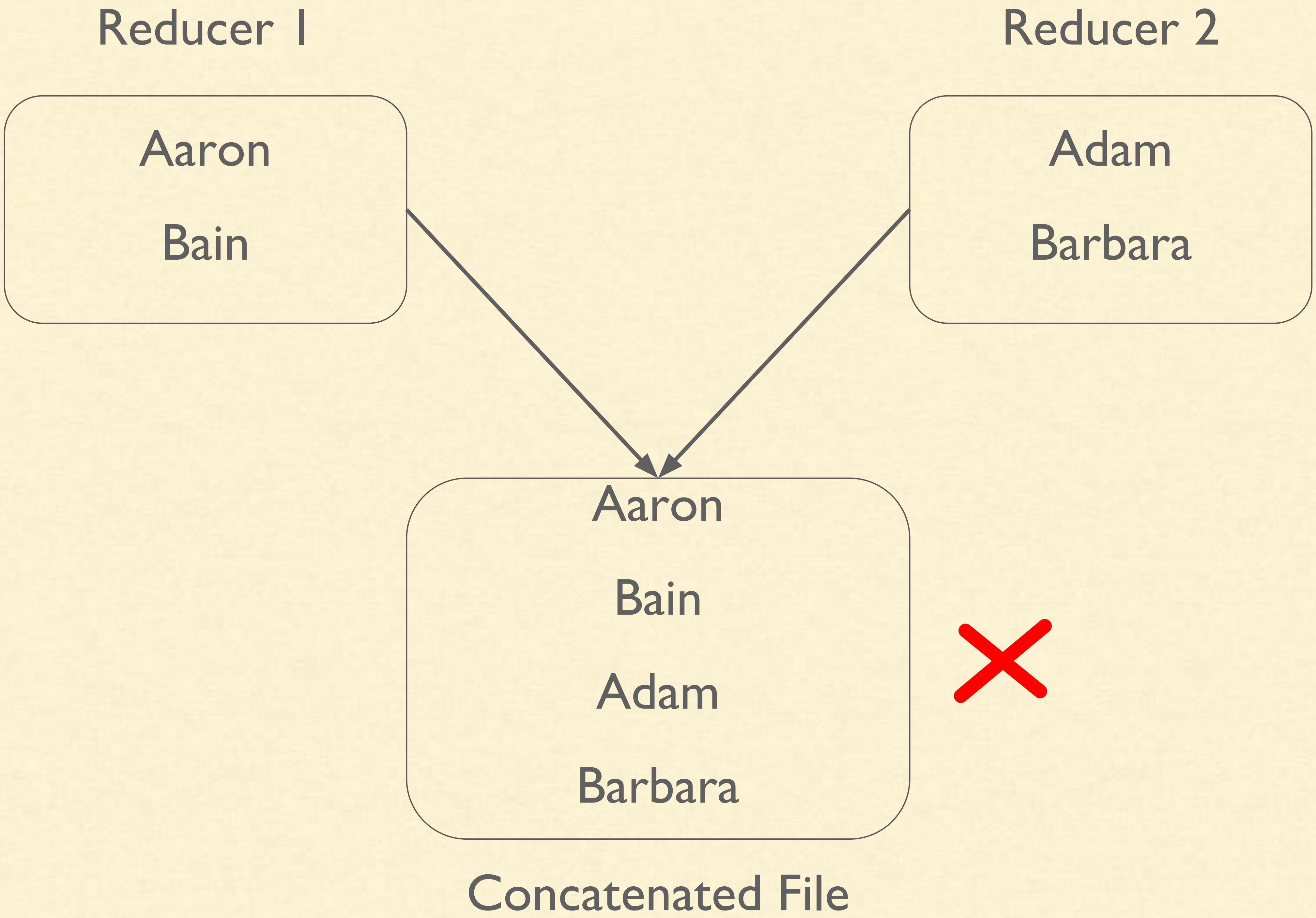
- Guarantees global ordering
- Data goes through just one reducer
- This is unacceptable for large datasets as it will overload the reducer
- You end up one sorted file as output

Hive - Sorting & Distributing - Sort By

SORT BY x

- Orders data at each of N reducers
- Number of reducers are 1 per 1GB
- You end up with N or more sorted files with overlapping ranges

Hive - Sorting & Distributing - Sort By



Reducer 1

Aaron

Bain

Reducer 2

Adam

Barbara

Aaron

Bain

Adam

Barbara

✗

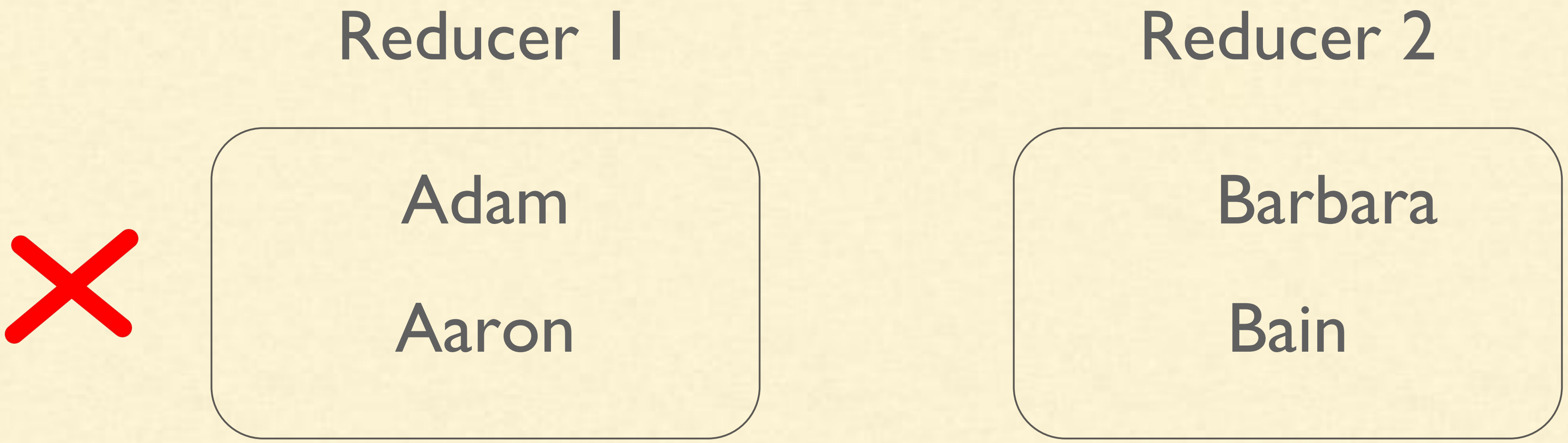
Concatenated File

Hive - Sorting & Distributing - Distribute By

DISTRIBUTE BY x

- Ensures each of N reducers gets non-overlapping ranges of x
- But doesn't sort the output of each reducer
- You end up with N or unsorted files with non-overlapping ranges

Hive - Sorting & Distributing - Distribute By



Reducer 1

✗

Adam

Aaron

Reducer 2

Barbara

Bain

Hive - Sorting & Distributing - Cluster By

CLUSTER BY x

- Gives global ordering
- Is the same as (DISTRIBUTE BY x and SORT BY x)
- CLUSTER BY is basically the more scalable version of ORDER BY

Hive - Bucketing

```
CREATE TABLE page_view(viewTime INT, userid BIGINT,
    page_url STRING, referrer_url STRING,
    ip STRING COMMENT 'IP Address of the User'
)
COMMENT 'This is the page view table'
PARTITIONED BY(dt STRING, country STRING)
CLUSTERED BY(userid) INTO 32 BUCKETS
ROW FORMAT DELIMITED FIELDS TERMINATED BY '\001'
COLLECTION ITEMS TERMINATED BY '\002'
MAP KEYS TERMINATED BY '\003'
STORED AS SEQUENCEFILE;
```

Hive - ORC Files

- Optimized Row Columnar file format
- Provides a highly efficient way to store Hive data
- Improves performance when
    - Reading
    - Writing
    - Processing
- Has a built-in index, min/max values, and other aggregations
- Proven in large-scale deployments
    - Facebook uses the ORC file format for a 300+ PB deployment

Hive - ORC Files - Example

```
CREATE TABLE orc_table (
  first_name STRING,
  last_name STRING
) STORED AS ORC;


INSERT INTO orc_table VALUES('John', 'Gill');
SELECT * from orc_table;
```

To Know more, please visit https://orc.apache.org

Hive - Quick Recap

- Each table has got a location
- By default the table is in a directory under the location /apps/hive/warehouse
- We can override that location by mentioning 'location' in create table clause
- Load data copies the data if it is local
- Load moves the data if it is on hdfs for both external and managed tables
- Dropping managed table deletes the data at the 'location'
- Dropping external table does not delete the data at the 'location'
- The metadata is stored in the relational database - hive metastore

Hive - Connecting to Tableau

- Tableau is a visualization tool
- Tableau allows for instantaneous insight by transforming data into visually appealing, interactive visualizations called dashboards

Hive - Connecting to Tableau - Steps

- Download and install Tableau desktop from

  https://www.tableau.com/products/desktop

- Download and install Hortonworks ODBC driver for Apache Hive for your OS

  https://hortonworks.com/downloads/

Hive - Connecting to Tableau - Hands-on

Visualize top 10 stocks with highest opening price on Dec 31, 2009

Hive - Quick Demo

1. **Copy data from /data/ml100k/u.data into our hdfs home**
2. **Open Hive in Hue and run following:**

```
CREATE TABLE u_data( userid INT, movieid INT, rating INT, unixtime STRING)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY '\t'
STORED AS TEXTFILE;

LOAD DATA INPATH '/user/sandeepgiri9034/u.data' overwrite into table u_data;

select * from u_data limit 5;

select movieid, avg(rating) ar from u_data group by movieid order by ar desc
```

Hive - Quick Demo

Join with Movie Names

```
create view top100m as
select movieid, avg(rating) ar from u_data group by movieid order by ar desc

CREATE TABLE m_data( movieid INT, name STRING)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY '|'
STORED AS TEXTFILE;

load data inpath '/user/sandeepgiri9034/u.item' into table m_data;
select * from m_data limit 100
select * from m_data, top100m where top100m.movieid = m_data.movieid
```

Hive - Assignment

1. For each movie how many users rated it
2. For movies having more than 30 ratings, what is the average rating