

Course Title & Code: Big Data Storage and Management (CDS502)

Introduction to Hadoop

Course Lecturers:
Dr. Mohd. Adib Haji Omar
Dr. Chew XinYing

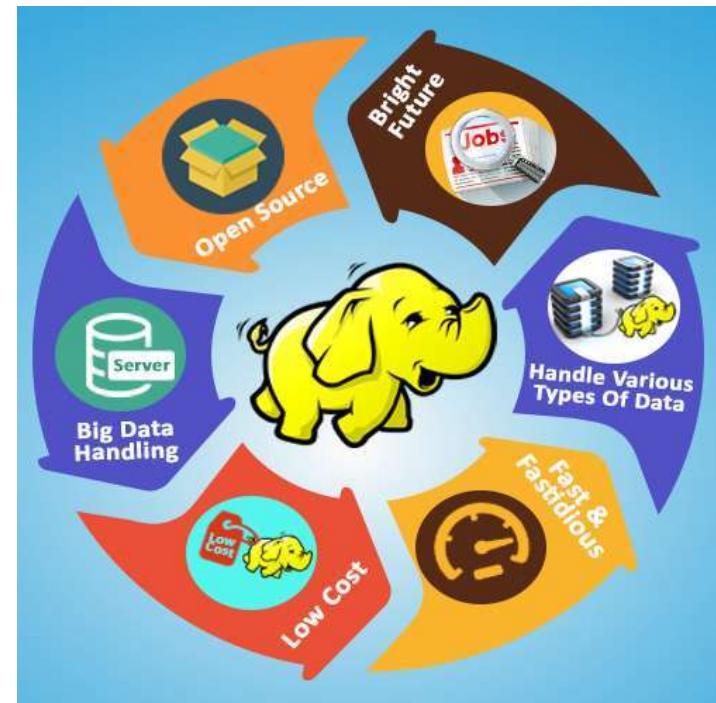
Download & Install

WinSCP

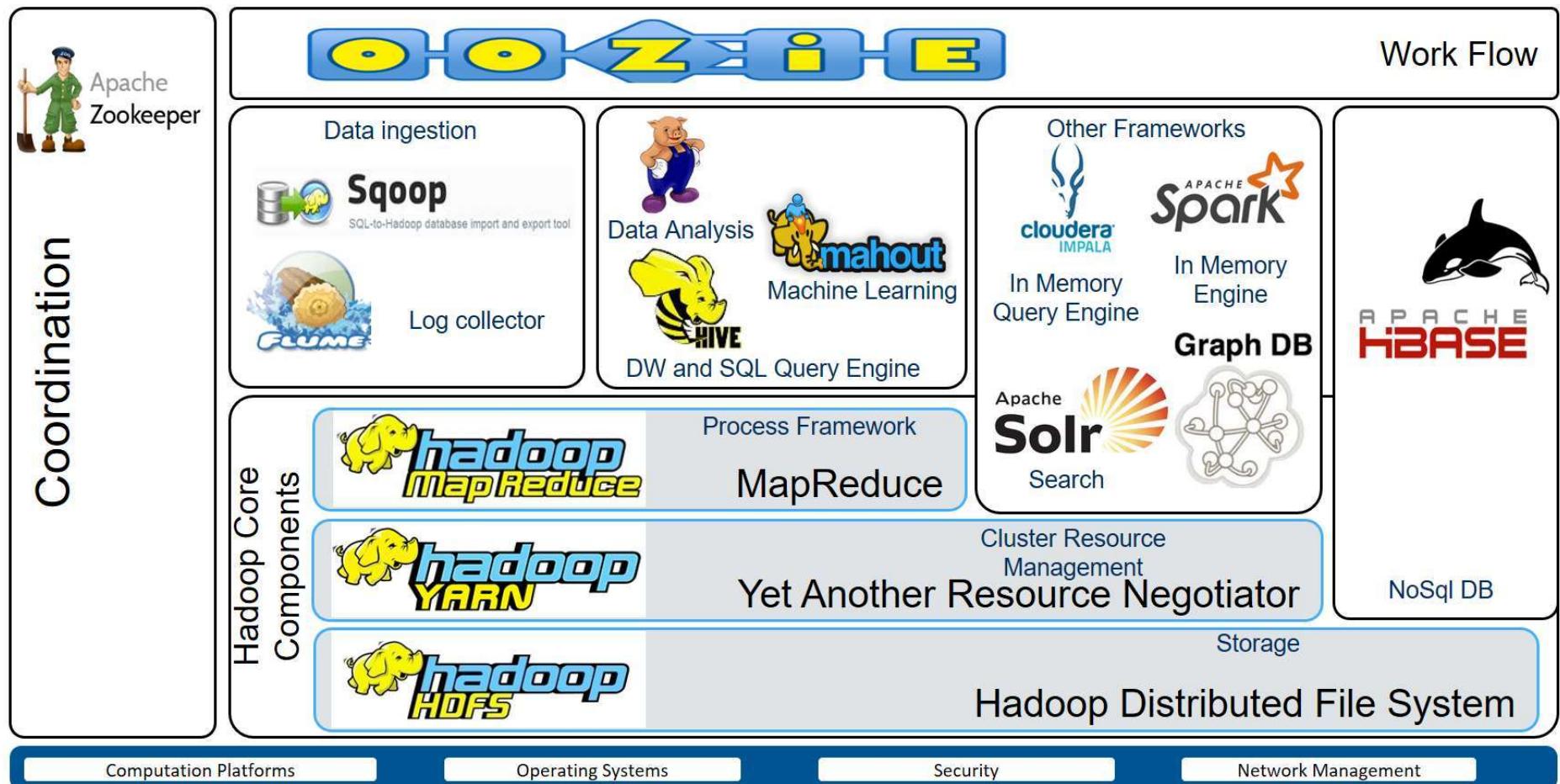


What is Hadoop?

- **Hadoop** is an open source, Java-based programming framework that supports the processing and storage of extremely large data sets in a distributed computing environment.
- It is part of the Apache project sponsored by the Apache Software Foundation



Hadoop Core Components and Ecosystem



Computation Platforms

Operating Systems

Security

Network Management

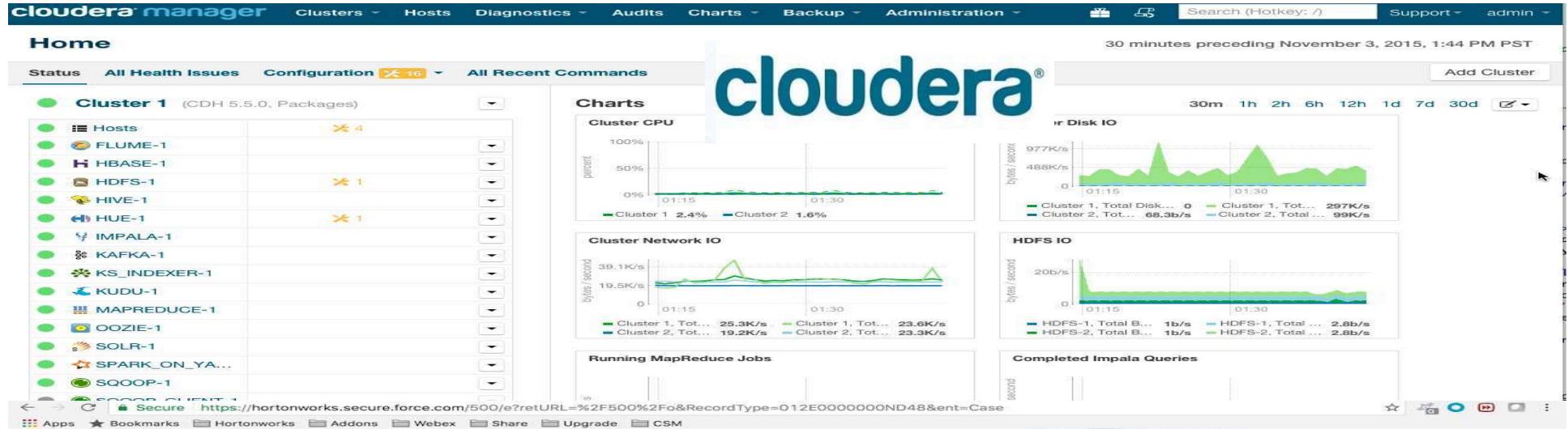
Modules of Hadoop Ecosystem

- Hadoop Distributed File System (HDFS): A distributed file system that provides high-throughput access to application data.
- Hadoop YARN: A framework for job scheduling and cluster resource management.
- Hadoop MapReduce: A YARN-based system for parallel processing of large data sets.



Popular Hadoop Distributions

Hadoop Distribution	Advantages	Disadvantages
Cloudera Distribution for Hadoop (CDH) 	CDH has a user friendly interface with many features and useful tools like Cloudera Impala	CDH is comparatively slower than MapR Hadoop Distribution
MapR Hadoop Distribution 	It is one of the fastest hadoop distribution with multi node direct access.	MapR does not have a good interface console as Cloudera
Hortonworks Data Platform (HDP) 	It is the only Hadoop Distribution that supports Windows platform.	The Ambari Management interface on HDP is just a basic one and does not have many rich features.



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Search: Search All Go! Advanced Search...

Find KB Articles: Go! Create New... Recent Items: ENV-00594

Case Edit Case Information Submit Cancel

Product Type: HDP (Hortonworks Data Platform)

Deployment Phase: Production

Ambari Version: --None--

Operating System: 2.4.1.0

Cloud Provider: --None--

Product Info

Product Component: Problem Type: Does your case involve Kerberos, Ra

Security Features Involved: Chosen

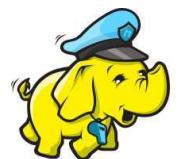
SmartSense Info (Get more info About SmartSense): Will you be uploading a SmartSense Support Bundle after creating this case?

Stack Version: 2.6.0 Environment: Severity: --None--



When to Use Hadoop?

- **Your Data Sets Are Really Big** – If data is small, use Excel, a SQL BI tool on Postgres, or some similar combination, but if data is in TBs or Petabytes, Hadoop's superior scalability will save you a considerable amount of time and money.
- **You Celebrate Data Diversity** – It doesn't matter whether your raw data is structured (like out of an ERP system), semi-structured (like XML and log files), unstructured (like video files) or all three—Hadoop and its forgiving schema will gobble it up.
- **You Are Building an ‘Enterprise Data Hub’ for the Future** – If you work for large enterprise, you might sign up for Hadoop even if your data isn't particularly massive or diverse or fast at this point in time.
- **You Find Yourself Throwing Away Perfectly Good Data** – Hadoop can store petabytes of data. If you find that you are throwing away potentially valuable data because its costs too much to archive, you may find that setting up a Hadoop cluster allows you to retain this data, and gives you the time to figure out how to best make use of that data.



Where Hadoop is Used Now?



2006

YAHOO!



2007



last.fm

2008



2009



2010



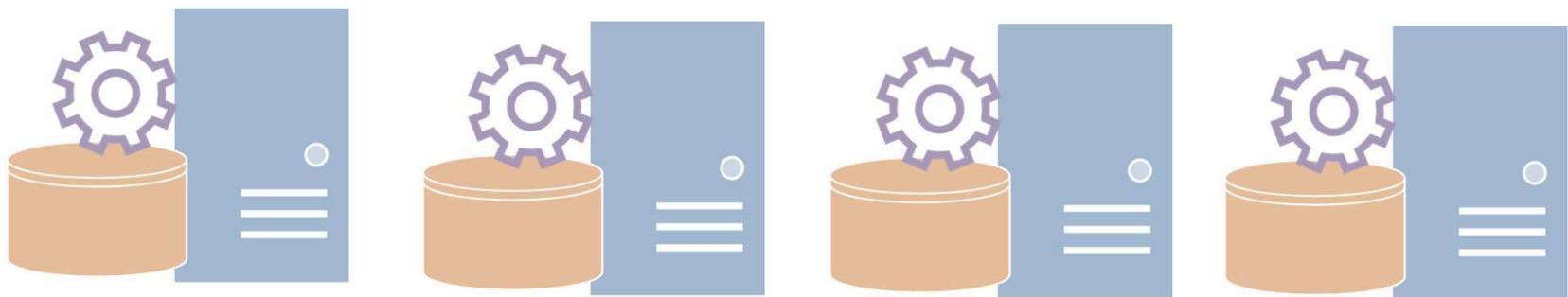
Hadoop in a Nut Shell

1. Build a cluster of machines

2. Distribute your data



3. Process your data in parallel



Hadoop Distributed File System (HDFS)

- A Java-based file system that provides **scalable, fault-tolerant, distributed storage** system.
- A **Hadoop cluster** has nominally a single **NameNode** plus a cluster of **DataNodes**.
- HDFS stores filesystem **metadata** and application **data** separately.



At a Glance

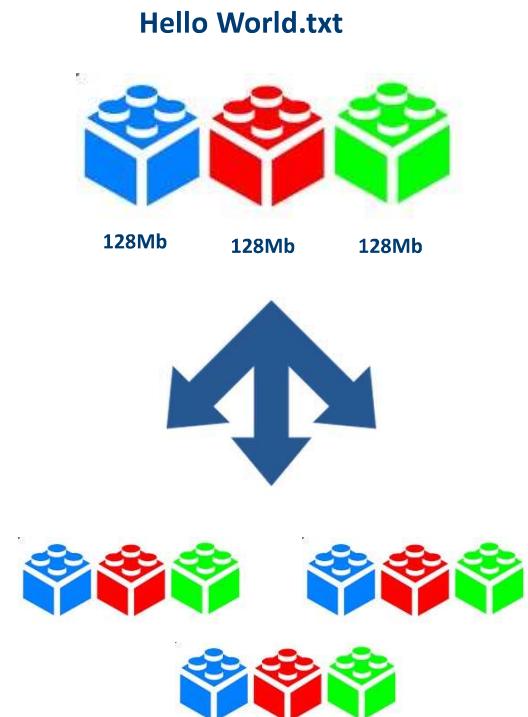


Introduction to Hadoop

At-A-Glance

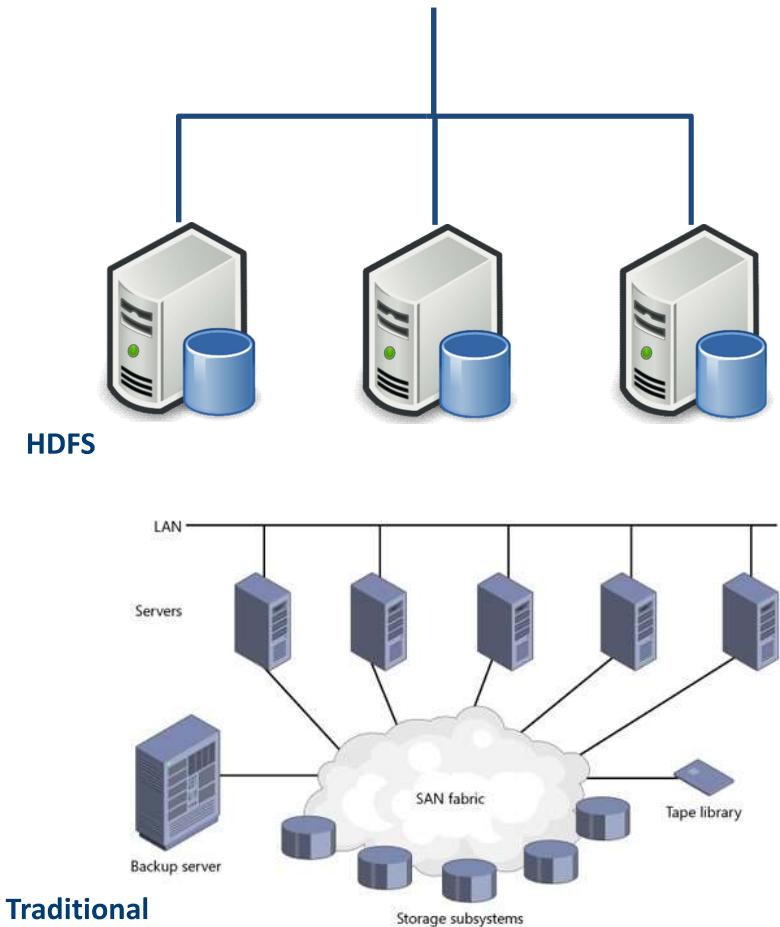
HDFS - Concepts

- Splits files into large blocks and distributes them across nodes in a cluster.
 - Typically 128 megabytes
- Each block of the file is independently replicated at multiple **DataNodes**.
 - Data nodes can talk to each other to rebalance data, to move copies around, and to keep the replication of data high
- Default replication value, 3, data is stored on three nodes.
 - Two on the same rack, and one on a different rack



HDFS - Concepts

- This approach takes advantage of **data locality**, nodes manipulating the data they have access to
 - Allow the dataset to be processed faster and more efficiently
- **“Moving Computation is Cheaper than Moving Data”**
 - A computation requested by an application is much more efficient if it is executed near the data it operates on.



HDFS - Concepts



- **HDFS Client**
 - HDFS client interacts with **Namenode** and **Datanode** on behalf of user to fulfil user request.
 - Establishes communication with HDFS through **File System API** and normal I/O operations.
- **Namenode**
 - Namenode is the **masternode** of HDFS cluster.
 - It stores **metadata** information and edit log in it.
 - Metadata information contains addresses of **block locations** of Datanodes.
 - This information is used for file **read and write operation** to access the blocks in a HDFS cluster.
 - The NameNode maintains the **namespace tree** and the mapping of **blocks** to DataNodes.

HDFS - Concepts



- **Datanode**
 - Datanodes holds the actual **data**.
 - Datanode gives periodic **heartbeat signals** to Masternode to indicate that it is alive and can be used to store and retrieve data.



Hands-on Environment

- Connection:
 - Server name: **chew.cs.usm.my**
 - Port: 22
 - User name: user# (e.g. user2)
 - Password: user2@123
 - **# (From 2 to 30)**

Group 11

1. Eng Jia Yun (P-COM0253/20) - Group Leader
2. Ong Boon Tean (P-COM0229/20)
3. Ng Tze Hong (P-COM0022/21)
4. Lim Zhi Mei (P-COM0257/20)
5. Ng Jia Chen (P-COM0049/21)
6. Ching Fum Yew (P-COM0243/20)



XY 21m
user12

- Each group will share an account (For today's session)
- Please follow the group for your Group Project (5-6 Members / Group)
- Refer to the Padlet link:
<https://padlet.com/abuluqman/CDS502ProjectGroup> for the user name.

DEMO



Hadoop Commands

Print the Hadoop version	hadoop version
Help	hadoop fs -help
List the contents of the root directory in HDFS	<i>hadoop fs -ls [-d] [-h] [-R] [-t] [-S] [-r] [-u] <args></i> hadoop fs -ls /
List files in HDFS	hadoop fs -ls hadoop fs -ls
Create a new directory in HDFS (subdirectory)	<i>hadoop fs -mkdir [-p] <paths></i> hadoop fs -mkdir /temp
Create a empty file	hadoop fs -touchz URI hadoop fs -touchz /temp/empty
Delete the file	<i>hadoop fs -rm [-f] [-r -R] [-skipTrash] URI [URI ...]</i> hadoop fs -rm /temp/empty
Move the directory to trash	<i>hadoop fs -rmdir [--ignore-fail-on-non-empty] URI [URI ...]</i> hadoop fs -rmdir /temp

docker exec -it nodemaster /bin/bash

docker cp iris.csv nodemaster:/



Hadoop Gateway

```
> docker exec -it nodemaster /bin/bash  
> python try.py
```

```
hadoop@nodemaster: /tmp  
*** System restart required ***  
Last login: Wed Oct  2 13:49:50 2019 from 10.207.202.244  
hadoop1@ChewXY-USM-T30:~$ docker exec -u hadoop -it nodemaster /bin/bash  
hadoop@nodemaster:/$ cd /tmp  
hadoop@nodemaster:/tmp$ python try.py  
0:00:00.003271  
   id SepalLengthCm ... PetalWidthCm      Species  
0    1          5.1 ...        0.2 Iris-setosa  
1    2          4.9 ...        0.2 Iris-setosa  
2    3          4.7 ...        0.2 Iris-setosa  
3    4          4.6 ...        0.2 Iris-setosa  
4    5          5.0 ...        0.2 Iris-setosa  
5    6          5.4 ...        0.4 Iris-setosa  
6    7          4.6 ...        0.3 Iris-setosa  
7    8          5.0 ...        0.2 Iris-setosa  
8    9          4.4 ...        0.2 Iris-setosa  
9   10          4.9 ...        0.1 Iris-setosa  
10  11          5.4 ...        0.2 Iris-setosa  
11  12          4.8 ...        0.2 Iris-setosa  
12  13          4.8 ...        0.1 Iris-setosa  
13  14          4.3 ...        0.1 Iris-setosa  
14  15          5.8 ...        0.2 Iris-setosa  
15  16          5.7 ...        0.4 Iris-setosa  
16  17          5.4 ...        0.4 Iris-setosa
```

Group Activity 1

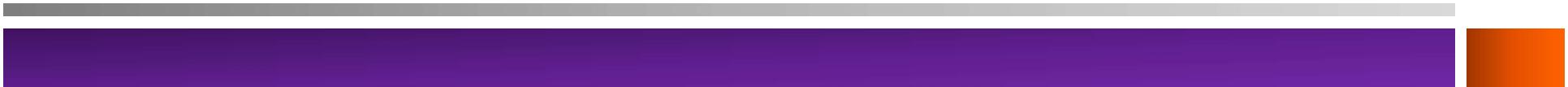
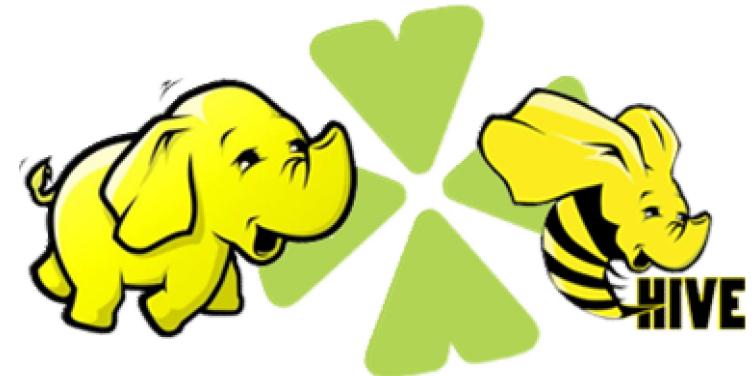


- Perform & Screenshot the following activities:
 - List the contents of the root directory in HDFS.
 - Create a new directory in HDFS (subdirectory) – Name the directory with your first name.
 - Create an empty file (name it with your last name) in the new directory that you have created before.
 - Delete the file created.
 - Delete the directory created.
- Submit your doc. To the link created in e-learn. (Group Activity 1) **Only 1 submission per group.**

Apache Hive



Apache Hive



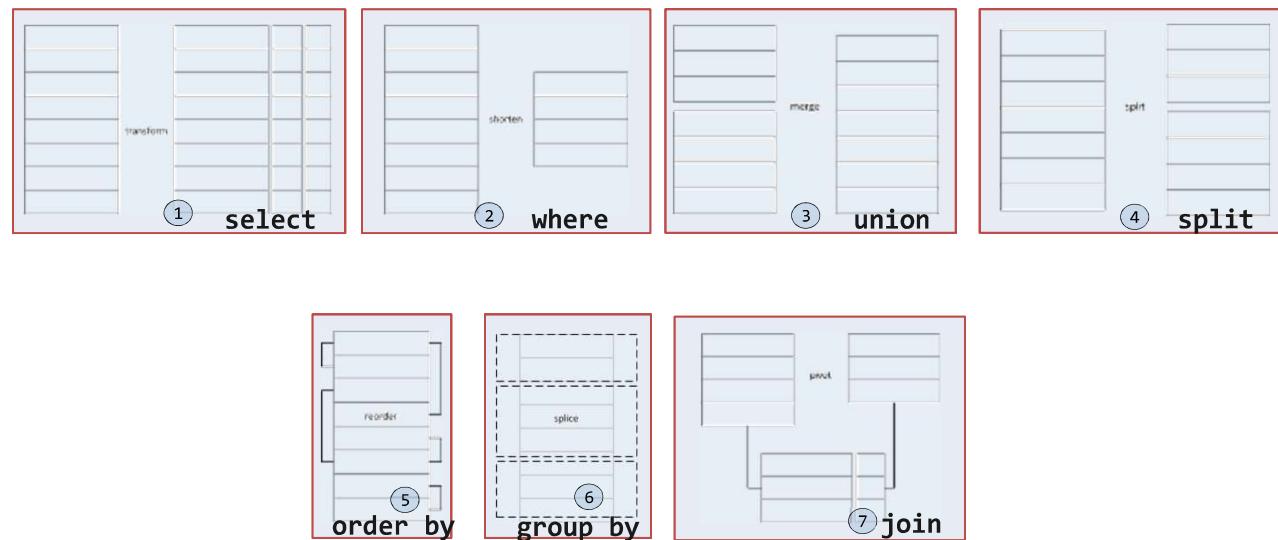
What is Hive?

- Developed by Facebook.
- Enable SQL dialect on Hadoop patterns; SQL is easier to learn and easier to acquire.
- Enable easy data analytics, statistics, and aggregates on big data.

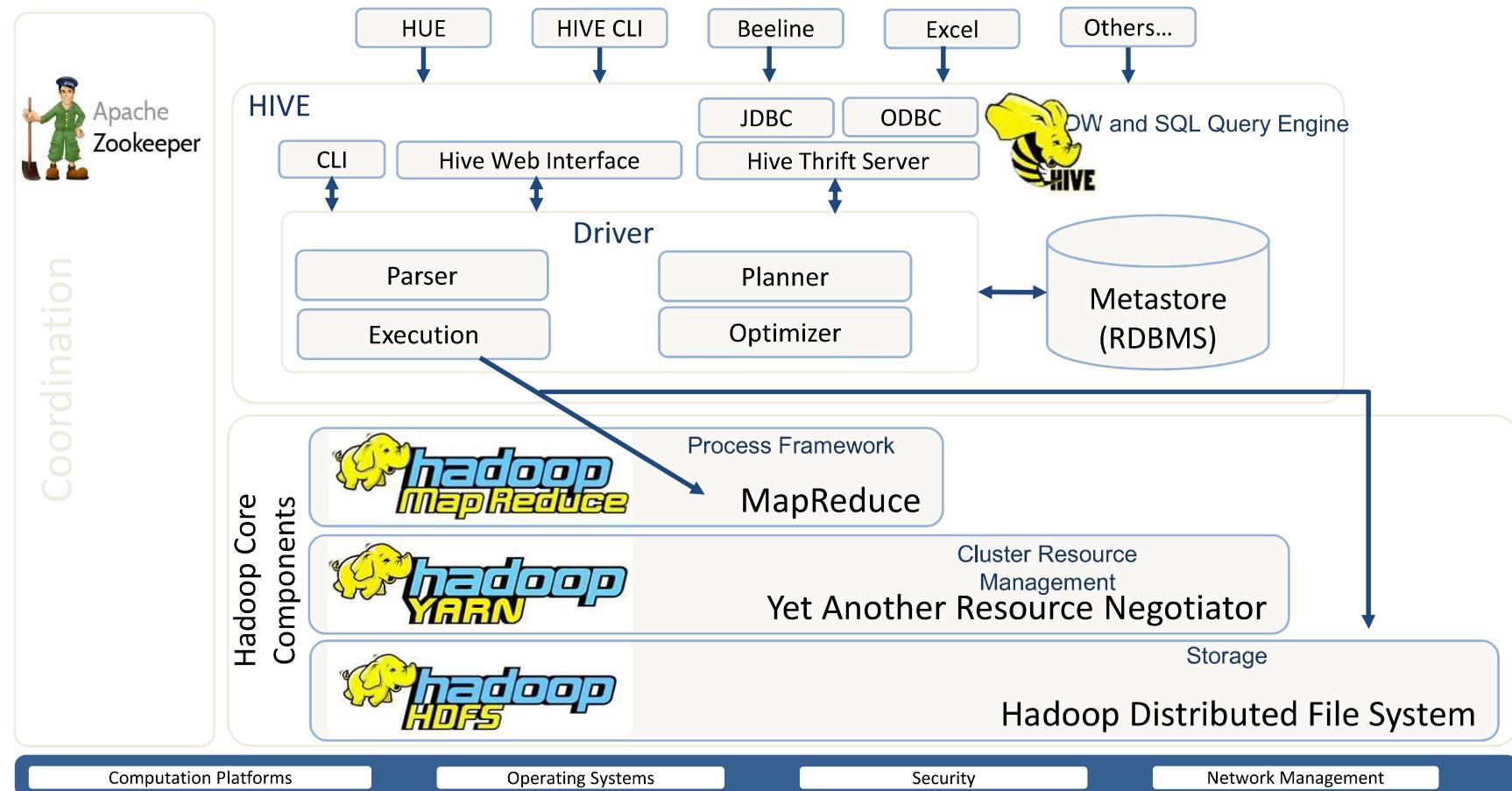


Hive is a DW “model” on top of Hadoop
But, Hive is NOT SQL

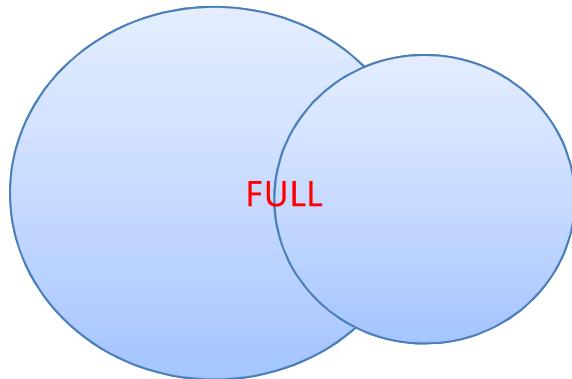
Big Data Patterns – Applicable to Hive



Hive Architecture

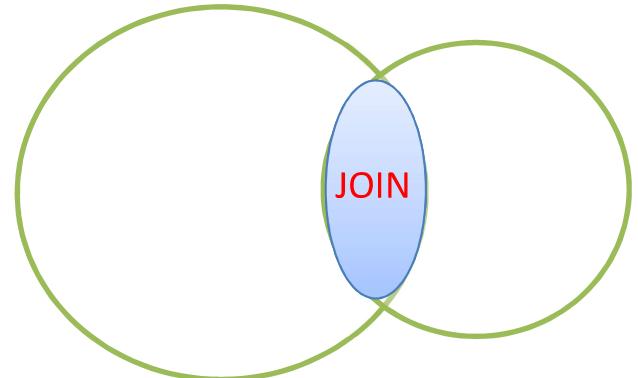


HiveQL - Select-Joins

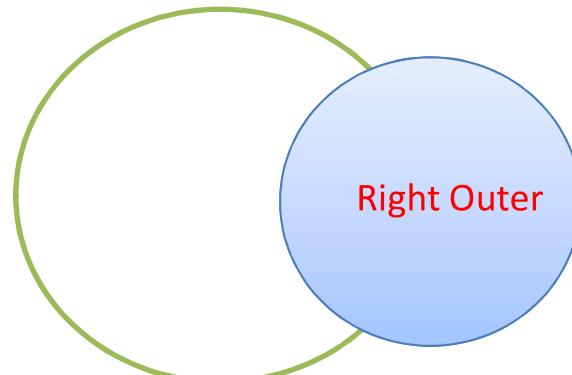
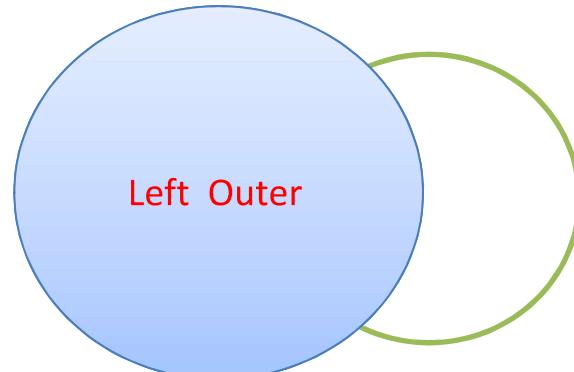


There are different types of joins given as follows:

- JOIN
- LEFT OUTER JOIN
- RIGHT OUTER JOIN
- FULL OUTER JOIN



JOIN is a clause that is used for combining specific fields from two tables by using values common to each one. It is used to combine records from two or more tables in the database. It is more or less similar to SQL JOIN.



HiveQL - Select-Joins



Consider the following tables:

Table Name: STUDENT

MATRIXNO	NAME	AGE	COUNTRY	EARNINGS
1	Mary	22	Australia	4000.00
2	Peter	52	England	2400.00
3	Blue	27	Malaysia	1455.00
4	Jane	38	Denmark	12000.00
5	David	49	Nigeria	9000.00
6	Brown	22	Algeria	2411.00
7	Jack	17	Belgium	2415.00

Table Name: ORDER1

IDMATRIX	DATETIME	STUDENTMATRIX	AMOUNT
202	2009-11-08 00:00:00	3	1500
200	2007-10-08 00:00:00	3	2790
201	2006-12-09 00:00:00	2	4976
203	2005-10-11 00:00:00	4	9477

HiveQL - Select-Joins

- JOIN clause is used to combine and retrieve the records from multiple tables. A JOIN condition is to be raised using the primary keys and foreign keys of the tables.
- The following query executes **JOIN** on the STUDENT and ORDER1 tables, and retrieves the records:

```
hive> SELECT c.MATRIXNO, c.NAME, c.AGE, o.AMOUNT
  FROM STUDENT c JOIN ORDER1 o
  ON (c.MATRIXNO = o.STUDENTMATRIX);
```

On successful execution of the query, you get to see the following response:

MATRIXNO	NAME	AGE	AMOUNT
3	Blue	27	1500
3	Blue	27	2790
2	Peter	52	4976
4	Jane	38	9477

HiveQL - Select-Joins

- The HiveQL **LEFT OUTER JOIN** returns all the rows from the left table, even if there are no matches in the right table. This means, if the ON clause matches 0 (zero) records in the right table, the JOIN still returns a row in the result, but with NULL in each column from the right table.
- A LEFT JOIN returns all the values from the left table, plus the matched values from the right table, or NULL in case of no matching JOIN predicate.
- The following query demonstrates **LEFT OUTER JOIN** between STUDENT and ORDER1 tables:

```
hive> SELECT c.MATRIXNO, c.NAME, o.AMOUNT, o.DATETIME  
FROM STUDENT c LEFT OUTER JOIN ORDER1 o  
ON (c.MATRIXNO = o.STUDENTMATRIX);
```

On successful execution of the query, you get to see the following response:

MATRIXNO	NAME	AMOUNT	DATETIME
1	Mary	NULL	NULL
2	Peter	497	2006-12-09 00:00:00
3	Blue	1500	2009-11-08 00:00:00
3	Blue	2790	2007-10-08 00:00:00
4	Jane	9477	2005-10-11 00:00:00
5	David	NULL	NULL
6	Brown	NULL	NULL
7	Jack	NULL	NULL

HiveQL - Select-Joins

- The HiveQL **RIGHT OUTER JOIN** returns all the rows from the right table, even if there are no matches in the left table. If the ON clause matches 0 (zero) records in the left table, the JOIN still returns a row in the result, but with NULL in each column from the left table.
- A RIGHT JOIN returns all the values from the right table, plus the matched values from the left table, or NULL in case of no matching join predicate.
- The following query demonstrates **RIGHT OUTER JOIN** between the CUSTOMER and ORDER1 tables:

```
hive> SELECT c.MATRIXNO, c.NAME, o.AMOUNT, o.DATETIME  
FROM STUDENT c RIGHT OUTER JOIN ORDER1 o  
ON (c.MATRIXNO = o.STUDENTMATRIX);
```

On successful execution of the query, you get to see the following response:

MATRIXNO	NAME	AMOUNT	DATETIME
3	Blue	1500	2009-11-08 00:00:00
3	Blue	2790	2007-10-08 00:00:00
2	Peter	497	2006-12-09 00:00:00
4	Jane	9477	2005-10-11 00:00:00

HiveQL - Select-Joins

- The HiveQL **FULL OUTER JOIN** combines the records of both the left and the right outer tables that fulfil the JOIN condition. The joined table contains either all the records from both the tables, or fills in NULL values for missing matches on either side.
- The following query demonstrates **FULL OUTER JOIN** between CUSTOMER and ORDER1 tables:

```
hive> SELECT c.MATRIXNO, c.NAME, o.AMOUNT, o.DATETIME  
FROM STUDENT c FULL OUTER JOIN ORDER1 o  
ON (c.MATRIXNO = o.STUDENTMATRIX);
```

On successful execution of the query, you get to see the following response:

MATRIXNO	NAME	AMOUNT	DATETIME
1	Mary	NULL	NULL
2	Peter	497	2006-12-09 00:00:00
3	Blue	1500	2009-11-08 00:00:00
3	Blue	2790	2007-10-08 00:00:00
4	Jane	9477	2005-10-11 00:00:00
5	David	NULL	NULL
6	Brown	NULL	NULL
7	Jack	NULL	NULL

Hands-on

```
$user> hive #open hive

$hive> show databases; #show databases/schemas in the warehouse

$hive> create schema userdb; #create new databases/schemas

$hive> use userdb; #use new databases/schemas

$hive> set hive.cli.print.current.db=true; #display databases/schemas

$hive> create table student (matrixno int, name string, age int, country string,
earnings BigInt) row format delimited fields terminated by ',' lines terminated by '\n'
stored as textfile; #create new table

$hive> load data local inpath '/student.csv' into table student; #load data into new
table

$hive> desc student; #show datatype of columns

$hive> select * from student; #show content of tables
```

docker exec -it nodemaster /bin/bash

docker cp student.csv nodemaster:/



Hands-on

```
$hive> set hive.cli.print.header=true; #display header/title of tables

$hive> create table order1 (idmatrix int, datetime string, studentmatrix int, amount
int) row format delimited fields terminated by ',' lines terminated by '\n' stored as
textfile; #create another new table

$hive> load data local inpath '/order.csv' into table order1; #load data into new
table

$hive> desc order1; #show datatype of new table

$hive> select * from order1; #show content of tables

$hive> exit; #quit from hive
```





What is HUE?

- Hue is a set of web applications that enable you to interact with a CDH cluster. Hue applications let you browse HDFS and work with Hive and Cloudera Impala queries, MapReduce jobs, and Oozie workflows.
- Hue applications run in a Web browser and require no client installation.
- Hue is available in 8 languages. (Spanish, French, German, Portuguese, Brazilian Portuguese, Japanese, simplified Chinese and Korean.)

HUE - Features



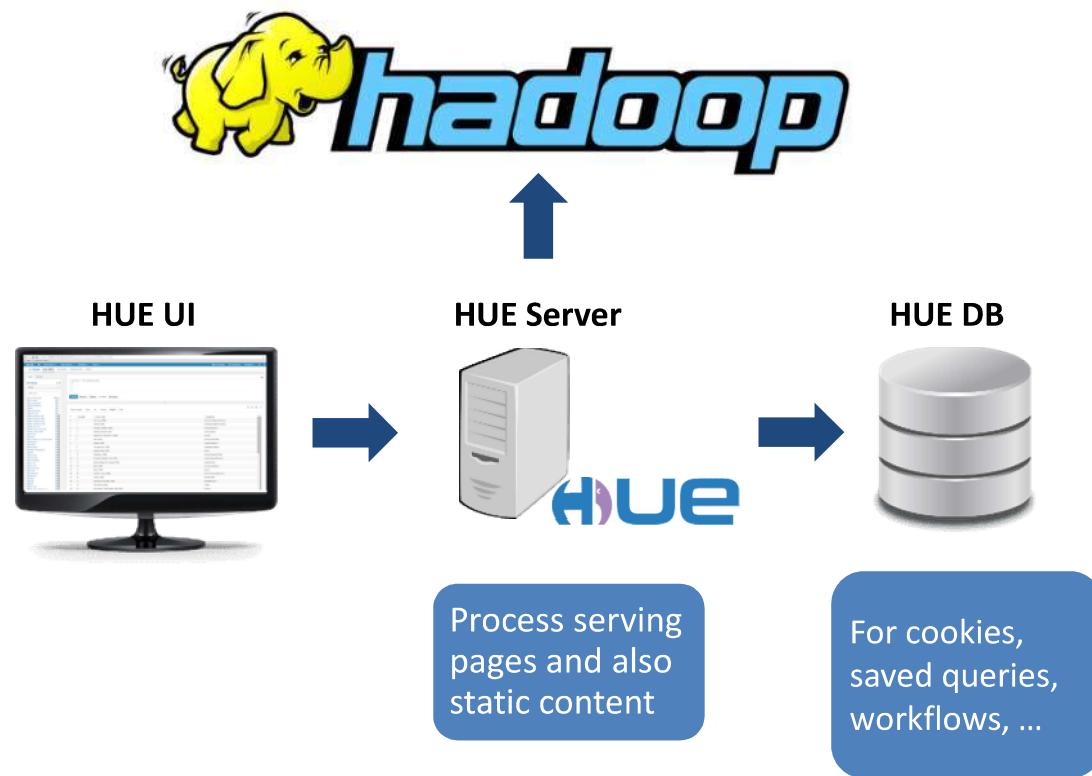
- SQL editors for Hive, Impala
- Metastore Manager- Metadata Browsing for Hive/Impala
- Pig Editor
- HDFS file browser, including file manipulation
- Job Monitoring & Browsing
- *Dynamic Search dashboards with Solr*
- *Scheduling of jobs and workflows through an Oozie Editor and Dashboard*

Metastore Manager



- Is an application to manage databases, tables, and partitions stored in a relational database that applications, like HIVE, access through the Metastore service API.
- Use Metastore Manager to perform the following table operations:
 - Create tables
 - Browse tables
 - Import table data
 - Drop tables
 - View table location

HUE – Architecture



HUE – Query Editor



HUE Home Query Editors Data Browsers Workflows Search File Browser Job Browser jghosh ? +

Impala **Query Editor** My Queries Saved Queries History

Assist Settings Session

hdce (134) Q C

Tables

Press "tab", then "enter".

1 select * from hdce.business limit 10

Execute Save Save as... Explain Format or create a New query

Recent queries Query Log Columns Results Chart

#	city	review_count	name	neighborhoods	type	business_id	full_address	hours
1	Phoenix	9	Eric Goldberg, MD		business	vcNAWILM4dR7D2nwwwJ7nCA	4840 E Indian School Rd Ste 101 Phoenix, AZ 85018	{u'Thursday': {u'close': u'17:00', u'open': u'08:00}, u'Tuesday': {u'close': u'17:
2	Dravsburg	4	Clancy's Pub		business	UsFtqoBl7naz8AVUBZMjQQ	202 McClure St Dravsburg, PA 15034	0
3	Bethel Park	5	Cool Springs Golf Center		business	cE27W9VPgO88Qxeol6y_g	1530 Hamilton Rd Bethel Park, PA 15234	0
4	Pittsburgh	3	Verizon Wireless		business	HZdLhv6COClleJMo7nPiRA	301 S Hills Vlg Pittsburgh, PA 15241	{u'Monday': {u'close': u'21:00', u'open': u'10:00}, u'Tuesday': {u'close': u'21:00', u'open': u'10:00}, u'Thursday': {u'close': u'19:00', u'open': u'10:00}, u'Friday': {u'close': u'20:00', u'open': u'10:00}, u'Saturday': {u'close': u'21:00", u'open": u'10:00"}, u'Sunday': {u'close': u'21:00", u'open": u'10:00}}
5	Braddock	11	Emil's Lounge		business	mVHrayjG3uZ_RLhkLJ-AMg	414 Hawkins Ave Braddock, PA 15104	{u'Tuesday': {u'close': u'19:00", u'open": u'10:00"}, u'Friday': {u'close': u'20:00", u'open": u'10:00"}, u'Saturday': {u'close': u'21:00", u'open": u'10:00"}, u'Sunday': {u'close': u'21:00", u'open": u'10:00}}
6	Carnegie	15	Alexion's Bar & Grill	[u'Greentree']	business	KayYbHCt-RkbGcPdGOThNg	141 Hawthorne St Greentree Carnegie, PA 15106	0
7	Carnegie	5	Flynn's E W Tire Service Center		business	b12U9TFESStdy7CsTtcOeg	718 Hope Hollow Rd Carnegie, PA 15106	0
8	Carnegie	4	Forsythe Miniature Golf & Snacks	[u'Carnegie']	business	Sk7j1eHQFuVa-M4bgnEh8g	920 Forsythe Rd Carnegie Carnegie, PA 15106	0
9	Carnegie	3	Quaker State Construction	[u'Carnegie']	business	3ZVKmuK2l7uXPE6IXY4Dbg	8 Logan St Carnegie Carnegie, PA 15106	0
10	Carnegie	8	Kings Family Restaurant		business	wJr6kSA5dchdgOdwh6dZ2w	2100 Washington Pike Carnegie, PA 15106	{u'Monday': {u'close': u'02:00", u'open": u'08:00"}, u'Tuesday': {u'close': u'02:00", u'open": u'08:00"}, u'Wednesday': {u'close': u'02:00", u'open": u'08:00"}, u'Thursday': {u'close': u'02:00", u'open": u'08:00"}, u'Friday': {u'close': u'02:00", u'open": u'08:00"}, u'Saturday': {u'close': u'02:00", u'open": u'08:00"}, u'Sunday': {u'close': u'02:00", u'open": u'08:00}}

HUE

HUE- Data Browser



Screenshot of the HUE Metastore Manager interface showing the 'hdce' database.

Databases > **hdce**

STATS

- No comment.
- Date: 2014-01-0

TABLES

Table Name	Comment	Type
aligned	List of yelp business	
amol_cmprsn_prqt		
amol_cmprsn_small_test		
bdrf_bomitemview		
bomitemview		
business		
calldetails		
cards_amarshim		
cards_eachimei		
cards_hive		
cards_merlikhm		
cards_mgispan		
cards_michal		
cards_nredala		
cards_nredala_parquet		
cards_user_slberma		
color_summary_nredala		
compute_account		
contacts		
cooked_project_files		
dual_parquet		
dwscr_scr_role		
finishedgoodscombinedhierarchydetail		
finishedgoodspivotedscharview		
flumetable		
genre_view_nredala		
hana_itemmaterialclassview		
itemmaterialclassview		
itemview		

Metastore Manager is used to perform the following table operations:

- Create tables
- Drop tables
- Browse tables
- View table location
- Import table data

HUE – File Browser



HUE Home Query Editors Data Browsers Workflows Search File Browser Job Browser jghosh ? +

File Browser

Search for file name Actions Move to trash Upload New

Home / user / jghosh History Trash

Name	Size	User	Group	Permissions	Date
hdfs		hdfs	supergroup	drwxr-xnwx	December 06, 2016 12:27 AM
.		jghosh	supergroup	drwx-----	December 06, 2016 08:15 PM
.Trash		jghosh	supergroup	drwx-----	August 29, 2015 05:00 PM
.sparkStaging		jghosh	supergroup	drwxrwxr-x	April 05, 2016 12:39 AM
.staging		jghosh	supergroup	drwx-----	December 06, 2016 08:06 PM
alarmtitle		jghosh	supergroup	drwxrwxr-x	August 14, 2014 01:05 AM
emp.txt	0 bytes	jghosh	supergroup	-rw-rw-r-	July 06, 2016 07:49 PM
item.dat	98.1 MB	jghosh	supergroup	-rwxr-xr-x	September 23, 2014 08:38 PM
oozie-oozi		jghosh	supergroup	drwxrwxr-x	December 06, 2016 08:06 PM
users.dat	107.6 KB	jghosh	supergroup	-rw-rw-r-	December 06, 2016 08:15 PM
zero	0 bytes	jghosh	supergroup	-rw-rw-r-	May 19, 2016 11:01 PM



HUE – Job Browser



HUE Home Query Editors Data Browsers Workflows Search File Browser Job Browser (2) jghosh ? Help

Job Browser

Username: jghosh Text: Search for text Succeeded Running Failed Killed

Logs ID	Name	Application Type	Status	User	Maps	Reduces	Queue	Priority	Duration	Submitted	Action
1477682969645_78509	PigLatin.script.pig	MAPREDUCE	RUNNING	jghosh	5%	5%	root.jghosh	N/A	12/06/16 20:18:51	Kill	
1477682969645_78508	oozie.launcher.T=pig;W=pig-app-hue-script.A=pig-5760;ID=0000649-161028125514631-oozie-oozi-W	MAPREDUCE	RUNNING	jghosh	5%	5%	root.jghosh	N/A	12/06/16 20:18:34	Kill	
1477682969645_78507	oozie.launcher.T=pig;W=pig-app-hue-script.A=pig-5760;ID=0000648-161028125514631-oozie-oozi-W	MAPREDUCE	SUCCEEDED	jghosh	100%	100%	root.jghosh	N/A	12s	12/06/16 20:17:29	
1477682969645_78496	oozie.launcher.T=pig;W=pig-app-hue-script.A=pig-5760;ID=0000647-161028125514631-oozie-oozi-W	MAPREDUCE	SUCCEEDED	jghosh	100%	100%	root.jghosh	N/A	12s	12/06/16 20:05:59	

Showing 1 to 4 of 4 entries ← Previous 1 Next →



Group Activity 2

- Work in group (the same group).
- Refer to table members.csv & movies.csv.
 - Create new database/schema and name it with your last name.
 - Create 2 tables name members and movies in the database.
 - Load members.csv into table ‘members’ and movies into table ‘movies’.
 - Perform different types of join (*join, full outer join, left outer join and right outer join*) – ‘members’ on ‘movies’; by using ‘movie_id’ and ‘id’ as the primary key.
 - Paste your output (the table) to Ms. Word doc.
 - **Note: The output should display only the firstname, lastname and title.**
- Submit your doc. to the link created in e-learn (**Group Activity 2**).
Only 1 submission per group.



Thank You

Prepared & Presented by:
Dr. Chew XinYing
School of Computer Sciences