HandsOn – **MapReduce**

Quick Introduction To Java and MapReduce

WordCount – Mapper

```
import java.io.IOException;
import java.util.StringTokenizer;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;

public class WordCount {

  public static class TokenizerMapper
       extends Mapper<Object, Text, Text, IntWritable>{

    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();

    public void map(Object key, Text value, Context context
                    ) throws IOException, InterruptedException {
      StringTokenizer itr = new StringTokenizer(value.toString());
      while (itr.hasMoreTokens()) {
        word.set(itr.nextToken());
        context.write(word, one);
      }
    }
  }
```

WordCount – Reducer

```
  public static class IntSumReducer
       extends Reducer<Text,IntWritable,Text,IntWritable> {
    private IntWritable result = new IntWritable();

    public void reduce(Text key, Iterable<IntWritable> values,
                       Context context
                       ) throws IOException, InterruptedException {
      int sum = 0;
      for (IntWritable val : values) {
        sum += val.get();
      }
      result.set(sum);
      context.write(key, result);
    }
  }

  public static void main(String[] args) throws Exception {
    Configuration conf = new Configuration();
    Job job = Job.getInstance(conf, "word count");
    job.setJarByClass(WordCount.class);
    job.setMapperClass(TokenizerMapper.class);
    job.setCombinerClass(IntSumReducer.class);
    job.setReducerClass(IntSumReducer.class);
    job.setOutputKeyClass(Text.class);
    job.setOutputValueClass(IntWritable.class);
    FileInputFormat.addInputPath(job, new Path(args[0]));
    FileOutputFormat.setOutputPath(job, new Path(args[1]));
    System.exit(job.waitForCompletion(true) ? 0 : 1);
  }
}
```


Run Java MapReduce Job

1. Compile Java file:

```
hadoop/bin/hadoop com.sun.tools.javac.Main WordCount.java
```

2. Create Jar File:

```
jar cf WordCount.jar WordCount*.class
```

3. Execute MapRedcue Job:

```
hadoop jar WordCount.jar WordCount /user/hadoop/Faust_1.txt
/user/hadoop/wordcount_output
```


Run Java MapReduce Job

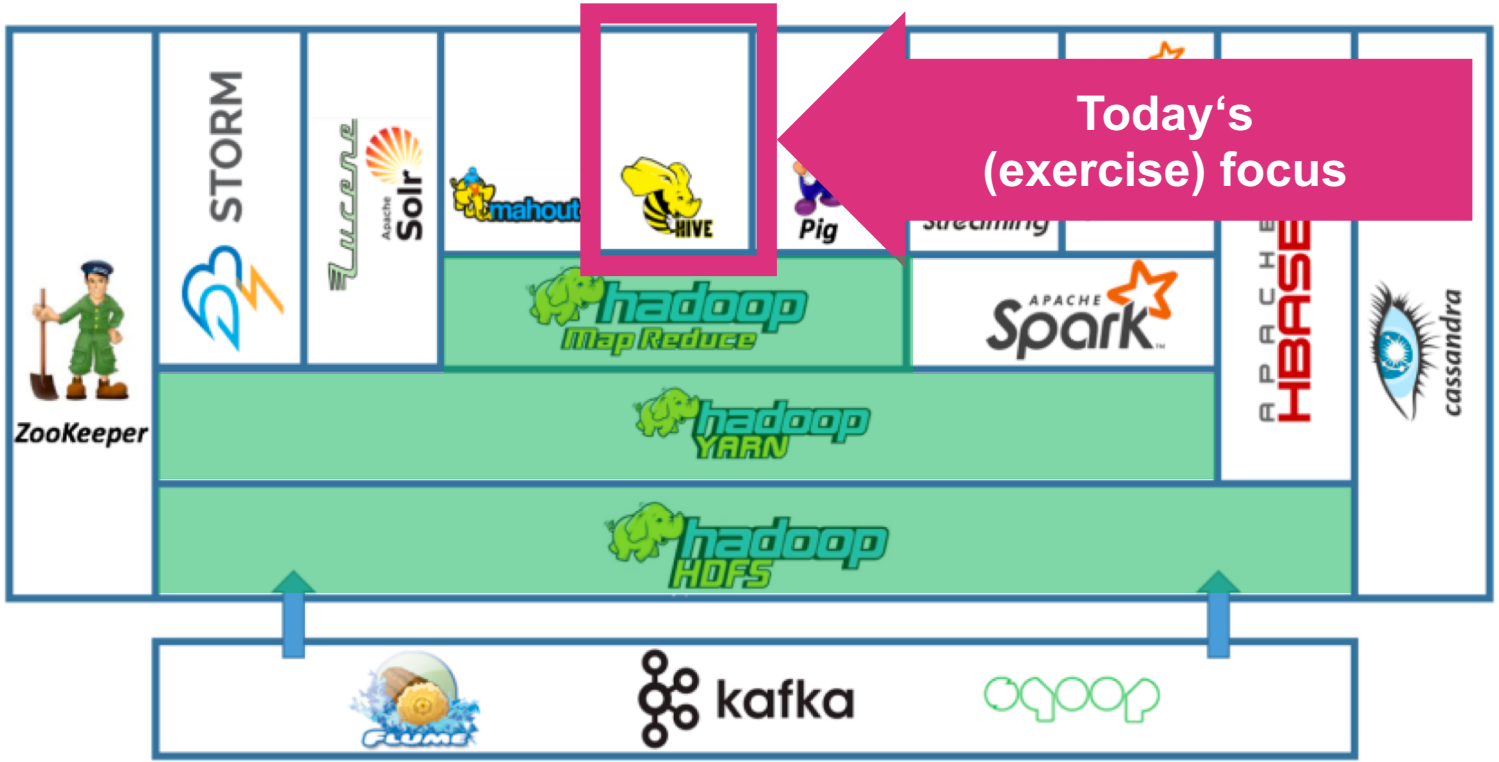
4. Take a look at the results:

```
hadoop fs -cat /user/hadoop/wordcount_output/part-r-00000 | head -10
"Allein,  1
"Alles    1
"Als      1
"Der      1
"Die      2
"Er       2
"Ich      4
"Im       1
"Mein     1
"Nur      1
[…]
```


HandsOn – **Hive and HiveQL**

Quick Introduction To Hive and HiveQL

The Hadoop Ecosystem



Apache Hive

Apache Hive

- Initial Release in October 2010
- written in Java
- current Version: 3.1.0

http://hive.apache.org

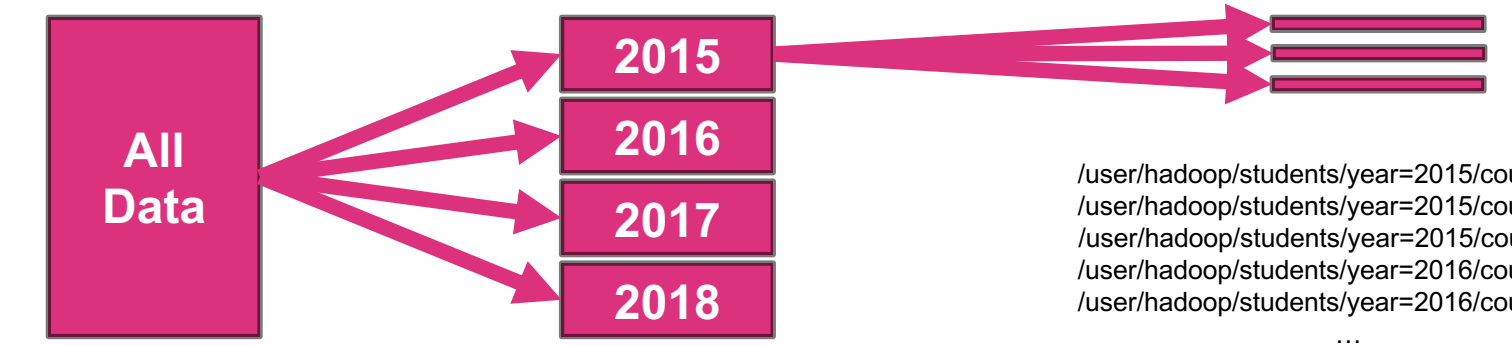
- **What is Hive:**
  - **easy to use** (HiveQL)
  - **based on Hadoop** (HDFS, YARN)
  - **good scale-out capabilities** (e.g. by partitioning and underlying HDFS and YARN)
  - **best used for:**
    - (BigData) **datawarehousing tasks**
    - a **DataLake**
    - **interface** for Analysts, DataScientists, Develo pers
    - **adhoc** (batch) **querying, aggregation** and **a nalysis** of large amounts of data (**PB!**) and hundreds of nodes
- **What Hive is NOT**:
  - **transactional database**
  - **highly responsive**

HiveQL

- SQL like **query language**
- Supported by: Hive CLI (*deprecated*), Beeline CLI and most JDBC clients
- Hive supported HDFS file formats:
  - **TextFile** (even compressed by gzip or bzip2)
  - **SequenceFile**
  - **RCFile**
  - **ORC**
  - **Parquet**
  - **Avro**

HDFS/Hive - **Partitioning**

- Partitioning of data distributes load and speeds up data processing
- A table can have one or more partition columns, defined by the time of creating a table (`CREATE TABLE student(id Int, name STRING) PARTITIONED BY (year STRING)… STORED AS TEXTFILE LOCATION '/user/hadoop/students';`)
- partitioning can be done either **static** or **dynamic**
- each distinct value of a partition column is represented by a **HDFS directory**



HDFS/Hive - **Wordcount**

- Previous WordCount example achieved by using Hive and HiveQL:

```
CREATE TABLE faust (line STRING);

LOAD DATA INPATH '/user/hadoop/faust' OVERWRITE INTO TABLE faust;

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

```
SELECT * from word_counts ORDER BY count DESC LIMIT 10;
```

word	count
und	509
die	463
der	440
ich	435
Und	400
nicht	346
zu	319
[…]	

Exercises Preparation A

Install and Setup Hive

Install and Setup Hive

1. Get Hive:

```
wget http://ftp.halifax.rwth-aachen.de/apache/hive/hive-3.1.0/apache-hive-3.1.0-bin.tar.gz
```

2. Uncompress Hive:

```
tar -xzf apache-hive-3.1.0-bin.tar.gz
```

3. Move Binaries:

```
mv apache-hive-3.1.0-bin /home/hadoop/hive
```


Install and Setup Hive

4. Setup **UNIX** Environment Parameters:

```
vi .bashrc
```

```
export HIVE_HOME=/home/hadoop/hive
export PATH=$PATH:/home/hadoop/hive/bin
```

```
source .bashrc
```

Install and Setup Hive

5. Verify **Hive** Installation:

```
hive --version
```

```
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/hadoop/hive/lib/log4j-slf4j-impl-2.10.0
.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/home/hadoop/hadoop/share/hadoop/common/lib/s
lf4j-log4j12-1.7.25.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation
.
SLF4J: Actual binding is of type [org.apache.logging.slf4j.Log4jLoggerFactory]
Hive 3.1.0
Git git://vgargwork.local/Users/vgarg/repos/hive.apache.master -r bcc7df9582483
1a8d2f1524e4048dfc23ab98c19
Compiled by vgarg on Mon Jul 23 16:02:03 PDT 2018
From source with checksum 147d8070369f8c672407753089777fd
```

Install and Setup Hive

6. Create Hive directories within *HDFS*:

```
hadoop fs -mkdir -p /user/hive/warehouse
hadoop fs -chmod g+w /user/hive/warehouse
```

```
hadoop fs -mkdir -p /tmp
hadoop fs -chmod g+w /tmp
```

7. Create Hive Config SH:

```
cp hive/conf/hive-env.sh.template hive/conf/hive-env.sh
vi hive/conf/hive-env.sh
```

```
export HADOOP_HOME=/home/hadoop/hadoop
export HIVE_CONF_DIR=/home/hadoop/hive/conf
```

Install and Setup Hive

8. Create Hive Config (*hive-site.xml*):

```
vi hive/conf/hive-site.xml
```

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?><!--
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distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
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limitations under the License.
-->
<configuration>
                <property>
                                <name>javax.jdo.option.ConnectionURL</name>
                                <value>jdbc:derby:;databaseName=/home/hadoop/hive/metastore_db;create=true</value>
                                <description>
                                JDBC connect string for a JDBC metastore. To use SSL to encrypt/authenticate the connectio
                                n, provide database-specific SSL flag in the connection URL.
                                For example, jdbc:postgresql://myhost/db?ssl=true for postgres database.
                                </description>
                                </property>
```

Install and Setup Hive

```
        <property>
                <name>hive.metastore.warehouse.dir</name>
                <value>/user/hive/warehouse</value>
                <description>location of default database for the warehouse
                </description>
        </property>
        <property>
                <name>hive.metastore.uris</name>
                <value/>
                <description>Thrift URI for the remote metastore. Used by metastore cli
                ent to connect to remote metastore.
                </description>
        </property>
        <property>
                <name>javax.jdo.option.ConnectionDriverName</name>
                <value>org.apache.derby.jdbc.EmbeddedDriver</value>
                <description>Driver class name for a JDBC metastore</description>
        </property>
        <property>
                <name>javax.jdo.PersistenceManagerFactoryClass</name>
                <value>org.datanucleus.api.jdo.JDOPersistenceManagerFactory</value>
                <description>class implementing the jdo persistence</description>
        </property>
</configuration>
```


Install and Setup Hive

9. Edit YARN MapRed Config (*mapred-site.xml*) for higher memory usage:

```
vi hadoop/etc/hadoop/mapred-site.xml
```

```
<property>
        <name>mapreduce.map.memory.mb</name>
        <value>3072</value>
    </property>
    <property>
        <name>mapreduce.reduce.memory.mb</name>
        <value>3072</value>
    </property>
```

10. Restart DFS and YARN:

```
stop-all.sh
start-dfs.sh
Start-yarn.sh
```


Install and Setup Hive

11. By default Hive makes use of *Derby* as a metastore database, so we need to initialize *Derby*:

```
hive/bin/schematool -initSchema -dbType derby
```

```
[…]
Starting metastore schema initialization to 3.1.0
Initialization script hive-schema-3.1.0.derby.sql
[…]
Initialization script completed
schemaTool completed
```

Install and Setup Hive

12. Test if Hive Installation and Configuration is successful. Start Hive:

```
hive
```

```
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/hadoop/hive/lib/log4j-slf4j-impl-2.10.0.jar!/org/slf4j/
impl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/home/hadoop/hadoop/share/hadoop/common/lib/slf4j-log4j12-1.7
.25.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.apache.logging.slf4j.Log4jLoggerFactory]
Hive Session ID = c120d0b1-9025-43db-96e4-48ccfb875f1a

Logging initialized using configuration in jar:file:/home/hadoop/hive/lib/hive-common-3.1.0.jar
!/hive-log4j2.properties Async: true
Hive-on-MR is deprecated in Hive 2 and may not be available in the future versions. Consider us
ing a different execution engine (i.e. spark, tez) or using Hive 1.X releases.
Hive Session ID = fdd6f06a-d4e4-48e6-8971-997e8a0a8e2c
hive>
```


Install and Setup Hive

13. Execute First SQL Query:

```
hive> show databases;
OK
default
Time taken: 0.083 seconds, Fetched: 1 row(s)
hive>
```


Hive: Create and Work with External Tables

Using public dataset of IMDb.com

Get IMDb Data And Move It To HDFS

1. Get **IMDb Data** (*https://www.imdb.com/interfaces/*):

```
wget https://datasets.imdbws.com/title.basics.tsv.gz
wget https://datasets.imdbws.com/title.ratings.tsv.gz
```

2. Uncompress IMDb Data:

```
gunzip title.basics.tsv.gz
gunzip title.ratings.tsv.gz
```

3. Create HDFS Directories for IMDb Data:

```
hadoop fs -mkdir /user/hadoop/imdb
hadoop fs -mkdir /user/hadoop/imdb/name
hadoop fs -mkdir /user/hadoop/imdb/ratings
```

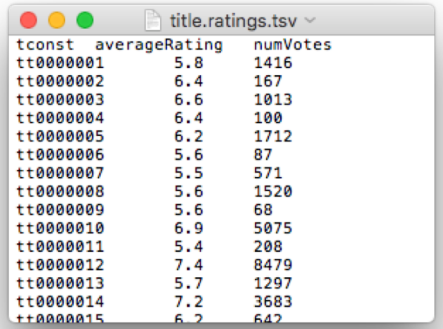

Create External Tables In Hive

4. Transfer IMDb data files to HDFS:

```
hadoop fs -put title.ratings.tsv /user/hadoop/imdb/ratings/ratings.tsv
hadoop fs -put  name.basics.tsv /user/hadoop/imdb/name/title.tsv
```

5. Create External Table **`imdb_ratings`** (file *title.ratings.tsv*) in Hive:

```
hive > CREATE EXTERNAL TABLE IF NOT EXISTS imdb_ratings(
          tconst STRING,
          average_rating DECIMAL(2,1),
          num_votes BIGINT
) COMMENT ‚IMDb Ratings‘
ROW FORMAT DELIMITED FIELDS TERMINATED BY '\t' STORED AS
TEXTFILE LOCATION '/user/hadoop/imdb/ratings';
```



Create External Tables In Hive

6. Create External Table `imdb_movies` for file *title.basics.tsv* in Hive:

title.basics.tsv

```
tconst  titleType       primaryTitle    originalTitle   isAdult startYear       endYear runtimeMinutes  genres
tt0000001       short   Carmencita      Carmencita      0       1894    \N      1       Documentary,Short
tt0000002       short   Le clown et ses chiens  Le clown et ses chiens  0       1892    \N      5       Animation,Short
tt0000003       short   Pauvre Pierrot  Pauvre Pierrot  0       1892    \N      4       Animation,Comedy,Romance
tt0000004       short   Un bon bock     Un bon bock     0       1892    \N      \N      Animation,Short
tt0000005       short   Blacksmith Scene        Blacksmith Scene        0       1893    \N      1       Comedy,Short
tt0000006       short   Chinese Opium Den       Chinese Opium Den       0       1894    \N      1       Short
tt0000007       short   Corbett and Courtney Before the Kinetograph     Corbett and Courtney Before the Kinetograph     0       1894    \N      1       Short,Sport
tt0000008       short   Edison Kinetoscopic Record of a Sneeze  Edison Kinetoscopic Record of a Sneeze  0       1894    \N      1       Documentary,Short
tt0000009       movie   Miss Jerry      Miss Jerry      0       1894    \N      45      Romance
tt0000010       short   Employees Leaving the Lumière Factory   La sortie de l'usine Lumière à Lyon      0       1895    \N      1       Documentary,Short
tt0000011       short   Akrobatisches Potpourri Akrobatisches Potpourri 0       1895    \N      1       Documentary,Short
tt0000012       short   The Arrival of a Train  L'arrivée d'un train à La Ciotat        0       1896    \N      1       Documentary,Short
tt0000013       short   The Photographical Congress Arrives in Lyon     Neuville-sur-Saône: Débarquement du congrès des photographes à Lyon     0       1895    \N      1       Documentary,Short
tt0000014       short   Tables Turned on the Gardener   L'arroseur arrosé       0       1895    \N      1       Comedy,Short
tt0000015       short   Autour d'une cabine     Autour d'une cabine     0       1894    \N      2       Animation,Short
tt0000016       short   Barque sortant du port  Barque sortant du port  0       1895    \N      1       Documentary,Short
tt0000017       short   Italienischer Bauerntanz        Italienischer Bauerntanz        0       1895    \N      1       Documentary,Short
tt0000018       short   Das boxende Känguruh    Das boxende Känguruh    0       1895    \N      1       Short
tt0000019       short   The Clown Barber        The Clown Barber        0       1898    \N      \N      Comedy,Short
tt0000020       short   The Derby 1895  The Derby 1895  0       1895    \N      1       Documentary,Short,Sport
tt0000022       short   Blacksmith Scene        Les forgerons   0       1895    \N      1       Documentary,Short
tt0000023       short   The Sea Baignade en mer 0       1895    \N      1       Documentary,Short
tt0000024       short   Opening of the Kiel Canal       Opening of the Kiel Canal       0       1895    \N      \N      News,Short
tt0000025       short   The Oxford and Cambridge University Boat Race   The Oxford and Cambridge University Boat Race   0       1895    \N      \N      News,Short,Sport
tt0000026       short   The Messers. Lumière at Cards   Partie d'écarté 0       1896    \N      1       Documentary,Short
tt0000027       short   Cordeliers' Square in Lyon      Place des Cordeliers à Lyon     0       1895    \N      1       Documentary,Short
tt0000028       short   Fishing for Goldfish    La pêche aux poissons rouges    0       1895    \N      1       Documentary,Short
tt0000029       short   Baby's Dinner   Repas de bébé   0       1895    \N      1       Documentary,Short
tt0000030       short   Rough Sea at Dover      Rough Sea at Dover      0       1895    \N      1       Documentary,Short
```

Create External Tables In Hive

6. Create External Table **`imdb_movies`** for file *title.basics.tsv* in Hive:

```
hive > CREATE EXTERNAL TABLE IF NOT EXISTS imdb_movies(
          tconst STRING,
          title_type STRING,
          primary_title STRING,
          original_title STRING,
          is_adult DECIMAL(1,0),
          start_year DECIMAL(4,0),
          end_year STRING,
          runtime_minutes INT,
          genres STRING
) COMMENT 'IMDb Movies' ROW FORMAT DELIMITED FIELDS TERMINATED
BY '\t' STORED AS TEXTFILE LOCATION '/user/hadoop/imdb/name';
```


Exercises I

Hive: Create and Work with External Tables

HDFS and HiveQL Exercises - **IMDB**

1. Execute Tasks of previous HandsOn Slides
2. Download https://datasets.imdbws.com/name.basics.tsv.gz
3. Create HDFS Directory **/user/hadoop/imdb/actors/**names.tsv for file name.basics.tsv
4. Create External Hive Table `imdb_actors` for name.tsv
5. Use HiveQL to answer following questions:
   a) How many movies are within the IMDB dataset?
   b) Who is the oldest actor/writer/… within the dataset?
   c) Create a list (`m.tconst, m.original_title, m.start_year, r.average_rating, r.num_votes`) of movies which are:
   - equal or newer than year 2000
   - have an average rating better than 8
   - have been voted more than 100.000 times

   d) How many movies are in list of c)?

HDFS and HiveQL Exercises - **IMDB**

5. Use HiveQL to answer following questions:

e) We want to know which years have been great for cinema.
Create a list with one row per year and a related count of movies which:
- have an average rating better than 8
- have been voted more than 100.000 times

ordered descending by count of movies.