## Solution File

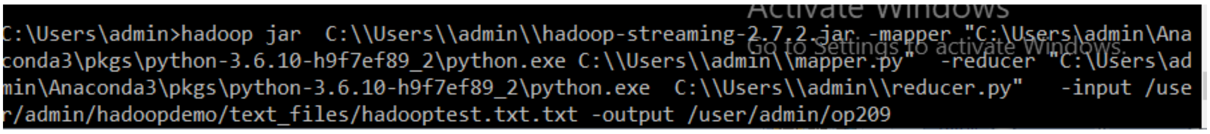
## Distributed Data Analytics – exercise sheet 5

### Exercise 2:

### 1,4) Computing the maximum, minimum, and average departure delay for each airport.

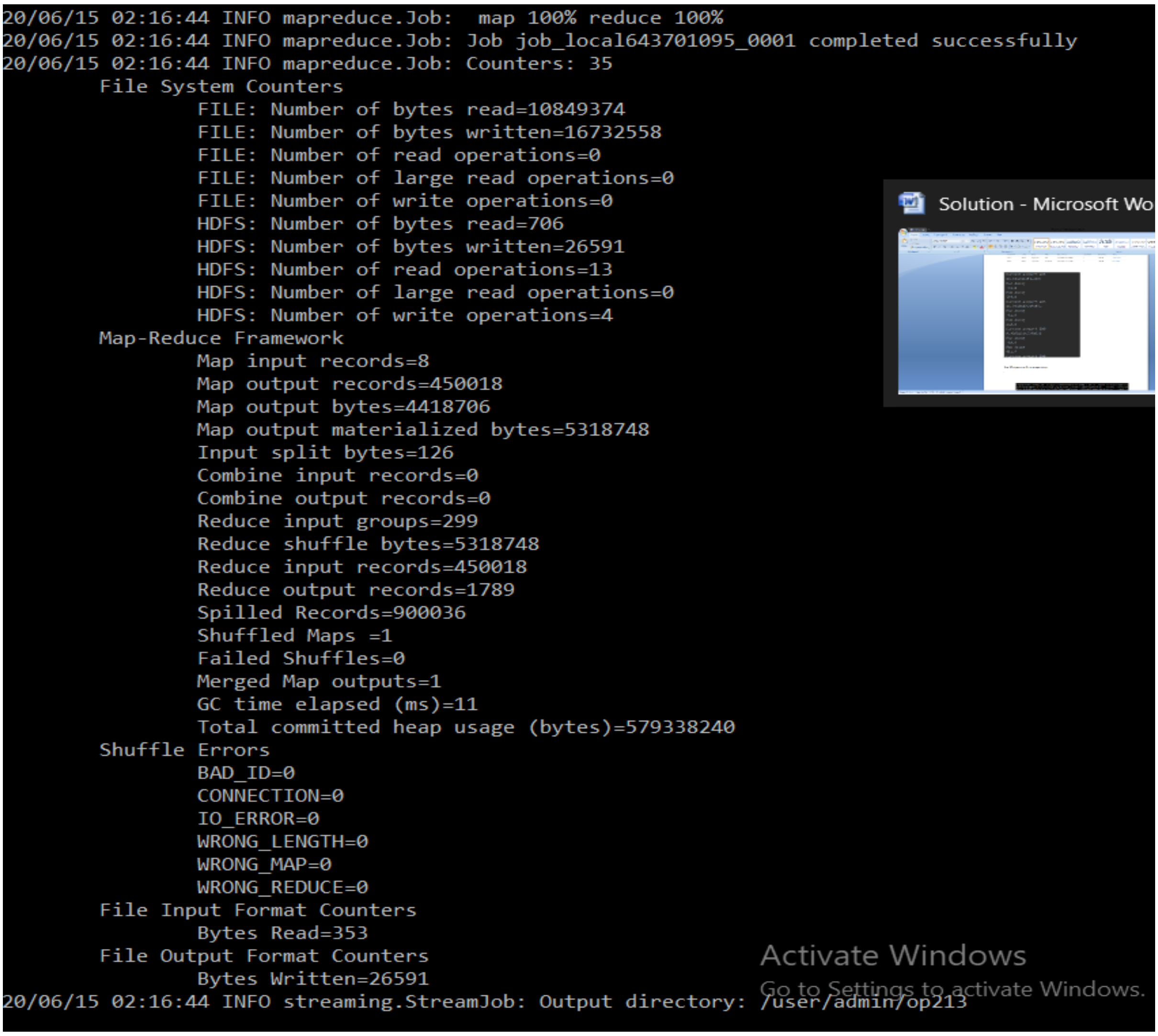
**Screenshots of output:**

**Running mapper.py and reducer.py:**



```
:\Users\admin>hadoop jar  C:\\Users\\admin\\hadoop-streaming-2.7.2.jar -mapper "C:\Users\admin\Ana
conda3\pkgs\python-3.6.10-h9f7ef89_2\python.exe C:\\Users\\admin\\mapper.py"  -reducer "C:\Users\ad
min\Anaconda3\pkgs\python-3.6.10-h9f7ef89_2\python.exe  C:\\Users\\admin\\reducer.py"   -input /use
r/admin/hadoopdemo/text_files/hadooptest.txt.txt -output /user/admin/op209
```

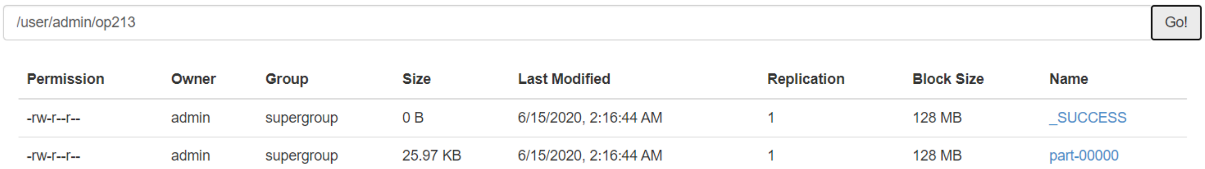
**The following screenshot shows complete execution of mapper and reducer jobs  and shows the number of bytes written to part-r-00000:**



```
20/06/15 02:16:44 INFO mapreduce.Job:  map 100% reduce 100%
20/06/15 02:16:44 INFO mapreduce.Job: Job job_local643701095_0001 completed successfully
20/06/15 02:16:44 INFO mapreduce.Job: Counters: 35
        File System Counters
                FILE: Number of bytes read=10849374
                FILE: Number of bytes written=16732558
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=706
                HDFS: Number of bytes written=26591
                HDFS: Number of read operations=13
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=4
        Map-Reduce Framework
                Map input records=8
                Map output records=450018
                Map output bytes=4418706
                Map output materialized bytes=5318748
                Input split bytes=126
                Combine input records=0
                Combine output records=0
                Reduce input groups=299
                Reduce shuffle bytes=5318748
                Reduce input records=450018
                Reduce output records=1789
                Spilled Records=900036
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=11
                Total committed heap usage (bytes)=579338240
        Shuffle Errors
                BAD_ID=0
                CONNECTION=0
                IO_ERROR=0
                WRONG_LENGTH=0
                WRONG_MAP=0
                WRONG_REDUCE=0
        File Input Format Counters
                Bytes Read=353
        File Output Format Counters
                Bytes Written=26591
20/06/15 02:16:44 INFO streaming.StreamJob: Output directory: /user/admin/op213
```

[Shri Shalini Sekar]

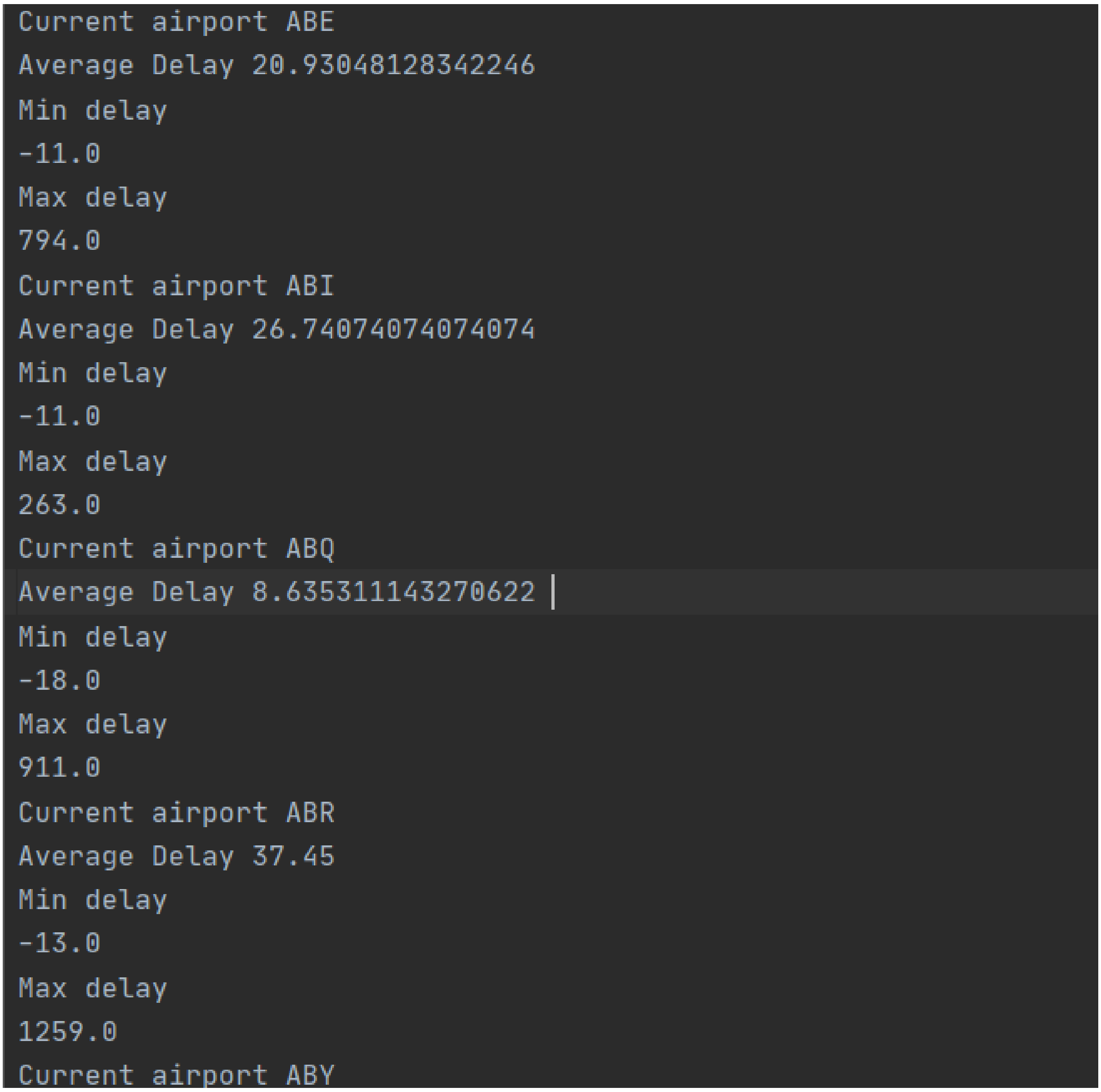
**part-r-00000 is written to, as a result of executing mapper and reducer:**



| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| -rw-r--r-- | admin | supergroup | 0 B | 6/15/2020, 2:16:44 AM | 1 | 128 MB | _SUCCESS |
| -rw-r--r-- | admin | supergroup | 25.97 KB | 6/15/2020, 2:16:44 AM | 1 | 128 MB | part-00000 |

**Output in part-r-0000:**

**-Shows average delay, min delay and max delay for each airport (departure)**



```
Current airport ABE
Average Delay 20.93048128342246
Min delay
-11.0
Max delay
794.0
Current airport ABI
Average Delay 26.74074074074074
Min delay
-11.0
Max delay
263.0
Current airport ABQ
Average Delay 8.635311143270622
Min delay
-18.0
Max delay
911.0
Current airport ABR
Average Delay 37.45
Min delay
-13.0
Max delay
1259.0
Current airport ABY
```

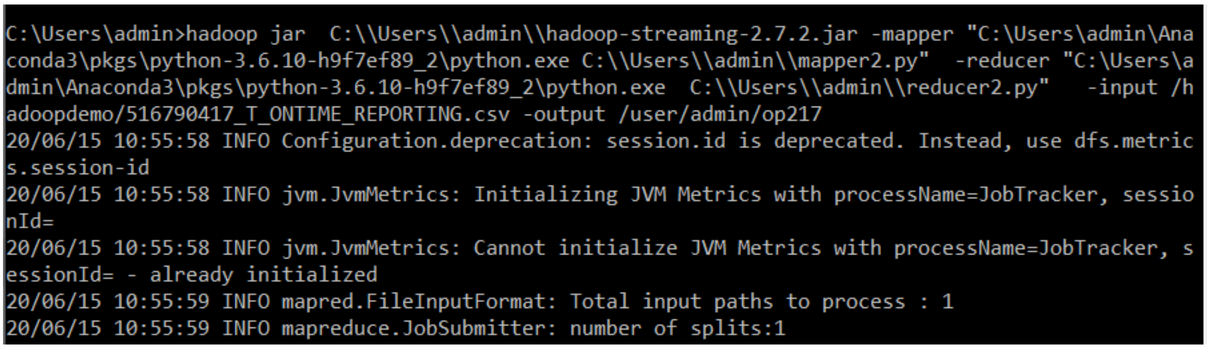
Mapper used – mapper.py

Reducer used – reducer.py

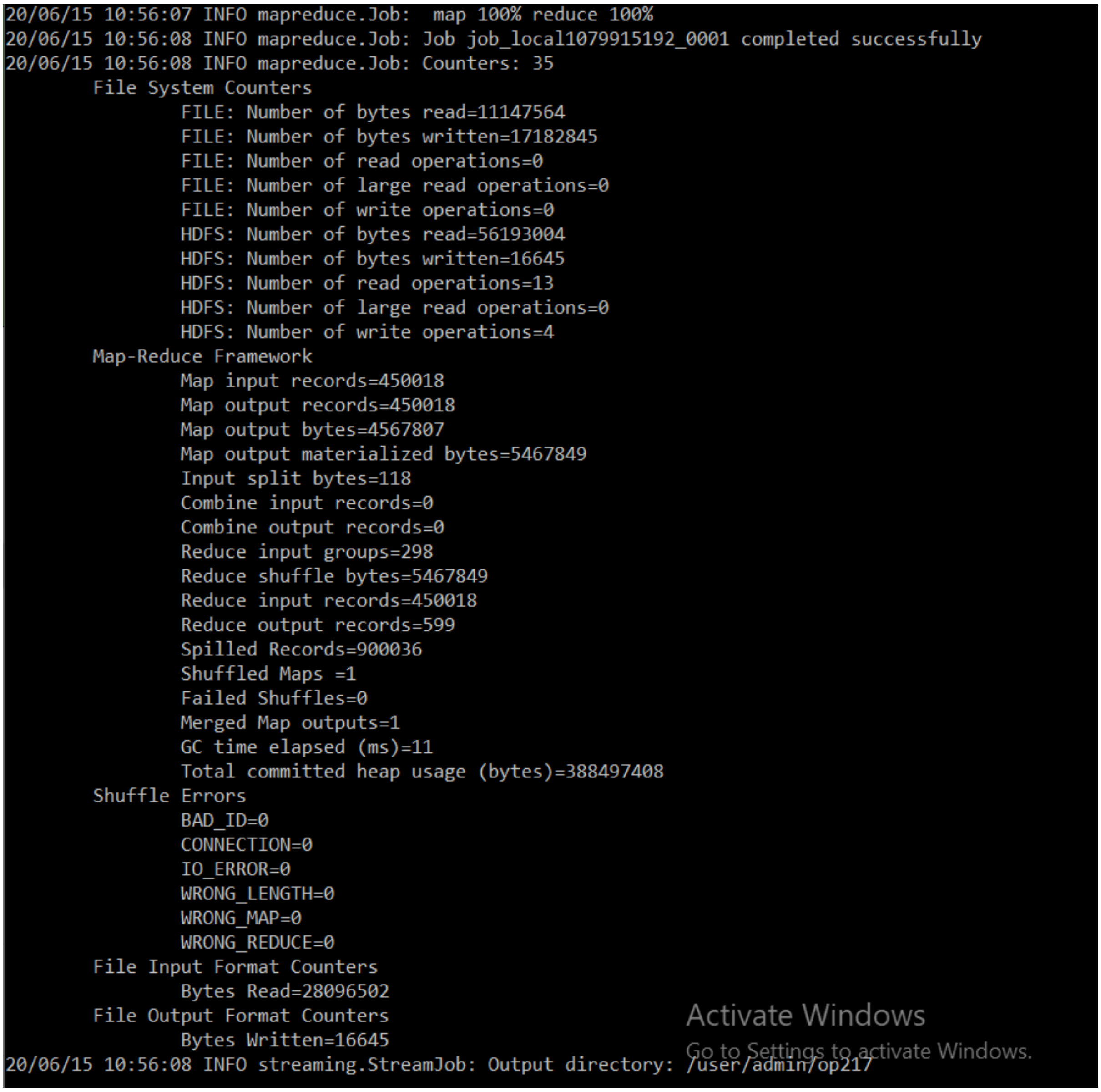
[Shri Shalini Sekar]

### 2,4) Computing a ranking list that contains top 10 airports by their average Arrival delay.

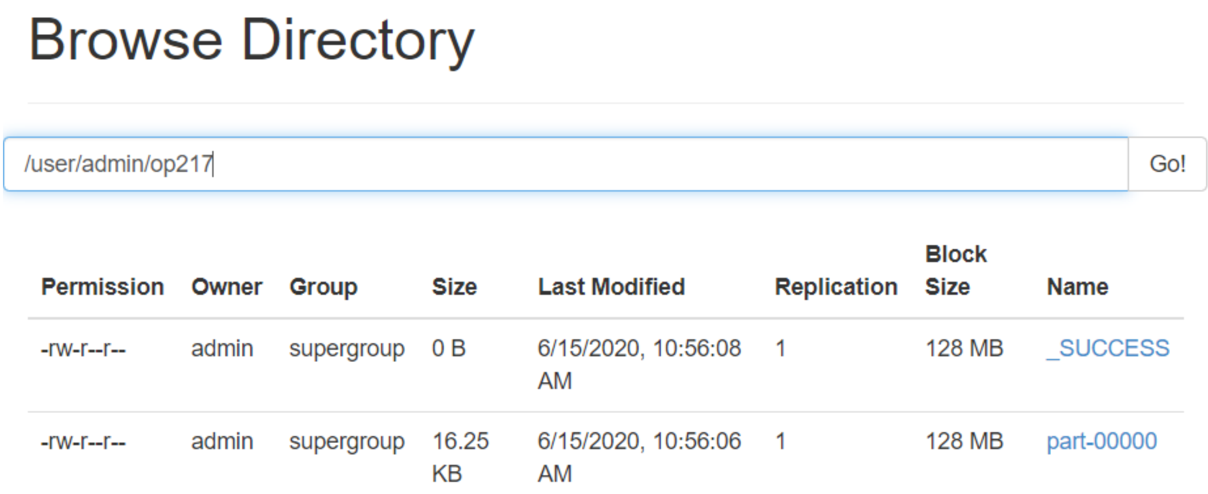
### Running the mapper and reducer.py



```
C:\Users\admin>hadoop jar  C:\\Users\\admin\\hadoop-streaming-2.7.2.jar -mapper "C:\Users\admin\Ana
conda3\pkgs\python-3.6.10-h9f7ef89_2\python.exe C:\\Users\\admin\\mapper2.py"  -reducer "C:\Users\a
dmin\Anaconda3\pkgs\python-3.6.10-h9f7ef89_2\python.exe  C:\\Users\\admin\\reducer2.py"   -input /h
adoopdemo/516790417_T_ONTIME_REPORTING.csv -output /user/admin/op217
20/06/15 10:55:58 INFO Configuration.deprecation: session.id is deprecated. Instead, use dfs.metric
s.session-id
20/06/15 10:55:58 INFO jvm.JvmMetrics: Initializing JVM Metrics with processName=JobTracker, sessio
nId=
20/06/15 10:55:58 INFO jvm.JvmMetrics: Cannot initialize JVM Metrics with processName=JobTracker, s
essionId= - already initialized
20/06/15 10:55:59 INFO mapred.FileInputFormat: Total input paths to process : 1
20/06/15 10:55:59 INFO mapreduce.JobSubmitter: number of splits:1
```



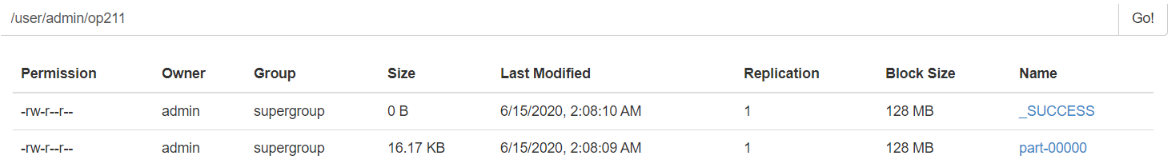
```
20/06/15 10:56:07 INFO mapreduce.Job:  map 100% reduce 100%
20/06/15 10:56:08 INFO mapreduce.Job: Job job_local1079915192_0001 completed successfully
20/06/15 10:56:08 INFO mapreduce.Job: Counters: 35
        File System Counters
                FILE: Number of bytes read=11147564
                FILE: Number of bytes written=17182845
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=56193004
                HDFS: Number of bytes written=16645
                HDFS: Number of read operations=13
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=4
        Map-Reduce Framework
                Map input records=450018
                Map output records=450018
                Map output bytes=4567807
                Map output materialized bytes=5467849
                Input split bytes=118
                Combine input records=0
                Combine output records=0
                Reduce input groups=298
                Reduce shuffle bytes=5467849
                Reduce input records=450018
                Reduce output records=599
                Spilled Records=900036
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=11
                Total committed heap usage (bytes)=388497408
        Shuffle Errors
                BAD_ID=0
                CONNECTION=0
                IO_ERROR=0
                WRONG_LENGTH=0
                WRONG_MAP=0
                WRONG_REDUCE=0
        File Input Format Counters
                Bytes Read=28096502
        File Output Format Counters
                Bytes Written=16645
20/06/15 10:56:08 INFO streaming.StreamJob: Output directory: /user/admin/op217
```



# Browse Directory

/user/admin/op217 Go!

| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| -rw-r--r-- | admin | supergroup | 0 B | 6/15/2020, 10:56:08 AM | 1 | 128 MB | _SUCCESS |
| -rw-r--r-- | admin | supergroup | 16.25 KB | 6/15/2020, 10:56:06 AM | 1 | 128 MB | part-00000 |

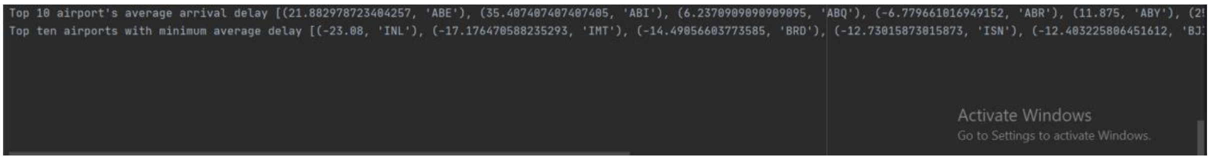


/user/admin/op211 Go!

| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| -rw-r--r-- | admin | supergroup | 0 B | 6/15/2020, 2:08:10 AM | 1 | 128 MB | _SUCCESS |
| -rw-r--r-- | admin | supergroup | 16.17 KB | 6/15/2020, 2:08:09 AM | 1 | 128 MB | part-00000 |

**Output:**

Top 10 airport's average arrival delay [(21.882978723404257, 'ABE'), (35.407407407407405, 'ABI'), (6.2370909090909095, 'ABQ'), (-6.779661016949152, 'ABR'), (11.875, 'ABY'), (25.252525252525253, 'ACT'), (8.369047619047619, 'ACV'), (8.84829721362229, 'ACY'), (8.88888888888889, 'ADK'), (1.875, 'ADQ')]
Top ten airports with minimum average delay [(-23.08, 'INL'), (-17.176470588235293, 'IMT'), (-14.49056603773585, 'BRD'), (-12.73015873015873, 'ISN'), (-12.403225806451612, 'BJI'), (-11.346153846153847, 'HIB'), (-9.944444444444445, 'YAK'), (-9.166666666666666, 'RHI'), (-7.890804597701149, 'DLH'), (-7.702127659574468, 'LAR')]



```
Top 10 airport's average arrival delay [(21.882978723404257, 'ABE'), (35.407407407407405, 'ABI'), (6.2370909090909095, 'ABQ'), (-6.779661016949152, 'ABR'), (11.875, 'ABY'), (2
Top ten airports with minimum average delay [(-23.08, 'INL'), (-17.176470588235293, 'IMT'), (-14.49056603773585, 'BRD'), (-12.73015873015873, 'ISN'), (-12.403225806451612, 'BJ
```

**Mapper used – mapper2.py**

**Reducer used – reducer2.py**

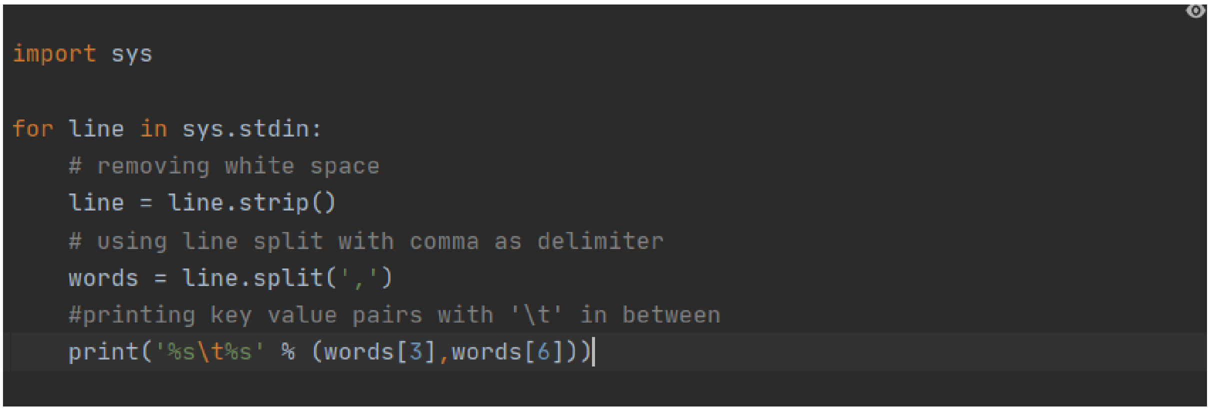
[Shri Shalini Sekar]

**3. What are your mapper.py and reduce.py solutions?**

**Answer:**

**Question 1) (Computing the maximum, minimum, and average departure delay for each airport.**

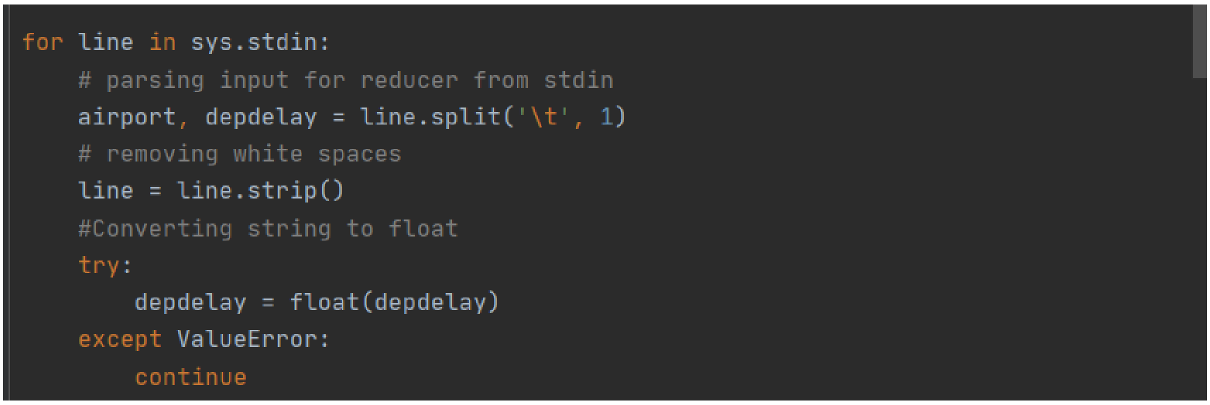
**mapper.py:**



```python
import sys

for line in sys.stdin:
    # removing white space
    line = line.strip()
    # using line split with comma as delimiter
    words = line.split(',')
    #printing key value pairs with '\t' in between
    print('%s\t%s' % (words[3],words[6]))
```

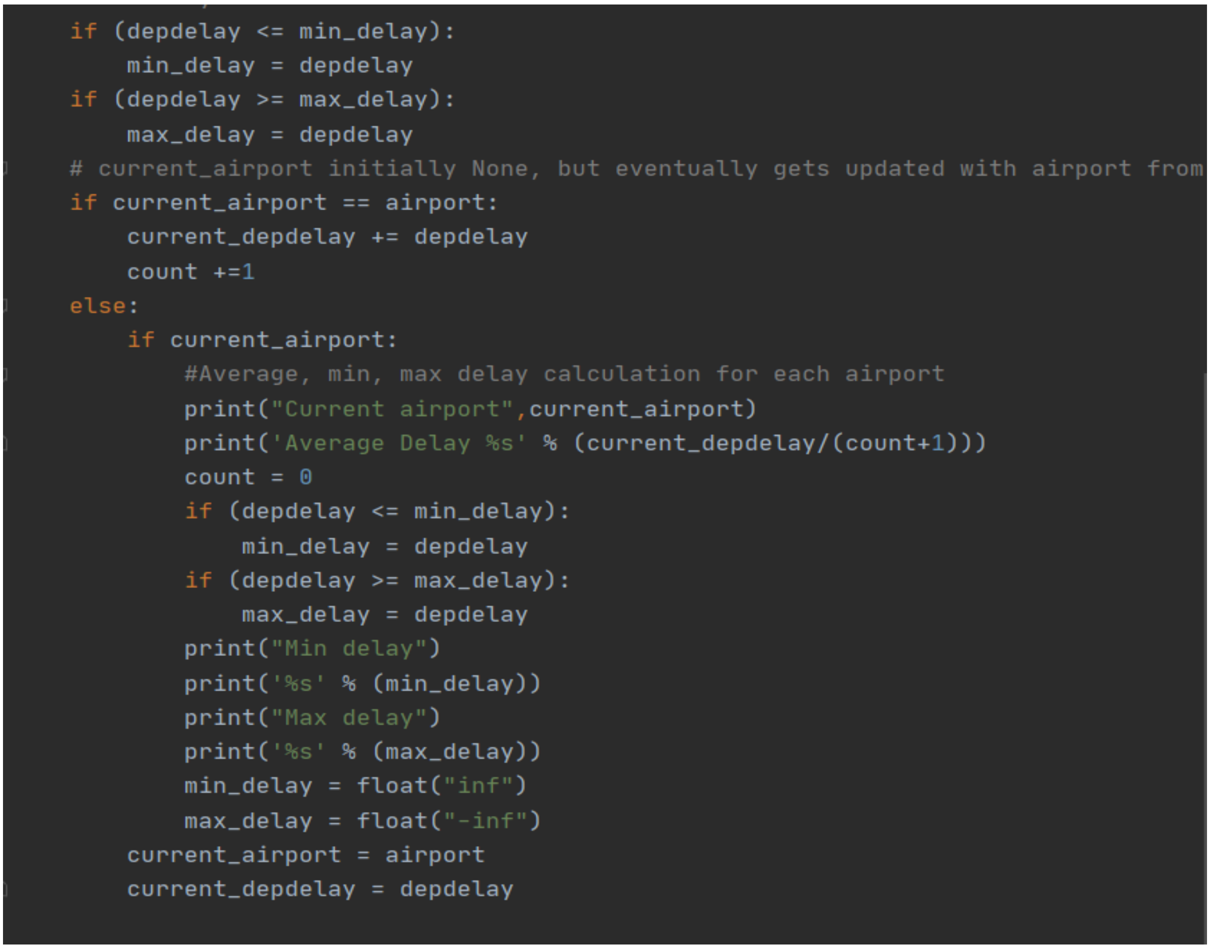
**reducer.py**

**Interpreting airport and departure delay from the mapper output:**



```python
for line in sys.stdin:
    # parsing input for reducer from stdin
    airport, depdelay = line.split('\t', 1)
    # removing white spaces
    line = line.strip()
    #Converting string to float
    try:
        depdelay = float(depdelay)
    except ValueError:
        continue
```

**Min, max, average delay calculation:**

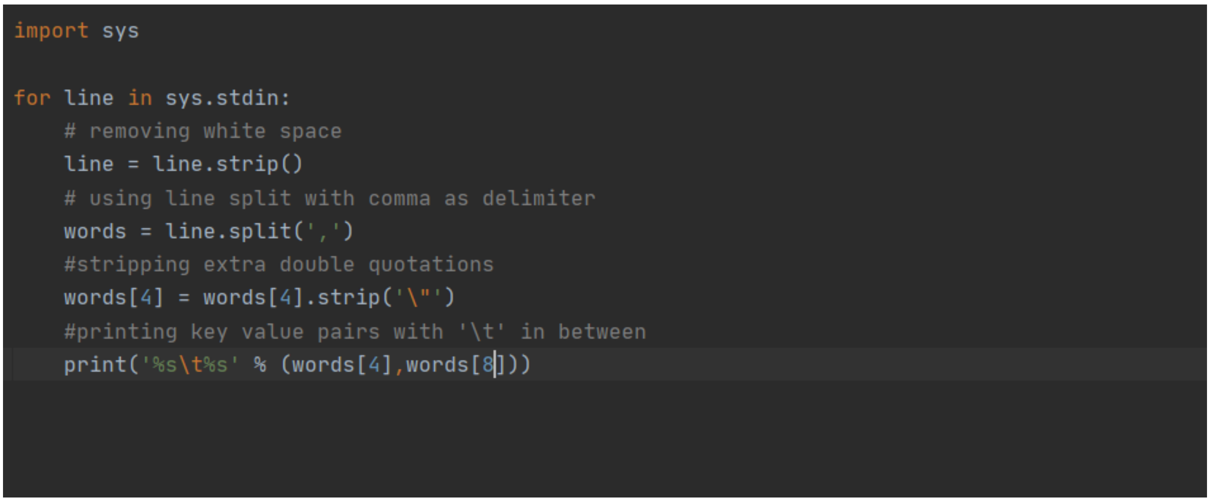


```
    if (depdelay <= min_delay):
        min_delay = depdelay
    if (depdelay >= max_delay):
        max_delay = depdelay
    # current_airport initially None, but eventually gets updated with airport from
    if current_airport == airport:
        current_depdelay += depdelay
        count +=1
    else:
        if current_airport:
            #Average, min, max delay calculation for each airport
            print("Current airport",current_airport)
            print('Average Delay %s' % (current_depdelay/(count+1)))
            count = 0
            if (depdelay <= min_delay):
                min_delay = depdelay
            if (depdelay >= max_delay):
                max_delay = depdelay
            print("Min delay")
            print('%s' % (min_delay))
            print("Max delay")
            print('%s' % (max_delay))
            min_delay = float("inf")
            max_delay = float("-inf")
        current_airport = airport
        current_depdelay = depdelay
```

**Question 2) (Computing a ranking list that contains top 10 airports by their average Arrival delay.)**

**mapper2.py**

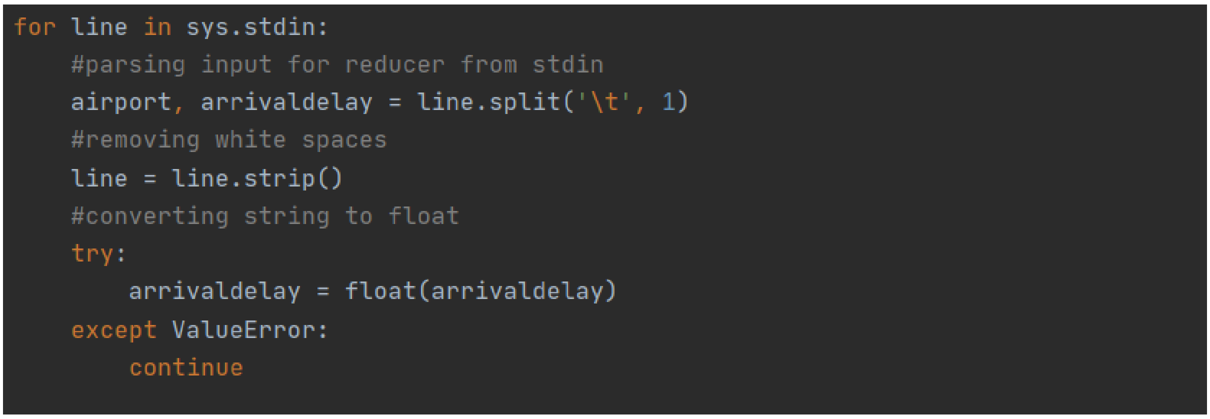
The data is prepared and is printed in the mapper.py



```
import sys

for line in sys.stdin:
    # removing white space
    line = line.strip()
    # using line split with comma as delimiter
    words = line.split(',')
    #stripping extra double quotations
    words[4] = words[4].strip('\"')
    #printing key value pairs with '\t' in between
    print('%s\t%s' % (words[4],words[8]))
```

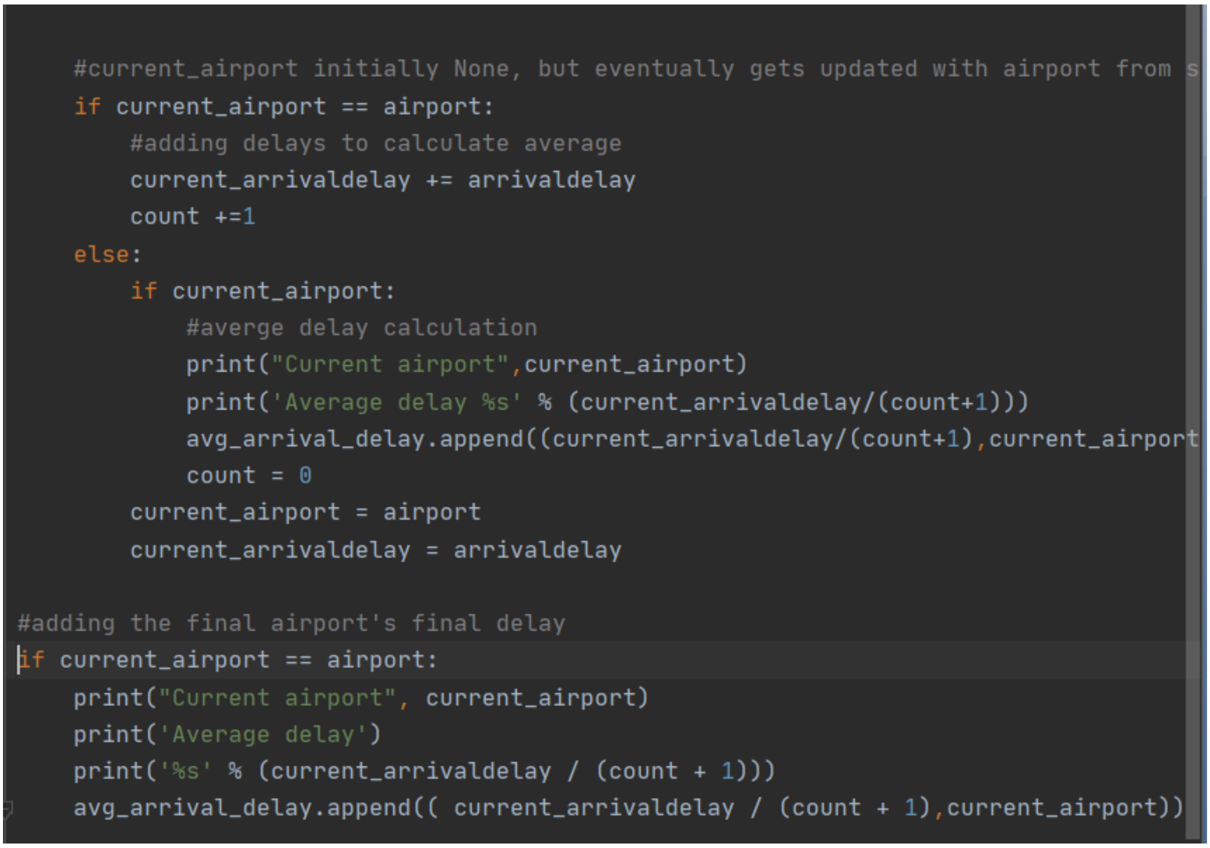
**reducer2.py:**

**Interpreting airport and arrival delay from the mapper output:**



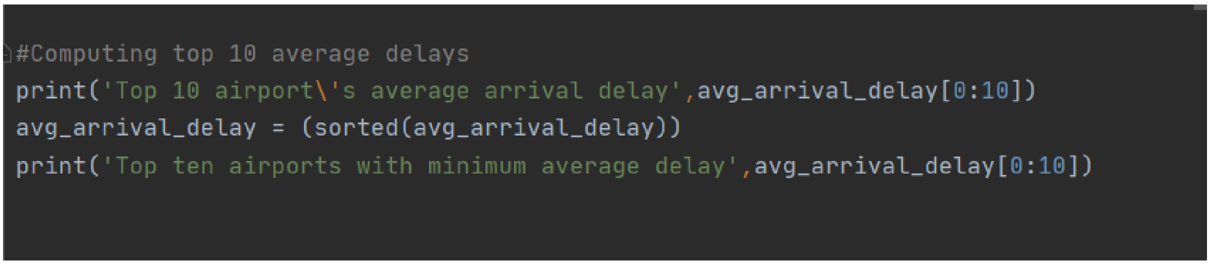
```
for line in sys.stdin:
    #parsing input for reducer from stdin
    airport, arrivaldelay = line.split('\t', 1)
    #removing white spaces
    line = line.strip()
    #converting string to float
    try:
        arrivaldelay = float(arrivaldelay)
    except ValueError:
        continue
```

**Average delay calculations:**



```
    #current_airport initially None, but eventually gets updated with airport from s
    if current_airport == airport:
        #adding delays to calculate average
        current_arrivaldelay += arrivaldelay
        count +=1
    else:
        if current_airport:
            #averge delay calculation
            print("Current airport",current_airport)
            print('Average delay %s' % (current_arrivaldelay/(count+1)))
            avg_arrival_delay.append((current_arrivaldelay/(count+1),current_airport
            count = 0
        current_airport = airport
        current_arrivaldelay = arrivaldelay

#adding the final airport's final delay
if current_airport == airport:
    print("Current airport", current_airport)
    print('Average delay')
    print('%s' % (current_arrivaldelay / (count + 1)))
    avg_arrival_delay.append(( current_arrivaldelay / (count + 1),current_airport))
```

**Computing top 10 average delay:**



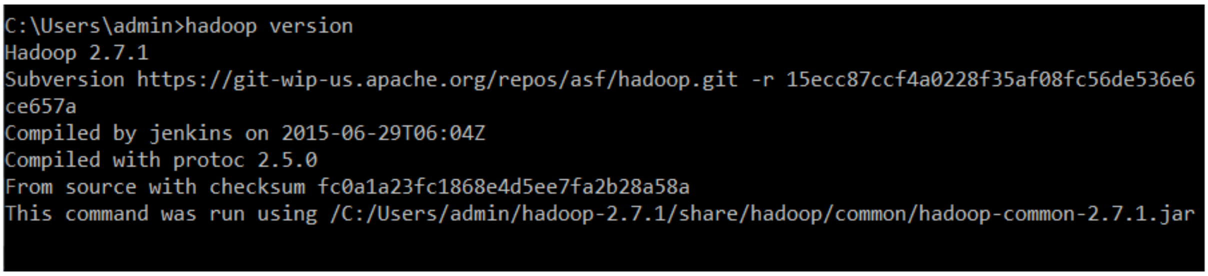
```
#Computing top 10 average delays
print('Top 10 airport\'s average arrival delay',avg_arrival_delay[0:10])
avg_arrival_delay = (sorted(avg_arrival_delay))
print('Top ten airports with minimum average delay',avg_arrival_delay[0:10])
```

[Shri Shalini Sekar]

**Exercise 1:**

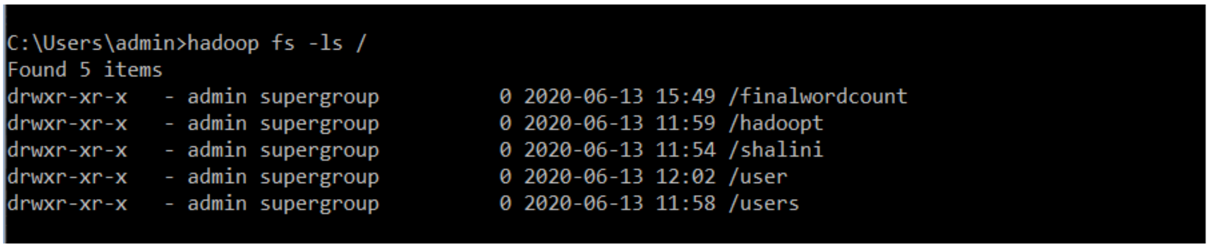
**Exercise 1.2:**

**Hadoop version:**



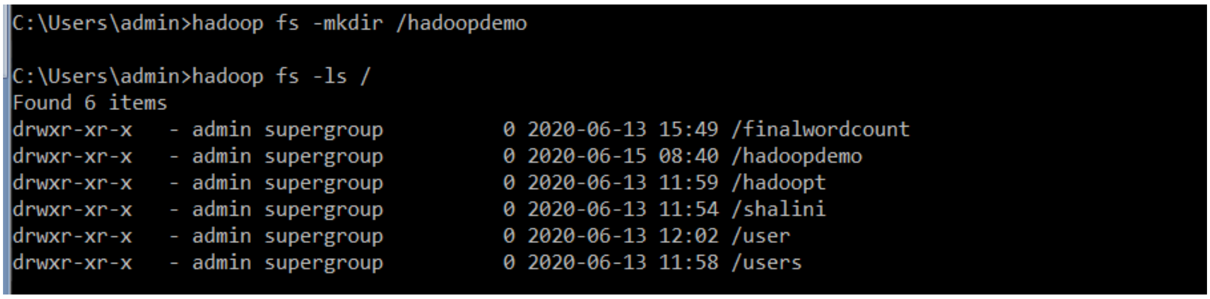
```
C:\Users\admin>hadoop version
Hadoop 2.7.1
Subversion https://git-wip-us.apache.org/repos/asf/hadoop.git -r 15ecc87ccf4a0228f35af08fc56de536e6
ce657a
Compiled by jenkins on 2015-06-29T06:04Z
Compiled with protoc 2.5.0
From source with checksum fc0a1a23fc1868e4d5ee7fa2b28a58a
This command was run using /C:/Users/admin/hadoop-2.7.1/share/hadoop/common/hadoop-common-2.7.1.jar
```

**Listing the directories under the root directory:**



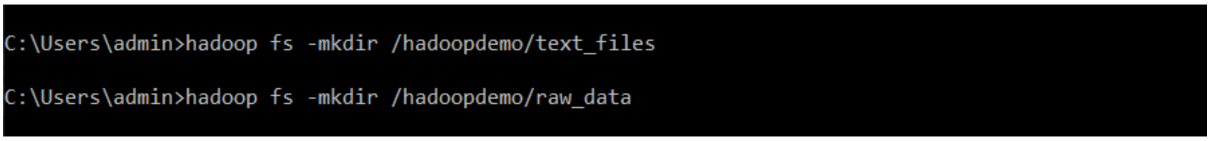
```
C:\Users\admin>hadoop fs -ls /
Found 5 items
drwxr-xr-x   - admin supergroup          0 2020-06-13 15:49 /finalwordcount
drwxr-xr-x   - admin supergroup          0 2020-06-13 11:59 /hadoopt
drwxr-xr-x   - admin supergroup          0 2020-06-13 11:54 /shalini
drwxr-xr-x   - admin supergroup          0 2020-06-13 12:02 /user
drwxr-xr-x   - admin supergroup          0 2020-06-13 11:58 /users
```

**Creating a directory ”hadoopdemo”:**

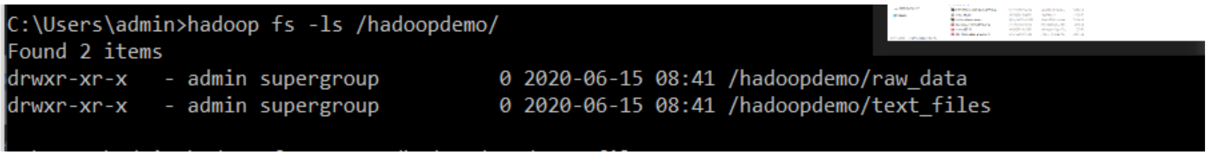


```
C:\Users\admin>hadoop fs -mkdir /hadoopdemo

C:\Users\admin>hadoop fs -ls /
Found 6 items
drwxr-xr-x   - admin supergroup          0 2020-06-13 15:49 /finalwordcount
drwxr-xr-x   - admin supergroup          0 2020-06-15 08:40 /hadoopdemo
drwxr-xr-x   - admin supergroup          0 2020-06-13 11:59 /hadoopt
drwxr-xr-x   - admin supergroup          0 2020-06-13 11:54 /shalini
drwxr-xr-x   - admin supergroup          0 2020-06-13 12:02 /user
drwxr-xr-x   - admin supergroup          0 2020-06-13 11:58 /users
```

**Creating and listing sub directories in hadoopdemo:**

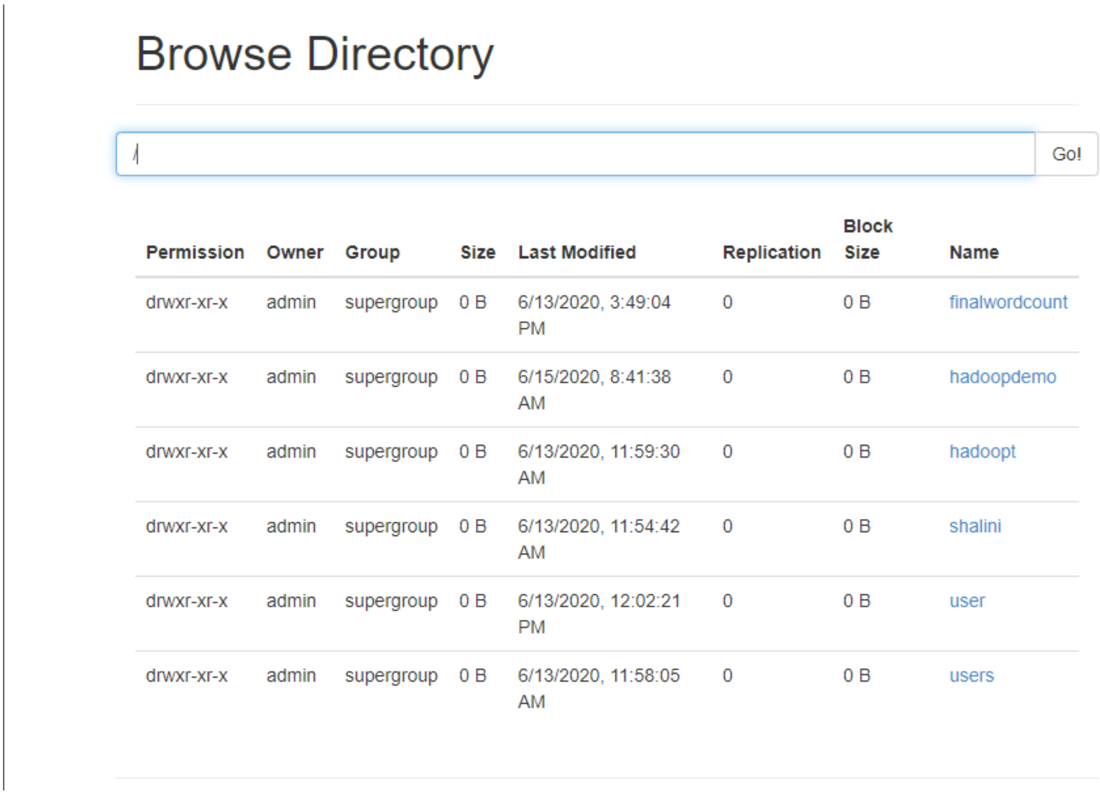


```
C:\Users\admin>hadoop fs -mkdir /hadoopdemo/text_files

C:\Users\admin>hadoop fs -mkdir /hadoopdemo/raw_data
```



```
C:\Users\admin>hadoop fs -ls /hadoopdemo/
Found 2 items
drwxr-xr-x   - admin supergroup          0 2020-06-15 08:41 /hadoopdemo/raw_data
drwxr-xr-x   - admin supergroup          0 2020-06-15 08:41 /hadoopdemo/text_files
```

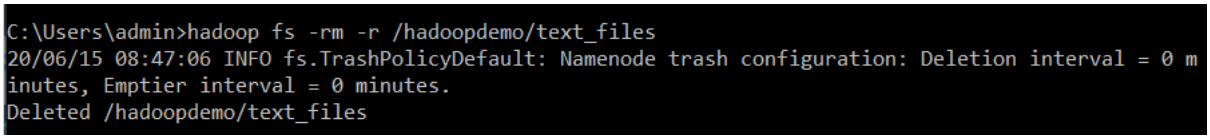
**Hadoop Web UI reflects the creation of a new directory:**



Browse Directory

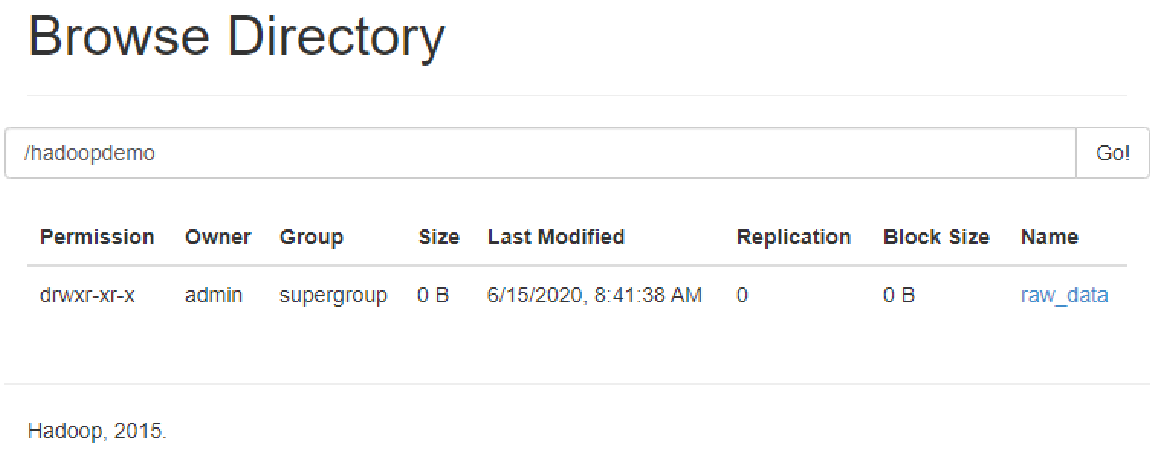
| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 3:49:04 PM | 0 | 0 B | finalwordcount |
| drwxr-xr-x | admin | supergroup | 0 B | 6/15/2020, 8:41:38 AM | 0 | 0 B | hadoopdemo |
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 11:59:30 AM | 0 | 0 B | hadoopt |
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 11:54:42 AM | 0 | 0 B | shalini |
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 12:02:21 PM | 0 | 0 B | user |
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 11:58:05 AM | 0 | 0 B | users |

**Removing “text_files” directory:**



```
C:\Users\admin>hadoop fs -rm -r /hadoopdemo/text_files
20/06/15 08:47:06 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion interval = 0 m
inutes, Emptier interval = 0 minutes.
Deleted /hadoopdemo/text_files
```

**“text_file” directory is not present in the WEB UI since it is deleted:**



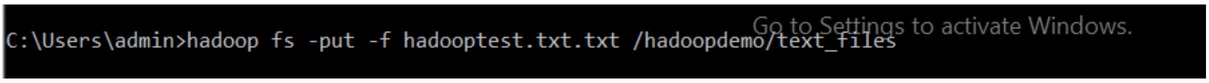
## Browse Directory

/hadoopdemo

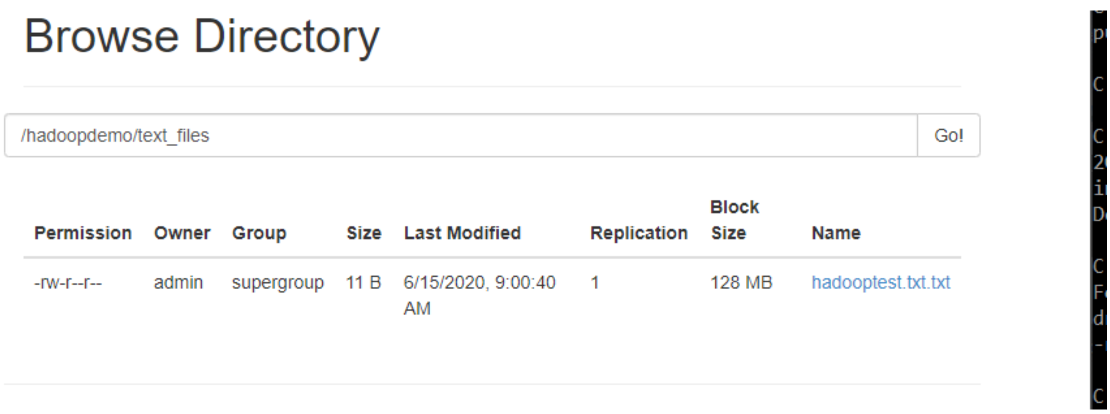
| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| drwxr-xr-x | admin | supergroup | 0 B | 6/15/2020, 8:41:38 AM | 0 | 0 B | raw_data |

Hadoop, 2015.

**Putting text file into hdfs:**



```
C:\Users\admin>hadoop fs -put -f hadooptest.txt.txt /hadoopdemo/text_files
```

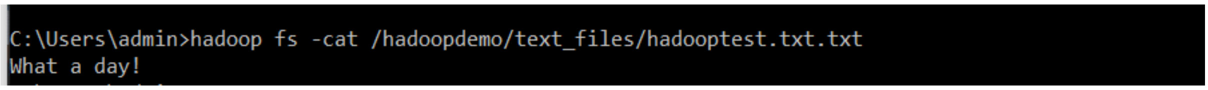


## Browse Directory

/hadoopdemo/text_files

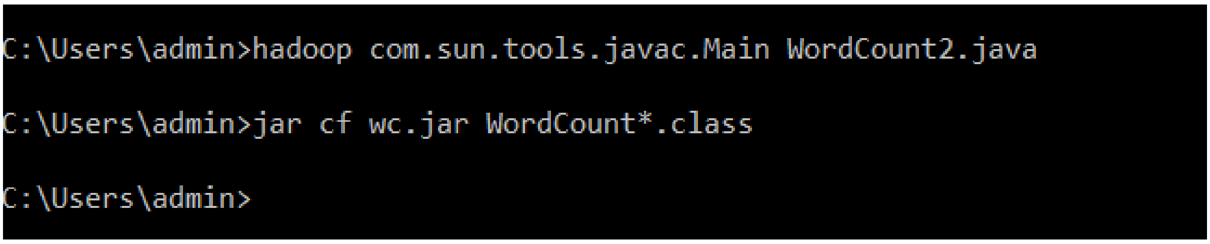
| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| -rw-r--r-- | admin | supergroup | 11 B | 6/15/2020, 9:00:40 AM | 1 | 128 MB | hadooptest.txt.txt |

**Displaying the text file:**

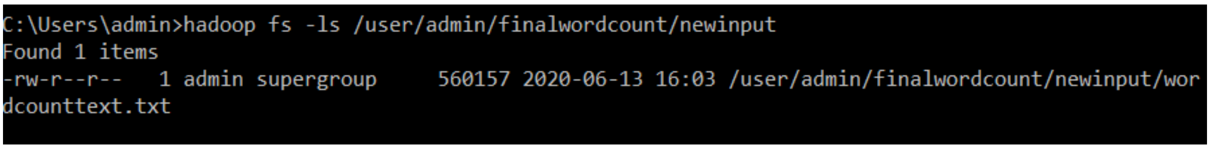


```
C:\Users\admin>hadoop fs -cat /hadoopdemo/text_files/hadooptest.txt.txt
What a day!
```

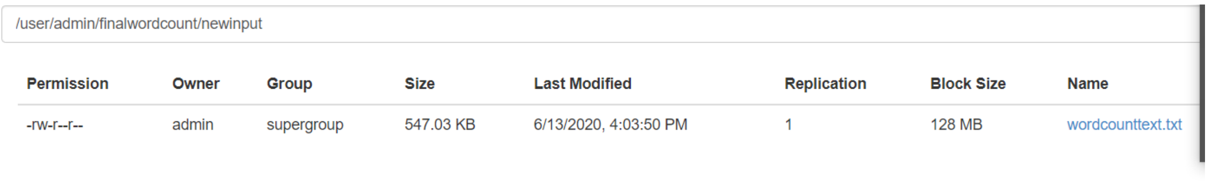
**Exercise 1.3:**



```
C:\Users\admin>hadoop com.sun.tools.javac.Main WordCount2.java

C:\Users\admin>jar cf wc.jar WordCount*.class

C:\Users\admin>
```

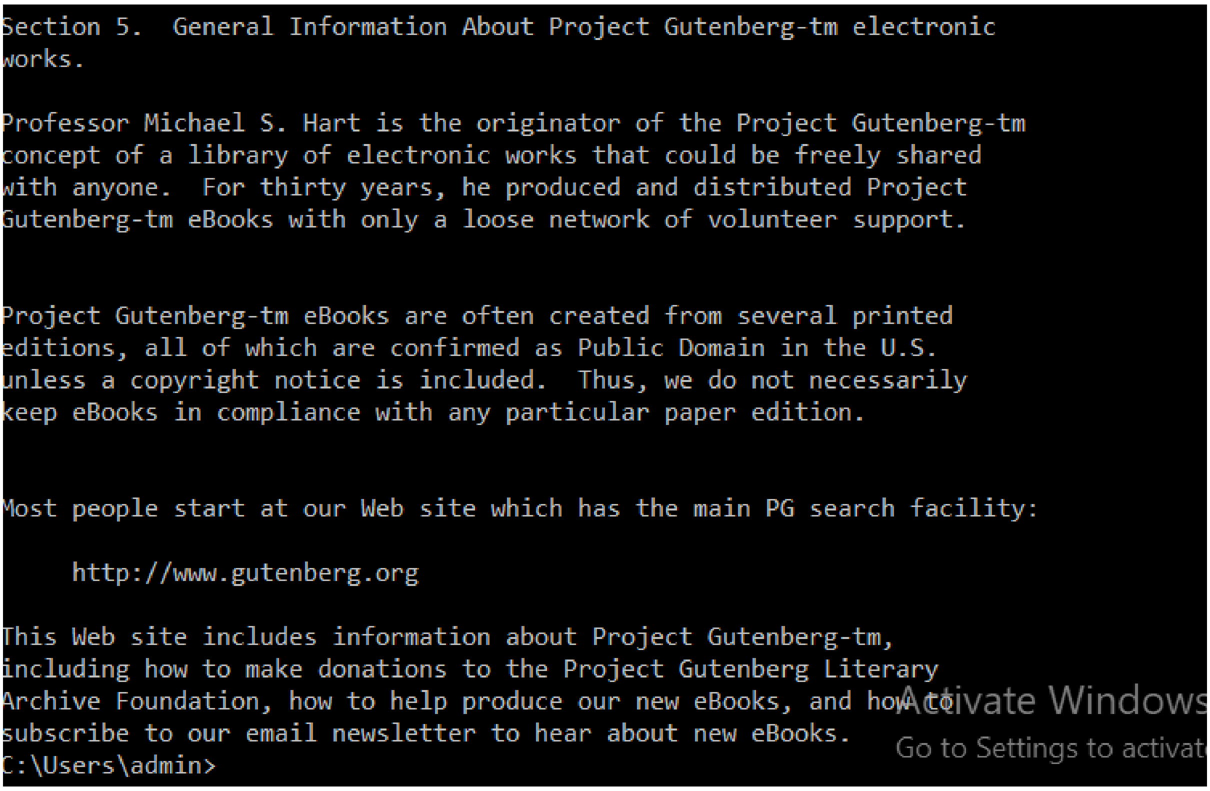


```
C:\Users\admin>hadoop fs -ls /user/admin/finalwordcount/newinput
Found 1 items
-rw-r--r--   1 admin supergroup     560157 2020-06-13 16:03 /user/admin/finalwordcount/newinput/wor
dcounttext.txt
```



/user/admin/finalwordcount/newinput

| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| -rw-r--r-- | admin | supergroup | 547.03 KB | 6/13/2020, 4:03:50 PM | 1 | 128 MB | wordcounttext.txt |



```
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subscribe to our email newsletter to hear about new eBooks.
C:\Users\admin>
```
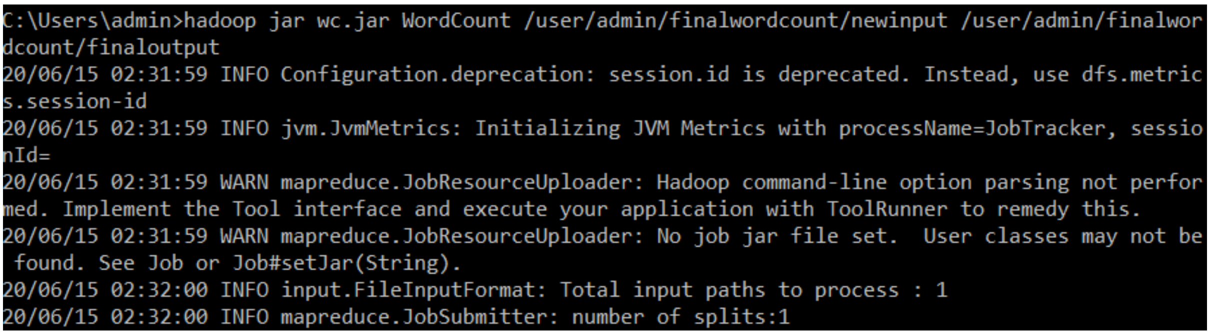
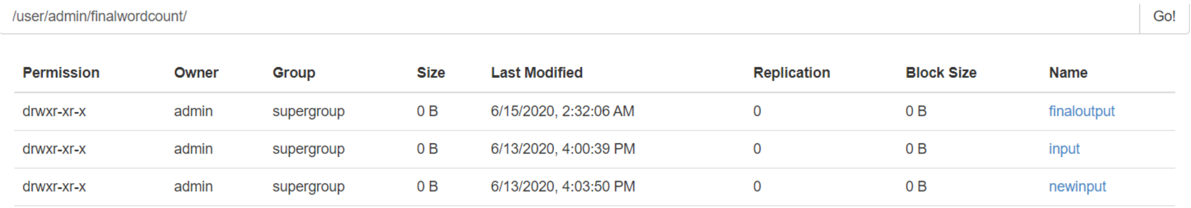
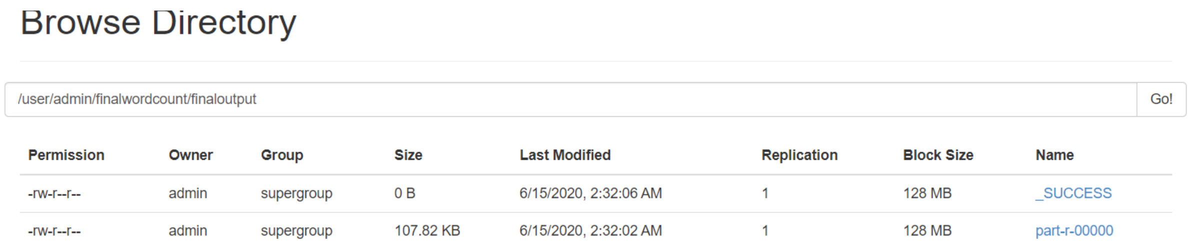



```
C:\Users\admin>hadoop jar wc.jar WordCount /user/admin/finalwordcount/newinput /user/admin/finalwor
dcount/finaloutput
20/06/15 02:31:59 INFO Configuration.deprecation: session.id is deprecated. Instead, use dfs.metric
s.session-id
20/06/15 02:31:59 INFO jvm.JvmMetrics: Initializing JVM Metrics with processName=JobTracker, sessio
nId=
20/06/15 02:31:59 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not perfor
med. Implement the Tool interface and execute your application with ToolRunner to remedy this.
20/06/15 02:31:59 WARN mapreduce.JobResourceUploader: No job jar file set.  User classes may not be
 found. See Job or Job#setJar(String).
20/06/15 02:32:00 INFO input.FileInputFormat: Total input paths to process : 1
20/06/15 02:32:00 INFO mapreduce.JobSubmitter: number of splits:1
```



/user/admin/finalwordcount/

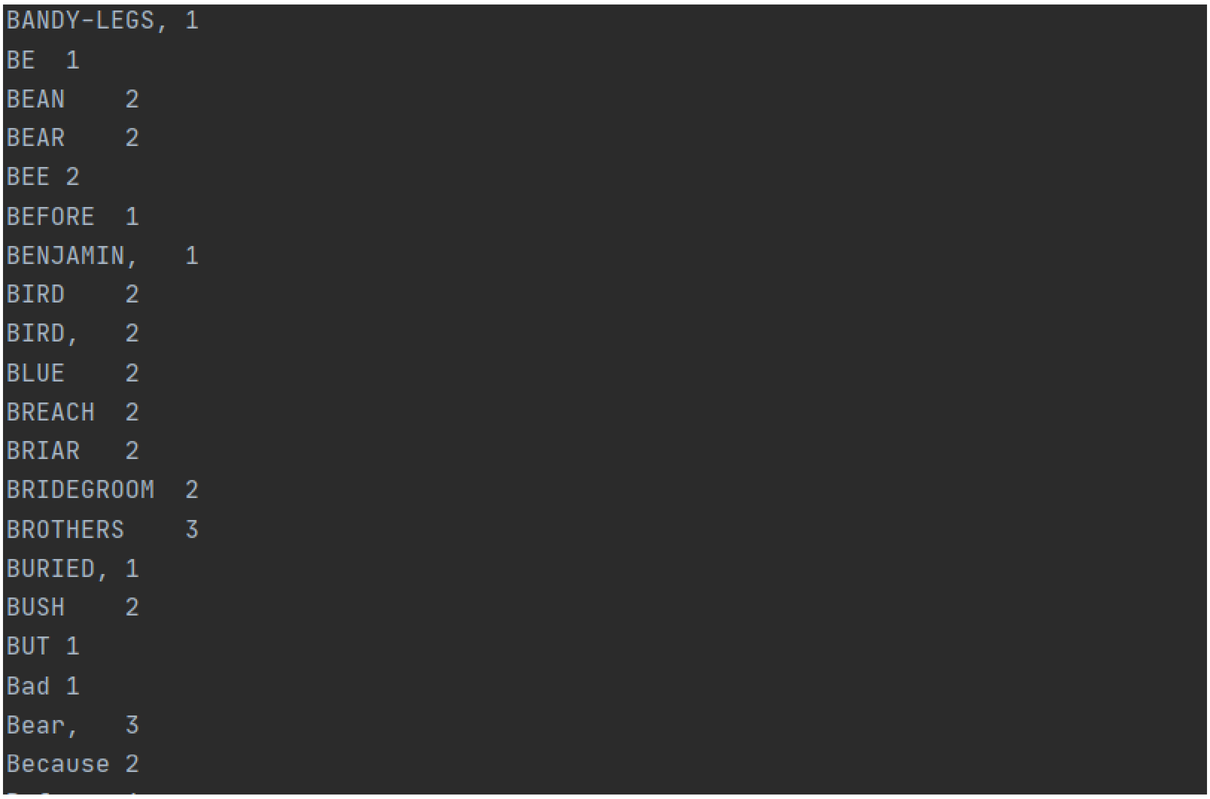
| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| drwxr-xr-x | admin | supergroup | 0 B | 6/15/2020, 2:32:06 AM | 0 | 0 B | finaloutput |
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 4:00:39 PM | 0 | 0 B | input |
| drwxr-xr-x | admin | supergroup | 0 B | 6/13/2020, 4:03:50 PM | 0 | 0 B | newinput |



Browse Directory

/user/admin/finalwordcount/finaloutput

| Permission | Owner | Group | Size | Last Modified | Replication | Block Size | Name |
|---|---|---|---|---|---|---|---|
| -rw-r--r-- | admin | supergroup | 0 B | 6/15/2020, 2:32:06 AM | 1 | 128 MB | _SUCCESS |
| -rw-r--r-- | admin | supergroup | 107.82 KB | 6/15/2020, 2:32:02 AM | 1 | 128 MB | part-r-00000 |



```
BANDY-LEGS, 1
BE  1
BEAN    2
BEAR    2
BEE 2
BEFORE  1
BENJAMIN,   1
BIRD    2
BIRD,   2
BLUE    2
BREACH  2
BRIAR   2
BRIDEGROOM  2
BROTHERS    3
BURIED, 1
BUSH    2
BUT 1
Bad 1
Bear,   3
Because 2
```