Assignment 1

Student Name: Akhil Kumar Gour
SJSU ID: 012455586

I. Installation

- Cloudera provides Apache Hadoop Ecosystem as QuickStarts, Cloudera Manager and Cloudera Director.
- Before selecting any of the packages, we need to make sure we have VMware or Virtual Box installed.
- We selected QuickStarts as our download package. Using QuickStarts, we can start using Cloudera's VM or Docker image in a sandbox environment on our local machine.
- After downloading the QuickStarts installation package, we just need to run it in order to launch the VM instance.
- We can configure the VM as per our requirement; we can increase the memory to be allotted, the network adapter to use etc., in the VMware settings.
- Due to low disk space and just 8 GB of RAM, my VM was slow to boot.
- I increased the memory allotted to the VM from 4 GB to 6 GB and it started working smoothly.

Exercise 1: Hadoop Pi

The first test with Hadoop will be to run an existing Hadoop program, to make sure you can launch the program, monitor progress, and get/put files on the HDFS. The simplest program computes pi in parallel on 5 nodes with 5 samples:

The command used for this was:

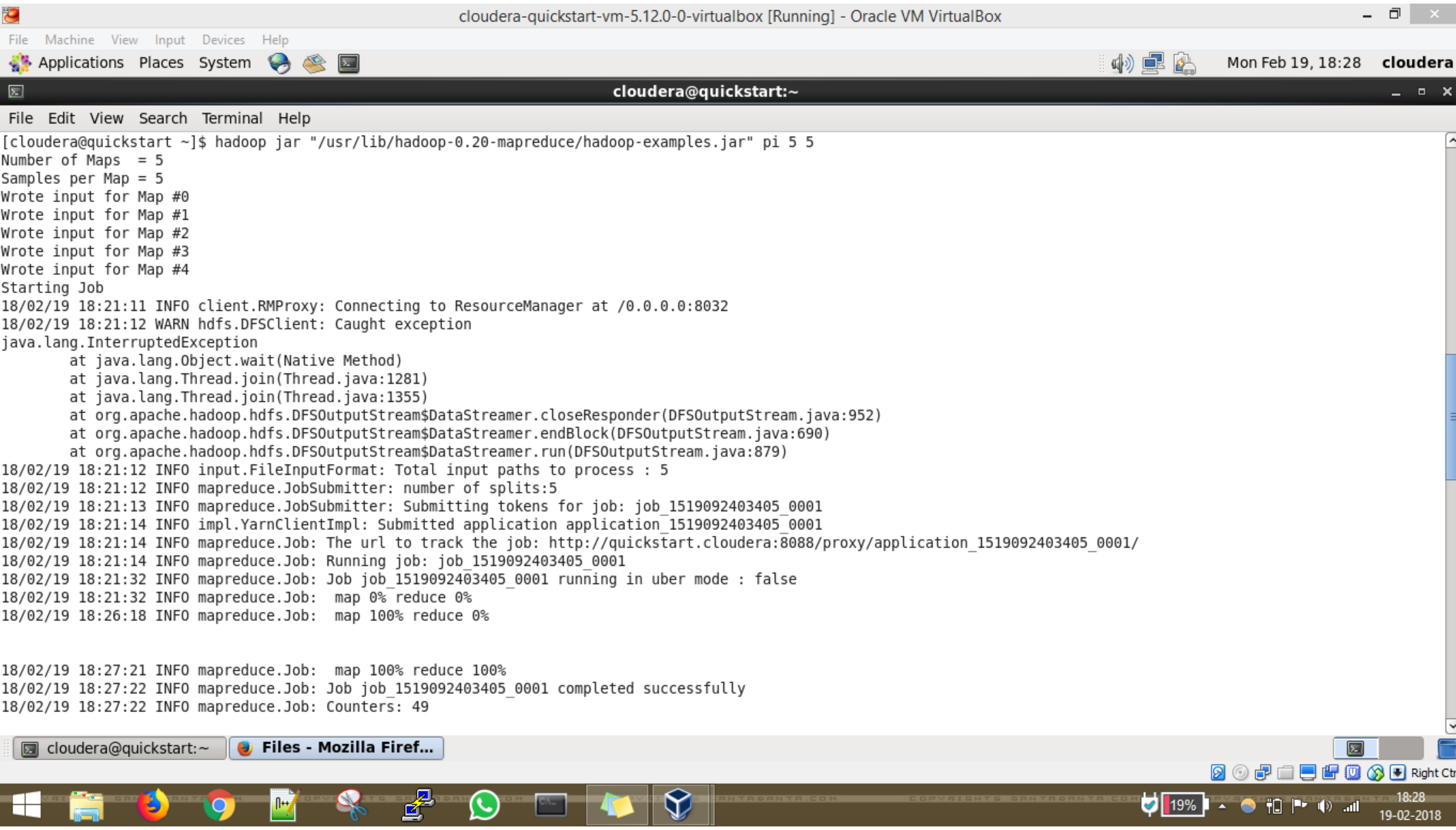
```
$ Hadoop jar "/usr/lib/hadoop-0.20-mapreduce/hadoop-examples.jar" pi 5 5
```

Answer 1:

The Output value received was:

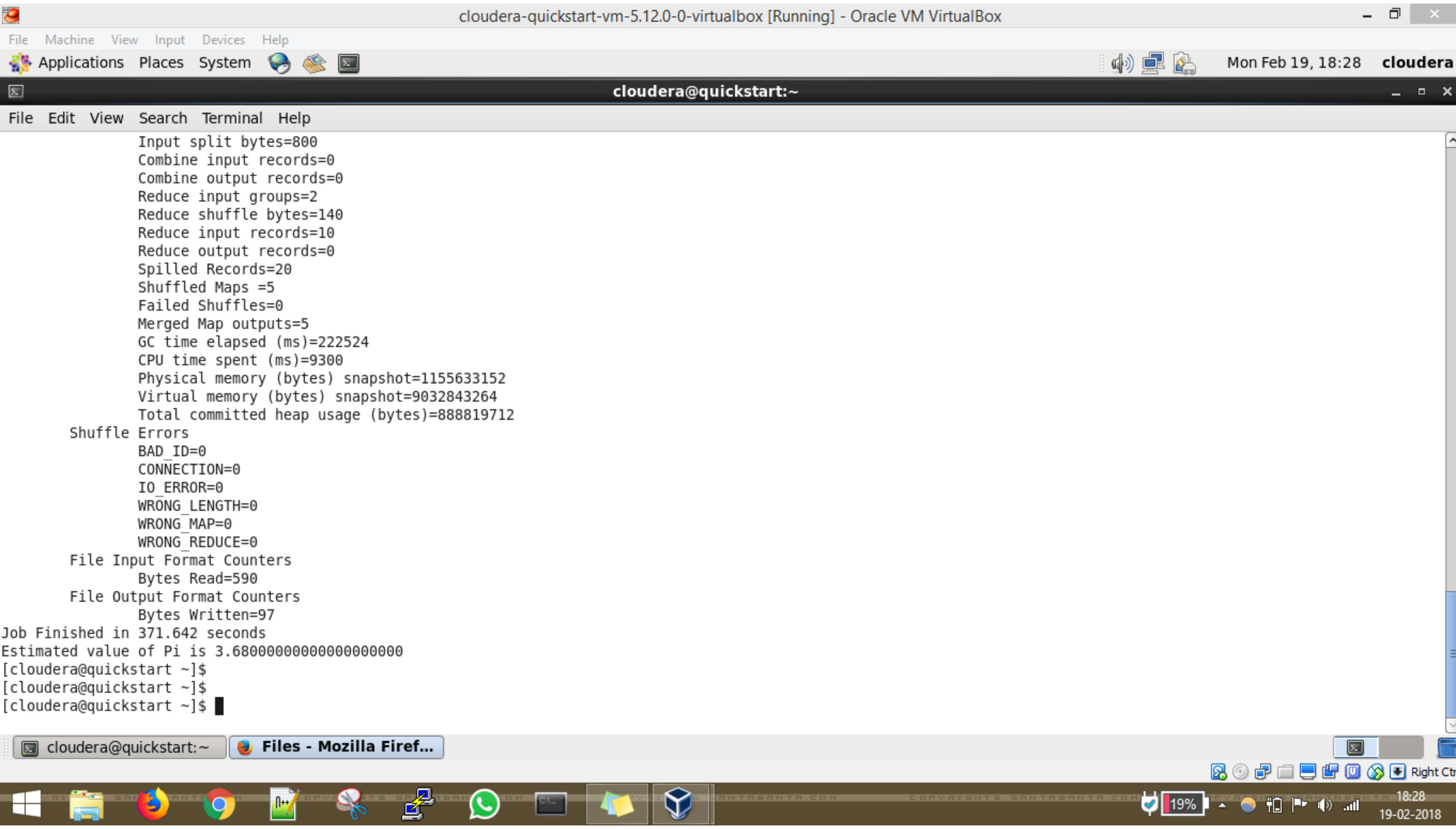
3.68000000000000000000000000

Screenshots:


cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Mon Feb 19, 18:28 cloudera
cloudera@quickstart:~
File Edit View Search Terminal Help
cloudera@quickstart:~
Files - Mozilla Firef...
Right Ctrl
19%
18:28
19-02-2018

```
[cloudera@quickstart ~]$ hadoop jar "/usr/lib/hadoop-0.20-mapreduce/hadoop-examples.jar" pi 5 5
Number of Maps  = 5
Samples per Map = 5
Wrote input for Map #0
Wrote input for Map #1
Wrote input for Map #2
Wrote input for Map #3
Wrote input for Map #4
Starting Job
18/02/19 18:21:11 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
18/02/19 18:21:12 WARN hdfs.DFSClient: Caught exception
java.lang.InterruptedException
        at java.lang.Object.wait(Native Method)
        at java.lang.Thread.join(Thread.java:1281)
        at java.lang.Thread.join(Thread.java:1355)
        at org.apache.hadoop.hdfs.DFSOutputStream$DataStreamer.closeResponder(DFSOutputStream.java:952)
        at org.apache.hadoop.hdfs.DFSOutputStream$DataStreamer.endBlock(DFSOutputStream.java:690)
        at org.apache.hadoop.hdfs.DFSOutputStream$DataStreamer.run(DFSOutputStream.java:879)
18/02/19 18:21:12 INFO input.FileInputFormat: Total input paths to process : 5
18/02/19 18:21:12 INFO mapreduce.JobSubmitter: number of splits:5
18/02/19 18:21:13 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1519092403405_0001
18/02/19 18:21:14 INFO impl.YarnClientImpl: Submitted application application_1519092403405_0001
18/02/19 18:21:14 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1519092403405_0001/
18/02/19 18:21:14 INFO mapreduce.Job: Running job: job_1519092403405_0001
18/02/19 18:21:32 INFO mapreduce.Job: Job job_1519092403405_0001 running in uber mode : false
18/02/19 18:21:32 INFO mapreduce.Job:  map 0% reduce 0%
18/02/19 18:26:18 INFO mapreduce.Job:  map 100% reduce 0%


18/02/19 18:27:21 INFO mapreduce.Job:  map 100% reduce 100%
18/02/19 18:27:22 INFO mapreduce.Job: Job job_1519092403405_0001 completed successfully
18/02/19 18:27:22 INFO mapreduce.Job: Counters: 49
```

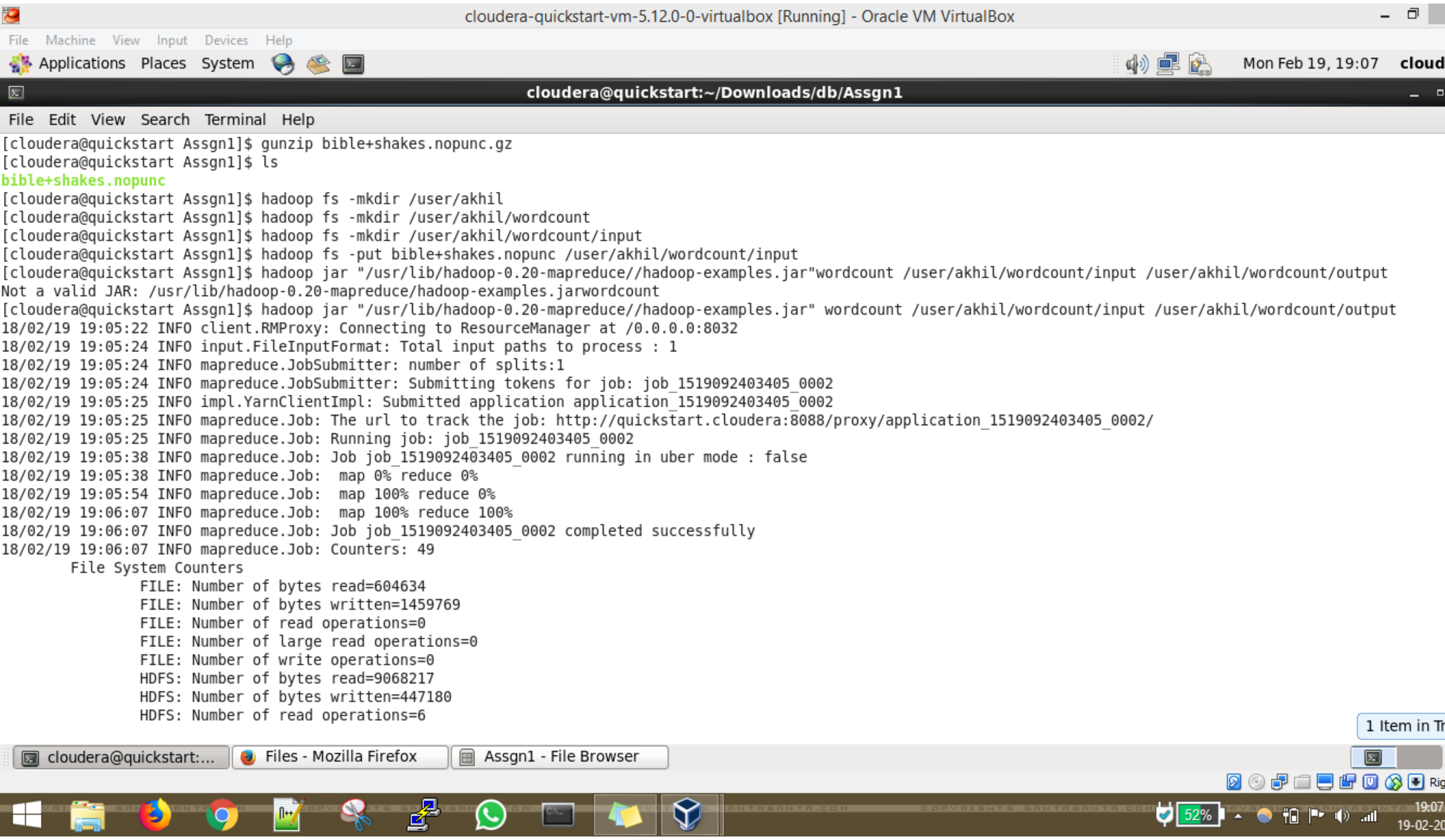

cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Mon Feb 19, 18:28 cloudera
cloudera@quickstart:~
File Edit View Search Terminal Help
cloudera@quickstart:~
Files - Mozilla Firef...
Right Ctrl
19%
18:28
19-02-2018

```
                Input split bytes=800
                Combine input records=0
                Combine output records=0
                Reduce input groups=2
                Reduce shuffle bytes=140
                Reduce input records=10
                Reduce output records=0
                Spilled Records=20
                Shuffled Maps =5
                Failed Shuffles=0
                Merged Map outputs=5
                GC time elapsed (ms)=222524
                CPU time spent (ms)=9300
                Physical memory (bytes) snapshot=1155633152
                Virtual memory (bytes) snapshot=9032843264
                Total committed heap usage (bytes)=888819712
        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=590
        File Output Format Counters
                Bytes Written=97
Job Finished in 371.642 seconds
Estimated value of Pi is 3.68000000000000000000
[cloudera@quickstart ~]$
[cloudera@quickstart ~]$
[cloudera@quickstart ~]$
```

Exercise 2: Hadoop Word Count:

The next program to test is the Hadoop word count program. This example reads text files and counts how often words occur. The input is text files and the output is text files, each line of which contains a word and the count of how often it occurred, separated by a tab.

Before we can run the example, we'll have to copy some data into the distributed file system (HDFS). Here we will create an input directory, and copy in the complete works of Shakespeare and the bible (a standard large corpus for text mining).

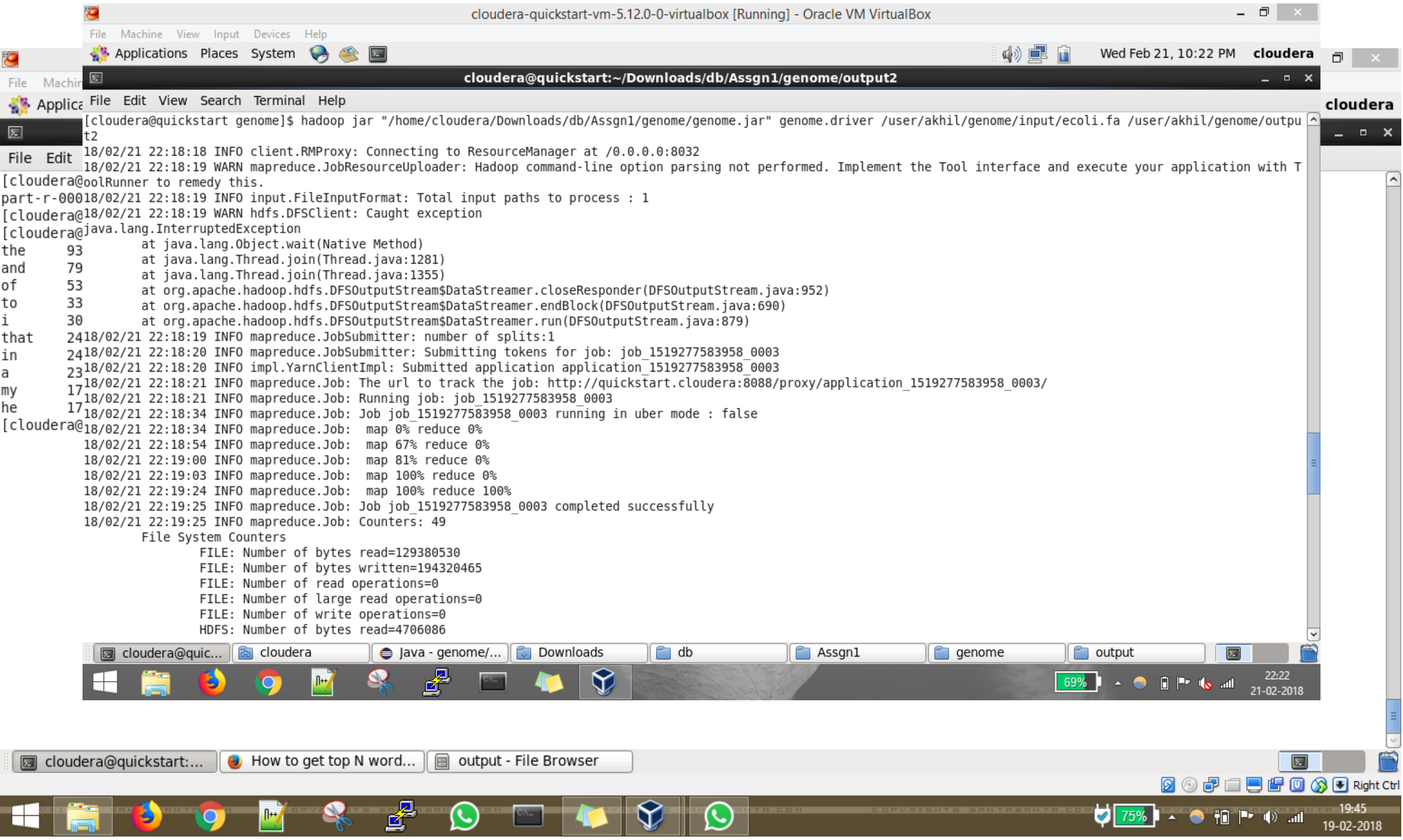

cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Mon Feb 19, 19:07
cloud
cloudera@quickstart:~/Downloads/db/Assgn1
File Edit View Search Terminal Help
1 Item in Tr
cloudera@quickstart:...
Files - Mozilla Firefox
Assgn1 - File Browser
52%
19:07
19-02-20

```
[cloudera@quickstart Assgn1]$ gunzip bible+shakes.nopunc.gz
[cloudera@quickstart Assgn1]$ ls
bible+shakes.nopunc
[cloudera@quickstart Assgn1]$ hadoop fs -mkdir /user/akhil
[cloudera@quickstart Assgn1]$ hadoop fs -mkdir /user/akhil/wordcount
[cloudera@quickstart Assgn1]$ hadoop fs -mkdir /user/akhil/wordcount/input
[cloudera@quickstart Assgn1]$ hadoop fs -put bible+shakes.nopunc /user/akhil/wordcount/input
[cloudera@quickstart Assgn1]$ hadoop jar "/usr/lib/hadoop-0.20-mapreduce//hadoop-examples.jar"wordcount /user/akhil/wordcount/input /user/akhil/wordcount/output
Not a valid JAR: /usr/lib/hadoop-0.20-mapreduce/hadoop-examples.jarwordcount
[cloudera@quickstart Assgn1]$ hadoop jar "/usr/lib/hadoop-0.20-mapreduce//hadoop-examples.jar" wordcount /user/akhil/wordcount/input /user/akhil/wordcount/output
18/02/19 19:05:22 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
18/02/19 19:05:24 INFO input.FileInputFormat: Total input paths to process : 1
18/02/19 19:05:24 INFO mapreduce.JobSubmitter: number of splits:1
18/02/19 19:05:24 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1519092403405_0002
18/02/19 19:05:25 INFO impl.YarnClientImpl: Submitted application application_1519092403405_0002
18/02/19 19:05:25 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1519092403405_0002/
18/02/19 19:05:25 INFO mapreduce.Job: Running job: job_1519092403405_0002
18/02/19 19:05:38 INFO mapreduce.Job: Job job_1519092403405_0002 running in uber mode : false
18/02/19 19:05:38 INFO mapreduce.Job:  map 0% reduce 0%
18/02/19 19:05:54 INFO mapreduce.Job:  map 100% reduce 0%
18/02/19 19:06:07 INFO mapreduce.Job:  map 100% reduce 100%
18/02/19 19:06:07 INFO mapreduce.Job: Job job_1519092403405_0002 completed successfully
18/02/19 19:06:07 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=604634
                FILE: Number of bytes written=1459769
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=9068217
                HDFS: Number of bytes written=447180
                HDFS: Number of read operations=6
```

Answer 2:

The top 10 most frequently used words were:

the	93739
and	79182
of	53121
to	33929
i	30240
that	24407
in	24350
a	23504
my	17312
he	17887



cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Wed Feb 21, 10:22 PM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/genome/output2
File Edit View Search Terminal Help
cloudera@quic... cloudera Java - genome/... Downloads db Assgn1 genome output
69% 22:22 21-02-2018
cloudera@quickstart:... How to get top N word... output - File Browser
Right Ctrl
75% 19:45 19-02-2018

```
[cloudera@quickstart genome]$ hadoop jar "/home/cloudera/Downloads/db/Assgn1/genome/genome.jar" genome.driver /user/akhil/genome/input/ecoli.fa /user/akhil/genome/outpu
t2
18/02/21 22:18:18 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
18/02/21 22:18:19 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with T
oolRunner to remedy this.
18/02/21 22:18:19 INFO input.FileInputFormat: Total input paths to process : 1
18/02/21 22:18:19 WARN hdfs.DFSClient: Caught exception
java.lang.InterruptedException
        at java.lang.Object.wait(Native Method)
        at java.lang.Thread.join(Thread.java:1281)
        at java.lang.Thread.join(Thread.java:1355)
        at org.apache.hadoop.hdfs.DFSOutputStream$DataStreamer.closeResponder(DFSOutputStream.java:952)
        at org.apache.hadoop.hdfs.DFSOutputStream$DataStreamer.endBlock(DFSOutputStream.java:690)
        at org.apache.hadoop.hdfs.DFSOutputStream$DataStreamer.run(DFSOutputStream.java:879)
18/02/21 22:18:19 INFO mapreduce.JobSubmitter: number of splits:1
18/02/21 22:18:20 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1519277583958_0003
18/02/21 22:18:20 INFO impl.YarnClientImpl: Submitted application application_1519277583958_0003
18/02/21 22:18:21 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1519277583958_0003/
18/02/21 22:18:21 INFO mapreduce.Job: Running job: job_1519277583958_0003
18/02/21 22:18:34 INFO mapreduce.Job: Job job_1519277583958_0003 running in uber mode : false
18/02/21 22:18:34 INFO mapreduce.Job:  map 0% reduce 0%
18/02/21 22:18:54 INFO mapreduce.Job:  map 67% reduce 0%
18/02/21 22:19:00 INFO mapreduce.Job:  map 81% reduce 0%
18/02/21 22:19:03 INFO mapreduce.Job:  map 100% reduce 0%
18/02/21 22:19:24 INFO mapreduce.Job:  map 100% reduce 100%
18/02/21 22:19:25 INFO mapreduce.Job: Job job_1519277583958_0003 completed successfully
18/02/21 22:19:25 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=129380530
                FILE: Number of bytes written=194320465
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=4706086
```

```
[cloudera@
part-r-000
[cloudera@
[cloudera@
the     93
and     79
of      53
to      33
i       30
that    24
in      24
a       23
my      17
he      17
[cloudera@
```

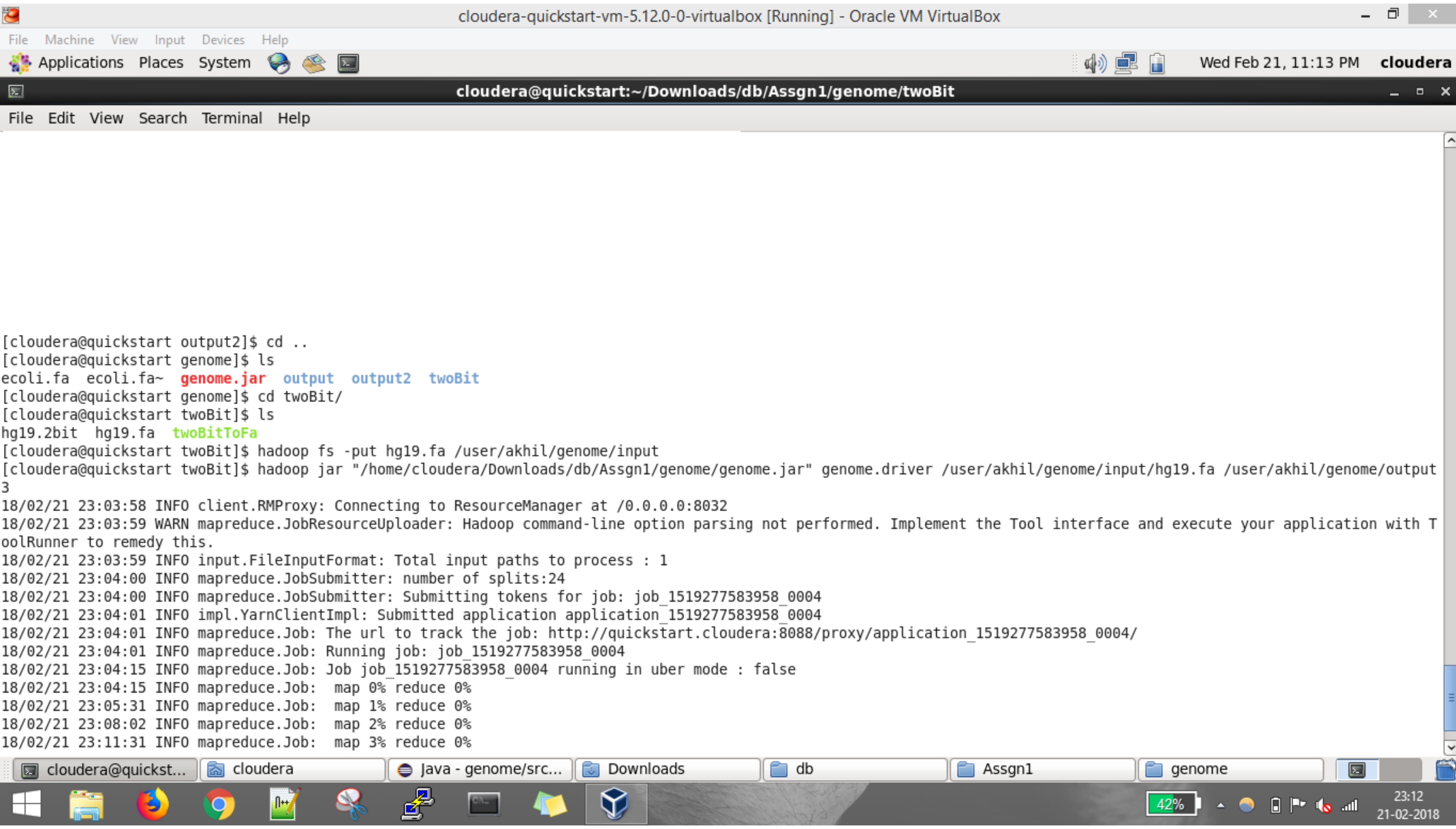
Exercise 3: Hadoop KMER counting:

The next exercise was to implement a KMER counter using Hadoop. Conceptually this is very similar to the word count program, but since there are no spaces in the human genome, we counted the overlapping KMERS instead of discrete words.

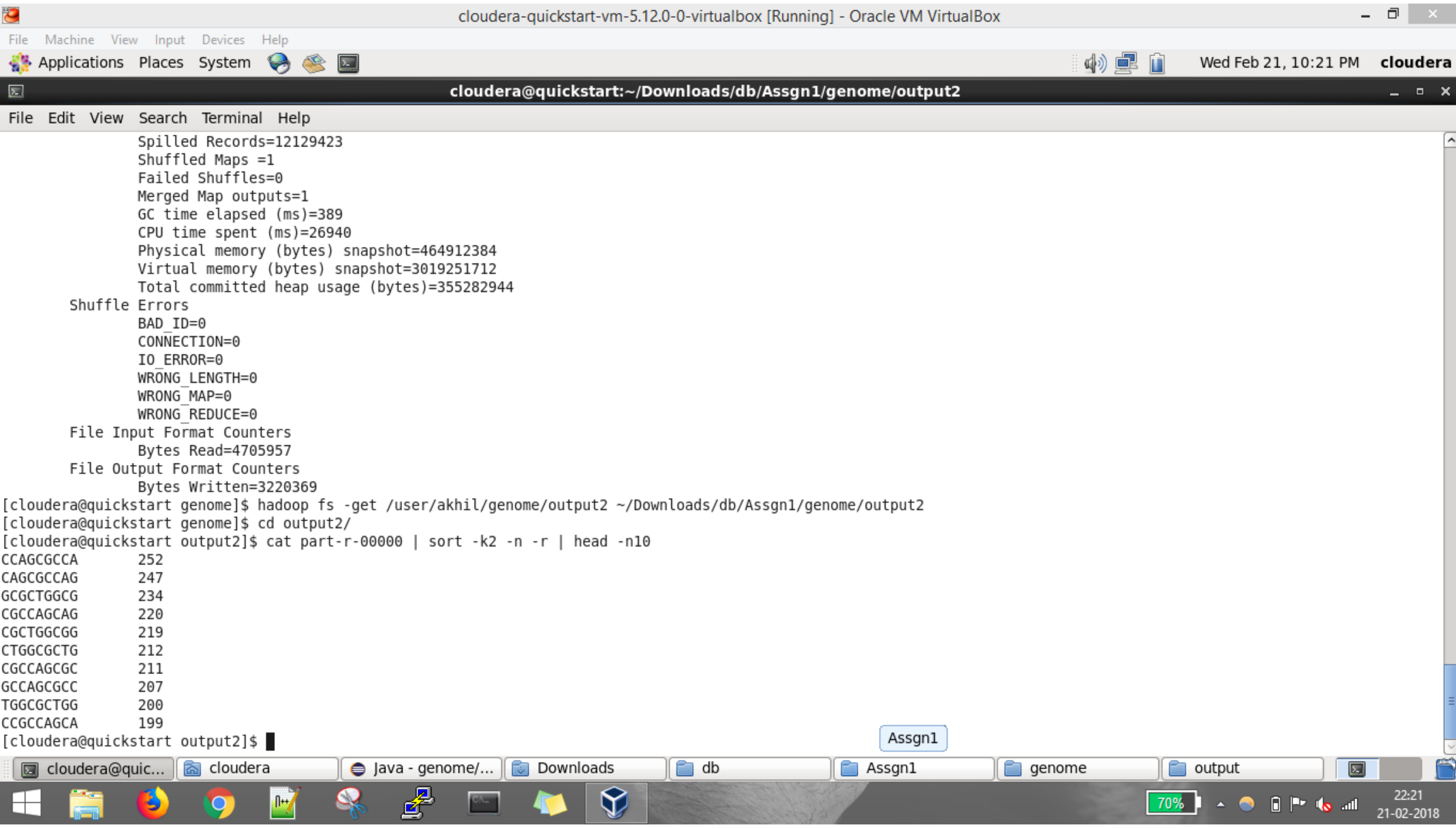
Output:

Top 10 most frequently occurring 9-mers in E coli:

CCAGCGCCA	252
CAGCGCCAG	247
GCGCTGGCG	234
CGCCAGCAG	220
CCGTAGCGG	219
CGCTGGACC	212
CGCCAGGCC	211
GGCGTCGCA	207
TCCAGCGCG	200
CAGGTCGGC	199


cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Wed Feb 21, 11:13 PM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/genome/twoBit
File Edit View Search Terminal Help
cloudera@quickst... cloudera Java - genome/src... Downloads db Assgn1 genome
42%
23:12
21-02-2018

```
[cloudera@quickstart output2]$ cd ..
[cloudera@quickstart genome]$ ls
ecoli.fa  ecoli.fa~  genome.jar  output  output2  twoBit
[cloudera@quickstart genome]$ cd twoBit/
[cloudera@quickstart twoBit]$ ls
hg19.2bit  hg19.fa  twoBitToFa
[cloudera@quickstart twoBit]$ hadoop fs -put hg19.fa /user/akhil/genome/input
[cloudera@quickstart twoBit]$ hadoop jar "/home/cloudera/Downloads/db/Assgn1/genome/genome.jar" genome.driver /user/akhil/genome/input/hg19.fa /user/akhil/genome/output
3
18/02/21 23:03:58 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
18/02/21 23:03:59 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with T
oolRunner to remedy this.
18/02/21 23:03:59 INFO input.FileInputFormat: Total input paths to process : 1
18/02/21 23:04:00 INFO mapreduce.JobSubmitter: number of splits:24
18/02/21 23:04:00 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1519277583958_0004
18/02/21 23:04:01 INFO impl.YarnClientImpl: Submitted application application_1519277583958_0004
18/02/21 23:04:01 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1519277583958_0004/
18/02/21 23:04:01 INFO mapreduce.Job: Running job: job_1519277583958_0004
18/02/21 23:04:15 INFO mapreduce.Job: Job job_1519277583958_0004 running in uber mode : false
18/02/21 23:04:15 INFO mapreduce.Job:  map 0% reduce 0%
18/02/21 23:05:31 INFO mapreduce.Job:  map 1% reduce 0%
18/02/21 23:08:02 INFO mapreduce.Job:  map 2% reduce 0%
18/02/21 23:11:31 INFO mapreduce.Job:  map 3% reduce 0%
```


cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Wed Feb 21, 10:21 PM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/genome/output2
File Edit View Search Terminal Help
Assgn1
cloudera@quic... cloudera Java - genome/... Downloads db Assgn1 genome output
70%
22:21
21-02-2018

```
                Spilled Records=12129423
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=389
                CPU time spent (ms)=26940
                Physical memory (bytes) snapshot=464912384
                Virtual memory (bytes) snapshot=3019251712
                Total committed heap usage (bytes)=355282944
        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=4705957
        File Output Format Counters
                Bytes Written=3220369
[cloudera@quickstart genome]$ hadoop fs -get /user/akhil/genome/output2 ~/Downloads/db/Assgn1/genome/output2
[cloudera@quickstart genome]$ cd output2/
[cloudera@quickstart output2]$ cat part-r-00000 | sort -k2 -n -r | head -n10
CCAGCGCCA       252
CAGCGCCAG       247
GCGCTGGCG       234
CGCCAGCAG       220
CGCTGGCGG       219
CTGGCGCTG       212
CGCCAGCGC       211
GCCAGCGCC       207
TGGCGCTGG       200
CCGCCAGCA       199
[cloudera@quickstart output2]$ 
```

Exercise 4: Hadoop Playing Cards Counting

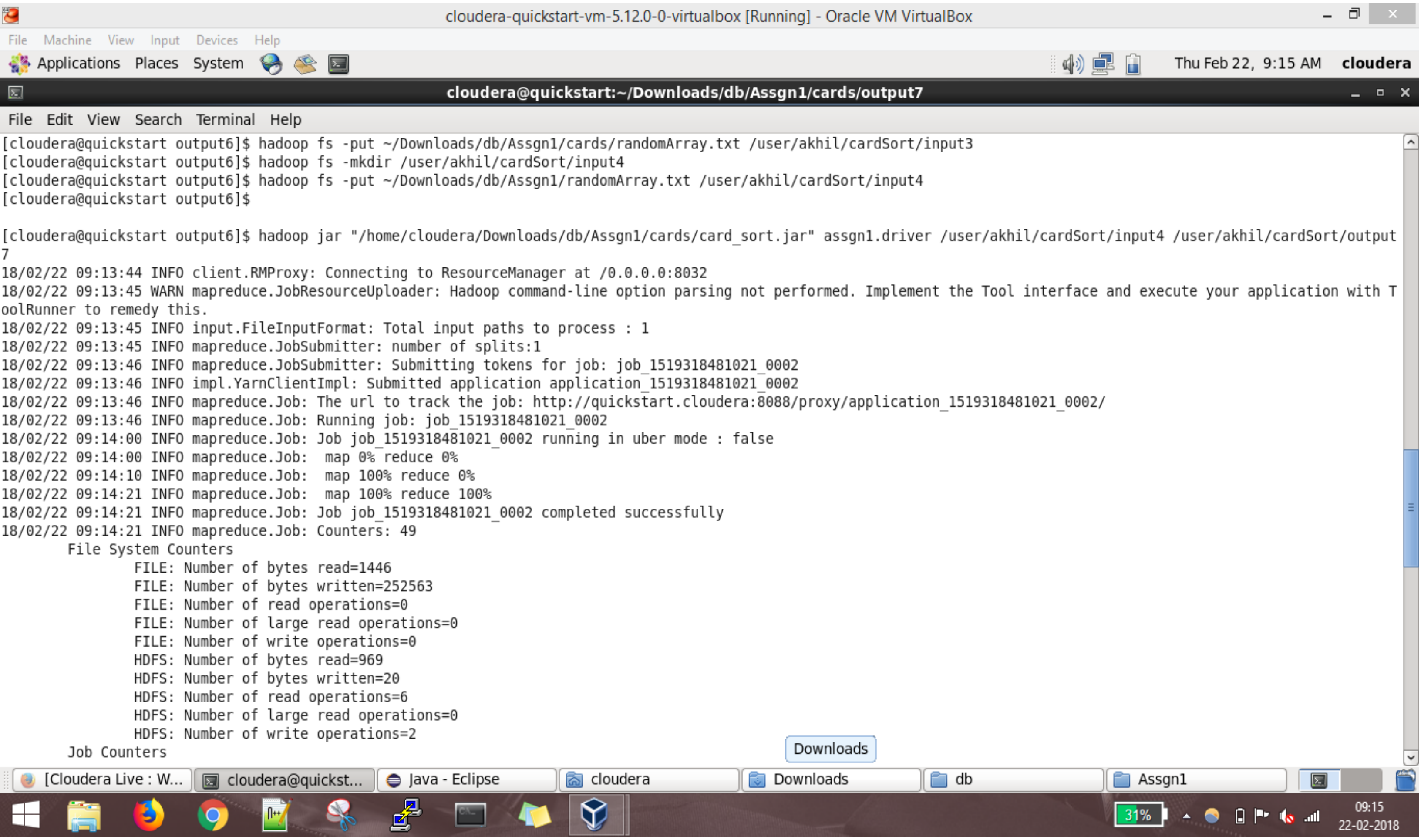
Use the same Hadoop/Mapreduce framework to write your own mapper and reducer codes in Java to count the numeric number for each suit of playing cards. (as the demo in the class)

For data file, we needed to write java codes to generate an input file containing shuffled 100 decks of 54 cards.

NOTE: *I was confused about* ***whether we have to count the total cards in a suit or we have to sum it****, so I wrote* ***program for both, addition and counting****. I've attached screenshots for both.*

For a deck of 5:
First we generated an input file containing 5 shuffled decks of cards.

We will be ignoring all the face cards and the joker cards.

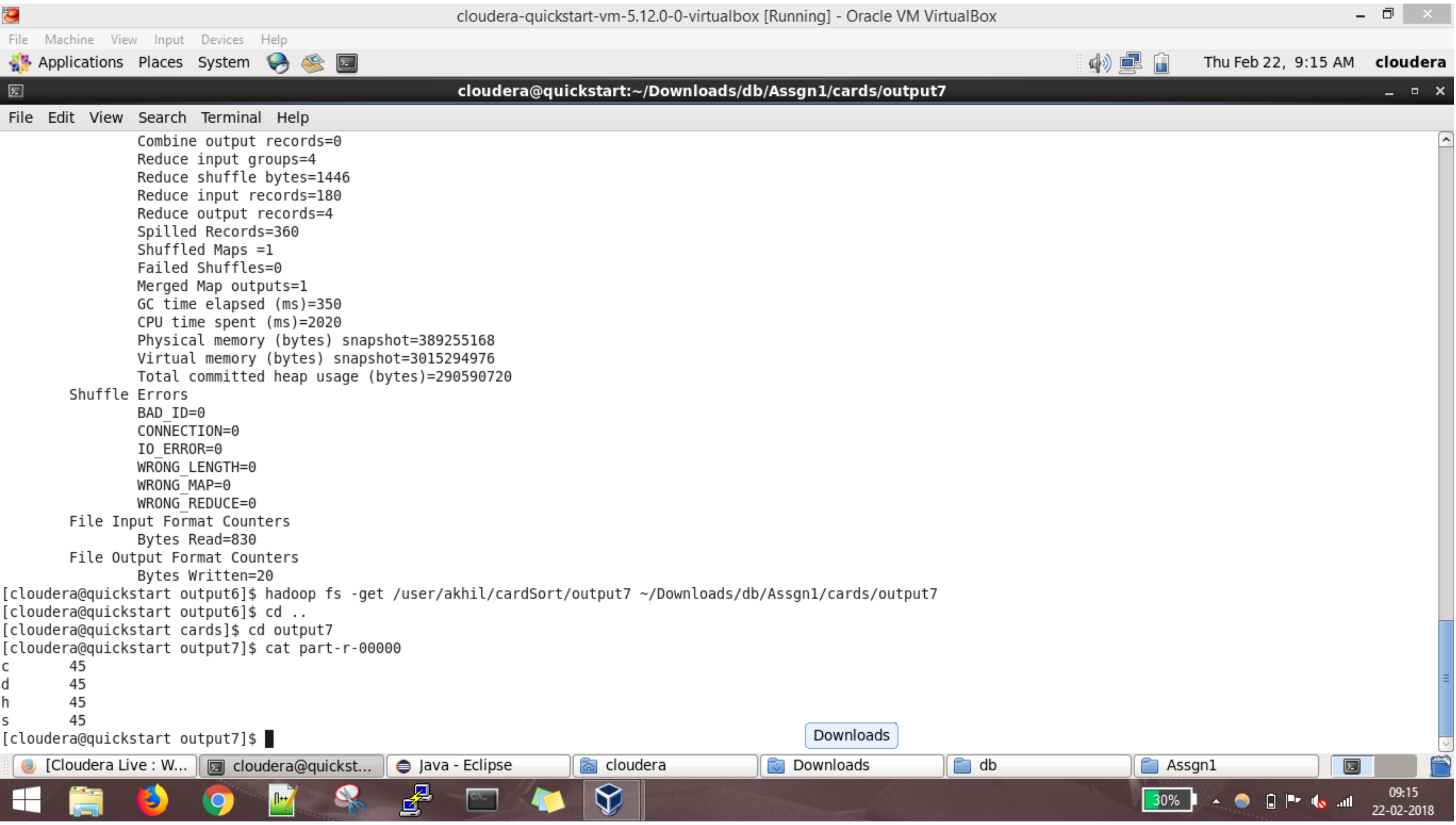

cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Thu Feb 22, 9:15 AM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/cards/output7
File Edit View Search Terminal Help
Downloads
[Cloudera Live : W...
cloudera@quickst...
Java - Eclipse
cloudera
Downloads
db
Assgn1
31%
09:15
22-02-2018

```
[cloudera@quickstart output6]$ hadoop fs -put ~/Downloads/db/Assgn1/cards/randomArray.txt /user/akhil/cardSort/input3
[cloudera@quickstart output6]$ hadoop fs -mkdir /user/akhil/cardSort/input4
[cloudera@quickstart output6]$ hadoop fs -put ~/Downloads/db/Assgn1/randomArray.txt /user/akhil/cardSort/input4
[cloudera@quickstart output6]$

[cloudera@quickstart output6]$ hadoop jar "/home/cloudera/Downloads/db/Assgn1/cards/card_sort.jar" assgn1.driver /user/akhil/cardSort/input4 /user/akhil/cardSort/output
7
18/02/22 09:13:44 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
18/02/22 09:13:45 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with T
oolRunner to remedy this.
18/02/22 09:13:45 INFO input.FileInputFormat: Total input paths to process : 1
18/02/22 09:13:45 INFO mapreduce.JobSubmitter: number of splits:1
18/02/22 09:13:46 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1519318481021_0002
18/02/22 09:13:46 INFO impl.YarnClientImpl: Submitted application application_1519318481021_0002
18/02/22 09:13:46 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1519318481021_0002/
18/02/22 09:13:46 INFO mapreduce.Job: Running job: job_1519318481021_0002
18/02/22 09:14:00 INFO mapreduce.Job: Job job_1519318481021_0002 running in uber mode : false
18/02/22 09:14:00 INFO mapreduce.Job:  map 0% reduce 0%
18/02/22 09:14:10 INFO mapreduce.Job:  map 100% reduce 0%
18/02/22 09:14:21 INFO mapreduce.Job:  map 100% reduce 100%
18/02/22 09:14:21 INFO mapreduce.Job: Job job_1519318481021_0002 completed successfully
18/02/22 09:14:21 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=1446
                FILE: Number of bytes written=252563
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=969
                HDFS: Number of bytes written=20
                HDFS: Number of read operations=6
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
```

Output for 5 decks of cards:
For counting total number of numeric cards in a suit.

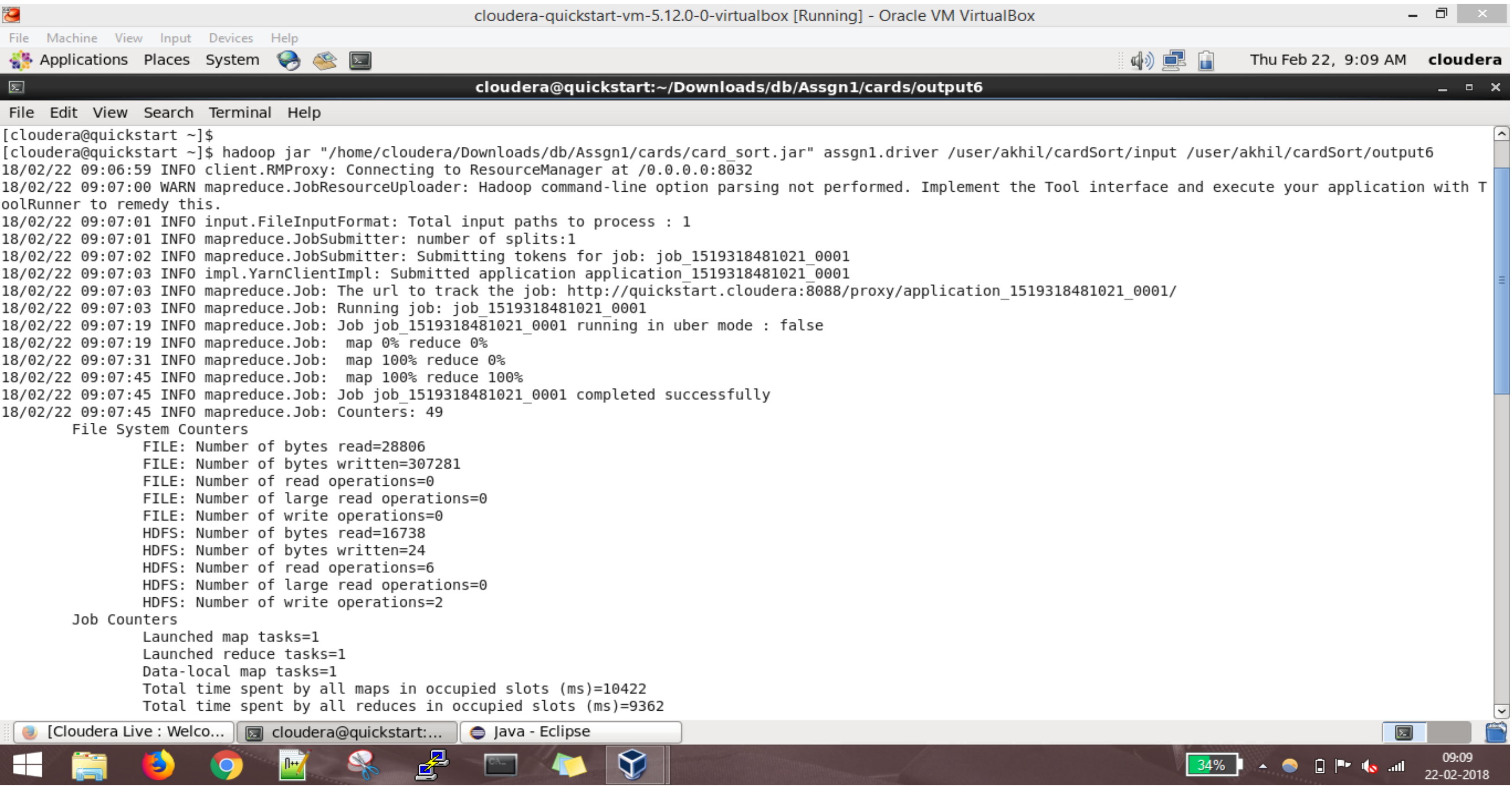
c	45	(clubs)
d	45	(diamonds)
h	45	(hearts)
s	45	(spades)


cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Thu Feb 22, 9:15 AM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/cards/output7
File Edit View Search Terminal Help
Downloads
[Cloudera Live : W...
cloudera@quickst...
Java - Eclipse
cloudera
Downloads
db
Assgn1
30%
09:15
22-02-2018

```
                Combine output records=0
                Reduce input groups=4
                Reduce shuffle bytes=1446
                Reduce input records=180
                Reduce output records=4
                Spilled Records=360
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=350
                CPU time spent (ms)=2020
                Physical memory (bytes) snapshot=389255168
                Virtual memory (bytes) snapshot=3015294976
                Total committed heap usage (bytes)=290590720
        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=830
        File Output Format Counters
                Bytes Written=20
[cloudera@quickstart output6]$ hadoop fs -get /user/akhil/cardSort/output7 ~/Downloads/db/Assgn1/cards/output7
[cloudera@quickstart output6]$ cd ..
[cloudera@quickstart cards]$ cd output7
[cloudera@quickstart output7]$ cat part-r-00000
c       45
d       45
h       45
s       45
[cloudera@quickstart output7]$ 
```

For Deck of 100 cards:

For counting total number of numeric cards in a suit.

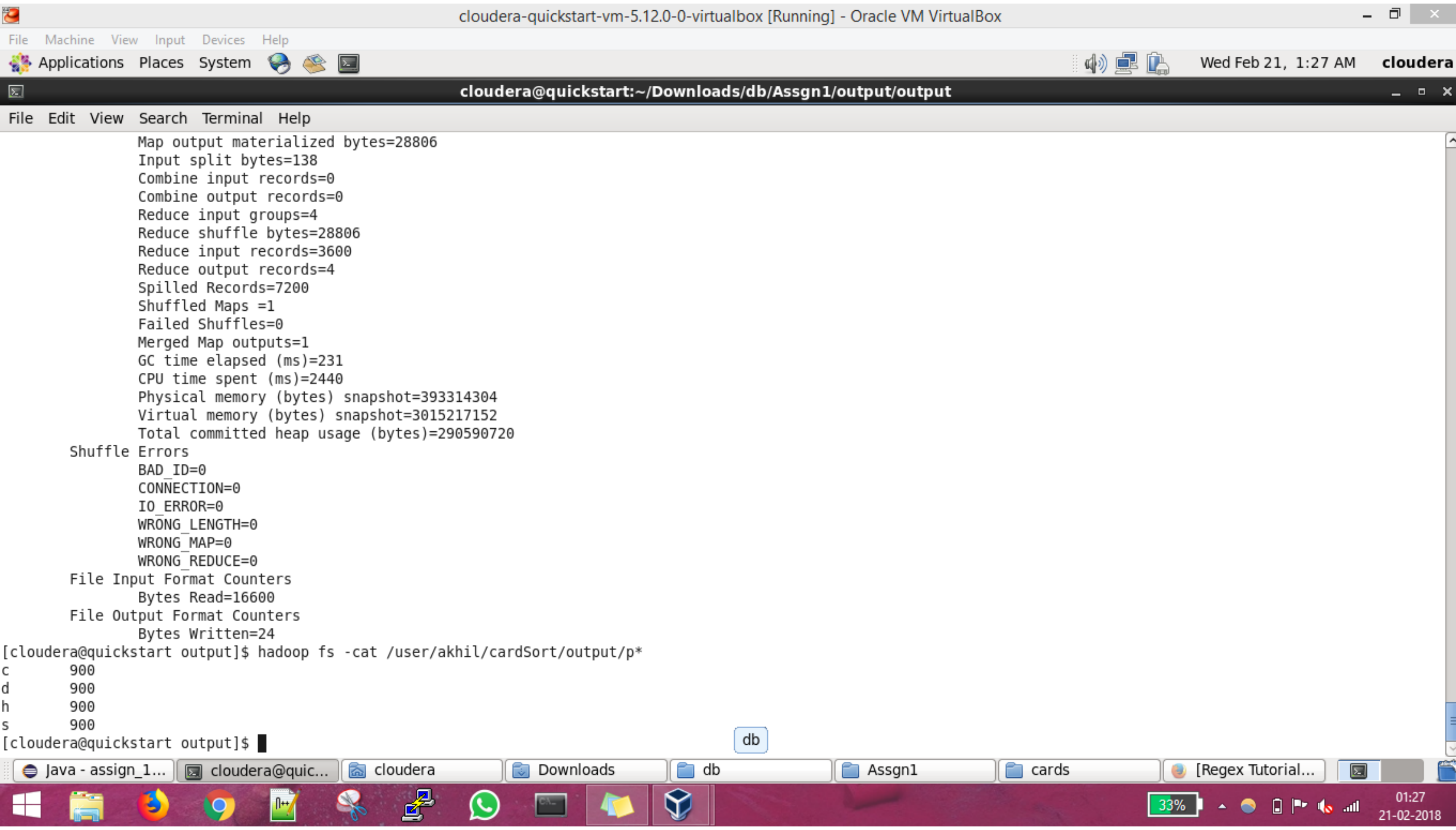

cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Thu Feb 22, 9:09 AM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/cards/output6
File Edit View Search Terminal Help
[Cloudera Live : Welco...
cloudera@quickstart:...
Java - Eclipse
34%
09:09
22-02-2018

```
[cloudera@quickstart ~]$
[cloudera@quickstart ~]$ hadoop jar "/home/cloudera/Downloads/db/Assgn1/cards/card_sort.jar" assgn1.driver /user/akhil/cardSort/input /user/akhil/cardSort/output6
18/02/22 09:06:59 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
18/02/22 09:07:00 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with T
oolRunner to remedy this.
18/02/22 09:07:01 INFO input.FileInputFormat: Total input paths to process : 1
18/02/22 09:07:01 INFO mapreduce.JobSubmitter: number of splits:1
18/02/22 09:07:02 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1519318481021_0001
18/02/22 09:07:03 INFO impl.YarnClientImpl: Submitted application application_1519318481021_0001
18/02/22 09:07:03 INFO mapreduce.Job: The url to track the job: http://quickstart.cloudera:8088/proxy/application_1519318481021_0001/
18/02/22 09:07:03 INFO mapreduce.Job: Running job: job_1519318481021_0001
18/02/22 09:07:19 INFO mapreduce.Job: Job job_1519318481021_0001 running in uber mode : false
18/02/22 09:07:19 INFO mapreduce.Job:  map 0% reduce 0%
18/02/22 09:07:31 INFO mapreduce.Job:  map 100% reduce 0%
18/02/22 09:07:45 INFO mapreduce.Job:  map 100% reduce 100%
18/02/22 09:07:45 INFO mapreduce.Job: Job job_1519318481021_0001 completed successfully
18/02/22 09:07:45 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=28806
                FILE: Number of bytes written=307281
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=16738
                HDFS: Number of bytes written=24
                HDFS: Number of read operations=6
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
                Launched map tasks=1
                Launched reduce tasks=1
                Data-local map tasks=1
                Total time spent by all maps in occupied slots (ms)=10422
                Total time spent by all reduces in occupied slots (ms)=9362
```

Output for 100 decks of cards:

For counting total number of numeric cards in a suit.

c	900	(clubs)
d	900	(diamonds)
h	900	(hearts)
s	900	(spades)

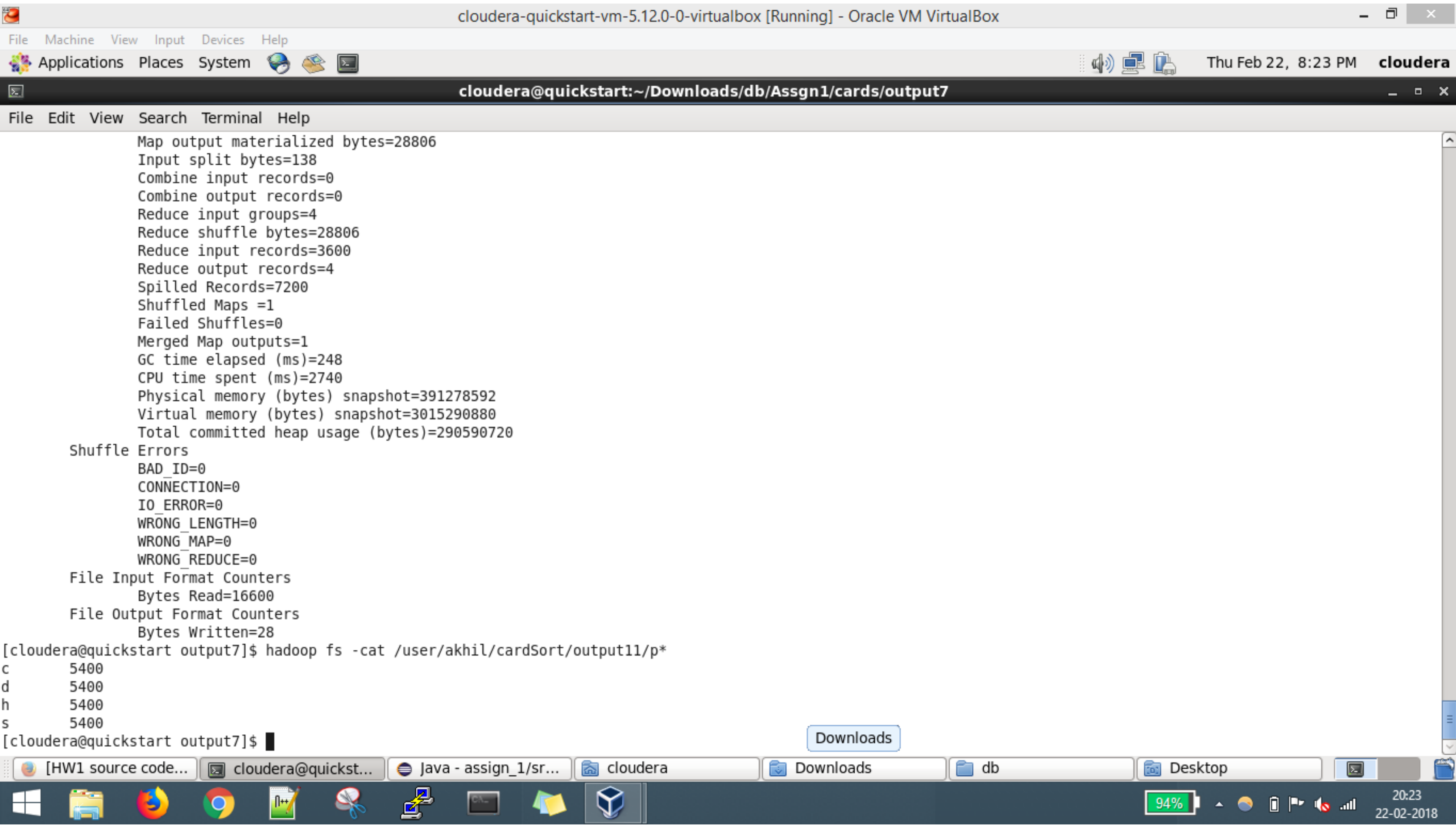


cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Wed Feb 21, 1:27 AM cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/output/output
File Edit View Search Terminal Help
db
Java - assign_1...
cloudera@quic...
cloudera
Downloads
db
Assgn1
cards
[Regex Tutorial...
33%
01:27
21-02-2018

```
                Map output materialized bytes=28806
                Input split bytes=138
                Combine input records=0
                Combine output records=0
                Reduce input groups=4
                Reduce shuffle bytes=28806
                Reduce input records=3600
                Reduce output records=4
                Spilled Records=7200
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=231
                CPU time spent (ms)=2440
                Physical memory (bytes) snapshot=393314304
                Virtual memory (bytes) snapshot=3015217152
                Total committed heap usage (bytes)=290590720
        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=16600
        File Output Format Counters
                Bytes Written=24
[cloudera@quickstart output]$ hadoop fs -cat /user/akhil/cardSort/output/p*
c       900
d       900
h       900
s       900
[cloudera@quickstart output]$ 
```

For addition of total values of numeric cards in a suit:

c	5400	(clubs)
d	5400	(diamonds)
h	5400	(hearts)
s	5400	(spades)


cloudera-quickstart-vm-5.12.0-0-virtualbox [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Thu Feb 22, 8:23 PM
cloudera
cloudera@quickstart:~/Downloads/db/Assgn1/cards/output7
File Edit View Search Terminal Help
Downloads
[HW1 source code...
cloudera@quickst...
Java - assign_1/sr...
cloudera
Downloads
db
Desktop
94%
20:23
22-02-2018

```
                Map output materialized bytes=28806
                Input split bytes=138
                Combine input records=0
                Combine output records=0
                Reduce input groups=4
                Reduce shuffle bytes=28806
                Reduce input records=3600
                Reduce output records=4
                Spilled Records=7200
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=248
                CPU time spent (ms)=2740
                Physical memory (bytes) snapshot=391278592
                Virtual memory (bytes) snapshot=3015290880
                Total committed heap usage (bytes)=290590720
        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=16600
        File Output Format Counters
                Bytes Written=28
[cloudera@quickstart output7]$ hadoop fs -cat /user/akhil/cardSort/output11/p*
c       5400
d       5400
h       5400
s       5400
[cloudera@quickstart output7]$ 
```

Lessons learnt:

- How to use Hadoop file system.
- The purpose of MapReduce program.
- How MapReduce eases mining of massive data sets.
- To write programs or applications in eclipse for using Hadoop MapReduce and how to modify the program as per our requirement.
- Learnt some advance Linux commands to use with HDFS.
- Executing java applications and providing input to get the expected results.