Assignment 1

(Amardeep Singh)

All timing values are in milliseconds.

Q) For each of the versions of your sequential and multithreaded program detailed in B and C, report the minimum, average, and maximum running time observed over the 10 runs.

Answer: -

[..] – Denotes the 10 run times sorted in ascending order.

Scenario B

Running Times

1. SEQ Running times :-

Minimum time is =2959
Maximum time is =3815
Average time is =3140

2. No Lock Running times:-

Minimum time is =1501
Maximum time is =2225
Average time is =1613

3. Coarse-Lock Running times:-

Minimum time is =1611
Maximum time is =2379
Average time is =1750

4.Fine-Lock

Minimum time is =1514

Maximum time is =2270

Average time is =1618

5.No Share Running times:-

Minimum time is =1597

Maximum time is =2465

Average time is =1701

Scenario C

1. SEQ Running times: -

Minimum time is =3185

Maximum time is =3963

Average time is =3326

2. No Lock Running times:-

Minimum time is =1545

Maximum time is =2254

Average time is =1665

3.Coarse-Lock Running times:-

Minimum time is =1739

Maximum time is =2401

Average time is =1860

4.Fine-Lock

Minimum time is =1617
Maximum time is =2466
Average time is =1696

5.No Share

Minimum time is =1621
Maximum time is =2620
Average time is =1798

Question-Report the number of worker threads used and the speedup of themultithreaded versions based on the corresponding average running times. (5 points)
Answer- The number of worker threads used – **4** (depends on the cores of the CPU, generated using ***Runtime.getRuntime().availableProcessors()***)

Speed Up for Multithreaded Versions: (Time for Sequential / Time for Parallel)

Scenario B

2.No Lock Running -

Speedup=3140/1613
=1.95

3.Coarse-Lock -

Speedup=3140/1750
=1.79

4.Fine-Lock -

Speedup=3140/1618
=1.94

5.No Share -
Speedup=3140/1701
=1.84

Scenario C

2.No Lock -
Speedup=3326/1665
=1.99

3.Coarse-Lock -
Speedup=3326/1860
=1.78

4.Fine-Lock -
Speedup=3326/1696
=1.96

5.No Share -
Speedup=3326/1795
=1.85

Question 1) Which program version (SEQ, NO-LOCK, COARSE-LOCK, FINE-LOCK, NO-SHARING) would you normally expect to finish

fastest and why? Do the experiments confirm your expectation? If not, try to explain the reasons.

Answer- I would expect the **NO-LOCK** version to be the fastest among all because

- It uses multiple threads to do the job in parallel unlike the SEQ code, hence its faster than SEQ.
- Coarse-lock and Fine-lock use the same multiple threads to get the job done but have an overhead of synchronization and locks because all the threads are modifying a shared data structure. Since NO-LOCK uses no such locks or synchronization there is not overhead making it faster than Coarse-lock and fine-lock.
- In No-sharing all the threads work on their own separate data structures which are then later combined into one to find the average per station. This overhead caused by the combining step (which is not needed in NO-LOCK) causes this to be slower than NO-LOCK.

✓ There is no waiting for any thread in NO-LOCK for either any lock or shared resource. Hence making it fastest among all the approaches above.

✓ My experiments confirm my expectations.

Question 2) Which program version (SEQ, NO-LOCK, COARSE-LOCK, FINE-LOCK, NO-SHARING) would you normally expect to finish slowest and why? Do the experiments confirm your expectation? If not, try to explain the reasons.

Answer-I would expect the SEQ version to finish the slowest because in this sequential process entire work is done by a single processor while the other tasks and waiting for the processor to be free and only then one of them can make use of the processor. This leads to high waiting times. Whereas in other versions

(multithreaded) of the program, tasks are performed in parallel by multiple threads, hence making them faster.

- ✓ My experiment confirms my expectation.

Question 3) Compare the temperature averages returned by each program version. Report if any of them is incorrect or if any of the programs crashed because of concurrent accesses.

Answer: - On comparison of the temperature averages it was found that the temperature averages calculated with NO-LOCK version were wrong and also inconsistent.

Question 4) Compare the running times of SEQ and COARSE-LOCK. Try to explain why one is slower than the other. (Make sure to consider the results of both B and C—this might support or refute a possible hypothesis.)

Answer: - Coarse-lock is faster than the SEQ version because in SEQ version all processes have to wait till the processor is done with the task it is executing. Whereas in the Coarse-Lock version the contention is only between the shared resource which is locked and only one thread has access to this at a time. Apart from this threads are free to perform all other tasks (which don't need access to shared resource) in parallel. This is not the case in SEQ version hence leading to more wait times

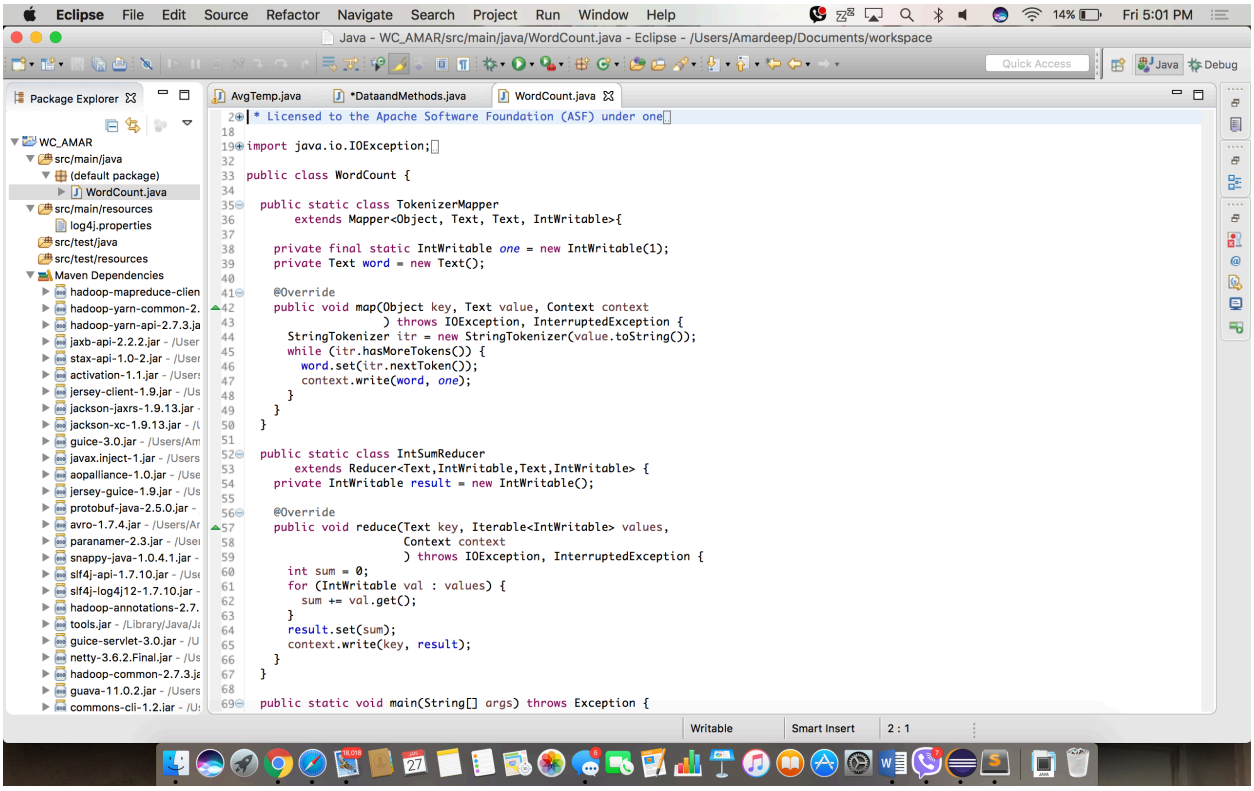
In Scenario C adding Fibonacci lead to more computation and hence increasing the time taken by both the versions. But still SEQ version remains slower than the Coarse-Lock version.

Question 5) How does the higher computation cost in part C (additional Fibonacci computation) affect the difference between COARSE-LOCK and FINE-LOCK? Try to explain the reason.

Answer :- On adding extra computation in Scenario C the running times for both the versions increase. The average time in Coarse lock version increases by ~110ms(between scenario B and c) whereas in case of fine lock the increase is ~75ms.
The possible reason will be that in coarse lock we lock the entire resource irrespective of what part of the resource is being accessed. There is a high possibility of parts of resource being unavailable for process despite of the fact that no other processes are working on them. Eg: Locking a HashMap to update any key value in case of coarse lock will lock the Hashmap for all reads and writes happening at other keys. If we add a processing task in this lock it will increase the wait time for other processes, which might need other parts of the same resource.
FINE-LOCK just locks the part of resource, which is being contended for by two processes hence eliminating unnecessary wait times. If we add processing in the block, which locks the parts of the resource, it affects only the processes that are contending for the resource i.e. all reads and writes on the same key. But the other parts of the resources are still available to the processes running, so the processing delays will be reduced.

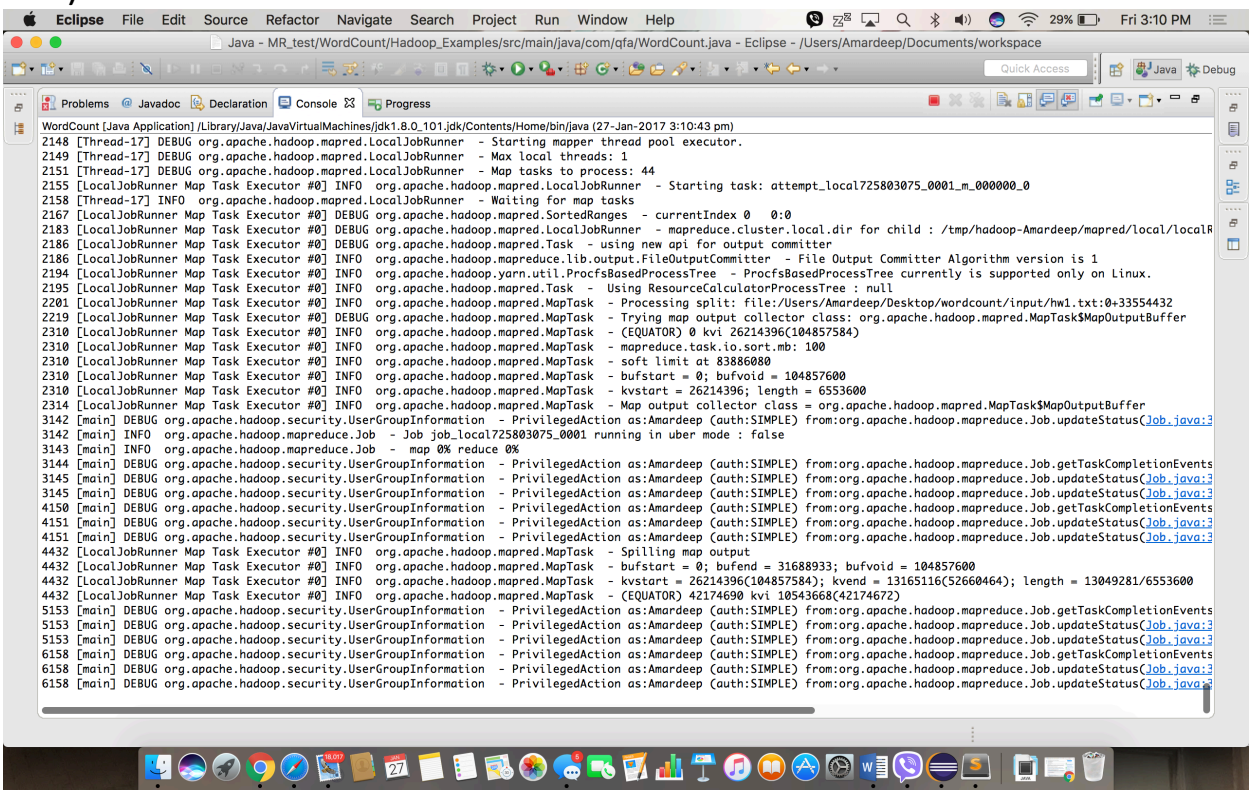
Week 2

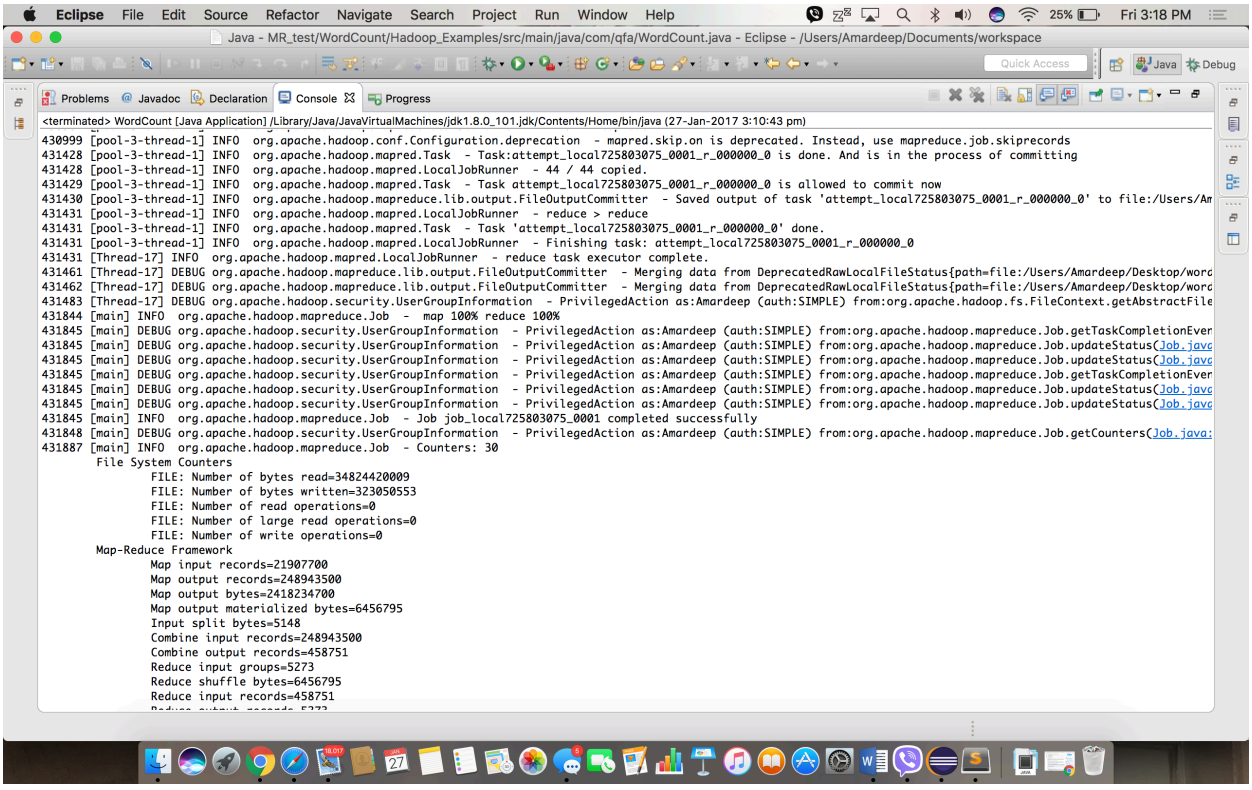
Question1) Word Count Local Execution Show a screenshot of your IDE window. It should contain the following information: • Project directory structure, showing that the WordCount.java file is somewhere in the src directory.

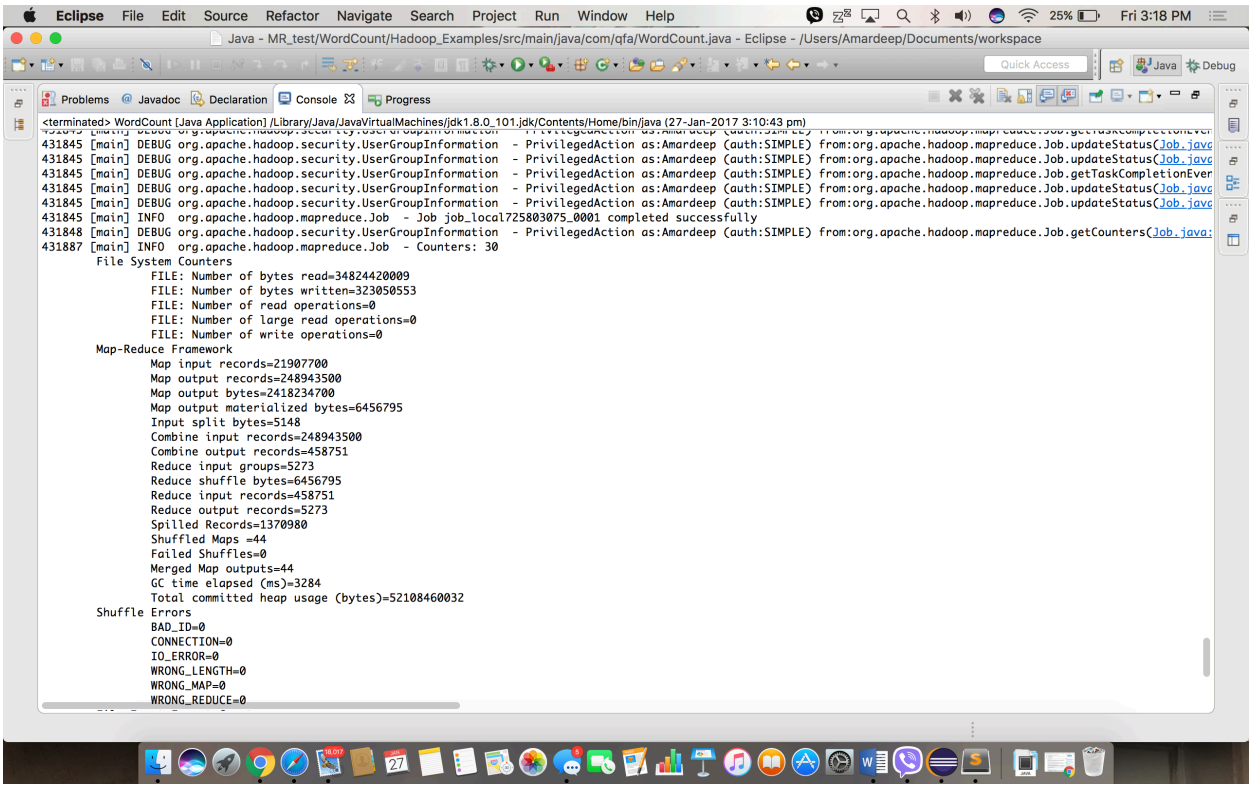


Qustion2) The console output for a successful run of the WordCount program inside the IDE. The console output refers to the job summary information Hadoop produces, not the output your job emits. Show at least the last 20 lines of the console output.

Ans)

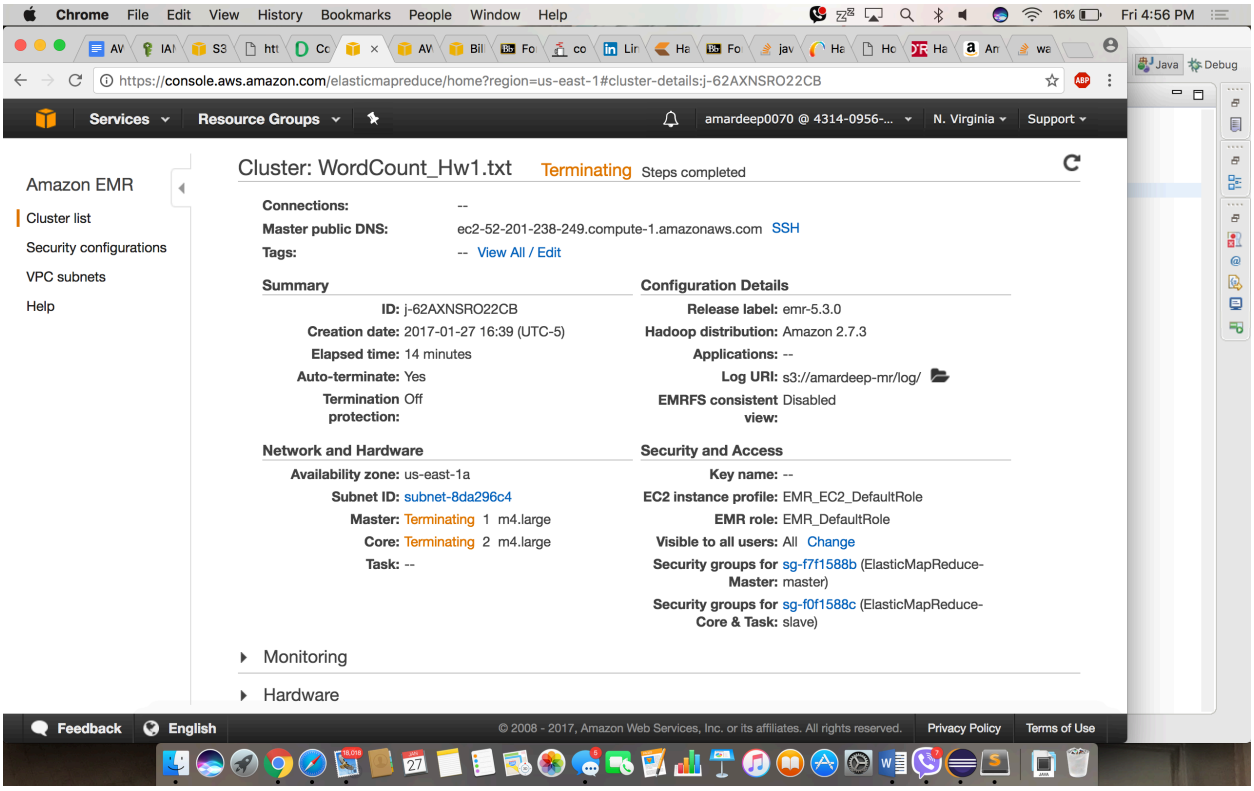

Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
Fri 3:10 PM
Java - MR_test/WordCount/Hadoop_Examples/src/main/java/com/qfa/WordCount.java - Eclipse - /Users/Amardeep/Documents/workspace
Problems Javadoc Declaration Console Progress
WordCount [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_101.jdk/Contents/Home/bin/java (27-Jan-2017 3:10:43 pm)
2148 [Thread-17] DEBUG org.apache.hadoop.mapred.LocalJobRunner - Starting mapper thread pool executor.
2149 [Thread-17] DEBUG org.apache.hadoop.mapred.LocalJobRunner - Max local threads: 1
2151 [Thread-17] DEBUG org.apache.hadoop.mapred.LocalJobRunner - Map tasks to process: 44
2155 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.LocalJobRunner - Starting task: attempt_local725803075_0001_m_000000_0
2158 [Thread-17] INFO org.apache.hadoop.mapred.LocalJobRunner - Waiting for map tasks
2167 [LocalJobRunner Map Task Executor #0] DEBUG org.apache.hadoop.mapred.SortedRanges - currentIndex 0 0:0
2183 [LocalJobRunner Map Task Executor #0] DEBUG org.apache.hadoop.mapred.LocalJobRunner - mapreduce.cluster.local.dir for child : /tmp/hadoop-Amardeep/mapred/local/localR
2186 [LocalJobRunner Map Task Executor #0] DEBUG org.apache.hadoop.mapred.Task - using new api for output committer
2186 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapreduce.lib.output.FileOutputCommitter - File Output Committer Algorithm version is 1
2194 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.yarn.util.ProcfsBasedProcessTree - ProcfsBasedProcessTree currently is supported only on Linux.
2195 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.Task - Using ResourceCalculatorProcessTree : null
2201 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - Processing split: file:/Users/Amardeep/Desktop/wordcount/input/hw1.txt:0+33554432
2219 [LocalJobRunner Map Task Executor #0] DEBUG org.apache.hadoop.mapred.MapTask - Trying map output collector class: org.apache.hadoop.mapred.MapTask$MapOutputBuffer
2310 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - (EQUATOR) 0 kvi 26214396(104857584)
2310 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - mapreduce.task.io.sort.mb: 100
2310 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - soft limit at 83886080
2310 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - bufstart = 0; bufvoid = 104857600
2310 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - kvstart = 26214396; length = 6553600
2314 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - Map output collector class = org.apache.hadoop.mapred.MapTask$MapOutputBuffer
3142 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
3142 [main] INFO org.apache.hadoop.mapreduce.Job - Job job_local725803075_0001 running in uber mode : false
3143 [main] INFO org.apache.hadoop.mapreduce.Job - map 0% reduce 0%
3144 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getTaskCompletionEvents
3145 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
3145 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
4150 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getTaskCompletionEvents
4151 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
4151 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
4432 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - Spilling map output
4432 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - bufstart = 0; bufend = 31688933; bufvoid = 104857600
4432 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - kvstart = 26214396(104857584); kvend = 13165116(52660464); length = 13049281/6553600
4432 [LocalJobRunner Map Task Executor #0] INFO org.apache.hadoop.mapred.MapTask - (EQUATOR) 42174690 kvi 10543668(42174672)
5153 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getTaskCompletionEvents
5153 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
5153 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
6158 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getTaskCompletionEvents
6158 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3
6158 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java:3


Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
Fri 3:18 PM
Java - MR_test/WordCount/Hadoop_Examples/src/main/java/com/qfa/WordCount.java - Eclipse - /Users/Amardeep/Documents/workspace
Problems Javadoc Declaration Console Progress
<terminated> WordCount [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_101.jdk/Contents/Home/bin/java (27-Jan-2017 3:10:43 pm)
430999 [pool-3-thread-1] INFO org.apache.hadoop.conf.Configuration.deprecation - mapred.skip.on is deprecated. Instead, use mapreduce.job.skiprecords
431428 [pool-3-thread-1] INFO org.apache.hadoop.mapred.Task - Task:attempt_local725803075_0001_r_000000_0 is done. And is in the process of committing
431428 [pool-3-thread-1] INFO org.apache.hadoop.mapred.LocalJobRunner - 44 / 44 copied.
431429 [pool-3-thread-1] INFO org.apache.hadoop.mapred.Task - Task attempt_local725803075_0001_r_000000_0 is allowed to commit now
431430 [pool-3-thread-1] INFO org.apache.hadoop.mapreduce.lib.output.FileOutputCommitter - Saved output of task 'attempt_local725803075_0001_r_000000_0' to file:/Users/Am
431431 [pool-3-thread-1] INFO org.apache.hadoop.mapred.LocalJobRunner - reduce > reduce
431431 [pool-3-thread-1] INFO org.apache.hadoop.mapred.Task - Task 'attempt_local725803075_0001_r_000000_0' done.
431431 [pool-3-thread-1] INFO org.apache.hadoop.mapred.LocalJobRunner - Finishing task: attempt_local725803075_0001_r_000000_0
431431 [Thread-17] INFO org.apache.hadoop.mapred.LocalJobRunner - reduce task executor complete.
431461 [Thread-17] DEBUG org.apache.hadoop.mapreduce.lib.output.FileOutputCommitter - Merging data from DeprecatedRawLocalFileStatus{path=file:/Users/Amardeep/Desktop/word
431462 [Thread-17] DEBUG org.apache.hadoop.mapreduce.lib.output.FileOutputCommitter - Merging data from DeprecatedRawLocalFileStatus{path=file:/Users/Amardeep/Desktop/word
431483 [Thread-17] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.fs.FileContext.getAbstractFile
431844 [main] INFO org.apache.hadoop.mapreduce.Job - map 100% reduce 100%
431845 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getTaskCompletionEver
431845 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java
431845 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java
431845 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getTaskCompletionEver
431845 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java
431845 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.updateStatus(Job.java
431845 [main] INFO org.apache.hadoop.mapreduce.Job - Job job_local725803075_0001 completed successfully
431848 [main] DEBUG org.apache.hadoop.security.UserGroupInformation - PrivilegedAction as:Amardeep (auth:SIMPLE) from:org.apache.hadoop.mapreduce.Job.getCounters(Job.java:
431887 [main] INFO org.apache.hadoop.mapreduce.Job - Counters: 30
File System Counters
FILE: Number of bytes read=34824420009
FILE: Number of bytes written=323050553
FILE: Number of read operations=0
FILE: Number of large read operations=0
FILE: Number of write operations=0
Map-Reduce Framework
Map input records=21907700
Map output records=248943500
Map output bytes=2418234700
Map output materialized bytes=6456795
Input split bytes=5148
Combine input records=248943500
Combine output records=458751
Reduce input groups=5273
Reduce shuffle bytes=6456795
Reduce input records=458751



Question2) Word Count AWS Execution Show a similar screenshot that provides convincing evidence of a successful run of the Word Count program on AWS. Make sure you run the program using at least three machines, i.e., one master node and two core nodes (those with HDFS) as workers.

Ans)


Chrome File Edit View History Bookmarks People Window Help
https://console.aws.amazon.com/elasticmapreduce/home?region=us-east-1#cluster-details:j-62AXNSRO22CB
Services Resource Groups amardeep0070 @ 4314-0956-... N. Virginia Support
Amazon EMR
Cluster list
Security configurations
VPC subnets
Help
Cluster: WordCount_Hw1.txt Terminating Steps completed
Connections: --
Master public DNS: ec2-52-201-238-249.compute-1.amazonaws.com SSH
Tags: -- View All / Edit
Summary
ID: j-62AXNSRO22CB
Creation date: 2017-01-27 16:39 (UTC-5)
Elapsed time: 14 minutes
Auto-terminate: Yes
Termination protection: Off
Configuration Details
Release label: emr-5.3.0
Hadoop distribution: Amazon 2.7.3
Applications: --
Log URI: s3://amardeep-mr/log/
EMRFS consistent view: Disabled
Network and Hardware
Availability zone: us-east-1a
Subnet ID: subnet-8da296c4
Master: Terminating 1 m4.large
Core: Terminating 2 m4.large
Task: --
Security and Access
Key name: --
EC2 instance profile: EMR_EC2_DefaultRole
EMR role: EMR_DefaultRole
Visible to all users: All Change
Security groups for Master: sg-f7f1588b (ElasticMapReduce-master)
Security groups for Core & Task: sg-f0f1588c (ElasticMapReduce-slave)
Monitoring
Hardware
Feedback English
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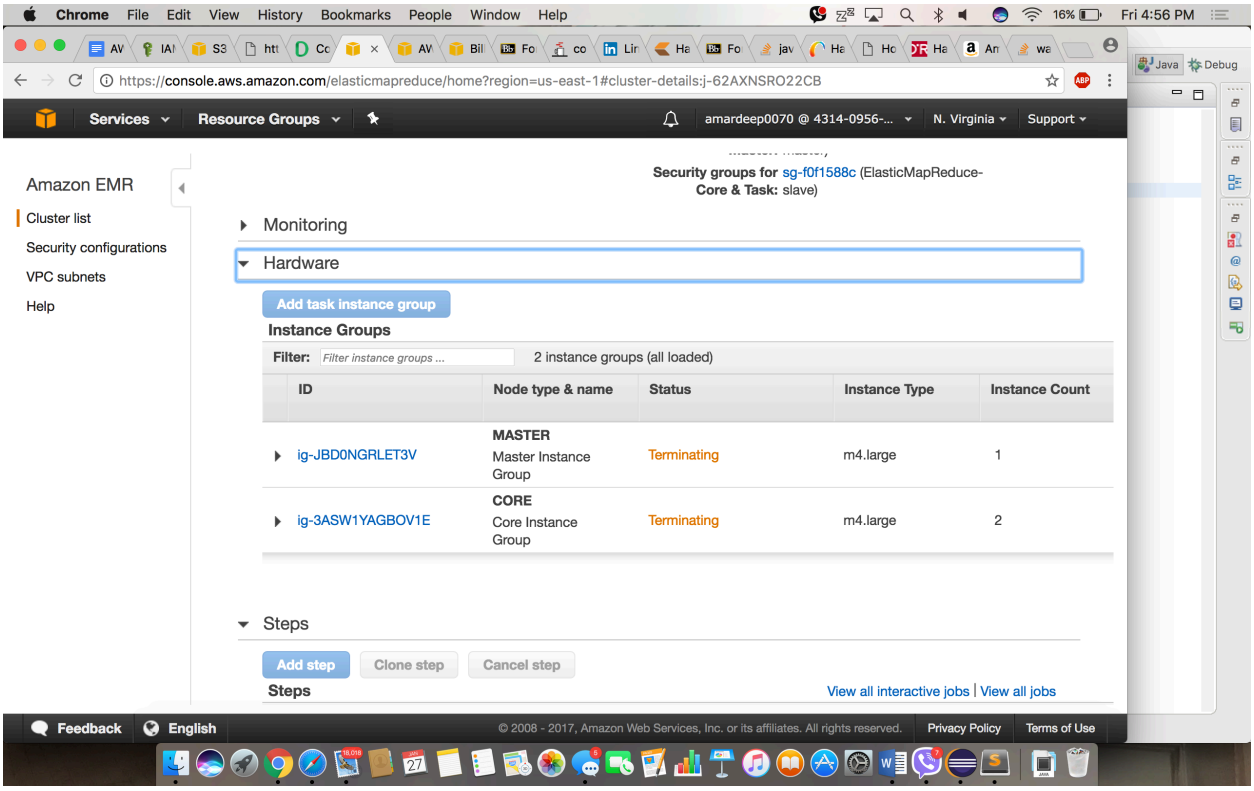
Chrome File Edit View History Bookmarks People Window Help
https://console.aws.amazon.com/elasticmapreduce/home?region=us-east-1#cluster-details:j-62AXNSRO22CB
Services Resource Groups amardeep0070 @ 4314-0956-... N. Virginia Support
Amazon EMR
Cluster list
Security configurations
VPC subnets
Help
Security groups for Core & Task: sg-f0f1588c (ElasticMapReduce-slave)
Monitoring
Hardware
Add task instance group
Instance Groups
Filter: Filter instance groups ... 2 instance groups (all loaded)
ID
Node type & name
Status
Instance Type
Instance Count
ig-JBD0NGRLET3V
MASTER
Master Instance Group
Terminating
m4.large
1
ig-3ASW1YAGBOV1E
CORE
Core Instance Group
Terminating
m4.large
2
Steps
Add step
Clone step
Cancel step
Steps
View all interactive jobs | View all jobs
Feedback English
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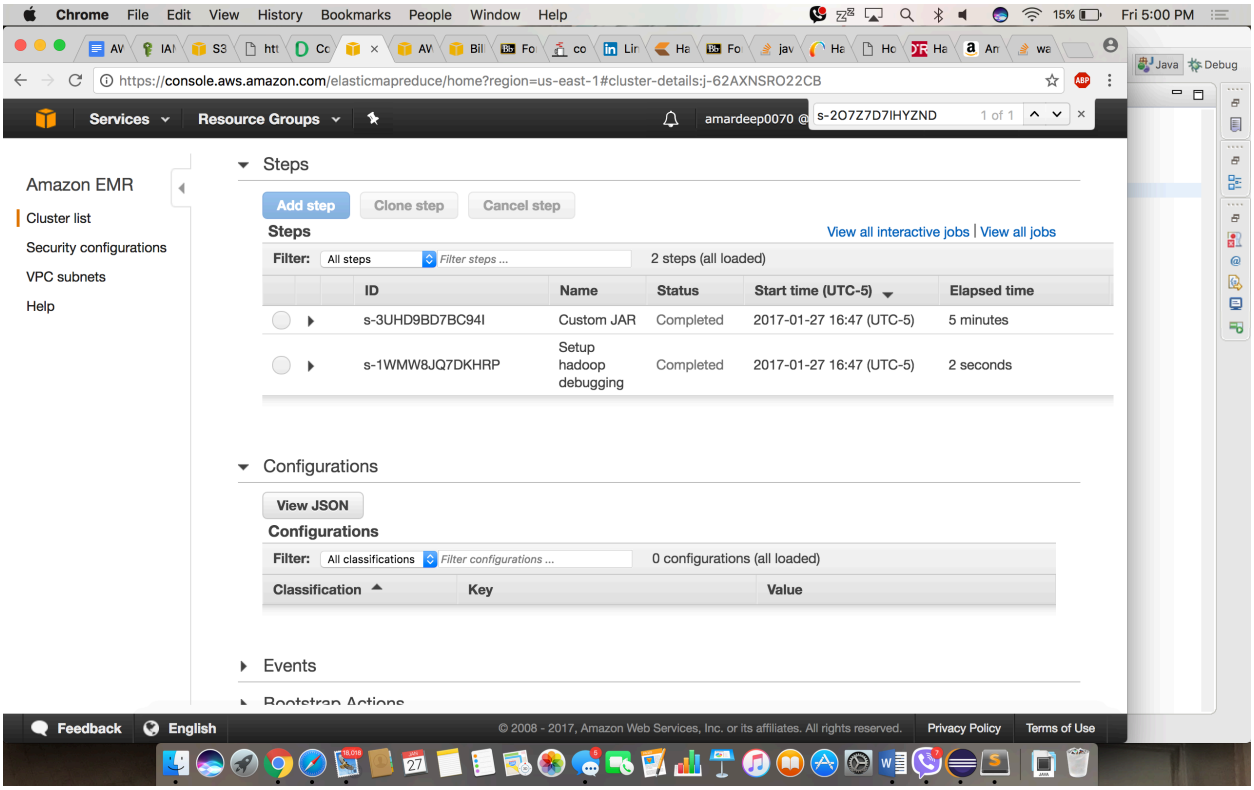
Chrome File Edit View History Bookmarks People Window Help
https://console.aws.amazon.com/elasticmapreduce/home?region=us-east-1#cluster-details:j-62AXNSRO22CB
Services
Resource Groups
amardeep0070 @
s-2O7Z7D7IHYZND
1 of 1
Amazon EMR
Cluster list
Security configurations
VPC subnets
Help
Steps
Add step
Clone step
Cancel step
Steps
View all interactive jobs | View all jobs
Filter: All steps Filter steps ...
2 steps (all loaded)
ID
Name
Status
Start time (UTC-5)
Elapsed time
s-3UHD9BD7BC94I
Custom JAR
Completed
2017-01-27 16:47 (UTC-5)
5 minutes
s-1WMW8JQ7DKHRP
Setup hadoop debugging
Completed
2017-01-27 16:47 (UTC-5)
2 seconds
Configurations
View JSON
Configurations
Filter: All classifications Filter configurations ...
0 configurations (all loaded)
Classification
Key
Value
Events
Bootstrap Actions
Feedback
English
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