Map Reduce

By Group No. 4

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Setup

The mapreduce framework was setup in assignment 3. But the setup steps are mentioned below.

1. **Add necessary environment variables to the ~/.bash_profile file (on all machines).**

```
export JAVA_HOME=/usr/lib/jvm/java-7-openjdk-amd64
export PATH=$PATH:$HADOOP_HOME/sbin:$HADOOP_HOME/bin
export HADOOP_CLASSPATH=${JAVA_HOME}/lib/tools.jar
```

2. **Start Hadoop & Yarn**

```
start-dfs.sh
start-yarn.sh
```

Part A: Word Count

1. **Prepare input**

   The input file is 6MB.

```
hadoop fs -put ./words.txt /wordcount/input-bs-128mb
hadoop fs -D dfs.blocksize=1048576 -put ./words.txt
/wordcount/input-bs-1mb
```

2. **SSH into master node (vm1) and write code**

```
ssh vm1
vim WordCount.java
```

3. **Compile and build JAR**

```
hadoop com.sun.tools.javac.Main WordCount.java
jar cf wc.jar WordCount*.class
```

4. **Run the mapreduce job**

```
hadoop jar wc.jar WordCount /wordcount/input /wordcount/output-bs-1mb
```

5. **View results**

```
hadoop fs -ls /wordcount/output-bs-1mb
hadoop fs -cat /wordcount/output-bs-1mb/part-r-00000
```

Handling of failures

We found that 6 MB is too small a size because in default block-size (64/128 MB) there's only one block and therefore only one worker.

So, we tried running on a large file (~900 GB, with a blocksize of 64 MB) which resulted in 15 blocks.

MapReduce runs a per job AppManager that monitors the job lifecycle and negotiates with ResourceManager (running on VM1 in our case).

So, we started the WordCount program, and then rebooted:

1. **Node running AppManager**

   In this case, the ResourceManager repeatedly tries to contact the node based on a retry policy, which after reaching a max count results in the failure of the entire job.

```
baadalservervm@vm1:~/mapred$ hadoop jar wc.jar WordCount
/wordcount/input-large-bs-64mb /wordcount/output-large-bs-64mb
18/10/24 17:52:49 WARN util.NativeCodeLoader: Unable to load native-hadoop library
for your platform... using builtin-java classes where applicable
18/10/24 17:52:50 INFO client.RMProxy: Connecting to ResourceManager at
vm1/10.17.50.109:8050
18/10/24 17:52:51 INFO input.FileInputFormat: Total input paths to process : 1
18/10/24 17:52:51 INFO mapreduce.JobSubmitter: number of splits:15
18/10/24 17:52:51 INFO mapreduce.JobSubmitter: Submitting tokens for job:
job_1540281383352_0011
18/10/24 17:52:51 INFO impl.YarnClientImpl: Submitted application
application_1540281383352_0011
18/10/24 17:52:51 INFO mapreduce.Job: The url to track the job:
http://vm1:8088/proxy/application_1540281383352_0011/
18/10/24 17:52:51 INFO mapreduce.Job: Running job: job_1540281383352_0011
18/10/24 17:52:59 INFO mapreduce.Job: Job job_1540281383352_0011 running in uber
mode : false
18/10/24 17:52:59 INFO mapreduce.Job:  map 0% reduce 0%
18/10/24 17:53:10 INFO mapreduce.Job:  map 2% reduce 0%
18/10/24 17:53:12 INFO mapreduce.Job:  map 5% reduce 0%
18/10/24 17:53:13 INFO mapreduce.Job:  map 7% reduce 0%
18/10/24 17:53:18 INFO mapreduce.Job:  map 8% reduce 0%
18/10/24 17:53:19 INFO mapreduce.Job:  map 10% reduce 0%
18/10/24 17:53:21 INFO mapreduce.Job:  map 11% reduce 0%
18/10/24 17:53:22 INFO mapreduce.Job:  map 12% reduce 0%
18/10/24 17:53:25 INFO mapreduce.Job:  map 14% reduce 0%
18/10/24 17:53:27 INFO mapreduce.Job:  map 17% reduce 0%
```

```
...

18/10/24 17:54:16 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 0 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:17 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 1 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:18 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 2 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:20 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 0 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:21 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 1 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:22 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 2 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:23 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 0 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:24 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 1 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:25 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 2 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:26 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 0 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 17:54:27 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 1 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 18:06:26 INFO ipc.Client: Retrying connect to server:
vm2/10.17.50.169:43413. Already tried 2 time(s); retry policy is
RetryUpToMaximumCountWithFixedSleep(maxRetries=3, sleepTime=1000 MILLISECONDS)
18/10/24 18:06:30 INFO mapreduce.Job:  map 27% reduce 0%
18/10/24 18:06:36 INFO mapreduce.Job: Task Id :
attempt_1540281383352_0011_m_000008_1002, Status : FAILED
Container launch failed for container_1540281383352_0011_02_000020 :
org.apache.hadoop.security.token.SecretManager$InvalidToken: No NMToken sent for
vm3:53889
       at
org.apache.hadoop.yarn.client.api.impl.ContainerManagementProtocolProxy$ContainerMa
nagementProtocolProxyData.newProxy(ContainerManagementProtocolProxy.java:254)
       at
org.apache.hadoop.yarn.client.api.impl.ContainerManagementProtocolProxy$ContainerMa
nagementProtocolProxyData.<init>(ContainerManagementProtocolProxy.java:244)
       at
org.apache.hadoop.yarn.client.api.impl.ContainerManagementProtocolProxy.getProxy(Co
ntainerManagementProtocolProxy.java:129)
```

```
	at
org.apache.hadoop.mapreduce.v2.app.launcher.ContainerLauncherImpl.getCMProxy(Contai
nerLauncherImpl.java:403)
	at
org.apache.hadoop.mapreduce.v2.app.launcher.ContainerLauncherImpl$Container.launch(
ContainerLauncherImpl.java:138)
	at
org.apache.hadoop.mapreduce.v2.app.launcher.ContainerLauncherImpl$EventProcessor.ru
n(ContainerLauncherImpl.java:369)
	at
java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1152)
	at
java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:622)
	at java.lang.Thread.run(Thread.java:748)

18/10/24 18:06:36 INFO mapreduce.Job: Task Id :
attempt_1540281383352_0011_m_000012_1002, Status : FAILED
Container launch failed for container_1540281383352_0011_02_000019 :
org.apache.hadoop.security.token.SecretManager$InvalidToken: No NMToken sent for
vm2:58451
	at
org.apache.hadoop.yarn.client.api.impl.ContainerManagementProtocolProxy$ContainerMa
nagementProtocolProxyData.newProxy(ContainerManagementProtocolProxy.java:254)
	at
org.apache.hadoop.yarn.client.api.impl.ContainerManagementProtocolProxy$ContainerMa
nagementProtocolProxyData.<init>(ContainerManagementProtocolProxy.java:244)
	at
org.apache.hadoop.yarn.client.api.impl.ContainerManagementProtocolProxy.getProxy(Co
ntainerManagementProtocolProxy.java:129)
	at
org.apache.hadoop.mapreduce.v2.app.launcher.ContainerLauncherImpl.getCMProxy(Contai
nerLauncherImpl.java:403)
	at
org.apache.hadoop.mapreduce.v2.app.launcher.ContainerLauncherImpl$Container.launch(
ContainerLauncherImpl.java:138)
	at
org.apache.hadoop.mapreduce.v2.app.launcher.ContainerLauncherImpl$EventProcessor.ru
n(ContainerLauncherImpl.java:369)
	at
java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1152)
	at
java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:622)
	at java.lang.Thread.run(Thread.java:748)

18/10/24 18:06:38 INFO mapreduce.Job:  map 100% reduce 100%
18/10/24 18:06:38 INFO mapreduce.Job: Job job_1540281383352_0011 failed with state
FAILED due to: Task failed task_1540281383352_0011_m_000002
Job failed as tasks failed. failedMaps:1 failedReduces:0

18/10/24 18:06:38 INFO mapreduce.Job: Counters: 41
	File System Counters
		FILE: Number of bytes read=15021960
		FILE: Number of bytes written=19100058
```

```
            FILE: Number of read operations=0
            FILE: Number of large read operations=0
            FILE: Number of write operations=0
            HDFS: Number of bytes read=201339210
            HDFS: Number of bytes written=0
            HDFS: Number of read operations=9
            HDFS: Number of large read operations=0
            HDFS: Number of write operations=0
      Job Counters
            Failed map tasks=20
            Killed map tasks=11
            Killed reduce tasks=1
            Launched map tasks=24
            Other local map tasks=14
            Data-local map tasks=6
            Total time spent by all maps in occupied slots (ms)=128606
            Total time spent by all reduces in occupied slots (ms)=0
            Total time spent by all map tasks (ms)=128606
            Total time spent by all reduce tasks (ms)=0
            Total vcore-milliseconds taken by all map tasks=128606
            Total vcore-milliseconds taken by all reduce tasks=0
            Total megabyte-milliseconds taken by all map tasks=131692544
            Total megabyte-milliseconds taken by all reduce tasks=0
      Map-Reduce Framework
            Map input records=3983232
            Map output records=33997293
            Map output bytes=335167270
            Map output materialized bytes=3755490
            Input split bytes=330
            Combine input records=34974057
            Combine output records=1220955
            Spilled Records=1220955
            Failed Shuffles=0
            Merged Map outputs=0
            GC time elapsed (ms)=1386
            CPU time spent (ms)=56160
            Physical memory (bytes) snapshot=850751488
            Virtual memory (bytes) snapshot=2521341952
            Total committed heap usage (bytes)=625999872
      WordCount$TokenizerMapper$CountersEnum
            INPUT_WORDS=33997293
      File Input Format Counters
            Bytes Read=201338880
```

2. **Any other slave node**

   In this case however, there's effectively no change in the results.

```
baadalservervm@vm1:~/mapred$ hadoop jar wc.jar WordCount
/wordcount/input-large-bs-64mb /wordcount/output-large-bs-64mb
18/10/24 18:47:44 WARN util.NativeCodeLoader: Unable to load native-hadoop library
for your platform... using builtin-java classes where applicable
18/10/24 18:47:45 INFO client.RMProxy: Connecting to ResourceManager at
vm1/10.17.50.109:8050
18/10/24 18:47:46 INFO input.FileInputFormat: Total input paths to process : 1
18/10/24 18:47:46 INFO mapreduce.JobSubmitter: number of splits:15
18/10/24 18:47:46 INFO mapreduce.JobSubmitter: Submitting tokens for job:
job_1540281383352_0015
18/10/24 18:47:46 INFO impl.YarnClientImpl: Submitted application
application_1540281383352_0015
18/10/24 18:47:46 INFO mapreduce.Job: The url to track the job:
http://vm1:8088/proxy/application_1540281383352_0015/
18/10/24 18:47:46 INFO mapreduce.Job: Running job: job_1540281383352_0015
18/10/24 18:47:54 INFO mapreduce.Job: Job job_1540281383352_0015 running in uber
mode : false
18/10/24 18:47:54 INFO mapreduce.Job:  map 0% reduce 0%
18/10/24 18:48:05 INFO mapreduce.Job:  map 2% reduce 0%
18/10/24 18:48:07 INFO mapreduce.Job:  map 3% reduce 0%
...
18/10/24 18:51:06 INFO mapreduce.Job:  map 100% reduce 31%
18/10/24 18:51:09 INFO mapreduce.Job:  map 100% reduce 100%
18/10/24 18:54:06 INFO mapreduce.Job: Job job_1540281383352_0015 completed
successfully
18/10/24 18:54:06 INFO mapreduce.Job: Counters: 52
      File System Counters
            FILE: Number of bytes read=92635330
            FILE: Number of bytes written=114385130
            FILE: Number of read operations=0
            FILE: Number of large read operations=0
            FILE: Number of write operations=0
            HDFS: Number of bytes read=973358894
            HDFS: Number of bytes written=1103920
            HDFS: Number of read operations=48
            HDFS: Number of large read operations=0
            HDFS: Number of write operations=2
      Job Counters
            Killed map tasks=1
            Launched map tasks=19
            Launched reduce tasks=1
            Data-local map tasks=18
            Rack-local map tasks=1
            Total time spent by all maps in occupied slots (ms)=401891
            Total time spent by all reduces in occupied slots (ms)=156736
            Total time spent by all map tasks (ms)=401891
            Total time spent by all reduce tasks (ms)=156736
            Total vcore-milliseconds taken by all map tasks=401891
            Total vcore-milliseconds taken by all reduce tasks=156736
            Total megabyte-milliseconds taken by all map tasks=411536384
            Total megabyte-milliseconds taken by all reduce tasks=160497664
      Map-Reduce Framework
            Map input records=19268550
```

```
            Map output records=164354250
            Map output bytes=1620324150
            Map output materialized bytes=20029274
            Input split bytes=1650
            Combine input records=168912482
            Combine output records=5860584
            Reduce input groups=81397
            Reduce shuffle bytes=20029274
            Reduce input records=1302352
            Reduce output records=81397
            Spilled Records=7325730
            Shuffled Maps =15
            Failed Shuffles=0
            Merged Map outputs=15
            GC time elapsed (ms)=5372
            CPU time spent (ms)=330090
            Physical memory (bytes) snapshot=4587204608
            Virtual memory (bytes) snapshot=13427912704
            Total committed heap usage (bytes)=3213885440
      Shuffle Errors
            BAD_ID=0
            CONNECTION=0
            IO_ERROR=0
            WRONG_LENGTH=0
            WRONG_MAP=0
            WRONG_REDUCE=0
      WordCount$TokenizerMapper$CountersEnum
            INPUT_WORDS=164354250
      File Input Format Counters
            Bytes Read=973357244
      File Output Format Counters
            Bytes Written=1103920
```

Part B: Average Grade

1. **Prepare input**

The input file has 10000 records generated randomly. The files are generated using a python script, which assigns 100 courses randomly to a selection of 10K students, (taking 100 students per course). A grade is randomly generated in the range of 1-100. Then the file is placed in the Hadoop file system, using two different block sizes - default of 128 Mb and another using a block size of 2 Mb.

```
python grades.py 10000
hadoop fs -put ./grades-10000.txt /grades/grades-10000
hadoop fs -D dfs.blocksize=2097152 -put ./grades-1000000.txt
/grades/grades-1000000
```

2. **SSH into master node (vm1) and write code**

```
ssh vm1
vim AverageGrade.java
```

3. **Compile and build JAR**

```
hadoop com.sun.tools.javac.Main AverageGrade.java
jar cf ag.jar AverageGrade*.class
```

4. **Run the mapreduce job**

```
hadoop jar ag.jar AverageGrade /grades/grades-10000
/grades/grades-10000_output

hadoop jar ag.jar AverageGrade /grades/grades-1000000
/grades/grades-1000000_output
```

5. **View results**

```
hadoop fs -ls /grades/grades-1000000_output
hadoop fs -cat /grades/grades-1000000_output/part-r-00000
```

Output

```
baadalservervm@vm1:~/mapred$ hadoop jar ag.jar AverageGrade /grades/grades-1000000
/grades/grades-1000000_output_2
18/10/25 09:11:56 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform...
using builtin-java classes where applicable
18/10/25 09:11:57 INFO client.RMProxy: Connecting to ResourceManager at vm1/10.17.50.109:8050
```

```
18/10/25 09:11:57 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed.
Implement the Tool interface and execute your application with ToolRunner to remedy this.
18/10/25 09:11:58 INFO input.FileInputFormat: Total input paths to process : 1
18/10/25 09:11:58 INFO mapreduce.JobSubmitter: number of splits:8
18/10/25 09:11:58 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1540281383352_0016
18/10/25 09:11:58 INFO impl.YarnClientImpl: Submitted application application_1540281383352_0016
18/10/25 09:11:58 INFO mapreduce.Job: The url to track the job:
http://vm1:8088/proxy/application_1540281383352_0016/
18/10/25 09:11:58 INFO mapreduce.Job: Running job: job_1540281383352_0016
18/10/25 09:12:04 INFO mapreduce.Job: Job job_1540281383352_0016 running in uber mode : false
18/10/25 09:12:04 INFO mapreduce.Job:  map 0% reduce 0%
18/10/25 09:12:11 INFO mapreduce.Job:  map 13% reduce 0%
18/10/25 09:12:15 INFO mapreduce.Job:  map 50% reduce 0%
18/10/25 09:12:18 INFO mapreduce.Job:  map 63% reduce 0%
18/10/25 09:12:24 INFO mapreduce.Job:  map 88% reduce 0%
18/10/25 09:12:25 INFO mapreduce.Job:  map 100% reduce 0%
18/10/25 09:12:26 INFO mapreduce.Job:  map 100% reduce 100%
18/10/25 09:12:26 INFO mapreduce.Job: Job job_1540281383352_0016 completed successfully
18/10/25 09:12:26 INFO mapreduce.Job: Counters: 50
        File System Counters
                FILE: Number of bytes read=10406
                FILE: Number of bytes written=987179
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=16840057
                HDFS: Number of bytes written=1664
                HDFS: Number of read operations=27
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
                Killed map tasks=1
                Launched map tasks=8
                Launched reduce tasks=1
                Data-local map tasks=8
                Total time spent by all maps in occupied slots (ms)=60252
                Total time spent by all reduces in occupied slots (ms)=7810
                Total time spent by all map tasks (ms)=60252
                Total time spent by all reduce tasks (ms)=7810
                Total vcore-milliseconds taken by all map tasks=60252
                Total vcore-milliseconds taken by all reduce tasks=7810
                Total megabyte-milliseconds taken by all map tasks=61698048
                Total megabyte-milliseconds taken by all reduce tasks=7997440
        Map-Reduce Framework
                Map input records=1000000
                Map output records=1000000
                Map output bytes=11000000
                Map output materialized bytes=10448
                Input split bytes=816
                Combine input records=1000000
                Combine output records=800
                Reduce input groups=100
                Reduce shuffle bytes=10448
                Reduce input records=800
                Reduce output records=100
                Spilled Records=1600
```

```
                Shuffled Maps =8
                Failed Shuffles=0
                Merged Map outputs=8
                GC time elapsed (ms)=683
                CPU time spent (ms)=14660
                Physical memory (bytes) snapshot=2383572992
                Virtual memory (bytes) snapshot=7535296512
                Total committed heap usage (bytes)=1717043200
        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=16839241
        File Output Format Counters
                Bytes Written=1664
```

References

- MapReduce Setup and Word Count:
    - http://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html#Usage