

## Table of Contents

1.	Install Spark in centos Linux – 60 Minutes .....	3
2.	Running a Spark Application – 45 Minutes .....	8
3.	Spark Standalone Cluster – 60 Minutes.....	17
4.	Spark Two Nodes Cluster Using Docker – 120 Minutes .....	29
5.	Launching on a Cluster: Hadoop YARN – 120 Minutes .....	46
6.	Jobs Monitoring : Using Web UI. – 45 Minutes .....	83
7.	Troubleshooting & Tuning– 60 Minutes.....	94
8.	Annexure:.....	103
	Miscellaneous: .....	109
	Unable to start spark shell with the following error .....	109
	issue: Cannot assign requested address .....	110
	Unable to start spark shell:.....	111
	Yum repo config .....	111
	Scala IDE.....	112

Last Updated: 19 Mar 2022 ( Yellow – Updated )

spark-3.1.2-bin-hadoop3.2.tgz

Hadoop 3.1.2 ([hadoop-3.2.2.tar.gz](#))

zeppelin-0.9.0-bin-all.tgz

## 2 Learning Spark

- Use the version specified above.
- All Job Monitoring to be done in Spark cluster since it required lower memory
- Zeppelin 0.90 is not compatible with spark 3.1.2.
- Use zeppelin for spark shell examples only.

### 3 Learning Spark

#### 1. Install Spark in centos Linux – 60 Minutes

Use: VM Centos 7 64 bit. CLI

Start the VM or the container and open a terminal to the host using putty. Perform the following activities in the console.

Download the required software

Apache Spark – Version 3.0.1 – Prebuilt for Apache Hadoop 3.2 and later.

File : [spark-3.0.1-bin-hadoop3.2.tgz](#)

Url : <https://spark.apache.org/downloads.html>

Inflate all the software in /opt folder.

JDK installation (jdk-8u45-linux-x64.tar.gz)

<https://www.oracle.com/in/java/technologies/javase/javase8-archive-downloads.html>

Extract the jdk and rename the folder to jdk.

```
#tar -xvf jdk-8u45-linux-x64.tar.gz -C /opt  
#mv jdk* jdk
```

Untar spark-X.X.o-bin-hadoop.X.tar to /opt

## 4 Learning Spark

```
# tar -xvf spark-x-bin-hadoop.x.tgz.gz -C /opt/
```

It should create a folder inside spark.X, rename to spark folder.

```
mv sparkX spark
```

Set the JAVA\_HOME and initialize the PATH variable.

Open the profile and update with the following statements.

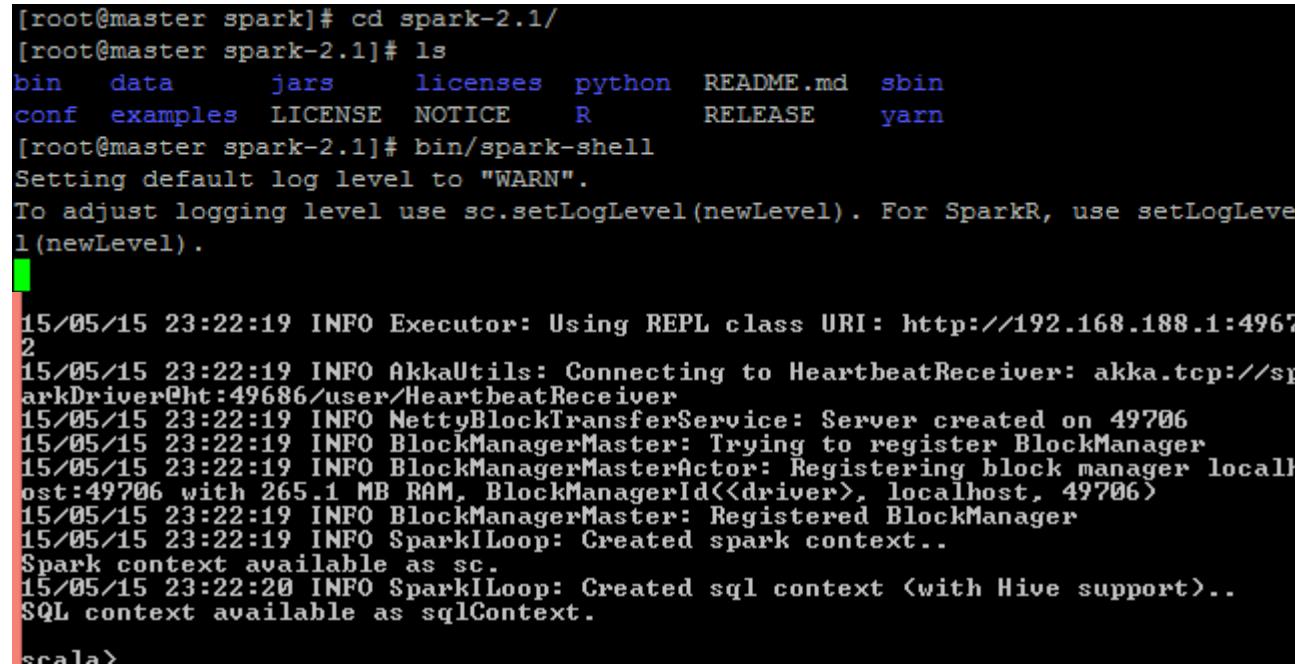
```
vi ~/.bashrc
export JAVA_HOME=/opt/jdk
export PATH=$PATH:$JAVA_HOME/bin
export PATH=$PATH:/opt/spark/bin
```

## 5 Learning Spark

Type bash, to initialize the profile.

Go to the installation directory:

```
# cd /opt/spark/bin  
execute  
.spark-shell
```



```
[root@master spark]# cd spark-2.1/  
[root@master spark-2.1]# ls  
bin      data      jars      licenses  python  README.md  sbin  
conf    examples  LICENSE  NOTICE     R        RELEASE  yarn  
[root@master spark-2.1]# bin/spark-shell  
Setting default log level to "WARN".  
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).  
  
15/05/15 23:22:19 INFO Executor: Using REPL class URI: http://192.168.188.1:4967  
2  
15/05/15 23:22:19 INFO AkkaUtils: Connecting to HeartbeatReceiver: akka.tcp://sparkDriver@ht:49686/user/HeartbeatReceiver  
15/05/15 23:22:19 INFO NettyBlockTransferService: Server created on 49706  
15/05/15 23:22:19 INFO BlockManagerMaster: Trying to register BlockManager  
15/05/15 23:22:19 INFO BlockManagerMasterActor: Registering block manager localhost:49706 with 265.1 MB RAM, BlockManagerId<driver>, localhost, 49706  
15/05/15 23:22:19 INFO BlockManagerMaster: Registered BlockManager  
15/05/15 23:22:19 INFO SparkILoop: Created spark context..  
Spark context available as sc.  
15/05/15 23:22:20 INFO SparkILoop: Created sql context (with Hive support)..  
SQL context available as sqlContext.  
scala>
```

Enter the following command in the scala console to create a data set of 1..10 integers

## 6 Learning Spark

```
#val data = 1 to 10  
#data.foreach(println)  
#println(data(2))
```

```
scala> val data = 1 to 10  
data: scala.collection.immutable.Range.Inclusive = Range 1 to 10  
  
scala> data.foreach(println)  
1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
  
scala> println(data(2))  
3  
  
scala> 
```

As seen above, you have initialized data variable with range from 1 to 10. Then print its value using foreach method of scala. You can also access the data using index.

Web UI of the spark shell can be accessed using the following URL. You can click on each tab and verify the screen.

## 7 Learning Spark

<http://ht:4040/jobs/>

The screenshot shows the Apache Spark 2.2.0 Web UI. At the top, there is a header bar with navigation icons (back, forward, search) and a URL field showing '10.10.20.27:4040/jobs/'. Below the header is a navigation menu with tabs: 'Jobs' (which is selected), 'Stages', 'Storage', 'Environment', 'Executors', and 'SQL'. The main content area is titled 'Spark Jobs (?)'. It displays system statistics: 'User: root', 'Total Uptime: 43 s', and 'Scheduling Mode: FIFO'. There is also a link '▶ Event Timeline'. The overall interface is light gray with dark blue headers and tabs.

### Spark Jobs (?)

User: root

Total Uptime: 43 s

Scheduling Mode: FIFO

▶ Event Timeline

Further details on this web UI will be discussed later.

You have successfully installed spark for local development.

-----Lab Ends Here -----

### 2. Running a Spark Application – 45 Minutes

Using CLI – SBT

Install Scala Build Tools. You can refer the following documents for your respective OS.

<https://www.scala-sbt.org/download.html>

<https://www.scala-sbt.org/1.x/docs/Installing-sbt-on-Linux.html>

Mac Os:

```
# brew install sbt
```

Linux:

```
curl https://bintray.com/sbt/rpm/rpm | tee /etc/yum.repos.d/bintray-sbt-rpm.repo
```

```
# yum install sbt
```

## 9 Learning Spark

```
@893094f7bb92/software (com.... 961 @893094f7bb92/software (com.... 962 bash 963 bash 964
hazeover psychopy zulu
hbuilderx publii
--> Deleted Casks
aliwangwang coronasdk delta levelator odio waterfox yandexradio
aspera-connect daedalus docear megahertz-knotes realm-studio xact

--> Downloading https://homebrew.bintray.com/bottles/openjdk-15.0.1.high_sierra.bottle.tar.gz
--> Downloading from https://d29vzk4ow7wi7.cloudfront.net/bef2e4a43a6485253c655979cf719332fb8631792720c0b9f6591559fb513f1?response-cont
#####
##### 100.0%
--> Downloading https://github.com/sbt/sbt/releases/download/v1.4.2/sbt-1.4.2.tgz
--> Downloading from https://github-production-release-asset-2e65be.s3.amazonaws.com/279553/0dfe9580-1ca2-11eb-905b-53dfebeffb64?X-Amz-Al
#####
##### 100.0%
Error: sbt 1.3.13 is already installed
To upgrade to 1.4.2, run `brew upgrade sbt`.
```

Create a directory to store the code and its build command.

```
#mkdir spark-sbt
# cd spark-sbt
# touch build.sbt
```

Update the build.sbt with the following instructions:

```
name := "Simple Project"
version := "1.0"
scalaVersion := "2.12.10"
libraryDependencies += "org.apache.spark" %% "spark-sql" % "3.0.1"
```

```
#mkdir -p src/main/scala/
```

---

Actual code section:

```
#cd src/main/scala/
```

Write the code as shown below in a file, NameList.scala in the same folder.

```
import org.apache.spark.sql.SparkSession
object NameList {
    def main(args: Array[String]) {
        if (args.length < 2) {
            System.err.println(
                "Usage: NameList <input-file> <output-file>")
            System.exit(1)
        }
        val spark = SparkSession.builder.getOrCreate()
        spark.sparkContext.setLogLevel("WARN")
        val peopleDF = spark.read.json(args(0))
        val namesDF = peopleDF.select("firstName", "lastName")
        namesDF.write.option("header", "true").csv(args(1))
        spark.stop
    }
}
```

Change to the directory where build.sbt is located.

```
# cd /opt/spark-sbt
```

```
# Package a jar containing your application
```

```
$ sbt package
```

Usually take sometimes to download all the packages depending on the speed, usually 5 to 10 minutes.

@893094f7bb92:/software (com.... #1	@893094f7bb92:/software (com.... #2	bash #3	java #4
https://repo1.maven.org/maven2/org/apache/orc/orc-mapreduce/1.5.10/orc-mapreduce-1.5.10.jar 100.0% [#####] 47.0 KiB (135.8 KiB / s)			
https://repo1.maven.org/maven2/org/apache/xbean/xbean-asm7-shaded/4.15/xbean-asm7-shaded-4.15.jar 100.0% [#####] 274.8 KiB (699.1 KiB / s)			
https://repo1.maven.org/maven2/org/apache/curator/curator-recipes/2.7.1/curator-recipes-2.7.1.jar 100.0% [#####] 264.0 KiB (665.0 KiB / s)			
https://repo1.maven.org/maven2/org/glassfish/jersey/core/jersey-common/2.30/jersey-common-2.30.jar 100.0% [#####] 1.1 MiB (1.1 MiB / s)			
https://repo1.maven.org/maven2/com/fasterxml/jackson/core/jackson-databind/2.10.0/jackson-databind-2.10.0.jar 100.0% [#####] 1.3 MiB (923.2 KiB / s)			
https://repo1.maven.org/maven2/org/apache/hadoop/hadoop-yarn-api/2.7.4/hadoop-yarn-api-2.7.4.jar 100.0% [#####] 1.9 MiB (1.4 MiB / s)			
https://repo1.maven.org/maven2/org/apache/commons/commons-math3/3.4.1/commons-math3-3.4.1.jar 100.0% [#####] 1.9 MiB (1.6 MiB / s)			
https://repo1.maven.org/maven2/org/apache/spark/spark-catalyst_2.12/3.0.1/spark-catalyst_2.12-3.0.1.jar 100.0% [#####] 9.0 MiB (1.4 MiB / s)			
[info] Fetched artifacts of			
[warn] There may be incompatibilities among your library dependencies; run 'evicted' to see detailed eviction warnings.			
[info] Compiling 1 Scala source to /Users/henrypotsangbam/Documents/Code/spark-sbt/target/scala-2.12/classes ...			
https://repo1.maven.org/maven2/org.scala-sbt/util-interface/1.3.0/util-interface-1.3.0.pom 100.0% [#####] 2.7 KiB (7.3 KiB / s)			
[info] Non-compiled module 'compiler-bridge_2.12' for Scala 2.12.10. Compiling...			
[info] Compilation completed in 9.215s.			
[success] Total time: 92 s (01:32), completed 11-Nov-2020, 4:20:18 pm			
(base) Henrys-MacBook-Air:spark-sbt henrypotsangbam\$			

It created an application jar as shown below inside the target folder.

## 13 Learning Spark

```
(base) Henrys-MacBook-Air:scala-2.12 henrypotsangbam$  
(base) Henrys-MacBook-Air:scala-2.12 henrypotsangbam$ pwd  
/Users/henrypotsangbam/Documents/code/spark-sbt/target/scala-2.12  
(base) Henrys-MacBook-Air:scala-2.12 henrypotsangbam$ ls  
classes           update  
simple-project_2.12-1.0.jar  
(base) Henrys-MacBook-Air:scala-2.12 henrypotsangbam$ █
```

Copy the above jar to your cluster and deploy it.

Use spark-submit to run your application. Specify the files location appropriately. (e.x /opt/ or /software)

```
# export PATH=$PATH:/opt/spark/bin  
# cd /opt
```

```
#spark-submit --class "NameList" --master local[2] simple-project_2.12-1.0.jar names.json  
myname.txt
```

```
[root@893094f7bb92 software]#  
[root@893094f7bb92 software]# ls  
J_AddCat.csv  derby.log          namesAndAges.parquet  people.txt      users.json  
J_AddDist.csv influxdb-1.8.2.x86_64.rpm pcodes.csv       person.txt      zcodes.csv  
README.md      metastore_db      people-no-pcode.csv  postalcode.txt  
age.json       mydata           people.csv          sfpd.csv  
age1.json      names.json       people.json         simple-project_2.12-1.0.jar  
[root@893094f7bb92 software]# spark-submit --class "NameList" --master local[2] simple-project_2.12-1.0.jar n  
ames.json myname.txt  
WARNING: An illegal reflective access operation has occurred  
WARNING: Illegal reflective access by org.apache.spark.unsafe.Platform (file:/opt/spark/jars/spark-unsafe_2.12  
-3.0.1.jar) to constructor java.nio.DirectByteBuffer(long,int)  
WARNING: Please consider reporting this to the maintainers of org.apache.spark.unsafe.Platform  
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations  
WARNING: All illegal access operations will be denied in a future release  
20/11/12 10:56:43 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using built  
in-java classes where applicable  
Using Spark's default log4j profile: org/apache/spark/log4j-defaults.properties  
20/11/12 10:56:44 INFO SparkContext: Running Spark version 3.0.1  
20/11/12 10:56:44 INFO ResourceUtils:
```

```
20/11/12 10:56:45 INFO SparkRMEnv: Registering OutputCommitCoordinator
20/11/12 10:56:46 INFO Utils: Successfully started service 'SparkUI' on port 4040.
20/11/12 10:56:46 INFO SparkUI: Bound SparkUI to 0.0.0.0, and started at http://893094f7bb92:4040
20/11/12 10:56:46 INFO SparkContext: Added JAR file:/software/simple-project_2.12-1.0.jar at spark://893094f7bb92:45111/jars/simple-project_2.12-1.0.jar with timestamp 1605178606870
20/11/12 10:56:47 INFO Executor: Starting executor ID driver on host 893094f7bb92
20/11/12 10:56:47 INFO Utils: Successfully started service 'org.apache.spark.network.netty.NettyBlockTransferService' on port 35995.
20/11/12 10:56:47 INFO NettyBlockTransferService: Server created on 893094f7bb92:35995
20/11/12 10:56:47 INFO BlockManager: Using org.apache.spark.storage.RandomBlockReplicationPolicy for block replication policy
20/11/12 10:56:47 INFO BlockManagerMaster: Registering BlockManager BlockManagerId(driver, 893094f7bb92, 35995, None)
20/11/12 10:56:47 INFO BlockManagerMasterEndpoint: Registering block manager 893094f7bb92:35995 with 434.4 MiB RAM, BlockManagerId(driver, 893094f7bb92, 35995, None)
20/11/12 10:56:47 INFO BlockManagerMaster: Registered BlockManager BlockManagerId(driver, 893094f7bb92, 35995, None)
20/11/12 10:56:47 INFO BlockManager: Initialized BlockManager: BlockManagerId(driver, 893094f7bb92, 35995, None)
[root@893094f7bb92 software]#
```

You can verify the output : change the directory to myname.txt folder and view the output.

```
[root@893094f7bb92 software]# ls
J_AddCat.csv    derby.log          names.json      people.json   simple-project_2.12-1.0.jar
J_AddDist.csv   influxdb-1.8.2.x86_64.rpm namesAndAges.parquet  people.txt   users.json
README.md        metastore_db       pcodes.csv     person.txt   zcodes.csv
age.json         mydata           people-no-pcode.csv  postalcode.txt
age1.json        myname.txt        people.csv     sfpd.csv
[root@893094f7bb92 software]# more my
mydata/
myname.txt/
[root@893094f7bb92 software]# cd myname.txt/
[root@893094f7bb92 myname.txt]# ls
_SUCCESS  part-00000-adf88d05-f7ca-431e-900a-61d1ba4b5653-c000.csv
[root@893094f7bb92 myname.txt]# more part-00000-adf88d05-f7ca-431e-900a-61d1ba4b5653-c000.csv
firstName,lastName
Grace,Hopper
Alan,Turing
Ada,Lovelace
Charles,Babbage
[root@893094f7bb92 myname.txt]#
```

----- Lab Ends Here -----

### **3. Spark Standalone Cluster – 60 Minutes.**

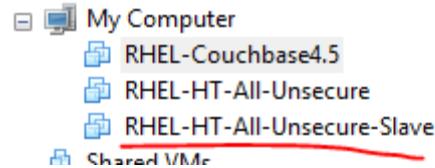
You will learn to configure two nodes Spark Standalone Cluster.

Create another instance of the VM by copying the VM folder or making clone. You need to shutdown the VM for that.

If you use clone, then specify as shown below. Hints: Select the parent virtual machine and select VM > Manage > Clone.

It will take few minutes depending on your VM size.

At the end, you will get an additional VM as shown below: (ex)



You need to power on both VM at this step.

Add another node i.e slave node to the Cluster. Change the hostname of the slave node, slave.

Logon to the slave VM. Your slave node should be as shown below.

```
[root@slave sbin]#  
[root@slave sbin]# hostname  
slave  
[root@slave sbin]#
```

Ensure to provide entries in /etc/hosts of both the VMs, so that it can communicate each other's using hostname.

*192.168.188.178 master  
192.168.188.174 slave*

Logon to the first VM i.e master to configure password less connection between the nodes.  
SSH access

The root user on the master must be able to connect

- a) to its own user account on the master – i.e. ssh master in this context and not necessarily ssh localhost – and
- b) to the root user account on the slave via a password-less SSH login.

You have to add the root@master's public SSH key (which should be in \$HOME/.ssh/id\_rsa.pub) to the authorized\_keys file of root@slave (in this user's \$HOME/.ssh/authorized\_keys).

The following steps will ensure that root user can ssh to its own account without password in all nodes.

Let us generate the keys for user root on the master node, to make sure that root user on master can ssh to slave nodes without password.

```
$ su - root  
$ ssh-keygen -t rsa -P "" -f ~/.ssh/id_rsa
```

```
$cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys  
$ ssh master  
You need to accept the key for the first time.
```

You can do this manually or use the following SSH command: to copy public key to all the slave nodes.

```
$ ssh-copy-id -i $HOME/.ssh/id_rsa.pub root@slave
```

Accept it, yes and supply the root password for the last time.

This command will prompt you for the login password for user root on slave, then copy the public SSH key for you, creating the correct directory and fixing the permissions as necessary.

The final step is to test the SSH setup by connecting with user root from the master to the user account root on the slave. This step is also needed to save slave's host key fingerprint to the root@master's known\_hosts file.

So, connecting from master to master...

```
$ ssh master
```

And from master to slave.

```
$ ssh slave
```

```
[root@master sbin]# ssh-keygen -t rsa -P ""
Generating public/private rsa key pair.
Enter file in which to save the key (/root/.ssh/id_rsa):
/root/.ssh/id_rsa already exists.
Overwrite (y/n)? y
Your identification has been saved in /root/.ssh/id_rsa.
Your public key has been saved in /root/.ssh/id_rsa.pub.
The key fingerprint is:
dd:87:61:51:6e:f9:1e:88:70:a0:ff:f6:92:e5:7f:fb root@master
The key's randomart image is:
---[ RSA 2048]---
+-----+
|       .   |
|       . o  |
|     . .o + |
|     ..oo.+..|
|    S...o....|
|     . o ...|
|     o+ .  |
|     .o... . |
|     ...oE|
+-----+
[root@master sbin]# scp
usage: scp [-1246BCpqrv] [-c cipher] [-F ssh_config] [-i identity_file]
           [-l limit] [-o ssh_option] [-P port] [-S program]
           [[user@]host1:]file1 ... [[user@]host2:]file2
[root@master sbin]# cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
[root@master sbin]# ssh master
Last login: Thu Sep  1 23:45:46 2016 from localhost
[root@master ~]# ssh-copy-id -i $HOME/.ssh/id_rsa.pub root@slave
root@slave's password:
Now try logging into the machine, with "ssh 'root@slave'", and check in:

.ssh/authorized_keys

to make sure we haven't added extra keys that you weren't expecting.

[root@master ~]# ssh slave
Last login: Thu Sep  1 23:45:46 2016 from localhost
[root@slave ~]#
```

Go to SPARK\_HOME/conf/ and create new file with name spark-env.sh on the master node

*There will be **spark-env.sh.template** in same folder and this file gives you detail on how to declare various environment variables.*

Now we will give the IP address of Master.

**SPARK\_LOCAL\_IP=192.168.188.173**

**SPARK\_MASTER\_HOST={IP Address}**

```
# Options read by executors and drivers running inside the cluster
# - SPARK_LOCAL_IP, to set the IP address Spark binds to on this node
SPARK_LOCAL_IP=192.168.188.173
# - SPARK_PUBLIC_DNS, to set the public DNS name of the driver program
# - SPARK_CLASSPATH, default classpath entries to append
# - SPARK_LOCAL_DIRS, storage directories to use on this node for shuffle and RD

# Options for the daemons used in the standalone deploy mode
# - SPARK_MASTER_HOST, to bind the master to a different IP address or hostname
SPARK_MASTER_HOST=192.168.188.173
# - SPARK_MASTER_PORT / SPARK_MASTER_WEBUI_PORT, to use non-default ports for the master
# - SPARK_DAEMON_MEMORY, memory allocated for each daemon process
# - SPARK_WORKER_CORES, number of cores to use for workers
# - SPARK_WORKER_MEMORY, memory allocated for workers
# - SPARK_WORKER_DIR, storage directory to use for workers
# - SPARK_WORKER_INSTANCES, number of worker instances to start on this host
# - SPARK_DAEMON_JAVA_OPTS, Java options for the daemons
# - SPARK_WORKER_JAVA_OPTS, Java options for workers
```

**// Note: You need to specify IP only.**

On master node; Create SPARK\_HOME/conf/slaves and enter the following entries.  
Worker process will be started in both the nodes.

```
[root@master conf]# more slaves
slave
master
[root@master conf]#
```

Then go to Spark HOME\_DIRECTORY/sbin and run following command from terminal

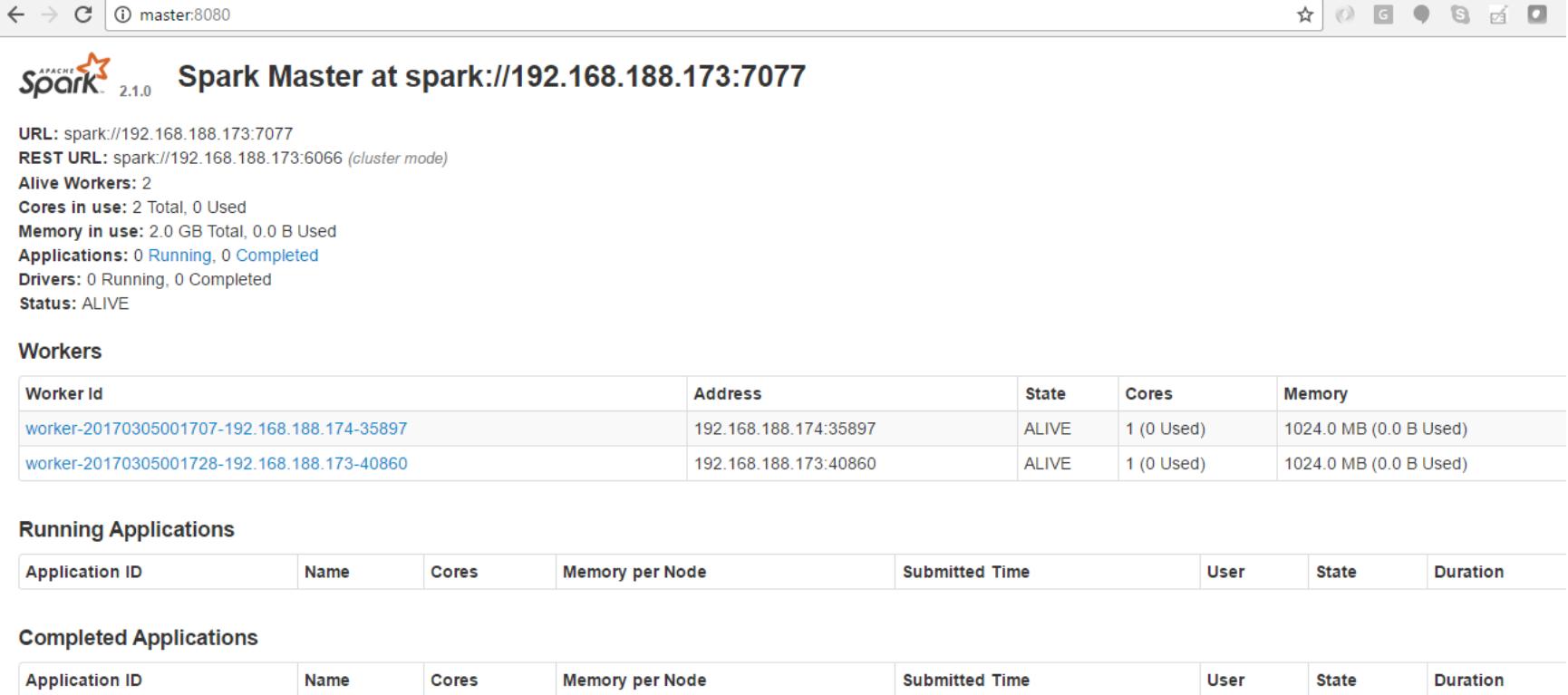
sh sbin/start-all.sh

```
[root@master sbin]# sh start-all.sh
starting org.apache.spark.deploy.master.Master, logging to /spark/spark-2.1/logs
/spark-root-org.apache.spark.deploy.master.Master-1-master.out
slave: starting org.apache.spark.deploy.worker.Worker, logging to /spark/spark-2
.1/logs/spark-root-org.apache.spark.deploy.worker.Worker-1-slave.out
master: starting org.apache.spark.deploy.worker.Worker, logging to /spark/spark-
2.1/logs/spark-root-org.apache.spark.deploy.worker.Worker-1-master.out
master: failed to launch: nice -n 0 /spark/spark-2.1/bin/spark-class org.apache.
spark.deploy.worker.Worker --webui-port 8081 spark://192.168.188.173:7077
master: full log in /spark/spark-2.1/logs/spark-root-org.apache.spark.deploy.wor
ker.Worker-1-master.out
```

This will start a standalone master server by executing it

<http://master:8080/>

You can access the Spark Master with the above URL.



The screenshot shows the Apache Spark 2.1.0 master web UI at `spark://192.168.188.173:7077`. The UI displays cluster statistics, lists of workers and applications, and a completed applications section.

**Cluster Statistics:**

- URL: `spark://192.168.188.173:7077`
- REST URL: `spark://192.168.188.173:6066 (cluster mode)`
- Alive Workers: 2
- Cores in use: 2 Total, 0 Used
- Memory in use: 2.0 GB Total, 0.0 B Used
- Applications: 0 Running, 0 Completed
- Drivers: 0 Running, 0 Completed
- Status: ALIVE

**Workers**

Worker Id	Address	State	Cores	Memory
worker-20170305001707-192.168.188.174-35897	192.168.188.174:35897	ALIVE	1 (0 Used)	1024.0 MB (0.0 B Used)
worker-20170305001728-192.168.188.173-40860	192.168.188.173:40860	ALIVE	1 (0 Used)	1024.0 MB (0.0 B Used)

**Running Applications**

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration

**Completed Applications**

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration

Once started, the master will print out a `spark://HOST:PORT` URL for itself, which you can use to connect workers to it, or pass as the “master” argument to `SparkContext`. You can also find this URL on the master’s web UI, which is `http://localhost:8080` by default. Once you have started a worker, look at the master’s web UI (`http://localhost:8080` by default). You should see the new node listed there, along with its number of CPUs and memory (minus one gigabyte left for the OS). In our case its 2 node.

Then you can verify the Node using the master UI:

**Workers**

Worker Id	Address	State	Cores	Memory
worker-20170305001707-192.168.188.174-35897	192.168.188.174:35897	ALIVE	1 (0 Used)	1024.0 MB (0.0 B Used)
worker-20170305001728-192.168.188.173-40860	192.168.188.173:40860	ALIVE	1 (0 Used)	1024.0 MB (0.0 B Used)

Let us execute Spark shell using Cluster mode:

You can perform from any client/server node i.e windows desktop client.

Connecting an Application to the Cluster

To run an application on the Spark cluster, simply pass the spark://IP:PORT URL of the master as to the SparkContext constructor.

To run an interactive Spark shell against the cluster, run the following command from the bin folder:

We are executing from the slave node.

```
#bin/spark-shell --master spark://192.168.173:8090
```

You can verify the application execution from the web UI


**Spark Master at spark://192.168.188.173:7077**

**URL:** spark://192.168.188.173:7077  
**REST URL:** spark://192.168.188.173:6066 (cluster mode)  
**Alive Workers:** 2  
**Cores in use:** 2 Total, 2 Used  
**Memory in use:** 2.0 GB Total, 2.0 GB Used  
**Applications:** 1 Running, 0 Completed  
**Drivers:** 0 Running, 0 Completed  
**Status:** ALIVE

**Workers**

Worker Id	Address	State	Cores	Memory
worker-20170305001707-192.168.188.174-35897	192.168.188.174:35897	ALIVE	1 (1 Used)	1024.0 MB (1024.0 MB Used)
worker-20170305001728-192.168.188.173-40860	192.168.188.173:40860	ALIVE	1 (1 Used)	1024.0 MB (1024.0 MB Used)

**Running Applications**

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration
app-20170305004646-0000	(kill) Spark shell	2	1024.0 MB	2017/03/05 00:46:46	root	RUNNING	6.4 min

**Let's make a new RDD from the text of the README file in the Spark source directory:**

```
scala> val textFile = sc.textFile("README.md")
```

```
scala> val textFile = sc.textFile("/MyTrainingWork/Spark/README.md")
15/06/03 23:32:06 INFO MemoryStore: ensureFreeSpace(73391) called with curMem=18
1810, maxMem=278019440
15/06/03 23:32:06 INFO MemoryStore: Block broadcast_1 stored as values in memory
(estimated size 71.7 KB, free 264.9 MB)
15/06/03 23:32:06 INFO MemoryStore: ensureFreeSpace(31262) called with curMem=25
5201, maxMem=278019440
15/06/03 23:32:06 INFO MemoryStore: Block broadcast_1_piece0 stored as bytes in
memory (estimated size 30.5 KB, free 264.9 MB)
15/06/03 23:32:06 INFO BlockManagerInfo: Added broadcast_1_piece0 in memory on 1
localhost:1599 (size: 30.5 KB, free: 265.1 MB)
15/06/03 23:32:06 INFO BlockManagerMaster: Updated info of block broadcast_1_pie
ce0
15/06/03 23:32:06 INFO SparkContext: Created broadcast 1 from textFile at <conso
le>:21
textFile: org.apache.spark.rdd.RDD[String] = /MyTrainingWork/Spark/README.md Map
PartitionsRDD[3] at textFile at <console>:21
```

Let's start with a few actions:

```
scala> textFile.count() // Number of items in this RDD
```

```
PartitionsRDD[3] at textFile at <console>:21
scala> textFile.count()
15/06/03 23:32:16 INFO FileInputFormat: Total input paths to process : 1
15/06/03 23:32:16 INFO SparkContext: Starting job: count at <console>:24
15/06/03 23:32:16 INFO DAGScheduler: Got job 0 (count at <console>:24) with 2 ou
tput partitions (allowLocal=false)
15/06/03 23:32:16 INFO DAGScheduler: Final stage: Stage 0(count at <console>:24)

15/06/03 23:32:16 INFO DAGScheduler: Parents of final stage: List()
15/06/03 23:32:16 INFO DAGScheduler: Missing parents: List()
15/06/03 23:32:16 INFO DAGScheduler: Submitting Stage 0 (/MyTrainingWork/Spark/R
EADME.md MapPartitionsRDD[3] at textFile at <console>:21), which has no missing
parents
```

```
tes result sent to driver
15/06/03 23:32:17 INFO TaskSetManager: Finished task 0.0 in stage 0.0 (TID 0) in
352 ms on localhost (1/2)
15/06/03 23:32:17 INFO TaskSetManager: Finished task 1.0 in stage 0.0 (TID 1) in
338 ms on localhost (2/2)
15/06/03 23:32:17 INFO TaskSchedulerImpl: Removed TaskSet 0.0, whose tasks have
all completed, from pool
15/06/03 23:32:17 INFO DAGScheduler: Stage 0 (count at <console>:24) finished in
0.393 s
15/06/03 23:32:17 INFO DAGScheduler: Job 0 finished: count at <console>:24, took
0.678076 s
res2: Long = 98
scala>
```

scala> `textFile.first() // First item in this RDD`

```
.MD:0+1814
15/06/03 23:34:06 INFO Executor: Finished task 0.0 in stage 1.0 (TID 2). 1809 by
tes result sent to driver
15/06/03 23:34:06 INFO TaskSetManager: Finished task 0.0 in stage 1.0 (TID 2) in
10 ms on localhost (1/1)
15/06/03 23:34:06 INFO DAGScheduler: Stage 1 (first at <console>:24) finished in
0.011 s
15/06/03 23:34:06 INFO TaskSchedulerImpl: Removed TaskSet 1.0, whose tasks have
all completed, from pool
15/06/03 23:34:06 INFO DAGScheduler: Job 1 finished: first at <console>:24, took
0.019875 s
res3: String = # Apache Spark
scala>
```

Now let's use a transformation. We will use the `filter` transformation to return a new RDD with a subset of the items in the file.

scala> `val linesWithSpark = textFile.filter(line => line.contains("Spark"))`

We can chain together transformations and actions:

scala> `textFile.filter(line => line.contains("Spark")).count() // How many lines contain "Spark"?`

```
15/06/03 23:35:17 INFO Executor: Finished task 0.0 in stage 2.0 (TID 3). 1830 by
tes result sent to driver
15/06/03 23:35:17 INFO TaskSetManager: Finished task 1.0 in stage 2.0 (TID 4) in
12 ms on localhost <1/2>
15/06/03 23:35:17 INFO TaskSetManager: Finished task 0.0 in stage 2.0 (TID 3) in
14 ms on localhost <2/2>
15/06/03 23:35:17 INFO DAGScheduler: Stage 2 (count at <console>:24) finished in
0.014 s
15/06/03 23:35:17 INFO TaskSchedulerImpl: Removed TaskSet 2.0, whose tasks have
all completed, from pool
15/06/03 23:35:17 INFO DAGScheduler: Job 2 finished: count at <console>:24, took
0.028214 s
res4: Long = 19
scala>
```

Let's say we want to find the line with the most words

```
scala> textFile.map(line => line.split(" ").size).reduce((a, b) => if (a > b) a else b)
```

Stop the spark process. Hints [sbin/stop-all.sh]

----- Lab Ends Here -----

#### 4. Spark Two Nodes Cluster Using Docker – 120 Minutes

Prerequisites:

- Install Docker
- Pull Centos Image (Preferable spark kafka Image)

Steps for deploying two node spark cluster in docker:

- Create two containers using the above image
  - o Spark0
  - o Spark1
- Create a network to connect between these two nodes.

You should pull the following images from docker hub.

```
(base) Henrys-MacBook-Air:~ henrypotsangbam$ docker images
REPOSITORY          TAG      IMAGE ID      CREATED       SIZE
spark-kafka         latest   a0c16a0aebc1  2 days ago   3.84GB
centos              7        7e6257c9f8d8  4 weeks ago  203MB
(base) Henrys-MacBook-Air:~ henrypotsangbam$
```

Let us create a common network for our two nodes cluster.

```
#docker network create --driver bridge spark-net
```

Create first node, sparko container

```
#docker run -it --name sparko --privileged -p 8080:8080 -p 7077:7077 -p 4040:4040 -p 8081:8081 -p 8090:8090 centos:7 /usr/sbin/init
```

Docker command with Host folder mounted. (Skip)

```
# docker run -it --name spark0 --hostname spark0 --privileged --network spark-net -v /Users/henrypotsangbam/Documents/Docker:/opt -p 8080:8080 -p 7077:7077 -p 4040:4040 -p 8081:8081 -p 8090:8090 centos:7 /usr/sbin/init
```

[ Alternative Optional: Skip this step.

```
#docker create -it --name sparko --privileged -p 8080:8080 -p 7077:7077 -p 4040:4040 -p 8081:8081 -p 8090:8090 --network spark-net --entrypoint /usr/sbin/init centos:7
```

or use tag - spark-kafka

]

To connect a **running** container to an existing user-defined bridge, use the docker network connect command. If the sparko is already started without the network being attached execute the following else skip the following step.

```
$ docker network connect spark-net sparko
```

Start the first container:

```
#docker start sparko
```

Connect to you first node:

```
# docker exec -it sparko /usr/bin/bash
```

Start the second node and perform the installation as specify in the first lab.

```
#docker run -dit --name spark1 -p 8082:8081 -p 4041:4040 --network spark-net --entrypoint /bin/bash centos:7
```

or

Docker command with Host folder mounted. (Skip)

```
# docker run -it --name spark1 --hostname spark1 --privileged --network spark-net -v  
/Users/henrypotsangbam/Documents/Docker:/opt -p 4041:4040 -p 8082:8081 centos:7  
/usr/sbin/init
```

Confirm the Network status:

Inspect the network and find the IP addresses of the two containers

```
#docker network inspect spark-net
```

```
    "ConfigOnly": false,
    "Containers": [
        "e34277dc489b480dd6fb4528c84a333a40a322c054be3877da827005a84f593e": {
            "Name": "spark1",
            "EndpointID": "d5c0c550a1b58782b590909ffb56e3c66826d4ccb046853fbe7c4f5646239038",
            "MacAddress": "02:42:ac:13:00:03",
            "IPv4Address": "172.19.0.3/16",
            "IPv6Address": ""
        },
        "ef2232096b600d78c553dc7cab22b8b0bbdb7065d2d59eb57637d36699839ac7": {
            "Name": "spark0",
            "EndpointID": "e3bfa88d7a67b2f6b82cd2543637eee22abcaeeb9c8ff1c00415d47308d96da8",
            "MacAddress": "02:42:ac:13:00:02",
            "IPv4Address": "172.19.0.2/16",
            "IPv6Address": ""
        }
    ],
    ...
}
```

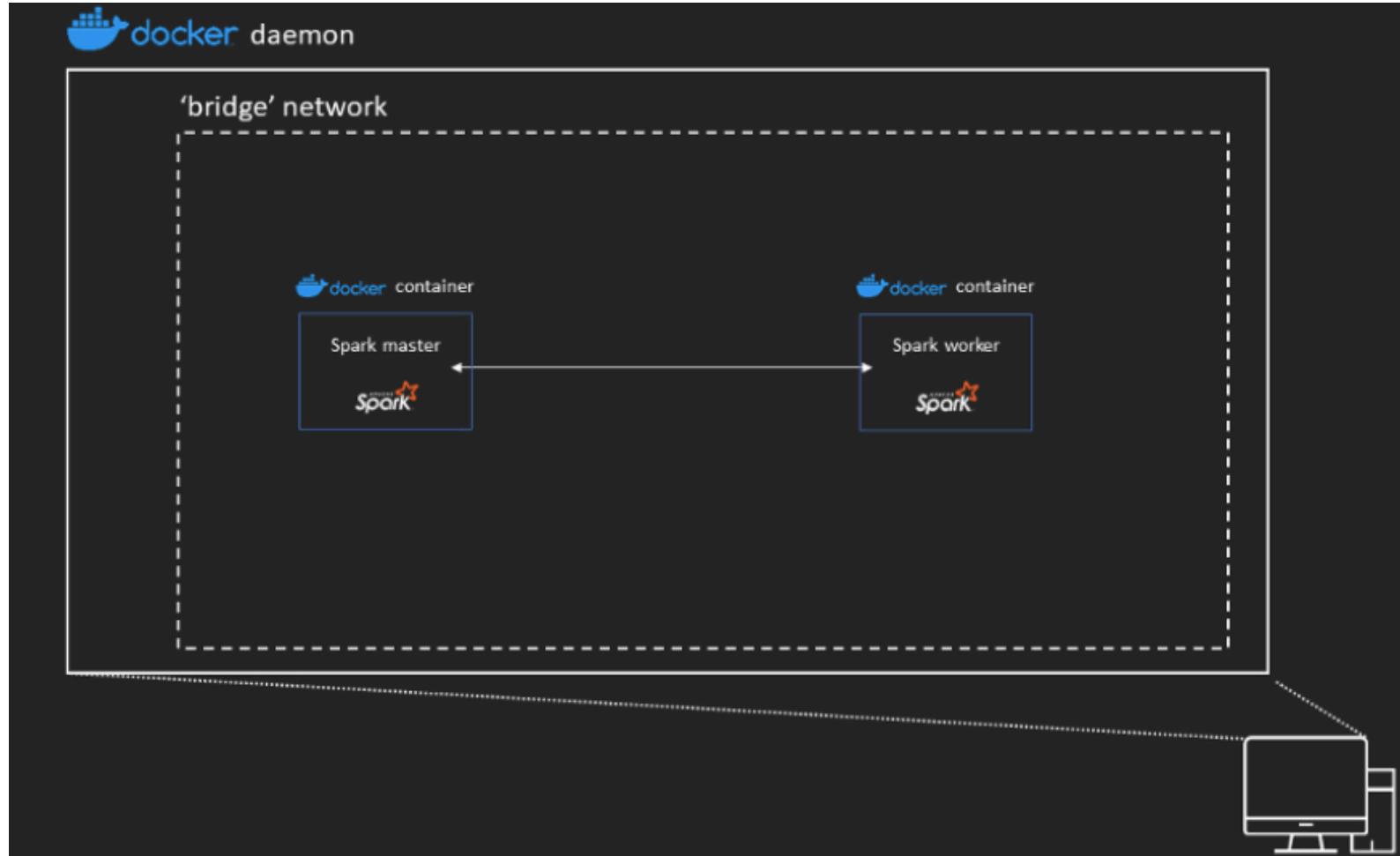
Ensure to substitute IPs accordingly.

Attach to the spark-master container and test its communication to the spark-worker container using both it's IP address and then using its container name.

```
# ping spark0
```

```
[root@ef2232096b60 /]# ping spark0
PING spark0 (172.19.0.2) 56(84) bytes of data.
64 bytes from ef2232096b60 (172.19.0.2): icmp_seq=1 ttl=64 time=0.062 ms
64 bytes from ef2232096b60 (172.19.0.2): icmp_seq=2 ttl=64 time=0.104 ms
64 bytes from ef2232096b60 (172.19.0.2): icmp_seq=3 ttl=64 time=0.062 ms
^C
--- spark0 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2060ms
rtt min/avg/max/mdev = 0.062/0.076/0.104/0.019 ms
[root@ef2232096b60 /]# ping spark1
PING spark1 (172.19.0.3) 56(84) bytes of data.
64 bytes from spark1.spark-net (172.19.0.3): icmp_seq=1 ttl=64 time=0.202 ms
64 bytes from spark1.spark-net (172.19.0.3): icmp_seq=2 ttl=64 time=0.204 ms
^C
--- spark1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1004ms
rtt min/avg/max/mdev = 0.202/0.203/0.204/0.001 ms
#[root@ef2232096b60 /]#
```

## Architecture



master – spark0 and Slave – spark1

Let us start the Spark master.

Install the spark. You can refer the first lab.

Execute the following in Sparko

Setup a Spark master node

Change the Master Port to 8090, there is issue when it is executed in 7077 in docker environment.

Execute on the sparko – Terminal.

```
#export PATH=$PATH:/opt/spark/bin  
#export SPARK_MASTER_PORT=8090  
#spark-class org.apache.spark.deploy.master.Master
```

```

@5d486484cd1c:/software (docker)          361           bash          362
20/09/12 02:33:29 INFO Master: Started daemon with process name: 35@5d486484cd1c
20/09/12 02:33:29 INFO SignalUtils: Registered signal handler for TERM
20/09/12 02:33:29 INFO SignalUtils: Registered signal handler for HUP
20/09/12 02:33:29 INFO SignalUtils: Registered signal handler for INT
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by org.apache.spark.unsafe.Platform (file:/opt/spark/jars/spark-unsafe_2.12-3.0.1.jar) to constructor java.nio.DirectByteBuffer(long,int)
WARNING: Please consider reporting this to the maintainers of org.apache.spark.unsafe.Platform
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations
WARNING: All illegal access operations will be denied in a future release
20/09/12 02:33:30 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
20/09/12 02:33:30 INFO SecurityManager: Changing view acls to: root
20/09/12 02:33:30 INFO SecurityManager: Changing modify acls to: root
20/09/12 02:33:30 INFO SecurityManager: Changing view acls groups to:
20/09/12 02:33:30 INFO SecurityManager: Changing modify acls groups to:
20/09/12 02:33:30 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users with view permissions: Set(root); groups with view permissions: Set(); users with modify permissions: Set(root); groups with modify permissions: Set()
20/09/12 02:33:31 INFO Utils: Successfully started service 'sparkMaster' on port 7077.
20/09/12 02:33:31 INFO Master: Starting Spark master at spark://172.17.0.2:7077
20/09/12 02:33:31 INFO Master: Running Spark version 3.0.1
20/09/12 02:33:32 INFO Utils: Successfully started service 'MasterUI' on port 8080.
20/09/12 02:33:32 INFO MasterWebUI: Bound MasterWebUI to 0.0.0.0, and started at http://5d486484cd1c:8080
20/09/12 02:33:32 INFO Master: I have been elected leader! New state: ALIVE

```

Start a worker process On Node/spark o: In a separate terminal.

Attach a worker node to the cluster, execute the following in the sparko container.

```
#export PATH=$PATH:/opt/spark/bin
```

```
#spark-class org.apache.spark.deploy.worker.Worker -c 1 -m 1G spark://172.17.0.2:8090
```

You need to replace with the IP of the sparko node. It can be retrieve using ifconfig command.

```
20/09/12 02:55:17 INFO Worker: Starting Spark worker 172.17.0.2:38483 with 1 cores, 2.0 GiB RAM
20/09/12 02:55:17 INFO Worker: Running Spark version 3.0.1
20/09/12 02:55:17 INFO Worker: Spark home: /opt/spark
20/09/12 02:55:17 INFO ResourceUtils: =====
20/09/12 02:55:17 INFO ResourceUtils: Resources for spark.worker:

20/09/12 02:55:17 INFO ResourceUtils: =====
20/09/12 02:55:17 INFO Utils: Successfully started service 'WorkerUI' on port 8081.
20/09/12 02:55:17 INFO WorkerWebUI: Bound WorkerWebUI to 0.0.0.0, and started at http://224e200bfc56:8081
20/09/12 02:55:17 INFO Worker: Connecting to master 172.17.0.2:7077...
20/09/12 02:55:18 INFO TransportClientFactory: Successfully created connection to /172.17.0.2:7077 after 40 ms (0 ms spent in bootstraps)
20/09/12 02:55:18 INFO Worker: Successfully registered with master spark://172.17.0.2:7077
20/09/12 02:55:18 INFO Worker: Asked to launch executor app-20200912025310-0000/0 for Spark shell
20/09/12 02:55:18 INFO SecurityManager: Changing view acls to: root
20/09/12 02:55:18 INFO SecurityManager: Changing modify acls to: root
20/09/12 02:55:18 INFO SecurityManager: Changing view acls groups to:
20/09/12 02:55:18 INFO SecurityManager: Changing modify acls groups to:
20/09/12 02:55:18 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users with view permissions: Set(root); groups with view permissions: Set(); users with modify permissions: Set(root); groups with modify permissions: Set()
20/09/12 02:55:18 INFO ExecutorRunner: Launch command: "/opt/java/bin/java" "-cp" "/opt/spark/conf/:/opt/spark/jars/*" "-Xmx1024M" "-Dspark.driver.port=35927" "org.apache.spark.executor.CoarseGrainedExecutorBackend" "--driver-url" "spark://CoarseGrainedScheduler@224e200bfc56:35927" "--executor-id" "0" "--hostname" "172.17.0.2" "--cores" "1" "--app-id" "app-20200912025310-0000" "--worker-url" "spark://Worker@172.17.0.2:38483"
```

If unable to connect to localhost replace it with the container IP or the container alias i.e sparko.

Refresh the web ui, ensure that you can see a worker as shown below.

<http://127.0.0.1:8080>

The screenshot shows the Spark Web UI interface. At the top, there is a header with the Spark logo and the text "Spark Master at spark://172.17.0.2:8090". Below the header, there is a summary of system resources:

- URL: spark://172.17.0.2:8090
- Alive Workers: 1
- Cores in use: 1 Total, 0 Used
- Memory in use: 1024.0 MiB Total, 0.0 B Used
- Resources in use:
- Applications: 0 Running, 0 Completed
- Drivers: 0 Running, 0 Completed
- Status: ALIVE

Below the summary, there is a section titled "Workers (1)" which contains a table with one row of data:

Worker Id	Address	State	Cores	Memory	Resources
worker-20210118134218-172.17.0.2-34667	172.17.0.2:34667	ALIVE	1 (0 Used)	1024.0 MiB (0.0 B Used)	

There are also sections for "Running Applications (0)" and "Completed Applications (0)", each with its own table header.

Start the Node on spark1

Ensure that you have install spark in the Spark1 too.

```
#docker exec -it spark1 bash
```

```
#export PATH=$PATH:/opt/spark/bin  
# spark-class org.apache.spark.deploy.worker.Worker -c 1 -m 1G spark://172.17.0.2:8090
```

At the end of this step, you should have 2 worker nodes as shown below:

The screenshot shows the Spark 3.0.1 master UI at `spark://172.19.0.3:8090`. The top section displays cluster statistics: URL: `spark://172.19.0.3:8090`, Alive Workers: 2, Cores in use: 2 Total, 0 Used, Memory in use: 2.0 GiB Total, 0.0 B Used, Resources in use: Applications: 0 Running, 0 Completed, Drivers: 0 Running, 0 Completed, Status: ALIVE. Below this is a table titled "Workers (2)" showing two workers with their IDs, addresses, states, cores, memory, and resources.

Worker Id	Address	State	Cores	Memory	Resources
worker-20200912142723-172.19.0.3-35677	172.19.0.3:35677	ALIVE	1 (0 Used)	1024.0 MiB (0.0 B Used)	
worker-20200912142924-172.19.0.2-38199	172.19.0.2:38199	ALIVE	1 (0 Used)	1024.0 MiB (0.0 B Used)	

Below the workers table is a section titled "Running Applications (0)".

Application ID	Name	Cores	Memory per Executor	Resources Per Executor	Submitted Time	User	State	Duration
----------------	------	-------	---------------------	------------------------	----------------	------	-------	----------

Finally, there is a section titled "Completed Applications (0)".

Application ID	Name	Cores	Memory per Executor	Resources Per Executor	Submitted Time	User	State	Duration
----------------	------	-------	---------------------	------------------------	----------------	------	-------	----------

Open a scala shell and connect to the Spark cluster

```
#SPARK_HOME/bin/spark-shell --conf spark.executor.memory=512mb --conf
spark.executor.cores=1 --master spark://spark0:8090
```

Run an example job in the interactive scala shell

```
val myRange = spark.range(100).toDF("number")
```

```
val divisBy2 = myRange.where("number % 2 = 0")
```

`divisBy2.count()`

Check the application UI by navigating to <http://localhost:4040>. You should see the following



The console should display the result as shown below:

Hints: (For submitting job in cluster)

You need to complete the **Lab - Running a Spark Application** before going ahead. Submit from the /software folder, since the input file exist in that folder.

Copy the names.json in /software folder

```
# export PATH=$PATH:/opt/spark/bin  
  
#spark-submit --class "NameList" --master spark://sparko:8090 simple-project_2.12-  
1.0.jar names.json mynames --conf spark.executor.memory=256mb
```

Verify the output.

```
#ls /software/mynames  
  
_temporary part-00000-ba4c474e-4f80-4824-83e7-4dc8d47cc79b-c000.csv  
  
#more part-00000-ba4c474e-4f80-4824-83e7-4dc8d47cc79b-c000.csv  
  
firstName,lastName  
Grace,Hopper  
Alan,Turing  
Ada,Lovelace  
Charles,Babbage  
Optional only for Java.
```

```
#spark-submit --class "com.ostech.spark.SimpleApp" --master spark://sparko:8090  
LearningSpark-0.0.1-SNAPSHOT.jar --conf spark.executor.memory=256mb
```

----- Lab Ends Here -----  
-----

<https://towardsdatascience.com/diy-apache-spark-docker-bb4f11c10d24>

## 5. Launching on a Cluster: Hadoop YARN – 120 Minutes

In this lab, you will deploy Spark Application on Hadoop Cluster.

Configure and install YARN.

One Node will be exclusively running YARN,

Options:

- Copy a VM and rename to HadoopVM-YARN.
- Create another container

Install YARN.

By now, you should have two VM on your workstation or Two container:

For Me, the first VM hostname is hp.com and the second one is ht.com. Ensure to follow the same nomenclature to avoid confusion. Its very important.

Host/VM	Container	Remarks
hp.com	Hadoopo	YARN Services
ht.com	Sparko	Spark Client or Spark.

Using Docker:

```
#docker run -it --name hadoopo --privileged -p 8088:8088 -p 9870:9870 -p 9864:9864 -p 8032:8032 -p 8188:8188 -p 8020:8020 --hostname hadoopo centos:7 /usr/sbin/init
```

Verify the hostname and the /etc/hosts. You need to enter each IP and host name as shown above. Update details accordingly in your local machine.

```
[root@hp ~]# hostname  
hp.com  
[root@hp ~]# more /etc/hosts  
# Do not remove the following line, or various programs  
# that require network functionality will fail.  
#127.0.0.1          hp.com localhost  
#:1                  hp.com localhost6  
  
192.168.188.134 ht.com  
192.168.188.136 hp.com localhost  
[root@hp ~]#
```

You should see in your window as follows for ht.com. Changes the IP as your system.

```
[root@ht ~]# bash  
[root@ht ~]# hostname  
ht.com  
[root@ht ~]# more /etc/hosts  
# Do not remove the following line, or various programs  
# that require network functionality will fail.  
#127.0.0.1          localhost.localdomain localhost  
#:1                  localhost6.localdomain6 localhost6  
192.168.188.134 ht.com localhost  
192.168.188.136 hp.com  
[root@ht ~]#
```

All the below commands should be executed on hp.com unless specify. We are configuring YARN cluster now.

Change directory to the location where you have the software.

Download Location: (hadoop-3.2.2.tar.gz)  
<https://hadoop.apache.org/releases.html>

Untar as follows:

```
tar -xvf hadoop-X.tar.gz -C /opt  
tar -xvf jdk-8u40-linux-i586.tar.gz -C /opt
```

Rename the folder:

```
#mv hadoo* hadoop  
#mv jdk* jdk
```

--- Install JDK and set Java Home (Copy the bin file in the YARN folder) , To include JAVA\_HOME for all bash users , make an entry in /etc/profile.d as follows:

```
echo "export JAVA_HOME=/opt/jdk/" > /etc/profile.d/java.sh
```

Unpack the downloaded Hadoop distribution. In the distribution, edit the file /opt/hadoop/etc/hadoop/hadoop-env.sh to define some parameters as follows:

```
# set to the root of your Java installation  
  
export JAVA_HOME=/opt/jdk
```

```
# cd /opt/hadoop
```

Try the following command:

```
$ bin/hadoop
```

You need to modify some setting as follows: Replace with your hostname accordingly.

Use the following:

etc/hadoop/core-site.xml:

```
<configuration>
  <property>
    <name>fs.defaultFS</name>
    <value>hdfs://hadoop0:8020</value>
  </property>
</configuration>
```

etc/hadoop/hdfs-site.xml:

```
<configuration>
  <property>
    <name>dfs.replication</name>
    <value>1</value>
  </property>
</configuration>
```

## Setup passphraseless ssh

Now check that you can ssh to the localhost without a passphrase:

```
yum -y install openssh-server openssh-clients  
systemctl start sshd
```

Change the passwd using passwd command.

```
$ ssh localhost
```

If you cannot ssh to localhost without a passphrase, execute the following commands:

```
$ ssh-keygen -t rsa -P '' -f ~/.ssh/id_rsa  
$ cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys  
$ chmod 0600 ~/.ssh/authorized_keys
```

copy the key to the slaves node:

```
scp ~/.ssh/id_rsa.pub master1:~/ssh/master.pub
```

```
[user@host1:~]# ... [user@host2:~]#  
[root@master0 hadoop]# scp ~/.ssh/id_rsa.pub master1:~/ssh/master.pub  
Warning: the ECDSA host key for 'master1' differs from the key for the IP address '172.18.0.3'  
Offending key for IP in /root/.ssh/known_hosts:4  
Matching host key in /root/.ssh/known_hosts:7  
Are you sure you want to continue connecting (yes/no)? yes  
id_rsa.pub                                         100%  401   324.3KB/s  00:00  
[root@master0 hadoop]#
```

Log on the slave node. Adding the master public key as an authroized key in the slave node.

```
[root@master1 ~]#  
[root@master1 ~]#  
[root@master1 ~]# cat ~/ssh/master.pub >> ~/ssh/authorized_keys  
[root@master1 ~]#
```

Add the environment variable.

```
export HDFS_NAMENODE_USER="root"  
export HDFS_DATANODE_USER="root"  
export HDFS_SECONDARYNAMENODE_USER="root"  
export YARN_RESOURCEMANAGER_USER="root"  
export YARN_NODEMANAGER_USER="root"
```

**Format the filesystem:**

```
$ bin/hdfs namenode -format
```

**Start NameNode daemon and DataNode daemon:**

```
$ sbin/start-dfs.sh
```

```
[root@hadoop0 hadoop]# sbin/start-dfs.sh
Starting namenodes on [localhost]
Last login: Thu Jan 21 08:00:44 UTC 2021 from localhost on pts/2
Starting datanodes
Last login: Thu Jan 21 08:06:21 UTC 2021 on pts/2
Starting secondary namenodes [hadoop0]
Last login: Thu Jan 21 08:06:23 UTC 2021 on pts/2
hadoop0: Warning: Permanently added 'hadoop0,172.17.0.2' (ECDSA) to the list of known hosts.
[root@hadoop0 hadoop]#
```

1. Browse the web interface for the NameNode; by default it is available at:
  - o NameNode - <http://localhost:9870/>
2. Make the HDFS directories required to execute MapReduce jobs:

```
3. $ bin/hdfs dfs -mkdir /user
```

```
$ bin/hdfs dfs -mkdir /user/root
```

You can run a MapReduce job on YARN in a pseudo-distributed mode

## Start HDFS and YARN on the YARN Node: hp.com

1. Configure parameters as follows:

etc/hadoop/mapred-site.xml:

```
<configuration>
  <property>
    <name>mapreduce.framework.name</name>
    <value>yarn</value>
  </property>
  <property>
    <name>mapreduce.application.classpath</name>
    <value>$HADOOP_MAPRED_HOME/share/hadoop/mapreduce/*:$HADOOP_MAPRED_HOME/share/hadoop/mapreduce/lib/*
  </value>
  </property>
</configuration>
```

etc/hadoop/yarn-site.xml:

```
<configuration>
<property>
    <name>yarn.nodemanager.aux-services</name>
    <value>mapreduce_shuffle</value>
</property>
<property>
    <name>yarn.nodemanager.env-whitelist</name>
    <value>JAVA_HOME,HADOOP_COMMON_HOME,HADOOP_HDFS_HOME,HADOOP_CONF_DIR,CLASSPATH_PREPEND_DISTCACHE,HAD
OOP_YARN_HOME,HADOOP_MAPRED_HOME</value>
</property>
</configuration>
```

2. Start ResourceManager daemon and NodeManager daemon:

```
$ sbin/start-yarn.sh
```

```
[root@hadoop0 hadoop]# sbin/start-yarn.sh
Starting resourcemanager
Last login: Thu Jan 21 08:06:32 UTC 2021 on pts/2
Starting nodemanagers
Last login: Thu Jan 21 08:13:09 UTC 2021 on pts/2
[root@hadoop0 hadoop]#
```

3. Browse the web interface for the ResourceManager; by default it is available at:

- o ResourceManager - <http://localhost:8088/>

4. When you're done, you can stop the daemons with: Optional.

```
$ sbin/stop-yarn.sh
```

#verify with jps , all the above services should be there.  
jps

```
[root@hadoop0 hadoop]# export PATH=$PATH:/opt/jdk/bin
[root@hadoop0 hadoop]# jps
1826 NodeManager
919 NameNode
1034 DataNode
1210 SecondaryNameNode
1708 ResourceManager
2174 Jps
[root@hadoop0 hadoop]#
```

Hadoop Node - Let us set some environment and path variable as follows: ( vi ~/.bashrc)

```
export HADOOP_HOME=/opt/hadoop  
export PATH=$HADOOP_HOME/bin:$PATH
```

Let us create a temporary folder, that will be used for working space for the YARN cluster.

```
hadoop fs -mkdir /tmp  
hadoop fs -chmod -R 1777 /tmp  
hadoop fs -mkdir /tmp/in  
hadoop fs -ls /tmp
```

You can get the README.md file from the Software folder, which is provided along with the training.

```
hadoop fs -copyFromLocal /opt/hadoop/README.txt /tmp/in  
hadoop fs -ls /tmp/in
```

```
#hadoop fs -mkdir /tmp/spark-events
```

Congrats! You have successfully configure Yarn Cluster.

If you are using docker, join the hadoopo and sparko containers in a single network:

```
#docker network connect spark-net hadoopo
```

Verify it:

```
#docker network inspect spark-net
```

```
"Containers": {
    "303b681436449f211ee3f828ec09af683947652bd1db52c68288e6ac75d71e04": {
        "Name": "spark0",
        "EndpointID": "56cfed9c11107e578a688ddab77af96e72c1063ebd2631bd801629f328b17e2",
        "MacAddress": "02:42:ac:12:00:02",
        "IPv4Address": "172.18.0.2/16",
        "IPv6Address": ""
    },
    "c88c1c8cb01a6aecd1832d1bf3d3cb22dec209f45a5749ace85a66d1d1d0cf12": {
        "Name": "hadoop0",
        "EndpointID": "3c030821125613a7bf5c1cea99f510144a01220b9cc38391bbeb71274076c824",
        "MacAddress": "02:42:ac:12:00:03",
        "IPv4Address": "172.18.0.3/16",
        "IPv6Address": ""
    }
},
"Options": {},
"Labels": {}
}
```

Start the Spark VM/spark container, if it's not yet started, i.e ht.com and issue the following command. Logon to the machine using telnet. You can use the VM, share folder options to copy the file to the VM from your workstation or else copy using the mouse from your workstation to the folder specify.

Let us copy the program, simple-project\_2.12-1.0.jar to the spark nodes. It was developed earlier.

Let us configure hadoop client setting on the Spark VM --> ht.com or sparko node.

Compress the Hadoop folder on the Hadoop instances or Hadoop node.

```
#cd /opt  
#tar -cvzf hadoop.tar hadoop/
```

Copy the compressed hadoop folder to the sparko or spark node and uncompressed in /opt folder.

[Docker:

```
copy from hadoop to host : docker cp hadoop:/opt/hadoop.tar .  
copy from host to spark : docker cp hadoop.tar sparko:/opt/]
```

```
#tar -xvf hadoop.tar
```

Update yarn-site.xml on the Spark Node. – Replace the RM hostname with that of your server.

```
<property>
  <name>yarn.resourcemanager.hostname</name>
  <value>mastero</value>
  <description>The hostname of the RM.</description>
</property>
<property>
  <name>yarn.resourcemanager.address</name>
  <value>mastero:8032</value>
  <description>The hostname of the RM.</description>
</property>
```

Create the following file in /opt on hadoop node and copy the file in to hdfs /user/root/input folder.

File names.json contains:

```
{"firstName":"Grace","lastName":"Hopper"}
{"firstName":"Alan","lastName":"Turing"}
 {"firstName":"Ada","lastName":"Lovelace"}
 {"firstName":"Charles","lastName":"Babbage"}
```

```
#hdfs dfs -mkdir /user/root/input  
# hdfs dfs -copyFromLocal /opt/names.json /user/root/input/
```

You can verify the file using the following command:

```
# hdfs dfs -ls -R /user/root/input
```

Open a command console to execute the Spark jobs to submit on YARN.  
Export Hadoop and Yarn environment variable pointing to the Spark Node – Hadoop conf file.

```
#cd /opt/spark/bin  
#export HADOOP_CONF_DIR=/opt/hadoop-spark/etc/hadoop  
#export YARN_CONF_DIR=/opt/hadoop-spark/etc/hadoop  
#./spark-submit --class "NameList" --master yarn --deploy-mode cluster  
/opt/data/simple-project_2.12-1.0.jar \  
    hdfs://hadoop0:8020/user/root/input1 hdfs://hadoop0:8020/user/root/output4  
or  
../spark-submit --class "NameList" --master yarn --driver-memory 1G --executor-memory 1G --num-  
executors 2 --deploy-mode cluster /opt/data/simple-project_2.12-1.0.jar \  
    hdfs://hadoop0:8020/user/root/input1 hdfs://hadoop0:8020/user/root/output7  
  
../spark-submit --class "NameList" --master yarn --driver-memory 512m --executor-memory 512m --  
num-executors 2 --deploy-mode cluster /opt/data/simple-project_2.12-1.0.jar \  
    hdfs://master0:8020/user/root/input hdfs://master0:8020/user/root/output7  
  
../spark-submit --class "NameList" --master yarn --driver-memory 512m --executor-memory 512m --  
num-executors 2 --deploy-mode client /opt/data/simple-project_2.12-1.0.jar \  
    hdfs://hadoop0:8020/user/root/input1 hdfs://hadoop0:8020/user/root/output7
```

or using spark-shell

Ensure that `HADOOP_CONF_DIR` or `YARN_CONF_DIR` points to the directory which contains the (client side) configuration files for the Hadoop cluster.

```
./bin/spark-shell --master yarn --deploy-mode client
```

Note --> Application Jar should be in the local file system, In folder is in HDFS and Out should not be present in the HDFS,it will be automatically created.

You can verify the progress of the application using <http://hp.com:8088/cluster>

Click on Cluster-->Application --> accepted

Cluster Metrics																	
Apps Submitted	Apps Pending	Apps Running	Apps Completed	Containers Running	Memory Used	Memory Total	Memory Reserved	Vcores Used	Vcores Total	Vcores Reserved	Active Nodes	Decommissioned Nodes	Lost Nodes	Unhealthy Nodes	Re	N	
3	0	1	2	1	1 GB	8 GB	0 B	1	8	0	1	0	0	0	0	0	
Show 20 ▾ entries																	
ID	User	Name	Application Type	Queue	StartTime	FinishTime	State	FinalStatus	Progress	Tracking URL							
<a href="#">application_1434297324587_0003</a>	root	com.ht.sparks.WordCount	SPARK	default	Sun, 14 Jun 2015 17:55:58 GMT	N/A	ACCEPTED	UNDEFINED	<div style="width: 0%; background-color: #ccc;"></div>	UNASSIGNED							
<a href="#">application_1434297324587_0002</a>	root	com.ht.sparks.WordCount	SPARK	default	Sun, 14 Jun 2015 16:27:58	Sun, 14 Jun 2015 16:30:02	FINISHED	SUCCEEDED	<div style="width: 100%; background-color: #ccc;"></div>	<a href="#">History</a>							

Wait for few moment and verify on Running tab.

## 64 Learning Spark

Cluster Metrics																
Apps Submitted	Apps Pending	Apps Running	Apps Completed	Containers Running	Memory Used	Memory Total	Memory Reserved	VCores Used	VCores Total	VCores Reserved	Active Nodes	Decommissioned Nodes	Lost Nodes	Unhealthy Nodes	Rebo Noc	
3	0	1	2	4	7 GB	8 GB	0 B	4	8	0	1	0	0	0	0	
Show 20 ▾ entries															Search:	
ID	User	Name	Application Type	Queue	StartTime	FinishTime	State	FinalStatus	Progress	Tracking UI						
application_1434297324587_0003	root	com.ht.sparks.WordCount	SPARK	default	Sun, 14 Jun 2015 17:55:58 GMT	N/A	RUNNING	UNDEFINED		ApplicationMa						

Showing 1 to 1 of 1 entries

First Previous 1 Next Last

Click on the Application ID --> Logs

The screenshot shows the Hadoop Cluster UI at [http://hp.com:8088/cluster/app/application\\_1434297324587\\_0003](http://hp.com:8088/cluster/app/application_1434297324587_0003). The left sidebar has sections for Cluster (About, Nodes, Applications, Scheduler), Tools, and a collapsed section. The main area has tabs for Application Overview, Application Metrics, and ApplicationMaster.

**Application Overview:**

User:	root
Name:	com.ht.sparks.WordCount
Application Type:	SPARK
Application Tags:	
State:	RUNNING
FinalStatus:	UNDEFINED
Started:	14-Jun-2015 23:25:58
Elapsed:	3mins, 57sec
Tracking URL:	ApplicationMaster
Diagnostics:	

**Application Metrics:**

Total Resource Preempted:	<memory:0, vCores:0>
Total Number of Non-AM Containers Preempted:	0
Total Number of AM Containers Preempted:	0
Resource Preempted from Current Attempt:	<memory:0, vCores:0>
Number of Non-AM Containers Preempted from Current Attempt:	0
Aggregate Resource Allocation:	701453 MB-seconds, 459 vcore-seconds

**ApplicationMaster:**

Attempt Number	Start Time	Node	Logs
1	14-Jun-2015 23:25:58	hp.com:8042	<a href="#">logs</a>

Logs --> Stderr to get details as follows:

The screenshot shows the Hadoop NodeManager logs page. At the top, there's a navigation bar with back, forward, and refresh buttons, and a URL field showing `hp.com:8042/node/containerlogs/container_1434297324587_0003_01_000001/root`. Below the navigation is the Hadoop logo and the title "Logs for container\_143429732458". On the left, a sidebar menu includes "ResourceManager" (with "RM Home" selected), "NodeManager" (selected), and "Tools". The main content area displays log entries:  
stderr : Total file length is 16271 bytes.  
stdout : Total file length is 0 bytes.

**After sometimes click on Finished, after the console exit the program.**

The screenshot shows the Hadoop Cluster Applications page. At the top, there's a navigation bar with back, forward, and refresh buttons, and a URL field showing `hp.com:8088/cluster/apps/FINISHED`. To the right, it says "Logged in as: [username]". Below the navigation is the Hadoop logo and the title "FINISHED Applications". On the left, a sidebar menu under "Cluster" shows "About", "Nodes", "Applications" (with "FINISHED" selected), and a list of application states: NEW, NEW SAVING, SUBMITTED, ACCEPTED, RUNNING, FINISHED, FAILED, KILLED. The main content area displays "Cluster Metrics" and a table of finished applications. The table has columns: ID, User, Name, Application Type, Queue, StartTime, FinishTime, State, FinalStatus, Progress, and Track UI. One row is highlighted: application\_1434297324587\_0003, root, com.ht.sparks.WordCount, SPARK, default, Sun, 14 Jun 2015 17:55:58, Sun, 14 Jun 2015 18:00:50, FINISHED, SUCCEEDED.

## On the job submit console.

```
2021-01-22 16:36:11,589 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:12,662 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:13,765 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:14,896 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:16,011 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:17,296 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:18,725 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:19,914 INFO yarn.Client: Application report for application_1611331123305_0002 (state: RUNNING)
2021-01-22 16:36:21,041 INFO yarn.Client: Application report for application_1611331123305_0002 (state: FINISHED)
2021-01-22 16:36:21,401 INFO yarn.Client:
    client token: N/A
    diagnostics: N/A
    ApplicationMaster host: hadoop0
    ApplicationMaster RPC port: 38603
    queue: default
    start time: 1611333080086
    final status: SUCCEEDED
    tracking URL: http://hadoop0:8088/proxy/application_1611331123305_0002/
    user: root
2021-01-22 16:36:23,265 INFO util.ShutdownHookManager: Shutdown hook called
2021-01-22 16:36:23,442 INFO util.ShutdownHookManager: Deleting directory /tmp/spark-7b20b446-2b75-4550-9e2d-c84ad6
7c9b3b
2021-01-22 16:36:23,532 INFO util.ShutdownHookManager: Deleting directory /tmp/spark-89770943-febc-4bdb-bf6e-404103
88026d
[root@303b68143644 bin]#
```

You can verify the output file in the hdfs as shown below:

```
#hdfs dfs -ls -R /user/root/output  
#hdfs dfs -cat /user/root/output/part-00000-f9b9bf86-3d82-4341-b167-7a237950c754-  
c000.csv
```

```
[root@hadoop0 opt]# hdfs dfs -ls -R /user/root/output  
-rw-r--r-- 1 root supergroup 0 2021-01-22 16:36 /user/root/output/_SUCCESS  
-rw-r--r-- 1 root supergroup 73 2021-01-22 16:36 /user/root/output/part-00000-f9b9bf86-3d82-4341-b167-7a2  
37950c754-c000.csv  
[root@hadoop0 opt]# hdfs dfs -cat /user/root/output/part-00000-f9b9bf86-3d82-4341-b167-7a237950c754-c000.csv  
firstName,lastName  
Grace,Hopper  
Alan,Turing  
Ada,Lovelace  
Charles,Babbage  
[root@hadoop0 opt]#
```

Great! You have successfully executed spark job in YARN cluster. Let us verify the output now using HDFS browser.

<http://localhost:9870/explorer.html#/>

Click Utilities --> Browse the file system → /user/root/output (Enter in the Directory ) - Go

## Browse Directory

/user/root/output								Go!			
Show 25 entries								Search:			
	Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name			
<input type="checkbox"/>	-rw-r--r--	root	supergroup	0 B	Jan 22 22:06	1	128 MB	_SUCCESS			
<input type="checkbox"/>	-rw-r--r--	root	supergroup	73 B	Jan 22 22:06	1	128 MB	part-00000-f9b9bf86-3d82-4341-b167-7a237950c754-c000.csv			

Showing 1 to 2 of 2 entries

Previous 1 Next

Hadoop, 2021.

**Click on the above mark file.**

## Browse Directory

/tmp/out							Go!
Permission	Owner	Group	Size	Replication	Block Size	Name	
-rw-r--r--	root	supergroup	0 B	3	128 MB	_SUCCESS	
-rw-r--r--	root	supergroup	60.71 KB	3	128 MB	part-00000	
-rw-r--r--	root	supergroup	61.17 KB	3	128 MB	part-00001	
-rw-r--r--	root	supergroup	60.76 KB	3	128 MB	part-00002	
-rw-r--r--	root	supergroup	57.2 KB	3	128 MB	part-00003	

Let us view one of the output. click on part-0001 --> Download.

```
1 (Kakrafoon,,1)
2 (pitifully,1)
3 (mattered,2)
4 (proped,1)
5 (House,2)
6 (bone,8)
7 ("Conceited,1)
8 (afternoon's,1)
9 (screen.,7)
10 (five.,1)
11 (gaping,2)
12 (tents,1)
13 (2~Imports:,1)
14 (envelope,1)
15 (tone.,4)
16 (consideration,,1)
17 (conclusively,3)
18 (activation.,1)
19
```

Congrats!.

----- End of Lab -----

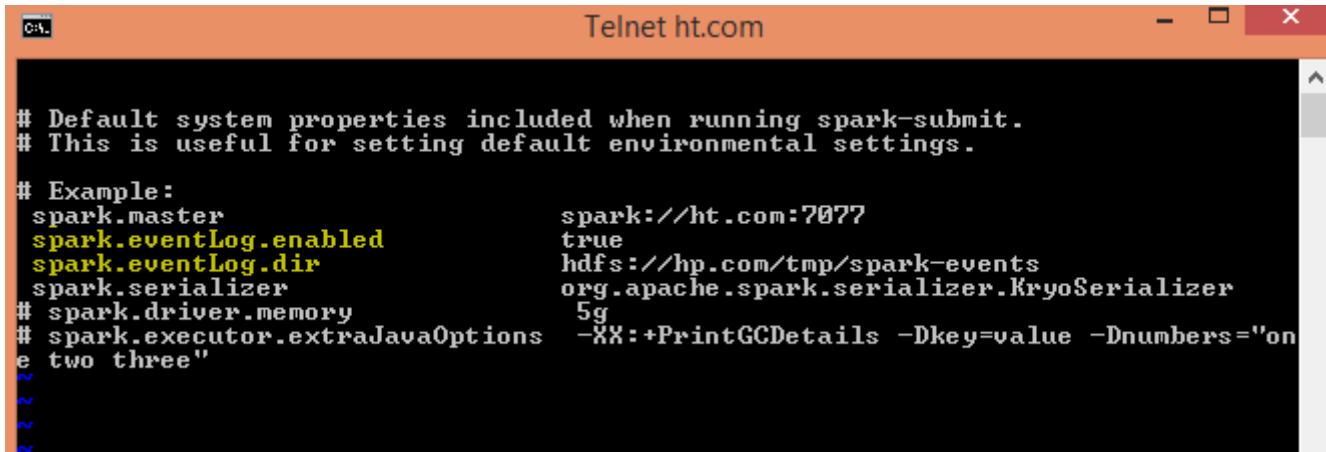
**Errata:**

1) 15/06/14 21:50:46 INFO storage.BlockManagerMasterActor: Registering block manager ht.com:50475 with 267.3 MB RAM, BlockManagerId(<driver>, ht.com, 50475)  
15/06/14 21:50:46 INFO storage.BlockManagerMaster: Registered BlockManager  
Exception in thread "main" java.lang.IllegalArgumentException: Wrong FS:  
file:/tmp/spark-events/application\_1434297324587\_0001.inprogress, expected:  
hdfs://hp.com at org.apache.hadoop.fs.FileSystem.checkPath(FileSystem.java:643)  
at  
org.apache.hadoop.hdfs.DistributedFileSystem.getPathName(DistributedFileSystem.java:191)  
at  
org.apache.hadoop.hdfs.DistributedFileSystem.access\$ooo(DistributedFileSystem.java:102)  
at  
org.apache.hadoop.hdfs.DistributedFileSystem\$22.doCall(DistributedFileSystem.java:1266)  
)  
at  
org.apache.hadoop.hdfs.DistributedFileSystem\$22.doCall(DistributedFileSystem.java:1262)  
)  
at  
org.apache.hadoop.fs.FileSystemLinkResolver.resolve(FileSystemLinkResolver.java:81)  
at  
org.apache.hadoop.hdfs.DistributedFileSystem.setPermission(DistributedFileSystem.java:1262)

at  
org.apache.spark.scheduler.EventLoggingListener.start(EventLoggingListener.scala:128)

```
15/06/14 21:50:46 INFO storage.BlockManagerMasterActor: Registering block manager ht.com:50475 with 267.3 MB RAM, BlockManagerId<<driver>, ht.com, 50475>
15/06/14 21:50:46 INFO storage.BlockManagerMaster: Registered BlockManager
Exception in thread "main" java.lang.IllegalArgumentException: Wrong FS: file:/tmp/spark-events/application_1434297324587_0001.inprogress, expected: hdfs://hp.com
        at org.apache.hadoop.fs.FileSystem.checkPath(FileSystem.java:643)
        at org.apache.hadoop.hdfs.DistributedFileSystem.getPathName(DistributedFileSystem.java:191)
        at org.apache.hadoop.hdfs.DistributedFileSystem.access$000(DistributedFileSystem.java:102)
        at org.apache.hadoop.hdfs.DistributedFileSystem$22.doCall(DistributedFileSystem.java:1266)
        at org.apache.hadoop.hdfs.DistributedFileSystem$22.doCall(DistributedFileSystem.java:1262)
        at org.apache.hadoop.fs.FileSystemLinkResolver.resolve(FileSystemLinkResolver.java:81)
        at org.apache.hadoop.hdfs.DistributedFileSystem.setPermission(DistributedFileSystem.java:1262)
        at org.apache.spark.scheduler.EventLoggingListener.start(EventLoggingListener.scala:128)
        at org.apache.spark.SparkContext.<init>(SparkContext.scala:399)
        at org.apache.spark.api.java.JavaSparkContext.<init>(JavaSparkContext.scala:61)
```

Solution: Verify default configuration of the spark installation. /spark/spark-1.3.0-bin-hadoop2.4/conf/spark-defaults.conf



```
# Default system properties included when running spark-submit.  
# This is useful for setting default environmental settings.  
  
# Example:  
spark.master          spark://ht.com:7077  
spark.eventLog.enabled true  
spark.eventLog.dir    hdfs://hp.com/tmp/spark-events  
spark.serializer      org.apache.spark.serializer.KryoSerializer  
# spark.driver.memory  5g  
# spark.executor.extraJavaOptions -XX:+PrintGCDetails -Dkey=value -Dnumbers="one  
two three"  
  
~  
~  
~
```

Check that spark.eventLog.dir is begin with hdfs:// and the /tmp/spark-events is already created in HDFS system

You can verify on the YARN cluster only.

Verify using : hadoop fs -ls -R /tmp/

```
[root@hp ~]# hadoop fs -ls -R /tmp/
Java HotSpot(TM) Client VM warning: You have loaded library /YARN/hadoop-2.6.0/lib/native/libhadoop.so.1.0.0 which might have disabled stack guard. The VM will try to fix the stack guard now.
It's highly recommended that you fix the library with 'execstack -c <libfile>', or link it with '-z noexecstack'.
15/06/14 22:04:11 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
drwxr-xr-x  - root supergroup          0 2015-06-14 16:25 /tmp/in
-rw-r--r--  1 root supergroup 3629 2015-06-14 16:25 /tmp/in/README.md
drwxr-xr-x  - root supergroup          0 2015-06-14 17:47 /tmp/out
-rw-r--r--  3 root supergroup          0 2015-06-14 17:47 /tmp/out/_SUCCESS
-rw-r--r--  3 root supergroup 1956 2015-06-14 17:47 /tmp/out/part-00000
-rw-r--r--  3 root supergroup 1717 2015-06-14 17:47 /tmp/out/part-00001
drwxr-xr-x  - root supergroup          0 2015-06-14 17:50 /tmp/out1
-rw-r--r--  3 root supergroup          0 2015-06-14 17:50 /tmp/out1/_SUCCESS
-rw-r--r--  3 root supergroup 1956 2015-06-14 17:50 /tmp/out1/part-00000
-rw-r--r--  3 root supergroup 1717 2015-06-14 17:50 /tmp/out1/part-00001
drwxr-xr-x  - root supergroup          0 2015-06-14 17:52 /tmp/out3
-rw-r--r--  3 root supergroup          0 2015-06-14 17:52 /tmp/out3/_SUCCESS
-rw-r--r--  3 root supergroup 1956 2015-06-14 17:52 /tmp/out3/part-00000
-rw-r--r--  3 root supergroup 1717 2015-06-14 17:52 /tmp/out3/part-00001
drwxr-xr-x  - root supergroup          0 2015-06-14 21:59 /tmp/out5
-rw-r--r--  3 root supergroup          0 2015-06-14 21:59 /tmp/out5/_SUCCESS
-rw-r--r--  3 root supergroup 1956 2015-06-14 21:59 /tmp/out5/part-00000
-rw-r--r--  3 root supergroup 1717 2015-06-14 21:59 /tmp/out5/part-00001
drwxr-xr-x  - root supergroup          0 2015-06-14 21:58 /tmp/spark-events
-rw-rw-r--  3 root supergroup 20287 2015-06-14 21:59 /tmp/spark-events/app
lication_1434297324587_0002.inprogress
.......
```

2) 15/06/14 00:41:20 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032

15/06/14 21:58:27 INFO yarn.Client: Application report for application\_1434297324587\_0002 (state: ACCEPTED)

Indefinite loop of above

**Solution:** Ensure that all configuration file are map to appropriate hostname and hostname to ip details are modified in the hosts file , Increase the resources and wait for few minutes to convert the status to running.

**Yarn-site.xml**

yarn.scheduler.minimum-allocation-mb: 256m  
yarn.scheduler.increment-allocation-mb: 256m

```
<property>
<name>yarn.nodemanager.resource.memory-mb</name>
<value>4096</value>
</property>
<property>
<name>yarn.scheduler.minimum-allocation-mb</name>
<value>512</value>
</property>
<property>
<name>yarn.scheduler.increment-allocation-mb</name>
<value>256</value>
</property>
```

**yarn-site.xml** – Spark Node. (Specify the hostname of the Hadoop RM Node as shown below)

```
<property>
  <name>yarn.resourcemanager.hostname</name>
  <value>hadoopo</value>
  <description>The hostname of the RM.</description>
</property>
```

```
<property>
  <name>yarn.resourcemanager.address</name>
  <value>hadoop:8032</value>
  <description>The hostname of the RM.</description>
</property>
```

3) If unhealthy nodes is being displayed in the cluster URL with 1/1 local-dirs are bad:  
/tmp/hadoop-yarn/nm-local-dir;

**Solution:** delete the folder using the following command and ensure that nodes are healthy before proceeding forward, you can restart if require

```
hadoop fs -rm -fr /tmp/hadoop-yarn/*
```

Try the following command:

```
yarn application -list
```

```
yarn application -kill [application name]
```

You can view jps in YARN cluster when spark job is executing. It will start Coarse\* processes.

```
[root@hp ~]# jps
5082 DataNode
9633 CoarseGrainedExecutorBackend
9670 Jps
4980 NameNode
5345 NodeManager
9625 CoarseGrainedExecutorBackend
5029 SecondaryNameNode
9420 ApplicationMaster
5294 ResourceManager
9629 CoarseGrainedExecutorBackend
[root@hp ~]#
```

Even, cluster mode works

```
15/06/14 23:43:46 INFO yarn.Client: Application report for application_143429732
4587_0004 (state: FINISHED)
15/06/14 23:43:46 INFO yarn.Client:
  client token: N/A
  diagnostics: N/A
  ApplicationMaster host: hp.com
  ApplicationMaster RPC port: 0
  queue: default
  start time: 1434305512588
  final status: SUCCEEDED
  tracking URL: http://hp.com:8088/proxy/application_1434297324587_0004/
  user: root
[root@ht spark-1.3.0-bin-hadoop2.4]# ./bin/spark-submit --master yarn-cluster -
--class com.ht.sparks.WordCount --num-executors 3 --executor-cores 1 /spark/Sp
arkWC-0.0.1-SNAPSHOT.jar /tmp/in /tmp/out?
```

Issue:

```
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:08 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 2 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:09 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 3 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:10 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 4 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:11 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 5 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:12 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 6 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:13 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 7 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:14 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 8 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:15 INFO Client: Retrying connect to server: 0.0.0.0/0.0.0.0:8032. Already tried 9 time(s); retry policy is Retry
UpToMaximumCountWithFixedSleep(maxRetries=10, sleepTime=1000 MILLISECONDS)
21/01/23 05:38:15 INFO RetryInvocationHandler: java.net.ConnectException: Your endpoint configuration is wrong; For more details see: http://wiki.apache.org/hadoop/UnsetHostnameOrPort, while invoking ApplicationProtocolPBClientImpl.getClusterMetrics over null after 1 failover attempts. Trying to failover after sleeping for 42760ms.
```

Verify the ip of the resource manager and set the home directory appropriately.  
Try updating the following setting in yarn-site.xml of Hadoop and spark node too..

```
<property>
  <name>yarn.resourcemanager.hostname</name>
  <value>hadoopo</value>
  <description>The hostname of the RM.</description>
</property>
<property>
  <name>yarn.resourcemanager.address</name>
```

```
<value>hadoop:8032</value>
<description>The hostname of the RM.</description>
</property>
```

Error:

Failing this attempt. Diagnostics: [2022-06-18 03:01:08.210]Container  
[pid=1686,containerID=container\_1655521013018\_0001\_02\_000001] is running  
32197120B beyond the 'VIRTUAL' memory limit. Current usage: 198.8 MB of 1 GB physical  
memory used; 2.1 GB of 2.1 GB virtual memory used. Killing container.

Add following property in yarn-site.xml

```
<property>
  <name>yarn.nodemanager.vmem-check-enabled</name>
  <value>false</value>
  <description>Whether virtual memory limits will be enforced for
containers</description>
</property>
<property>
  <name>yarn.nodemanager.vmem-pmem-ratio</name>
  <value>4</value>
  <description>Ratio between virtual memory to physical memory when setting memory
limits for containers</description>
</property>
```

Complete yarn-site.xml

```
<configuration>
  <property>
    <name>yarn.nodemanager.aux-services</name>
    <value>mapreduce_shuffle</value>
  </property>
  <property>
    <name>yarn.nodemanager.env-whitelist</name>
    <value>JAVA_HOME,HADOOP_COMMON_HOME,HADOOP_HDFS_HOME,HADOOP_CONF_DIR,CLASSPATH_PREPEND_DISTCACHE,HADOOP_YARN_HOME,HADOOP_MAPRED_HOME</value>
  </property>
  <property>
    <name>yarn.resourcemanager.hostname</name>
    <value>mastero</value>
    <description>The hostname of the RM.</description>
  </property>
  <property>
    <name>yarn.resourcemanager.address</name>
    <value>mastero:8032</value>
    <description>The hostname of the RM.</description>
```

```
</property>
<property>
<name>yarn.nodemanager.resource.memory-mb</name>
<value>4096</value>
</property>
<property>
<name>yarn.scheduler.minimum-allocation-mb</name>
<value>512</value>
</property>
<property>
<name>yarn.scheduler.increment-allocation-mb</name>
<value>256</value>
</property>
<property>
<name>yarn.nodemanager.vmem-check-enabled</name>
<value>false</value>
<description>Whether virtual memory limits will be enforced for
containers</description>
</property>
<property>
<name>yarn.nodemanager.vmem-pmem-ratio</name>
<value>4</value>
<description>Ratio between virtual memory to physical memory when setting memory
limits for containers</description>
</property>
```

</configuration>

---

**6. Jobs Monitoring : Using Web UI. – 45 Minutes**

Execute the Job as specified in the Spark standalone cluster lab/ Using Docker before proceeding ahead.

Copy the input file in both the nodes, if you are executing on the Standalone cluster.

Or start the Cluster and execute the following jobs:

The file should be in the Executing node.

File names.json contains:

```
{"firstName":"Grace","lastName":"Hopper"}  
 {"firstName":"Alan","lastName":"Turing"}  
 {"firstName":"Ada","lastName":"Lovelace"}  
 {"firstName":"Charles","lastName":"Babbage"}
```

Enter the following commands one at a time.

```
#spark-shell --master spark://spark0:8090  
val ip="/software/names.json"  
val op="/software/nameop"  
spark.sparkContext.setLogLevel("WARN")  
val peopleDF = spark.read.json(ip)  
val namesDF = peopleDF.select("firstName","lastName")
```

```
namesDF.write.option("header","true").csv(op)
```

<http://127.0.0.1:8080>

Click on Application ID → Application Detail UI

Spark shell - Spark Jobs **Application: Spark shell**

ID: app-20201113095544-0006  
**Name:** Spark shell  
**User:** root  
**Cores:** Unlimited (2 granted)  
**Executor Limit:** Unlimited (2 granted)  
**Executor Memory:** 1024.0 MiB  
**Executor Resources:**  
**Submit Date:** 2020/11/13 09:55:44  
**State:** RUNNING  
[Application Detail UI](#)

**Executor Summary (2)**

ExecutorID	Worker	Cores	Memory	Resources	State	Logs
1	worker-20201113080544-172.18.0.2-38441	1	1024		RUNNING	stdout stderr
0	worker-20201113080133-172.18.0.3-46519	1	1024		RUNNING	stdout stderr

Or You can verify the Jobs details Using: <http://master:4040/jobs/>

web UI comes with the following tabs (which may not all be visible at once as they are lazily created on demand, e.g. Streaming tab):

- Jobs
- Stages
- Storage with RDD size and memory use

- Environment
- Executors
- SQL

The **Jobs Tab** shows status of all Spark jobs in a Spark application



Display the timeline of Executor being added in the Job. When the Job Get completed etc. In above, you can verify that 2 executors have been added.

When you hover over a job in Event Timeline not only you see the job legend but also the job is highlighted in the Summary section.

The Event Timeline section shows not only jobs but also executors.

You can verify the completed and failed jobs too:

- Completed Jobs (2)  
Application: Spark shell

Job Id ▲	Description	Submitted	Duration	Stages: Succeeded/Total	Tasks (for all stages): Succeeded/Total
1	json at <console>:25 json at <console>:25	2020/11/13 09:59:47	3 s	1/1	1/1
2	csv at <console>:28 csv at <console>:28	2020/11/13 10:00:55	1 s	1/1	1/1

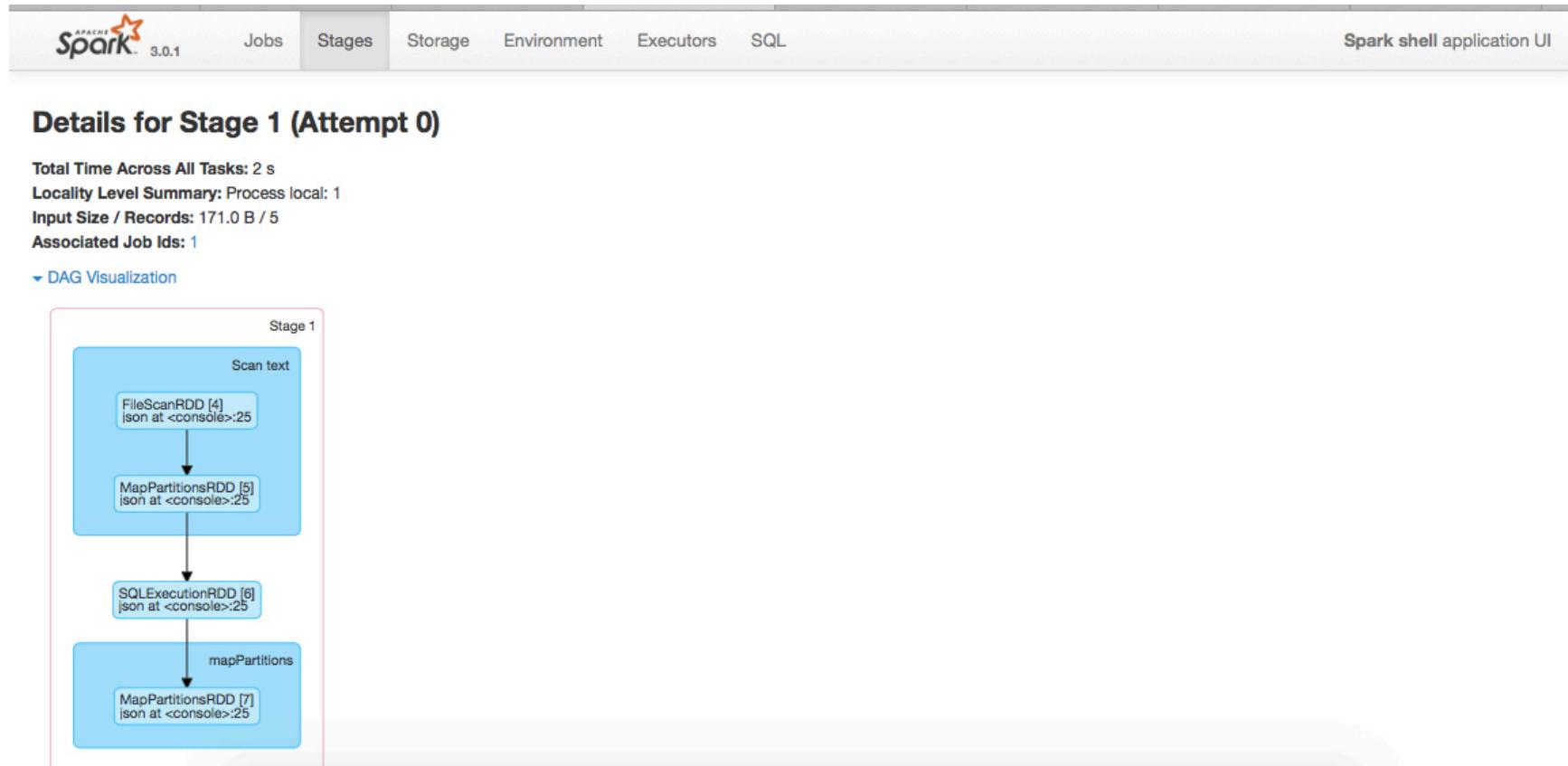
Page: 1 1 Pages. Jump to 1 . Show 100 items in a page. Go

- Failed Jobs (1)

Job Id ▼	Description	Submitted	Duration	Stages: Succeeded/Total	Tasks (for all stages): Succeeded/Total
0	json at <console>:25 json at <console>:25	2020/11/13 09:57:04	3 s	0/1 (1 failed)	0/1 (4 failed)

Page: 1 1 Pages. Jump to 1 . Show 100 items in a page. Go

Click on On job -> for details on Description → stages to view DAG - When you click a job in All Jobs Page page, you see the **Details for Job** page.



It shows the DAG graph and the stage details.



Scroll down to view the task metrics: which task take majority of the time etc. How much byte consume or output by each task and its statistics.

Showing 1 to 1 of 1 entries

Application: Spark shell Tasks by Executor

Show 20 entries Search:

Executor ID	Logs	Address	Task Time	Total Tasks	Failed Tasks	Killed Tasks	Succeeded Tasks	Blacklisted	Input Size / Records
1	stdout stderr	172.18.0.2:41887	3 s	1	0	0	1	false	171 B / 5

Showing 1 to 1 of 1 entries

Tasks (1)

Show 20 entries Search:

Index	Task ID	Attempt	Status	Locality level	Executor ID	Host	Logs	Launch Time	Duration	GC Time	Input Size / Records	Errors
0	4	0	SUCCESS	PROCESS_LOCAL	1	172.18.0.2	stdout stderr	2020-11-13 15:29:47	2 s	68.0 ms	171 B / 5	

## Executors Tab

Stats of each executor, how much time it spends on GC etc. How much data get shuffle?  
 Executors tab in web UI shows

**Summary**

RDD Blocks	Storage Memory	Disk Used	Cores	Active Tasks	Failed Tasks	Complete Tasks	Total Tasks	Task Time (GC Time)	Input	Shuffle Read	Shuffle Write
<b>Active(3)</b> 1	23.4 KB / 1.3 GB	0.0 B	2	0	0	0	0	0 ms (0 ms)	0.0 B	0.0 B	0.0 B
<b>Dead(4)</b> 2	46.8 KB / 1.7 GB	0.0 B	4	0	0	7	7	1.0 min (6 s)	21 KB	0.0 B	0.0 B
<b>Total(7)</b> 3	70.2 KB / 3 GB	0.0 B	6	0	0	7	7	1.0 min (6 s)	21 KB	0.0 B	0.0 B

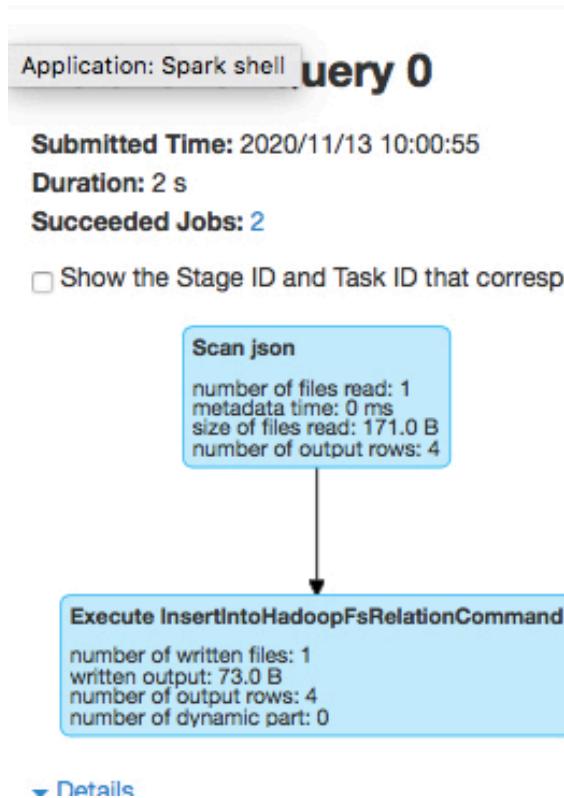
**Executors**

Show 20 ▾ entries

Search: 

Executor ID	Address	Status	RDD Blocks	Storage Memory	Disk Used	Cores	Active Tasks	Failed Tasks	Complete Tasks	Total Tasks	Task Time (GC Time)		Logs	Thread Dump	
											Input	Shuffle Read	Shuffle Write		
driver	192.168.188.173:54112	Active	1	23.4 KB / 434 MB	0.0 B	0	0	0	0	0	0 ms (0 ms)	0.0 B	0.0 B	0.0 B	Thread Dump
0	192.168.188.173:54931	Dead	1	23.4 KB / 434 MB	0.0 B	1	0	0	4	4	37 s (6 s)	9.5 KB	0.0 B	0.0 B	stdout stderr Thread Dump
1	192.168.188.174:34320	Dead	1	23.4 KB / 434 MB	0.0 B	1	0	0	3	3	25 s (0.3 s)	11.5 KB	0.0 B	0.0 B	stdout stderr Thread Dump
2	192.168.188.174:46874	Dead	0	0.0 B / 434 MB	0.0 B	1	0	0	0	0	0 ms (0 ms)	0.0 B	0.0 B	0.0 B	stdout stderr Thread Dump
3	192.168.188.173:34382	Dead	0	0.0 B / 434 MB	0.0 B	1	0	0	0	0	0 ms (0 ms)	0.0 B	0.0 B	0.0 B	stdout stderr Thread Dump
4	192.168.188.174:44548	Active	0	0.0 B / 434 MB	0.0 B	1	0	0	0	0	0 ms (0 ms)	0.0 B	0.0 B	0.0 B	stdout stderr Thread Dump

Click on SQL tab



Verify the plan

```
▼ Details
  Application: Spark shell
  InsertIntoHadoopFsRelationCommand file:/software/nameop, false, CSV, Map(header -> true, path -> /software/nameop), ErrorIfExists, [firstName, lastName]
  +- Project [firstName#14, lastName#15]
    +- Relation[firstName#14,lastName#15] json

  == Analyzed Logical Plan ==

  InsertIntoHadoopFsRelationCommand file:/software/nameop, false, CSV, Map(header -> true, path -> /software/nameop), ErrorIfExists, [firstName, lastName]
  +- Project [firstName#14, lastName#15]
    +- Relation[firstName#14,lastName#15] json

  == Optimized Logical Plan ==
  InsertIntoHadoopFsRelationCommand file:/software/nameop, false, CSV, Map(header -> true, path -> /software/nameop), ErrorIfExists, [firstName, lastName]
  +- Relation[firstName#14,lastName#15] json

  == Physical Plan ==
  Execute InsertIntoHadoopFsRelationCommand file:/software/nameop, false, CSV, Map(header -> true, path -> /software/nameop), ErrorIfExists, [firstName, lastName]
  +- FileScan json [firstName#14,lastName#15] Batched: false, DataFilters: [], Format: JSON, Location: InMemoryFileIndex[file:/software/names.json], PartitionFilters: [], PushedFilters: [],
    ReadSchema: struct<firstName:string,lastName:string>
```

----- Lab Ends Here -----  
--

## 7. Troubleshooting & Tuning– 60 Minutes

Here, you will learn the following:

- Specify job configuration parameters
- Specify the number of partitions
- Verify job details using Spark web UI

The number of cores can be specified with any of the following:

- `--executor-cores` flag when invoking `spark-submit`, `spark-shell`, and `pyspark`
- `spark.executor.cores` property in the `spark-defaults.conf` file
- on a `SparkConf` object.

Similarly, the heap size can be controlled with any of the following parameters:

- `--executor-memory` flag
- `spark.executor.memory` property.

The `cores` property controls the number of concurrent tasks an executor can run.

`--executor-cores 5` means that each executor can run a maximum of five tasks at the same time.

The `--num-executors` command-line flag or `spark.executor.instances` configuration property control the number of executors requested.

Best practice is to avoid setting this property by turning on `dynamic allocation` with the `spark.dynamicAllocation.enabled` property

The relevant YARN properties are:

`yarn.nodemanager.resource.memory-mb` controls the maximum sum of memory used by the containers on each node.

`yarn.nodemanager.resource.cpu-vcores` controls the maximum sum of cores used by the containers on each node.

```
</property>
▼<property>
  <name>yarn.nodemanager.resource.memory-mb</name>
  <value>4096</value>
  <final>false</final>
  <source>yarn-site.xml</source>
</property>
```

```
</property>
▼<property>
  <name>yarn.nodemanager.resource.cpu-vcores</name>
  <value>-1</value>
  <final>false</final>
  <source>yarn-default.xml</source>
</property>
```

YARN may round the requested memory up a little. YARN's `yarn.scheduler.minimum-allocation-mb` and `yarn.scheduler.increment-allocation-mb` properties control the minimum and increment request values respectively.

```
</property>
  <property>
    <name>yarn.scheduler.minimum-allocation-mb</name>
    <value>512</value>
    <final>false</final>
    <source>yarn-site.xml</source>
  </property>
  <property>
    <name>yarn.scheduler.increment-allocation-mb</name>
    <value>256</value>
    <final>false</final>
    <source>yarn-site.xml</source>
  </property>
```

Verify the above setting and note down the value for your cluster.

Let us submit the job specifying the configuration.

You need to upload the input file for executing this program to the HDFS cluster.

```
#hdfs dfs -mkdir /tuneip
#hdfs dfs -copyFromLocal flights20170102.json /tuneip
```

Open a new sparkshell from a terminal

spark-shell

```
#export HADOOP_CONF_DIR=/opt/hadoop/etc/hadoop
```

Only Standalone Mode:

```
# spark-shell --executor-cores 2 --executor-memory 250 --num-executors 2
```

On YARN Mode

```
# spark-shell --master yarn --executor-memory 512mb --executor-cores 2 --num-executors 2
```

```
import org.apache.spark.sql.types._  
import org.apache.spark.sql._  
import org.apache.spark.sql.functions._
```

```
var file = "hdfs://master0/tuneip/flights20170102.json"
```

```
case class Flight(_id: String, dofW: Long, carrier: String, origin: String, dest: String,  
crsdephour: Long, crsdeptime: Double, depdelay: Double, crsarrtime: Double, arrdelay:  
Double, crselapsedtime: Double, dist: Double) extends Serializable
```

```
val df = spark.read.format("json").option("inferSchema", "true").load(file).as[Flight]
```

```
val df2 = df.filter($"depdelay" > 40)
```

```
df2.take(1)
```

```
df2.explain(true)
```

---

```
scala> var file = "hdfs://master0/tuneip/flights20170102.json"
file: String = hdfs://master0/tuneip/flights20170102.json

scala> val df = spark.read.format("json").option("inferSchema", "true").load(file).as[Flight]
df: org.apache.spark.sql.Dataset[Flight] = [_id: string, arrdelay: double ... 10 more fields]

scala> val df2 = df.filter($"depdelay" > 40)
df2: org.apache.spark.sql.Dataset[Flight] = [_id: string, arrdelay: double ... 10 more fields]

scala> df2.take(1)
res0: Array[Flight] = Array(Flight(ATL_BOS_2017-01-02_16_DL_1210,1,DL,ATL,BOS,16,1616.0,68.0,1852.0,49.0,156.0,946.0))
```

```

scala> df2.explain(true)
== Parsed Logical Plan ==
'Filter ('depdelay > 40)
+- Relation[_id#7,arrdelay#8,carrier#9,crsarrtime#10,crsdephour#11L,crsdeptime#12,crselapsedtime#13,depdelay#14,dest#15,dist#16,dofW#17L,origin#18]
json

== Analyzed Logical Plan ==
_id: string, arrdelay: double, carrier: string, crsarrtime: double, crsdephour: bigint, crsdeptime: double, crselapsedtime: double, depdelay: double, dest: string,
dist: double, dofW: bigint, origin: string
Filter (depdelay#14 > cast(40 as double))
+- Relation[_id#7,arrdelay#8,carrier#9,crsarrtime#10,crsdephour#11L,crsdeptime#12,crselapsedtime#13,depdelay#14,dest#15,dist#16,dofW#17L,origin#18]
json

== Optimized Logical Plan ==
Filter (isnotnull(depdelay#14) AND (depdelay#14 > 40.0))
+- Relation[_id#7,arrdelay#8,carrier#9,crsarrtime#10,crsdephour#11L,crsdeptime#12,crselapsedtime#13,depdelay#14,dest#15,dist#16,dofW#17L,origin#18]
json

== Physical Plan ==
*(1) Filter (isnotnull(depdelay#14) AND (depdelay#14 > 40.0))
+- FileScan json
[_id#7,arrdelay#8,carrier#9,crsarrtime#10,crsdephour#11L,crsdeptime#12,crselapsedtime#13,depdelay#14,dest#15,dist#16,dofW#17L,origin#18] Batched:
false, DataFilters: [isnotnull(depdelay#14), (depdelay#14 > 40.0)], Format: JSON, Location: InMemoryFileIndex[hdfs://master0/tunepip/flights20170102.json],
PartitionFilters: [], PushedFilters: [IsNotNull(depdelay), GreaterThan(depdelay,40.0)], ReadSchema:
struct<_id:string,arrdelay:double,carrier:string,crsarrtime:double,crsdephour:bigint,crsdeptime:d...

```

val df3 = df2.groupBy("carrier").count

df3.collect

df3.explain

```
scala> val df3 = df2.groupBy("carrier").count
df3: org.apache.spark.sql.DataFrame = [carrier: string, count: bigint]

scala> df3.collect
res2: Array[org.apache.spark.sql.Row] = Array([UA,2420], [AA,757], [DL,1043], [WN,244])

scala>

scala> df3.explain
== Physical Plan ==
*(2) HashAggregate(keys=[carrier#9], functions=[count(1)])
+- Exchange hashpartitioning(carrier#9, 200), ENSURE_REQUIREMENTS, [id=#49]
  +- *(1) HashAggregate(keys=[carrier#9], functions=[partial_count(1)])
    +- *(1) Project [carrier#9]
      +- *(1) Filter (isnotnull(depdelay#14) AND (depdelay#14 > 40.0))
        +- FileScan json [carrier#9,depdelay#14] Batched: false, DataFilters: [isnotnull(depdelay#14), (depdelay#14 > 40.0)], Format: JSON, Location: InMemoryFileIndex[hdfs://master0/tunepip/flights20170102.json], PartitionFilters: [], PushedFilters: [IsNotNull(depdelay), GreaterThan(depdelay,40.0)], ReadSchema: struct<carrier:string,depdelay:double>

scala>
```

As observe, it has created 200 partitions.  
How many executors? And cores

Apache Spark 3.1.2 Jobs Stages Storage Environment **Executors** SQL Spark shell application U

## Executors

Show Additional Metrics

### Summary

	RDD Blocks	Storage Memory	Disk Used	Cores	Active Tasks	Failed Tasks	Complete Tasks	Total Tasks	Task Time (GC Time)	Input	Shuffle Read	Shuffle Write	Excluded
<b>Active(2)</b>	0	116.4 KiB / 459.6 MiB	0.0 B	2	0	0	205	205	48 s (1 s)	17 MiB	573 B	573 B	0
<b>Dead(0)</b>	0	0.0 B / 0.0 B	0.0 B	0	0	0	0	0	0.0 ms (0.0 ms)	0.0 B	0.0 B	0.0 B	0
<b>Total(2)</b>	0	116.4 KiB / 459.6 MiB	0.0 B	2	0	0	205	205	48 s (1 s)	17 MiB	573 B	573 B	0

### Executors

Show 20 entries Search:

Executor ID	Address	Status	RDD Blocks	Storage Memory	Disk Used	Cores	Active Tasks	Failed Tasks	Complete Tasks	Total Tasks	Task Time (GC Time)	Input	Shuffle Read	Shuffle Write	Logs	Thread Dump
driver	master0.hp.com:33483	Active	0	58.2 KiB / 366.3 MiB	0.0 B	0	0	0	0	0	0.0 ms (0.0 ms)	0.0 B	0.0 B	0.0 B		Thread Dump
1	master0.hp.com:42155	Active	0	58.2 KiB / 93.3 MiB	0.0 B	2	0	0	205	205	48 s (1 s)	17 MiB	573 B	573 B	stdout stderr	Thread Dump

1 Executor and 2 Cores.

Let us reduce the no of partitions

```
spark.conf.set("spark.sql.shuffle.partitions",2)
df2.groupBy("carrier").count.collect
```

```
scala> spark.conf.set("spark.sql.shuffle.partitions",2)

scala> df2.groupBy("carrier").count.collect
res19: Array[org.apache.spark.sql.Row] = Array([WN,244], [DL,1043], [UA,2420], [AA,757])

scala> 
```

### Spark Jobs (?)

User: root  
 Total Uptime: 32 min  
 Scheduling Mode: FIFO  
 Completed Jobs: 6

[Event Timeline](#)

[Completed Jobs \(6\)](#)

Page:

1 Pages. Jump to  . Show  items in a page.

Job Id	Description	Submitted	Duration	Stages: Succeeded/Total	Tasks (for all stages): Succeeded/Total
5	collect at <console>:35 collect at <console>:35	2022/06/18 08:43:46	1 s	2/2	4/4
4	collect at <console>:37 collect at <console>:37	2022/06/18 08:38:04	12 s	3/3	205/205

As shown above, partition has been reduce, hence the number of tasks come down and the duration also decreases.

----- Lab Ends Here -----

**8. Annexure:****Kafka Installation:**

Perform only on the first Node or Sparko container.

Steps to be performed:

- Install Kafka and start it along with producer.

Download Kafka from - <https://kafka.apache.org/downloads>

Install kafka: kafka\_2.13-2.7.0.tgz

```
#tar -xvf kafka_*.tgz -C /opt  
# mv kafka* kafka  
#cd /opt/kafka
```

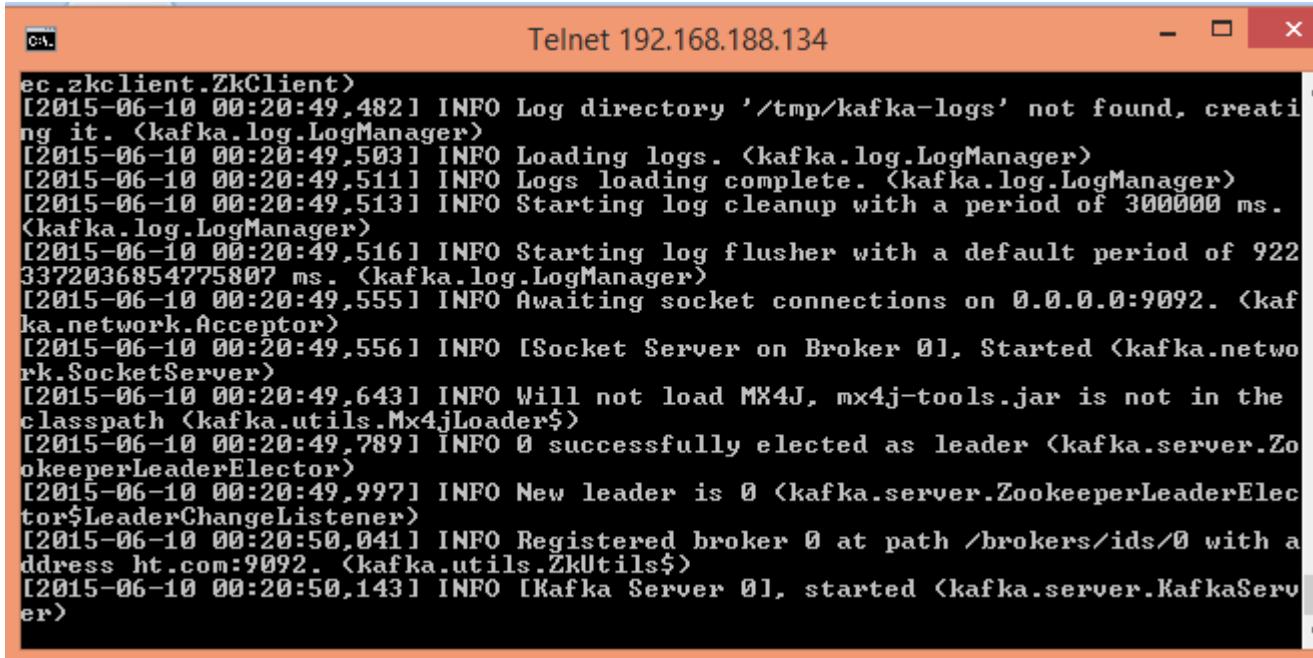
To Start the server, start zookeeper first from a terminal

bin/zookeeper-server-start.sh config/zookeeper.properties

```
[2015-06-10 00:18:38,101] INFO Server environment:java.compiler=(NONE) <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,401] INFO Server environment:os.name=Linux <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,401] INFO Server environment:os.arch=i386 <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,401] INFO Server environment:os.version=2.6.18-164.el5 <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,402] INFO Server environment:user.name=root <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,402] INFO Server environment:user.home=/root <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,402] INFO Server environment:user.dir=/spark/kafka_2.11-0.8.2.1 <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,428] INFO tickTime set to 3000 <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,428] INFO minSessionTimeout set to -1 <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,428] INFO maxSessionTimeout set to -1 <org.apache.zookeeper.server.ZooKeeperServer>
[2015-06-10 00:18:38,515] INFO binding to port 0.0.0.0/0.0.0.0:2181 <org.apache.zookeeper.server.NIOServerCnxnFactory>
```

*Now start the Kafka server on other terminal*

bin/kafka-server-start.sh config/server.properties



The screenshot shows a Telnet session connected to host 192.168.188.134. The window title is "Telnet 192.168.188.134". The log output is as follows:

```
ec.zkclient.ZkClient>
[2015-06-10 00:20:49,482] INFO Log directory '/tmp/kafka-logs' not found, creating it. <kafka.log.LogManager>
[2015-06-10 00:20:49,503] INFO Loading logs. <kafka.log.LogManager>
[2015-06-10 00:20:49,511] INFO Logs loading complete. <kafka.log.LogManager>
[2015-06-10 00:20:49,513] INFO Starting log cleanup with a period of 300000 ms. <kafka.log.LogManager>
[2015-06-10 00:20:49,516] INFO Starting log flusher with a default period of 9223372036854775807 ms. <kafka.log.LogManager>
[2015-06-10 00:20:49,555] INFO Awaiting socket connections on 0.0.0.0:9092. <kafka.network.Acceptor>
[2015-06-10 00:20:49,556] INFO [Socket Server on Broker 0], Started <kafka.network.SocketServer>
[2015-06-10 00:20:49,643] INFO Will not load MX4J, mx4j-tools.jar is not in the classpath <kafka.utils.Mx4jLoader$>
[2015-06-10 00:20:49,789] INFO 0 successfully elected as leader <kafka.server.ZookeeperLeaderElector>
[2015-06-10 00:20:49,997] INFO New leader is 0 <kafka.server.ZookeeperLeaderElector$LeaderChangeListener>
[2015-06-10 00:20:50,041] INFO Registered broker 0 at path /brokers/ids/0 with address ht.com:9092. <kafka.utils.ZkUtils$>
[2015-06-10 00:20:50,143] INFO [Kafka Server 0], started <kafka.server.KafkaServer>
```

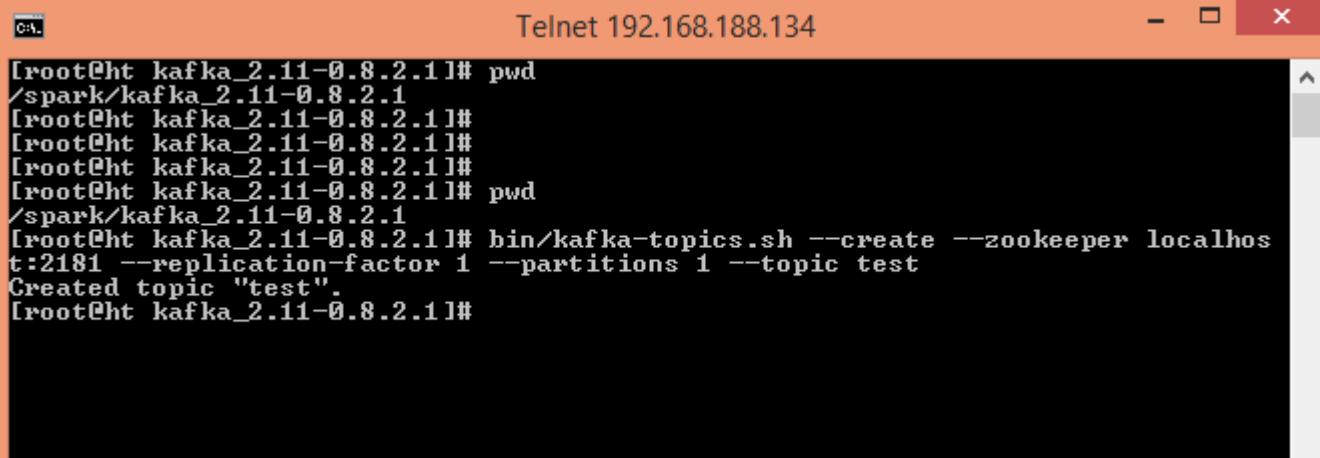
Keep both the console open.

### Create a topic

Let's create a topic named "test" with a single partition and only one replica: Open another terminal

```
# cd /opt/kafka
```

```
#bin/kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic test
```



The screenshot shows a Telnet session with the title 'Telnet 192.168.188.134'. The command entered is:

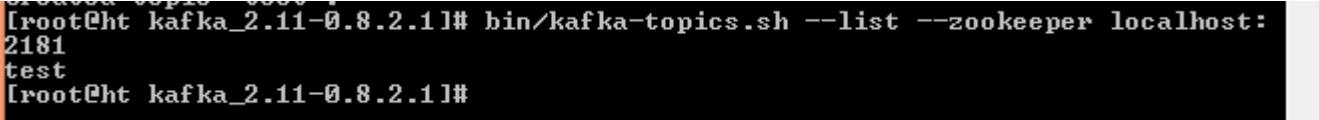
```
[root@ht kafka_2.11-0.8.2.1]# bin/kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic test
```

The output shows the topic 'test' has been created:

```
Created topic "test".
```

We can now see that topic if we run the list topic command:

```
> bin/kafka-topics.sh --list --zookeeper localhost:2181
```



The screenshot shows a terminal window with the command:

```
[root@ht kafka_2.11-0.8.2.1]# bin/kafka-topics.sh --list --zookeeper localhost:2181
```

The output shows the topic 'test' listed:

```
test
```

### Send some messages

// Open a new console, change directory to the kafka installation folder

```
test
[root@ht kafka_2.11-0.8.2.1]# bin/kafka-console-producer.sh --broker-list localhost:9092 --topic test
[2015-06-10 00:25:31,582] WARN Property topic is not valid <kafka.utils.VerifiableProperties>
I am sending a message
```

```
#bin/kafka-console-producer.sh --broker-list localhost:9092 --topic test
```

```
// type some message
```

Start a consumer

// Open a new console, change directory to the kafka installation folder

```
#bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --topic test --from-beginning
```

```
[root@303b68143644 kafka]# bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --topic test --from-beginning
Hello How r u?
```

Try sending some information from the producer to consumer.

The screenshot shows two terminal windows side-by-side. The left terminal window, titled 'kafka\_2.11-0.8.2.1#', displays the command 'bin/kafka-console-producer.sh --broker-list localhost:9092 --topic test'. It outputs a warning about an invalid topic name and then three lines of text: 'I am sending a message', 'Oh its working', and 'ta.txt'. The right terminal window, also titled 'kafka\_2.11-0.8.2.1#', displays the command 'bin/kafka-console-consumer.sh --zookeeper localhost:2181 --topic test --from-beginning'. It also outputs the same three lines of text: 'I am sending a message', 'Oh its working', and 'ta.txt'. Both terminals show a file structure on the right side of their respective panes, including 'ta.txt', '0', 'ls', 'ogs NOTICE', and 'pwd'.

```
[root@ht kafka_2.11-0.8.2.1]# bin/kafka-console-producer.sh --broker-list localhost:9092 --topic test
[2015-06-10 00:25:31.582] WARN Property topic is not valid <kafka.utils.VerifiableProperties>
I am sending a message
Oh its working
ta.txt
0
ls
ogs NOTICE
pwd

[root@ht kafka_2.11-0.8.2.1]# bin/kafka-console-consumer.sh --zookeeper localhost:2181 --topic test --from-beginning
I am sending a message
Oh its working
ta.txt
```

You have successfully configured Kafka.

----- Kafka Installation ends Here -----

Miscellaneous:

Quit Scala CLI :- :q

Error: No suitable device found: no device found for connection 'System etho'.

You could try removing/renaming /etc/udev/rules.d/70-persistent-net.rules and reboot. A new file will be created, sometimes that fixes this kind of problems.

You could also add a file "/etc/sysconfig/network-scripts/ifcfg-eth1", can you bring up eth1 then?

Changing hostname:

- /etc/hosts
- vi /etc/sysconfig/network
- sysctl kernel.hostname=slave
- bash

Unable to start spark shell with the following error

at  
org.apache.hadoop.hive.ql.session.SessionState.createSessionDirs(SessionState.java:554)  
at org.apache.hadoop.hive.ql.session.SessionState.start(SessionState.java:508)  
... 85 more  
Caused by: java.net.ConnectException: Connection refused  
at sun.nio.ch.SocketChannelImpl.checkConnect(Native Method)  
at sun.nio.ch.SocketChannelImpl.finishConnect(SocketChannelImpl.java:717)  
at org.apache.hadoop.net.SocketIOWithTimeout.connect(SocketIOWithTimeout.java:206)

```
at org.apache.hadoop.net.NetUtils.connect(NetUtils.java:531)
at org.apache.hadoop.net.NetUtils.connect(NetUtils.java:495)
at org.apache.hadoop.ipc.Client$Connection.setupConnection(Client.java:614)
at org.apache.hadoop.ipc.Client$Connection.setupIOstreams(Client.java:712)
at org.apache.hadoop.ipc.Client$Connection.access$2900(Client.java:375)
at org.apache.hadoop.ipc.Client.getConnection(Client.java:1528)
at org.apache.hadoop.ipc.Client.call(Client.java:1451)
```

Solution: unset HADOOP\_CONF\_DIR and unset HADOOP\_HOME

<https://jaceklaskowski.gitbooks.io/mastering-apache-spark/>

issue: Cannot assign requested address

17/03/15 21:44:15 ERROR spark.SparkContext: Error initializing SparkContext.  
java.net.BindException: Cannot assign requested address: Service 'sparkDriver' failed after 16 retries (starting from 0)! Consider explicitly setting the appropriate port for the service 'sparkDriver' (for example spark.ui.port for SparkUI) to an available port or increasing spark.port.maxRetries.

```
at sun.nio.ch.Net.bind0(Native Method)
at sun.nio.ch.Net.bind(Net.java:433)
at sun.nio.ch.Net.bind(Net.java:425)
at sun.nio.ch.ServerSocketChannelImpl.bind(ServerSocketChannelImpl.java:223)
```

**Solution:**

- include host to ip entry in /etc/hosts --> 192.168.188.178 master
- update in conf/spark-env.sh
  - SPARK\_LOCAL\_IP=127.0.0.1
  - SPARK\_MASTER\_HOST=192.168.188.178
- comment the following in conf/spark-defaults.conf
  - # spark.master spark://master:7077

Unable to start spark shell:

Caused by: java.io.IOException: Error accessing /opt/jdk/jre/lib/ext/.\_cld\*.jar

Such kind of error resolve by removing all the hidden file. .\*(You can determine the file by running #ls -alt). List all the hidden dot file and remove it.

Yum repo config

```
# mkdir -p /redhatimg  
# mount -o loop,ro /mnt/hgfs/MyExperiment/rhel-server-6.4-x86_64-dvd.iso /redhatimg
```

Create an entry in /etc/fstab so that the system always mounts the DVD image after a reboot.

```
/mnt/hgfs/MyExperiment/rhel-server-6.4-x86_64-dvd.iso /redhatimg iso9660 loop,ro o o
```

/etc/yum.repos.d/rheldiso.repo

```
[rhel6dvdiso]
name=RedHatOS DVD ISO
mediaid=1359576196.686790
baseurl=file:///redhatimg
enabled=1
gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-redhat-release
```

## Scala IDE

Download Scala Eclipse or install scala plugin from Eclipse Marketplace.

Eclipse IDE - [Eclipse IDE for Enterprise Java Developers](#)

<https://www.eclipse.org/downloads/packages/>

Scala IDE for Eclipse is best installed (and updated) directly from within Eclipse.

<http://download.scala-ide.org/sdk/lithium/e47/scala212/stable/site>

This is done by using **Help** → **Install New Software...**, add the **Add...** button in the dialog.

Choose a name for the update site (Scala IDE is an obvious choice). Then read the next section to select which version you will install.

Available Software

Check the items that you wish to install.

Work with: [Scala IDE - http://download.scala-ide.org/sdk/lithium/e47/scala212/stable/site](http://download.scala-ide.org/sdk/lithium/e47/scala212/stable/site)

Pending...

**Scala IDE for Eclipse**

- Scala 2.12.3
- Scala IDE for Eclipse
- zinc 1.0.0

3 items selected

Details

Work with: [Scala IDE - http://download.scala-ide.org/sdk/lithium/e47/scala212/stable/site](http://download.scala-ide.org/sdk/lithium/e47/scala212/stable/site)

Pending...

**Scala IDE for Eclipse**

- Scala 2.12.3
- Scala IDE for Eclipse
- zinc 1.0.0

3 items selected

Details

<http://scala-ide.org/download/current.html>

Or Download IDE

<http://scala-ide.org/download/sdk.html>

Download Latest Spark : Specify in the first Lab.

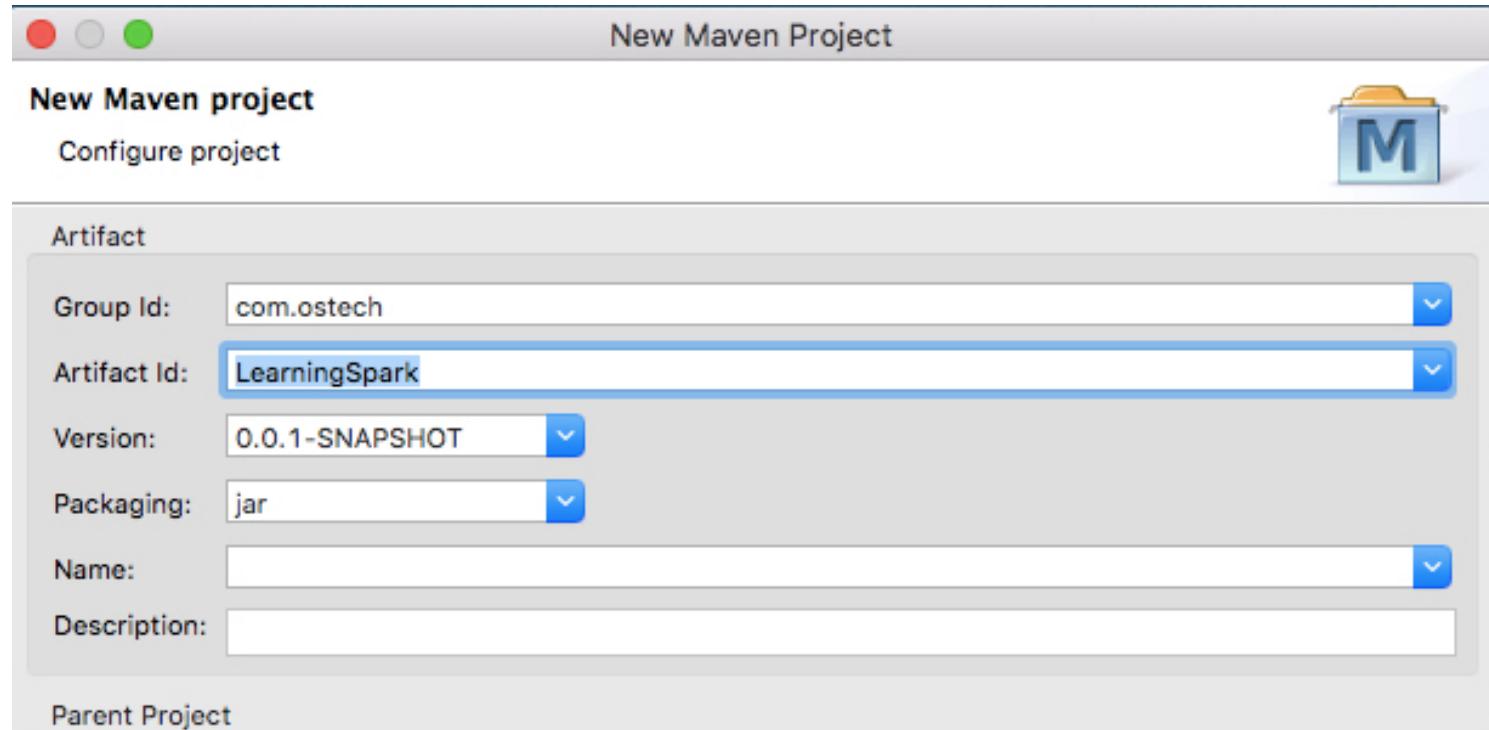
[<https://spark.apache.org/downloads.html>].

Add Spark Libraries

Go to **Java Build Path**, and add all the jars present under `scala-n.n.n-bin-hadoopN.N/jars/`.

Create a simple maven project:

Com.ostechnix:LearningSpark



Adding packages in Zeppelin

If using zeppelin, configure the following in the Interpreter.

spark.jars.packages

org.apache.spark:spark-streaming-kafka-0.10\_2.12;3.0.1

Comma-separated list of Maven coordinates of jars to include on the driver and executor classpaths. The coordinates should be groupId:artifactId:version. If spark.jars.ivySettings is given artifacts will be resolved according to the configuration in the file, otherwise artifacts will be searched for in the local maven repo, then maven central and finally any additional remote repositories given by the command-line option --repositories.