Apache Spark

Setting up Apache Spark cluster of N=3 nodes in standalone mode

Pre-Setup:

- Setting up ubuntu 14.04.5 on all the three nodes having same user name
- Editing the /etc/hostname on one pc as “master” and other two as “worker1”, “worker2”
  - Making appropriate changes in /etc/hosts and instead of binding the hostname to 127.0.1.1 bind it to actual ip.

Supporting screenshots

```
ubuntu@master: ~
ubuntu@master:~$ cat /etc/hosts
127.0.0.1       localhost
172.50.89.95       master

# The following lines are desirable for IPv6 capable hosts
::1     ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ubuntu@master:~$
```

/etc/hosts on master also see the changes done to replace 127.0.1.1 by actual ip

```
ubuntu@worker1:~$ cat /etc/hosts
127.0.0.1       localhost
172.50.89.94    worker1

# The following lines are desirable for IPv6 capable hosts
::1     ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ubuntu@worker1:~$
```

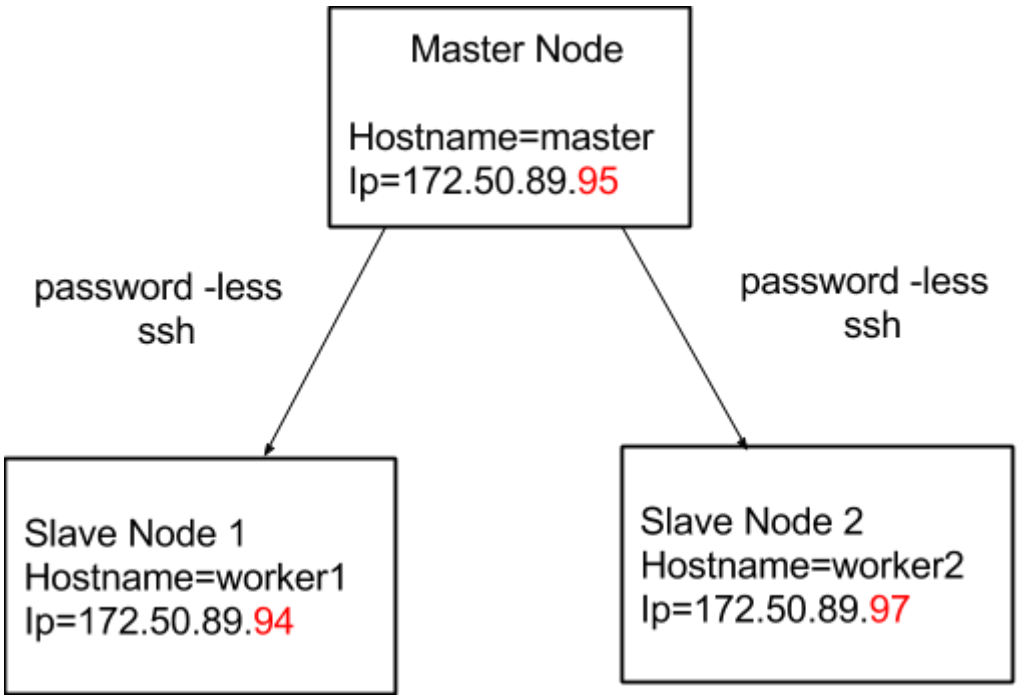
/etc/hosts on worker1

```
ubuntu@worker2:~$ cat /etc/hosts
127.0.0.1       localhost
172.50.89.97    worker2

# The following lines are desirable for IPv6 capable hosts
::1     ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ubuntu@worker2:~$
```

/etc/hosts on worker2

Architecture of cluster

Ip address	Status(Master or Worker)
172.50.89.95	Master and Worker
172.50.89.94	Worker1
172.50.89.97	Worker2



Now to install spark on all the nodes run the install.sh script on all nodes with sudo permissions

➢**sudo sh install.sh**

It will install **spark** (version-2.0.0), **jdk7**, **scala** (version-2.11.7), and also sets up path as required

Now for password-less ssh so that master and worker can communicate easily.In order to start worker services and interact with workers, mater node should have login access to worker nodes.Generate private SSH key on master node and add the same to workers node.

Go into the home directory of master

➢**ssh-keygen**

➢**ssh-copy-id -i ~/.ssh/id_rsa.pub 172.50.89.94**

(on prompting enter worker1 password)

➢**ssh-copy-id -i ~/.ssh/id_rsa.pub 172.50.89.97**

(on prompting enter worker2 password)

➢**cat ~/.ssh/id_rsa.pub >> ~/.ssh/.authorized_keys**

Supporting screenshots

```
ubuntu@master:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/ubuntu/.ssh/id_rsa):
/home/ubuntu/.ssh/id_rsa already exists.
Overwrite (y/n)? y
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/ubuntu/.ssh/id_rsa.
Your public key has been saved in /home/ubuntu/.ssh/id_rsa.pub.
The key fingerprint is:
0e:26:86:7d:d9:77:11:46:d2:9b:a5:f6:a7:40:ed:de ubuntu@master
The key's randomart image is:
+--[ RSA 2048]----+
|          .o+    |
|           o...  |
|            .*   |
|   o   o    *..  |
|  . + = S .o.o   |
|   . + o . .. o .|
|        .    o + |
|              o E|
|                 |
+-----------------+
ubuntu@master:~$
```

Ssh-keygen on master

```
ubuntu@master:~$ cd ~/.ssh/
ubuntu@master:~/.ssh$ ssh-copy-id -i ./id_rsa.pub 172.50.89.94
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter
out any that are already installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt
ed now it is to install the new keys
ubuntu@172.50.89.94's password:

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh '172.50.89.94'"
and check to make sure that only the key(s) you wanted were added.

ubuntu@master:~/.ssh$
```

ssh-copy-id -i ~/.ssh/id_rsa.pub 172.50.89.94

```
ubuntu@master:~/.ssh$ ssh-copy-id -i ./id_rsa.pub 172.50.89.97
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter
out any that are already installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt
ed now it is to install the new keys
Agent admitted failure to sign using the key.
ubuntu@172.50.89.97's password:

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh '172.50.89.97'"
and check to make sure that only the key(s) you wanted were added.

ubuntu@master:~/.ssh$
```

ssh-copy-id -i ~/.ssh/id_rsa.pub 172.50.89.97

```
ubuntu@master:~$ ssh 172.50.89.94
Welcome to Ubuntu 14.04.5 LTS (GNU/Linux 4.4.0-38-generic x86_64)

 * Documentation:  https://help.ubuntu.com/

17 packages can be updated.
14 updates are security updates.

New release '16.04.1 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

Your Hardware Enablement Stack (HWE) is supported until April 2019.
Last login: Sat Oct  8 11:37:39 2016 from 172.50.89.95
ubuntu@worker1:~$
```

Test to login to worker1 without password

Now we update some conf files on master to make our cluster run as standalone cluster

Goto /usr/local/spark/conf

➢**cd /usr/local/spark/conf**

➢ **cp slaves.template slaves**

➢ **sudo nano slaves**

In this file add

localhost

172.50.89.94

172.50.89.97

Now edit spark-env.sh

➢ **cp spark-env.sh.template spark-env.sh**

➢ **sudo nano spark-env.sh**

(you can use spark-env.sh.template file to edit)

In this file add

SPARK_WORKER_INSTANCES=2

SPARK_MASTER_IP=172.50.89.95

SPARK_LOCAL_IP=172.50.88.95 # This ip should be corresponding to each node.

(In order to start N number of worker instances we need to update spark-env.sh file)

Now edit spark-env.sh in each of worker nodes

➢ **cp spark-env.sh.template spark-env.sh**

➢ **sudo nano spark-env.sh**

(you can use spark-env.sh.template file to edit)

In this file add

SPARK_WORKER_INSTANCES=2

SPARK_MASTER_IP=172.50.89.95

SPARK_LOCAL_IP=172.50.88.94 # This ip should be corresponding to each node.

Spark comes with inbuilt scripts to start

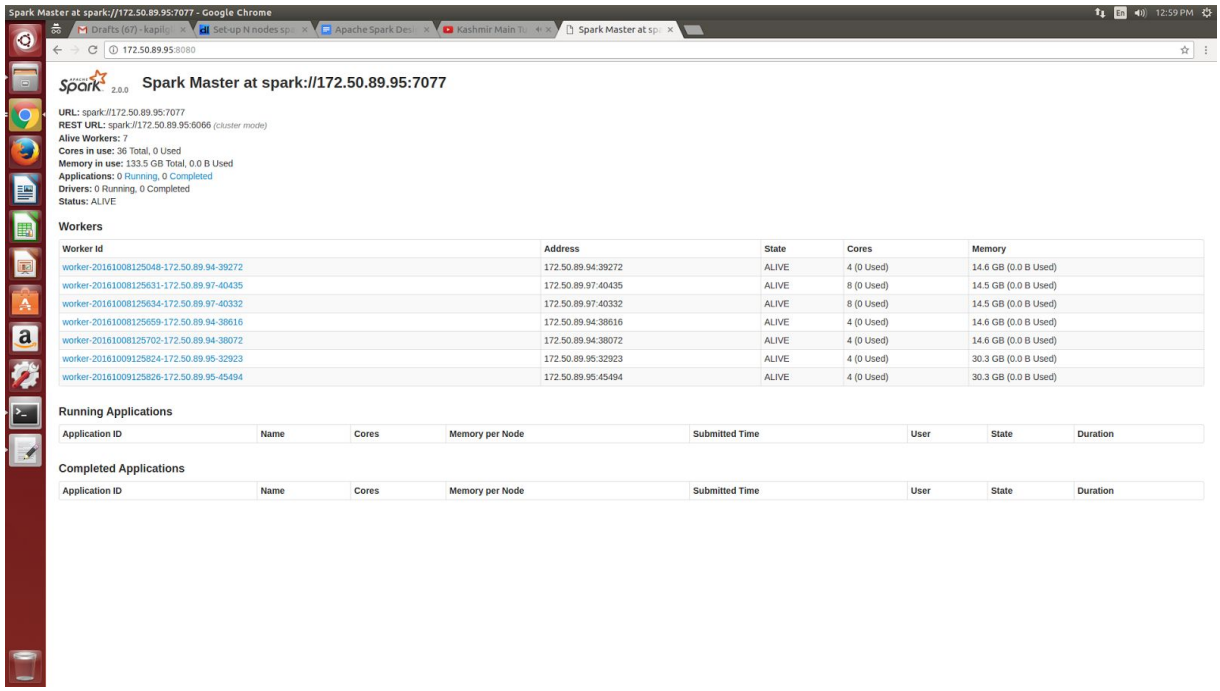
Just go to sbin directory on master and start

➢ **cd /usr/local/spark/sbin**

➢**./start-all.sh**

```
ubuntu@master:/usr/local/spark/sbin$ ./start-all.sh
starting org.apache.spark.deploy.master.Master, logging to /usr/local/spark/logs
/spark-ubuntu-org.apache.spark.deploy.master.Master-1-master.out
localhost: starting org.apache.spark.deploy.worker.Worker, logging to /usr/local
/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-1-master.out
172.50.89.94: starting org.apache.spark.deploy.worker.Worker, logging to /usr/lo
cal/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-1-worker1.out
172.50.89.97: starting org.apache.spark.deploy.worker.Worker, logging to /usr/lo
cal/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-1-worker2.out
localhost: starting org.apache.spark.deploy.worker.Worker, logging to /usr/local
/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-2-master.out
172.50.89.94: starting org.apache.spark.deploy.worker.Worker, logging to /usr/lo
cal/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-2-worker1.out
172.50.89.97: starting org.apache.spark.deploy.worker.Worker, logging to /usr/lo
cal/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-2-worker2.out
172.50.89.94: starting org.apache.spark.deploy.worker.Worker, logging to /usr/lo
cal/spark/logs/spark-ubuntu-org.apache.spark.deploy.worker.Worker-3-worker1.out
ubuntu@master:/usr/local/spark/sbin$ jps
8936 Jps
8621 Master
8773 Worker
8850 Worker
ubuntu@master:/usr/local/spark/sbin$
```

We can see it on web gui also
172.50.89.95:8080



Now to run our search-query

spark-submit --master spark://172.50.89.95:7077 <python file> <input-folder> <query-file>

➢**spark-submit --master spark://172.50.89.95:7077 spark.py raw.en query**

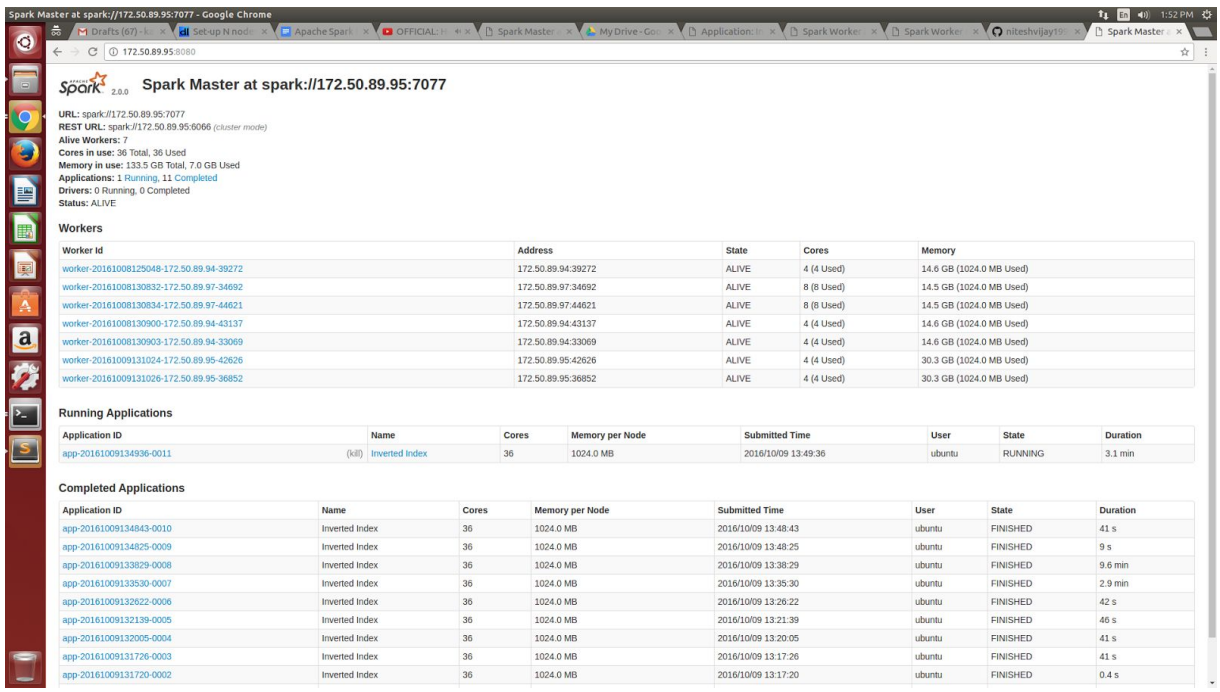
Currently our cluster supports only single word search and returns no. of hits it received of that particular word in that text file.

```
ubuntu@master:~$ spark-submit --master spark://172.50.89.95:7077 spark.py raw.en query

16/10/09 13:35:29 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes
16/10/09 13:35:30 WARN SparkConf:
SPARK_WORKER_INSTANCES was detected (set to '2').
This is deprecated in Spark 1.0+.

Please instead use:
 - ./spark-submit with --num-executors to specify the number of executors
 - Or set SPARK_EXECUTOR_INSTANCES
 - spark.executor.instances to configure the number of instances in the spark config.

Time to build inverted index is 1.41080093384
[Stage 0:>                                                          (0 + 2) / 2]
```

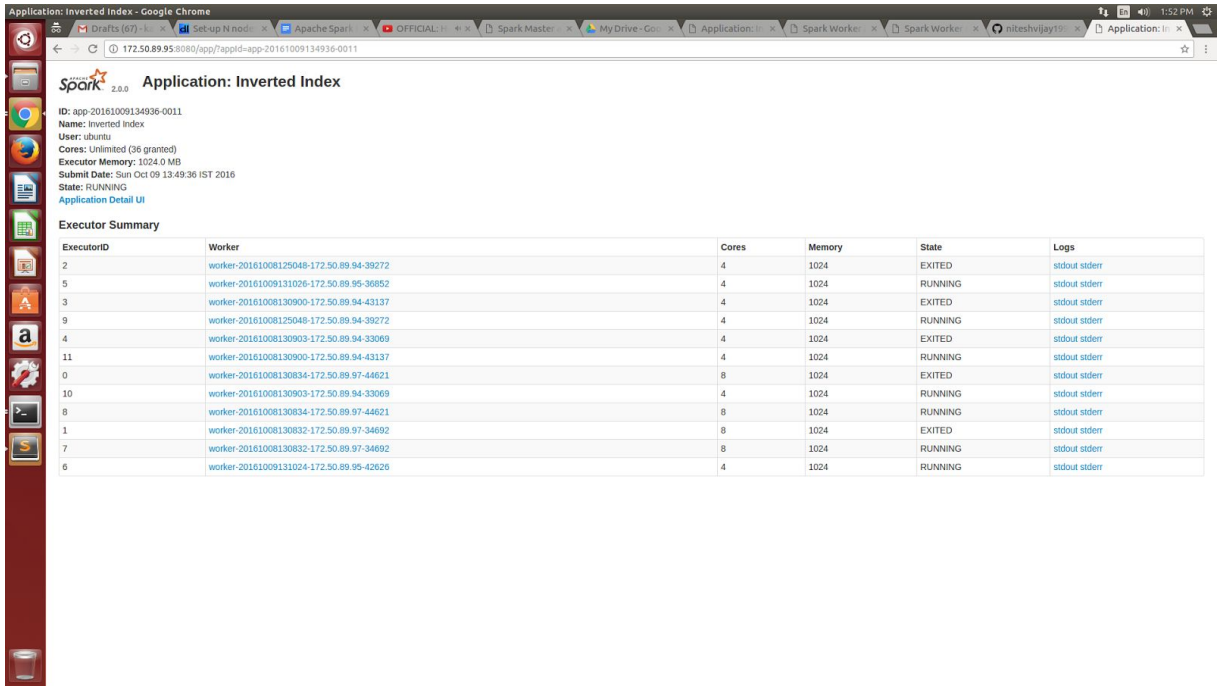
Time to build whole inverted index is 1.4108 sec
And then system comes to halt.

So it was built again with only three docs from original corpus and ran again with same set of queries .

➢**spark-submit --master spark://172.50.89.95:7077 spark.py corpus query** > output
Time to build inverted index was 0.568 secs

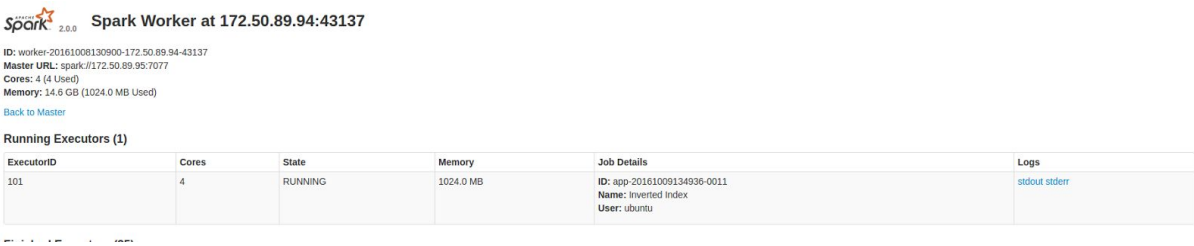


Web gui when our app is running
It shows all the instances and the apps running.



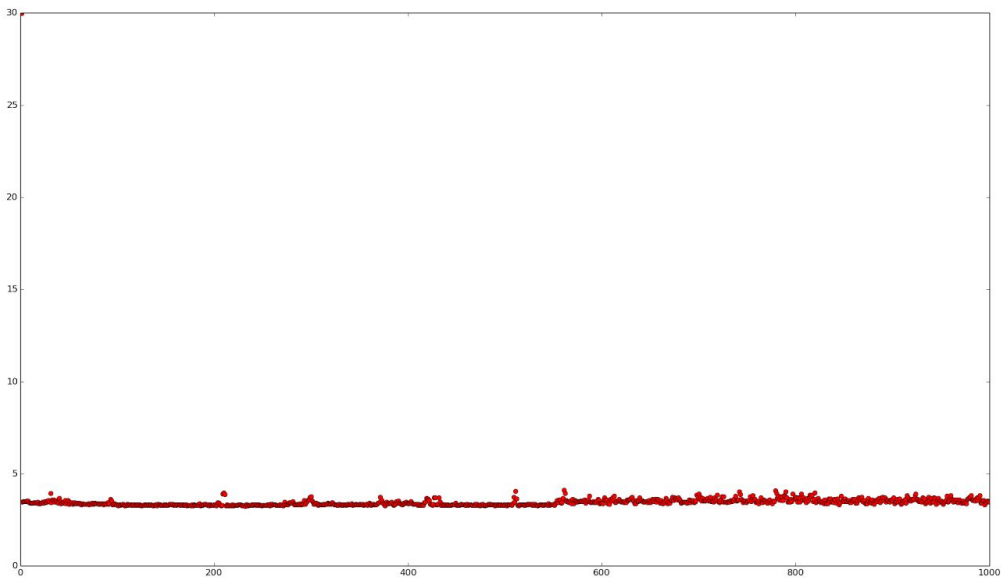
ExecutorID	Worker	Cores	Memory	State	Logs
2	worker-20161008125048-172.50.89.94-39272	4	1024	EXITED	stdout stderr
5	worker-20161009131026-172.50.89.95-36852	4	1024	RUNNING	stdout stderr
3	worker-20161008130900-172.50.89.94-43137	4	1024	EXITED	stdout stderr
9	worker-20161008125048-172.50.89.94-39272	4	1024	RUNNING	stdout stderr
4	worker-20161008130903-172.50.89.94-33069	4	1024	EXITED	stdout stderr
11	worker-20161008130900-172.50.89.94-43137	4	1024	RUNNING	stdout stderr
0	worker-20161008130834-172.50.89.97-44621	8	1024	EXITED	stdout stderr
10	worker-20161008130903-172.50.89.94-33069	4	1024	RUNNING	stdout stderr
8	worker-20161008130834-172.50.89.97-44621	8	1024	RUNNING	stdout stderr
1	worker-20161008130832-172.50.89.97-34692	8	1024	EXITED	stdout stderr
7	worker-20161008130832-172.50.89.97-34692	8	1024	RUNNING	stdout stderr
6	worker-20161009131024-172.50.89.95-42626	4	1024	RUNNING	stdout stderr

Provides info about our running app like which instance is using how much memory, its status etc



ExecutorID	Cores	State	Memory	Job Details	Logs
101	4	RUNNING	1024.0 MB	ID: app-20161009134936-0011 Name: Inverted Index User: ubuntu	stdout stderr

Tells specifically about each instances running on each node. We can see logs also from here.



Graph generated by running 1000 queries

In the directory along wih install.sh, spark.py , the query file and output got by running it for corpus of three docs is also included.

**********THANK YOU**********