# Interacting with Apache Spark

In this document we are going to review:

I. Spark cluster resources and Web UIs
II. Login Spark Cluster
III. HDFS
IV. Interact with Spark interactively with a Shell
V. Test Spark on a Self-Contained application
    a. Local mode
    b. Yarn Resource Manager
    c. Standalone Resource Manager
VI. Interact with Apache Spark by using Jypiter Notebooks

## Spark cluster resources

**Architecture**

- node1 : HDFS NameNode + Spark Master + Anaconda + Jupyter
- node2 : YARN ResourceManager + JobHistoryServer + ProxyServer
- node3 : HDFS DataNode + YARN NodeManager + Spark Slave
- node4 : HDFS DataNode + YARN NodeManager + Spark Slave

**Web UIs**: You can check the following URLs to monitor your work

- NameNode (http://10.211.55.101:50070/dfshealth.html): Tells you information about hadoop filesystem
- ResourceManager (http://10.211.55.102:8088/cluster): Tells you information about the jobs submitted to the Hadoop Cluster by using Yarn
- Spark (http://10.211.55.101:8080): Tells you information about the jobs submitted to Spark in standalone mode.
- Spark History (http://10.211.55.101:18080)
- Jupyter Notebook (http://10.211.55.101:8888)

## Login into Spark Cluster

**Users will mainly log into node 1 as a root user:**

>> vagrant ssh node-1
>> sudo su

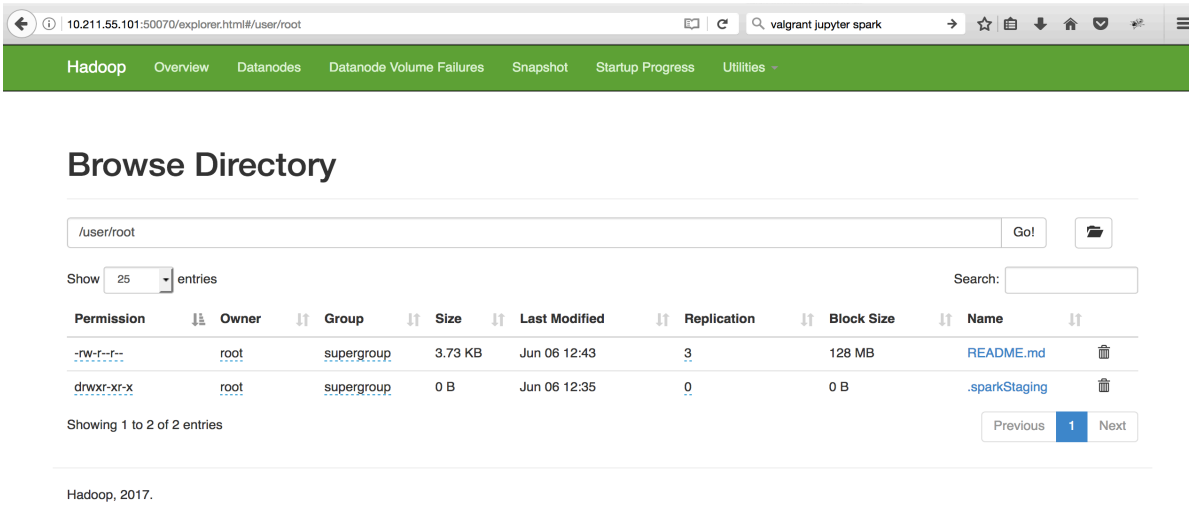
## HDFS

### Storing a file into HDFS file system

Type the following command to store a file ( /usr/local/README.md) file into HDFS file system. We will use this file later for testing spark.

```
>>hdfs dfs –put /usr/local/README.md README.md
```

Check the file in the **NameNode UI**→ In (Utilities / Browse Directory) → you will be able to see this file now in your /user/root/ directory.




## Interact with Spark interactively with a Shell

Type the following command to start a PySpark Shell.

```
>> $SPARK_HOME/bin/pyspark
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 2.1.1
      /_/

Using Python version 3.6.1 (default, May 11 2017 13:09:58)
SparkSession available as 'spark'.
>>>
```

Type the following commands in your PySpark shell

```
>> textFile = sc.textFile("README.md")
>> textFile.first()
'# Apache Spark'
>> linesWithSpark = textFile.filter(lambda line: "Spark" in line)
>> textFile.filter(lambda line: "Spark" in line).count()  # How many
lines contain "Spark"?
20
>> textFile.map(lambda line: len(line.split())).reduce(lambda a, b:
a if (a > b) else b)
22
>> wordCounts = textFile.flatMap(lambda line:
line.split()).map(lambda word: (word, 1)).reduceByKey(lambda a, b:
a+b)
>> wordCounts.collect()
[('#', 1), ('Apache', 1), ('Spark', 16), ('is', 6), ('a', 8),
('fast', 1), ('and', 9), ('general', 3), ('cluster', 2), ……
('contributing', 1), ('project.', 1)]
>> linesWithSpark.cache()
PythonRDD[10] at RDD at PythonRDD.scala:48
>> linesWithSpark.count()
20
>> exit()
```

## Test Spark on a Self-Contained application

Lets write our first self-contained application using the Spark API in Python. Copy the following lines into a script called SimpleApp.py

```
---------------------------------------------------------------------
"""SimpleApp.py"""
from pyspark import SparkContext

logFile = "README.md"  # Should be some file on your system
sc = SparkContext("local", "Simple App")
textFile = sc.textFile(logFile)

wordCounts = textFile.flatMap(lambda line:
line.split()).map(lambda word: (word, 1)).reduceByKey(lambda
a, b: a+b)
wordCounts.collect()

sc.stop()
```

For submitting the application to the Spark Cluser, you will need to se the spark-submit command**:**

```
./bin/spark-submit \   --class <main-class> \   --master <master-url> \   --deploy-mode <deploy-mode> \   --conf <key>=<value> \   ... # other options   <application-jar> \   [application-arguments]
```

This command takes care of setting up the classpath with Spark and its dependencies, and can support different cluster managers and deploy modes that Spark supports:

- `--class`: The entry point for your application (e.g. `org.apache.spark.examples.SparkPi`)
- `--master`: The master URL for the cluster (e.g. `spark://node1:7077, yarn-cluster, local`)
- `--deploy-mode`: Whether to deploy your driver on the worker nodes (`cluster`) or locally as an external client (`client`)
- `--conf`: Arbitrary Spark configuration property in key=value format. For values that contain spaces wrap "key=value" in quotes (as shown).
- `application-jar`: Path to a bundled jar including your application and all dependencies. The URL must be globally visible inside of your cluster, for instance, an `hdfs://` path or a `file://` path that is present on all nodes.
- `application-arguments`: Arguments passed to the main method of your main class, if any

**Launching SimpleApp.py on local mode with 2 cores**

```
>> $SPARK_HOME/bin/spark-submit --master local[2] SimpleApp.py
```

**Launching SimpleApp.py on Standalone mode**

```
>> $SPARK_HOME/bin/spark-submit --master spark://node1:7077 SimpleApp.py
```

**Launching SimpleApp.py on YARN**

```
>> $SPARK_HOME/bin/spark-submit --master yarn-cluster SimpleApp.py
```

A good Spark example to checkout your Spark cluster instance is the SparkPi example. (Note: the source code of this example is located in "/usr/local/spark/examples/src/main/scala/org/apache/spark/examples/SparkPi.scala")

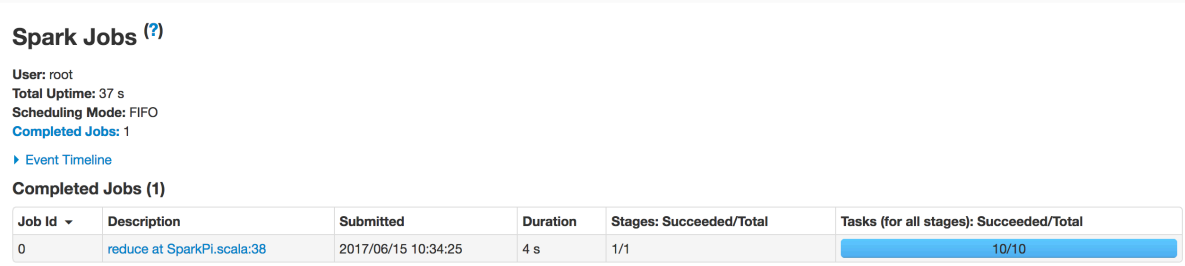
**Testing SparkPi on YARN**

```
>> $SPARK_HOME/bin/spark-submit --class org.apache.spark.examples.SparkPi --master yarn-cluster --num-executors 10 --executor-cores 2 $SPARK_HOME/examples/jars/spark-examples_2.11-2.1.1.jar 10
```

Check the **Resource Manager UI** to see if the job status: running/finished/failed

| application_1496748187136_0004 | root | org.apache.spark.examples.SparkPi | SPARK | default | 0 | Tue Jun 6 14:07:09 +0100 2017 | Tue Jun 6 14:07:56 +0100 2017 | FINISHED | SUCCEEDED | N |
|---|---|---|---|---|---|---|---|---|---|---|

Check the **Spark History UI** and select the application that you just submitted. See the options available (e.g. Event TimeLine, DAG visulizations).




## Test SparkPi on Standalone mode

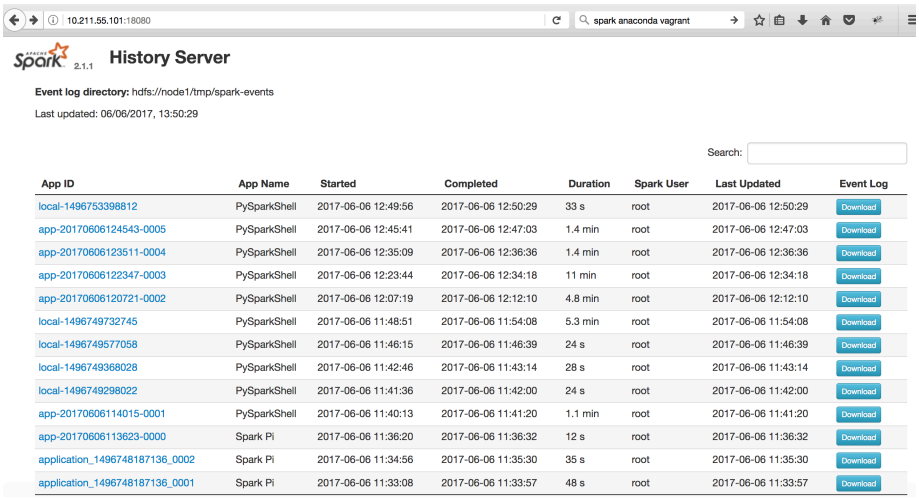
```
>> $SPARK_HOME/bin/spark-submit --class
org.apache.spark.examples.SparkPi --master spark://node1:7077 --num-
executors 10 --executor-cores 1 $SPARK_HOME/examples/jars/spark-
examples_2.11-2.1.1.jar 10
```

If you check the **Resource Manager UI**, you will see we didn't get any new entry. This is because we didn't use the YARN-Hadoop cluster to submit the job. However, if you check the **Spark History UI**, you will see a new entry.

## Test SparkPi on local mode

```
>> $SPARK_HOME/bin/spark-submit --class
org.apache.spark.examples.SparkPi --master local --num-executors 10 -
-executor-cores 1 $SPARK_HOME/examples/jars/spark-examples_2.11-
2.1.1.jar 10
```

Check the Spark History UI



**Curiosities**:
local-XXXX → Application submitted locally
app-XXXX -> Application submitted with the standalone cluster
application_xxxxx → Application submitted with YARN

Select a job, an explore the different information available (e.g DAG, Event TimeLine, Stages, etc.)

## Test Spark on a Jupyter Notebooks

Three environment variables need particular values to be able to work with Jupyter and Notebooks:

```
PYSPARK_PYTHON=/usr/local/anaconda/bin/python3.6

PYSPARK_DRIVER_PYTHON=jupyter

PYSPARK_DRIVER_PYTHON_OPTS="notebook --ip=0.0.0.0 --allow-root"
/usr/local/spark/bin/pyspark
```

We have already a script called **start_Jupyter_local.sh** `in /home/vagrant/notebooks`

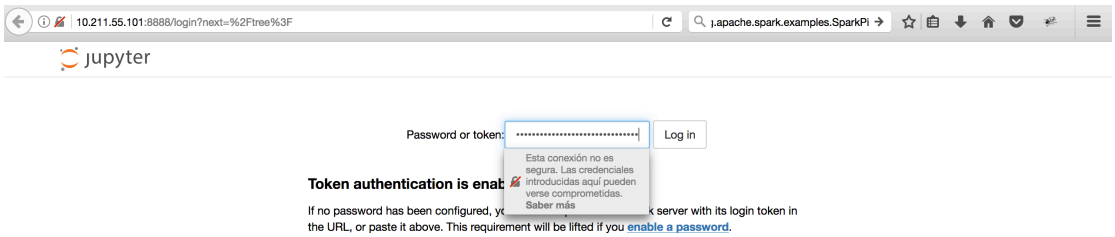
```
>> cd notebooks

>> ./start_jupyter_local.sh
```

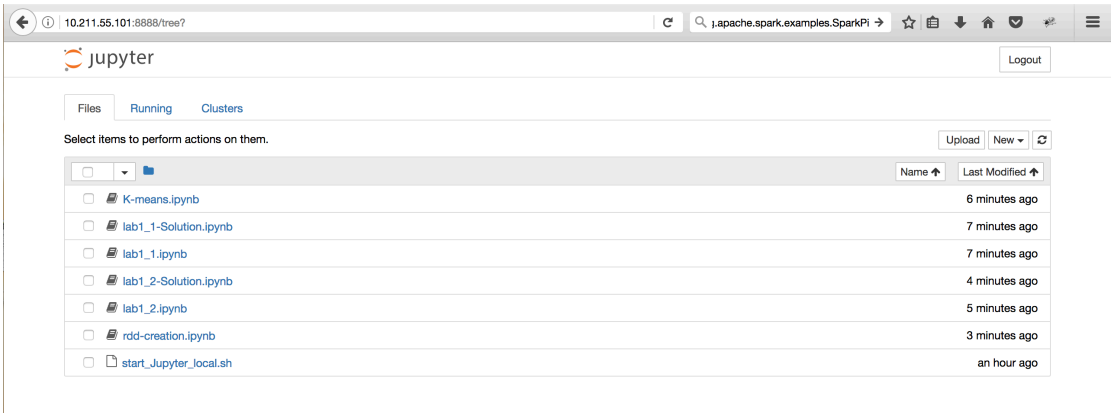
```
[root@node1 notebooks]# ./start_Jupyter_local.sh
[I 12:15:10.733 NotebookApp] Writing notebook server cookie secret to /root/.local/share/jupyter/runtime/notebook_cookie_sec
[I 12:15:10.782 NotebookApp] Serving notebooks from local directory: /home/vagrant/notebooks
[I 12:15:10.782 NotebookApp] 0 active kernels
[I 12:15:10.782 NotebookApp] The Jupyter Notebook is running at: http://0.0.0.0:8888/?token=9e3ea03d3bce3871924e287af665ba19
f2d1e2372e507
[I 12:15:10.782 NotebookApp] Use Control-C to stop this server and shut down all kernels (twice to skip confirmation).
[W 12:15:10.782 NotebookApp] No web browser found: could not locate runnable browser.
[C 12:15:10.782 NotebookApp]

    Copy/paste this URL into your browser when you connect for the first time,
    to login with a token:
        http://0.0.0.0:8888/?token=9e3ea03d3bce3871924e287af665ba1978df2d1e2372e507
```

Go to your browser and type: http://10.211.55.101:8888




Copy/Paste the token (this is only needed to do it the first type) that the shell gave into the browser (for this example the toke is: 9e3ea03d3bce3871924e287af665ba1978df2d1e2372e507 )




Select lab1_1 and start the exercise.