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 and Web UIs

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

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
```

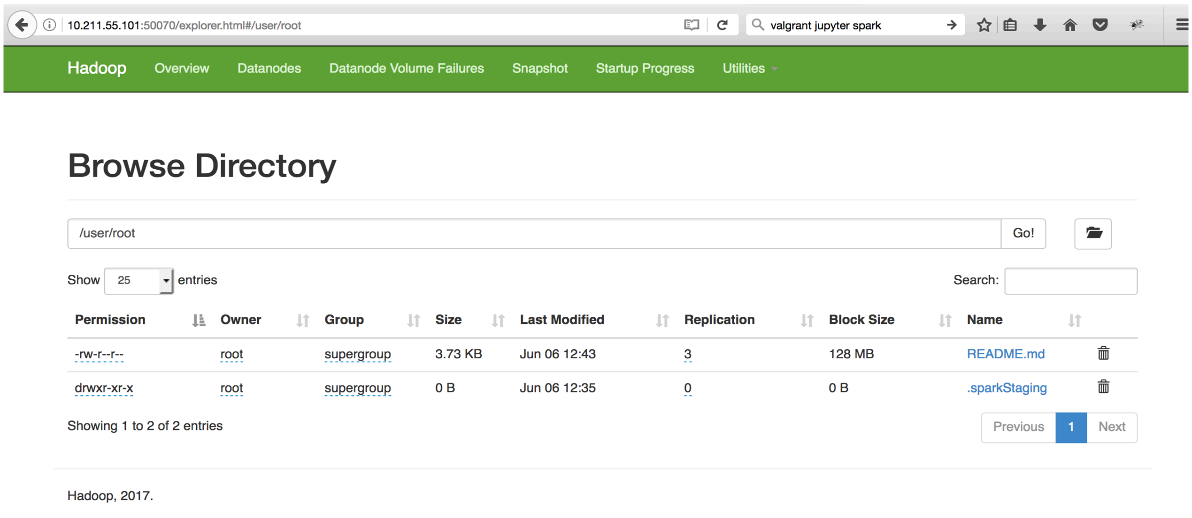
HDFS

Storing a file into HDFS file system

Type the following command to store a file (/usr/local/README.md) 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 **NameNode UI**→ In (Utilities / Browse Directory) → you will be able to see the file in your /user/root/ directory.



10.211.55.101:50070/explorer.html#/user/root

Hadoop | Overview | Datanodes | Datanode Volume Failures | Snapshot | Startup Progress | Utilities

Browse Directory

/user/root Go!

Show 25 entries Search:

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
-rw-r--r--	root	supergroup	3.73 KB	Jun 06 12:43	3	128 MB	README.md
drwxr-xr-x	root	supergroup	0 B	Jun 06 12:35	0	0 B	.sparkStaging

Showing 1 to 2 of 2 entries

Previous 1 Next

Hadoop, 2017.

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
```

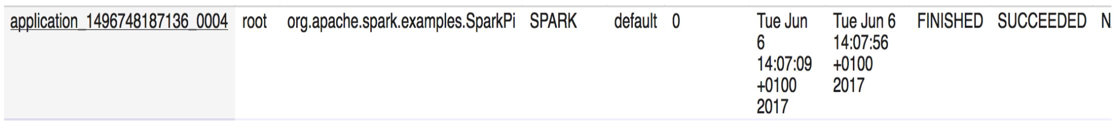
A good Spark example to checkout your Spark cluster instance is the SparkPi example. (Note: the source code of this example is located in "/usr/local/spark/examples/src/main/scala/org/apache/spark/examples/SparkPi.scala")

Testing SparkPi on YARN

```
>> $SPARK_HOME/bin/spark-submit --class
org.apache.spark.examples.SparkPi --master yarn-cluster --num-
```

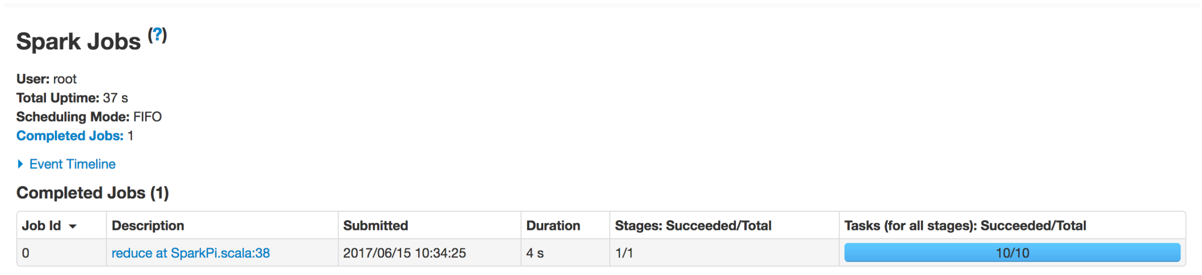
```
executors 10 --executor-cores 2 $SPARK_HOME/examples/jars/spark-
examples_2.11-2.1.1.jar 10
```

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).



Spark Jobs (?)

User: root
Total Uptime: 37 s
Scheduling Mode: FIFO
Completed Jobs: 1

▸ Event Timeline

Completed Jobs (1)

Job Id ▾	Description	Submitted	Duration	Stages: Succeeded/Total	Tasks (for all stages): Succeeded/Total
0	reduce at SparkPi.scala:38	2017/06/15 10:34:25	4 s	1/1	10/10

Test SparkPi on Standalone mode

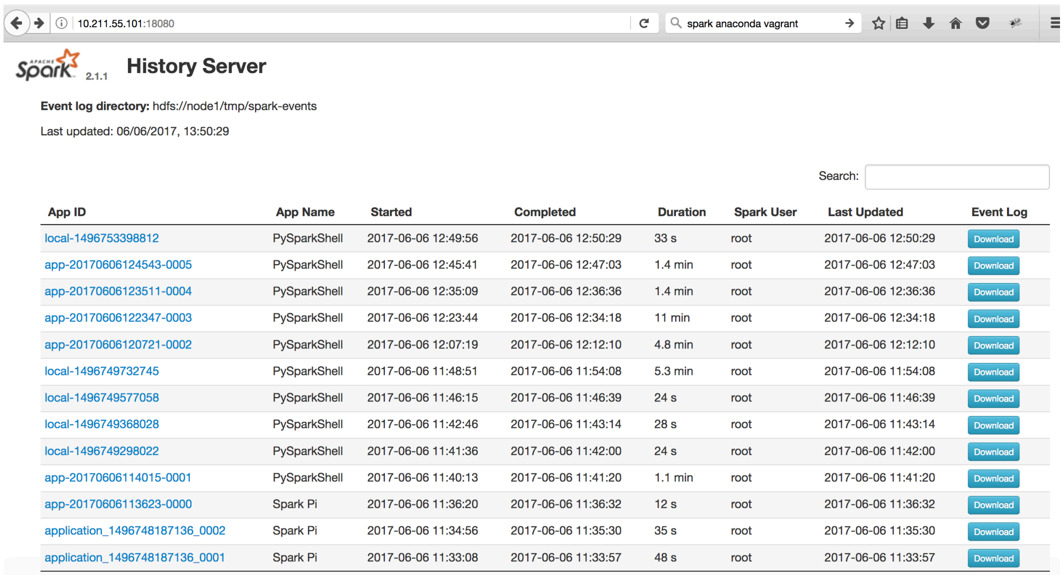
```
>> $SPARK_HOME/bin/spark-submit --class
org.apache.spark.examples.SparkPi --master spark://node1:7077 --num-
executors 10 --executor-cores 1 $SPARK_HOME/examples/jars/spark-
examples_2.11-2.1.1.jar 10
```

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


10.211.55.101:18080

History Server

Event log directory: hdfs://node1/tmp/spark-events

Last updated: 06/06/2017, 13:50:29

App ID	App Name	Started	Completed	Duration	Spark User	Last Updated	Event Log
local-1496753398812	PySparkShell	2017-06-06 12:49:56	2017-06-06 12:50:29	33 s	root	2017-06-06 12:50:29	Download
app-20170606124543-0005	PySparkShell	2017-06-06 12:45:41	2017-06-06 12:47:03	1.4 min	root	2017-06-06 12:47:03	Download
app-20170606123511-0004	PySparkShell	2017-06-06 12:35:09	2017-06-06 12:36:36	1.4 min	root	2017-06-06 12:36:36	Download
app-20170606122347-0003	PySparkShell	2017-06-06 12:23:44	2017-06-06 12:34:18	11 min	root	2017-06-06 12:34:18	Download
app-20170606120721-0002	PySparkShell	2017-06-06 12:07:19	2017-06-06 12:12:10	4.8 min	root	2017-06-06 12:12:10	Download
local-1496749732745	PySparkShell	2017-06-06 11:48:51	2017-06-06 11:54:08	5.3 min	root	2017-06-06 11:54:08	Download
local-1496749577058	PySparkShell	2017-06-06 11:46:15	2017-06-06 11:46:39	24 s	root	2017-06-06 11:46:39	Download
local-1496749368028	PySparkShell	2017-06-06 11:42:46	2017-06-06 11:43:14	28 s	root	2017-06-06 11:43:14	Download
local-1496749298022	PySparkShell	2017-06-06 11:41:36	2017-06-06 11:42:00	24 s	root	2017-06-06 11:42:00	Download
app-20170606114015-0001	PySparkShell	2017-06-06 11:40:13	2017-06-06 11:41:20	1.1 min	root	2017-06-06 11:41:20	Download
app-20170606113623-0000	Spark Pi	2017-06-06 11:36:20	2017-06-06 11:36:32	12 s	root	2017-06-06 11:36:32	Download
application_1496748187136_0002	Spark Pi	2017-06-06 11:34:56	2017-06-06 11:35:30	35 s	root	2017-06-06 11:35:30	Download
application_1496748187136_0001	Spark Pi	2017-06-06 11:33:08	2017-06-06 11:33:57	48 s	root	2017-06-06 11:33:57	Download

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

Notebook documents (or "notebooks", all lower case) are documents produced by the Jupyter Notebook App, which contain both computer code (e.g. python) and rich text elements (paragraph, equations, figures, links, etc...). Notebook documents are both human-readable documents containing the analysis description and the results (figures, tables, etc..) as well as executable documents which can be run to perform data analysis.

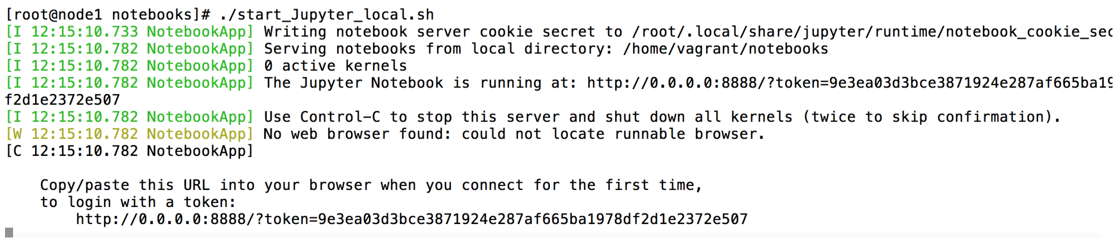
The *Jupyter Notebook App* is a server-client application that allows editing and running notebook documents via a web browser. The *Jupyter Notebook App* can be executed on a local desktop requiring no internet access (as described in this document) or can be installed on a remote server and accessed through the internet.

Important: 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
```

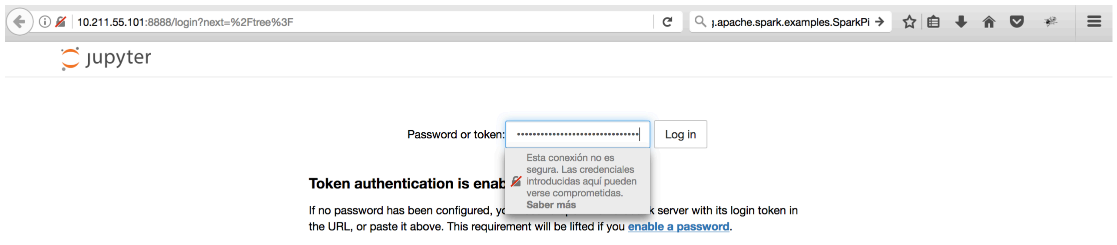
We have already a script **start_Jupyter_local.sh** `in /home/vagrant/notebooks` that sets these variables up for you.

```
>> 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


10.211.55.101:8888/login?next=%2Ftree%3F
j.apache.spark.examples.SparkPi
jupyter
Log in

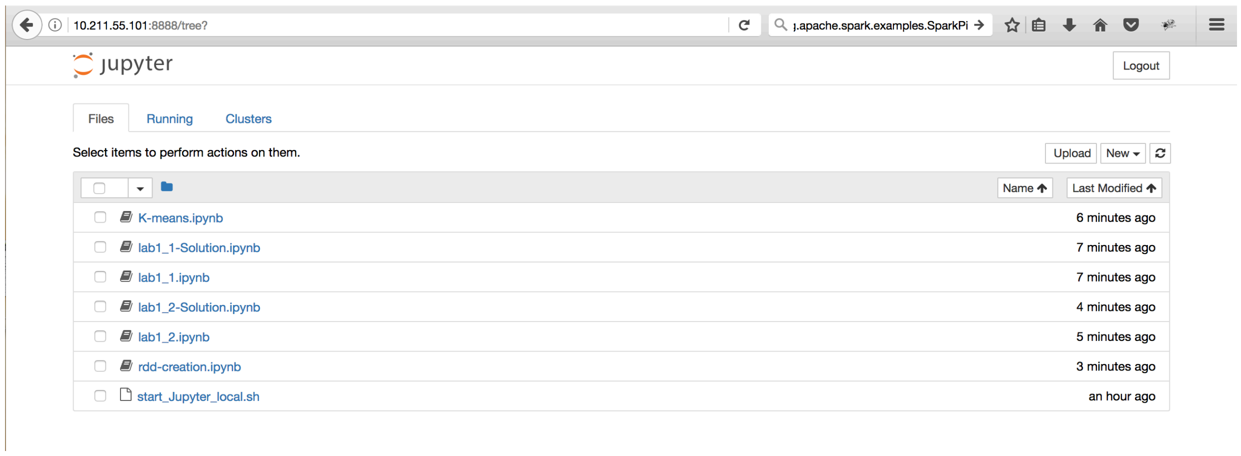
Password or token:

Esta conexión no es segura. Las credenciales introducidas aquí pueden verse comprometidas. Saber más

Token authentication is enab

If no password has been configured, yo k server with its login token in the URL, or paste it above. This requirement will be lifted if you enable a password.

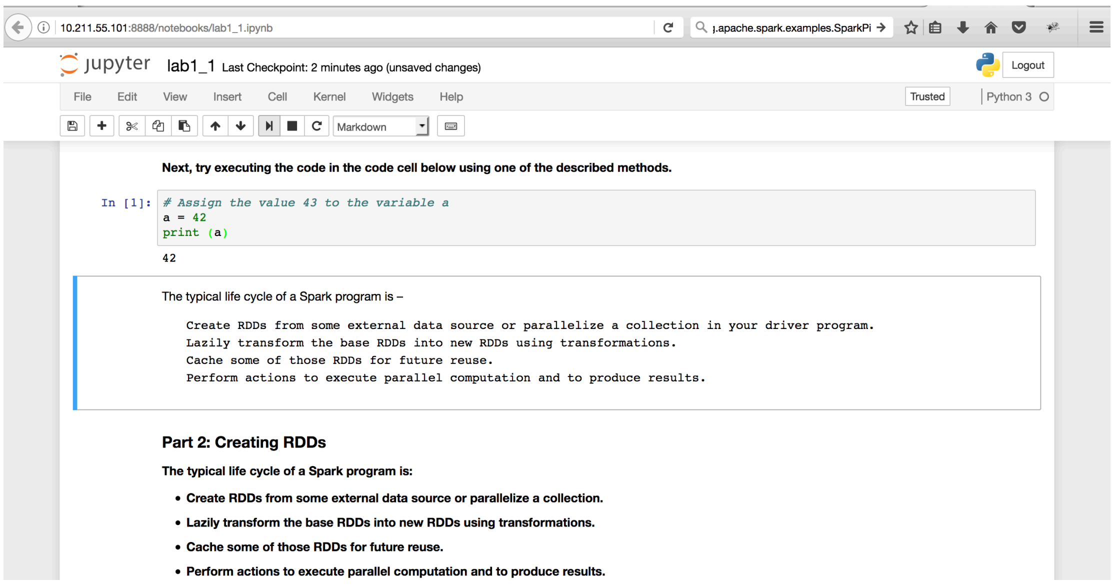
Copy/Paste the token (this is only needed to do it the first time that you run this script) that the shell gives into the browser (for this example the toke is: 9e3ea03d3bce3871924e287af665ba1978df2d1e2372e507)



Select items to perform actions on them.

K-means.ipynb	6 minutes ago
lab1_1-Solution.ipynb	7 minutes ago
lab1_1.ipynb	7 minutes ago
lab1_2-Solution.ipynb	4 minutes ago
lab1_2.ipynb	5 minutes ago
rdd-creation.ipynb	3 minutes ago
start_Jupyter_local.sh	an hour ago

Select lab1_1.ipynb and start the exercise.


10.211.55.101:8888/notebooks/lab1_1.ipynb
ȷ.apache.spark.examples.SparkPi
jupyter
lab1_1 Last Checkpoint: 2 minutes ago (unsaved changes)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Trusted
Python 3
Markdown

Next, try executing the code in the code cell below using one of the described methods.

In [1]:
```
# Assign the value 43 to the variable a
a = 42
print (a)
```

```
42
```

The typical life cycle of a Spark program is –

```
Create RDDs from some external data source or parallelize a collection in your driver program.
Lazily transform the base RDDs into new RDDs using transformations.
Cache some of those RDDs for future reuse.
Perform actions to execute parallel computation and to produce results.
```

Part 2: Creating RDDs

The typical life cycle of a Spark program is:

- **Create RDDs from some external data source or parallelize a collection.**
- **Lazily transform the base RDDs into new RDDs using transformations.**
- **Cache some of those RDDs for future reuse.**
- **Perform actions to execute parallel computation and to produce results.**