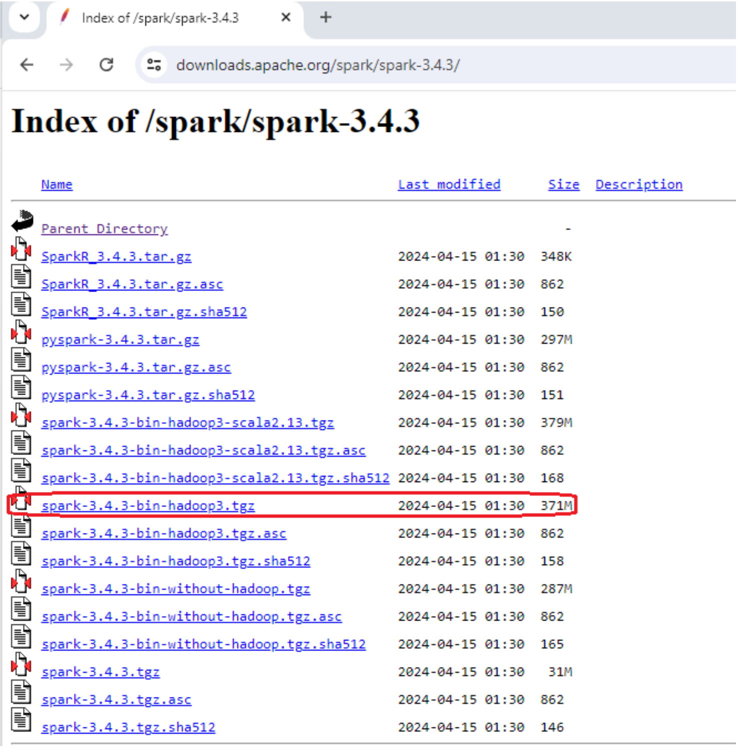
Tutorial 4 (Part II)

Apache Spark in Jupyter

Install and test Apache Spark in VirtualBox VM

1) Download Apache Spark 3.4.3 prebuilt for Hadoop3 from the link below in the **Downloads** folder by typing the web address in the Firefox browser
https://downloads.apache.org/spark/spark-3.4.3/spark-3.4.3-bin-hadoop3.tgz


Index of /spark/spark-3.4.3
downloads.apache.org/spark/spark-3.4.3/

Index of /spark/spark-3.4.3

Name	Last modified	Size	Description
Parent Directory		-	
SparkR_3.4.3.tar.gz	2024-04-15 01:30	348K	
SparkR_3.4.3.tar.gz.asc	2024-04-15 01:30	862	
SparkR_3.4.3.tar.gz.sha512	2024-04-15 01:30	150	
pyspark-3.4.3.tar.gz	2024-04-15 01:30	297M	
pyspark-3.4.3.tar.gz.asc	2024-04-15 01:30	862	
pyspark-3.4.3.tar.gz.sha512	2024-04-15 01:30	151	
spark-3.4.3-bin-hadoop3-scala2.13.tgz	2024-04-15 01:30	379M	
spark-3.4.3-bin-hadoop3-scala2.13.tgz.asc	2024-04-15 01:30	862	
spark-3.4.3-bin-hadoop3-scala2.13.tgz.sha512	2024-04-15 01:30	168	
spark-3.4.3-bin-hadoop3.tgz	2024-04-15 01:30	371M	
spark-3.4.3-bin-hadoop3.tgz.asc	2024-04-15 01:30	862	
spark-3.4.3-bin-hadoop3.tgz.sha512	2024-04-15 01:30	158	
spark-3.4.3-bin-without-hadoop.tgz	2024-04-15 01:30	287M	
spark-3.4.3-bin-without-hadoop.tgz.asc	2024-04-15 01:30	862	
spark-3.4.3-bin-without-hadoop.tgz.sha512	2024-04-15 01:30	165	
spark-3.4.3.tgz	2024-04-15 01:30	31M	
spark-3.4.3.tgz.asc	2024-04-15 01:30	862	
spark-3.4.3.tgz.sha512	2024-04-15 01:30	146	

After download completion, unzip it using the following command.

Check the download folder is present or not using (**$ls**) command. Do not write $ sign as it showed prompt in Ubuntu shell

```
$cd Downloads
$sudo tar -xvf spark-3.4.3-bin-hadoop3.tgz
```

OR use command line to download if you have any difficulty in downloading with the Mozilla Firefox browser. The below highlighted commands do not need to execute if you have already downloaded Apache Spark. If you have difficulty in downloading using browser, you can use terminal or shell to download Apache Spark.

Use the following command

```
$cd /home/hduser/Downloads
```

```
$wget https://downloads.apache.org/spark/spark-3.4.3/spark-3.4.3-bin-hadoop3.tgz
```

```
$ls -l
```

You can check the zip folder after this download and now you can unzip the folder as mentioned below

```
$sudo tar -xvf spark-3.4.3-bin-hadoop3.tgz
```

2) Install Apache Spark under **/usr/local** by running the commands

```
$sudo mv ./spark-3.4.3-bin-hadoop3 /usr/local

$cd /usr/local
```

3) Create a symbolic link called **spark** to the spark-3.4.3-bin-hadoop3.2:

```
$sudo ln -sf ./spark-3.4.3-bin-hadoop3 spark
```

4) Change the ownership of the files in the **spark** directory so that the group is assigned to **hadoop** and the owner is **hduser**:

```
$sudo chown -R hduser:hadoopgroup spark*
```

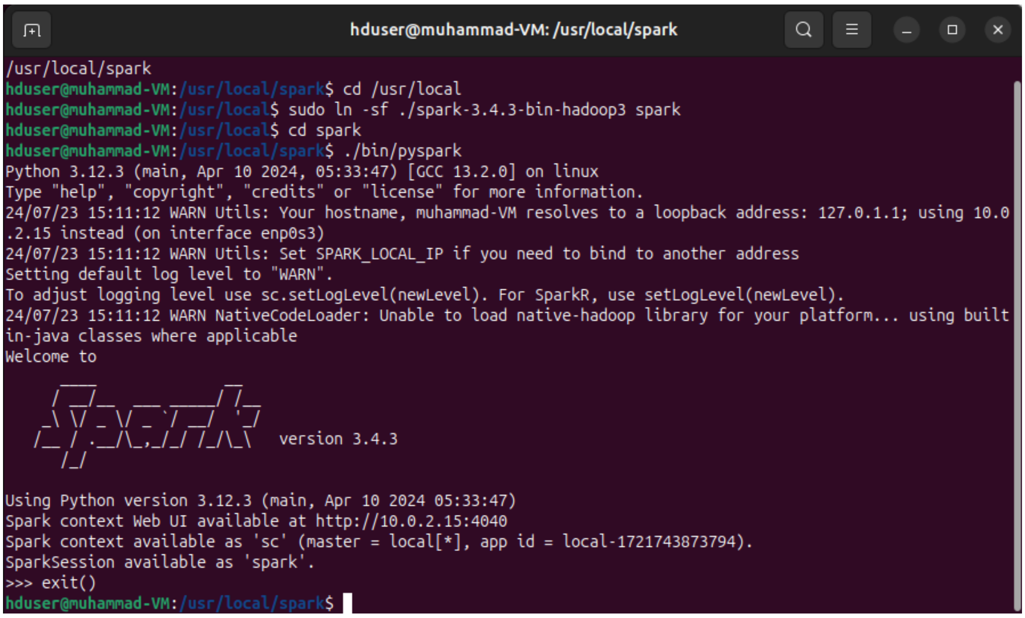
5) Test the installation at the path '`/usr/local/spark`'

```
$cd /usr/local/spark
```

and then

```
$./bin/pyspark
```

Did you get the Python shell as shown in the screenshot below? OK. If you did not get the python shell as mentioned below, then check the previous steps again.

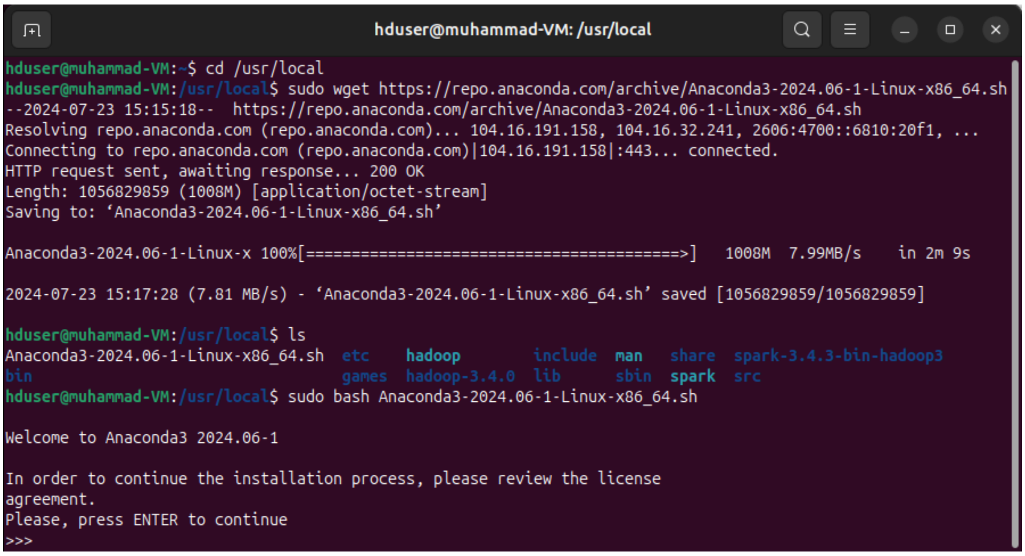


hduser@muhammad-VM: /usr/local/spark

```
/usr/local/spark
hduser@muhammad-VM:/usr/local/spark$ cd /usr/local
hduser@muhammad-VM:/usr/local$ sudo ln -sf ./spark-3.4.3-bin-hadoop3 spark
hduser@muhammad-VM:/usr/local$ cd spark
hduser@muhammad-VM:/usr/local/spark$ ./bin/pyspark
Python 3.12.3 (main, Apr 10 2024, 05:33:47) [GCC 13.2.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
24/07/23 15:11:12 WARN Utils: Your hostname, muhammad-VM resolves to a loopback address: 127.0.1.1; using 10.0
.2.15 instead (on interface enp0s3)
24/07/23 15:11:12 WARN Utils: Set SPARK_LOCAL_IP if you need to bind to another address
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/07/23 15:11:12 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using built
in-java classes where applicable
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 3.4.3
      /_/

Using Python version 3.12.3 (main, Apr 10 2024 05:33:47)
Spark context Web UI available at http://10.0.2.15:4040
Spark context available as 'sc' (master = local[*], app id = local-1721743873794).
SparkSession available as 'spark'.
>>> exit()
hduser@muhammad-VM:/usr/local/spark$
```

6) Install Anaconda using the following command:

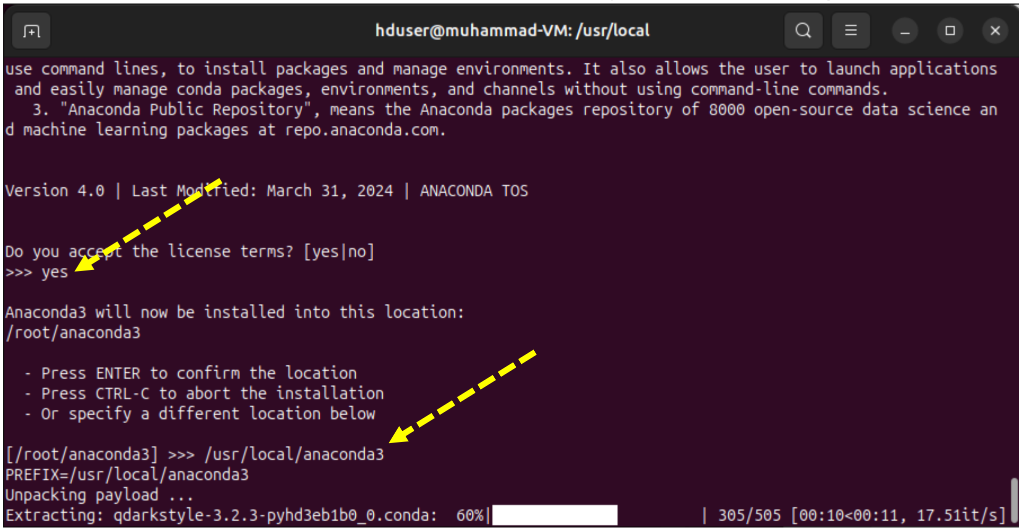
```
$cd /usr/local
$sudo wget https://repo.anaconda.com/archive/Anaconda3-2024.06-1-Linux-x86_64.sh
$sudo bash Anaconda3-2024.06-1-Linux-x86_64.sh
```



hduser@muhammad-VM: /usr/local

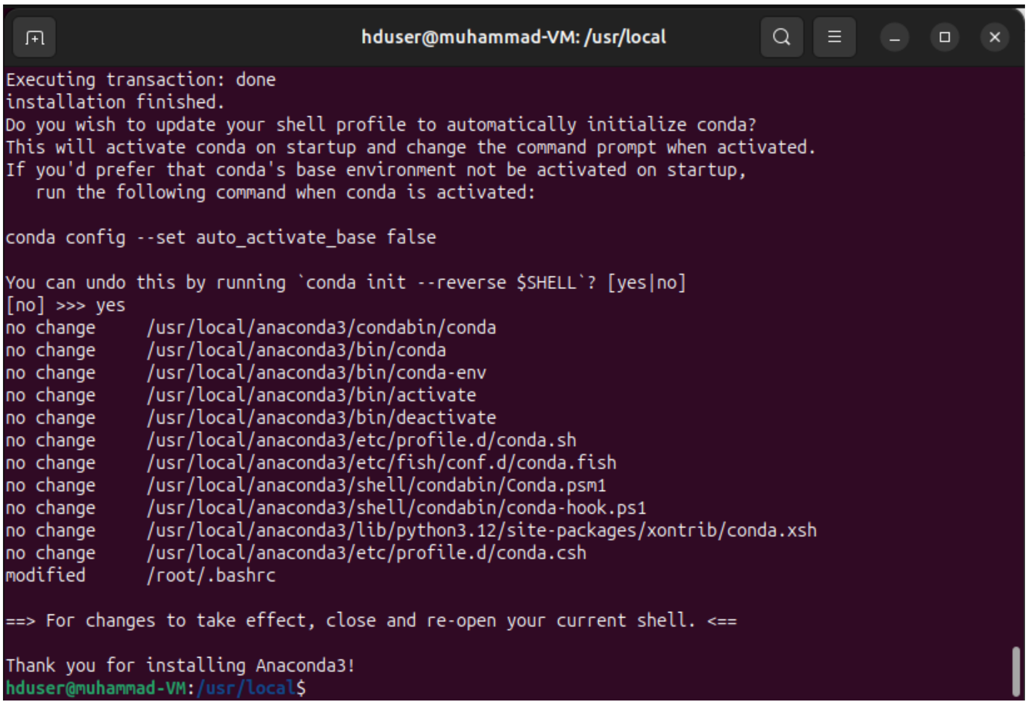
```
hduser@muhammad-VM:~$ cd /usr/local
hduser@muhammad-VM:/usr/local$ sudo wget https://repo.anaconda.com/archive/Anaconda3-2024.06-1-Linux-x86_64.sh
--2024-07-23 15:15:18--  https://repo.anaconda.com/archive/Anaconda3-2024.06-1-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.191.158, 104.16.32.241, 2606:4700::6810:20f1, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.191.158|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1056829859 (1008M) [application/octet-stream]
Saving to: 'Anaconda3-2024.06-1-Linux-x86_64.sh'

Anaconda3-2024.06-1-Linux-x 100%[=======================================>]   1008M  7.99MB/s    in 2m 9s

2024-07-23 15:17:28 (7.81 MB/s) - 'Anaconda3-2024.06-1-Linux-x86_64.sh' saved [1056829859/1056829859]

hduser@muhammad-VM:/usr/local$ ls
Anaconda3-2024.06-1-Linux-x86_64.sh  etc    hadoop        include  man   share  spark-3.4.3-bin-hadoop3
bin                                  games  hadoop-3.4.0  lib      sbin  spark  src
hduser@muhammad-VM:/usr/local$ sudo bash Anaconda3-2024.06-1-Linux-x86_64.sh

Welcome to Anaconda3 2024.06-1

In order to continue the installation process, please review the license
agreement.
Please, press ENTER to continue
>>>
```

Press the Enter Key and use arrow key to check the terms and conditions. Use arrow key to move to the end of this document. Then accept the license conditions as "yes" and choose option for **`/usr/local/anaconda3`** as the install directory and the following screenshot will appear as



```
use command lines, to install packages and manage environments. It also allows the user to launch applications
 and easily manage conda packages, environments, and channels without using command-line commands.
   3. "Anaconda Public Repository", means the Anaconda packages repository of 8000 open-source data science an
d machine learning packages at repo.anaconda.com.


Version 4.0 | Last Modified: March 31, 2024 | ANACONDA TOS


Do you accept the license terms? [yes|no]
>>> yes

Anaconda3 will now be installed into this location:
/root/anaconda3

  - Press ENTER to confirm the location
  - Press CTRL-C to abort the installation
  - Or specify a different location below

[/root/anaconda3] >>> /usr/local/anaconda3
PREFIX=/usr/local/anaconda3
Unpacking payload ...
Extracting: qdarkstyle-3.2.3-pyhd3eb1b0_0.conda:  60%|              | 305/505 [00:10<00:11, 17.51it/s]
```

When the installation of anaconda3 is completed, you will get the option for yes/ no for running anaconda.



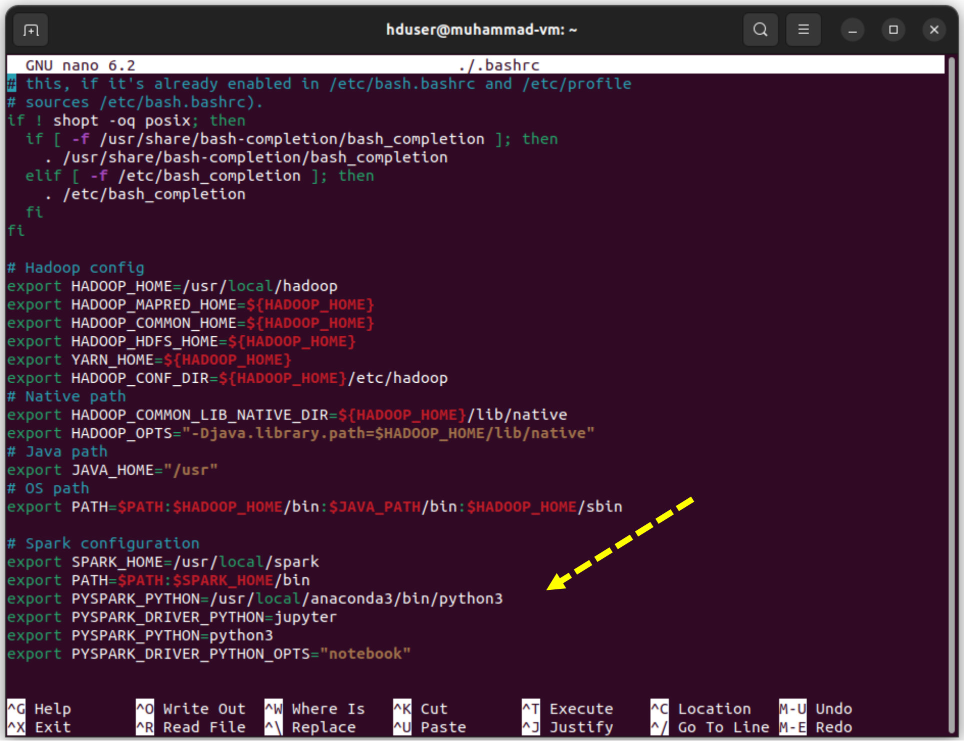
```
Executing transaction: done
installation finished.
Do you wish to update your shell profile to automatically initialize conda?
This will activate conda on startup and change the command prompt when activated.
If you'd prefer that conda's base environment not be activated on startup,
   run the following command when conda is activated:

conda config --set auto_activate_base false

You can undo this by running `conda init --reverse $SHELL`? [yes|no]
[no] >>> yes
no change     /usr/local/anaconda3/condabin/conda
no change     /usr/local/anaconda3/bin/conda
no change     /usr/local/anaconda3/bin/conda-env
no change     /usr/local/anaconda3/bin/activate
no change     /usr/local/anaconda3/bin/deactivate
no change     /usr/local/anaconda3/etc/profile.d/conda.sh
no change     /usr/local/anaconda3/etc/fish/conf.d/conda.fish
no change     /usr/local/anaconda3/shell/condabin/Conda.psm1
no change     /usr/local/anaconda3/shell/condabin/conda-hook.ps1
no change     /usr/local/anaconda3/lib/python3.12/site-packages/xontrib/conda.xsh
no change     /usr/local/anaconda3/etc/profile.d/conda.csh
modified      /root/.bashrc

==> For changes to take effect, close and re-open your current shell. <==

Thank you for installing Anaconda3!
hduser@muhammad-VM:/usr/local$
```

7) Open a new terminal and add Spark environment variables to the **`.bashrc`** file from /home/hduser:

```
$cd /home/hduser
$nano ./.bashrc
```

Add the following lines in the ./.bashrc file using **nano** editor at the end of the file. Save the file using nano editor.

```
# Spark configuration
export SPARK_HOME=/usr/local/spark
export PATH=$PATH:$SPARK_HOME/bin
export PYSPARK_PYTHON=/usr/local/anaconda3/bin/python3
export PYSPARK_DRIVER_PYTHON=jupyter
export PYSPARK_PYTHON=python3
export PYSPARK_DRIVER_PYTHON_OPTS="notebook"
```



```
  GNU nano 6.2                              ./.bashrc
# this, if it's already enabled in /etc/bash.bashrc and /etc/profile
# sources /etc/bash.bashrc).
if ! shopt -oq posix; then
  if [ -f /usr/share/bash-completion/bash_completion ]; then
    . /usr/share/bash-completion/bash_completion
  elif [ -f /etc/bash_completion ]; then
    . /etc/bash_completion
  fi
fi

# Hadoop config
export HADOOP_HOME=/usr/local/hadoop
export HADOOP_MAPRED_HOME=${HADOOP_HOME}
export HADOOP_COMMON_HOME=${HADOOP_HOME}
export HADOOP_HDFS_HOME=${HADOOP_HOME}
export YARN_HOME=${HADOOP_HOME}
export HADOOP_CONF_DIR=${HADOOP_HOME}/etc/hadoop
# Native path
export HADOOP_COMMON_LIB_NATIVE_DIR=${HADOOP_HOME}/lib/native
export HADOOP_OPTS="-Djava.library.path=$HADOOP_HOME/lib/native"
# Java path
export JAVA_HOME="/usr"
# OS path
export PATH=$PATH:$HADOOP_HOME/bin:$JAVA_PATH/bin:$HADOOP_HOME/sbin

# Spark configuration
export SPARK_HOME=/usr/local/spark
export PATH=$PATH:$SPARK_HOME/bin
export PYSPARK_PYTHON=/usr/local/anaconda3/bin/python3
export PYSPARK_DRIVER_PYTHON=jupyter
export PYSPARK_PYTHON=python3
export PYSPARK_DRIVER_PYTHON_OPTS="notebook"

^G Help      ^O Write Out  ^W Where Is  ^K Cut     ^T Execute   ^C Location    M-U Undo
^X Exit      ^R Read File  ^\ Replace   ^U Paste   ^J Justify   ^/ Go To Line  M-E Redo
```

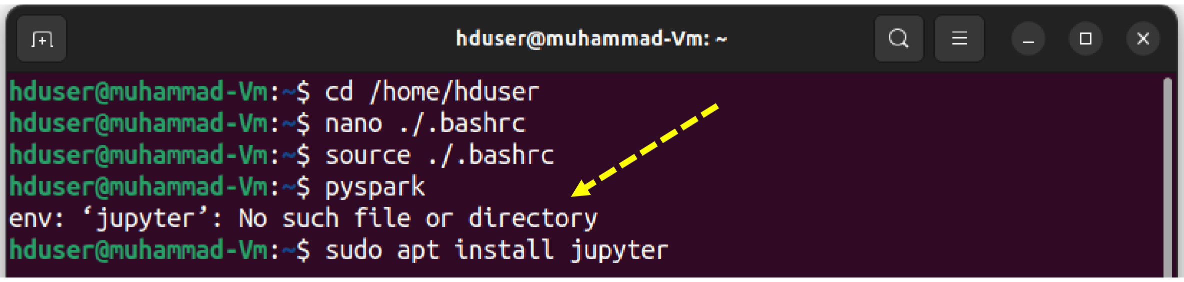
8) Save the above commands and source your **bashrc** with the command to update:

$source ./.bashrc

9) Test to see if Spark launches with the command:

$pyspark

NOTE: A web page is launched instead of the ripple launched earlier since we have opted (in the bashrc file) to launch a Juypter notebook and we will write our python code there.
If you see some errors like as mentioned on the below screenshot, then install jupyter installer



```
hduser@muhammad-Vm:~$ cd /home/hduser
hduser@muhammad-Vm:~$ nano ./.bashrc
hduser@muhammad-Vm:~$ source ./.bashrc
hduser@muhammad-Vm:~$ pyspark
env: ‘jupyter’: No such file or directory
hduser@muhammad-Vm:~$ sudo apt install jupyter
```

Use the command to launch **pyspark** and you should see a terminal in the browser will be opened. If you found an error like, env: ‘jupyter’: No such file or directory. Then install the jupyter notebook by using the command

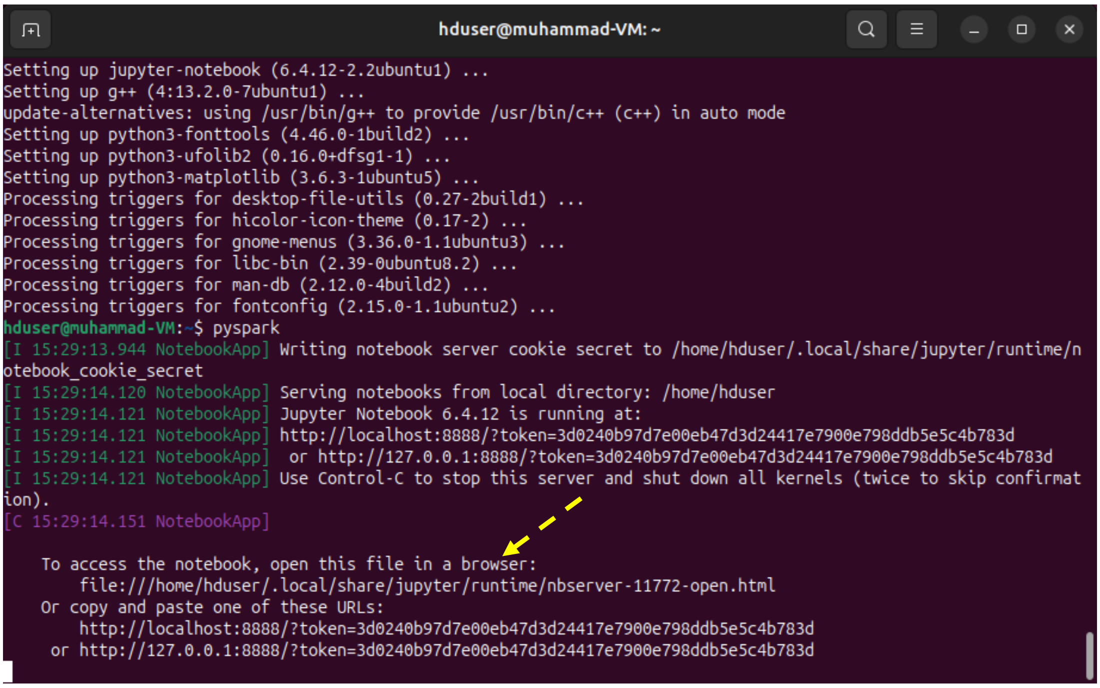
$sudo apt install jupyter

Write ‘y’ when asked for the installation.

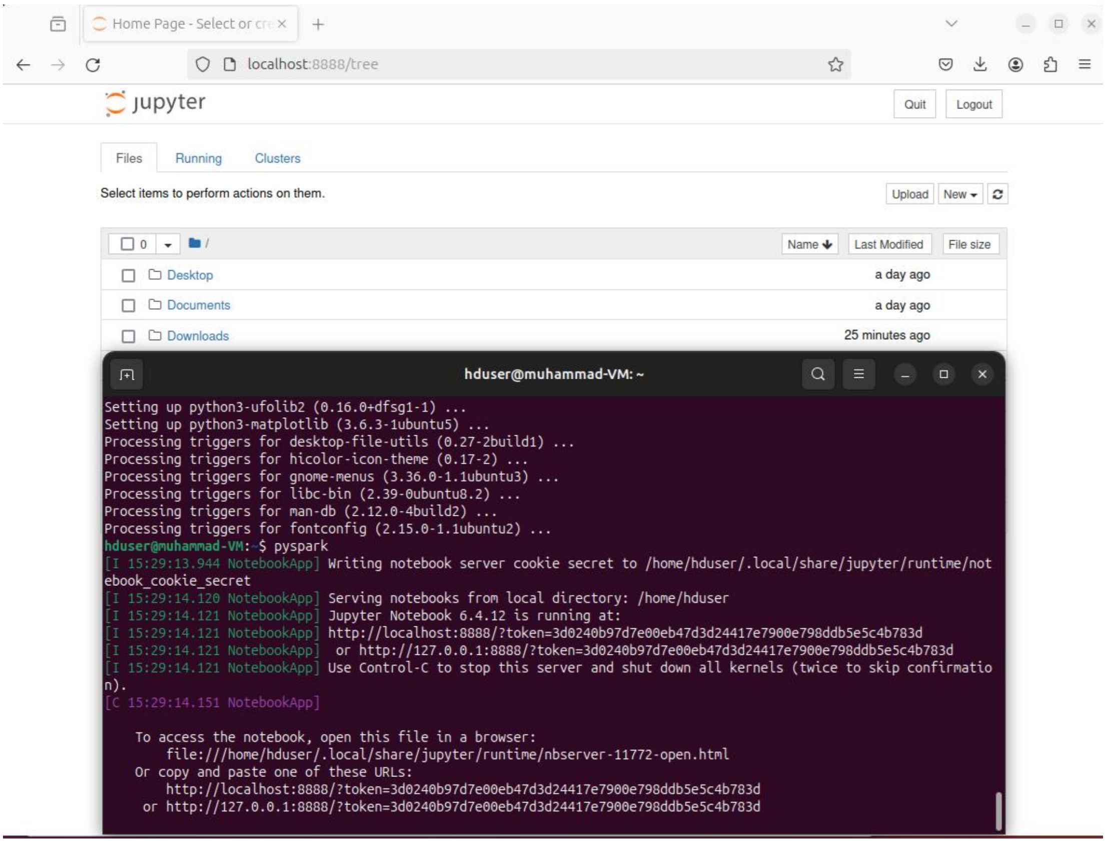
10) After installation of jupyter, write again **pyspark**

$pyspark

The jupyter notebook started automatically using google chrome browser (Installation of Google chrome is provided in Appendix A) or you can copy the link address from the terminal and paste in the Mozilla Firefox.



```
Setting up jupyter-notebook (6.4.12-2.2ubuntu1) ...
Setting up g++ (4:13.2.0-7ubuntu1) ...
update-alternatives: using /usr/bin/g++ to provide /usr/bin/c++ (c++) in auto mode
Setting up python3-fonttools (4.46.0-1build2) ...
Setting up python3-ufolib2 (0.16.0+dfsg1-1) ...
Setting up python3-matplotlib (3.6.3-1ubuntu5) ...
Processing triggers for desktop-file-utils (0.27-2build1) ...
Processing triggers for hicolor-icon-theme (0.17-2) ...
Processing triggers for gnome-menus (3.36.0-1.1ubuntu3) ...
Processing triggers for libc-bin (2.39-0ubuntu8.2) ...
Processing triggers for man-db (2.12.0-4build2) ...
Processing triggers for fontconfig (2.15.0-1.1ubuntu2) ...
hduser@muhammad-VM:~$ pyspark
[I 15:29:13.944 NotebookApp] Writing notebook server cookie secret to /home/hduser/.local/share/jupyter/runtime/n
otebook_cookie_secret
[I 15:29:14.120 NotebookApp] Serving notebooks from local directory: /home/hduser
[I 15:29:14.121 NotebookApp] Jupyter Notebook 6.4.12 is running at:
[I 15:29:14.121 NotebookApp] http://localhost:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
[I 15:29:14.121 NotebookApp]  or http://127.0.0.1:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
[I 15:29:14.121 NotebookApp] Use Control-C to stop this server and shut down all kernels (twice to skip confirmat
ion).
[C 15:29:14.151 NotebookApp]

    To access the notebook, open this file in a browser:
        file:///home/hduser/.local/share/jupyter/runtime/nbserver-11772-open.html
    Or copy and paste one of these URLs:
        http://localhost:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
     or http://127.0.0.1:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
```



Select items to perform actions on them.

```
□ 0 ▾  /
□ Desktop                                   a day ago
□ Documents                                 a day ago
□ Downloads                             25 minutes ago
```

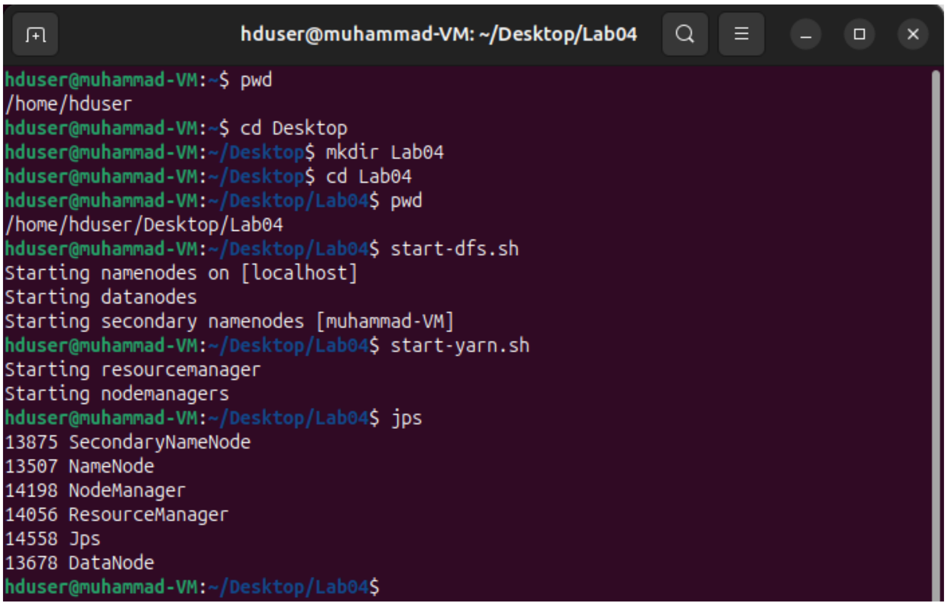
```
Setting up python3-ufolib2 (0.16.0+dfsg1-1) ...
Setting up python3-matplotlib (3.6.3-1ubuntu5) ...
Processing triggers for desktop-file-utils (0.27-2build1) ...
Processing triggers for hicolor-icon-theme (0.17-2) ...
Processing triggers for gnome-menus (3.36.0-1.1ubuntu3) ...
Processing triggers for libc-bin (2.39-0ubuntu8.2) ...
Processing triggers for man-db (2.12.0-4build2) ...
Processing triggers for fontconfig (2.15.0-1.1ubuntu2) ...
hduser@muhammad-VM:~$ pyspark
[I 15:29:13.944 NotebookApp] Writing notebook server cookie secret to /home/hduser/.local/share/jupyter/runtime/not
ebook_cookie_secret
[I 15:29:14.120 NotebookApp] Serving notebooks from local directory: /home/hduser
[I 15:29:14.121 NotebookApp] Jupyter Notebook 6.4.12 is running at:
[I 15:29:14.121 NotebookApp] http://localhost:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
[I 15:29:14.121 NotebookApp]  or http://127.0.0.1:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
[I 15:29:14.121 NotebookApp] Use Control-C to stop this server and shut down all kernels (twice to skip confirmatio
n).
[C 15:29:14.151 NotebookApp]

    To access the notebook, open this file in a browser:
        file:///home/hduser/.local/share/jupyter/runtime/nbserver-11772-open.html
    Or copy and paste one of these URLs:
        http://localhost:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
     or http://127.0.0.1:8888/?token=3d0240b97d7e00eb47d3d24417e7900e798ddb5e5c4b783d
```

11) Open a new terminal and create a working directory (**Lab04**) for the Spark.

```
$cd /home/hduser/Desktop
$pwd
$mkdir Lab04
$cd Lab04
$pwd
```

12) Now we copy some text, e.g. song lyrics from: http://www.songlyrics.com/ into a file **sample_lyric.txt** or Download the file **pg30123.txt** from Moodle. Store this file in Lab04 folder.

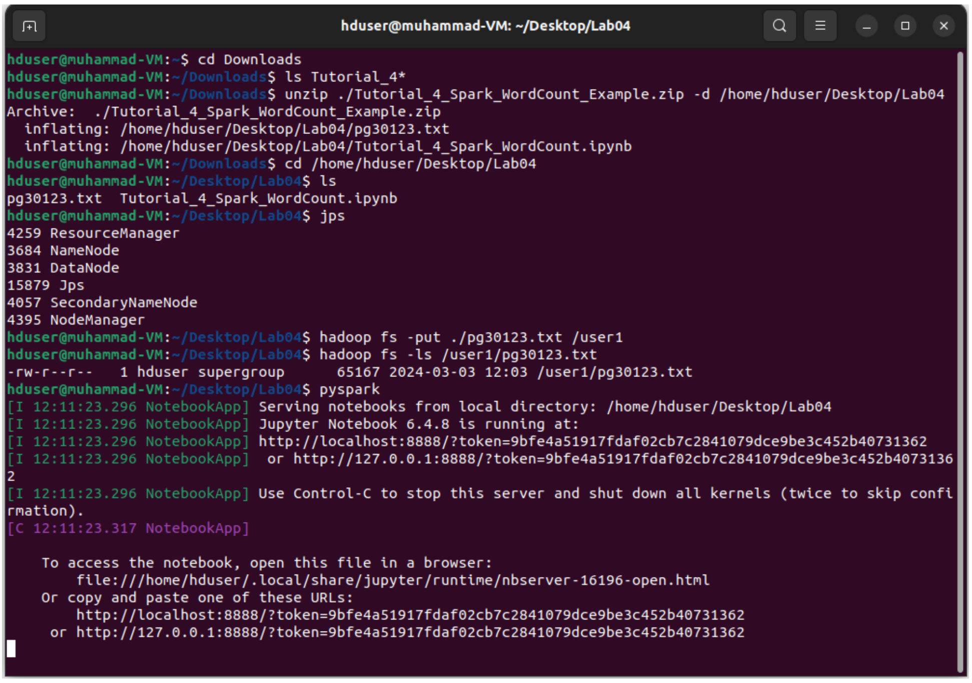
13) Start hadoop using the commands (`$start-dfs.sh` and `$start-yarn.sh`)



```
hduser@muhammad-VM:~$ pwd
/home/hduser
hduser@muhammad-VM:~$ cd Desktop
hduser@muhammad-VM:~/Desktop$ mkdir Lab04
hduser@muhammad-VM:~/Desktop$ cd Lab04
hduser@muhammad-VM:~/Desktop/Lab04$ pwd
/home/hduser/Desktop/Lab04
hduser@muhammad-VM:~/Desktop/Lab04$ start-dfs.sh
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [muhammad-VM]
hduser@muhammad-VM:~/Desktop/Lab04$ start-yarn.sh
Starting resourcemanager
Starting nodemanagers
hduser@muhammad-VM:~/Desktop/Lab04$ jps
13875 SecondaryNameNode
13507 NameNode
14198 NodeManager
14056 ResourceManager
14558 Jps
13678 DataNode
hduser@muhammad-VM:~/Desktop/Lab04$
```

14) Download the zip file from Moodle, Tutorial_4_Spark_WordCount_Example.zip, unzip it and copy both files into Lab04 folder on Desktop using the commands.

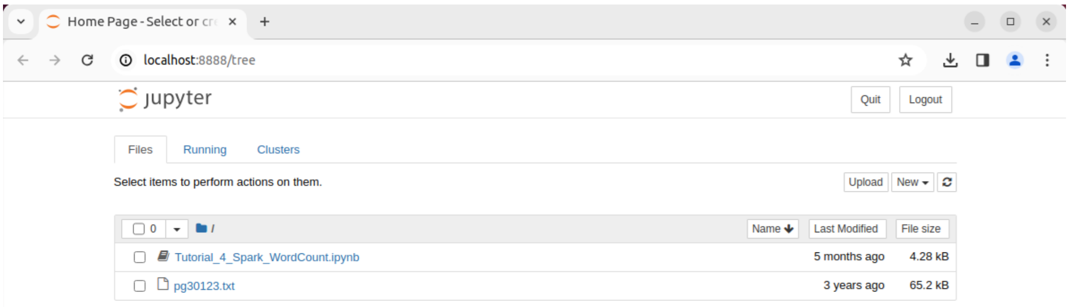
```
$cd Downloads
$ls
$unzip ./Tutorial_4_Spark_WordCount_Example.zip -d
/home/hduser/Desktop/Lab04
```



```
hduser@muhammad-VM:~$ cd Downloads
hduser@muhammad-VM:~/Downloads$ ls Tutorial_4*
hduser@muhammad-VM:~/Downloads$ unzip ./Tutorial_4_Spark_WordCount_Example.zip -d /home/hduser/Desktop/Lab04
Archive:  ./Tutorial_4_Spark_WordCount_Example.zip
  inflating: /home/hduser/Desktop/Lab04/pg30123.txt
  inflating: /home/hduser/Desktop/Lab04/Tutorial_4_Spark_WordCount.ipynb
hduser@muhammad-VM:~/Downloads$ cd /home/hduser/Desktop/Lab04
hduser@muhammad-VM:~/Desktop/Lab04$ ls
pg30123.txt  Tutorial_4_Spark_WordCount.ipynb
hduser@muhammad-VM:~/Desktop/Lab04$ jps
4259 ResourceManager
3684 NameNode
3831 DataNode
15879 Jps
4057 SecondaryNameNode
4395 NodeManager
hduser@muhammad-VM:~/Desktop/Lab04$ hadoop fs -put ./pg30123.txt /user1
hduser@muhammad-VM:~/Desktop/Lab04$ hadoop fs -ls /user1/pg30123.txt
-rw-r--r--   1 hduser supergroup      65167 2024-03-03 12:03 /user1/pg30123.txt
hduser@muhammad-VM:~/Desktop/Lab04$ pyspark
[I 12:11:23.296 NotebookApp] Serving notebooks from local directory: /home/hduser/Desktop/Lab04
[I 12:11:23.296 NotebookApp] Jupyter Notebook 6.4.8 is running at:
[I 12:11:23.296 NotebookApp] http://localhost:8888/?token=9bfe4a51917fdaf02cb7c2841079dce9be3c452b40731362
[I 12:11:23.296 NotebookApp]  or http://127.0.0.1:8888/?token=9bfe4a51917fdaf02cb7c2841079dce9be3c452b4073136
2
[I 12:11:23.296 NotebookApp] Use Control-C to stop this server and shut down all kernels (twice to skip confi
rmation).
[C 12:11:23.317 NotebookApp]

    To access the notebook, open this file in a browser:
        file:///home/hduser/.local/share/jupyter/runtime/nbserver-16196-open.html
    Or copy and paste one of these URLs:
        http://localhost:8888/?token=9bfe4a51917fdaf02cb7c2841079dce9be3c452b40731362
     or http://127.0.0.1:8888/?token=9bfe4a51917fdaf02cb7c2841079dce9be3c452b40731362
```

Move “**pg30123.txt**” file from Lab04 folder on your local VM into the folder on hadoop distributed file system (hdfs) before launching the wordcount code in pyspark as shown in the above screenshot.

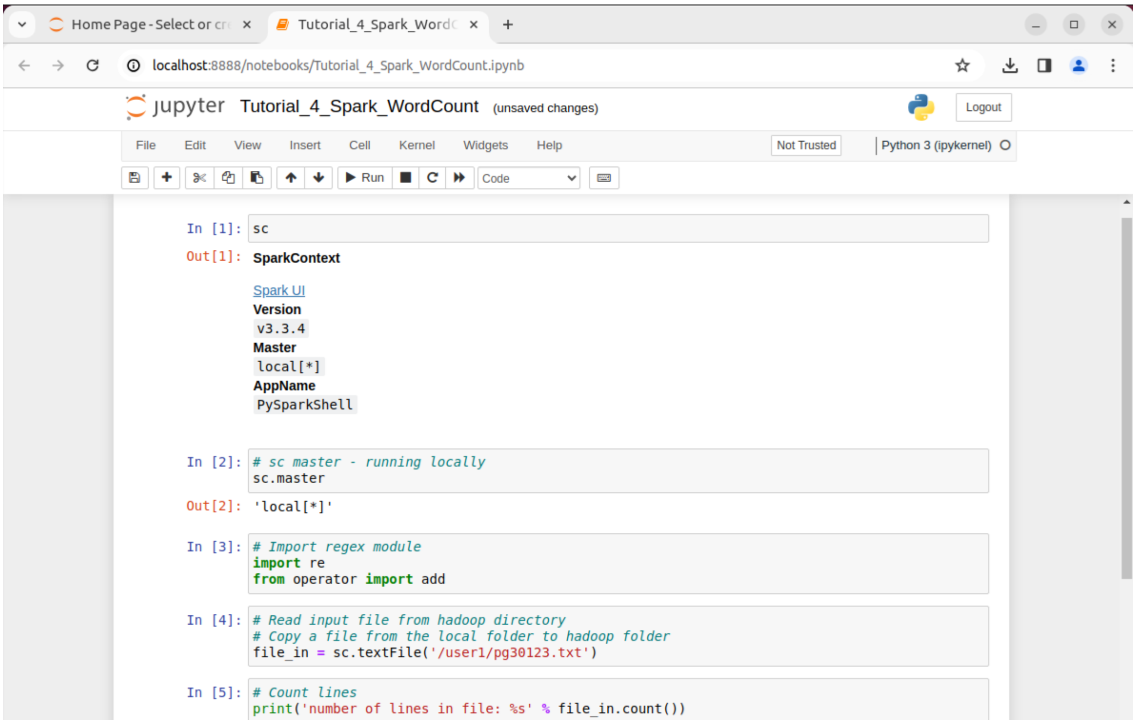
15) Now again launch Pyspark or you can move to the folder in Lab04 in the already opened jupyter notebook.



Select items to perform actions on them.

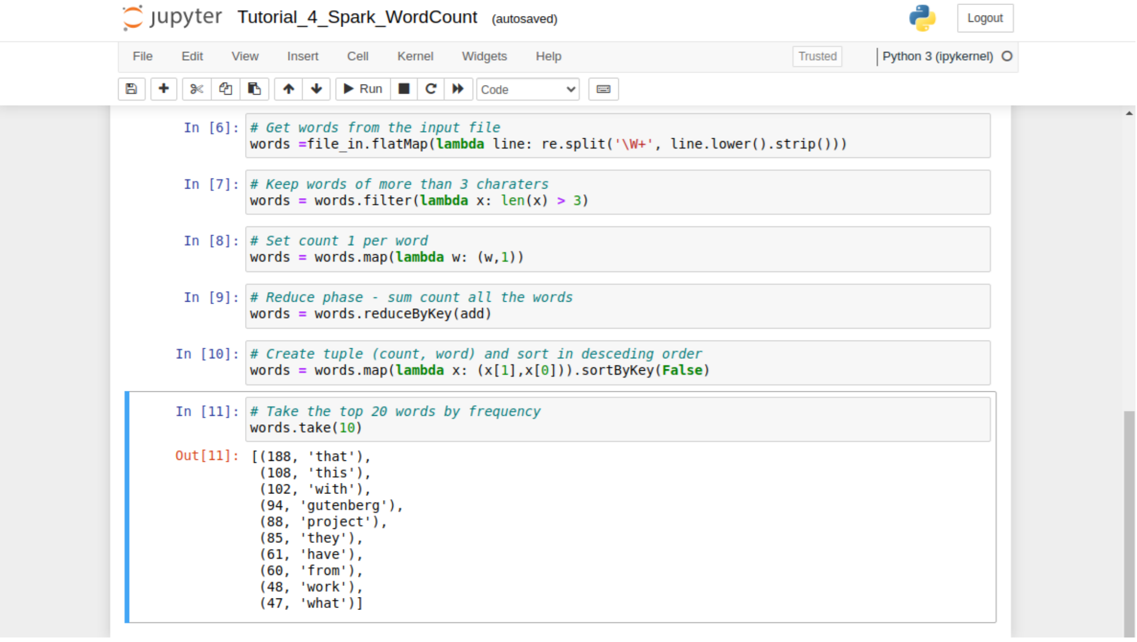
Name	Last Modified	File size
Tutorial_4_Spark_WordCount.ipynb	5 months ago	4.28 kB
pg30123.txt	3 years ago	65.2 kB

16) In the browser Jupyter interface navigate and open the Tutorial_4_Spark_WordCount.ipynb


Home Page - Select or cr
Tutorial_4_Spark_Word
localhost:8888/notebooks/Tutorial_4_Spark_WordCount.ipynb
jupyter Tutorial_4_Spark_WordCount (unsaved changes)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Code

```
In [1]: sc
Out[1]: SparkContext

        Spark UI
        Version
         v3.3.4
        Master
         local[*]
        AppName
         PySparkShell

In [2]: # sc master - running locally
        sc.master
Out[2]: 'local[*]'

In [3]: # Import regex module
        import re
        from operator import add

In [4]: # Read input file from hadoop directory
        # Copy a file from the local folder to hadoop folder
        file_in = sc.textFile('/user1/pg30123.txt')

In [5]: # Count lines
        print('number of lines in file: %s' % file_in.count())
```

17) Test the code and analyse what it does. Make sure the input file should be present on the hadoop distributed file system.


jupyter Tutorial_4_Spark_WordCount (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
Run
Code

```
In [6]: # Get words from the input file
        words =file_in.flatMap(lambda line: re.split('\W+', line.lower().strip()))

In [7]: # Keep words of more than 3 charaters
        words = words.filter(lambda x: len(x) > 3)

In [8]: # Set count 1 per word
        words = words.map(lambda w: (w,1))

In [9]: # Reduce phase - sum count all the words
        words = words.reduceByKey(add)

In [10]: # Create tuple (count, word) and sort in desceding order
        words = words.map(lambda x: (x[1],x[0])).sortByKey(False)

In [11]: # Take the top 20 words by frequency
        words.take(10)

Out[11]: [(188, 'that'),
          (108, 'this'),
          (102, 'with'),
          (94, 'gutenberg'),
          (88, 'project'),
          (85, 'they'),
          (61, 'have'),
          (60, 'from'),
          (48, 'work'),
          (47, 'what')]
```

18) Practice Tutorial exercises provided for further exploration Apache spark on Moodle.

Appendix A

If you would like to install google chrome, Follow the following steps as mentioned below

```
$sudo apt update
$ wget https://dl.google.com/linux/direct/google-chrome-stable_current_amd64.deb
$sudo dpkg -i google-chrome-stable_current_amd64.deb
$google-chrome
```

Add to your favorites when Google Chrome launches so that you won't need to use the terminal to launch it again.

References:

- https://spark.apache.org/examples.html
- https://www.cloudduggu.com/spark/