

Exercise 6

Get started with Apache Spark and Python

Prior Knowledge

Unix Command Line Shell

Simple Python

Learning Objectives

Understand the Spark system

Understand the Jupyter Notebook model

WordCount!

Software Requirements

(see separate document for installation of these)

- Apache Spark 3.0.0
- Python 3.8.x
- Jupyter notebooks

Part A. Spark Python Shell (pySpark)

1. We are going to do a wordcount against a set of books downloaded from Project Gutenberg. Wordcount is the definitive Big Data program (sort of Hello World for Big Data) and it is frankly embarrassing that we haven't done one yet.
2. Apache Spark has a useful Python shell, which we can use to interactively test and run code.
3. Let's make a directory for our code:

```
mkdir ~/pse  
cd ~/pse
```

4. Now start the Spark Python command line tool –

pyspark

5. In the command-line you will see something like

```
[I 13:53:23.865 NotebookApp] Serving notebooks from local directory: /home/oxclo/pse  
[I 13:53:23.866 NotebookApp] 0 active kernels  
[I 13:53:23.866 NotebookApp] The Jupyter Notebook is running at:  
http://localhost:8888/?token=fd655aab32ed4840ceb47b8b7392b1243a27f56350888a91  
[I 13:53:23.866 NotebookApp] Use Control-C to stop this server and shut down all  
kernels (twice to skip confirmation).  
[C 13:53:23.868 NotebookApp]
```

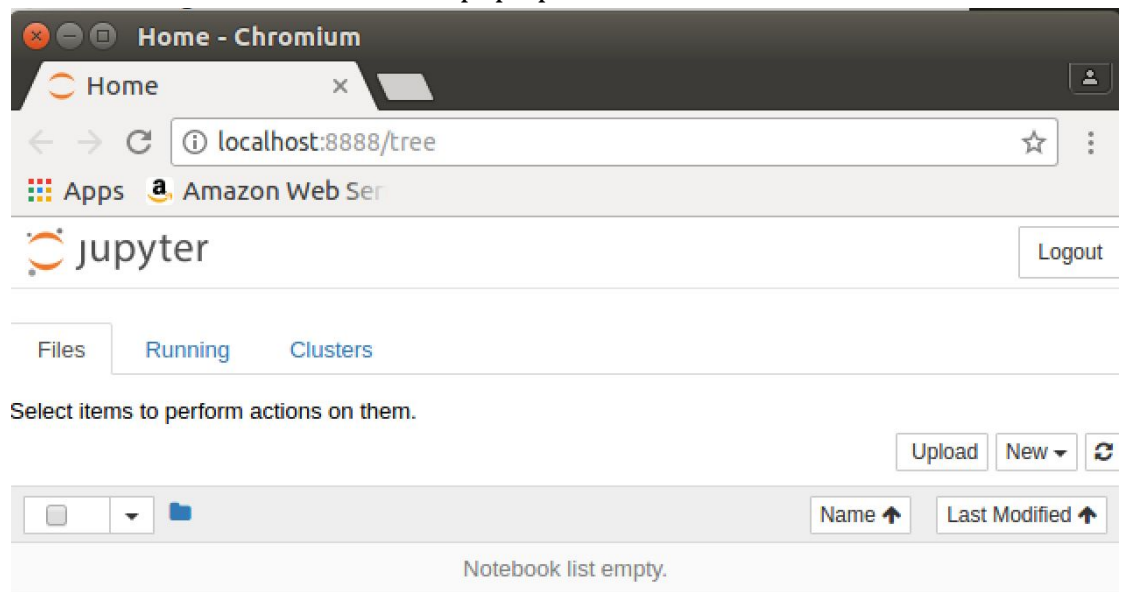
```
Copy/paste this URL into your browser when you connect for the first time,  
to login with a token:  
http://localhost:8888/?token=fd655aab32ed4840ceb47b8b7392b1243a27f56350888a91
```

6. Jupyter is starting. This is because I have **already** preconfigured the following environment variables in `~/ .bashrc`

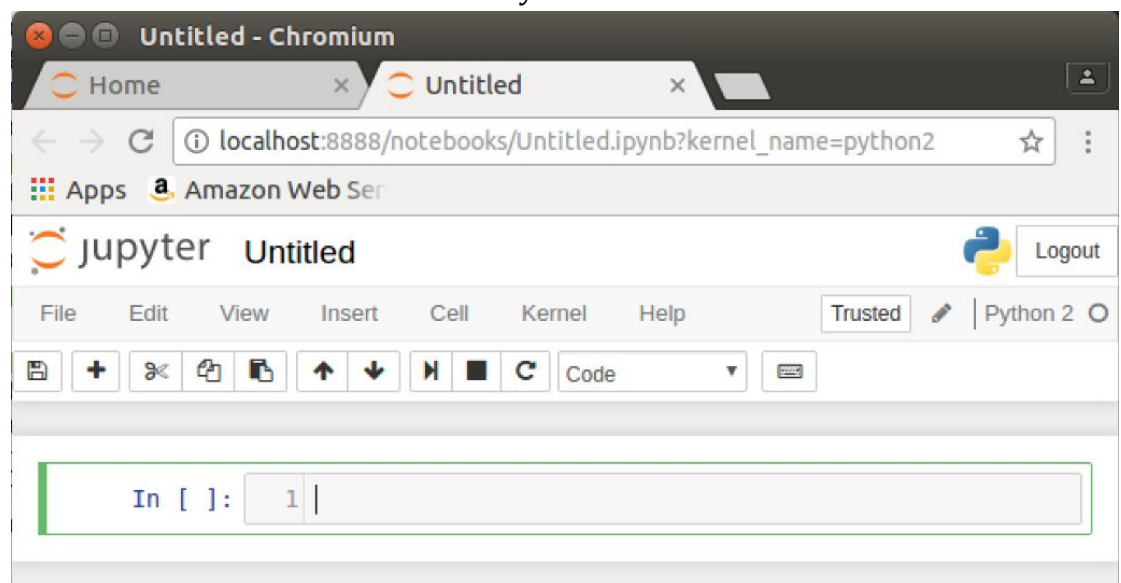
```
export PYSPARK_DRIVER_PYTHON=jupyter
export PYSPARK_DRIVER_PYTHON_OPTS='notebook'
```

You don't need to do this!

7. And then a browser window will pop up.

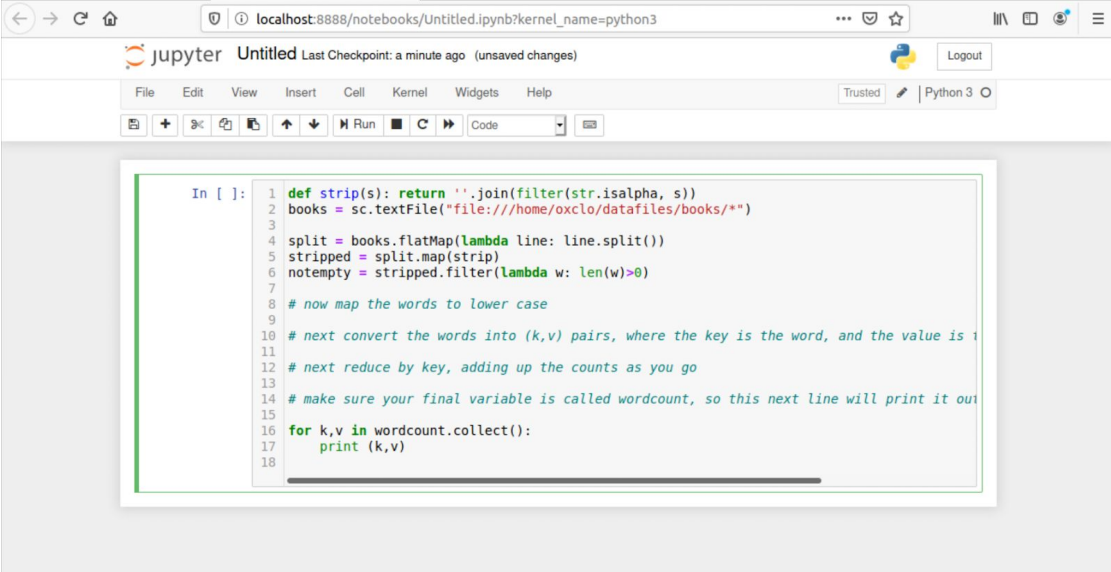


8. Use the **New** button to create a new Python3 notebook:



9. There is a starter of the code you need in the following URL:
<https://freo.me/first-notebook>

Paste that into the cell [1] so it looks like this:



The screenshot shows a Jupyter Notebook titled 'Untitled' with a last checkpoint of 'a minute ago'. The code cell contains the following Python code:

```
In [ ]: 1 def strip(s): return ''.join(filter(str.isalpha, s))
2 books = sc.textFile("file:///home/oxclo/datafiles/books/**")
3
4 split = books.flatMap(lambda line: line.split())
5 stripped = split.map(strip)
6 notempty = stripped.filter(lambda w: len(w)>0)
7
8 # now map the words to lower case
9
10 # next convert the words into (k,v) pairs, where the key is the word, and the value is 1
11
12 # next reduce by key, adding up the counts as you go
13
14 # make sure your final variable is called wordcount, so this next line will print it out
15
16 for k,v in wordcount.collect():
17     print (k,v)
18
```

10. There are some aspects that are not filled in that you need to write.
Basically this is a data-processing pipeline (also a directed acyclic graph)

11. *Let's look at the parts that are there already.*

12. We already have a SparkContext object defined in the notebook (in a program you need to define one, which we will see later)

13. We want to remove any non-alphanumeric characters. This is a function that will do that:

```
def strip(s): return ''.join(filter(str.isalpha, s))
```

14. With the preliminaries over, the next line loads the data in:

```
books =
sc.textFile("file:///home/oxclo/datafiles/books/*")
```

15. Then splits the lines into separate words

```
split = books.flatMap(lambda line: line.split())
```

16. Removes non-alpha characters:

```
stripped = split.map(strip)
```

and removes empty items:

```
notempty = stripped.filter(lambda w: len(w)>0)
```

17. Now it is time for you to do something!


Convert all the words to lower case, using a map operation. In python, if

str is a string, then `str.lower()` is the same string in lower case.

18. Now you need to get ready for a reduce. In order to do a reduce, we need some form of *key, value* pairs. I recommend using *tuples* which are simply (k,v) in Python (the brackets group the items into a tuple).
19. Remembering how reduce works, we need each word to have a count. Before reducing, that count is 1. So we need a lambda that takes a word *w* and returns (w,1)
20. Now we can do a reduce that adds all those counts together.

21. Finally, we need to collect the results and print them. In Spark, they may be distributed across different RDD partitions on different machines, so the `collect()` method brings them together.

```
for k,v in wordcount.collect():  
    print (k,v)
```

22. Try running the cell, by clicking 

23. Be patient. I suggest you look at the command window and wait until you see spark start working.

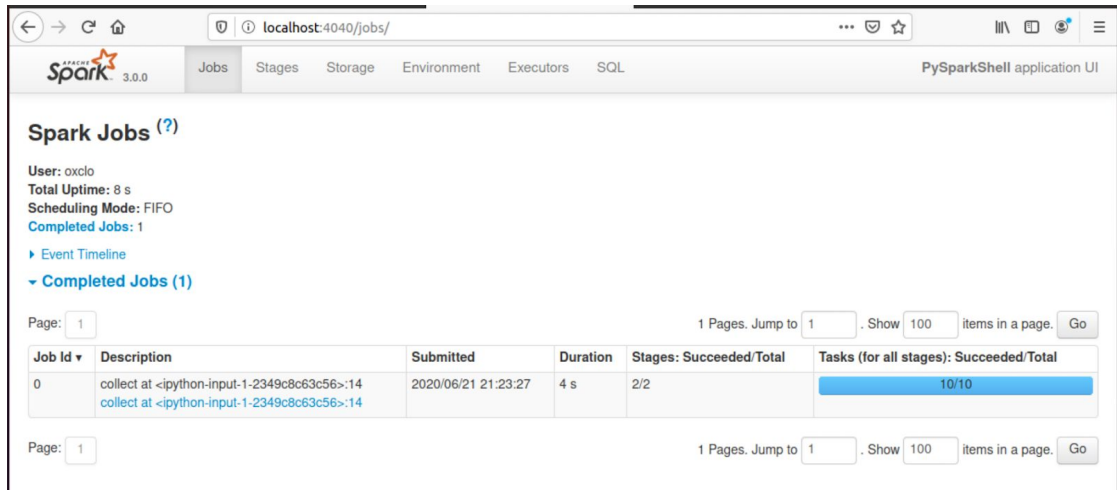
24. You should see a word count appear below cell 1:

```
systematic 7  
parallelogram 1  
sowell 1  
presnya 1  
four 265  
conjuring 1  
chamberagain 1  
marching 32  
sevens 4  
awistocwacy 1  
trotat 1  
canes 1  
shipnets 1  
understandthat 2  
lorn 16  
lore 1  
inwards 2  
wickam 62  
utterand 1  
alright 1
```

25. Congratulations!

26. While the pyspark is still running browse to <http://localhost:4040>

27. You will see the Spark web console:



The screenshot shows the Spark web console interface. At the top, there's a navigation bar with tabs for Jobs, Stages, Storage, Environment, Executors, and SQL. The main content area is titled "Spark Jobs (?)". It shows user information (User: oxclo, Total Uptime: 8 s, Scheduling Mode: FIFO, Completed Jobs: 1) and a section for "Completed Jobs (1)". Below this is a table with columns: Job Id, Description, Submitted, Duration, Stages: Succeeded/Total, and Tasks (for all stages): Succeeded/Total. The table contains one row for Job 0, which completed successfully. The table also includes pagination controls at the bottom.

| Job Id | Description | Submitted | Duration | Stages: Succeeded/Total | Tasks (for all stages): Succeeded/Total |
|--------|--|---------------------|----------|-------------------------|---|
| 0 | collect at <ipython-input-1-2349c8c63c56>:14 collect at <ipython-input-1-2349c8c63c56>:14 | 2020/06/21 21:23:27 | 4 s | 2/2 | 10/10 |

28. Click on the blue link “collect at ipython-input”

This shows you how Spark converted your code into stages:

Details for Job 0

Status: SUCCEEDED
Completed Stages: 2

Event Timeline
DAG Visualization

Stage 0: reduceByKey at <ipython-input-1-2349c8c63c56>:12
Stage 1: partitionBy, mapPartitions

Completed Stages (2)

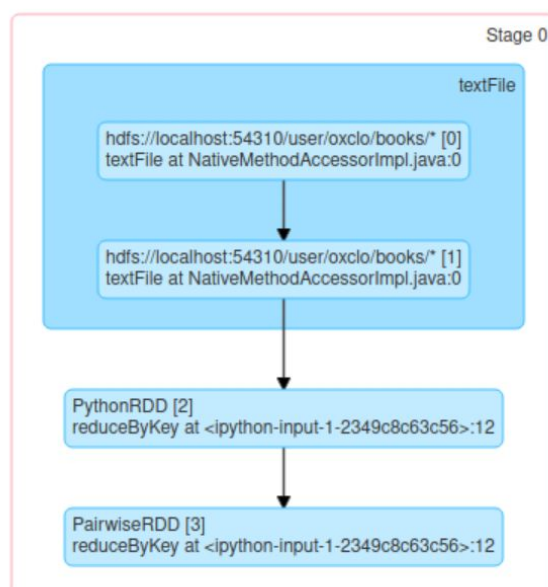
| Stage Id | Description | Submitted | Duration | Tasks: Succeeded/Total | Input | Output | Shuffle Read | Shuffle Write |
|----------|--|---------------------|----------|------------------------|----------|--------|--------------|---------------|
| 1 | collect at <ipython-input-1-2349c8c63c56>:14 | 2020/06/21 21:23:31 | 0.2 s | 5/5 | | | 860.6 KiB | |
| 0 | reduceByKey at <ipython-input-1-2349c8c63c56>:12 | 2020/06/21 21:23:27 | 4 s | 5/5 | 10.6 MiB | | | 860.6 KiB |

29. Click on Stage 0, or the latest Stage (Note that if you have done more than one run, it may not be Stage 0!)

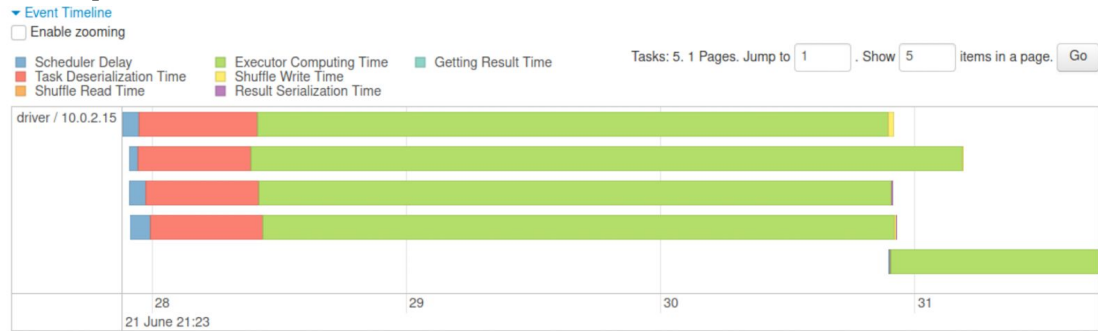
Details for Stage 0 (Attempt 0)

Total Time Across All Tasks: 11 s
Locality Level Summary: Process local: 5
Input Size / Records: 10.6 MiB / 224113
Shuffle Write Size / Records: 860.6 KiB / 330
Associated Job Ids: 0

DAG Visualization



30. And expand the Event Timeline:



Summary Metrics for 5 Completed Tasks

| Metric | Min | 25th percentile | Median | 75th percentile | Max |
|------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Duration | 0.8 s | 2 s | 2 s | 3 s | 3 s |
| GC Time | 0.0 ms | 10.0 ms | 10.0 ms | 10.0 ms | 10.0 ms |
| Input Size / Records | 1.8 MiB / 37272 | 1.8 MiB / 38588 | 1.9 MiB / 39566 | 2 MiB / 43680 | 3.1 MiB / 65007 |
| Shuffle Write Size / Records | 140.4 KiB / 65 | 168.1 KiB / 65 | 174.4 KiB / 65 | 176.4 KiB / 65 | 201.3 KiB / 70 |

31. Make sure your code is saved from the notebook.
32. Quit the notebook shell by typing Ctrl-C on the command line, and then Y
Also close the notebook windows in the browser.
33. Now let's run the same code as a "job" instead of interactively.
34. From <http://freo.me/oxclo-wc-py> copy the code into a file `wc-job.py`
35. You will notice that there is a bunch of "setup" code that we didn't need in the pyspark command line tool. That is because pyspark assumes you want all this and does it for you.
36. The default environment in your terminal session is telling Pyspark to use Jupyter. We need to stop that. Type:

```
unset PYSPARK_DRIVER_PYTHON
unset PYSPARK_DRIVER_PYTHON_OPTS
```

Note that this will reset when you start a new terminal window, so when you want to go back to using Jupyter, just kill this window and start another.

37. We run jobs locally on a single node directly on Spark:
The `local[*]` indicates to use as many threads as you have cores on your system: *(all on one line)*

```
~/spark/bin/spark-submit --master local[*] wc-job.py
"file:///home/oxclo/datafiles/books/*"
```

38. Congratulations, the lab is complete!

Extension

39. Re load the code into the Jupyter notebook and now improve it to show the wordcount in descending order, starting with the most common words.