Exercise 8

Get started with Cassandra and import data via Spark

Prior Knowledge
Unix Command Line Shell
HDFS
Simple Python
Spark Python
Simple SQL syntax

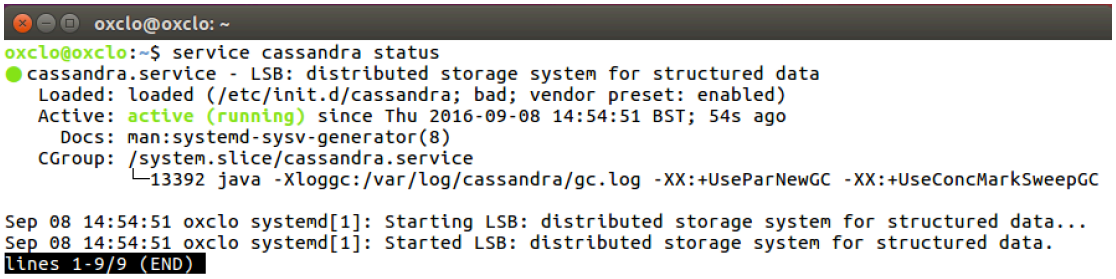
Learning Objectives
Understand Cassandra's CQL shell
Integrate Python, Cassandra and Spark
Load data from CSV into Cassandra using Spark Python

Software Requirements
(see separate document for installation of these)

- Apache Spark 2.2.0
- Python 2.7.12
- Apache Cassandra 3.11.1
- Nano text editor or other text editor

Part A

1. Make sure Cassandra is running
   a. In a Terminal window (Crtl-Alt-T) type:
   `service cassandra status`
   b. You should see



   c. Type q to get back to the command line
   d. If not, try
   `sudo service cassandra start`
   and then check the status again

2. Now you can ask Cassandra about its own situation:
`nodetool status`

   You should see something like:

```
oxclo@oxclo:~$ nodetool status
Datacenter: datacenter1
=======================
Status=Up/Down
|/ State=Normal/Leaving/Joining/Moving
--  Address    Load       Tokens       Owns (effective)  Host ID                               Rack
UN  127.0.0.1  102.8 KB   256          100.0%            53392ab9-9d1a-4ff8-ac0e-62cb1245d49b  rack1
```

3. You can also try:
`nodetool info`
You should see something like:

```
oxclo@oxclo:~$ nodetool info
ID                     : 53392ab9-9d1a-4ff8-ac0e-62cb1245d49b
Gossip active          : true
Thrift active          : false
Native Transport active: true
Load                   : 102.8 KB
Generation No          : 1473342909
Uptime (seconds)       : 203
Heap Memory (MB)       : 167.90 / 1620.00
Off Heap Memory (MB)   : 0.00
Data Center            : datacenter1
Rack                   : rack1
Exceptions             : 0
Key Cache              : entries 10, size 816 bytes, capacity 81 MB, 44 hits, 63 reque
sts, 0.698 recent hit rate, 14400 save period in seconds
Row Cache              : entries 0, size 0 bytes, capacity 0 bytes, 0 hits, 0 requests
, NaN recent hit rate, 0 save period in seconds
Counter Cache          : entries 0, size 0 bytes, capacity 40 MB, 0 hits, 0 requests,
NaN recent hit rate, 7200 save period in seconds
Token                  : (invoke with -T/--tokens to see all 256 tokens)
oxclo@oxclo:~$
```

4. Now you can start the Cassandra Shell:
Type:
`cqlsh`

   You should see:

```
big@big:~$ cqlsh
Connected to Test Cluster at 127.0.0.1:9042.
[cqlsh 5.0.1 | Cassandra 3.11.1 | CQL spec 3.4.4 | Native protocol v4]
Use HELP for help.
cqlsh>
```

   Let's create a new database (Keyspace):
   a. Type (all on a single line)

```
CREATE KEYSPACE TEST WITH REPLICATION = { 'class' :
'SimpleStrategy', 'replication_factor' : 1 };
```

b. Check it worked:
   Type:

```
desc keyspace test;
```

c. You should see:

```
CREATE KEYSPACE test WITH replication = {'class':
'SimpleStrategy', 'replication_factor': '1'}  AND
durable_writes = true;
```

5. Now we need to select to use that keyspace:
   `use test;`

6. The command prompt will change to:
   `cqlsh:test>`

7. Let's create a simple (key, value) table
   a. Type:
   `create table kv ( key text, value text, primary key (key));`

   b. Now type
   `desc kv;`

   c. You should see:

```
cqlsh:test> desc kv;

CREATE TABLE test.kv (
    key text PRIMARY KEY,
    value text
) WITH bloom_filter_fp_chance = 0.01
    AND caching = '{"keys":"ALL",
"rows_per_partition":"NONE"}'
    AND comment = ''
    AND compaction = {'class':
'org.apache.cassandra.db.compaction.SizeTieredCompactionStra
tegy'}
    AND compression = {'sstable_compression':
'org.apache.cassandra.io.compress.LZ4Compressor'}
    AND dclocal_read_repair_chance = 0.1
    AND default_time_to_live = 0
    AND gc_grace_seconds = 864000
    AND max_index_interval = 2048
    AND memtable_flush_period_in_ms = 0
    AND min_index_interval = 128
    AND read_repair_chance = 0.0
    AND speculative_retry = '99.0PERCENTILE';
```

   d. Add some simple values:
   ```
   insert into kv (key, value) values ('a','1');
   insert into kv (key, value) values ('b','2');
   insert into kv (key, value) values ('c','3');
   ```

   e. Now type:
   `select * from kv;`

You should see:

```
key | value
-----+-------
   a |     1
   c |     3
   b |     2

(3 rows)
```

8. You can also do other simple SQL of course

```
cqlsh:test> select * from kv where key='a' ;

 key | value
-----+-------
   a |     1

(1 rows)
```

PART B – Loading data from CSV files into Cassandra

9. Firstly, we need to create a database and a table in which to store our data. Start up the **cqlsh** again and type the following commands (available here: https://freo.me/winddata-ddl)

```
CREATE KEYSPACE wind
WITH replication = {'class': 'SimpleStrategy',
'replication_factor': '1'};

USE wind;

CREATE TABLE winddata (
          stationid text,
          time timestamp,
          direction float,
          temp float,
          velocity float,
          PRIMARY KEY (stationid, time)
      );
```

10. Type **exit** to leave the cqlsh command line.

11. In order to load the CSV files into Cassandra, we are going to use a Spark packages to help us: the Cassandra plugin for Spark.

    Please note, there are lots of ways of loading CSV data into Cassandra, including a built-in Cassandra utility, which might be easier to use for small datasets.

    This exercise is designed to demonstrate how to integrate Cassandra with Spark. For a really large dataset, if this was loaded from HDFS into Cassandra, this Spark-based approach would have the major benefit of parallelizing the operation.

12. To use these, we need to start pyspark with the correct command line. Since we are starting pyspark via Jupyter, we need to pass this via an environment variable.

13. Start a terminal window and type (all on one line)

    ```
    export PYSPARK_SUBMIT_ARGS="--packages datastax:spark-cassandra-connector:2.0.3-s_2.11 pyspark-shell"
    ```

    It is important that you start jupyter from this window now. If you close the window, this environment will be lost.

    Start Jupyter as before. Create a new Python2 notebook and copy code from
    https://freo.me/big-import
    to the notebook.

Let's look at it line by line.

```
1  import findspark
2  findspark.init()
3
4  from dateutil import parser
5
6  from pyspark.sql import Row, SparkSession
7  spark = SparkSession.builder.getOrCreate()
8  df = spark.read.csv('/home/big/sql/*.csv', header=True)
9
10 df.show(1)
11
12 convertTime = lambda t: parser.parse(t.replace('?',' '))
13
14 clean = lambda s: Row(stationid=s.Station_ID,
15     time=convertTime(s.Interval_End_Time),
16     direction=s.Wind_Direction_Deg,
17     temp=s.Ambient_Temperature_Deg_C,
18     velocity=s.Wind_Velocity_Mtr_Sec)
19
20 newDF = df.rdd.map(clean).toDF()
21
22 newDF.show(1)
23
24 newDF.write.format("org.apache.spark.sql.cassandra").mode('append').\
25     options(table="winddata", keyspace="wind").save()
26
27 print 'done'
```

You should recognize lines 1 and 2.
Line 4: dateutil.parser is a useful utility that can read most common date formats.
Lines 6-8: these are just as in the SQL exercise.

Line 10: This will print out one line of the data we've read in so we can see the format.

Line 12. This is a function that will parse the date time string into a Python datetime object. Unfortunately the input format is not one recognized by dateutil.parser, but we can easily fix that by removing the '?'.

Line 14: this function replaces one Row with another. In the new Row, the names are simpler (and match those we used to create the keyspace). Also the date is formatted using our **convertTime** function.

Line 20: This converts from a dataframe to an RDD, uses map to apply our clean function, and then converts back to a dataframe.

Line 22: This shows our more beautiful dataframe layout.

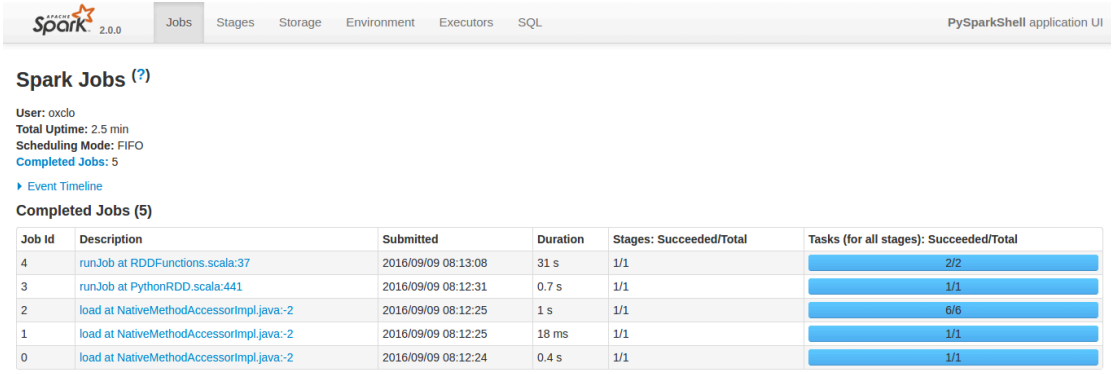
Line 24: This exports the dataframe to Cassandra, specifying the database and table to use.

14. Run the cell. This will take a bit of time.

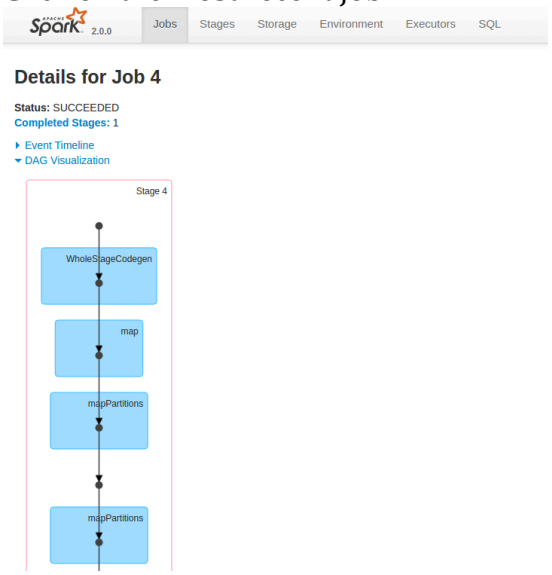
15. You should see the following:

```
+----------+--------------------+--------------+----------------+-----------------+----------------------+----------
----------------+------------------+-------------------------+--------------------------+
|Station_ID|        Station_Name|Location_Label|Interval_Minutes|Interval_End_Time|Wind_Velocity_Mtr_Sec|Wind_Direc
tion_Variance_Deg|Wind_Direction_Deg|Ambient_Temperature_Deg_C|Global_Horizontal_Irradiance|
+----------+--------------------+--------------+----------------+-----------------+----------------------+----------
----------------+------------------+-------------------------+--------------------------+
|      SF15|Warnerville Switc...|   Warnerville|               5| 2015-01-5? 00:05|                 1.628|
             8.1|             148.5|                     0.92|                     0.061|
+----------+--------------------+--------------+----------------+-----------------+----------------------+----------
----------------+------------------+-------------------------+--------------------------+
only showing top 1 row

+---------+---------+----+-------------------+--------+
|direction|stationid|temp|               time|velocity|
+---------+---------+----+-------------------+--------+
|    148.5|     SF15|0.92|2015-01-05 00:05:00|   1.628|
+---------+---------+----+-------------------+--------+
only showing top 1 row

done
```

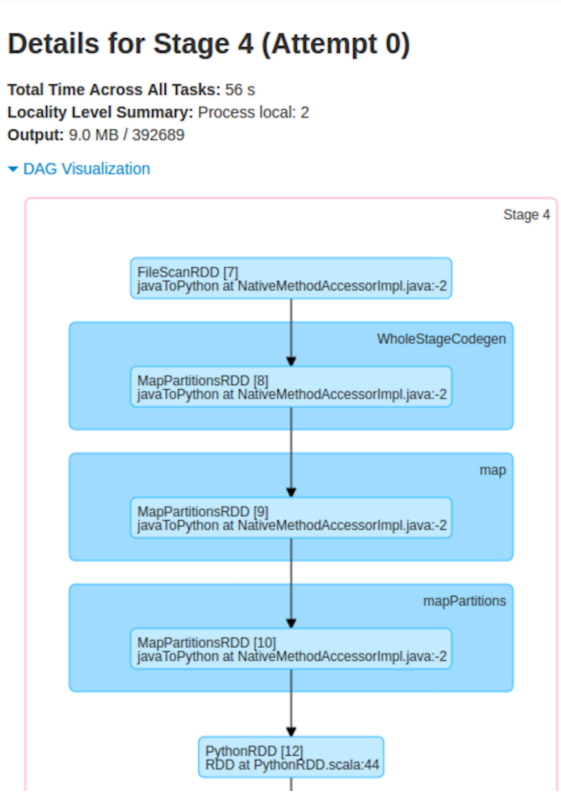
16. Browse to http://localhost:4040
    It will look similar to:



17. Click on the most recent job:



18. You can also get more details by clicking on a stage in the DAG (Directed Acyclic Graph) picture:



19. Check that the data has loaded. Start another terminal window and restart **cqlsh**.

20. In your **cqlsh** window type:

```
select * from wind.winddata limit 15;
```

21. You should see something like:

```
 stationid | time                     | direction | temp  | velocity
-----------+--------------------------+-----------+-------+----------
      SF36 | 2015-01-01 00:00:00+0000 |     116.9 | 11.33 |    2.727
      SF36 | 2015-01-01 00:05:00+0000 |     108.5 | 11.25 |    1.814
      SF36 | 2015-01-01 00:10:00+0000 |     113.7 |  11.2 |    2.621
      SF36 | 2015-01-01 00:15:00+0000 |     117.8 | 11.11 |    3.678
      SF36 | 2015-01-01 00:20:00+0000 |     117.3 | 11.07 |    2.842
      SF36 | 2015-01-01 00:25:00+0000 |     117.3 | 11.07 |    2.629
      SF36 | 2015-01-01 00:30:00+0000 |     117.3 | 11.09 |    2.235
      SF36 | 2015-01-01 00:35:00+0000 |     117.2 | 11.09 |    2.043
      SF36 | 2015-01-01 00:40:00+0000 |     117.2 | 11.05 |    1.635
      SF36 | 2015-01-01 00:45:00+0000 |     117.3 | 10.93 |    2.224
      SF36 | 2015-01-01 00:50:00+0000 |     112.5 | 10.86 |    1.822
      SF36 | 2015-01-01 00:55:00+0000 |     108.7 |  10.8 |    0.866
      SF36 | 2015-01-01 01:00:00+0000 |     108.7 | 10.67 |    1.068
      SF36 | 2015-01-01 01:05:00+0000 |     108.6 | 10.54 |    1.393
      SF36 | 2015-01-01 01:10:00+0000 |     108.7 | 10.44 |    1.468

(15 rows)
```

22. We can do some more queries on the data.

```
use wind;
select * from winddata where time = '2015-01-01' and stationid =
'SF36';
```

You should see:

```
 stationid | time                        | direction | temp  | velocity
-----------+-----------------------------+-----------+-------+----------
      SF36 | 2015-01-01 00:00:00+0000 |     116.9 | 11.33 |    2.727
```

Now try

```
select * from winddata where time <= '2015-01-02' and stationid =
'SF36' limit 20;
```

All normal:

```
 stationid | time                        | direction | temp  | velocity
-----------+-----------------------------+-----------+-------+----------
      SF36 | 2015-01-01 00:00:00+0000 |     116.9 | 11.33 |    2.727
      SF36 | 2015-01-01 00:05:00+0000 |     108.5 | 11.25 |    1.814
      SF36 | 2015-01-01 00:10:00+0000 |     113.7 |  11.2 |    2.621
      SF36 | 2015-01-01 00:15:00+0000 |     117.8 | 11.11 |    3.678
      SF36 | 2015-01-01 00:20:00+0000 |     117.3 | 11.07 |    2.842
      SF36 | 2015-01-01 00:25:00+0000 |     117.3 | 11.07 |    2.629
      SF36 | 2015-01-01 00:30:00+0000 |     117.3 | 11.09 |    2.235
      SF36 | 2015-01-01 00:35:00+0000 |     117.2 | 11.09 |    2.043
      SF36 | 2015-01-01 00:40:00+0000 |     117.2 | 11.05 |    1.635
      SF36 | 2015-01-01 00:45:00+0000 |     117.3 | 10.93 |    2.224
      SF36 | 2015-01-01 00:50:00+0000 |     112.5 | 10.86 |    1.822
      SF36 | 2015-01-01 00:55:00+0000 |     108.7 |  10.8 |    0.866
      SF36 | 2015-01-01 01:00:00+0000 |     108.7 | 10.67 |    1.068
      SF36 | 2015-01-01 01:05:00+0000 |     108.6 | 10.54 |    1.393
      SF36 | 2015-01-01 01:10:00+0000 |     108.7 | 10.44 |    1.468
      SF36 | 2015-01-01 01:15:00+0000 |     108.9 | 10.37 |    1.859
      SF36 | 2015-01-01 01:20:00+0000 |     108.6 | 10.29 |    1.67
      SF36 | 2015-01-01 01:25:00+0000 |     108.6 | 10.25 |    1.241
      SF36 | 2015-01-01 01:30:00+0000 |     108.5 | 10.21 |    0.675
      SF36 | 2015-01-01 01:35:00+0000 |     108.4 | 10.26 |    0.623

(20 rows)
```


23. Now another:
```
select * from winddata where time <= '2015-01-01 01:00:00' and
stationid in ('SF37', 'SF36');
```

```
 stationid | time                     | direction | temp  | velocity
-----------+--------------------------+-----------+-------+----------
      SF36 | 2015-01-01 00:00:00+0000 |     116.9 | 11.33 |    2.727
      SF36 | 2015-01-01 00:05:00+0000 |     108.5 | 11.25 |    1.814
      SF36 | 2015-01-01 00:10:00+0000 |     113.7 |  11.2 |    2.621
      SF36 | 2015-01-01 00:15:00+0000 |     117.8 | 11.11 |    3.678
      SF36 | 2015-01-01 00:20:00+0000 |     117.3 | 11.07 |    2.842
      SF36 | 2015-01-01 00:25:00+0000 |     117.3 | 11.07 |    2.629
      SF36 | 2015-01-01 00:30:00+0000 |     117.3 | 11.09 |    2.235
      SF36 | 2015-01-01 00:35:00+0000 |     117.2 | 11.09 |    2.043
      SF36 | 2015-01-01 00:40:00+0000 |     117.2 | 11.05 |    1.635
      SF36 | 2015-01-01 00:45:00+0000 |     117.3 | 10.93 |    2.224
      SF36 | 2015-01-01 00:50:00+0000 |     112.5 | 10.86 |    1.822
      SF36 | 2015-01-01 00:55:00+0000 |     108.7 |  10.8 |    0.866
      SF36 | 2015-01-01 01:00:00+0000 |     108.7 | 10.67 |    1.068
      SF37 | 2015-01-01 00:00:00+0000 |     252.3 | 11.11 |    3.774
      SF37 | 2015-01-01 00:05:00+0000 | 273.89999 | 10.75 |     2.69
      SF37 | 2015-01-01 00:10:00+0000 | 299.79999 |  11.1 |    1.747
      SF37 | 2015-01-01 00:15:00+0000 |     303.5 | 11.65 |    1.534
      SF37 | 2015-01-01 00:20:00+0000 | 282.79999 | 10.27 |    2.269
      SF37 | 2015-01-01 00:25:00+0000 | 281.70001 |  9.72 |    2.141
      SF37 | 2015-01-01 00:30:00+0000 | 292.70001 |  9.78 |    1.054
      SF37 | 2015-01-01 00:35:00+0000 | 280.39999 |  9.53 |     2.36
      SF37 | 2015-01-01 00:40:00+0000 | 280.29999 |   9.3 |    2.155
      SF37 | 2015-01-01 00:45:00+0000 | 266.10001 |  9.37 |      3.1
      SF37 | 2015-01-01 00:50:00+0000 |       272 |  9.46 |    2.703
      SF37 | 2015-01-01 00:55:00+0000 | 265.39999 |  9.54 |    3.026
      SF37 | 2015-01-01 01:00:00+0000 | 291.60001 |   9.7 |    1.508

(26 rows)
```

24. So we can query normally can we? Let's try something else:

```
select * from winddata where time <= '2015-01-01 01:00:00';
```

Uh oh!

```
InvalidRequest: code=2200 [Invalid query] message="Cannot execute
this query as it might involve data filtering and thus may have
unpredictable performance. If you want to execute this query despite
the performance unpredictability, use ALLOW FILTERING"
```

Basically, Cassandra will not do unbounded time queries, unless you force it to!

25. Try again, but this time explicitly enabling this query.
```
select * from winddata where time <= '2015-01-01 01:00:00' allow
filtering;
```

26. Now let's try another query:

```
select * from winddata where time <= '2015-01-01 01:00:00' and
temp < 10 ;
```

Again this fails. Unlike a normal SQL database, you cannot do arbitrary queries on Cassandra. You must limit your queries to those that can be done

based on the primary key. There are ways of creating secondary indices, but these basically create a whole new table under the covers to allow efficient searching.

That is all, unless you want to explore some advanced features of Cassandra.

If not, close down your cqlsh window (exit) and your Jupyter notebook and session as before.

Extension

First let's try some JSON support. Try the following:

```
CREATE KEYSPACE jsontest WITH REPLICATION =
  { 'class' : 'SimpleStrategy', 'replication_factor' : 1 };

use jsontest;
create table users  (id text primary key, name text, age int , job text);
insert into users (id, name, age, job) values ('1', 'Paul', 46, 'Student');
select json * from users;
```

You should see:

```
[json]
------------------------------------------------------------
 {"id": "1", "age": 46, "job": "Student", "name": "Paul"}

(1 rows)
```

27. Now let's insert data using JSON.

```
insert into users json
' {"id": "2", "age": 43, "job": "Teacher", "name": "Henry"} ';

select * from users;

id | age | job     | name
----+-----+---------+-------
  2 |  43 | Teacher | Henry
  1 |  46 | Student |  Paul

(2 rows)
```

Notice how we can use either JSON or not.

28. Of course JSON supports complex types including lists, maps, sets and other data. Luckily Cassandra does too. Try out the map type with the following commands:

```
create table demomap ( id int primary key, mapdata map<text,text>);
insert into demomap json
'{"id":1, "mapdata":{ "key1": "value1","key2":"value2"}}';

select * from demomap;

select json * from demomap;
```

29. Now let's try out the **set** type.

```
create table demoset (id int primary key, myset set<text>);

-- insert as json
insert into demoset json ' { "id":1, "myset":["a","b","c"]}';

-- insert in traditional sql style
insert into demoset (id, myset) values (2, {'hello','paul'});

select * from demoset;
select json * from demoset;
```

30. CQL also supports a list type. See if you can figure it out. If not, there is an example over the page.

List example:

```
create table demolist (id int primary key, list list<text>);

insert into demolist (id, list) values (1,['a1','b2','c3']);

select * from demolist;

id | list
----+--------------------
  1 | ['a1', 'b2', 'c3']

(1 rows)

update demolist set list = ['z1'] + list where id = 1;
select * from demolist;

-- what do you expect here?
```

Congratulations - you've completed this lab and extensions.