Session 1. Big Data Analytics with Spark (2 hours)

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1. Introduction

This session is intended to help the student to get started with Apache Spark, a powerful open source framework to process big data with high speed and easy to use.

2. Environment settings

In order to be able to perform the different tasks you should:

1) Boot the PC with the Linux image (preferable) or Windows
2) Log in with the user/password that you use for Atenea (or, in case it does not work, with (invitado, invitado) on Linux or (A2S105-??\invitado, without password) on Windows)

3. Install Spark

Spark requires Java 6 or higher. As we are going to use the Python interactive shell we will need Python 2.6 or higher:

```
$ java –version
$ python -V
```

First of all, we need to download the Spark environment. To do that, we can just execute the following command:

```
$     wget     http://apache.rediris.es/spark/spark-1.6.0/spark-1.6.0-bin-
hadoop2.6.tgz
```

Alternatively (if you want a different version or you are a Windows user) you can go to https://spark.apache.org/ and download the files. In all of this hands-on we will work with Spark v1.6.0. Important: you have to download one of pre-built version in "Choose a package type" section (for instance we tested this hands-on with spark-1.6.0-bin-hadoop2.6).

Once we have the tarball file, we need to uncompress it:

```
$ tar -xvzf spark-1.6.0-bin-hadoop2.6.tgz
```

Let's execute the interactive Python shell:

```
$ bin/pyspark
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 1.6.0
      /_/

Using Python version 2.7.5 (default, Mar  9 2014 22:15:05)
SparkContext available as sc, HiveContext available as sqlContext.
>>>
```

4. Example “word count” application

Download *example1.txt*.

```
$ wget https://raw.githubusercontent.com/rtous/edcav/master/spark/example1.txt
```

which has the following content:

```
En un lugar de la Mancha, de cuyo nombre no quiero acordarme,
No ha mucho tiempo que vivía un hidalgo de los de lanza en
astillero, adarga antigua, rocín flaco y galgo corredor.
```

Let’s now count the words with Spark:

```
>>> linesRDD = sc.textFile("example1.txt")
>>> countsRDD = linesRDD.flatMap(lambda line: line.split(" ")) \
            .map(lambda word: (word, 1)) \
            .reduceByKey(lambda a, b: a + b)
>>> countsRDD.first()
>>> countsRDD.saveAsTextFile("out.txt")
>>> quit()
```

Now that you have run your first Spark code using the shell, it’s time learn about programming in it in more detail. In Spark we express our computation through operations on distributed collections that are automatically parallelized across the cluster. These collections are called Resilient Distributed Datasets, or RDDs. In the example above, the variable called *linesRDD* is an RDD, created here from a text file on our local machine.

Once created, RDDs offer two types of operations: *transformations* and *actions*. Transformations construct a new RDD from a previous one. In our text file example, *flatMap*, *map* and *reduceByKey* are transformations. Spark only computes transformations in a lazy fashion, the first time they are used in an action (e.g. *first()* or *saveAsTextFile(…)* are actions).

5. Simple clustering example (K-Means)

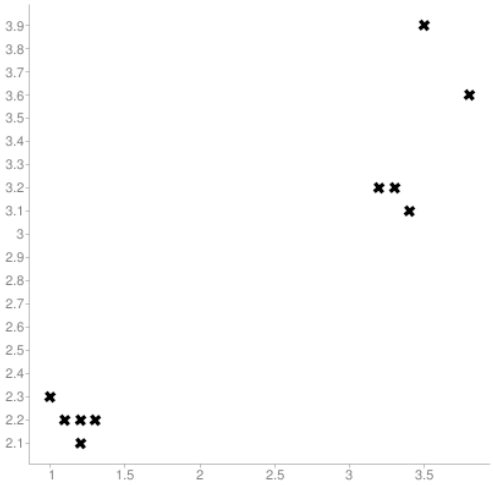
Download *example2.txt* :

```
$ wget https://raw.githubusercontent.com/rtous/edcav/master/spark/example2.txt
```

which has the following content:

```
1.2 2.1
1.1 2.2
1.0 2.3
1.3 2.2
1.2 2.2
3.3 3.2
3.4 3.1
3.8 3.6
3.5 3.9
```

```
3.2 3.2
```



Check the data with the following:

```
>>> data = sc.textFile("example2.txt")
>>> def show (x): print x
>>> data.foreach(show)
```

In the following example, after loading and parsing data, we use the K-Means object to cluster the data into five clusters. The number of desired clusters is passed to the algorithm. We then compute Within Set Sum of Squared Error (WSSSE). You can reduce this error measure by increasing de parameter k.

```
>>> from numpy import array
>>>  parsedData  =  data.map(lambda  line:  array([float(x)  for  x  in
line.split(' ')])).cache()
>>> parsedData.foreach(show)
```

At this point we have an array with the parsed data. With this data, we will train the k-means algorithm and compute the cost. To do that, we need to import some libraries like KMeans and sqrt. We use the KMeans object to cluster the data into two clusters. The number of desired clusters is passed to the algorithm.

```
>>> from pyspark.mllib.clustering import KMeans
>>> clusters = KMeans.train(parsedData, 2, maxIterations=10,
        runs=10, initializationMode="random")
>>> clusters.clusterCenters
```

We can predict the cluster to which a new data point would belong just by doing:

```
>>> clusters.predict([2.2, 2.0])
>>> clusters.predict([3.2, 1.9])
```

We can compute Within Set Sum of Squared Error (WSSSE). You can reduce this error measure by increasing k.

```
>>> from pyspark.mllib.clustering import KMeans
>>> from math import sqrt

def error(point):
    center = clusters.centers[clusters.predict(point)]
    return sqrt(sum([x**2 for x in (point - center)]))

WSSSE = parsedData.map(lambda point: error(point)).reduce(lambda x, y: x +
y)
print("Within Set Sum of Squared Error = " + str(WSSSE))
```

6. Delivery

The files **creates.sql**, **inserts.sql** i **the answers** have to be delivered in a single file (.zip or .tar.gz) through the proper section within http://atenea.upc.edu. The delivery has to be done before the start of the following lab session.