EECS E6893 Big Data Analytics
Spark 101

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Agenda

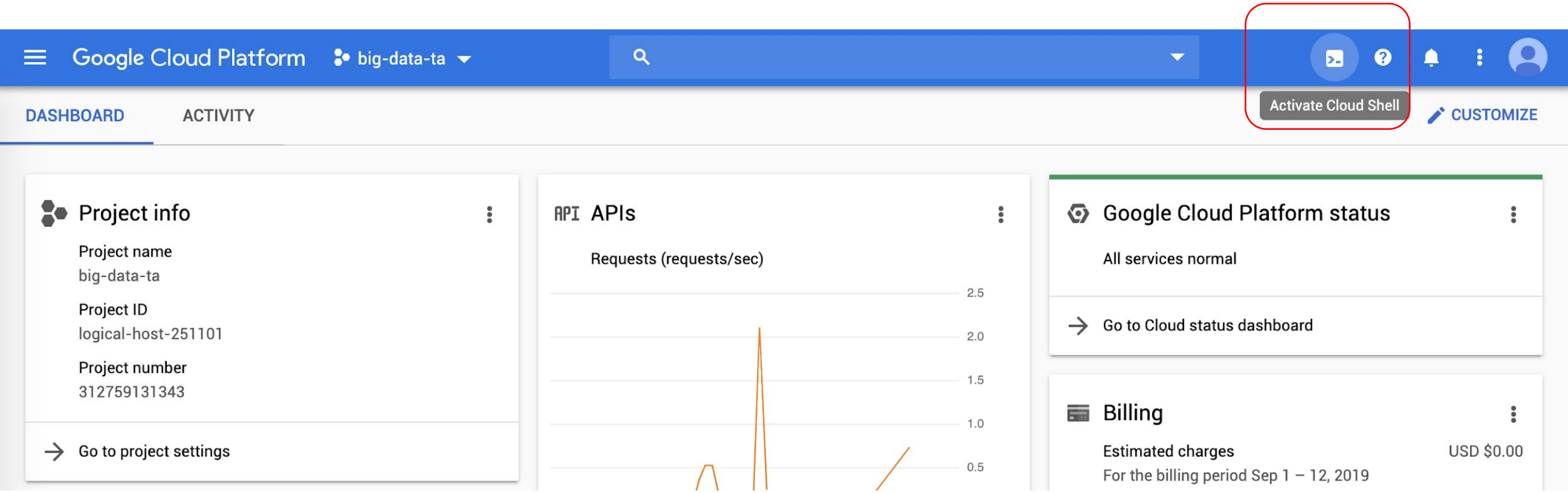
- More on GCP Cloud Shell
- Functional programming in Python
    - Lambda
- Crash course in Spark (PySpark)
    - RDD
    - Useful RDD operations
        - Actions
        - Transformations
    - Example: Word count

GCP Cloud Shell

GCP: Interaction

- Graphical UI / console: Useful to create VMs, set up clusters, provision resources, manage teams, etc
- Command line tools / Cloud SDK: Useful for interacting from local host and using the resources once provisioned. E.x. ssh into instances, submit jobs, copy files, etc
- Cloud shell: Same as command line, but web-based and pre-installed with SDK and tools

GCP: Cloud Shell



Project info

Project name
big-data-ta

Project ID
logical-host-251101

Project number
312759131343

APIs

Requests (requests/sec)

Google Cloud Platform status

All services normal

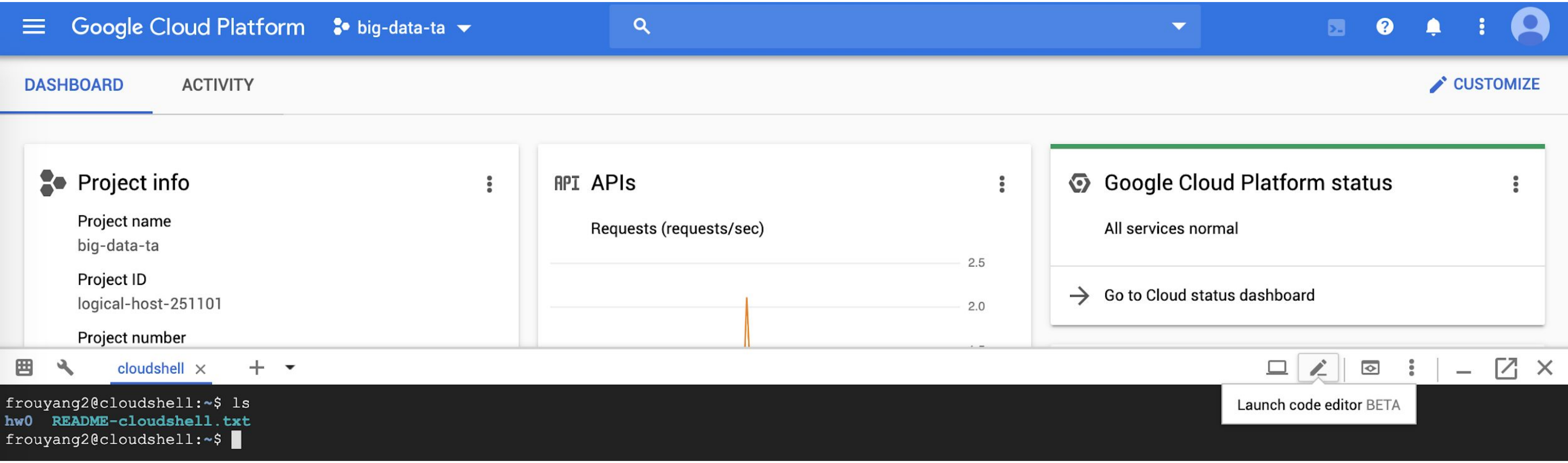
Billing

Estimated charges USD $0.00

For the billing period Sep 1 – 12, 2019

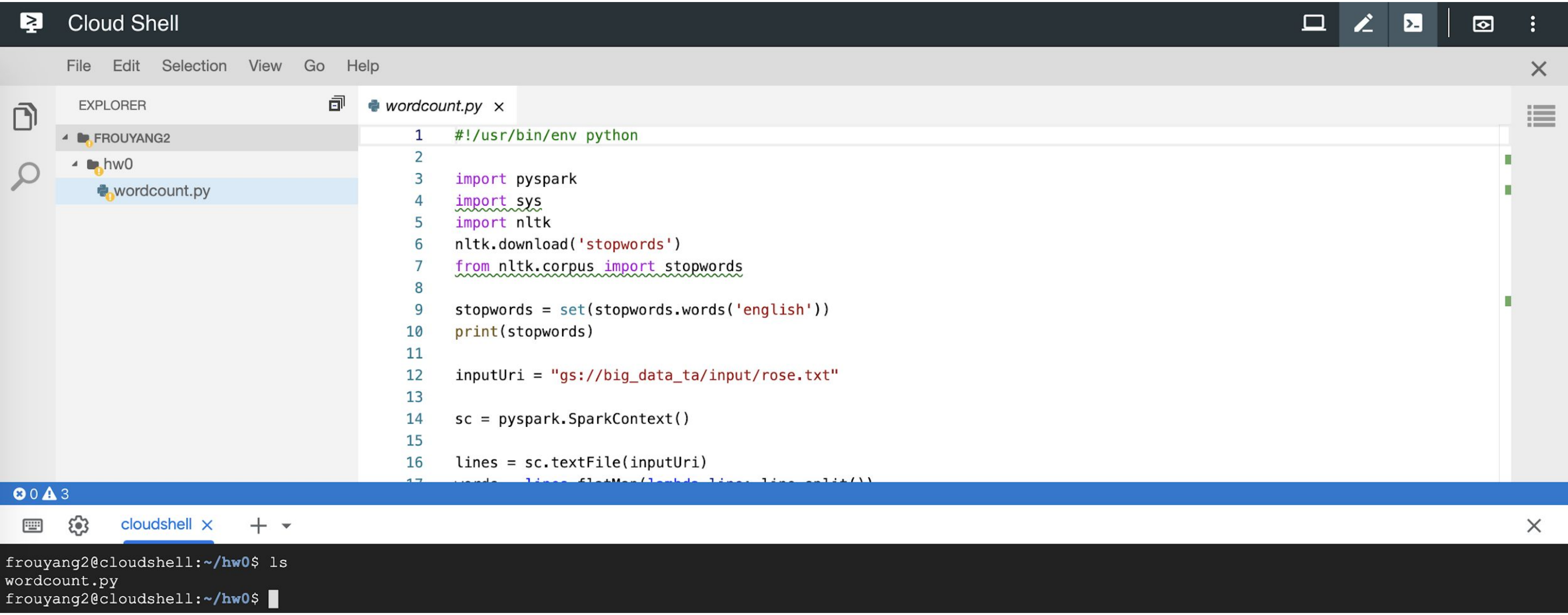
persistent home directory :)

GCP: Cloud Shell (Cont')



```
frouyang2@cloudshell:~$ ls
hw0  README-cloudshell.txt
frouyang2@cloudshell:~$
```

GCP: Code Editor



```python
#!/usr/bin/env python

import pyspark
import sys
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords

stopwords = set(stopwords.words('english'))
print(stopwords)

inputUri = "gs://big_data_ta/input/rose.txt"

sc = pyspark.SparkContext()

lines = sc.textFile(inputUri)
```

```
frouyang2@cloudshell:~/hw0$ ls
wordcount.py
frouyang2@cloudshell:~/hw0$
```

Functional programming in Python

Lambda expression

- Creating small, one-time, anonymous function objects in Python
- Syntax: `lambda arguments: expression`
    - Any number of arguments
    - Single expression
- Could be used together with *map, filter, reduce*
- Example:
    - Add:

```
add = lambda x, y : x + y

type(add) = <type 'function'>


add(2,3)
```

```
def add (x, y):
    return x + y
```

Crash course in Spark

Resilient Distributed Datasets (RDD)

- An *abstraction*
    - a collection of elements
    - partitioned across the nodes of the cluster
    - can be operated on in parallel
- Spark is RDD-centric
- RDDs are immutable
- RDDs can be cached in memory
- RDDs are computed lazily
- RDDs know who their parents are
- RDDs automatically recover from failures

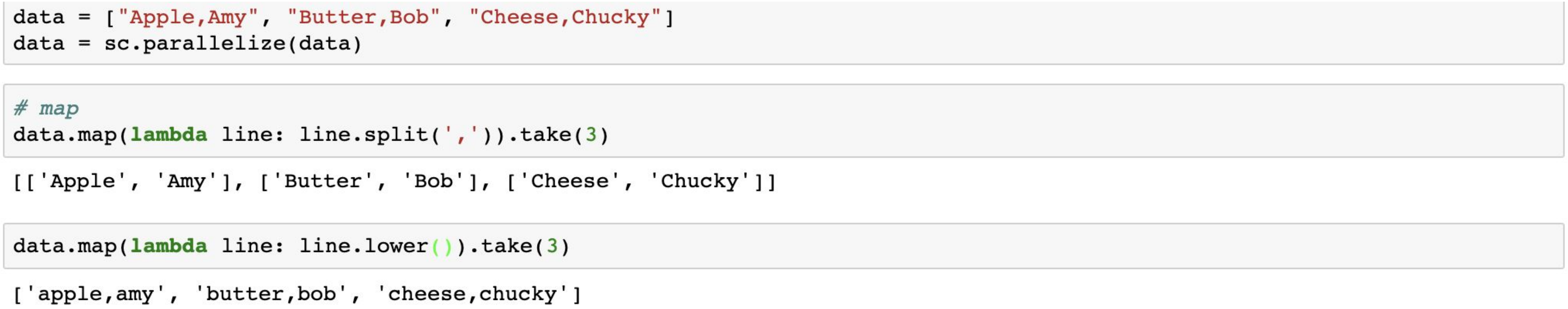
Useful RDD Actions

- take(n): return the first n elements in the RDD as an array.
- collect(): return all elements of the RDD as an array. Use with caution.
- count(): return the number of elements in the RDD as an int.
- saveAsTextFile(‘path/to/dir’): save the RDD to files in a directory. Will create the directory if it doesn’t exist and will fail if it does.
- foreach(func): execute the function against every element in the RDD, but don’t keep any results.

Useful RDD transformations

map(*func*)

- Apply a function to every element of an RDD and return a new result RDD



```
data = ["Apple,Amy", "Butter,Bob", "Cheese,Chucky"]
data = sc.parallelize(data)
```

```
# map
data.map(lambda line: line.split(',')).take(3)
```

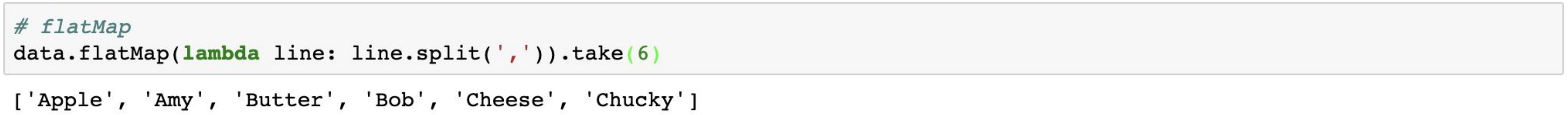
```
[['Apple', 'Amy'], ['Butter', 'Bob'], ['Cheese', 'Chucky']]
```

```
data.map(lambda line: line.lower()).take(3)
```

```
['apple,amy', 'butter,bob', 'cheese,chucky']
```

flatmap(*func*)

- Similar to *map()*, yet flatten by removing the outermost container



```
# flatMap
data.flatMap(lambda line: line.split(',')).take(6)
```

```
['Apple', 'Amy', 'Butter', 'Bob', 'Cheese', 'Chucky']
```

mapValues(*func*)

- Apply an operation to the value of every element of an RDD and return a new result RDD
- Only works with pair RDDs

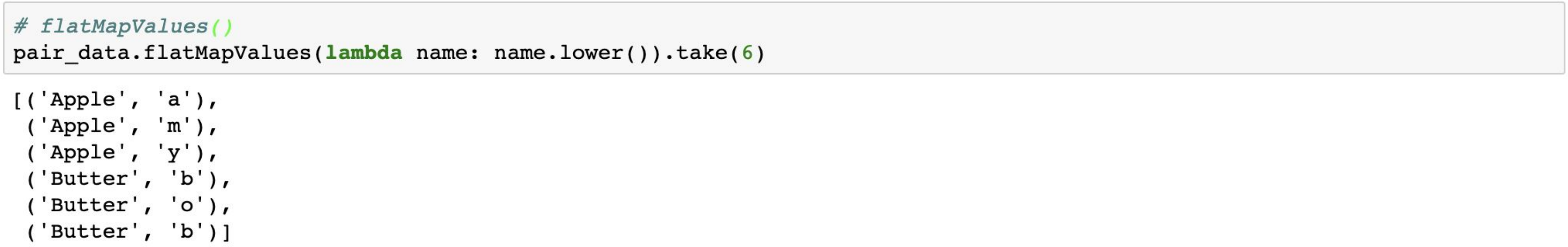
```
pair_data = [('Apple', 'Amy'), ('Butter', 'Bob'), ('Cheese', 'Chucky')]
pair_data = sc.parallelize(pair_data)
```

```
# mapValues()
# each pair: (key, value)
pair_data.mapValues(lambda name: name.lower()).take(3)
```

```
[('Apple', 'amy'), ('Butter', 'bob'), ('Cheese', 'chucky')]
```

flatMapValues(*func*)

- Pass each value in the (K, V) pair RDD through a *flatMap* function without changing the keys

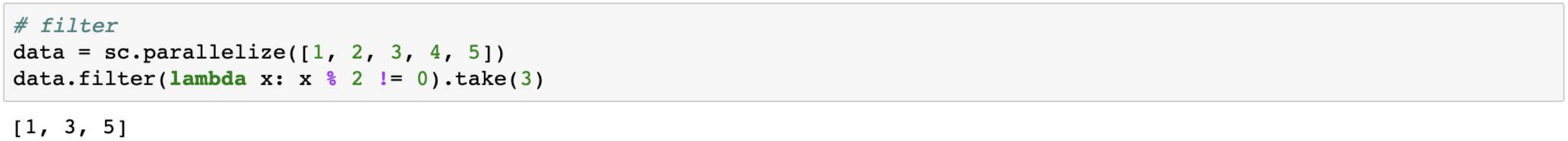


```python
# flatMapValues()
pair_data.flatMapValues(lambda name: name.lower()).take(6)
```

```
[('Apple', 'a'),
 ('Apple', 'm'),
 ('Apple', 'y'),
 ('Butter', 'b'),
 ('Butter', 'o'),
 ('Butter', 'b')]
```

filter(*func*)

- Return a new RDD by selecting the elements which func returns true

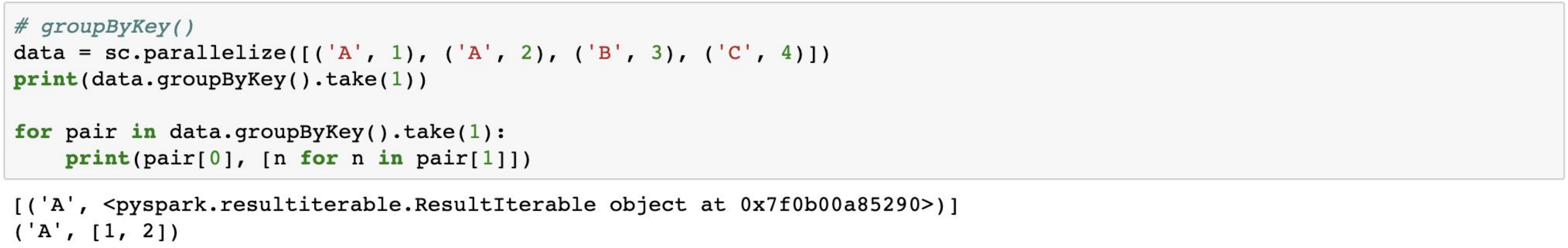


```
# filter
data = sc.parallelize([1, 2, 3, 4, 5])
data.filter(lambda x: x % 2 != 0).take(3)
```

```
[1, 3, 5]
```

groupByKey()

- When called on a RDD of (K, V) pairs, returns a new RDD of (K, Iterable<V>) pairs



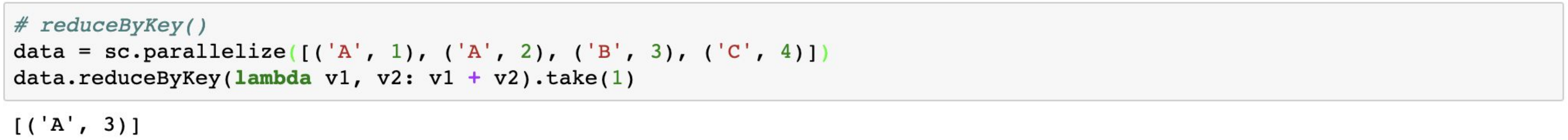
```python
# groupByKey()
data = sc.parallelize([('A', 1), ('A', 2), ('B', 3), ('C', 4)])
print(data.groupByKey().take(1))

for pair in data.groupByKey().take(1):
    print(pair[0], [n for n in pair[1]])
```

```
[('A', <pyspark.resultiterable.ResultIterable object at 0x7f0b00a85290>)]
('A', [1, 2])
```

reduceByKey(*func*)

- Combine elements of an RDD by key and then apply a *reduce func* to pairs of values until only a single value remains
- reduce function *func* must be of type (V,V) => V

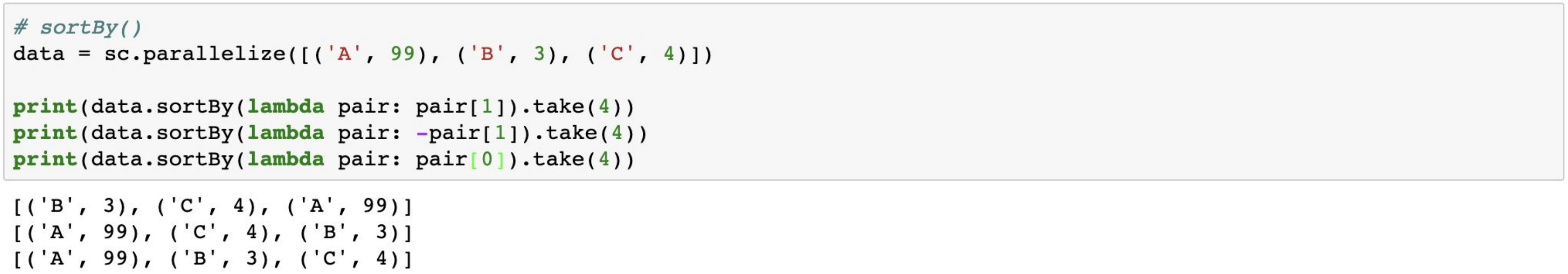


```
# reduceByKey()
data = sc.parallelize([('A', 1), ('A', 2), ('B', 3), ('C', 4)])
data.reduceByKey(lambda v1, v2: v1 + v2).take(1)
```

```
[('A', 3)]
```

sortBy(*func*)

- Sort an RDD according to a sorting *func* and return the results in a new RDD



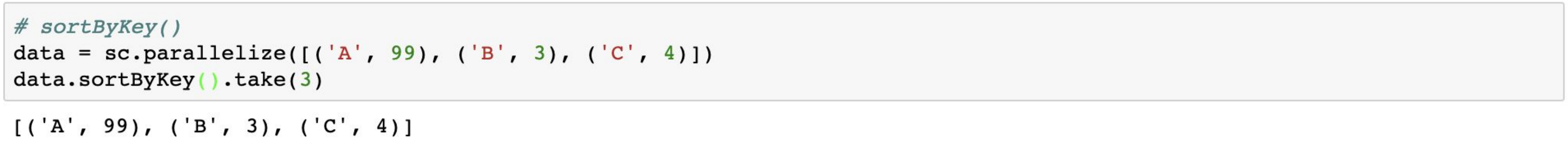
```python
# sortBy()
data = sc.parallelize([('A', 99), ('B', 3), ('C', 4)])

print(data.sortBy(lambda pair: pair[1]).take(4))
print(data.sortBy(lambda pair: -pair[1]).take(4))
print(data.sortBy(lambda pair: pair[0]).take(4))
```

```
[('B', 3), ('C', 4), ('A', 99)]
[('A', 99), ('C', 4), ('B', 3)]
[('A', 99), ('B', 3), ('C', 4)]
```

sortByKey()

- Sort an RDD according to the ordering of the keys and return the results in a new RDD.



```
# sortByKey()
data = sc.parallelize([('A', 99), ('B', 3), ('C', 4)])
data.sortByKey().take(3)
```

```
[('A', 99), ('B', 3), ('C', 4)]
```

substract()

- Return a new RDD that contains all the elements from the original RDD that do not appear in a target RDD.

```
# substract
data1 = sc.parallelize(['Apple,Amy', 'Butter,Bob', 'Cheese,Chucky'])
data2 = sc.parallelize(['Wendy', 'McDonald,Ronald', 'Cheese,Chucky'])
data1.subtract(data2).take(3)
```

```
['Butter,Bob', 'Apple,Amy']
```

Example: word count in Spark

- “Hello world” of Spark

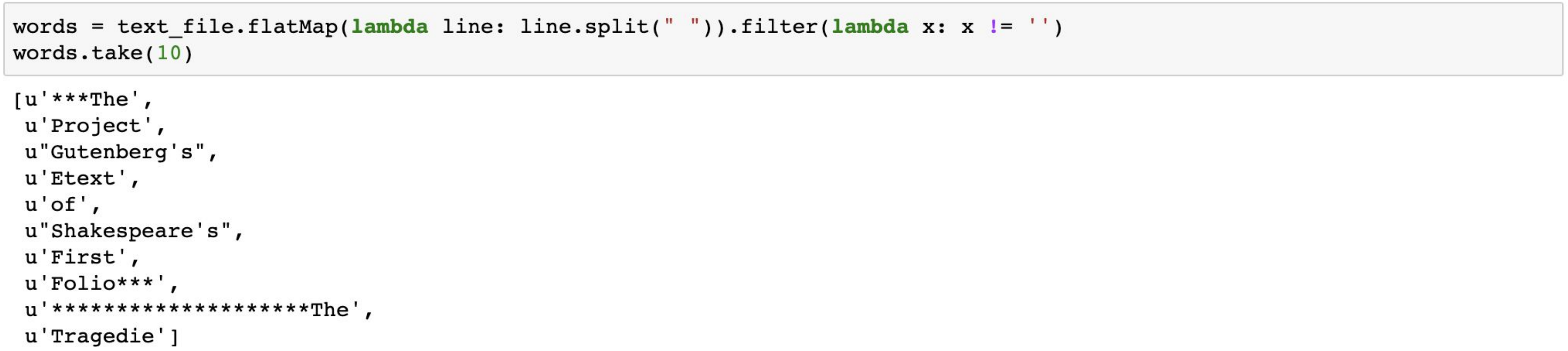
```
text_file = sc.textFile("hdfs://...")
counts = text_file.flatMap(lambda line: line.split(" ")) \
             .map(lambda word: (word, 1)) \
             .reduceByKey(lambda a, b: a + b)
counts.saveAsTextFile("hdfs://...")
```

Word count in Spark: read file into RDD (1)

```
text_file = sc.textFile("gs://big_data_ta/data/shakes.txt")
text_file.take(10)
```

```
[u"***The Project Gutenberg's Etext of Shakespeare's First Folio***",
 u'********************The Tragedie of Macbeth*********************',
 u'',
 u'This is our 3rd edition of most of these plays.  See the index.',
 u'',
 u'',
 u'Copyright laws are changing all over the world, be sure to check',
 u'the copyright laws for your country before posting these files!!',
 u'',
 u'Please take a look at the important information in this header.']
```

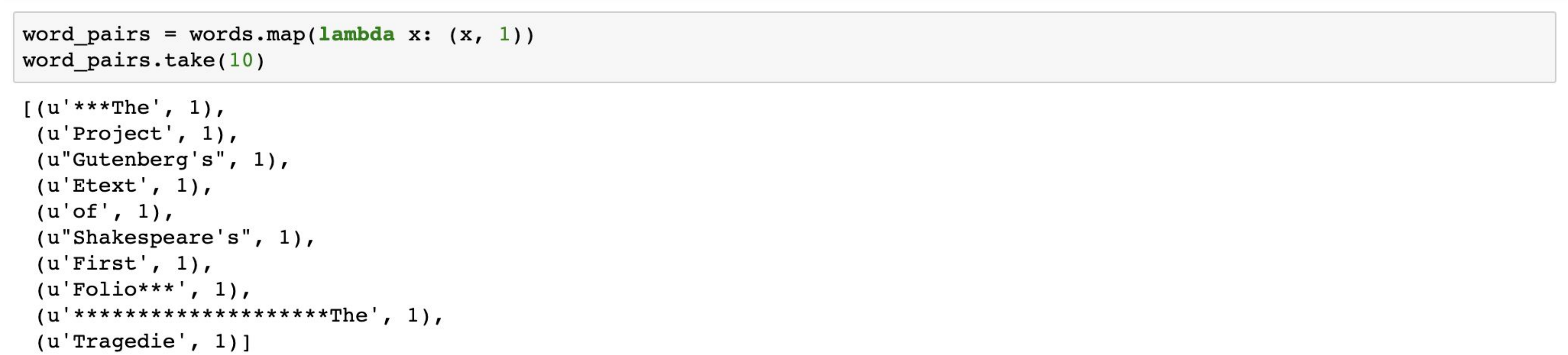
Word count in Spark: split into words (2)



```
words = text_file.flatMap(lambda line: line.split(" ")).filter(lambda x: x != '')
words.take(10)
```

```
[u'***The',
 u'Project',
 u"Gutenberg's",
 u'Etext',
 u'of',
 u"Shakespeare's",
 u'First',
 u'Folio***',
 u'********************The',
 u'Tragedie']
```

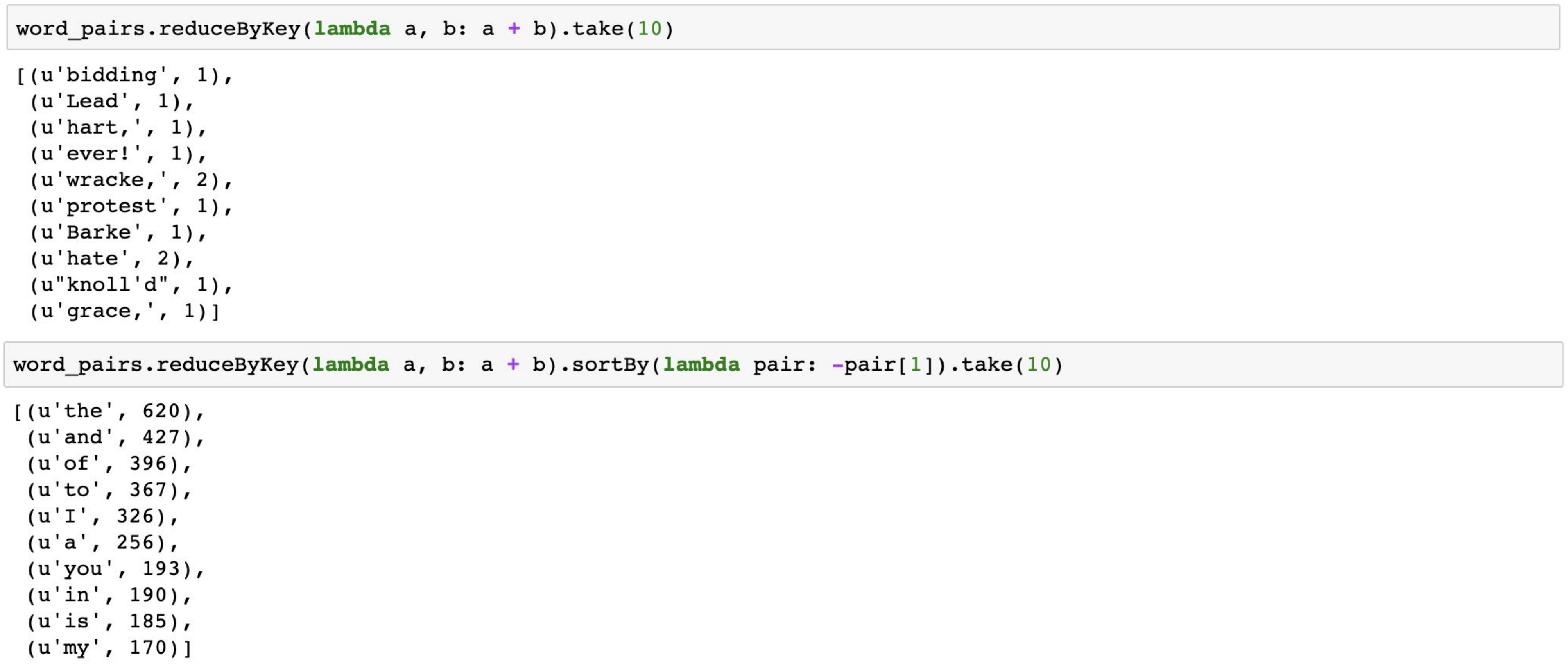
Word count in Spark: form (k, v) pairs (3)



```
word_pairs = words.map(lambda x: (x, 1))
word_pairs.take(10)
```

```
[(u'***The', 1),
 (u'Project', 1),
 (u"Gutenberg's", 1),
 (u'Etext', 1),
 (u'of', 1),
 (u"Shakespeare's", 1),
 (u'First', 1),
 (u'Folio***', 1),
 (u'********************The', 1),
 (u'Tragedie', 1)]
```

Word count in Spark: reduce by aggregating (4)



```
word_pairs.reduceByKey(lambda a, b: a + b).take(10)
```

```
[(u'bidding', 1),
 (u'Lead', 1),
 (u'hart,', 1),
 (u'ever!', 1),
 (u'wracke,', 2),
 (u'protest', 1),
 (u'Barke', 1),
 (u'hate', 2),
 (u"knoll'd", 1),
 (u'grace,', 1)]
```

```
word_pairs.reduceByKey(lambda a, b: a + b).sortBy(lambda pair: -pair[1]).take(10)
```

```
[(u'the', 620),
 (u'and', 427),
 (u'of', 396),
 (u'to', 367),
 (u'I', 326),
 (u'a', 256),
 (u'you', 193),
 (u'in', 190),
 (u'is', 185),
 (u'my', 170)]
```

Next week tutorial

- Spark Dataframe and Spark SQL
- Spark MLlib
- HW1

References

- GCP Cloud Shell
  - https://cloud.google.com/shell/docs/quickstart
- Python functional programming
  - https://book.pythontips.com/en/latest/map_filter.html
  - https://medium.com/better-programming/lambda-map-and-filter-in-python-4935f248593
- Spark
  - RDD programming guide: https://spark.apache.org/docs/latest/rdd-programming-guide.html
  - Spark paper: https://www.usenix.org/legacy/event/hotcloud10/tech/full_papers/Zaharia.pdf
  - RDD paper: https://www.usenix.org/system/files/conference/nsdi12/nsdi12-final138.pdf