

DoubleRDDs and basic statistical measures

DoubleRDDs

- Spark provides specific actions for a specific numerical type of RDD called `JavaDoubleRDD`
- `JavaDoubleRDD` is an RDD of doubles
 - However, it is different from `JavaRDD<Double>`
 - Even if they contains the same type of objects
- On `JavaDoubleRDDs`, the following actions are also available
 - `sum()`, `mean()`, `stdev()`, `variance()`, `max()`, `min()`,...

2

DoubleRDDs

- A generic `JavaRDD<T>` containing elements of type `T` can be transformed in a `JavaDoubleRDD` by using two specific transformations
 - `mapToDouble`
 - `flatMapToDouble`
- `mapToDouble` and `flatMapToDouble` operate similarly to `map` and `flatMap`, but they return a `JavaDoubleRDD`

3

DoubleRDDs

- `JavaDoubleRDDs` can be created also by using the `JavaDoubleRDD` `parallelizeDoubles(java.util.List<Double> list)` method of the `JavaSparkContext` class

4

MapToDouble transformation

MapToDouble transformation

- Goal
 - The `mapToDouble` transformation is used to create a new `DoubleRDD` by applying a function on each element of the "input" RDD
 - The new RDD contains one element `y` for each element `x` of the "input" RDD
 - The value of `y` is obtained by applying a user defined function `f` on `x`
 - `y=f(x)`
 - The data type of `y` is always double

6

MapToDouble transformation

- Method
 - The mapToDouble transformation is based on the `JavaDoubleRDD` `mapToDouble(DoubleFunction<T>)` method of the `JavaRDD<T>` class
 - An object of a class implementing the `DoubleFunction<T>` interface is passed to the `mapToDouble` method
 - The `public double call(T element)` method of the `DoubleFunction<T>` interface must be implemented
 - It contains the code that is applied on each element of the "input" RDD to create the double values of the returned `DoubleRDD`
 - For each element of the "input" RDD one single double is returned by the call method

7

MapToDouble transformation: Example

- Create an RDD from a textual file containing the surnames of a list of users
 - Each line of the file contains one surname
- Create a new `DoubleRDD` containing the lengths of the input surnames

8

MapToDouble transformation: Example

```
// Read the content of the input textual file
JavaRDD<String> surnamesRDD = sc.textFile("surnames.txt");

// Compute the lengths of the surnames
JavaDoubleRDD lengthsDoubleRDD =
surnamesRDD.mapToDouble(surname -> (double)surname.length());
```

9

FlatMapToDouble transformation

FlatMapToDouble transformation

- Goal
 - The `flatMapToDouble` transformation is used to create a new RDD by applying a function `f` on each element of the "input" RDD
 - The new RDD contains a list of elements obtained by applying `f` on each element `x` of the "input" RDD
 - The function `f` applied on an element `x` of the "input" RDD returns a list of double values `[y]`
 - `[y]=f(x)`
 - `[y]` can be the empty list

10

FlatMapToDouble transformation

- The final result is the concatenation of the list of values obtained by applying `f` over all the elements of the "input" RDD
 - i.e., the final RDD contains the merge of the lists obtained by applying `f` over all the elements of the input RDD
- The data type of `y` is always double

11

FlatMapToDouble transformation

- Method
 - The flatMapToDouble transformation is based on the `JavaRDD<R> flatMapToDouble(FlatMapFunction<T, R>)` method of the `JavaRDD<T>` class
 - An object of a class implementing the `FlatMapFunction<T, R>` interface is passed to the flatMap method
 - The `public Iterable<Double> call(T element)` method of the `DoubleFlatMapFunction<T>` interface must be implemented
 - It contains the code that is applied on each element of the "input" RDD and returns a list of Double elements included in the returned RDD
 - For each element of the "input" RDD a list of new elements is returned by the call method
 - The list can be empty

33

FlatMapToDouble transformation: Example 1

- Create an RDD from a textual file
 - Each line contains a sentence
- Create a new DoubleRDD containing the lengths of the words occurring in the input textual document

34

FlatMapToDouble transformation: Example 1

```
// Read the content of the input textual file
JavaRDD<String> sentencesRDD = sc.textFile("sentences.txt");

// Create a JavaDoubleRDD with the lengths of words occurring in
// sentencesRDD
JavaDoubleRDD wordLengthsDoubleRDD =
  sentencesRDD.flatMapToDouble(sentence ->
  {
    String[] words=sentence.split("");
    // Compute the length of each word
    ArrayList<Double> lengths=new ArrayList<Double>();
    for (String word: words) {
      lengths.add(new Double(word.length()));
    }
    return lengths.iterator();
  });
```

35

DoubleRDD actions

DoubleRDD actions

- The following actions are applicable only on `JavaDoubleRDDs` and return a `Double` value
 - `sum()`, `mean()`, `stdev()`, `variance()`, `max()`, `min()`
- All the examples reported in the following tables are applied on `inputRDD` that is a `DoubleRDD` containing the following elements (i.e., values)
 - {1.5, 3.5, 2.0}

37

DoubleRDD actions: Summary

Action	Purpose	Example	Result
<code>Double sum()</code>	Return the sum over the values of the inputRDD	<code>inputRDD.sum()</code>	7.0
<code>Double mean()</code>	Return the mean value	<code>inputRDD.mean()</code>	2.3333
<code>Double stdev()</code>	Return the standard deviation computed over the values of the inputRDD	<code>inputRDD.stdev()</code>	0.8498
<code>Double variance()</code>	Return the variance computed over the values of the inputRDD	<code>inputRDD.variance()</code>	0.7223
<code>Double max()</code>	Return the maximum value	<code>inputRDD.max()</code>	3.5
<code>Double min()</code>	Return the minimum value	<code>inputRDD.min()</code>	1.5

38

DoubleRDD actions: example

- Create a DoubleRDD containing the following values
 - {1.5, 3.5, 2.0}
- Print on the standard output the following statistics
 - sum, mean, standard deviation, variance, maximum value, and minimum value

29

DoubleRDD actions: example

```
// Create a local list of Doubles
List<Double> inputList = Arrays.asList(1.5, 3.5, 2.0);

// Build a DoubleRDD from the local list
JavaDoubleRDD distList = sc.parallelizeDoubles(inputList);

// Compute the statistics and print them on the standard output
System.out.println("sum: "+distList.sum());
System.out.println("mean: "+distList.mean());
System.out.println("stddev: "+distList.stddev());
System.out.println("variance: "+distList.variance());
System.out.println("max: "+distList.max());
System.out.println("min: "+distList.min());
```

30