ÉCOLE POLYTECHNIQUE
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Transformations and Actions on Pair RDDs

Big Data Analysis with Scala and Spark

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Some interesting Pair RDDs operations

Important operations defined on Pair RDDs:
(But not available on regular RDDs)

Transformations

- `groupByKey`
- `reduceByKey`
- `mapValues`
- `keys`
- `join`
- `leftOuterJoin`/`rightOuterJoin`

Action

- `countByKey`

Pair RDD Transformation: `groupByKey`

Recall `groupBy` from Scala collections.

Pair RDD Transformation: groupBy~~Key~~

Recall groupBy from Scala collections.

```scala
def groupBy[K](f: A => K): Map[K, Traversable[A]]
```

> *Partitions this traversable collection into a map of traversable collections according to some discriminator function.*

In English: Breaks up a collection into two or more collections according to a function that you pass to it. Result of the function is the key, the collection of results that return that key when the function is applied to it. Returns a Map mapping computed keys to collections of corresponding values.

Pair RDD Transformation: groupBy~~Key~~

Recall groupBy from Scala collections.

```
def groupBy[K](f: A => K): Map[K, Traversable[A]]
```

Example:

Let's group the below list of ages into "child", "adult", and "senior" categories.

```
val ages = List(2, 52, 44, 23, 17, 14, 12, 82, 51, 64)
val grouped = ages.groupBy { age =>
  if (age >= 18 && age < 65) "adult"
  else if (age < 18) "child"
  else "senior"
}
// grouped: scala.collection.immutable.Map[String,List[Int]] =
// Map(senior -> List(82), adult -> List(52, 44, 23, 51, 64),
// child -> List(2, 17, 14, 12))
```

Pair RDD Transformation: `groupByKey`

Recall `groupBy` from Scala collections. `groupByKey` can be thought of as a `groupBy` on Pair RDDs that is specialized on grouping all values that have the same key. As a result, it takes no argument.

```
def groupByKey(): RDD[(K, Iterable[V])]
```

Pair RDD Transformation: `groupByKey`

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```scala
def groupByKey(): RDD[(K, Iterable[V])]
```

Example:

```scala
case class Event(organizer: String, name: String, budget: Int)
val eventsRdd = sc.parallelize(...)
                  .map(event => (event.organizer, event.budget))

val groupedRdd = eventsRdd.groupByKey()
```

Here the key is `organizer`. What does this call do?

Pair RDD Transformation: groupByKey

Example:

```
case class Event(organizer: String, name: String, budget: Int)
val eventsRdd = sc.parallelize(...)
                  .map(event => (event.organizer, event.budget))

val groupedRdd = eventsRdd.groupByKey()

// TRICK QUESTION! As-is, it ”does” nothing. It returns an unevaluated RDD

groupedRdd.collect().foreach(println)
// (Prime Sound,CompactBuffer(42000))
// (Sportorg,CompactBuffer(23000, 12000, 1400))
// ...
```

Pair RDD Transformation: `reduceByKey`

Conceptually, `reduceByKey` can be thought of as a combination of `groupByKey` and `reduce`-ing on all the values per key. It's more efficient though, than using each separately. (We'll see why later.)

```scala
def reduceByKey(func: (V, V) => V): RDD[(K, V)]
```

Pair RDD Transformation: `reduceByKey`

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```
def reduceByKey(func: (V, V) => V): RDD[(K, V)]
```

Example: Let's use `eventsRdd` from the previous example to calculate the total budget per organizer of all of their organized events.

```
case class Event(organizer: String, name: String, budget: Int)
val eventsRdd = sc.parallelize(...)
                  .map(event => (event.organizer, event.budget))

val budgetsRdd = ...
```

Pair RDD Transformation: `reduceByKey`

Example: Let's use `eventsRdd` from the previous example to calculate the total budget per organizer of all of their organized events.

```scala
case class Event(organizer: String, name: String, budget: Int)
val eventsRdd = sc.parallelize(...)
                  .map(event => (event.organizer, event.budget))

val budgetsRdd = eventsRdd.reduceByKey(_+_)

reducedRdd.collect().foreach(println)
// (Prime Sound,42000)
// (Sportorg,36400)
// (Innotech,320000)
// (Association Balélec,50000)
```

Pair RDD Transformation: `mapValues` and Action: `countByKey`

`mapValues` (`def mapValues[U](f: V => U): RDD[(K, U)]`) can be thought of as a short-hand for:

```
rdd.map { case (x, y): (x, func(y))}
```

That is, it simply applies a function to only the values in a Pair RDD.

`countByKey` (`def countByKey(): Map[K, Long]`) simply counts the number of elements per key in a Pair RDD, returning a normal Scala `Map` (remember, it's an action!) mapping from keys to counts.

Pair RDD Transformation: `mapValues` and Action: `countByKey`

Example: we can use each of these operations to compute the average budget per event organizer, if possible.

```
// Calculate a pair (as a key's value) containing (budget, #events)
val intermediate = ??? // Can we use countByKey?
```

Pair RDD Transformation: `mapValues` and Action: `countByKey`

Example: we can use each of these operations to compute the average budget per event organizer, if possible.

```
// Calculate a pair (as a key's value) containing (budget, #events)
val intermediate =
  eventsRdd.mapValues(b => (b, 1))
               .reduceByKey(
```

$\underset{K}{(\text{org}}, \underset{V}{\text{budget})} \longrightarrow \underline{(\text{org}, (\text{budget}, 1))}$

Result should look like:

(org, (totalBudget, total#events organized))

Pair RDD Transformation: `mapValues` and Action: `countByKey`

Example: we can use each of these operations to compute the average budget per event organizer, if possible.

(budget, 1)

```
// Calculate a pair (as a key's value) containing (budget, #events)
val intermediate =
  eventsRdd.mapValues(b => (b, 1))
           .reduceByKey((v1, v2) => (v1._1 + v2._1, v1._2 + v2._2))
// intermediate: RDD[(String, (Int, Int))]
```

budgets

total # events

Pair RDD Transformation: `mapValues` and Action: `countByKey`

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// intermediate: RDD[(String, (Int, Int))]

val avgBudgets = ???
```

Pair RDD Transformation: mapValues and Action: countByKey

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```
// Calculate a pair (as a key's value) containing (budget, #events)
val intermediate =
  eventsRdd.mapValues(b => (b, 1))
           .reduceByKey((v1, v2) => (v1._1 + v2._1, v1._2 + v2._2))
// intermediate: RDD[(String, (Int, Int))]

val avgBudgets = intermediate.mapValues {
  case (budget, numberOfEvents) => budget / numberOfEvents
}
avgBudgets.collect().foreach(println)
// (Prime Sound,42000)
// (Sportorg,12133)
// (Innotech,106666)
// (Association Balélec,50000)
```

Pair RDD Transformation: `keys`

keys (`def keys: RDD[K]`) Return an RDD with the keys of each tuple.

Note: this method is a transformation and thus returns an RDD because the number of keys in a Pair RDD may be unbounded. It's possible for every value to have a unique key, and thus is may not be possible to collect all keys at one node.

Pair RDD Transformation: keys

keys (`def keys: RDD[K]`) Return an RDD with the keys of each tuple.

Note: this method is a transformation and thus returns an RDD because the number of keys in a Pair RDD may be unbounded. It's possible for every value to have a unique key, and thus is may not be possible to collect all keys at one node.

Example: we can count the number of unique visitors to a website using the `keys` transformation.

```
case class Visitor(ip: String, timestamp: String, duration: String)
val visits: RDD[Visitor] = sc.textfile(...)
                                  .map(v =>(v.ip, v.duration))

val numUniqueVisits = ???
```

Pair RDD Transformation: keys

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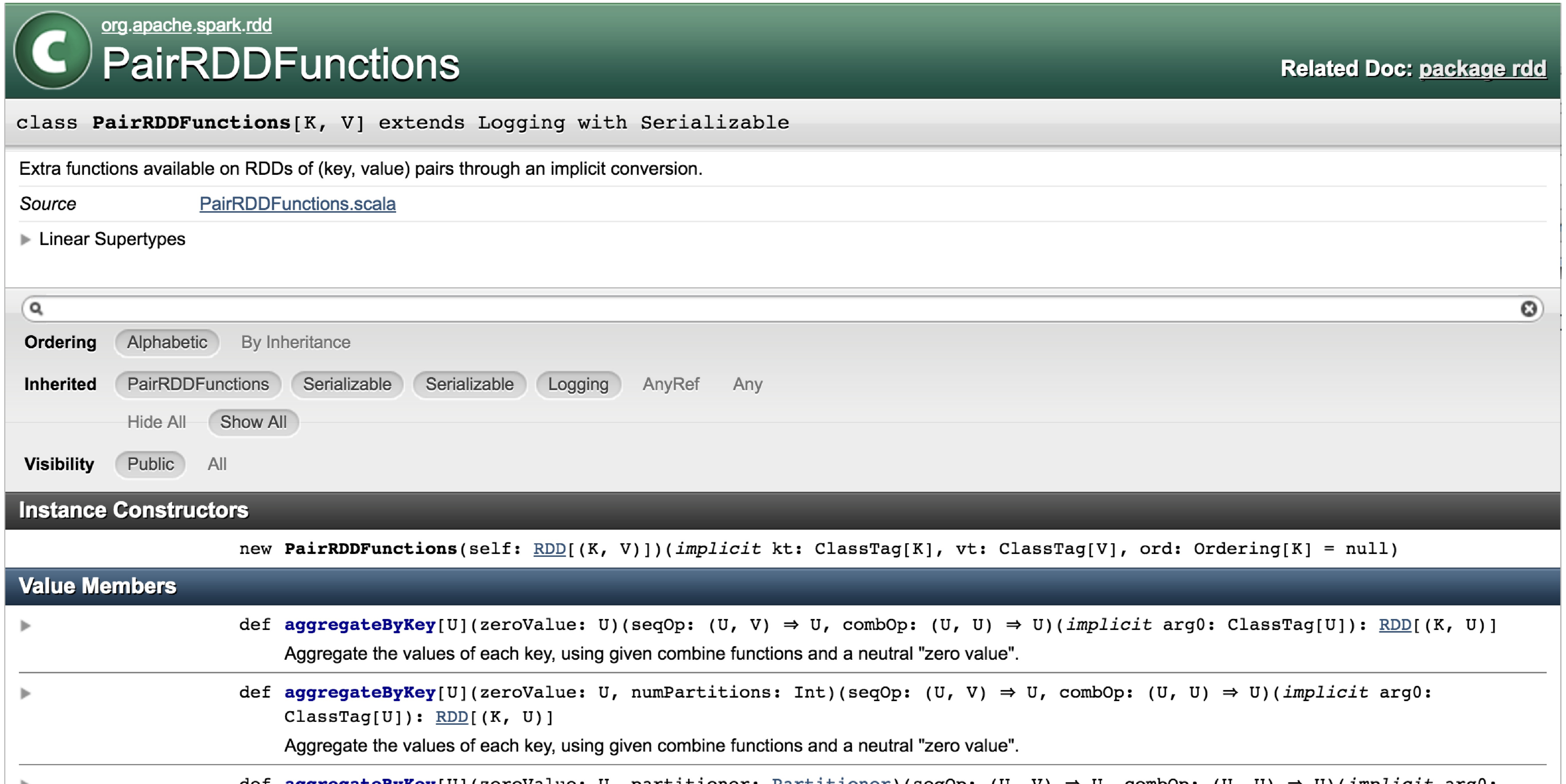
Example: we can count the number of unique visitors to a website using the `keys` transformation.

```scala
case class Visitor(ip: String, timestamp: String, duration: String)
val visits: RDD[Visitor] = sc.textfile(...)
                             .map( v => (v.ip , v.duration))

val numUniqueVisits = visits.keys.distinct().count()
// numUniqueVisits: Long = 3391
```

PairRDDFunctions

For a list of all available specialized Pair RDD operations, see the Spark API page for `PairRDDFunctions` (ScalaDoc):
http://spark.apache.org/docs/latest/api/scala/index.html#org.apache.spark.rdd.PairRDDFunctions



org.apache.spark.rdd

PairRDDFunctions

Related Doc: package rdd

```
class PairRDDFunctions[K, V] extends Logging with Serializable
```

Extra functions available on RDDs of (key, value) pairs through an implicit conversion.

Source PairRDDFunctions.scala

▸ Linear Supertypes

Ordering Alphabetic By Inheritance
Inherited PairRDDFunctions Serializable Serializable Logging AnyRef Any
Hide All Show All
Visibility Public All

Instance Constructors

```
new PairRDDFunctions(self: RDD[(K, V)])(implicit kt: ClassTag[K], vt: ClassTag[V], ord: Ordering[K] = null)
```

Value Members

```
def aggregateByKey[U](zeroValue: U)(seqOp: (U, V) ⇒ U, combOp: (U, U) ⇒ U)(implicit arg0: ClassTag[U]): RDD[(K, U)]
```
Aggregate the values of each key, using given combine functions and a neutral "zero value".

```
def aggregateByKey[U](zeroValue: U, numPartitions: Int)(seqOp: (U, V) ⇒ U, combOp: (U, U) ⇒ U)(implicit arg0:
ClassTag[U]): RDD[(K, U)]
```
Aggregate the values of each key, using given combine functions and a neutral "zero value".

```
def aggregateByKey[U](zeroValue: U, partitioner: Partitioner)(seqOp: (U, V) ⇒ U, combOp: (U, U) ⇒ U)(implicit arg0:
```