Big Data Architektúrák és Elemző módszerek

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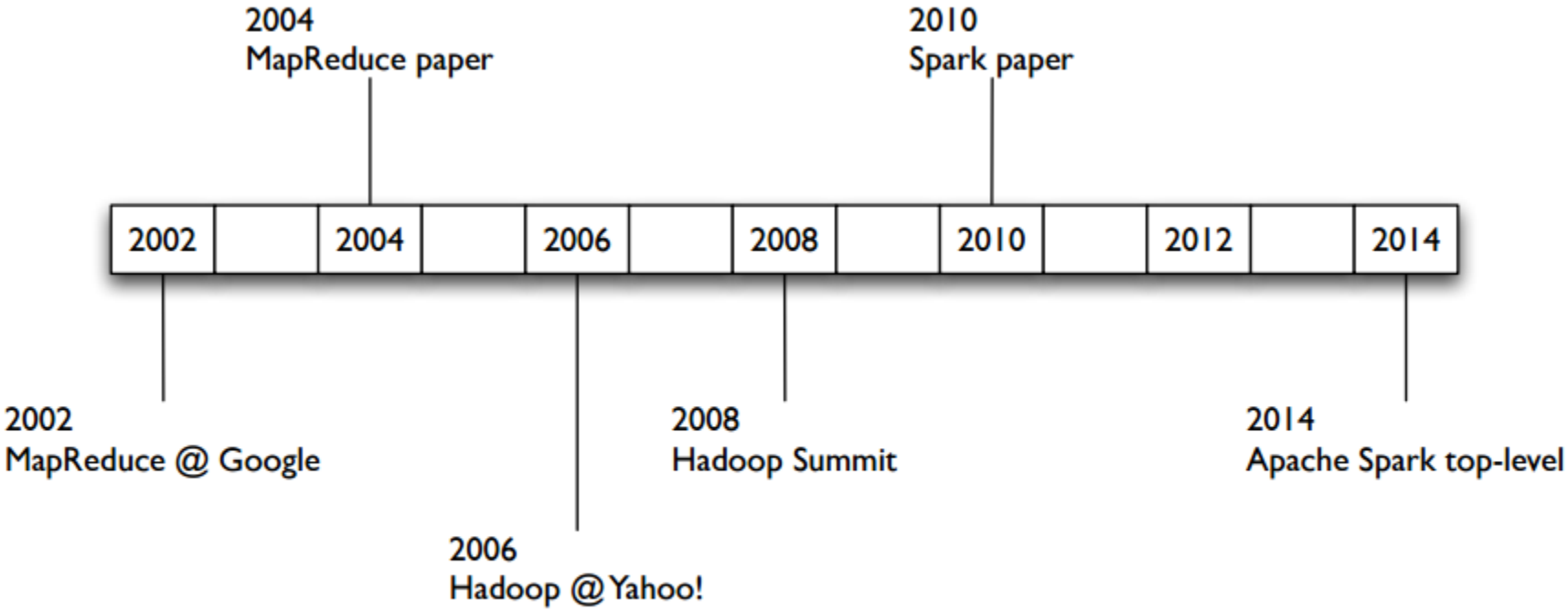
források: cognitiveclass.ai

Történelem


2004
MapReduce paper
2010
Spark paper
2002
2004
2006
2008
2010
2012
2014
2002
MapReduce @ Google
2006
Hadoop @Yahoo!
2008
Hadoop Summit
2014
Apache Spark top-level

Spark Motiváció

- Hadoop MapReduce problémák:
  - Programozás nehézkes
  - Performancia, sok I/O használat
  - Speciális alkalmazásokra nem alkalmas

MapReduce programozás

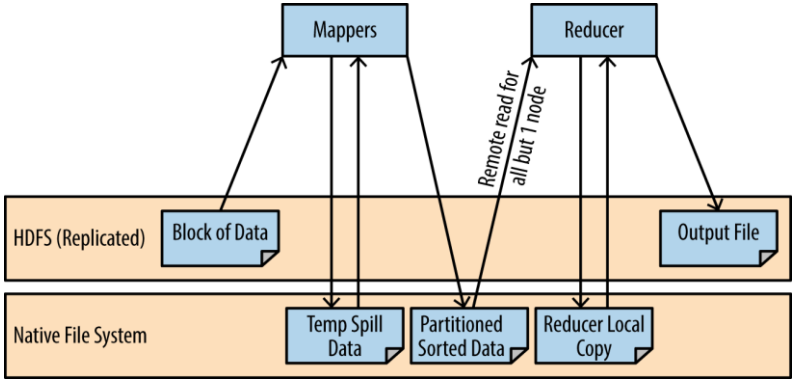
- Hadoop: 61 sor
- Spark: 1 sor

```
sc.textFile('...').flatMap(lambda x: x.split())
    .map(lambda x: (x, 1))
    .reduceByKey(lambda x, y: x+y)
    .saveAsTextFile('...')
```

```
import java.io.IOException;
import java.util.StringTokenizer;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;

public class WordCount {

  public static class TokenizerMapper
       extends Mapper<Object, Text, Text, IntWritable>{

    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();

    public void map(Object key, Text value, Context context
                    ) throws IOException, InterruptedException {
      StringTokenizer itr = new StringTokenizer(value.toString());
      while (itr.hasMoreTokens()) {
        word.set(itr.nextToken());
        context.write(word, one);
      }
    }
  }

  public static class IntSumReducer
       extends Reducer<Text,IntWritable,Text,IntWritable> {
    private IntWritable result = new IntWritable();

    public void reduce(Text key, Iterable<IntWritable> values,
                       Context context
                       ) throws IOException, InterruptedException {
      int sum = 0;
      for (IntWritable val : values) {
        sum += val.get();
      }
      result.set(sum);
      context.write(key, result);
    }
  }

  public static void main(String[] args) throws Exception {
    Configuration conf = new Configuration();
    Job job = Job.getInstance(conf, "word count");
    job.setJarByClass(WordCount.class);
    job.setMapperClass(TokenizerMapper.class);
    job.setCombinerClass(IntSumReducer.class);
    job.setReducerClass(IntSumReducer.class);
    job.setOutputKeyClass(Text.class);
    job.setOutputValueClass(IntWritable.class);
    FileInputFormat.addInputPath(job, new Path(args[0]));
    FileOutputFormat.setOutputPath(job, new Path(args[1]));
    System.exit(job.waitForCompletion(true) ? 0 : 1);
  }
}
```

Performancia

- MapReduce I/O műveltei egy jobban:
  - 3 vagy több



- Hive (SQL tool **Hadoop**ra)
  - Egy tipikus lekérdezés 3-5 MR Job

- Mit ad a **Spark**?
  - Lusta kiértékelés
    - Optimalizálja a job-ot mielőtt lefuttatná
  - Memória alapú cache
    - Egyszer olvassa a HDD-t, utána memóriát használja
  - Hatékony pipeline
    - Adatok átadása a folyamatok között HDD nélkül

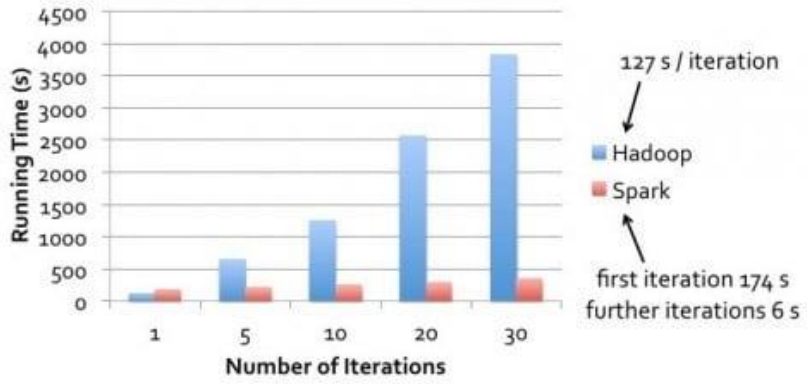
Performancia

Daytona Gray Sort 100TB Benchmark

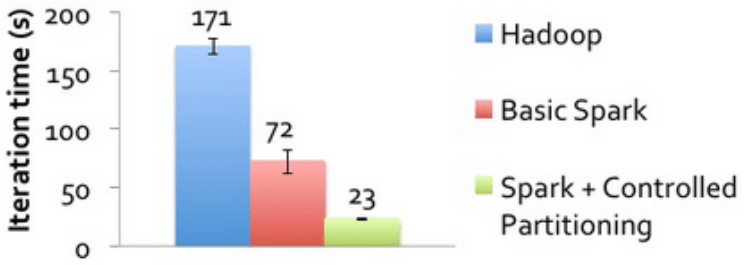
	Data Size	Time	Nodes	Cores
Hadoop MR (2013)	102.5 TB	72 min	2,100	50,400 physical
Apache Spark (2014)	100 TB	23 min	206	6,592 virtualized

source: http://databricks.com/blog/2014/11/05/spark-officially-sets-a-new-record-in-large-scale-sorting.html

Logistic Regression Performance

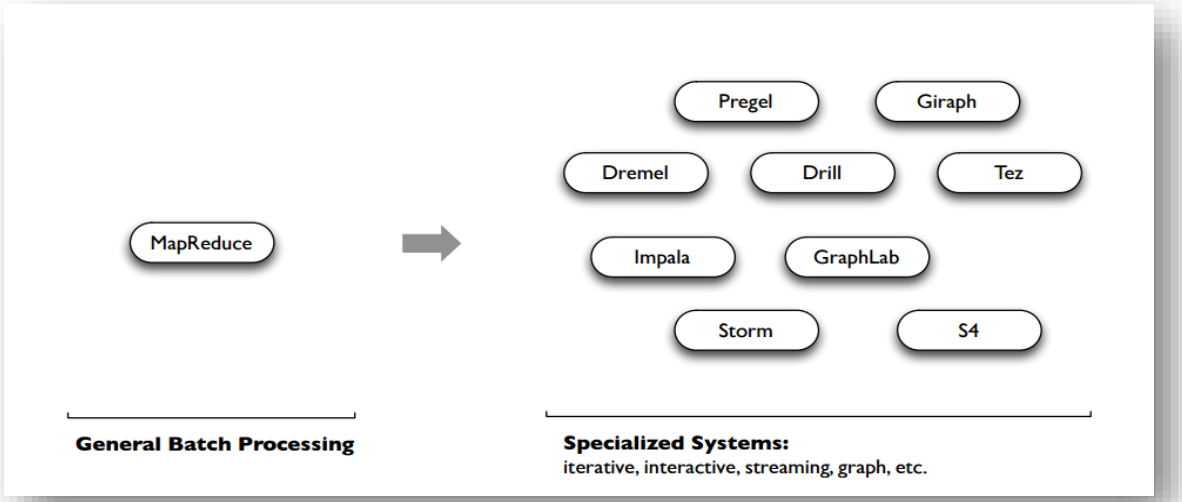


PageRank Performance

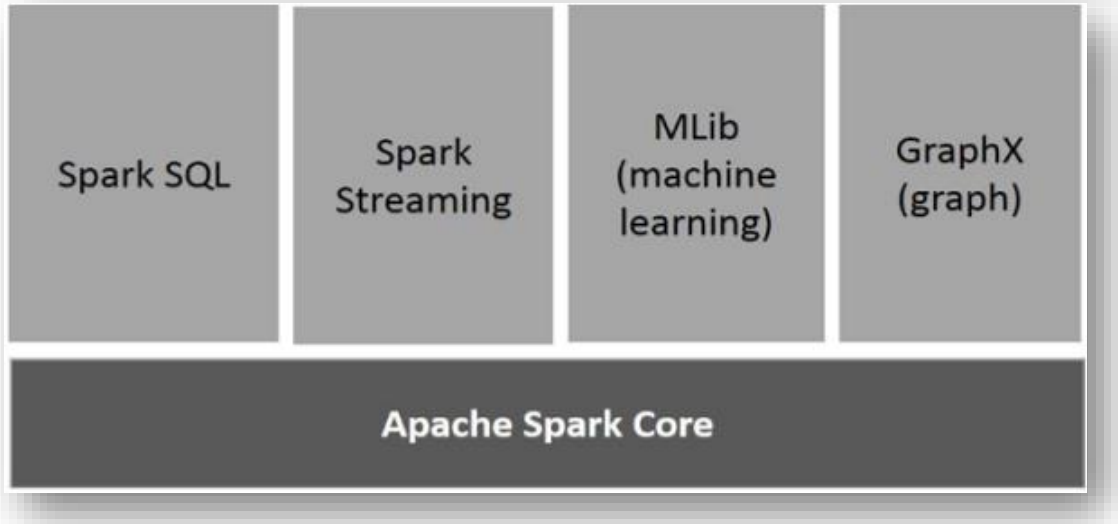


Speciális eszközök

Hadoop

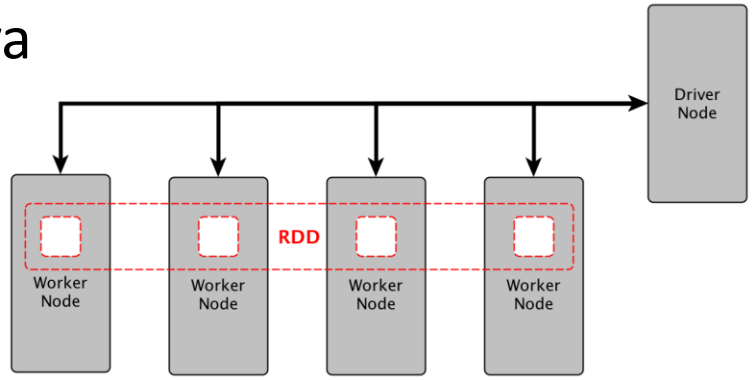


Spark



Spark fő eleme: RDD

- Egyszerűen:
  - az RDD egy kollekciója az adatpartícióknak, amelyek a worker node-okon vannak tárolva



- Komplexen:
  - egy interface az adat transzformációhoz
  - átmenetileg tárolja az adatokat
  - nem módosítható

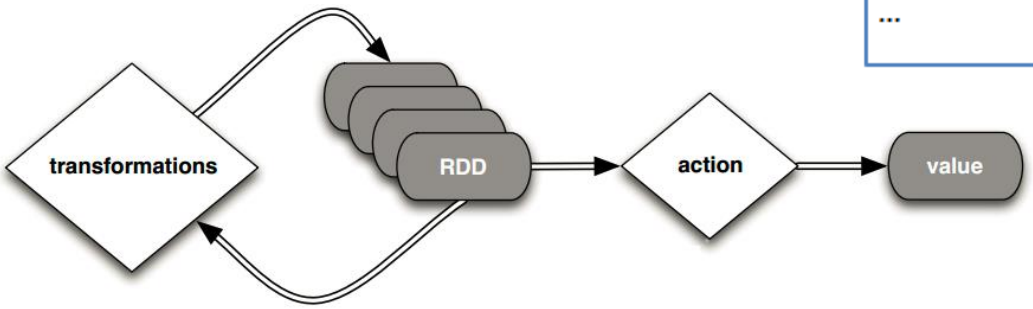
RDD Metadata

- Metainformációk
  - Partitions – mely adatok kapcsolódnak ehhez az RDD-hez
  - Dependencies – a „szülő” RDD-k listája
  - Compute – a „szülő” RDD-ken végezendő függvény
  - Preferred Locations – hol van a legjobb hely a számítás elvégzésére (data locality)
  - Partitioner – Hogyan vágjuk szét az adatot partíciókba

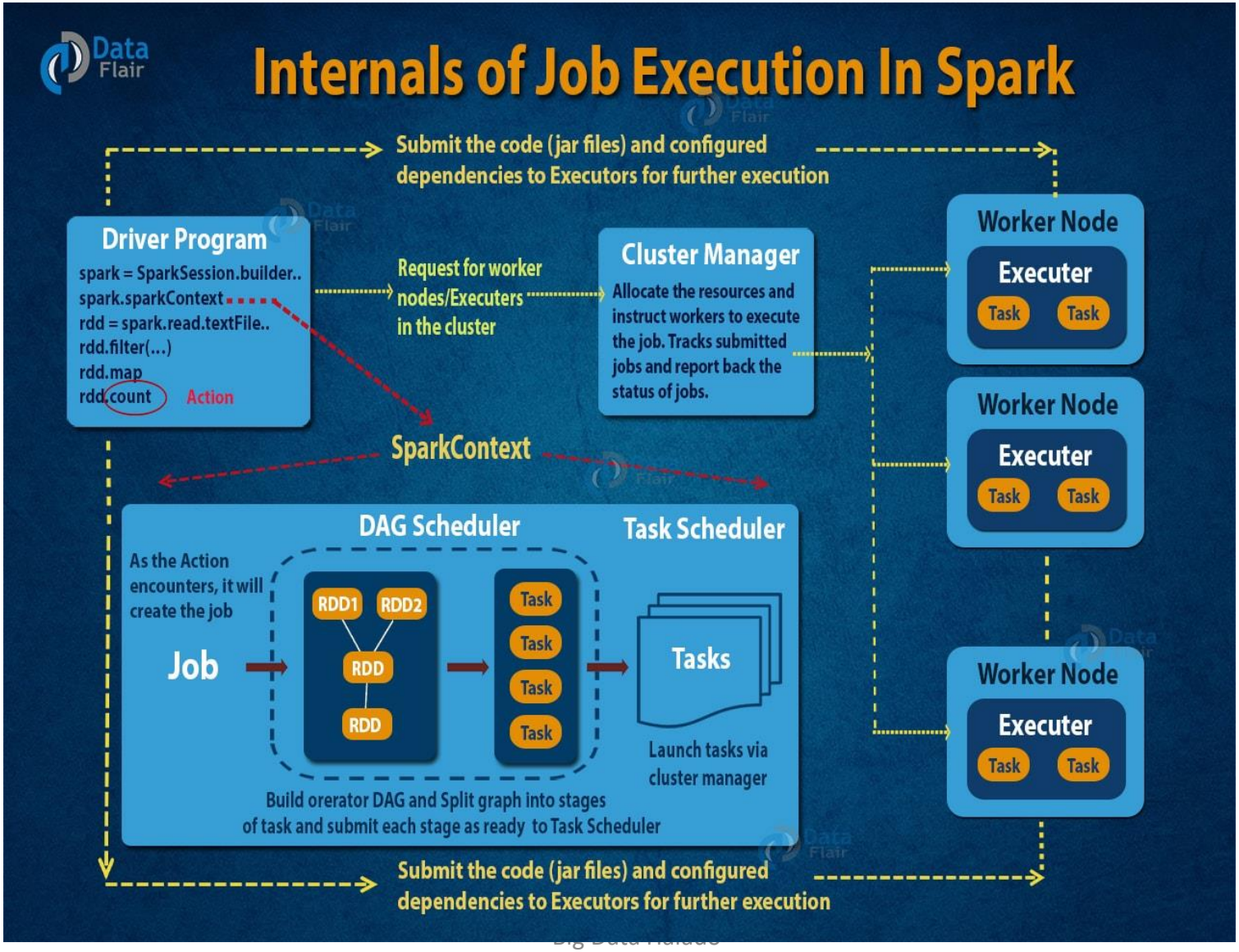
RDD

- Az egyetlen lehetőség az adatok módosítására Spark-ban
  - Transformations : RDD → RDD
  - Actions: RDD → Scalar

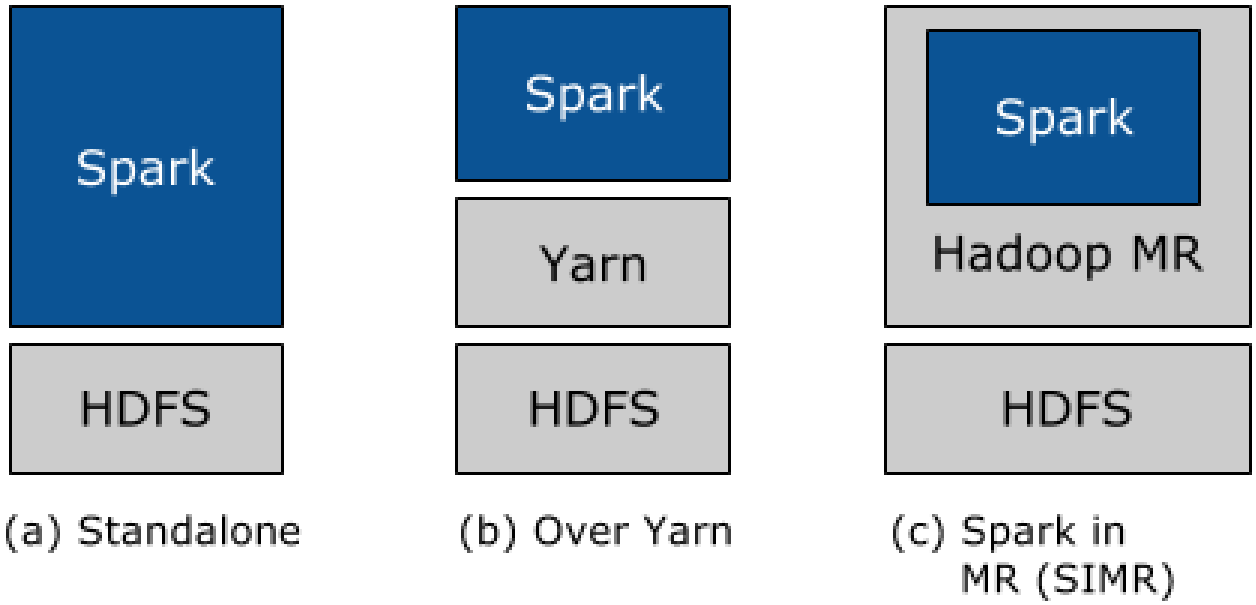
Transformations	Actions
map (func)	reduce(func)
flatMap(func)	collect()
filter(func)	count()
groupByKey()	first()
reduceByKey(func)	take(n)
mapValues(func)	saveAsTextFile(path)
sample(...)	countByKey()
union(other)	foreach(func)
distinct()	...
sortByKey()	
...	



DAG Scheduler

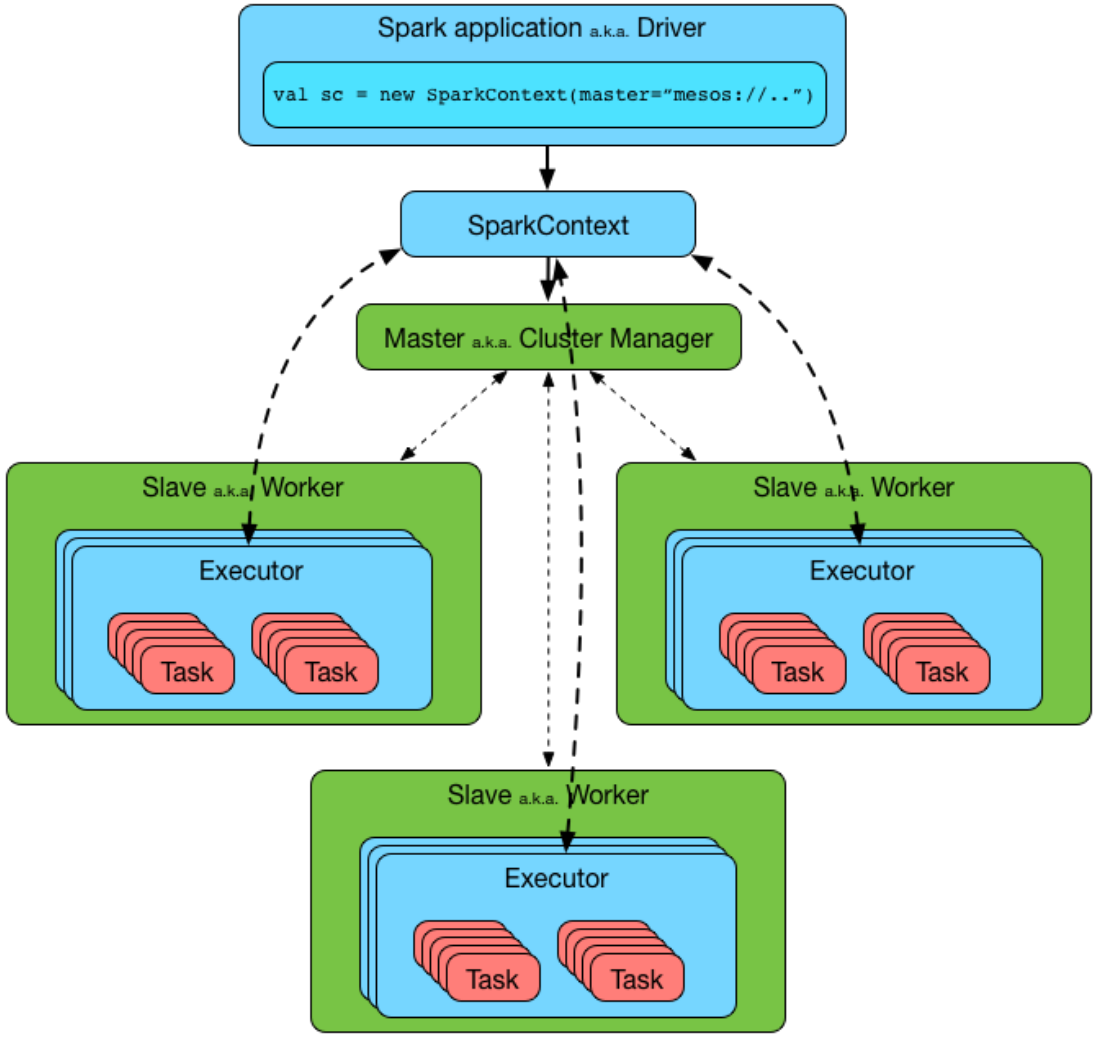


Spark Architektúra

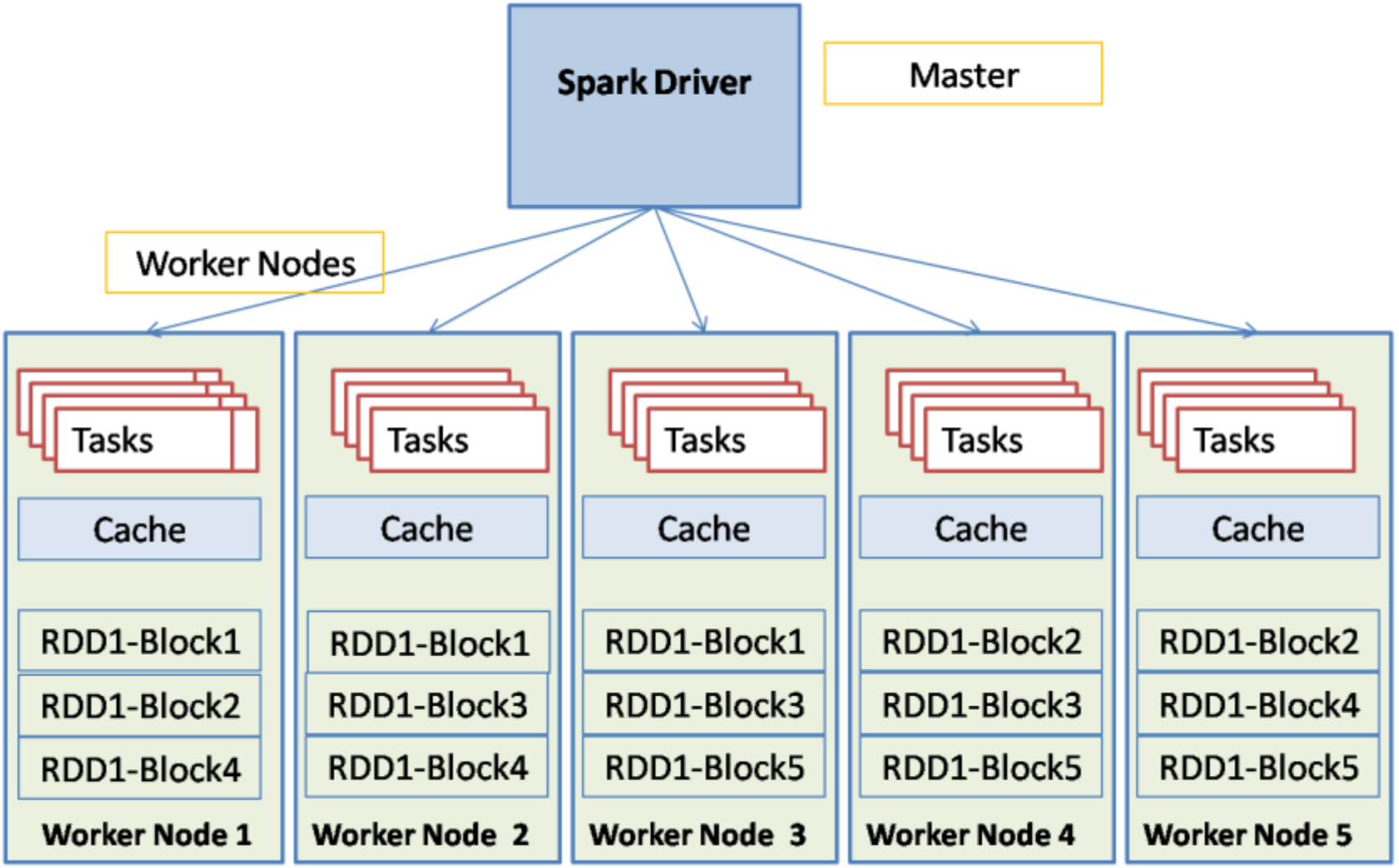


SIMR: Minden Spark woker map folyamatban fut.

Spark Architektúra



Spark Components



Spark Cluster

- Driver
  - Spark Shell elérés (Scala, Python, R, Java)
  - A hely ahol elkészül a SparkContext
  - Az RDD-t átalakítja egy lekérdezési gráffá
  - Stage-ekbe pakolja a lépéseket
  - Ütemezi a taskokat és íránytja a futásukat
  - Tárolja a metadata-t az RDD-kről
  - WebUI-t futtat

Spark Cluster

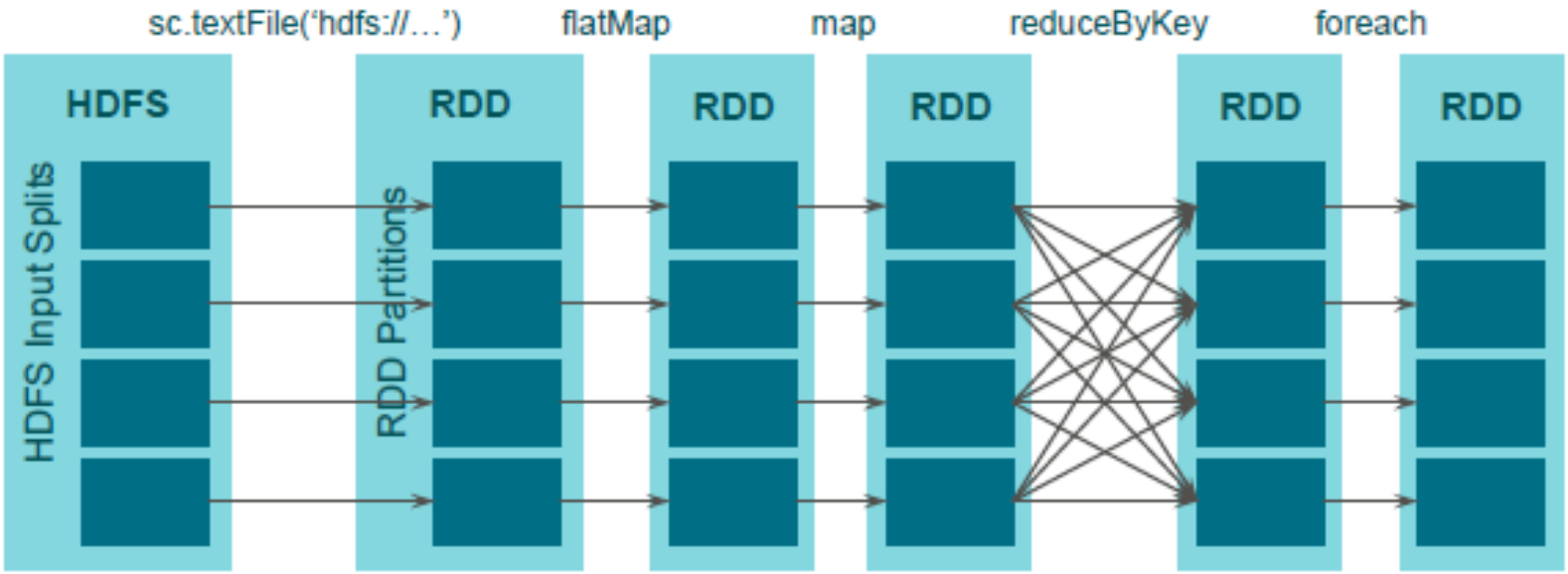
- Executor
  - Tárolja az adatot a cache-ben (JVM Heap, HDD)
  - Olvassa az adatot a külső forrásról
  - Írja az adatot külső forrásra
  - Elvégzi az adat feldolgozásokat

Alkalmazás dekompozíció

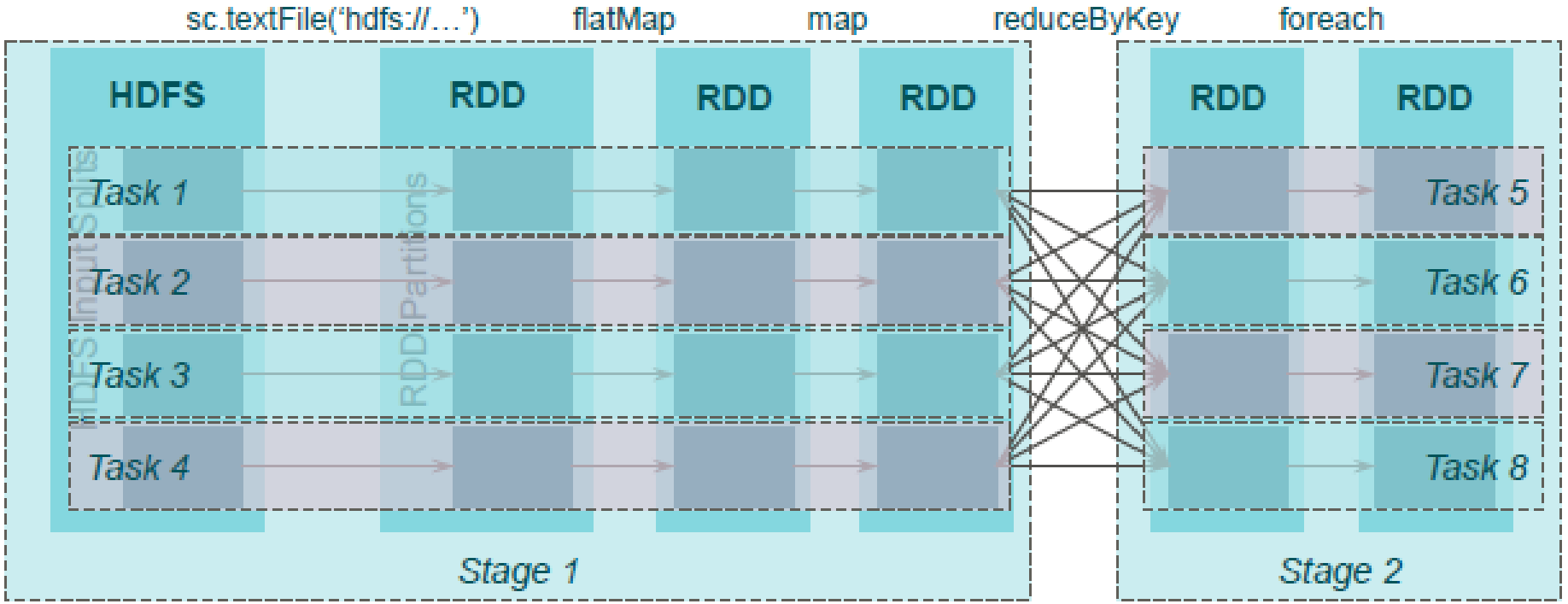
- Alkalmazás
  - Egy SparkContext ami tárol adatot a feldolgozáshoz, és ütemezi a jobok sorozatát
- Job
  - RDD transzformációk sorozata, amely egy action-nel vagy adat kiírással végződik, driver alkalmazás vezérli
- Stage
  - Transzformációk egy olyan sorozata, amelyet egy független worker el tud végezni.
- Task
  - Egy stage futtatása az adat egy partícióján.

WordCount példa

```
def printfunc (x):
    print 'Word "%s" occurs %d times' % (x[0], x[1])

infile = sc.textFile('hdfs://sparkdemo:8020/sparkdemo/textfiles/README.md', 4)
rdd1 = infile.flatMap(lambda x: x.split())
rdd2 = rdd1.map(lambda x: (x, 1)).reduceByKey(lambda x, y: x+y)
print rdd2.toDebugString()
rdd2.foreach(printfunc)
```



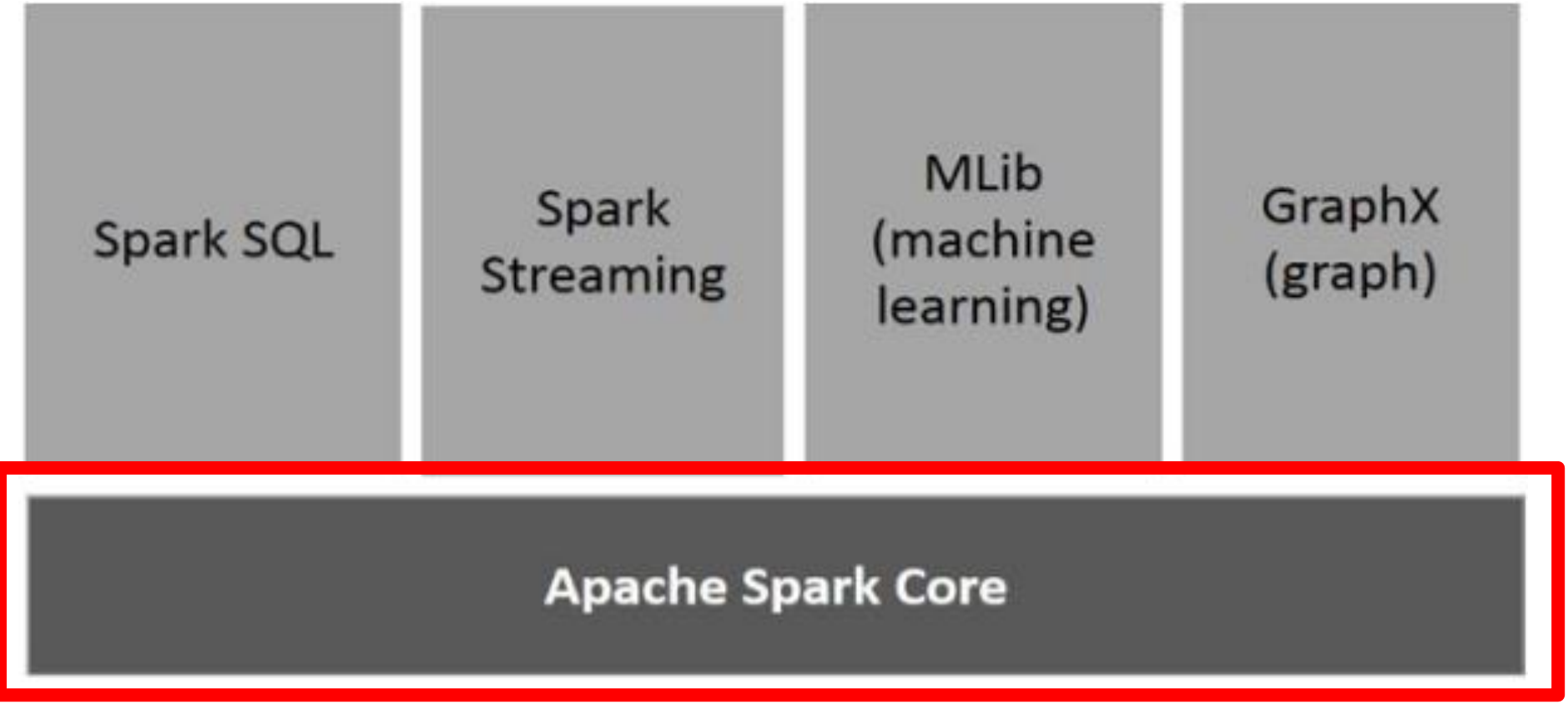
WordCount példa



Spark perzisztencia

Persistence Level	Leírás
MEMORY_ONLY	Az RDD deszerializálzt JAVA objektumként tároljuk. Ha nem fér el a memóriában újraszámoljuk.
MEMORY_AND_DISK	Az RDD deszerializálzt JAVA objektumként tároljuk. Ha nem fér el a memóriában tároljuk a lemezen.
MEMORY_ONLY_SER	Ua. mint MEMORY_ONLY, csak szerializálva tároljuk a memóriában.
MEMORY_AND_DISK_SER	Ua. mint MEMORY_AND_DISK, csak szerializálva tároljuk a memóriában.
DISK_ONLY	Az adatokat a lemezen tároljuk.
MEMORY_ONLY_2, DISK_ONLY_2	Ua. mint feljebb, csak replikáljuk a partíciókat a klaszterben.

Spark eszközök



Language Support

Python

```
lines = sc.textFile(...)
lines.filter(lambda s: "ERROR" in s).count()
```

Scala

```
val lines = sc.textFile(...)
lines.filter(x => x.contains("ERROR")).count()
```

Java

```
JavaRDD<String> lines = sc.textFile(...);
lines.filter(new Function<String, Boolean>() {
  Boolean call(String s) {
    return s.contains("error");
  }
}).count();
```

Standalone Programs

- Python, Scala, & Java

Interactive Shells

- Python & Scala

Performance

- Java & Scala are faster due to static typing
- …but Python is often fine

UCSB

Spark Context and Creating RDDs

```
#Start with sc – SparkContext as
```
Main entry point to Spark functionality

```
#Turn a Python collection into an RDD
>sc.parallelize([1, 2, 3])

# Load text file from local FS, HDFS, or S3
>sc.textFile("file.txt")
>sc.textFile("directory/*.txt")
>sc.textFile("hdfs://namenode:9000/path/file")
```

Basic Transformations

```
> nums = sc.parallelize([1, 2, 3])

# Pass each element through a function
> squares = nums.map(lambda x: x*x)   // {1, 4, 9}

# Keep elements passing a predicate
> even = squares.filter(lambda x: x % 2 == 0) // {4}
```

```
#read a text file and count number of lines
containing error

lines = sc.textFile("file.log")
lines.filter(lambda s: "ERROR" in s).count()
```

Basic Actions

```
> nums = sc.parallelize([1, 2, 3])

# Retrieve RDD contents as a local collection
> nums.collect() # => [1, 2, 3]

# Return first K elements
> nums.take(2)   # => [1, 2]

# Count number of elements
> nums.count()   # => 3

# Merge elements with an associative function
> nums.reduce(lambda x, y: x + y)  # => 6

# Write elements to a text file
> nums.saveAsTextFile("hdfs://file.txt")
```

Working with Key-Value Pairs

Spark's "distributed reduce" transformations operate on RDDs of key-value pairs

Python:

```
pair = (a, b)
       pair[0] # => a
                  pair[1] # => b
```

Scala:

```
val pair = (a, b)
                  pair._1 // => a
                  pair._2 // => b
```

Java:

```
Tuple2 pair = new Tuple2(a, b);
                  pair._1 // => a
                  pair._2 // => b
```

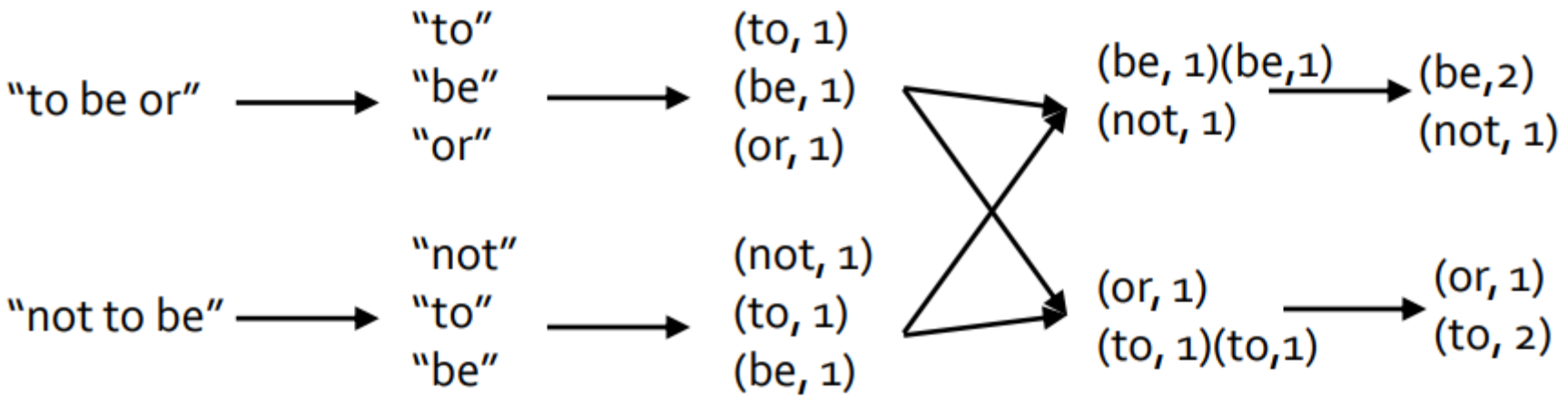
Some Key-Value Operations

```
> pets = sc.parallelize(
    [("cat", 1), ("dog", 1), ("cat", 2)])
> pets.reduceByKey(lambda x, y: x + y)
                        # => {(cat, 3), (dog, 1)}
> pets.groupByKey() # => {(cat, [1, 2]), (dog, [1])}
> pets.sortByKey()  # => {(cat, 1), (cat, 2), (dog, 1)}
```

`reduceByKey` **also automatically implements combiners on the map side**

Example: Word Count

```
> lines = sc.textFile("hamlet.txt")
> counts = lines.flatMap(lambda line: line.split(" "))
                .map(lambda word: (word, 1))
                .reduceByKey(lambda x, y: x + y)
```



Other Key-Value Operations

```
> visits = sc.parallelize([ ("index.html", "1.2.3.4"),
                            ("about.html", "3.4.5.6"),
                            ("index.html", "1.3.3.1") ])

> pageNames = sc.parallelize([ ("index.html", "Home"),
                               ("about.html", "About") ])

> visits.join(pageNames)
  # ("index.html", ("1.2.3.4", "Home"))
  # ("index.html", ("1.3.3.1", "Home"))
  # ("about.html", ("3.4.5.6", "About"))

> visits.cogroup(pageNames)
  # ("index.html", (["1.2.3.4", "1.3.3.1"], ["Home"]))
  # ("about.html", (["3.4.5.6"], ["About"]))
```

Setting the Level of Parallelism

All the pair RDD operations take an optional second parameter for number of tasks

```
> words.reduceByKey(lambda x, y: x + y, 5)
> words.groupByKey(5)
> visits.join(pageViews, 5)
```

Példák

scala> var ex = sc.parallelize(List("szoveg 1", "szoveg 2", "szoveg bla bla"))
ex: org.apache.spark.rdd.RDD[String] = ParallelCollectionRDD[0] at parallelize at <console>:21

scala> val lines = sc.textFile("c:/Users/bigdata/valami.txt")

scala> val pair = (a, b)
pair._1 // => a
pair._2 // => b

```
scala> object HelloWorld {
     |     def main(args: Array[String]) {
     |         println("Hello, world!")
     |     }
     | }
```
defined module HelloWorld

Példák

scala> HelloWorld.main(null)

Hello, world!

scala> ex.map(line => (line, 1))

res0: org.apache.spark.rdd.RDD[(String, Int)] = MapPartitionsRDD[1] at map at <console>:24

scala> res0.foreach(println)

(szoveg 1,1)

(szoveg bla bla,1)

(szoveg 2,1)

Példák

scala> ex.map(line => line.split(" "))

res4: org.apache.spark.rdd.RDD[Array[String]] = MapPartitionsRDD[2] at map at <console>:24

scala> res4.foreach(println)

[Ljava.lang.String;@3cc018c2

[Ljava.lang.String;@4c3da8ce

[Ljava.lang.String;@31a73053

scala> res4.flatMap(a => a)

res8: org.apache.spark.rdd.RDD[String] = MapPartitionsRDD[3] at flatMap at <console>:26

Példák

scala> res8.foreach(println)

szoveg

1

szoveg

2

szoveg

bla

bla

Példák

scala> res8.filter(l => l.contains("ove"))

res10: org.apache.spark.rdd.RDD[String] = MapPartitionsRDD[4] at filter at <console>:28

scala> res10.foreach(println)

szoveg

szoveg

szoveg

Példák

scala> res8.map(w => (w,1)).reduceByKey(_ + _)

res12: org.apache.spark.rdd.RDD[(String, Int)] = ShuffledRDD[6] at reduceByKey at <console>:28

scala> res12.foreach(println)

(1,1)

(2,1)

(bla,2)

(szoveg,3)

Példák

scala> res8.map(w => (w,1)).groupByKey().map(w => (w._1, w._2.reduce(_+_)))

res17: org.apache.spark.rdd.RDD[(String, Int)] = MapPartitionsRDD[11] at map at <console>:28

scala> res17.foreach(println)

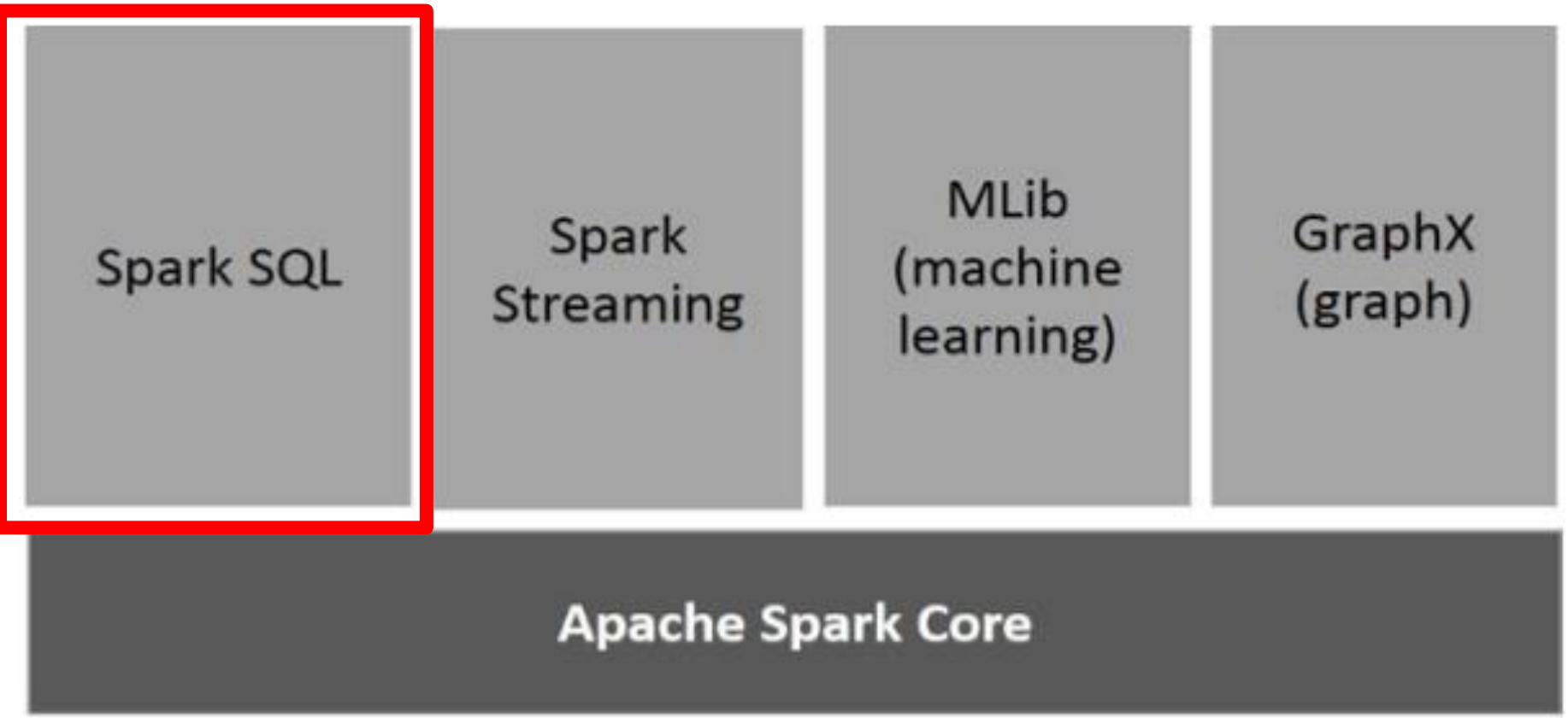
(1,1)

(bla,2)

(2,1)

(szoveg,3)

Spark eszközök



Shark (SQL Api)

- Alapja a DataFrame-k
- DataFrame:
  - Elosztott adatset
  - Nevesített oszlopokkal rendelkezik
- Forrás lehet:
  - Hive
  - Külső adatbázis
  - Meglévő RDDs
  - File

Shark (SQL Api)

```
val sc: SparkContext  // An existing SparkContext.
val sqlContext = new org.apache.spark.sql.SQLContext(sc)  // Create the DataFrame
val df = sqlContext.jsonFile("examples/src/main/resources/people.json")

// Show the content of the DataFrame
df.show()
// age name
// null Michael
// 30 Andy
// 19 Justin

// Print the schema in a tree format
df.printSchema()
// root
// |-- age: long (nullable = true)
// |-- name: string (nullable = true)
```

Shark (SQL Api)

// Select only the "name" column

df.select("name").show()

// name

// Michael

// Andy

// Justin

// Select everybody, but increment the age by 1

df.select(df("name"), df("age") + 1).show()

// name (age + 1)

// Michael null

// Andy 31

// Justin 20

Shark (SQL Api)

// Select people older than 21

df.filter(df("age") > 21).show()

// age name

// 30 Andy

// Count people by age

df.groupBy("age").count().show()

// age count

// null 1

// 19 1

// 30 1

Shark (SQL Api)

SQL Futtatás

```
val sqlContext = ... // An existing SQLContext
val df = sqlContext.sql("SELECT * FROM table")
```

Köszönöm a Figyelmet!