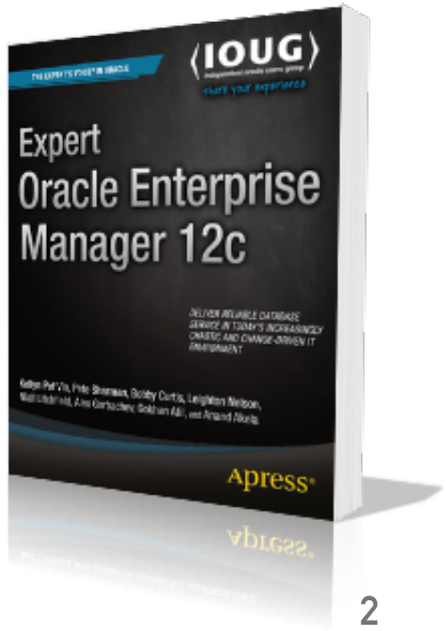
APACHE Spark™ WITH python

Gökhan Atıl

ORACLE ACE Director

GÖKHAN ATIL

- Database Administrator
- Oracle ACE Director (2016)
  ACE (2011)
- 10g/11g and R12 Oracle Certified Professional (OCP)
- Co-author of Expert Oracle Enterprise Manager 12c
- Founding Member and Vice President of TROUG
- Blogger (since 2008) gokhanatil.com
- Twitter: @gokhanatil



APACHE SPARK WITH PYTHON

- Introduction to Apache Spark
- Why Python *(PySpark)* instead of Scala?
- Spark RDD
- SQL and DataFrames
- Spark Streaming
- Spark Graphx
- Spark MLlib (Machine Learning)

INTRODUCTION TO APACHE SPARK

- A fast and general engine for large-scale data processing
- Top-Level Apache Project since 2014.
- Response to limitations in the MapReduce
- Run programs up to **100x** faster than Hadoop *MapReduce* in memory, or **10x** faster on disk
- Implemented in Scala programming language, supports Java, Scala, Python, R
- Runs on Hadoop, Mesos, Kubernetes, standalone, cloud

DOWNLOAD AND RUN ON YOUR PC

- https://spark.apache.org/downloads.html

1. Choose a Spark release: 2.3.0 (Feb 28 2018)
2. Choose a package type: Pre-built for Apache Hadoop 2.7 and later
3. Download Spark: spark-2.3.0-bin-hadoop2.7.tgz

- Extract and Spark is ready:

  tar -xzf spark-2.3.0-bin-hadoop2.7.tgz

  spark-2.3.0-bin-hadoop2.7/bin/spark

- You can also use PIP:

  pip install pyspark

PYSPARK AND SPARK-SUBMIT

- PySpark is the interface that gives access to Spark using the Python programming language

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 2.3.0
      /_/

Using Python version 2.7.14 (default, Mar 27 2018 12:28:59)
SparkSession available as 'spark'.
>>>
```

- The spark-submit script in Spark's bin directory is used to launch applications on a cluster

spark-submit ***example1.py***

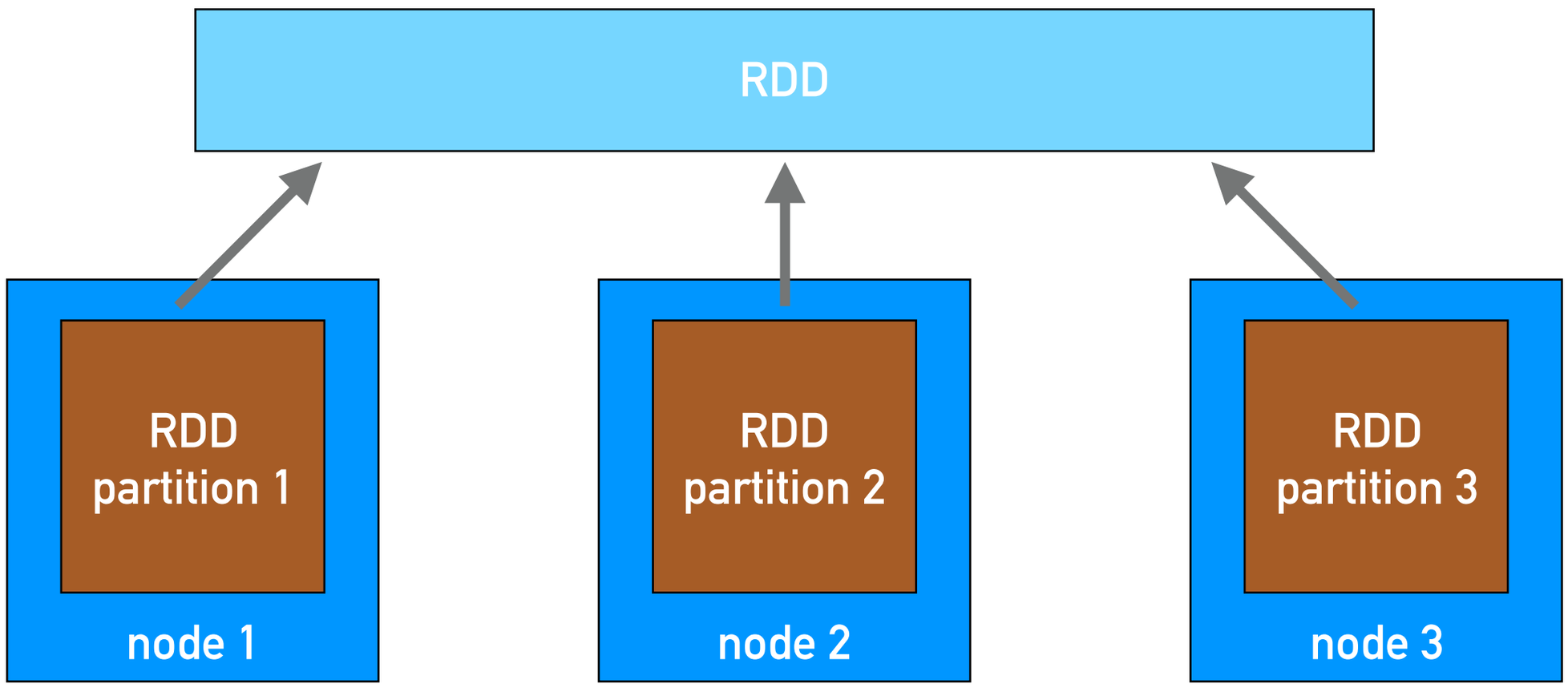
WHY PYTHON INSTEAD OF SCALA?

- If you know Scala, then use Scala!
- Learning curve: Python is comparatively easier to learn
- Easy to use: Code readability, maintainability and familiarity is far better with Python
- Libraries: Python comes with great libraries for data analysis, statistics and visualization (numpy, pandas, matplotlib etc...)
- Performance: Scala is faster then Python but if your Python code just calls Spark libraries, the differences in performance is minimal (*)

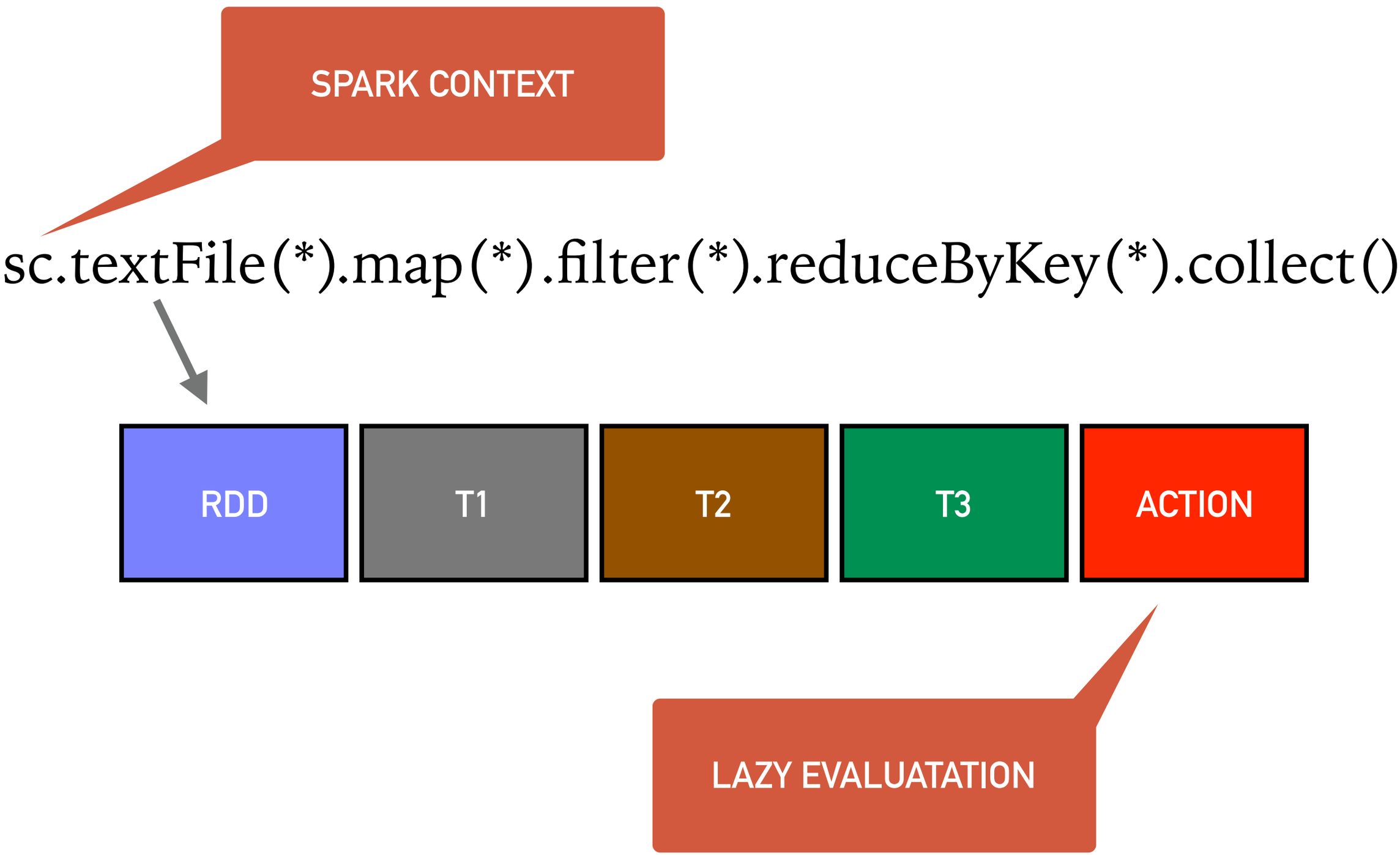
Reminder: Any new feature added in Spark API will be available in Scala first

RESILIENT DISTRIBUTED DATASET (RDD)

- RDDs are the core data structure in Spark
- Distributed, resilient, immutable, can store unstructured and structured data, lazy evaluated



RDD TRANSFORMATIONS AND ACTIONS



TRANSFORMATIONS

- map
- filter
- flatMap
- mapPartitions
- reduceByKey
- union
- intersection
- join

ACTIONS

- collect
- count
- first
- take
- takeSample
- takeOrdered
- saveAsTextFile
- foreach

HOW TO CREATE RDD IN PYSPARK

- Referencing a dataset in an external storage system:

```
rdd = sc.textFile( ... )
```

- Parallelizing already existing collection:

```
rdd = sc.parallelize( ... )
```

- Creating RDD from already existing RDDs:

```
rdd2 = rdd1.map( ... )
```

USERS.CSV (MOVIELENS DATABASE)

id | age | gender | occupation | zip

1|24|M|technician|85711

2|53|F|other|94043

3|23|M|writer|32067

4|24|M|technician|43537

5|33|F|other|15213

6|42|M|executive|98101

7|57|M|administrator|91344

8|36|M|administrator|05201

M = 670
F = 273

EXAMPLE #1: USE RDD TO GROUP DATA FROM CSV

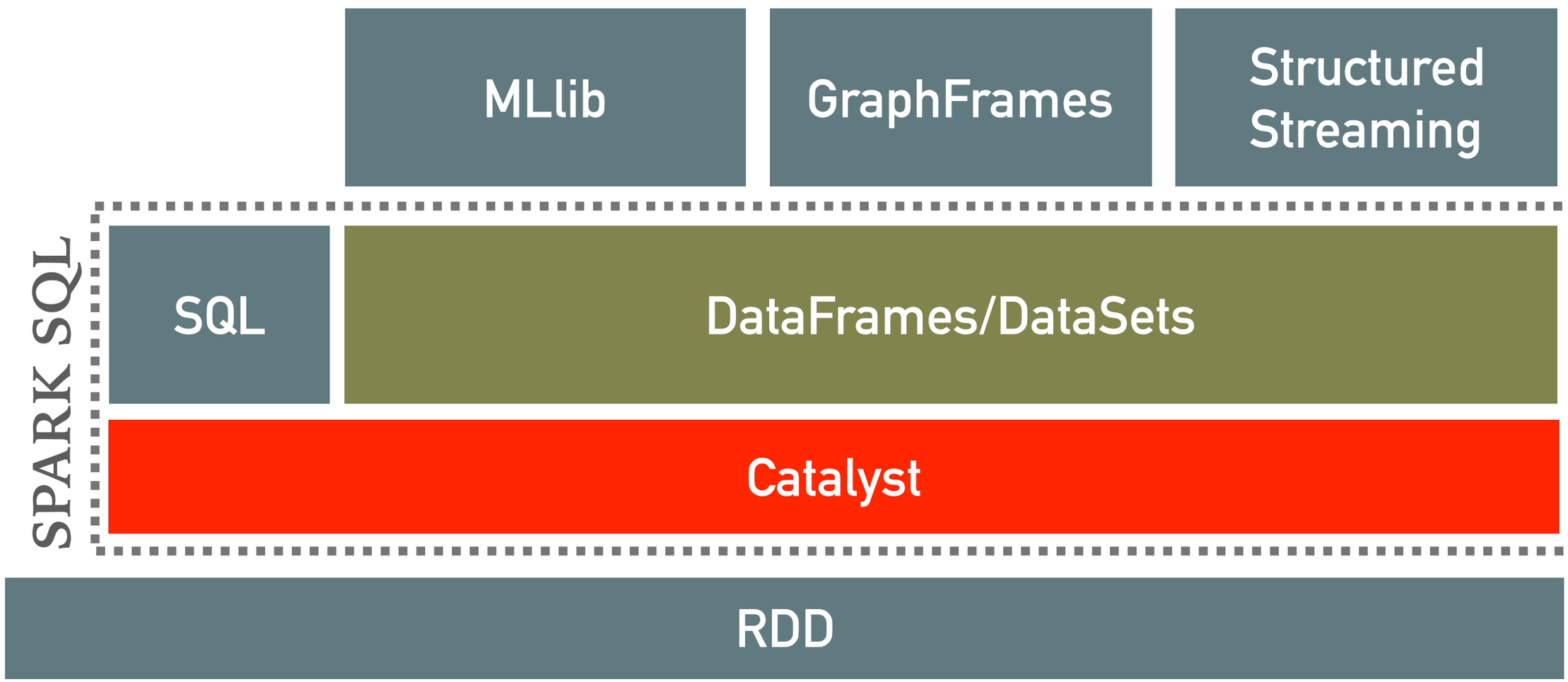
```
from pyspark import SparkContext

sc = SparkContext.getOrCreate()

print sc.textFile( "users.csv" ) \

.map( lambda x: (x.split("|")[2], 1) ) \

.reduceByKey(lambda x,y:x+y).collect()

sc.stop()
```

M, 1
M, 1
F, 1
M, 1

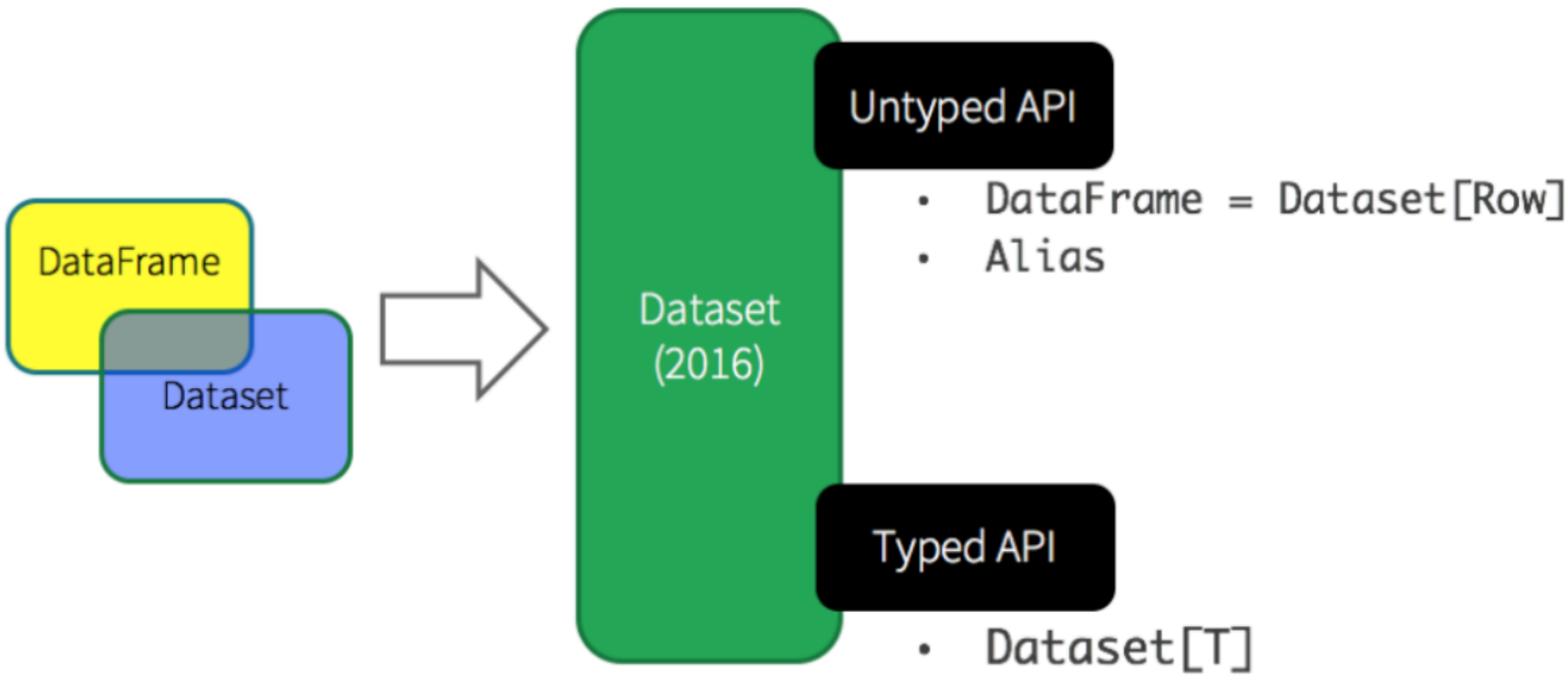
[(u'M', 670), (u'F', 273)]

SPARK SQL AND DATAFRAMES

- Spark SQL is Apache Spark's module for working with structured data



DATAFRAMES AND DATASETS

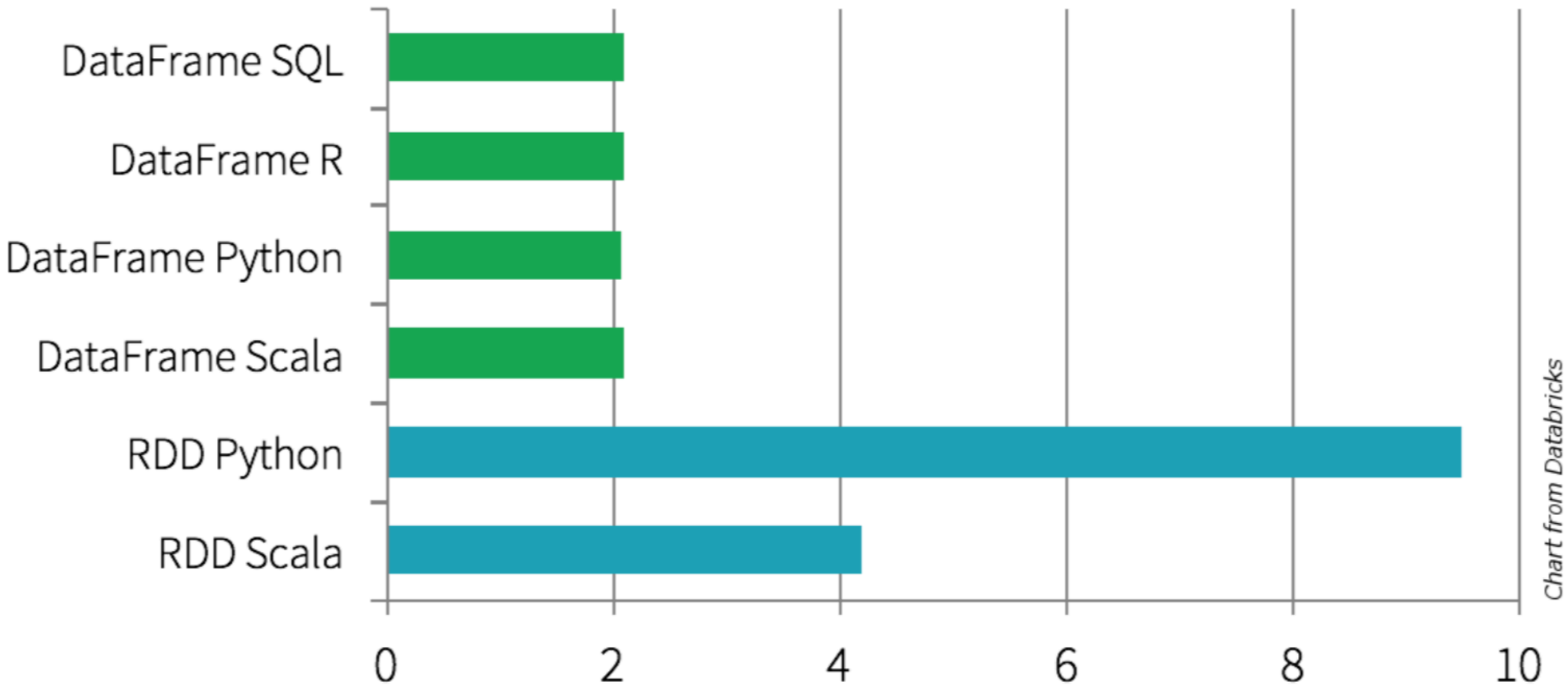


- DataFrame is a distributed collection of "structured" data, organized into named columns.
- Spark DataSets are statically typed, while Python is a dynamically typed programming language so Python supports only DataFrames.

EXAMPLE #2: USE DATAFRAME TO GROUP DATA FROM CSV

```
from pyspark import SparkContext
from pyspark.sql import SparkSession
sc = SparkContext.getOrCreate()
spark = SparkSession(sc)

spark.read.load( "users.csv", format="csv", sep="|" ) \
        .toDF( "id","age","gender","occupation","zip" ) \
        .groupby( "gender" ).count().show()

sc.stop()
```

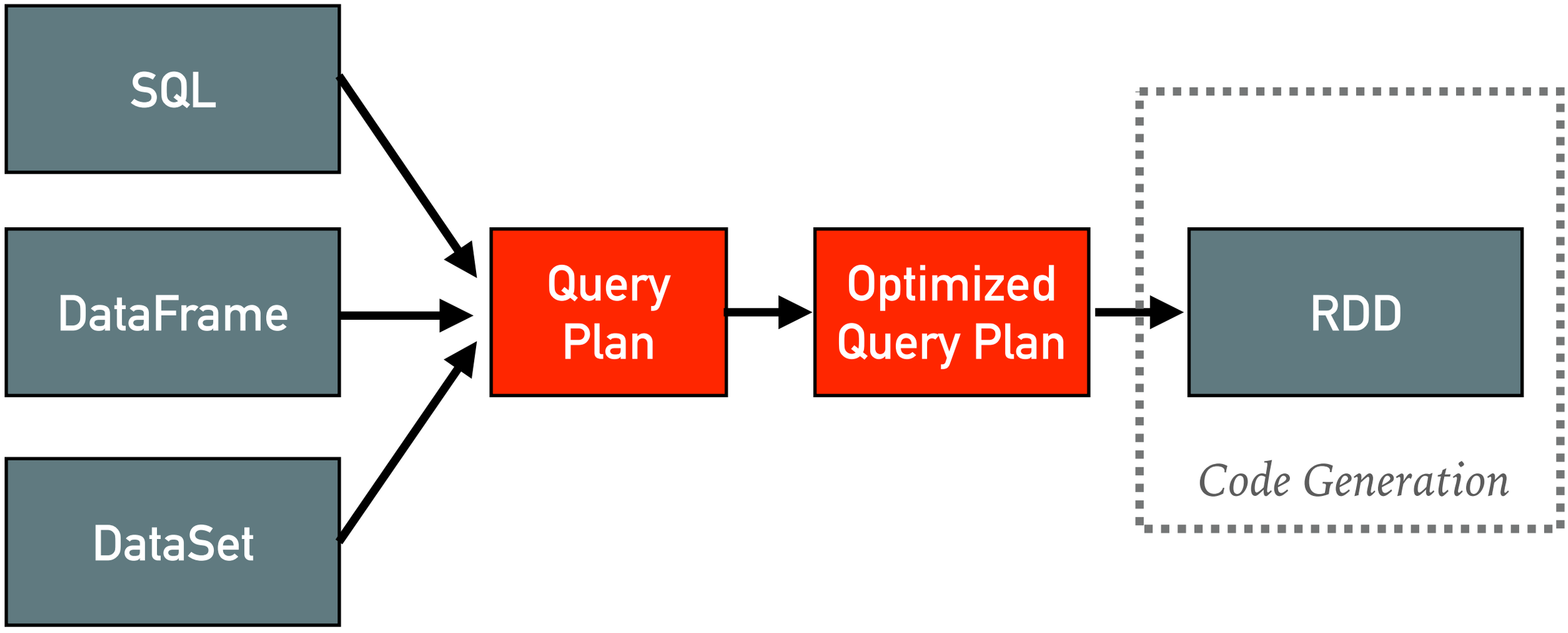
DATAFRAME VERSUS RDD



Time to aggregate 10 million integer pairs (in seconds)

CATALYST OPTIMIZER

- Spark SQL uses Catalyst optimizer to optimize query plans.
- Supports cost-based optimization since Spark 2.2



CONVERSION BETWEEN RDD AND DATAFRAME

- An RDD can be converted to DataFrame using createDataFrame or toDF method:

```
rdd = sc.parallelize([("osman",21),("ahmet",25)])
df = rdd.toDF( "name STRING, age INT" )
df.show()
```

- You can access underlying RDD of a DataFrame using rdd property:

```
df.rdd.collect()
```

```
[Row(name=u'osman',age=21),Row(name=u'ahmet',age=25)]
```

EXAMPLE #3: CREATE TEMPORARY VIEWS FROM DATAFRAMES

```
spark.read.load( "users.csv", format="csv", sep="|" ) \
    .toDF( "id","age","gender","occupation","zip" ) \
    .createOrReplaceTempView( "users" )

spark.sql( "select count(*) from users" ).show()

spark.sql( "select case when age < 25 then '-25' \
    when age between 25 and 39 then '25-40' \
    when age >= 40 then '40+' end age_group, \
    count(*) from users group by age_group order by 1" ).show()
```

EXAMPLE #4: READ AND WRITE DATA

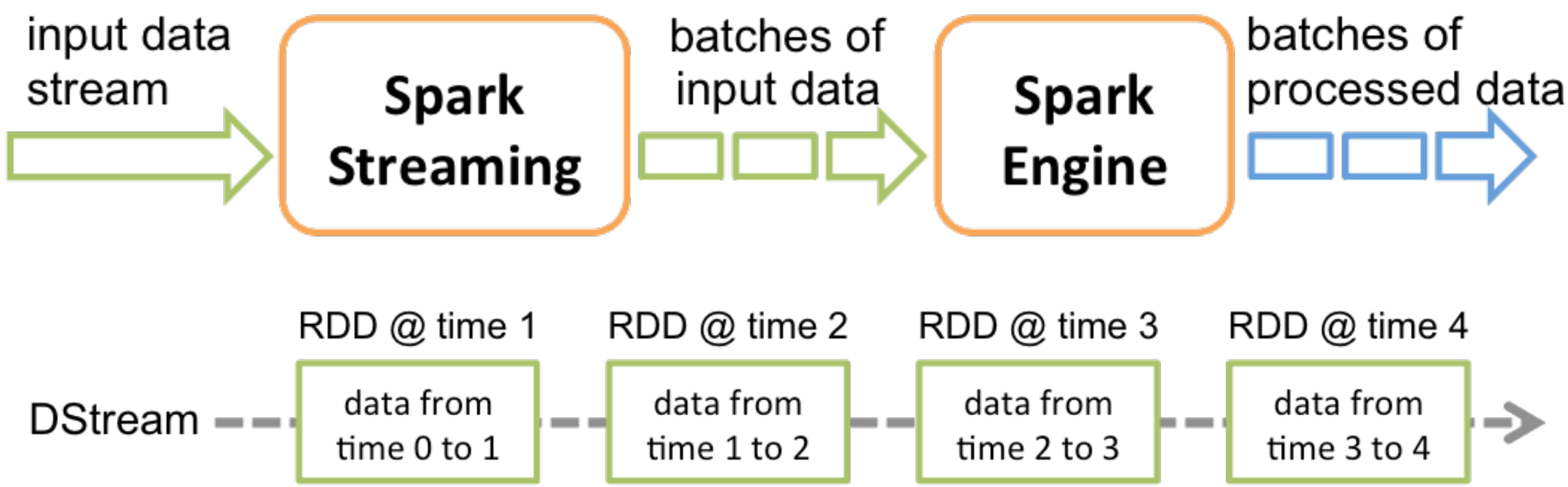
```
df = spark.read.load( "users.csv", format="csv", sep="|" ) \
    .toDF( "id","age","gender","occupation","zip" )

df.write.saveAsTable("users")
```

HIVE

```
df .write.save("users.json", format="json", mode="overwrite")

spark.sql("SELECT gender, count(*) FROM \
    json.`users.json` GROUP BY gender").show()
```

SPARK STREAMING (DSTREAMS)

- Scalable, high-throughput, fault-tolerant stream processing of live data streams
- Supports: File, Socket, Kafka, Flume, Kinesis
- Spark Streaming receives live input data streams and divides the data into batches



EXAMPLE #5: DISCRETIZED STREAMS (DSTREAMS)

```
ssc = StreamingContext(sc, 1)

stream_data = ssc.textFileStream("file:///tmp/stream") \
    .map( lambda x: x.split(","))

stream_data.pprint()

ssc.start()

ssc.awaitTermination()
```

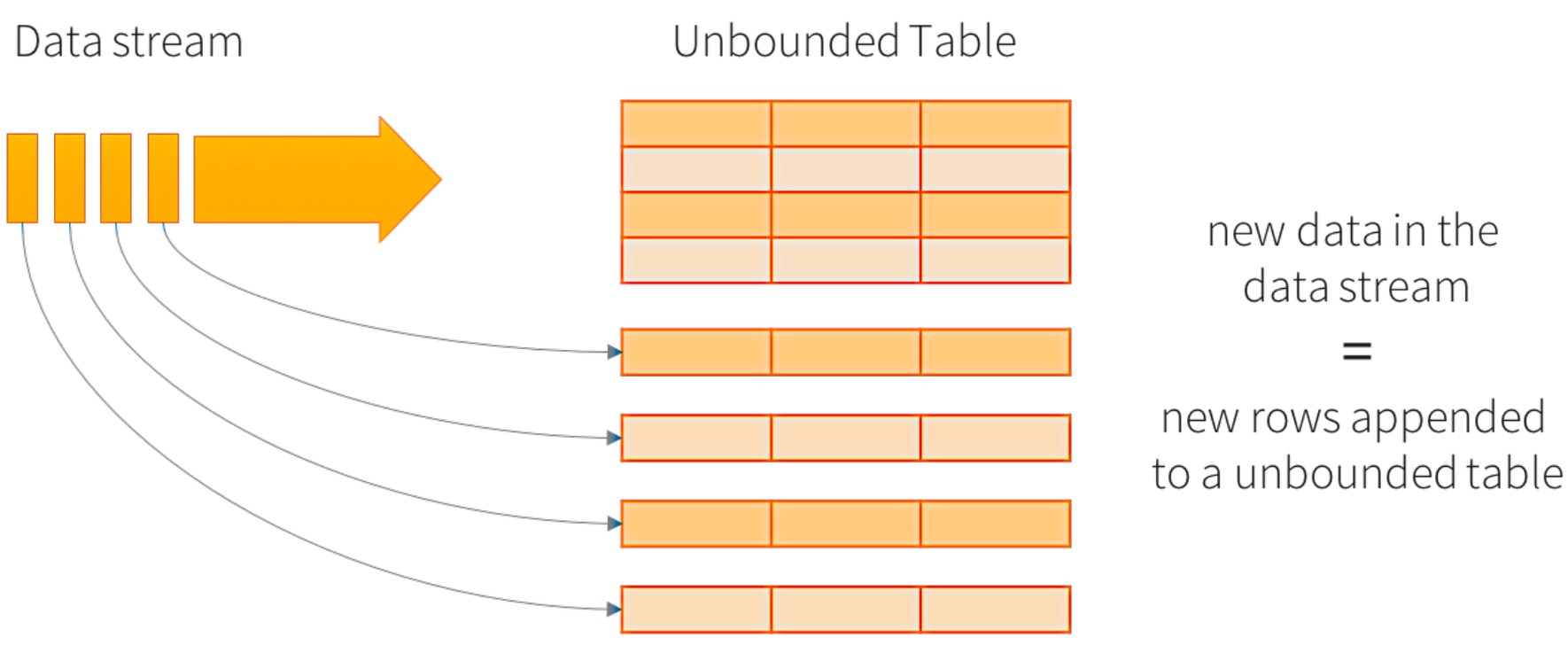
EXAMPLE #5: OUTPUT

```
Fatih,5
Cenk,4
Ahmet,3
Arda,1
```

```
-------------------------------------
Time: 2018-04-09 12:09:06
-------------------------------------
[u'Fatih', u'5']
[u'Cenk', u'4']
[u'Ahmet', u'3']
[u'Arda', u'1']

-------------------------------------
Time: 2018-04-09 12:09:07
-------------------------------------
```

STRUCTURED STREAMING

- Stream processing engine built on the Spark SQL engine
- Supports File and Kafka sources for production; Socket and Rate sources for testing



Data stream as an unbounded table

EXAMPLE #6: STRUCTURED STREAMING

```
stream_data = spark.readStream \
    .load( format="csv",path="/tmp/stream/*.csv",
    schema="name string, points int" ) \
    .groupBy("name").sum("points").orderBy( "sum(points)",
    ascending=0 )


stream_data.writeStream.start( format="console",
    outputMode="complete" ).awaitTermination()
```

EXAMPLE #6: OUTPUT

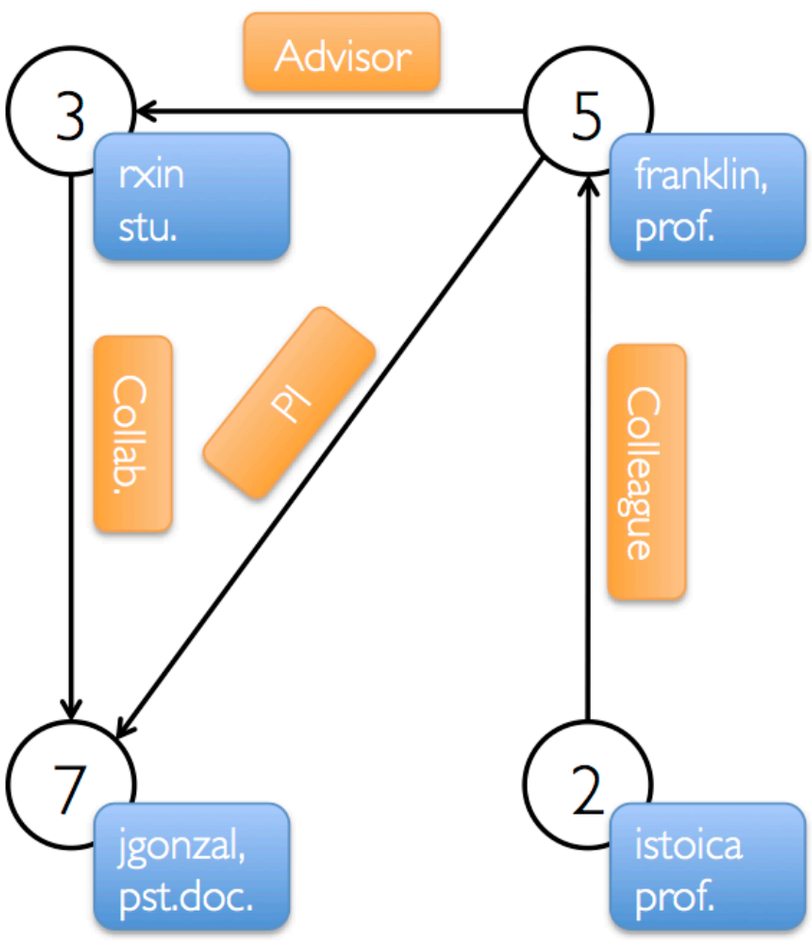
```
Fatih,5
Cenk,4
Ahmet,3
Arda,1
```

```
Cenk,4
Fatih,3
Osman,2
Ahmet,1
Arda,1
```

```
+-----+------------+
| name|sum(points)|
+-----+------------+
| Cenk|           8|
|Fatih|           8|
|Ahmet|           4|
| Arda|           2|
|Osman|           2|
+-----+------------+
```

GRAPHX (GRAPHFRAMES)

- GraphX is a *new* component in Spark for graphs and graph-parallel computation.



Vertex Table

Id	Property (V)
3	(rxin, student)
7	(jgonzal, postdoc)
5	(franklin, professor)
2	(istoica, professor)

Edge Table

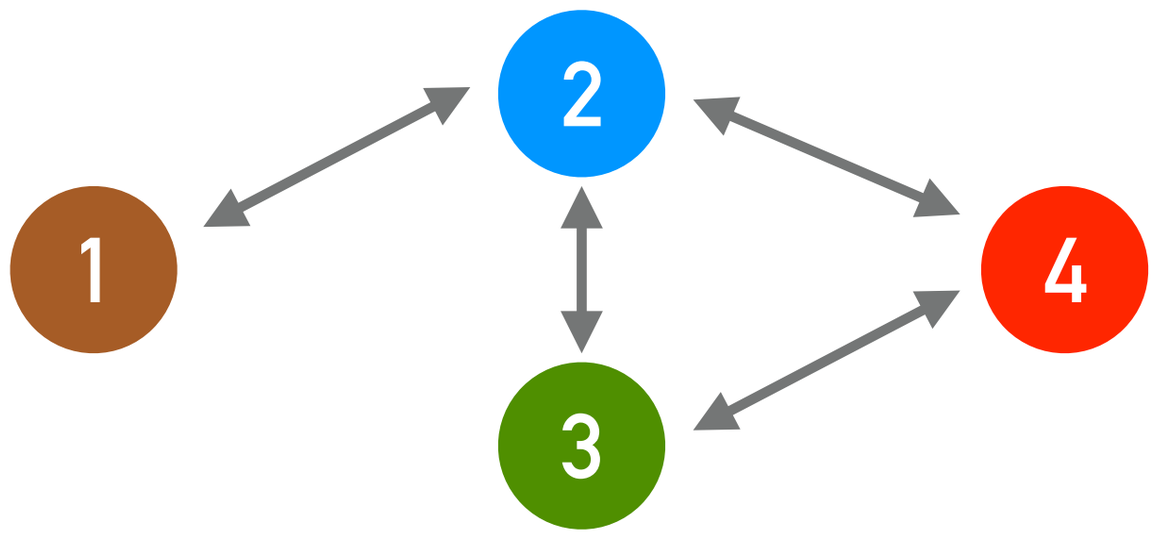
SrcId	DstId	Property (E)
3	7	Collaborator
5	3	Advisor
2	5	Colleague
5	7	PI

EXAMPLE #7: GRAPHFRAMES

```
vertex =
spark.createDataFrame([
    (1, "Ahmet"),
    (2, "Mehmet"),
    (3, "Cengiz"),
    (4, "Osman")],
    ["id", "name"])
```

```
edges =
spark.createDataFrame([
    ( 1, 2, "friend" ),
    ( 2, 1, "friend" ),
    ( 2, 3, "friend" ),
    ( 3, 2, "friend" ),
    ( 2, 4, "friend" ),
    ( 4, 2, "friend" ),
    ( 3, 4, "friend" ),
    ( 4, 3, "friend" )],
    ["src","dst", "relation"])
```

EXAMPLE #7: GRAPHFRAMES



pyspark *--packages* graphframes:graphframes:0.5.0-spark2.1-s_2.11

```
import graphframes as gf

g = gf.GraphFrame(vertex, edges)

g.shortestPaths([4]).show()
```

```
+---+------+----------+
| id|  name|distances|
+---+------+----------+
|  1| Ahmet| [4 -> 2]|
|  3|Cengiz| [4 -> 1]|
|  2|Mehmet| [4 -> 1]|
|  4| Osman| [4 -> 0]|
+---+------+----------+
```

MLLIB (MACHINE LEARNING)

- Supports common ML Algorithms such as classification, regression, clustering, and collaborative filtering
- Featurization:
  - Feature extraction (TF-IDF, Word2Vec, CountVectorizer ...)
  - Transformation (Tokenizer, StopWordsRemover ...)
  - Selection (VectorSlicer, RFormula ...)
- Pipelines: combine multiple algorithms into a single pipeline, or workflow
- DataFrame-based API is primary API

EXAMPLE #8: ALTERNATING LEAST SQUARES (ALS)

```
def parseratings( x ):
    v = x.split("::")
    return (int(v[0]), int(v[1]), float(v[2]))

ratings = sc.textFile("ratings.dat").map(parseratings) \
    .toDF( ["user", "id", "rating"] )

als = ALS(userCol="user",  itemCol="id", ratingCol="rating")
model = als.fit(ratings)
model.recommendForAllUsers(10).show()
```

EXAMPLE #8 OUTPUT

```
+-----------------------------------------------------------------------+
|title                                                                  |
+-----------------------------------------------------------------------+
|Fight Club (1999)                                                      |
|More (1998)                                                            |
|Amelie (Fabuleux destin d'Amélie Poulain, Le) (2001)                   |
|The Lord of the Rings: The Fellowship of the Ring (2001)               |
|The Lord of the Rings: The Two Towers (2002)                           |
|The Lord of the Rings: The Return of the King (2003)                   |
|The Life of Oharu (Saikaku ichidai onna) (1952)                        |
|The Man Who Planted Trees (Homme qui plantait des arbres, L') (1987)|
|Shadows of Forgotten Ancestors (1964)                                  |
|Sun Alley (Sonnenallee) (1999)                                         |
+-----------------------------------------------------------------------+
```

Blog: www.gokhanatil.com Twitter: [@gokhanatil](#)