DATAFRAMES

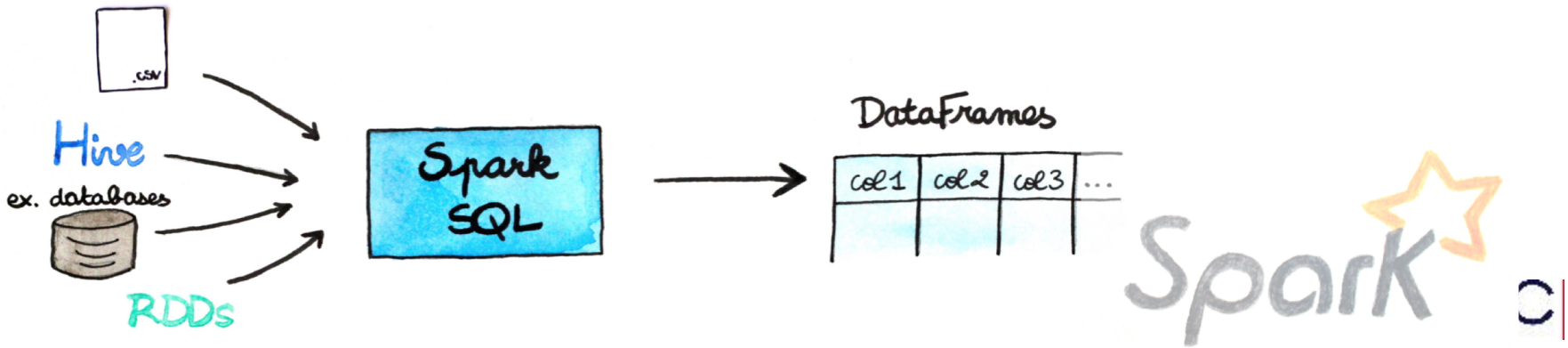
Spark SQL

Spark SQL is a component on top of **Spark Core** that facilitates processing of structured and semi-structured data and the integration of several data formats as source (Hive, Parquet, JSON).

https://spark.apache.org/docs/latest/sql-programming-guide.html

DataFrames

- DataFrame is an immutable distributed collection of data.
- Unlike an RDD, **data is organized into named columns**, like a table in a relational database or a dataframe in R/Python
- Distributed collection of data grouped into named columns:
  - DataFrames = RDD + Schema
- Designed to make large data sets processing even easier.
- Allows developers to impose a structure onto a distributed collection of data, allowing higher-level abstraction;

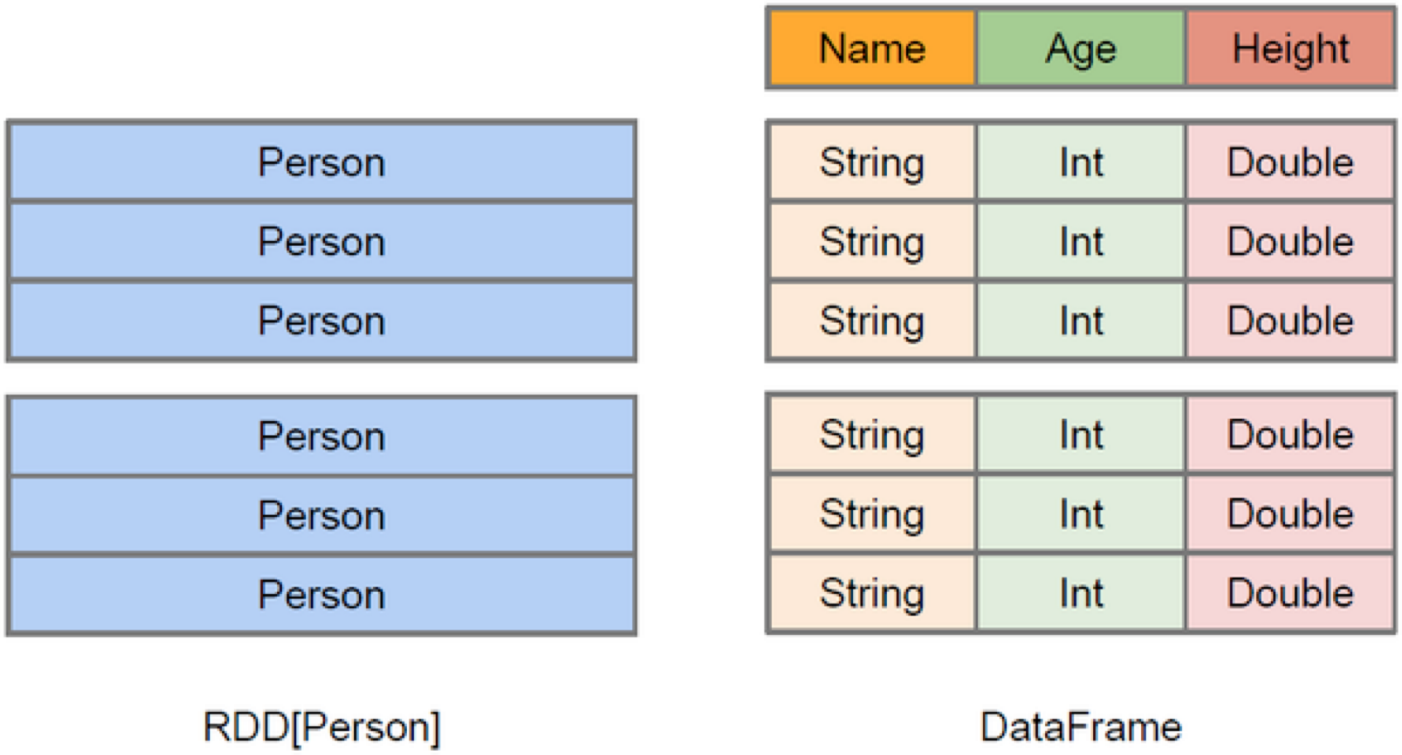


The structured spectrum

Structured	Semi-structured	Unstructured
• Relational Databases • Parquet • Formatted Messages	• HTML • XML • JSON	• Plain text • Generic media

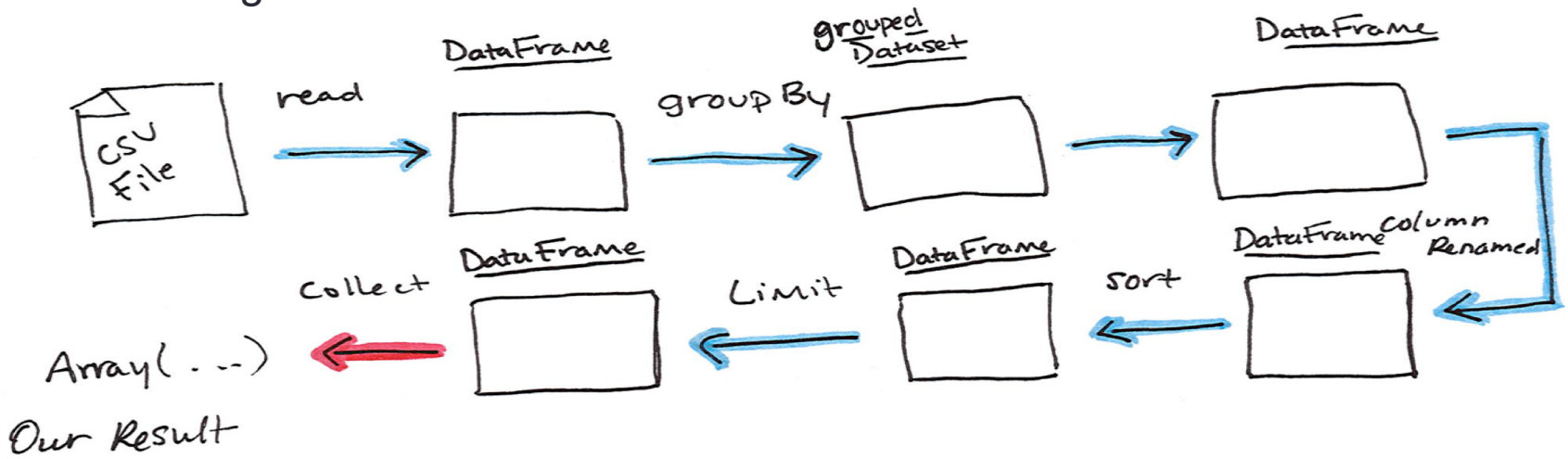
RDD vs DataFrames

DataFrames are composed of Row objects,
along with a schema that describes the data types of each column in the row.

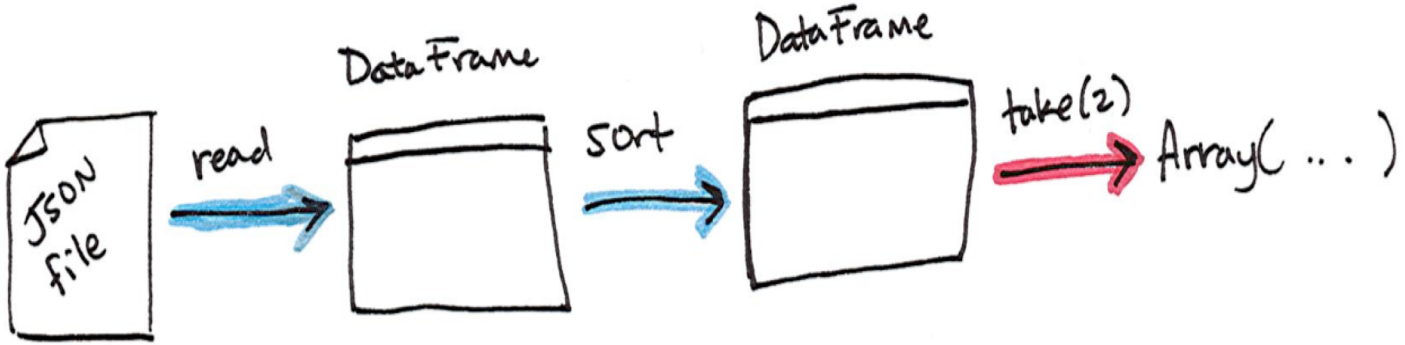


DataFrames and CVS/JSON Files

Working with CSV files



Working with Json files



https://spark.apache.org/docs/latest/sql-data-sources.html

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DataFrame – read/write formats

- sqlContext.read.[format]

```
>> sqlContext.read.parquet(path)
>> sqlContext.read.json(path, [schema])
>> sqlContext.read.jdbc(url, table)
>> sqlContext.read.load(path, [format])
```

- sqlContext.write.[format]

```
>> sqlContext.write.parquet(path)
>> sqlContext.write.json(path, [mode])
>> sqlContext.write.jdbc(url, table, [mode])
>> sqlContext.write.save(path, [format], [mode])
```

DataFrames and RDDs

- Create from RDD of tuples

```
>> rdd = sc.parallelize([(”a”, 1), (”b”, 2), (”c”, 3)])
>> df = sqlContext.createDataFrame(rdd,[”name”, ”id”])
>> df.show()
```

```
+----+--+
|name|id|
+----+--+
|   a| 1|
|   b| 2|
|   c| 3|
+----+--+
```

DataFrames and RDDs

- Create from RDD of Rows

```
>> from pyspark.sql  import Row
>> ExampleRow = Row(”name”, ”id”)
>> rdd = sc.parallelize([ ExampleRow(”a”, 1), ExampleRow(”b”, 2),
         ExampleRow(”c”, 3) ])
>> df = sqlContext.createDataFrame(rdd)
>> df.show()
```

```
+----+--+
|name|id|
+----+--+
|   a| 1|
|   b| 2|
|   c| 3|
+----+--+
```

```
>> df.printSchema()
root
 |-- name: string (nullable = false)
 |-- id: integer (nullable = false)
```

Examples of SparkSQL (1)

```
from pyspark import SparkContext
from pyspark.sql import SQLContext
sc = SparkContext('local', 'Spark SQL')
sqlc = SQLContext(sc)
#We can read a JSON file and create a DataFrame (Spark SQL json reader)
players = sqlc.read.json('players.json') # Print the schema in a tree format
players.printSchema()
#Select only the "FullName" column
players.select("FullName").show(4)
+-----------------------+
| FullName              |
 +-----------------------+
| Ãngel Bossio        |
| Juan Botasso       |
| Roberto Cherro  |
| Alberto Chividini|
+-----------------------+
```

Examples of SparkSQL (1)

```
#Then we can create a view of our DataFrame. The lifetime of this temporary table
is tied to the SparkSession that was used to create this DataFrame.

players.registerTempTable("players")


#We can then query our view; for instance to get the names of all the Teams

sqlc.sql("select distinct Team from players").show(5)

+----------+
| Team     |
 +----------+
|England |
|Paraguay|
| POL      |
 | Russia   |
 | BRA      |
+-----------+
```

Examples of SparkSQL (2)

```
# spark is an existing Spa
df = spark.read.json("exam
# Displays the content of
df.show()
# +----+-------+
# | age|   name|
# +----+-------+
# |null|Michael|
# |  30|   Andy|
# |  19| Justin|
# +----+-------+
```

Find full example code at "examples/

```
# 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|
# +-------+---------+

# 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|
# +----+-----+
# |  19|    1|
# |null|    1|
# |  30|    1|
# +----+-----+
```

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Pandas DataFrame

- When in PySpark, there is also an easy option to convert Spark DataFrame to Pandas dataframe.

```
# Convert Spark DataFrame to Pandas
pandas_df = spark_df.toPandas()

# Create a Spark DataFrame from Pandas
spark_df = context.createDataFrame(pandas_df)
```

- One powerful and easy way to visualize data is

```
dataframe.toPandas().plot()
```

Additional Slides – Parsing file formats to RDD

Parsing JSON data to RDD

```
import json


#parse multi-line json file
parsed = sc.textFile("data.json").map(lambda x:
json.loads(x))


#parse directory of json documents
parsed = sc.wholeTextFiles("data/").map(lambda x:
json.loads(x))


#write out json data
data.map(lambda x:json.dumps(x)).saveAsTextFile(output)
```

Parsing CSV data to RDD - Example

```
import csv
from StringIO import StringIO
# Read from CSV
def load_csv(contents):
    return csv.reader(StringIO(contents[1]))
data = sc.wholetextFile("data/").flatMap(load_csv)
# Write to CSV
def write_csv(recods):
   output = StringIO()
   writer = csv.writer()
   for record in records:
        writer.writerow(record)
   return [output.get_value()]
data.mapPartitions(write_csv).saveAsTextFile("output/")
```

Parsing Structured Objects to RDD

```
import csv

from datetime import datetime
from StringIO import StringIO
from collections import namedtuple

DATE_FMT = "%Y-%m-%d %H:%M:%S" # 2013-09-16 12:23:33
Customer = namedtuple('Customer', ('id', 'name', 'registered'))

def parse(row):
   row[0] = int(row[0]) # Parse ID to an integer
   row[4] = datetime.strptime(row[4], DATE_FMT)
   return Customer(*row)

def split(line):
    reader = csv.reader(StringIO(line))
    return reader.next()

customers = sc.textFile("customers.csv").map(split).map(parse)
```