Dataframes & Spark SQL

Spark SQL

Spark module
for
Structured Data Processing

Spark SQL

Integrated

- Provides **DataFrames**
- Mix SQL queries & Spark programs

Spark SQL

Uniform Data Access

- Source:
  - HDFS,
  - Hive
  - Relational Databases
- Avro, Parquet, ORC, JSON
- You can even join data across these sources.
- Hive Compatibility
- Standard Connectivity

DataFrames

RDD

1 sandeep
2 ted
3 thomas
4 priya
5 kush

Unstructured

Need code for processing

DataFrames

RDD

1 sandeep
2 ted
3 thomas
4 priya
5 kush

Unstructured

Need code for processing

Data Frame

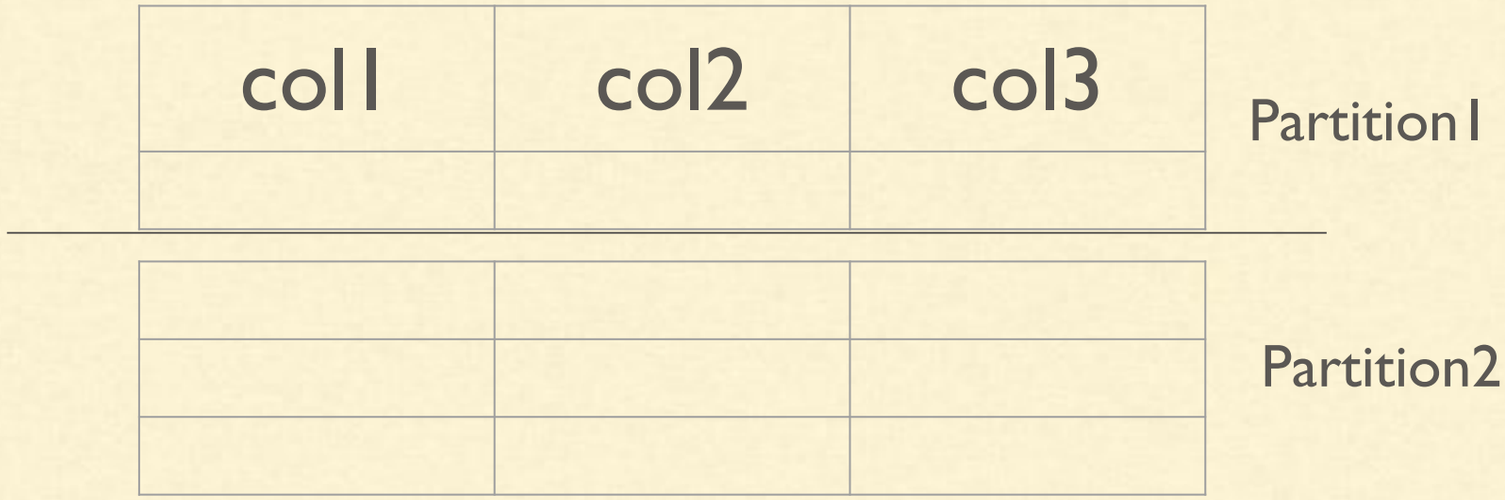
ID	Name
1	sandeep
2	ted
3	thomas
4	priya
5	kush

Structured

Can use SQL or R like syntax:
df.sql("select Id where name = 'priya'")

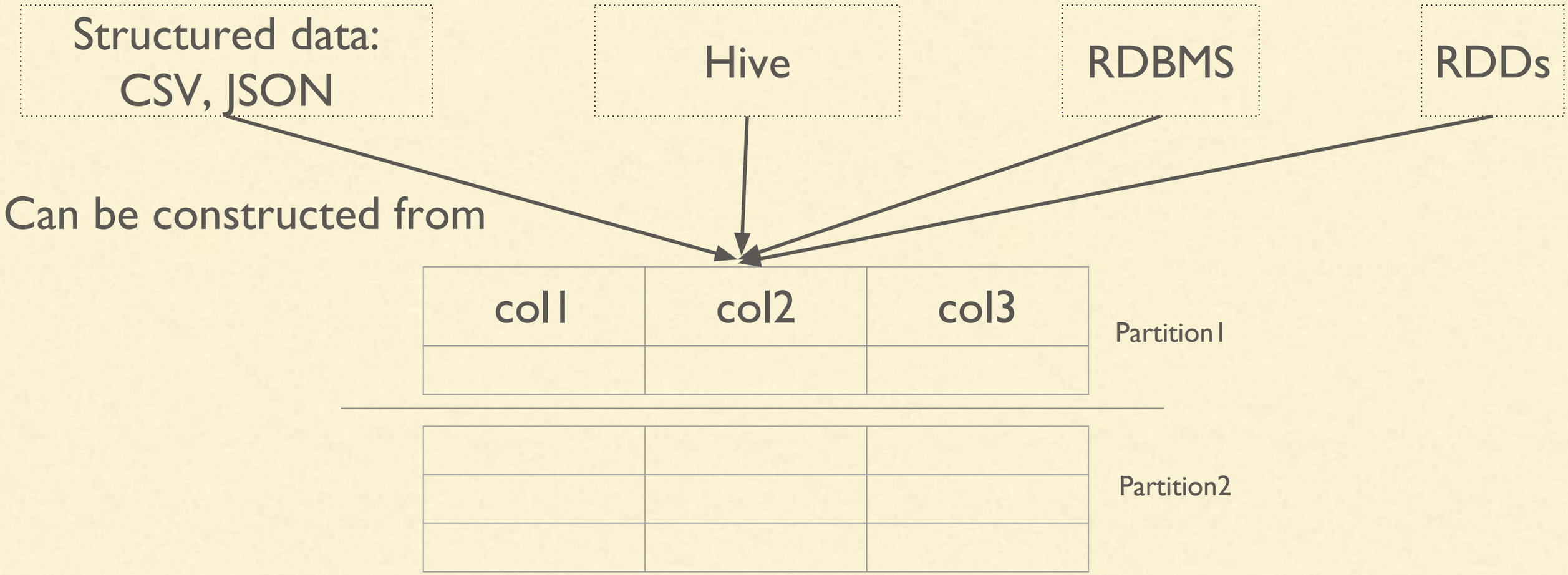
head(where(df, df$ID > 21))

Data Frames

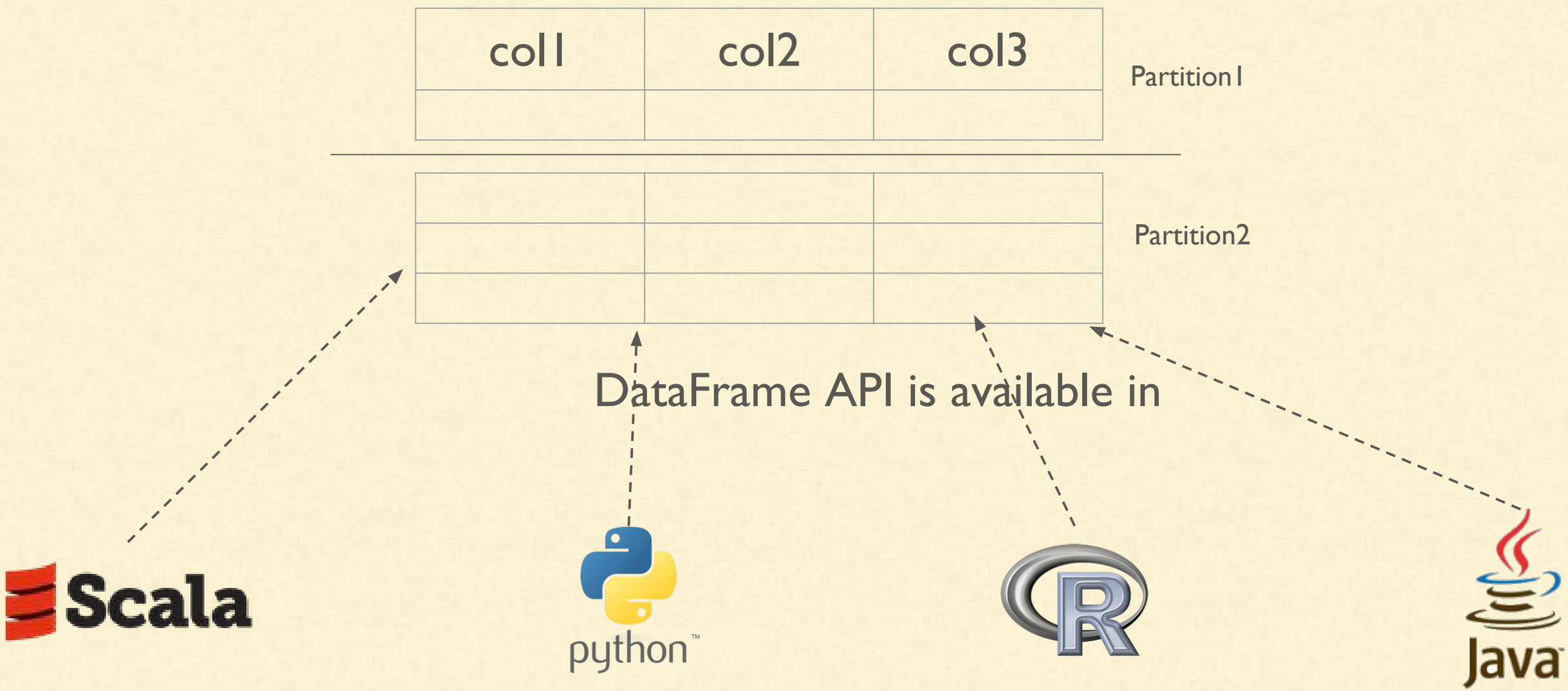


- Collection with named columns
- Distributed
- <> Same as database table
- <> A data frame in R/Python

Data Frames


Structured data:
CSV, JSON
Hive
RDBMS
RDDs
Can be constructed from
col1
col2
col3
Partition1
Partition2

Data Frames


col1
col2
col3
Partition1
Partition2
DataFrame API is available in
Scala
python
R
Java

Getting Started

- Available in Spark 2.0x onwards.
- Using usual interfaces
  - Spark-shell
  - Spark Application
  - Pyspark
  - Java
  - etc.

Getting Started

```
$ export HADOOP_CONF_DIR=/etc/hadoop/conf/
$ export YARN_CONF_DIR=/etc/hadoop/conf/
```

Getting Started

```
$ export HADOOP_CONF_DIR=/etc/hadoop/conf/
$ export YARN_CONF_DIR=/etc/hadoop/conf/
$ ls /usr/
bin  games  include  jdk64  lib64    local  share       spark1.6
spark2.0.2  tmp etc  hdp    java     lib    libexec  sbin   spark1.2.1
spark2.0.1  src
```

Getting Started

```
$ export HADOOP_CONF_DIR=/etc/hadoop/conf/
$ export YARN_CONF_DIR=/etc/hadoop/conf/
$ ls /usr/
bin  games  include  jdk64  lib64    local  share       spark1.6
spark2.0.2  tmp etc  hdp    java     lib    libexec  sbin   spark1.2.1
spark2.0.1  src
$ /usr/spark2.0.2/bin/spark-shell
```

Getting Started

```
Spark context Web UI available at http://172.31.60.179:4040
Spark context available as 'sc' (master = local[*], app id = local-1498489557917).
Spark session available as 'spark'.
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /___/ .__/\_,_/_/ /_/\_\   version 2.0.2
      /_/

Using Scala version 2.11.8 (OpenJDK 64-Bit Server VM, Java 1.8.0_91)
Type in expressions to have them evaluated.
Type :help for more information.

scala>
```

Getting Started

```
Spark context Web UI available at http://172.31.60.179:4040
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   /___/ .__/\_,_/_/ /_/\_\   version 2.0.2
      /_/

Using Scala version 2.11.8 (OpenJDK 64-Bit Server VM, Java 1.8.0_91)
Type in expressions to have them evaluated.
Type :help for more information.

scala>
```

Starting Point: SparkSession

```
import org.apache.spark.sql.SparkSession

val spark = SparkSession
  .builder()
  .appName("Spark SQL basic example")
  .config("spark.some.config.option", "some-value")
  .getOrCreate()
```

Starting Point: SparkSession

```
import org.apache.spark.sql.SparkSession

val spark = SparkSession
  .builder()
  .appName("Spark SQL basic example")
  .config("spark.some.config.option", "some-value")
  .getOrCreate()

//For implicit conversions, e.g. RDDs to DataFrames
import spark.implicits._
```

Creating DataFrames from JSON

```
In web console or ssh:
$ hadoop fs -cat /data/spark/people.json
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

Creating DataFrames from JSON

```
var df = spark.read.json("/data/spark/people.json")

# Displays the content of the DataFrame to stdout
df.show()
```

```
scala> df.show()
+----+-------+
| age|   name|
+----+-------+
|null|Michael|
|  30|   Andy|
|  19| Justin|
+----+-------+
```

Creating DataFrames from JSON

```
var df = spark.read.json("/data/spark/people.json")

# Displays the content of the DataFrame to stdout
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```

```
scala> df.show()
+----+-------+
| age|   name|
+----+-------+
|null|Michael|
|  30|   Andy|
|  19| Justin|
+----+-------+
```

Original JSON:

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

DataFrame Operations

```
# Print the schema in a tree format
df.printSchema()

root
 |-- age: long (nullable = true)
 |-- name: string (nullable = true)
```

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

DataFrame Operations

Select only the "name" column

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

```
+-------+
|   name|
+-------+
|Michael|
|   Andy|
| Justin|
+-------+
```

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

DataFrame Operations

```
# Increment the age by 1
df.select($"name",$"age" + 1).show()

+-------+----------+
|   name|(age + 1)|
+-------+----------+
|Michael|      null|
|   Andy|        31|
| Justin|        20|
+-------+----------+
```

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

DataFrame Operations

```
# Select people older than 21
df.filter($"age"> 21).show()
+---+----+
|age|name|
+---+----+
| 30|Andy|
+---+----+
```

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

DataFrame Operations

```
# Count people by age
df.groupBy("age").count().show()
+----+-----+
| age|count|
+----+-----+
|  19|    1|
|null|    1|
|  30|    1|
+----+-----+

#SQL Equivalent
Select age, count(*) from df group by age
```

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

Running SQL Queries Programmatically

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```
// Register the DataFrame as a SQL temporary view
df.createOrReplaceTempView("people")
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val sqlDF = spark.sql("SELECT * FROM people")
```

Running SQL Queries Programmatically

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// Register the DataFrame as a SQL temporary view
df.createOrReplaceTempView("people")

val sqlDF = spark.sql("SELECT * FROM people")
sqlDF.show()
+----+-------+
| age|   name|
+----+-------+
|null|Michael|
|  30|   Andy|
|  19| Justin|
+----+-------+
```

Datasets

Datasets

- Similar to RDDs
- instead Java serialization or Kryo
- use a specialized Encoder
- use Encoder to serialize

Encoders

- Are dynamically generated code
- Perform operations with deserializing

Creating Datasets

```
// Encoders for most common types are automatically
provided by importing spark.implicits._
val primitiveDS = Seq(1, 2, 3).toDS()
primitiveDS.map(_ + 1).collect() // Returns: Array(2, 3, 4)
```

Creating Datasets

```
case class Person(name: String, age: Long)

// Encoders are created for case classes
val caseClassDS = Seq(Person("Andy", 32)).toDS()
caseClassDS.show()
// +----+---+
// |name|age|
// +----+---+
// |Andy| 32|
// +----+---+
```

Creating Datasets

```
val path = "/data/spark/people.json"
val peopleDS = spark.read.json(path).as[Person]
peopleDS.show()
// +----+-------+
// | age|   name|
// +----+-------+
// |null|Michael|
// |  30|   Andy|
// |  19| Justin|
// +----+-------+
```

Interoperating with RDDs

RDD

1 sandeep
2 ted
3 thomas
4 priya
5 kush

Data Frame

ID	Name
1	sandeep
2	ted
3	thomas
4	priya
5	kush

How to convert an RDD into dataframe?

Interoperating with RDDs

RDD

1 sandeep
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Data Frame

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1	sandeep
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Two ways to convert RDDs to DF:

a. Inferring the Schema Using Reflection

b.

Interoperating with RDDs

RDD

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2 ted
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Data Frame

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1	sandeep
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Two ways to convert RDDs to DF:

a. Inferring the Schema Using Reflection
b. Programmatically Specifying the Schema

Inferring the Schema Using Reflection

- Spark SQL can convert an RDDs with case classes to a DataFrame
- The names of case class arguments are read using reflection and become columns
- Case classes can be nested or contain complex types
- Let us try to convert people.txt into dataframe

people.txt:
Michael, 29
Andy, 30
Justin, 19

Inferring the Schema Using Reflection

GitHub, Inc. [US] https://github.com/cloudxlab/bigdata/blob/master/spark/examples/dataframes/rdd_to_df.scala

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cloudxlab / bigdata
forked from singhabhinav/cloudxlab

Watch 1

Code Pull requests 0 Projects 0 Insights

Branch: master bigdata / spark / examples / dataframes / rdd_to_df.scala

girisandeep Create rdd_to_df.scala

1 contributor

9 lines (6 sloc) 285 Bytes Raw Bla

```
import spark.implicits._

case class Person(name: String, age: Long)

val txtRDD = sc.textFile("/data/spark/people.txt")
val arrayRDD = txtRDD.map(_.split(","))
val personRDD = arrayRDD.map(attributes => Person(attributes(0), attributes(1).trim.toInt))
val peopleDF = personRDD.toDF()
```

https://github.com/cloudxlab/bigdata/blob/master/spark/examples/dataframes/rdd_to_df.scala

Inferring the Schema Using Reflection

```
scala> import spark.implicits._
import spark.implicits._
```

Inferring the Schema Using Reflection

```
scala> import spark.implicits._
import spark.implicits._

scala> case class Person(name: String, age: Long)
defined class Person
```

Inferring the Schema Using Reflection

```
scala> import spark.implicits._
import spark.implicits._

scala> case class Person(name: String, age: Long)
defined class Person

scala> val textRDD = sc.textFile("/data/spark/people.txt")
textRDD: org.apache.spark.rdd.RDD[String] = /data/spark/people.txt
MapPartitionsRDD[3] at textFile at <console>:30
```

Inferring the Schema Using Reflection

```
scala> import spark.implicits._
import spark.implicits._

scala> case class Person(name: String, age: Long)
defined class Person

scala> val textRDD = sc.textFile("/data/spark/people.txt")
textRDD: org.apache.spark.rdd.RDD[String] = /data/spark/people.txt
MapPartitionsRDD[3] at textFile at <console>:30

scala> val arrayRDD = textRDD.map(_.split(","))
arrayRDD: org.apache.spark.rdd.RDD[Array[String]] = MapPartitionsRDD[4] at
map at <console>:32
```

Inferring the Schema Using Reflection

```
scala> import spark.implicits._
import spark.implicits._

scala> case class Person(name: String, age: Long)
defined class Person

scala> val textRDD = sc.textFile("/data/spark/people.txt")
textRDD: org.apache.spark.rdd.RDD[String] = /data/spark/people.txt
MapPartitionsRDD[3] at textFile at <console>:30

scala> val arrayRDD = textRDD.map(_.split(","))
arrayRDD: org.apache.spark.rdd.RDD[Array[String]] = MapPartitionsRDD[4] at
map at <console>:32

scala> val personRDD = arrayRDD.map(attributes => Person(attributes(0),
attributes(1).trim.toInt))
personRDD: org.apache.spark.rdd.RDD[Person] = MapPartitionsRDD[5] at map
at <console>:36
```

Inferring the Schema Using Reflection

```
scala> val peopleDF = personRDD.toDF()
peopleDF: org.apache.spark.sql.DataFrame = [name: string, age: bigint]
```

Inferring the Schema Using Reflection

```
scala> val peopleDF = personRDD.toDF()
peopleDF: org.apache.spark.sql.DataFrame = [name: string, age: bigint]

scala> peopleDF.show()
+-------+---+
|   name|age|
+-------+---+
|Michael| 29|
|   Andy| 30|
| Justin| 19|
+-------+---+
```

Inferring the Schema Using Reflection

```
// Register the DataFrame as a temporary view
peopleDF.createOrReplaceTempView("people")

// SQL statements can be run by using the sql methods provided by Spark
val teenagersDF = spark.sql("SELECT name, age FROM people WHERE age BETWEEN 13 AND
19")
```

Inferring the Schema Using Reflection

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// Register the DataFrame as a temporary view
peopleDF.createOrReplaceTempView("people")

// SQL statements can be run by using the sql methods provided by Spark
val teenagersDF = spark.sql("SELECT name, age FROM people WHERE age BETWEEN 13 AND
19")

// The columns of a row in the result can be accessed by field index
teenagersDF.map(teenager => "Name: " + teenager(0)).show()
// +------------+
// |       value|
// +------------+
// |Name: Justin|
// +------------+
```

Inferring the Schema Using Reflection

```
// Register the DataFrame as a temporary view
peopleDF.createOrReplaceTempView("people")

// SQL statements can be run by using the sql methods provided by Spark
val teenagersDF = spark.sql("SELECT name, age FROM people WHERE age BETWEEN 13 AND
19")

// The columns of a row in the result can be accessed by field index
teenagersDF.map(teenager => "Name: " + teenager(0)).show()
// +------------+
// |       value|
// +------------+
// |Name: Justin|
// +------------+

// or by field name
teenagersDF.map(teenager => "Name: " + teenager.getAs[String]("name")).show()
// +------------+
// |       value|
// +------------+
// |Name: Justin|
// +------------+
```

Inferring the Schema Using Reflection

```
// No pre-defined encoders for Dataset[Map[K,V]], define explicitly
implicit val mapEncoder = org.apache.spark.sql.Encoders.kryo[Map[String, Any]]
// Primitive types and case classes can be also defined as
// implicit val stringIntMapEncoder: Encoder[Map[String, Any]] = ExpressionEncoder()

// row.getValuesMap[T] retrieves multiple columns at once into a Map[String, T]
teenagersDF.map(teenager => teenager.getValuesMap[Any](List("name", "age"))).collect()
// Array(Map("name" -> "Justin", "age" -> 19))
```

Programmatically Specifying the Schema

- When case classes can't be defined during time of coding
  a. E.g. The fields expected in case classes are passed as arguments
- We need to programmatically create the dataframe:

Programmatically Specifying the Schema

- When case classes can't be defined during time of coding
  a. E.g. The fields expected in case classes are passed as arguments
- We need to programmatically create the dataframe:
  1. Create RDD of Row objects
  2. Create schema represented by StructType
  3. Apply schema with createDataFrame

Programmatically Specifying the Schema

people.txt:
Michael, 29
Andy, 30
Justin, 19

```
val schemaString = "name age"
```

Programmatically Specifying the Schema

```
import org.apache.spark.sql.types._
import org.apache.spark.sql._
```

Programmatically Specifying the Schema

```
import org.apache.spark.sql.types._
import org.apache.spark.sql._

// The schema is encoded in a string
val schemaString = "name age"
val fieldsArray = schemaString.split(" ")
val fields = fieldsArray.map(
   name => StructField(name, StringType, nullable = true)
   )
val schema = StructType(fields)
```

Programmatically Specifying the Schema

```
import org.apache.spark.sql.types._
import org.apache.spark.sql._

// The schema is encoded in a string
val schemaString = "name age"
val fieldsArray = schemaString.split(" ")
val fields = fieldsArray.map(
   name => StructField(name, StringType, nullable = true)
   )
val schema = StructType(fields)

val peopleRDD = spark.sparkContext.textFile("/data/spark/people.txt")
val rowRDD = peopleRDD.map(_.split(",")).map(
   attributes => Row(attributes(0), attributes(1).trim)
)
val peopleDF = spark.createDataFrame(rowRDD, schema)
```

Programmatically Specifying the Schema

```
import org.apache.spark.sql.types._
import org.apache.spark.sql._

// The schema is encoded in a string
val schemaString = "name age"
val fieldsArray = schemaString.split(" ")
val fields = fieldsArray.map(
   f => StructField(f, StringType, nullable = true)
   )
val schema = StructType(fields)

val peopleRDD = spark.sparkContext.textFile("/data/spark/people.txt")
val rowRDD = peopleRDD.map(_.split(",")).map(
   attributes => Row.fromSeq(attributes(0), attributes(1).trim)
)
val peopleDF = spark.createDataFrame(rowRDD, schema)
peopleDF.show()
+-------+---+
|   name|age|
+-------+---+
|Michael| 29|
|   Andy| 30|
| Justin| 19|
+-------+---+
```

APACHE Spark™

Spark SQL & Dataframes

Thank you!