CS 649 Big Data: Tools and Methods
Fall Semester, 2022
Doc 12 PySpark 2
Feb 15, 2022

Transformations & Actions

Transformations
- Done on worker machines
- Lazy

Actions
- Bring results to master machine
- Triggers transformations

Transformations

Add rows or columns

Remove rows or columns

Change row into column and column into row

Change order of rows

PySpark Actions

collect()
count()
describe(*cols)
first()
foreach(f)
foreachPartition(f)
head(n=None)
show(n=20, truncate=True, vertical=False)
summary(*statistics)

PySpark Transactions

agg(*exprs)
alias(alias)
coalesce(numPartitions)
colRegex(colName)
crossJoin(other)
cube(*cols)
distinct()
dropDuplicates(subset=None)
exceptAll(other)
filter(condition)
groupby(*cols)
intersect(other)
intersectAll(other)
join(other, on=None, how=None)
limit(num)
na

orderBy(*cols, **kwargs)
sample(withReplacement=None, fraction=None, seed=None
sampleBy(col, fractions, seed=None)
select(*cols)
selectExpr(*expr)
sort(*cols, **kwargs)
sortWithinPartitions(*cols, **kwargs)
stat
union(other)
unionAll(other)
unionByName(other)
where(condition)
withColumn(colName, col)
withColumnRenamed(existing, new)

Basic Dataset functions

approxQuantile(col, probabilities, relativeError)
cache()
checkpoint(eager=True)
columns
corr(col1, col2, method=None)
cov(col1, col2)
createGlobalTempView(name)
createOrReplaceGlobalTempView(name)
createOrReplaceTempView(name)
createTempView(name)
crosstab(col1, col2)
drop(*cols)
dropna(how='any', thresh=None, subset=None)
dtypes
explain(extended=False)
fillna(value, subset=None)
freqItems(cols, support=None)
hint(name, *parameters)
isLocal()
isStreaming
localCheckpoint(eager=True)
persist(storageLevel=StorageLevel(True, True,
printSchema()
randomSplit(weights, seed=None)
rdd
registerTempTable(name)
repartition(numPartitions, *cols)
repartitionByRange(numPartitions, *cols)
replace(to_replace, value=<no value>, subset=
rollup(*cols)
schema
storageLevel
subtract(other)
take(num
toDF(*cols)
toJSON(use_unicode=True)
toLocalIterator()
toPandas()
unpersist(blocking=False)
withWatermark(eventTime, delayThreshold)
write
writeStream

Data For Example

United States Bureau of Transportation statistics

The Definitive Guide, Zaharia & Chambers, O'Reilly Media

df = spark.read.json("2015-summary.json")
df.show(2)

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|    United States|            Croatia|    1|
+-----------------+-------------------+-----+
```

2015-summary.json

{"ORIGIN_COUNTRY_NAME":"Romania","DEST_COUNTRY_NAME":"United States","count":15}
{"ORIGIN_COUNTRY_NAME":"Croatia","DEST_COUNTRY_NAME":"United States","count":1}
{"ORIGIN_COUNTRY_NAME":"Ireland","DEST_COUNTRY_NAME":"United States","count":344}
...

Select & SelectExpr

SELECT * FROM dataFrameTable
SELECT columnName FROM dataFrameTable
SELECT columnName * 10, otherColumn, someOtherCol as c FROM dataFrameTable

from pyspark.sql.functions import column, col, expr

newDf = df.select("DEST_COUNTRY_NAME","ORIGIN_COUNTRY_NAME")
newDf.show(2)

```
+-----------------+-------------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|
+-----------------+-------------------+
|    United States|            Romania|
|    United States|            Croatia|
+-----------------+-------------------+
```

Different Syntax

```
import org.apache.spark.sql.functions.{expr, col, column}

df.select(
  df.col("DEST_COUNTRY_NAME"),
  col("DEST_COUNTRY_NAME"),
  column("DEST_COUNTRY_NAME"),
  'DEST_COUNTRY_NAME,
  $"DEST_COUNTRY_NAME",
  expr("DEST_COUNTRY_NAME")
)
```

Columns & expo

col("someCol") - 5 expr("someCol - 5")

(((col("someCol") + 5) * 200) - 6) < col("otherCol") # Boolean column

expr("(((someCol + 5) * 200) - 6) < otherCol") # Boolean column

Col example

```
import pyspark.sql.functions as F
newDf = df.select(
    F.col("DEST_COUNTRY_NAME"),
    F.col("ORIGIN_COUNTRY_NAME"),
    F.col("count")*2 - F.sin("count"))
newDf.show(2)
```

```
+-----------------+-------------------+-------------------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|((count * 2) - SIN(count))|
+-----------------+-------------------+-------------------------+
|    United States|            Romania|       29.349712159842884|
|    United States|            Croatia|       1.1585290151921035|
+-----------------+-------------------+-------------------------+
```

expr

```
from pyspark.sql.functions import expr

newDf = df.select(
    expr("DEST_COUNTRY_NAME"),
    expr("ORIGIN_COUNTRY_NAME"),
    expr("count *2 - sin(count)").alias("Goofy"))
newDf.show(2)
```

```
+-----------------+-------------------+------------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|             Goofy|
+-----------------+-------------------+------------------+
|    United States|            Romania|29.349712159842884|
|    United States|            Croatia|1.1585290151921035|
+-----------------+-------------------+------------------+
```

select + expr

```
newDf = df.selectExpr("DEST_COUNTRY_NAME",
                      "ORIGIN_COUNTRY_NAME",
                      "count *2 - sin(count) as Goofier")
newDf.show(2)
```

```
+-----------------+-------------------+-----------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|          Goofier|
+-----------------+-------------------+-----------------+
|    United States|            Romania|29.349712159842884|
|    United States|            Croatia|1.1585290151921035|
+-----------------+-------------------+-----------------+
```

Adding to Existing

```
df.selectExpr(
  "*",
  "(DEST_COUNTRY_NAME = ORIGIN_COUNTRY_NAME) as withinCountry"
).show(2)
```

```
+-----------------+-------------------+-----+-------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|withinCountry|
+-----------------+-------------------+-----+-------------+
|    United States|            Romania|   15|        false|
|    United States|            Croatia|    1|        false|
+-----------------+-------------------+-----+-------------+
```

Aggregate functions

```
newDf = df.selectExpr("sum(count) as `Total Flights`",
                      "count(DEST_COUNTRY_NAME) as `Country Pairs`",
                      "count(Distinct(DEST_COUNTRY_NAME)) as Destinations",
                      "count(Distinct(ORIGIN_COUNTRY_NAME)) as Origins"
)
newDf.show()
```

```
+-------------+-------------+------------+-------+
|Total Flights|Country Pairs|Destinations|Origins|
+-------------+-------------+------------+-------+
|       453316|          256|         132|    125|
+-------------+-------------+------------+-------+
```

So What Functions can we use?

See pyspark.sql.functions

pyspark.sql.DataFrameStatFunctions

pyspark.sql.DataFrameNaFunctions

Adding Columns with withColumn

import pyspark.sql.functions as F
df.**withColumn**("**numberOne**", F.**lit(1)**).show(2)

```
+-----------------+-------------------+-----+---------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|numberOne|
+-----------------+-------------------+-----+---------+
|    United States|            Romania|   15|        1|
|    United States|            Croatia|    1|        1|
+-----------------+-------------------+-----+---------+
```

df.withColumn("Random", F.**rand**()).show(2)

```
+-----------------+-------------------+-----+-------------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|             Random|
+-----------------+-------------------+-----+-------------------+
|    United States|            Romania|   15|0.6922143025538695|
|    United States|            Croatia|    1|0.4291601163044023|
+-----------------+-------------------+-----+-------------------+
```

WithColumn & Expr

```
import pyspark.sql.functions as F

in_country = df.withColumn(
  "withinCountry",
  F.expr("ORIGIN_COUNTRY_NAME == DEST_COUNTRY_NAME")
)

in_country.show(2)
```

```
+-----------------+-------------------+-----+-------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|withinCountry|
+-----------------+-------------------+-----+-------------+
|    United States|            Romania|   15|        false|
|    United States|            Croatia|    1|        false|
+-----------------+-------------------+-----+-------------+
```

Rename

df.**withColumnRenamed**("DEST_COUNTRY_NAME", "dest").columns

['dest', 'ORIGIN_COUNTRY_NAME', 'count']

to_date

```
reader = spark.read
reader.option("header",True)
reader.option("inferSchema",True)
reader.option("sep", "\t")
dwell_df = reader.csv("smallDwell.tsv")
dwell_df.show(2)
```

```
+--------------------+----------+
|                date|dwell-time|
+--------------------+----------+
|2014-12-31 16:03:43|        74|
|2014-12-31 16:32:12|       109|
+--------------------+----------+
```

```
import pyspark.sql.functions as F
dwellDf.withColumn("Date", F.to_date(F.col("date"))).show(2)
```

```
+----------+----------+
|      Date|dwell-time|
+----------+----------+
|2014-12-31|        74|
|2014-12-31|       109|
+----------+----------+
```

Date, Hour, format

```
import pyspark.sql.functions as F
with_hour = dwell_df.withColumnRenamed("date", "TimeStamp"). \
    withColumn("Date", F.to_date(col("TimeStamp"))). \
    withColumn("Hour", F.hour(col("TimeStamp"))). \
    withColumn("Month", F.date_format(col("Date"),"MMMM"))
with_hour.show(2)
```

```
+-------------------+----------+----------+----+--------+
|          TimeStamp|dwell-time|      Date|Hour|   Month|
+-------------------+----------+----------+----+--------+
|2014-12-31 16:03:43|        74|2014-12-31|  16|December|
|2014-12-31 16:32:12|       109|2014-12-31|  16|December|
+-------------------+----------+----------+----+--------+
```

Single Pass

```
import pyspark.sql.functions as F
with_hour = dwell_dff.withColumnRenamed("date", "TimeStamp"). \
    withColumn("Date", F.to_date(col("TimeStamp"))). \
    withColumn("Hour", F.hour(col("TimeStamp"))). \
    withColumn("Month", F.date_format(col("Date"),"MMMM"))
with_hour.explain()
```

```
== Physical Plan ==
*Project [date#1116 AS TimeStamp#1656, dwell-time#1117,
    to_date(cast(date#1116 as date)) AS Date#1660,
    hour(date#1116, Some(America/Los_Angeles)) AS Hour#1665,
    date_format(cast(to_date(cast(date#1116 as date)) as timestamp), MMMM, Some(America/
    Los_Angeles)) AS Month#1671]
+- *FileScan csv [date#1116,dwell-time#1117]
            Batched: false, Format: CSV,
            Location: InMemoryFileIndex[file:/Users/whitney/Courses/696/Fall17/notebookExamples/
smallDwell.tsv],
            PartitionFilters: [], PushedFilters: [], ReadSchema: struct<date:timestamp,dwell-time:int>
```

Dropping Columns

df = spark.read.json(flight_file)
df.show(2)

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|    United States|            Croatia|    1|
+-----------------+-------------------+-----+
```

df.**drop**("ORIGIN_COUNTRY_NAME").columns

['DEST_COUNTRY_NAME', 'count']

Selecting Rows filter = where

```
import pyspark.sql.functions as F

col_condition = df.filter(F.col("count") < 2).take(2)
conditional = df.where("count < 2").take(2)



df.where(F.col("count") < 2) \
.where(F.col("ORIGIN_COUNTRY_NAME") != "Croatia") \
.show(2)
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|          Singapore|    1|
|          Moldova|      United States|    1|
+-----------------+-------------------+-----+
```

Plan

```
df.where(F.col("count") < 2) \
  .where(F.col("ORIGIN_COUNTRY_NAME") != "Croatia") \
  .explain()
```

```
== Physical Plan ==
*(1) Filter (((isnotnull(count#318L) AND isnotnull(ORIGIN_COUNTRY_NAME#317)) AND
(count#318L < 2)) AND NOT (ORIGIN_COUNTRY_NAME#317 = Croatia))
+- FileScan json [DEST_COUNTRY_NAME#316,ORIGIN_COUNTRY_NAME#317,count#318L]
Batched: false,
    DataFilters: [
        isnotnull(count#318L),
        isnotnull(ORIGIN_COUNTRY_NAME#317),
        (count#318L < 2),
        NOT (ORIGIN_COUNTRY..., Format: JSON, Location: InMemoryFileIndex[file:/Users/
        whitney/Courses/696/Fall17/SparkBookData/flight-data/json/2015-summ..., PartitionFilters:
        [], PushedFilters: [IsNotNull(count), IsNotNull(ORIGIN_COUNTRY_NAME),
        LessThan(count,2), Not(EqualTo(ORIGIN_COUNTRY_...,
    ReadSchema:
    struct<DEST_COUNTRY_NAME:string,ORIGIN_COUNTRY_NAME:string,count:bigint>
```

Another where

```
in_country = df.withColumn("withinCountry",
                           expr("ORIGIN_COUNTRY_NAME == DEST_COUNTRY_NAME")) \
                           .where(F.col("withinCountry"))

in_country.show(2)
```

```
+-----------------+-------------------+------+-------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME| count|withinCountry|
+-----------------+-------------------+------+-------------+
|    United States|      United States|370002|         true|
+-----------------+-------------------+------+-------------+
```

where’s are anded

```
import pyspark.sql.functions as F


frequent = F.col("count") > 100
to_USA = F.col("DEST_COUNTRY_NAME").contains("United States")

frequent_to_USA = df.where(frequent).where(to_USA)
frequent_to_USA.show(5)
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Ireland|  344|
|    United States|        Sint Maarten|  325|
|    United States|             Russia|  161|
|    United States|        Netherlands|  660|
|    United States|            Ecuador|  300|
+-----------------+-------------------+-----+
```

or

~~import org.apache.spark.sql.functions.col~~

~~val frequent = col("count") > 100~~
~~val toUSA = col("DEST_COUNTRY_NAME").contains("United States”)~~

~~val frequentToUSA = df.where(~~**~~frequent.or(toUSA)~~**~~)~~
~~frequentToUSA.show(7)~~

or

```
import pyspark.sql.functions as F

frequent_to_USA = df.where(F.expr("(count > 100) or (DEST_COUNTRY_NAME == 'United States')"))
frequent_to_USA.show(7)here(frequent.or(toUSA))
frequentToUSA.show(7)
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|    United States|            Croatia|    1|
|    United States|            Ireland|  344|
|    United States|              India|   62|
|    United States|          Singapore|    1|
|    United States|            Grenada|   62|
|       Costa Rica|      United States|  588|
+-----------------+-------------------+-----+
```

!, not

~~val inCountry = df.withColumn(~~
~~ "withinCountry",~~
~~ expr("ORIGIN_COUNTRY_NAME == DEST_COUNTRY_NAME")~~
~~).where(**!**col(“withinCountry"))~~

~~inCountry.show(5)~~

~~).where(**not**(col("withinCountry")))~~

!, not

```
import pyspark.sql.functions as F
in_country = df.withColumn(
    "withinCountry",
    expr("ORIGIN_COUNTRY_NAME == DEST_COUNTRY_NAME")
).where(F.col("withinCountry") == False)

in_country.show(5)
```

```
+-----------------+-------------------+-----+-------------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|withinCountry|
+-----------------+-------------------+-----+-------------+
|    United States|            Romania|   15|        false|
|    United States|            Croatia|    1|        false|
|    United States|            Ireland|  344|        false|
|           Egypt|      United States|   15|        false|
|    United States|              India|   62|        false|
+-----------------+-------------------+-----+-------------+
```

Distinct Rows - distinct

```
df.select("ORIGIN_COUNTRY_NAME"). \
        distinct().\
        sort(col("ORIGIN_COUNTRY_NAME")).\
        take(10)
```

```
[Row(ORIGIN_COUNTRY_NAME='Angola'),
 Row(ORIGIN_COUNTRY_NAME='Anguilla'),
 Row(ORIGIN_COUNTRY_NAME='Antigua and Barbuda'),
 Row(ORIGIN_COUNTRY_NAME='Argentina'),
 Row(ORIGIN_COUNTRY_NAME='Aruba'),
 Row(ORIGIN_COUNTRY_NAME='Australia'),
 Row(ORIGIN_COUNTRY_NAME='Austria'),
 Row(ORIGIN_COUNTRY_NAME='Azerbaijan'),
 Row(ORIGIN_COUNTRY_NAME='Bahrain'),
 Row(ORIGIN_COUNTRY_NAME='Barbados')]
```

Sort === orderBy

```
df.sort("count").show(5)
df.orderBy("count", "DEST_COUNTRY_NAME").show(5)
df.orderBy(F.col("count"), F.col("DEST_COUNTRY_NAME")).show(5)
```

```
import pyspark.sql.functions as F
df.orderBy(expr("count desc")).show(2)
df.orderBy(F.desc("count"), F.asc("DEST_COUNTRY_NAME")).show(2)
```

WTF?

topTenDF = df.orderBy(expr("count **asc**"))
topTenDF.show(3)

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|          Moldova|      United States|    1|
|    United States|          Singapore|    1|
|    United States|            Croatia|    1|
+-----------------+-------------------+-----+
```

topTenDF = df.orderBy(expr("count **desc**"))
topTenDF.show(3)

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|          Moldova|      United States|    1|
|    United States|          Singapore|    1|
|    United States|            Croatia|    1|
+-----------------+-------------------+-----+
```

Limit

```
import pyspark.sql.functions as F

topTenDF = df.orderBy(F.desc("count")).limit(10)
topTenDF.show()
topTenDF.count()
```

```
+-----------------+-------------------+------+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME| count|
+-----------------+-------------------+------+
|    United States|      United States|370002|
|    United States|             Canada|  8483|
|           Canada|      United States|  8399|
|    United States|             Mexico|  7187|
|           Mexico|      United States|  7140|
|   United Kingdom|      United States|  2025|
|    United States|     United Kingdom|  1970|
|            Japan|      United States|  1548|
|    United States|              Japan|  1496|
|          Germany|      United States|  1468|
+-----------------+-------------------+------+
```

10

Take, Collect

Return DF to master node as Array

take(n)

collect returns all

on_master = df.take(3)

on_master

```
[Row(DEST_COUNTRY_NAME='United States', ORIGIN_COUNTRY_NAME='Romania', count=15),
 Row(DEST_COUNTRY_NAME='United States', ORIGIN_COUNTRY_NAME='Croatia', count=1),
 Row(DEST_COUNTRY_NAME='United States', ORIGIN_COUNTRY_NAME='Ireland', count=344)]
```

on_master[0]

```
Row(DEST_COUNTRY_NAME='United States', ORIGIN_COUNTRY_NAME='Romania', count=15)
```

on_master[0][0]

```
'United States'
```

on_master[0]['DEST_COUNTRY_NAME']

```
'United States'
```

toPanda

```
as_panda_df = df.toPandas()
as_panda_df.head(3)
```

	DEST_COUNTRY_NAME	ORIGIN_COUNTRY_NAME	count
0	United States	Romania	15
1	United States	Croatia	1
2	United States	Ireland	344

Appending Rows to a DataFrame

```
import pyspark.sql as sql
import pyspark.sql.functions as F

schema = df.schema

newRows = [sql.Row("New Country", "Other Country", 5),
  sql.Row("New Country 2", "Other Country 3", 1)]
parallelizedRows = spark.sparkContext.parallelize(newRows)

newDF = spark.createDataFrame(parallelizedRows, schema)
added = df.union(newDF)

added.where("count = 1"). \
  where(F.col("ORIGIN_COUNTRY_NAME") != "United States"). \
  show()
```

union add DataFrame to end

Schemas of the two DataFrames must match

Output

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Croatia|    1|
|    United States|          Singapore|    1|
|    United States|          Gibraltar|    1|
|    United States|             Cyprus|    1|
|    United States|            Estonia|    1|
|    United States|          Lithuania|    1|
|    United States|           Bulgaria|    1|
|    United States|            Georgia|    1|
|    United States|            Bahrain|    1|
|    United States|  Papua New Guinea|    1|
|    United States|         Montenegro|    1|
|    United States|            Namibia|    1|
|    New Country 2|   Other Country 3|    1|
+-----------------+-------------------+-----+
```

Random Samples

```
tenDF = df.limit(10)
tenDF.show
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|    United States|            Croatia|    1|
|    United States|            Ireland|  344|
|            Egypt|      United States|   15|
|    United States|              India|   62|
|    United States|          Singapore|    1|
|    United States|            Grenada|   62|
|       Costa Rica|      United States|  588|
|          Senegal|      United States|   40|
|          Moldova|      United States|    1|
+-----------------+-------------------+-----+
```

```
seed = 5
withReplacement = False
fraction = 0.5

smallSample = tenDF.sample(withReplacement, fraction, seed)
smallSample.show()
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|            Egypt|      United States|   15|
|    United States|              India|   62|
|       Costa Rica|      United States|  588|
|          Senegal|      United States|   40|
+-----------------+-------------------+-----+
```

Random Splits

Split DF into two disjoint parts randomly

One dataframe for training
One for validation

randomSplit

```
seed = 5
twoDF = tenDF.randomSplit((0.25, 0.75), seed)
twoDF[0].show()
twoDF[1].show()
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|    United States|            Croatia|    1|
|    United States|            Ireland|  344|
|            Egypt|      United States|   15|
|    United States|              India|   62|
|    United States|          Singapore|    1|
|    United States|            Grenada|   62|
|       Costa Rica|      United States|  588|
|          Senegal|      United States|   40|
|          Moldova|      United States|    1|
+-----------------+-------------------+-----+
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|       Costa Rica|      United States|  588|
|    United States|            Ireland|  344|
|    United States|            Romania|   15|
+-----------------+-------------------+-----+
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|            Egypt|      United States|   15|
|          Moldova|      United States|    1|
|          Senegal|      United States|   40|
|    United States|            Croatia|    1|
|    United States|            Grenada|   62|
|    United States|              India|   62|
|    United States|          Singapore|    1|
+-----------------+-------------------+-----+
```

Weights Normalized to 1

```
twoDF = tenDF.randomSplit([0.25, 0.50])
twoDF[0].show()
twoDF[1].show()
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|       Costa Rica|      United States|  588|
|    United States|            Ireland|  344|
|    United States|            Romania|   15|
+-----------------+-------------------+-----+

+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|            Egypt|      United States|   15|
|          Moldova|      United States|    1|
|          Senegal|      United States|   40|
|    United States|             Croatia|    1|
|    United States|             Grenada|   62|
|    United States|               India|   62|
|    United States|           Singapore|    1|
+-----------------+-------------------+-----+
```

pyspark.sql.functions

283 functions

from pyspark.sql.functions import **sin**

df = spark.createDataFrame([(1, "John Doe", 21)], ("id", "name", "age"))
df.select("id","name",**sin**("age")).show()

```
+---+--------+--------------------+
| id|    name|          SIN(age)|
+---+--------+--------------------+
|  1|John Doe|0.8366556385360561|
+---+--------+--------------------+
```

User Defined Functions on DataFrames

```
def to_upper(s):
    if s is not None:
        return s.upper()

df = spark.createDataFrame([(1, "John Doe", 21)], ("id", "name", "age"))
df.select("id", to_upper("name"),"age").show()
```

```
+---+--------+---+
| id|    NAME|age|
+---+--------+---+
|  1|John Doe| 21|
+---+--------+---+
```

Function is applied to the column name not the data!

User Defined Functions on DataFrames

```
from pyspark.sql.types import IntegerType, StringType
from pyspark.sql.functions import udf

slen = udf(lambda s: len(s), IntegerType())

def add_one(x):
    if x is not None:
        return x + 1

add_one_udf = udf(add_one, IntegerType())

def to_upper(s):
        if s is not None:
            return s.upper()
to_upper_udf = udf(to_upper, StringType())
```

User Defined Functions on DataFrames

df = spark.createDataFrame([(1, "John Doe", 21)], ("id", "name", "age"))
df.select(**slen**("name").alias("slen(name)"), **to_upper_udf**("name"), **add_one_udf**("age")).show()

```
+----------+--------------+------------+
|slen(name)|to_upper(name)|add_one(age)|
+----------+--------------+------------+
|         8|      JOHN DOE|          22|
+----------+--------------+------------+
```

Type Mismatch

```
df = spark.createDataFrame([(1, "John Doe", 21)], ("id", "name", "age"))
df.select("name", add_one_udf("name"), "age").show()
```

Python
    Exception

Scala
    Null values

Aggregations

Summarize

groupBy

roll up

cube

window

Aggregation Functions

count
countDistinct
approx_count_distinct
first, last
min, max
sum
sumDistinct
avg, mean
variance, var_samp, var_pop
stddev, stddev_samp, stddev_pop
skewness, kurtosis

Covariance & Correlation
    corr, covar_samp, covar_pop

Example

```
flight_file = "/Users/whitney/Courses/696/Fall17/SparkBookData/flight-data/json/2015-summary.json"
flight_df = spark.read.json(flight_file)
flight_df.show(3)
```

```
+-----------------+-------------------+-----+
|DEST_COUNTRY_NAME|ORIGIN_COUNTRY_NAME|count|
+-----------------+-------------------+-----+
|    United States|            Romania|   15|
|    United States|            Croatia|    1|
|    United States|            Ireland|  344|
+-----------------+-------------------+-----+
```

Example

```
import pyspark.sql.functions as F
newDf = flight_df.select(F.sum("count").alias('Sum'),
                         F.mean("count").alias('Mean'),
                         F.max("count").alias("Max"),
                         F.stddev_samp("count").alias("Sample StdDev"),
                         F.stddev_pop("count").alias("Pop StdDev"),
                         F.count("DEST_COUNTRY_NAME").alias("Count"))
newDf.show()
```

```
+------+-----------+------+------------------+------------------+-----+
|   Sum|       Mean|   Max|     Sample StdDev|       Pop StdDev|Count|
+------+-----------+------+------------------+------------------+-----+
|453316|1770.765625|370002|23126.516918551915|23081.30374350104|  256|
+------+-----------+------+------------------+------------------+-----+
```

countDistinct

```
import pyspark.sql.functions as F
newDf = flight_df.select(
    F.countDistinct(F.col("DEST_COUNTRY_NAME")).alias("Distinct Dest"),
    F.countDistinct(F.col("ORIGIN_COUNTRY_NAME")).alias("Distinct Origin"))

newDf.show()
```

```
+-------------+---------------+
|Distinct Dest|Distinct Origin|
+-------------+---------------+
|          132|            125|
+-------------+---------------+
```

countDistinct

```
import pyspark.sql.functions as F
newDf = flight_df.select(
    F.countDistinct(
        F.col("DEST_COUNTRY_NAME"),
        F.col("ORIGIN_COUNTRY_NAME")).alias("Distinct Pair"))

newDf.show()
```

```
+-------------+
|Distinct Pair|
+-------------+
|          256|
+-------------+
```

countDistinct

```
import pyspark.sql.functions as F
newDf = flight_df.select(
    F.countDistinct(
        "DEST_COUNTRY_NAME",
        "ORIGIN_COUNTRY_NAME",
        "count").alias("Distinct Rows"))

newDf.show()
```

```
+--------------+
|Distinct Rows|
+--------------+
|           256|
+--------------+
```

countDistinct

pyspark.sql.functions.countDistinct(col, *cols)

pyspark.sql.functions.count(col)

Group By Data

```
reader = spark.read
reader.option("header",True).option("inferSchema",True)
ordersDF = reader.csv("orders.csv")
ordersDF.show()
```

```
+--------+------+
|customer|amount|
+--------+------+
|       a|     2|
|       b|     8|
|       a|     3|
|       c|     9|
|       a|     4|
|       b|    16|
|       c|    11|
|       b|    24|
|       c|    30|
+--------+------+
```

groupBy

```
import pyspark.sql.functions as F

amountGrouped = ordersDF.groupBy("customer") \
    .agg(
        F.sum("amount").alias("Total"),
        F.mean("amount").alias("Average"),
        F.count("amount").alias("Number of Orders"))
amountGrouped.sort("customer").show()
```

```
+--------+------+
|customer|amount|
+--------+------+
|       a|     2|
|       b|     8|
|       a|     3|
|       c|     9|
|       a|     4|
|       b|    16|
|       c|    11|
|       b|    24|
|       c|    30|
+--------+------+
```

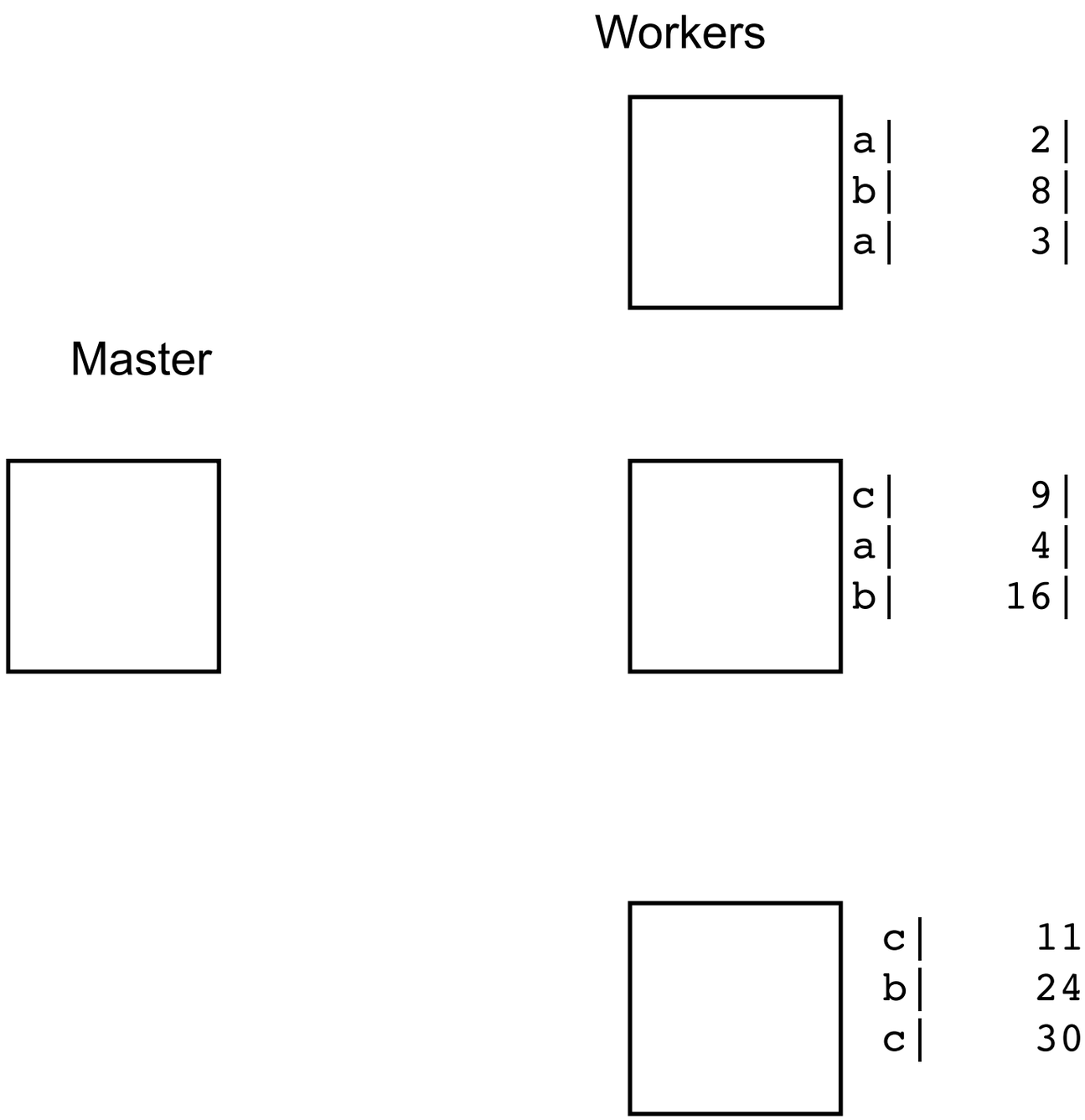
```
+--------+-----+------------------+----------------+
|customer|Total|           Average|Number of Orders|
+--------+-----+------------------+----------------+
|       a|    9|               3.0|               3|
|       b|   48|              16.0|               3|
|       c|   50|16.666666666666668|               3|
+--------+-----+------------------+----------------+
```

How does this work?

```
import pyspark.sql.functions as F

amountGrouped = ordersDF.groupBy("customer") \
                        .agg(F.sum("amount").alias("Total"))
amountGrouped.sort("customer").show()
```

```
+--------+-----+
|customer|Total|
+--------+-----+
|       a|    9|
|       b|   48|
|       c|   50|
+--------+-----+
```

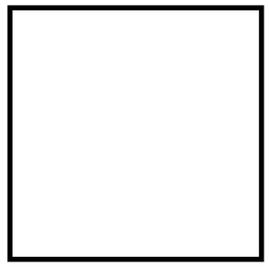
groupBy



customer	amount
a	2
b	8
a	3
c	9
a	4
b	16
c	11
b	24
c	30

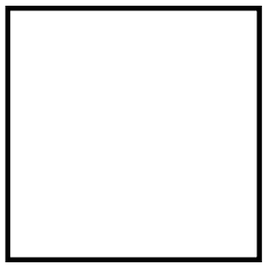
groupBy

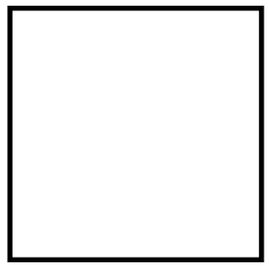
Workers



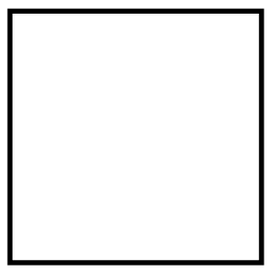
```
|a|    5|
|b|    8|
```

Master





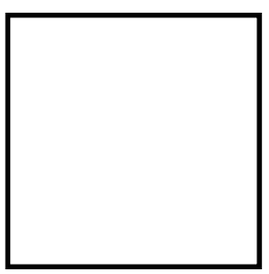
```
|c|    9|
|a|    4|
|b|   16|
```



```
|c|   41|
|b|   24|
```

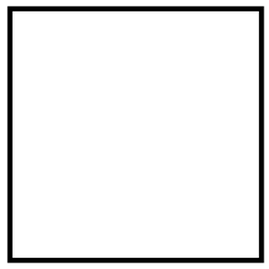
```
+--------+------+
|customer|amount|
+--------+------+
|       a|     2|
|       b|     8|
|       a|     3|

|       c|     9|
|       a|     4|
|       b|    16|

|       c|    11|
|       b|    24|
|       c|    30|
+--------+------+
```

groupBy

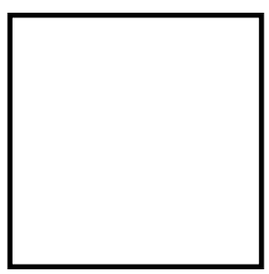


Master

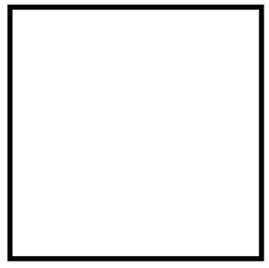
Workers



a| 9|



c| 50|



b| 48|

```
+--------+------+
|customer|amount|
+--------+------+
|       a|     2|
|       b|     8|
|       a|     3|

|       c|     9|
|       a|     4|
|       b|    16|

|       c|    11|
|       b|    24|
|       c|    30|
+--------+------+
```

groupBy
Transformation

SQL

```
df = spark.createDataFrame([
    ['red', 'banana', 1, 10], ['blue', 'banana', 2, 20], ['red', 'carrot', 3, 30],
    ['blue', 'grape', 4, 40], ['red', 'carrot', 5, 50], ['black', 'carrot', 6, 60],
    ['red', 'banana', 7, 70], ['red', 'grape', 8, 80]], schema=['color', 'fruit', 'v1', 'v2'])
df.show()
```

```
+-----+------+---+---+
|color| fruit| v1| v2|
+-----+------+---+---+
|  red|banana|  1| 10|
| blue|banana|  2| 20|
|  red|carrot|  3| 30|
| blue| grape|  4| 40|
|  red|carrot|  5| 50|
|black|carrot|  6| 60|
|  red|banana|  7| 70|
|  red| grape|  8| 80|
+-----+------+---+---+
```

```
df.groupby('color').avg().show()
```

```
+-----+-------+-------+
|color|avg(v1)|avg(v2)|
+-----+-------+-------+
|  red|    4.8|   48.0|
|black|    6.0|   60.0|
| blue|    3.0|   30.0|
+-----+-------+-------+
```

SQL

df.createOrReplaceTempView("tableA")
spark.sql("SELECT * from tableA where fruit = 'banana'").show()

```
+-----+------+---+---+
|color| fruit| v1| v2|
+-----+------+---+---+
|  red|banana|  1| 10|
| blue|banana|  2| 20|
|  red|banana|  7| 70|
+-----+------+---+---+
```

```
+-----+------+---+---+
|color| fruit| v1| v2|
+-----+------+---+---+
|  red|banana|  1| 10|
| blue|banana|  2| 20|
|  red|carrot|  3| 30|
| blue| grape|  4| 40|
|  red|carrot|  5| 50|
|black|carrot|  6| 60|
|  red|banana|  7| 70|
|  red| grape|  8| 80|
+-----+------+---+---+
```

SQL vs API

```
df.createOrReplaceTempView("tableA")
spark.sql("SELECT * from tableA where fruit = 'banana'").explain()
```

```
== Physical Plan ==
*(1) Filter (isnotnull(fruit#17) AND (fruit#17 = banana))
+- *(1) Scan ExistingRDD[color#16,fruit#17,v1#18L,v2#19L]
```

```
df.filter(df.fruit == 'banana').explain()
```

```
== Physical Plan ==
*(1) Filter (isnotnull(fruit#17) AND (fruit#17 = banana))
+- *(1) Scan ExistingRDD[color#16,fruit#17,v1#18L,v2#19L]
```