

Spark DataFrame SQL

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Load `sparklyr` and establish the Spark connection.

```
library(dplyr, warn.conflicts = FALSE)
library(sparklyr)

# start the sparklyr session
master <- "local"
# master <- "spark://master:7077"
sc <- spark_connect(master, spark_home = Sys.getenv("SPARK_HOME"),
                    method = c("shell"), app_name = "sparklyr")
```

5.3 Spark DataFrame SQL

`sparklyr` can import a wide range of data directly into Spark from an external data source, e.g., json. In addition, it is possible to query Spark DataFrames directly.

We will be using the `nycflights13` data again. The `flights` and `airlines` R data frames are copied into Spark.

```
library(nycflights13)
flights_sdf <- copy_to(sc, flights, "flights", overwrite = TRUE)
airlines_sdf <- copy_to(sc, airlines, "airlines", overwrite = TRUE)
```

5.3.1 Joining Spark Data Tables

In Section 5.2.1 the `dplyr` verbs were used to manipulate a Spark DataFrame. However, we often have multiple related Spark tables which we need to combine prior to performing data manipulations.

A workflow was developed in Section 5.2.1 to find the flights with a departure delay greater than 1000 minutes. However, we did not have the carrier names since they were in a different table. Providing this information can be done with a `left_join`.

```
flights_sdf %>%
  left_join(airlines_sdf, by = "carrier") %>%
  select(carrier, name, flight, year:day, arr_delay, dep_delay) %>%
  filter(dep_delay > 1000) %>%
  arrange(desc(dep_delay))
```

```
## # Source:      spark<??> [?? x 8]
## # Ordered by: desc(dep_delay)
##   carrier name          flight  year month  day arr_delay dep_delay
##   <chr>   <chr>          <int> <int> <int> <int>    <dbl>    <dbl>
## 1 HA     Hawaiian Airlines Inc.    51  2013     1     9     1272     1301
## 2 MQ     Envoy Air              3535  2013     6    15     1127     1137
## 3 MQ     Envoy Air              3695  2013     1    10     1109     1126
## 4 AA     American Airlines Inc.   177  2013     9    20     1007     1014
## 5 MQ     Envoy Air              3075  2013     7    22     989      1005
```

Notice that three of the top five largest delays were associated with Envoy Air, which was not obvious based on the two-letter abbreviation.

`dplyr` has various verbs that combine two tables. If this is not adequate, then the joins, or other operations, must be done in the database prior to importing the data into Spark

5.3.2 Querying a Spark DataFrame

It is also possible to use Spark DataFrames as tables in a “database” using the Spark SQL interface, which forms the basis of Spark DataFrames.

The `spark_connect` object implements a DBI interface for Spark, which allows you to use `dbGetQuery` to execute SQL commands. The returned result is an R data frame.

We now show that the above workflow can be done in R except that R data frames are used.

```
library(DBI)
flights_df <- dbGetQuery(sc, "SELECT * FROM flights")
airlines_df <- dbGetQuery(sc, "SELECT * FROM airlines")
flights_df %>%
  left_join(airlines_df, by = "carrier") %>%
  select(carrier, name, flight, year:day, arr_delay, dep_delay) %>%
  filter(dep_delay > 1000) %>%
  arrange(desc(dep_delay))
```

##	carrier	name	flight	year	month	day	arr_delay	dep_delay
## 1	HA	Hawaiian Airlines Inc.	51	2013	1	9	1272	1301
## 2	MQ	Envoy Air	3535	2013	6	15	1127	1137
## 3	MQ	Envoy Air	3695	2013	1	10	1109	1126
## 4	AA	American Airlines Inc.	177	2013	9	20	1007	1014
## 5	MQ	Envoy Air	3075	2013	7	22	989	1005

Of course, this assumes the Spark DataFrames can be imported into R, i.e., they must fit into local memory.

The `by` argument in the `left_join` is not needed if there is a single variable common to both tables. Alternately, we could use `by = c("carrier", "carrier")`, where the names could be different if they represent the same variable.

5.3.3 Sampling

We can sample random rows of a Spark DataFrame using:

- `sample_n` for a fixed number;
- `sample_frac` for a fixed fraction.

```
sample_n(flights_sdf, 10)
```

```
## # Source: spark<?> [?? x 19]
##   year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##   <int> <int> <int>   <int>         <int>         <dbl>   <int>         <int>
## 1  2013     1     1     517           515           2     830           819
## 2  2013     1     1     533           529           4     850           830
## 3  2013     1     1     542           540           2     923           850
## 4  2013     1     1     544           545          -1    1004          1022
## 5  2013     1     1     554           600          -6     812           837
## 6  2013     1     1     554           558          -4     740           728
```

```
## 7 2013 1 1 555 600 -5 913 854
## 8 2013 1 1 557 600 -3 709 723
## 9 2013 1 1 557 600 -3 838 846
## 10 2013 1 1 558 600 -2 753 745
## # ... with 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dtm>
```

```
sample_frac(flights_sdf, 0.01)
```

```
## # Source: spark<?> [?? x 19]
##   year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##   <int> <int> <int>   <int>         <int>         <dbl>    <int>         <int>
## 1 2013     1     1     558           600          -2      924           917
## 2 2013     1     1     801           805          -4      900           919
## 3 2013     1     1    1258          1300          -2     1459          1440
## 4 2013     1     1    1350          1329           21     1504          1453
## 5 2013     1     1    1356          1354           2     1537          1526
## 6 2013     1     1    1506          1512          -6     1723          1741
## 7 2013     1     1    1610          1555           15     1852          1834
## 8 2013     1     1    1701          1700            1     1856          1840
## 9 2013     1     1    1714          1720          -6     1915          1915
## 10 2013     1     1    1820          1820            0     2216          2150
## # ... with more rows, and 11 more variables: arr_delay <dbl>, carrier <chr>,
## #   flight <int>, tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>,
## #   distance <dbl>, hour <dbl>, minute <dbl>, time_hour <dtm>
```

Sampling is often done during the development and testing cycle to limit the size of the data.

5.3.4 Writing Data

We can save the results of our analysis or the tables that you have generated in Spark into persistent storage. Parquet is a commonly used persistent store for various data processing systems in the Hadoop ecosystem. It has a columnar storage format which Spark SQL supports for both reading and writing, including the schema of the original data.

As an example, we can write the `airlines_sdf` Spark DataFrame out to a Parquet file using the `spark_write_parquet` function.

```
library(rhdfs)
```

```
## Loading required package: rJava
##
## HADOOP_CMD=/opt/hadoop/bin/hadoop
##
## Be sure to run hdfs.init()
```

```
hdfs.init()
spark_write_parquet(airlines_sdf,
  path = "hdfs://hadoop:9000/user/rstudio/airlines_parquet",
  mode = "overwrite")
hdfs.ls("/user/rstudio")
```

```
## permission owner group size      modtime
## 1 drwxr-xr-x rstudio rstudio    0 2020-06-01 02:20
##                                     file
```

```
## 1 /user/rstudio/airlines_parquet
```

This writes the Spark DataFrame to the given HDFS path and names the Parquet file `airlines_parquet`.

You can use the `spark_read_parquet` function to read the same table back into a subsequent Spark session:

```
spark_read_parquet(sc, "airlines2_sdf",  
                    "hdfs://hadoop:9000/user/rstudio/airlines_parquet")
```

```
## # Source: spark<airlines2_sdf> [?? x 2]  
##   carrier name  
##   <chr>      <chr>  
## 1 9E         Endeavor Air Inc.  
## 2 AA         American Airlines Inc.  
## 3 AS         Alaska Airlines Inc.  
## 4 B6         JetBlue Airways  
## 5 DL         Delta Air Lines Inc.  
## 6 EV         ExpressJet Airlines Inc.  
## 7 F9         Frontier Airlines Inc.  
## 8 FL         AirTran Airways Corporation  
## 9 HA         Hawaiian Airlines Inc.  
## 10 MQ        Envoy Air  
## # ... with more rows
```

Use the `spark_write_csv` and `spark_write_json` functions to write data as csv or json files, respectively.

```
spark_disconnect(sc)
```