Spark DataFrame SQL

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Load `sparklyr` and establish the Spark connection.

```r
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.

```r
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`.

```r
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 I~     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 I~    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.

```r
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.

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

```
## # Source: spark<?> [?? x 19]
##     year month   day dep_time sched_dep_time dep_delay arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>
##  1  2013     1     1      517            515         2      830
##  2  2013     1     1      533            529         4      850
##  3  2013     1     1      542            540         2      923
##  4  2013     1     1      544            545        -1     1004
##  5  2013     1     1      554            600        -6      812
##  6  2013     1     1      554            558        -4      740
##  7  2013     1     1      555            600        -5      913
##  8  2013     1     1      557            600        -3      709
##  9  2013     1     1      557            600        -3      838
## 10  2013     1     1      558            600        -2      753
## # ... with 12 more variables: sched_arr_time <int>, arr_delay <dbl>,
## #   carrier <chr>, flight <int>, tailnum <chr>, origin <chr>, dest <chr>,
## #   air_time <dbl>, distance <dbl>, hour <dbl>, minute <dbl>,
## #   time_hour <dttm>
```

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

```
## # Source: spark<?> [?? x 19]
##     year month   day dep_time sched_dep_time dep_delay arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>
##  1  2013     1     1     1123           1110        13     1410
##  2  2013     1     1     1455           1459        -4     1655
##  3  2013     1     1     1534           1530         4     1755
##  4  2013     1     1     1707           1705         2     1928
##  5  2013     1     1     1716           1545        91     2140
##  6  2013     1     1     1855           1859        -4     2140
##  7  2013     1     1     2020           2030       -10     2148
##  8  2013     1     2      714            715        -1     1026
##  9  2013     1     2     1014           1015        -1     1215
## 10  2013     1     2     1156           1158        -2     1517
## # ... with more rows, and 12 more variables: sched_arr_time <int>,
## #   arr_delay <dbl>, carrier <chr>, flight <int>, tailnum <chr>,
## #   origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>, hour <dbl>,
## #   minute <dbl>, time_hour <dttm>
```

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.

```r
library(rhdfs)
```

```
## Loading required package: rJava

## 
## HADOOP_CMD=/opt/hadoop/bin/hadoop

## 
## Be sure to run hdfs.init()
```

```r
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 2019-06-19 14:52
##                           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:

```r
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.

```r
spark_disconnect(sc)
```

```
## NULL
```