Spark SQL

INTRODUCTION TO SPARK SQL IN PYTHON

Mark Plutowski Phd
Data Scientist

Create SQL table and query it

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

Load a dataframe from file

```
df = spark.read.csv(filename)
```

```
df = spark.read.csv(filename, header=True)
```

Create SQL table and query it

```
df.createOrReplaceTempView("schedule")

spark.sql("SELECT * FROM schedule WHERE station = 'San Jose'")
     .show()
```

```
+--------+--------+-----+
|train_id| station| time|
+--------+--------+-----+
|     324|San Jose|9:05a|
|     217|San Jose|6:59a|
+--------+--------+-----+
```

Inspecting table schema

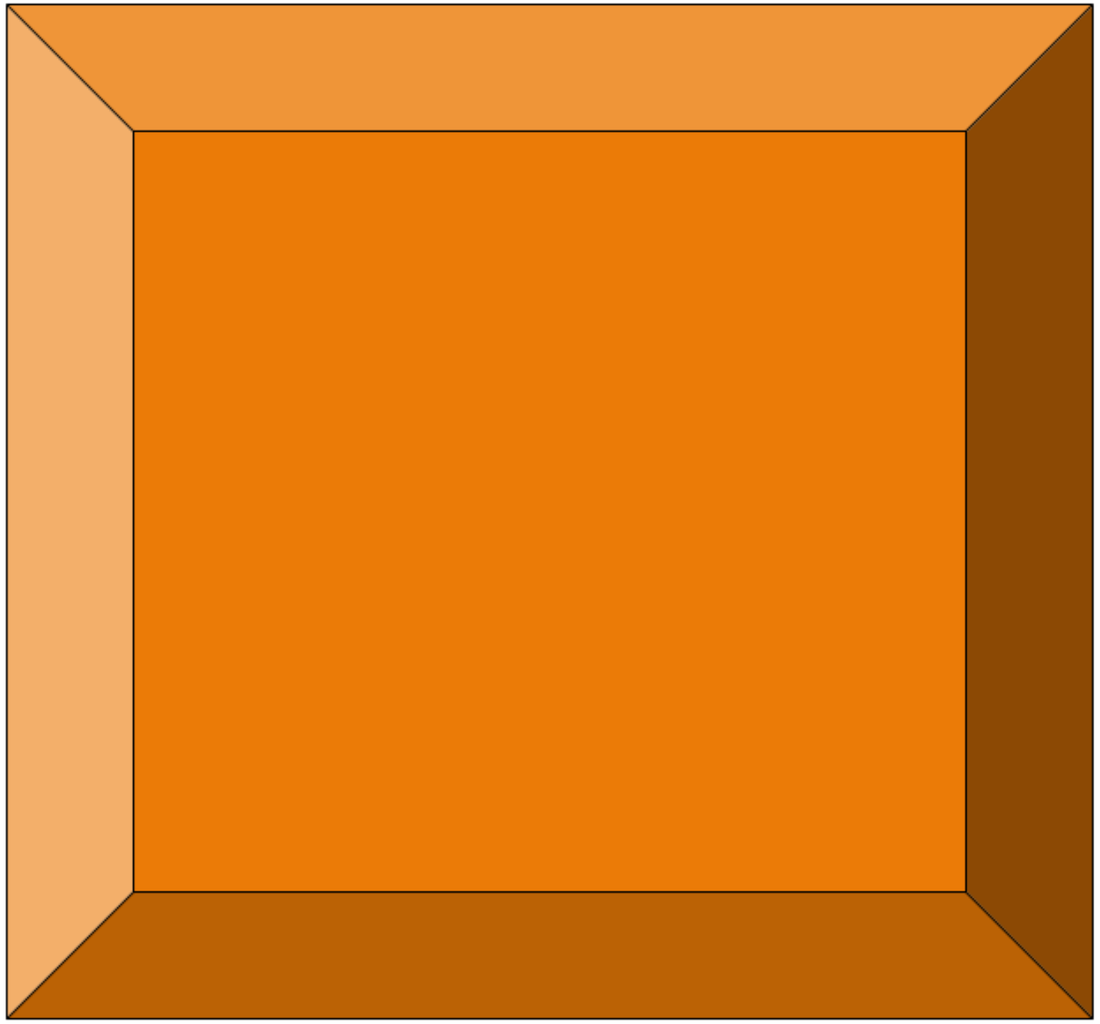
```
result = spark.sql("SHOW COLUMNS FROM tablename")
```

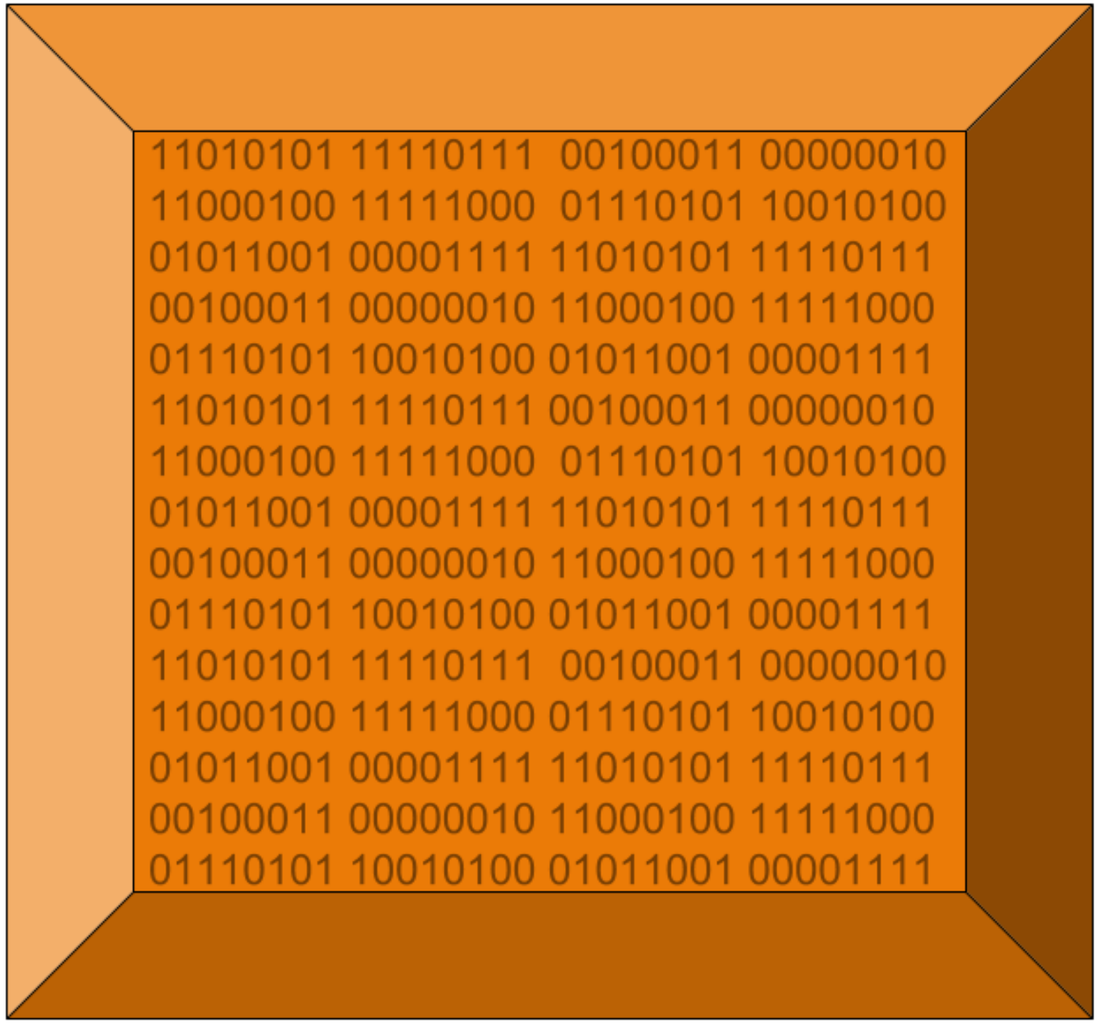
```
result = spark.sql("SELECT * FROM tablename LIMIT 0")
```

```
result = spark.sql("DESCRIBE tablename")
```

```
result.show()
```

```
print(result.columns)
```




11010101 11110111 00100011 00000010
11000100 11111000 01110101 10010100
01011001 00001111 11010101 11110111
00100011 00000010 11000100 11111000
01110101 10010100 01011001 00001111
11010101 11110111 00100011 00000010
11000100 11111000 01110101 10010100
01011001 00001111 11010101 11110111
00100011 00000010 11000100 11111000
01110101 10010100 01011001 00001111
11010101 11110111 00100011 00000010
11000100 11111000 01110101 10010100
01011001 00001111 11010101 11110111
00100011 00000010 11000100 11111000
01110101 10010100 01011001 00001111

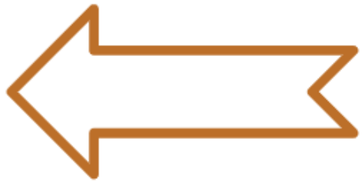
Tabular data

```
+--------+-------------+-----+
|train_id|      station| time|
+--------+-------------+-----+
|     324|San Francisco|7:59a|
|     324|  22nd Street|8:03a|
|     324|     Millbrae|8:16a|
|     324|    Hillsdale|8:24a|
|     324| Redwood City|8:31a|
|     324|    Palo Alto|8:37a|
|     324|     San Jose|9:05a|
|     217|       Gilroy|6:06a|
|     217|   San Martin|6:15a|
|     217|  Morgan Hill|6:21a|
|     217| Blossom Hill|6:36a|
|     217|      Capitol|6:42a|
|     217|       Tamien|6:50a|
|     217|     San Jose|6:59a|
+--------+-------------+-----+
```

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a



train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

train_id	station	time
217	Gilroy	6:06a
217	San Martin	6:15a
217	Morgan Hill	6:21a
217	Blossom Hill	6:36a
217	Capitol	6:42a
217	Tamien	6:50a
217	San Jose	6:59a

S

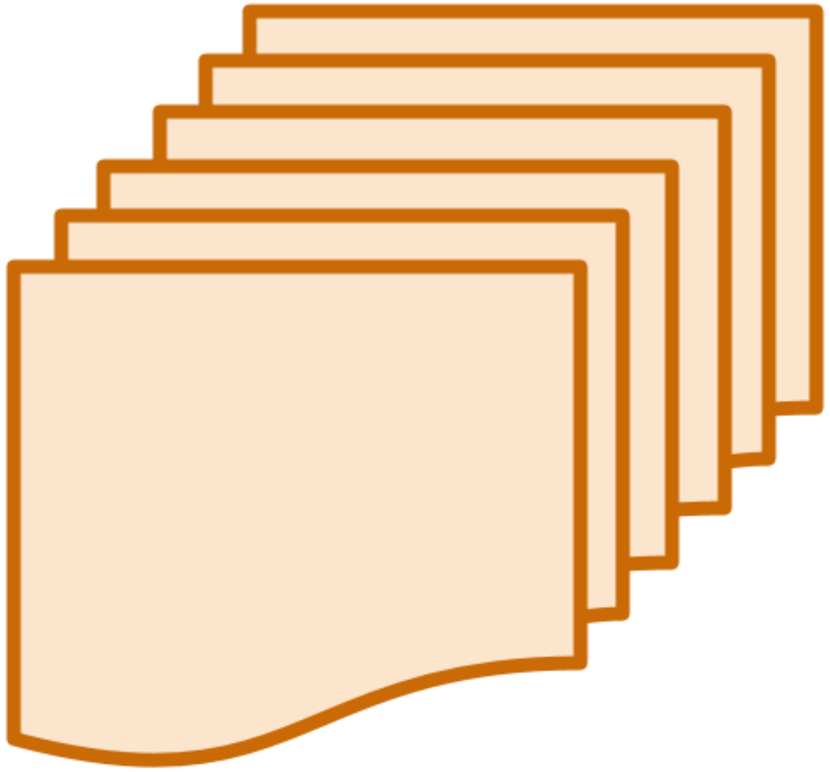
Q

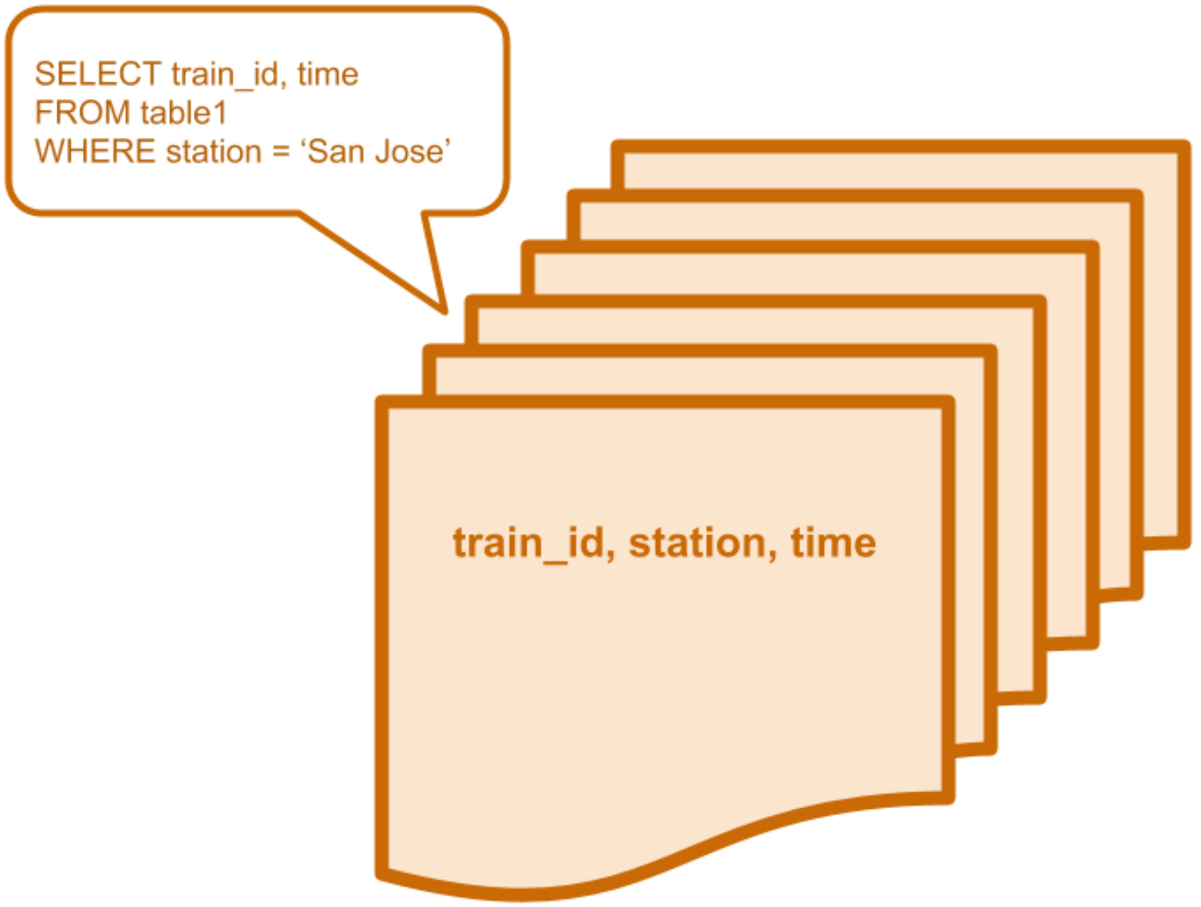
L

Structured Query Language

```
SELECT train_id, time
FROM table1
WHERE station = 'San Jose'
```

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a




SELECT train_id, time
FROM table1
WHERE station = ‘San Jose’
train_id, station, time

Loading delimited text

Loads a comma-delimited file `trainsched.txt` into a dataframe called `df` :

```
df = spark.read.csv("trainsched.txt", header=True)
```

Loading delimited text

```
df = spark.read.csv("trainsched.txt", header=True)
df.show()
```

```
+--------+-------------+-----+
|train_id|      station| time|
+--------+-------------+-----+
|     324|San Francisco|7:59a|
|     324|  22nd Street|8:03a|
|     324|     Millbrae|8:16a|
|     324|    Hillsdale|8:24a|
|     324| Redwood City|8:31a|
|     ...|          ...|  ...|
|     217| Blossom Hill|6:36a|
|     217|      Capitol|6:42a|
|     217|       Tamien|6:50a|
|     217|     San Jose|6:59a|
+--------+-------------+-----+
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>>
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>>
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>>
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>>
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>>
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>>
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\
      /_/

Using Python version 3.6
SparkSession available as 'spark'.
>>> |
```

Let's practice

INTRODUCTION TO SPARK SQL IN PYTHON

Window Function SQL

INTRODUCTION TO SPARK SQL IN PYTHON

Mark Plutowski
Data Scientist

What is a Window Function SQL?

- Express operations more simply than dot notation or queries
- Each row uses the values of other rows to calculate its value

A train schedule

train_id	station	time
324	San Francisco	7:59a
324	22nd Street	8:03a
324	Millbrae	8:16a
324	Hillsdale	8:24a
324	Redwood City	8:31a
324	Palo Alto	8:37a
324	San Jose	9:05a

Column with time until next stop added

train_id	station	time	time_to_next_stop
324	San Francisco	7:59a	4 min
324	22nd Street	8:03a	13 min
324	Millbrae	8:16a	8 min
324	Hillsdale	8:24a	7 min
324	Redwood City	8:31a	6 min
324	Palo Alto	8:37a	28 min
324	San Jose	9:05a	null

Column with time of next stop

train_id	station	time	time (following row)
324	San Francisco	7:59a	8:03a
324	22nd Street	8:03a	8:16a
324	Millbrae	8:16a	8:24a
324	Hillsdale	8:24a	8:31a
324	Redwood City	8:31a	8:37a
324	Palo Alto	8:37a	9:05a
324	San Jose	9:05a	null

OVER clause and ORDER BY clause

```
query = """
SELECT train_id, station, time,
LEAD(time, 1) OVER (ORDER BY time) AS time_next
FROM sched
WHERE train_id=324 """

spark.sql(query).show()
```

```
+--------+-------------+-----+---------+
|train_id|      station| time|time_next|
+--------+-------------+-----+---------+
|     324|San Francisco|7:59a|    8:03a|
|     324|  22nd Street|8:03a|    8:16a|
|     324|     Millbrae|8:16a|    8:24a|
|     324|    Hillsdale|8:24a|    8:31a|
|     324| Redwood City|8:31a|    8:37a|
|     324|    Palo Alto|8:37a|    9:05a|
|     324|     San Jose|9:05a|     null|
+--------+-------------+-----+---------+
```

PARTITION BY clause

```
SELECT
train_id,
station,
time,
LEAD(time,1) OVER (PARTITION BY train_id ORDER BY time) AS time_next
FROM sched
```

Result of adding PARTITION BY clause

```
+--------+-------------+-----+---------+
|train_id|      station| time|time_next|
+--------+-------------+-----+---------+
|     217|       Gilroy|6:06a|    6:15a|
|     217|   San Martin|6:15a|    6:21a|
|     217|  Morgan Hill|6:21a|    6:36a|
|     217| Blossom Hill|6:36a|    6:42a|
|     217|      Capitol|6:42a|    6:50a|
|     217|       Tamien|6:50a|    6:59a|
|     217|     San Jose|6:59a|     null|
|     324|San Francisco|7:59a|    8:03a|
|     324|  22nd Street|8:03a|    8:16a|
|     324|     Millbrae|8:16a|    8:24a|
|     324|    Hillsdale|8:24a|    8:31a|
|     324| Redwood City|8:31a|    8:37a|
|     324|    Palo Alto|8:37a|    9:05a|
|     324|     San Jose|9:05a|     null|
+--------+-------------+-----+---------+
```

train_id	station	time	time_to_next_stop
324	San Francisco	7:59a	4 min
324	22nd Street	8:03a	13 min
324	Millbrae	8:16a	8 min
324	Hillsdale	8:24a	7 min
324	Redwood City	8:31a	6 min
324	Palo Alto	8:37a	28 min
324	San Jose	9:05a	null

Let's practice

INTRODUCTION TO SPARK SQL IN PYTHON

Dot notation and SQL

INTRODUCTION TO SPARK SQL IN PYTHON

Mark Plutowski
Data Scientist

Our table has 3 columns

```
df.columns
```

```
['train_id', 'station', 'time']
```

```
df.show(5)
```

```
+--------+-------------+-----+
|train_id|      station| time|
+--------+-------------+-----+
|     324|San Francisco|7:59a|
|     324|  22nd Street|8:03a|
|     324|     Millbrae|8:16a|
|     324|    Hillsdale|8:24a|
|     324| Redwood City|8:31a|
+--------+-------------+-----+
```

We only need 2

```
df.select('train_id','station')
  .show(5)
```

```
+--------+-------------+
|train_id|      station|
+--------+-------------+
|     324|San Francisco|
|     324|  22nd Street|
|     324|     Millbrae|
|     324|    Hillsdale|
|     324| Redwood City|
+--------+-------------+
```

Three ways to select 2 columns

- `df.select('train_id', 'station')`
- `df.select(df.train_id, df.station)`
- `from pyspark.sql.functions import col`
- `df.select(col('train_id'), col('station'))`

Two ways to rename a column

```
df.select('train_id','station')
  .withColumnRenamed('train_id','train')
  .show(5)
```

```
+-----+-------------+
|train|      station|
+-----+-------------+
|  324|San Francisco|
|  324|  22nd Street|
|  324|     Millbrae|
|  324|    Hillsdale|
|  324| Redwood City|
+-----+-------------+
```

```
df.select(col('train_id').alias('train'), 'station')
```

Don’t do this!

```
df.select('train_id', df.station, col('time'))
```

SQL queries using dot notation

```
spark.sql('SELECT train_id AS train, station FROM schedule LIMIT 5')
     .show()
```

```
+-----+-------------+
|train|      station|
+-----+-------------+
|  324|San Francisco|
|  324|  22nd Street|
|  324|     Millbrae|
|  324|    Hillsdale|
|  324| Redwood City|
+-----+-------------+
```

```
df.select(col('train_id').alias('train'), 'station')
  .limit(5)
  .show()
```

Window function SQL

```
query = """
SELECT *,
ROW_NUMBER() OVER(PARTITION BY train_id ORDER BY time) AS id
FROM schedule
"""
spark.sql(query)
     .show(11)
```

Window function SQL

```
+--------+-------------+-----+---+
|train_id|      station| time| id|
+--------+-------------+-----+---+
|     217|       Gilroy|6:06a|  1|
|     217|   San Martin|6:15a|  2|
|     217|  Morgan Hill|6:21a|  3|
|     217| Blossom Hill|6:36a|  4|
|     217|      Capitol|6:42a|  5|
|     217|       Tamien|6:50a|  6|
|     217|     San Jose|6:59a|  7|
|     324|San Francisco|7:59a|  1|
|     324|  22nd Street|8:03a|  2|
|     324|     Millbrae|8:16a|  3|
|     324|    Hillsdale|8:24a|  4|
+--------+-------------+-----+---+
```

Window function using dot notation

```
from pyspark.sql import Window,
from pyspark.sql.functions import row_number
df.withColumn("id", row_number()
                    .over(
                          Window.partitionBy('train_id')
                                .orderBy('time')
                         )
  )
```

- ROW_NUMBER in SQL : `pyspark.sql.functions.row_number`
- The inside of the OVER clause : `pyspark.sql.Window`
- PARTITION BY : `pyspark.sql.Window.partitionBy`
- ORDER BY : `pyspark.sql.Window.orderBy`

Using a WindowSpec

- The `over` function in Spark SQL corresponds to a `OVER` clause in SQL.
- The class `pyspark.sql.window.Window` represents the inside of an `OVER` clause.

```
window = Window.partitionBy('train_id').orderBy('time')
dfx = df.withColumn('next', lead('time',1).over(window))
```

  - Above, type(window) is pyspark.sql.window.WindowSpec

Let's practice

INTRODUCTION TO SPARK SQL IN PYTHON