# Spark SQL

## INTRODUCTION TO SPARK SQL WITH 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

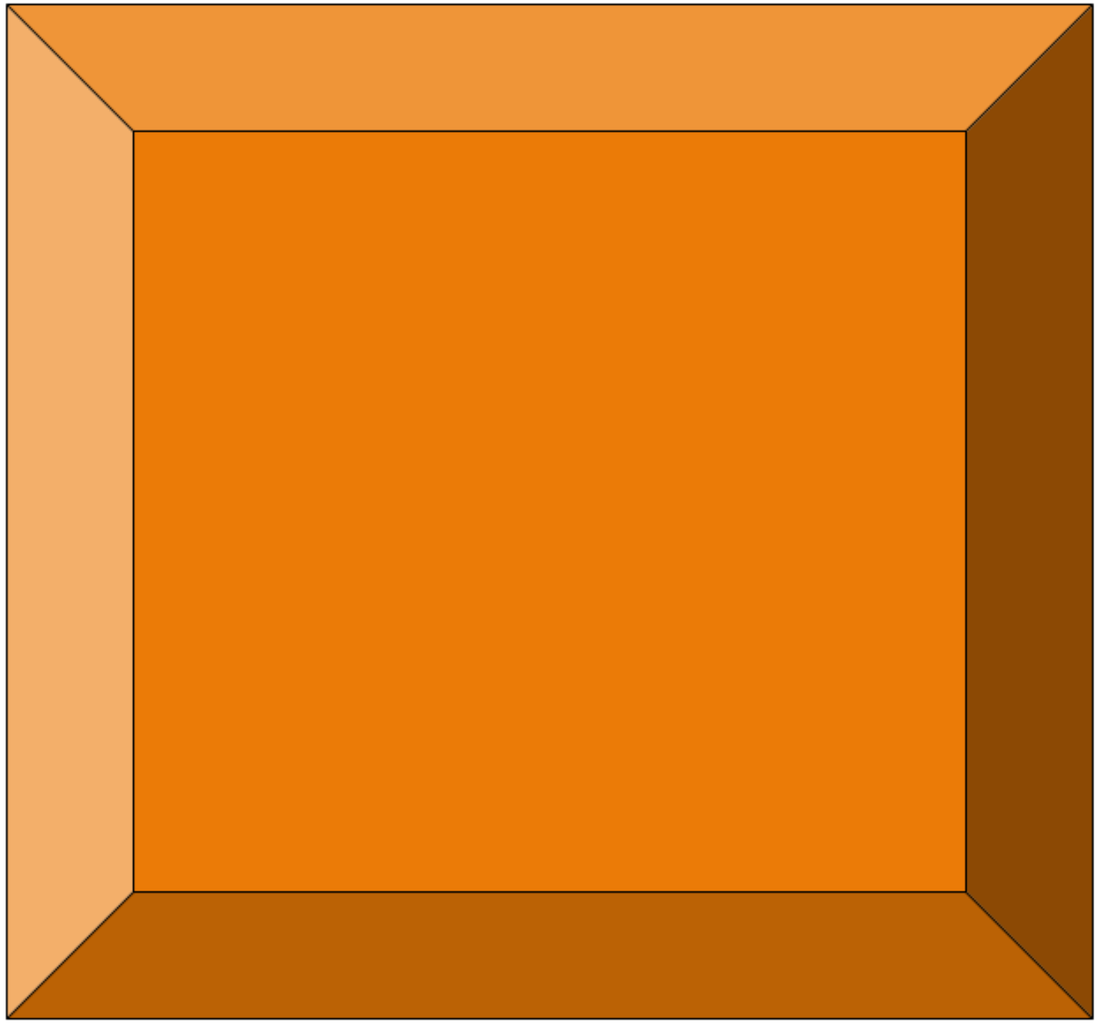
```
result = spark.sql("SHOW COLUMNS FROM tablename")
```

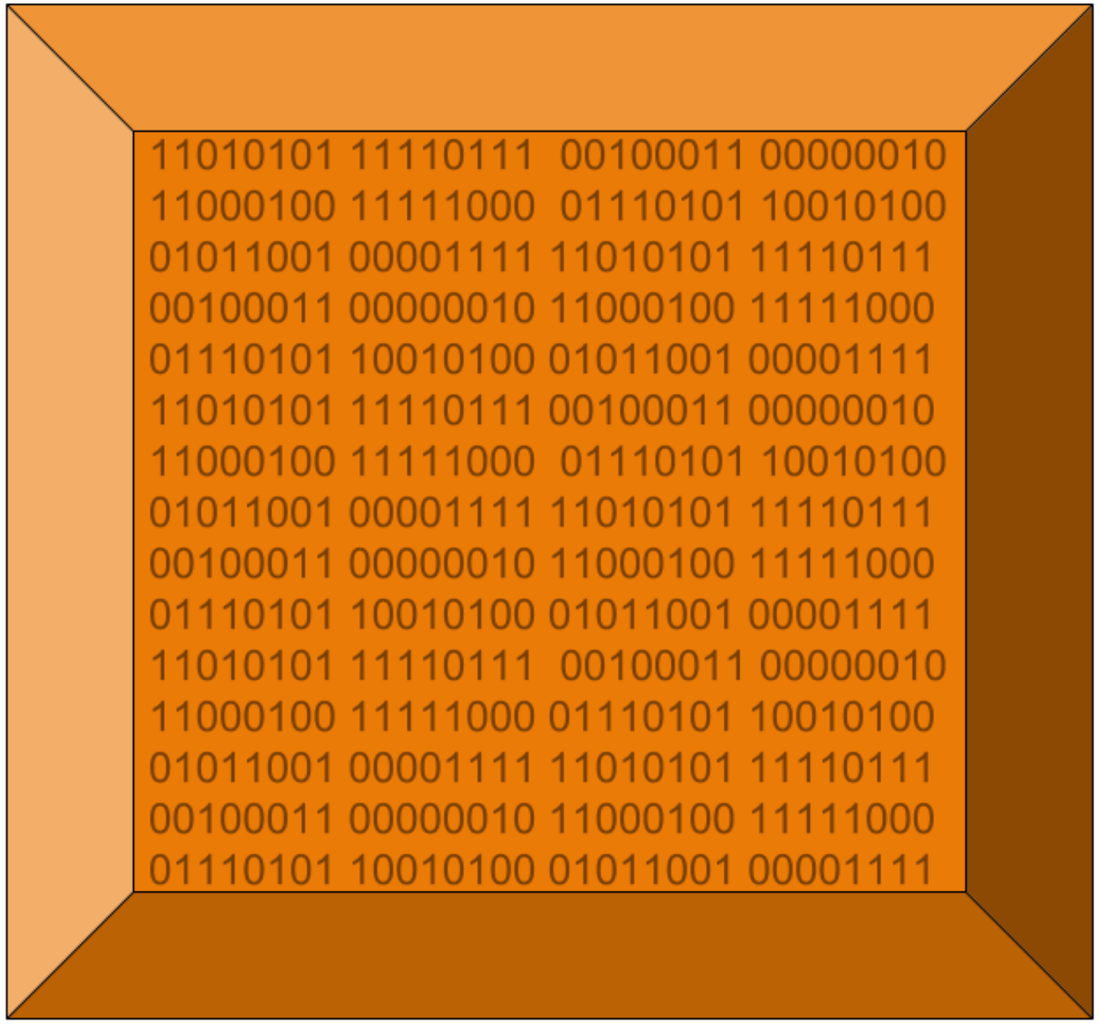
```
result = spark.sql("SELECT * FROM tablename LIMIT 0")
```

```
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

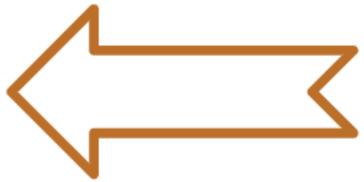
# Tabular data

```
+--------+-------------+-----+
|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 |

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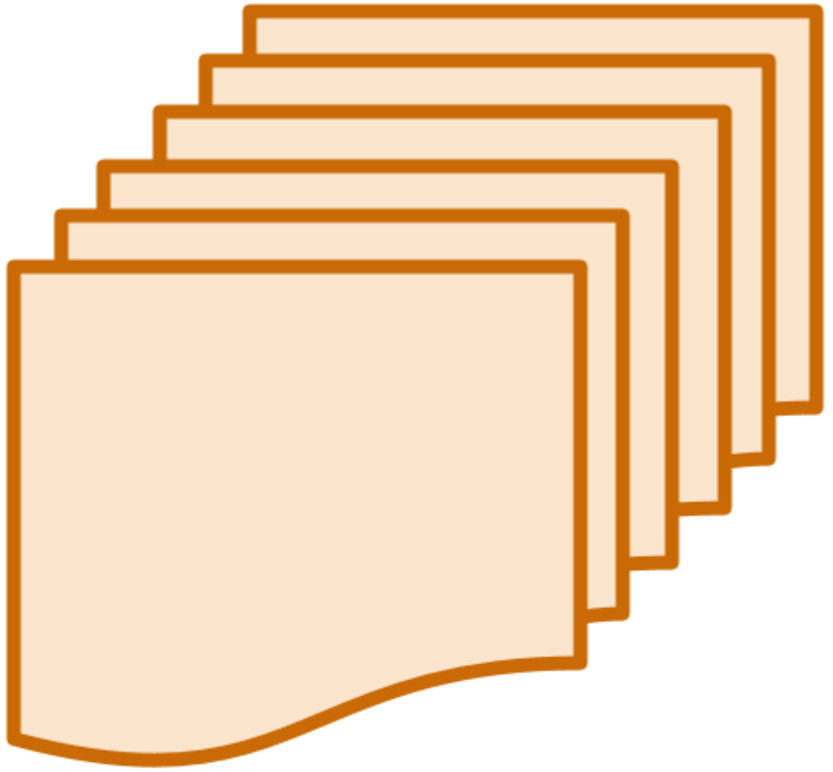
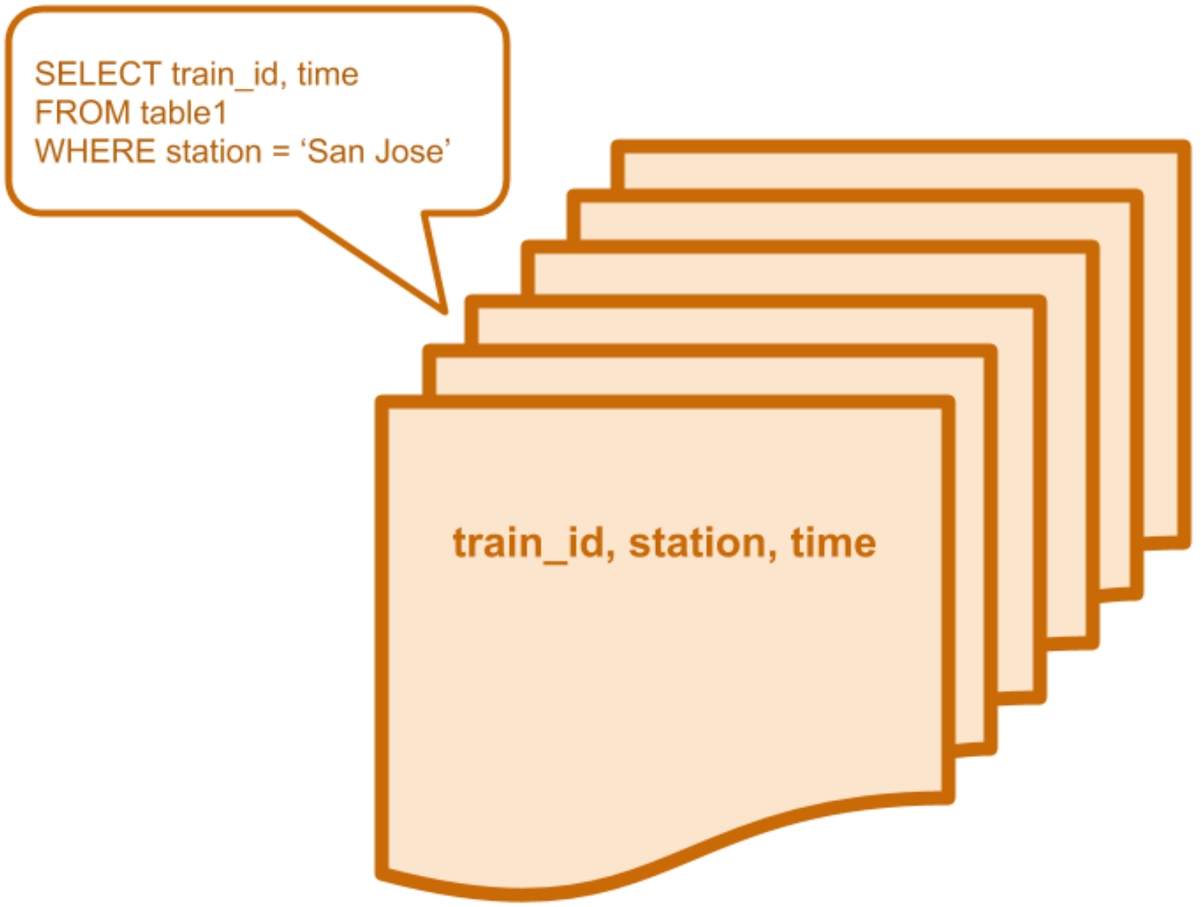
# Structured Query Language

```
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 WITH PYTHON

# Window Function SQL

INTRODUCTION TO SPARK SQL WITH 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 WITH PYTHON

# Dot notation and SQL

INTRODUCTION TO SPARK SQL WITH 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 WITH PYTHON