NETWORK TOWER PERFORMANCE ANALYSIS USING PYSPARK

UNDER THE GUIDANCE OF :

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1.Introduction

The project ' Network Tower Performance Analysis using PySpark', focuses on analyzing large-scale telecom data to evaluate the performance of different network towers. Using the distributed computing power of PySpark, the project aims to identify performance bottlenecks, monitor signal quality, and optimize network efficiency for better connectivity and user experience.

2.Raw Data Details

- **Dataset Name**: Network Tower Performance Data
- **Data Source**: Collected from telecom network monitoring system (CSV format)
- **Total Records**: 1000
- **Total Columns**: 12

Tower_ID
Location
Timestamp
Signal_Strength
Network_Type
Bandwidth_Mbps
Latency_ms
Uplink_Utilization
Downlink_Utilization
Power_status
Temperature_C
Alarm_Status

3.Loading Data

```
from pyspark.sql import SparkSession

spark = SparkSession.builder.appName("df").getOrCreate()
df= spark.read.format("csv").option( key: "header", value: "true").option( key: "inferSchema", value: "true").load(r"C:\sparkproject\project.csv")
df.show(1000)
df.printSchema()
```

```
+--------+---------+-----------------+-----------+-------------+----------+-----------------+-------------------+------------+-------------+------------+
|Tower_ID| Location|Signal_Strength_dBm|Network_Type|Bandwidth_Mbps|Latency_ms|Uplink_Utilization|Downlink_Utilization|Power_Status|Temperature_C|Alarm_Status|
+--------+---------+-----------------+-----------+-------------+----------+-----------------+-------------------+------------+-------------+------------+
|  TWR002|    Nagpur|            -78.0|         5G|        160.6|       109|               43|                 49|     Battery|         42.0|      Normal|
|  TWR002|    Mumbai|            -69.0|         5G|        122.1|        34|               61|                 83|          ON|         40.0| Minor Alarm|
|  TWR010|Aurangabad|            -84.0|         3G|        153.5|        89|               65|                 97|         OFF|         46.0|      Normal|
|  TWR002|    Nashik|            -76.0|         3G|        174.6|        21|               80|                 89|         OFF|         45.0|      Normal|
|  TWR007|     Pune|            -84.0|         3G|          8.5|        86|               79|                 62|     Battery|         48.0|      Normal|
|  TWR018|Aurangabad|            -93.0|         4G|        244.6|        80|               70|                 90|         OFF|         33.0|      Normal|
|  TWR013|    Nagpur|            -93.0|         5G|        206.1|        46|               93|                 82|         OFF|         45.0|      Normal|
|  TWR013|Aurangabad|            -87.0|         5G|         29.2|        21|               90|                 46|          ON|         34.0|      Normal|
|  TWR008|Aurangabad|            -62.0|         3G|         85.7|        96|               51|                 65|     Battery|         30.0|      Normal|
|  TWR019|Aurangabad|            -70.0|         4G|         90.3|        93|               78|                 70|         OFF|         46.0|      Normal|
|  TWR018|    Nashik|            -74.0|         5G|        198.4|        48|               94|                 57|         OFF|         43.0|      Normal|
|  TWR006|Aurangabad|            -66.0|         5G|         97.4|        92|               51|                 89|     Battery|         33.0|      Normal|
|  TWR001|     Pune|            -59.0|         2G|         67.6|        34|               89|                 81|         OFF|         30.0|      Normal|
|  TWR005|    Nagpur|            -80.0|         3G|        135.3|        62|               75|                 73|          ON|         30.0| Minor Alarm|
|  TWR004|    Nashik|            -85.0|         4G|        102.5|        72|               85|                 94|         OFF|         33.0|      Normal|
|  TWR013|    Nashik|            -73.0|         3G|         55.2|        31|               57|                 62|         OFF|         34.0|      Normal|
|  TWR006|    Nagpur|            -67.0|         4G|        238.9|        42|               86|                 50|         OFF|         40.0|      Normal|
|  TWR002|Aurangabad|            -85.0|         3G|        196.8|        70|               72|                 52|          ON|         37.0|      Normal|
|  TWR020|Aurangabad|            -95.0|         2G|         64.9|        87|               64|                 64|         OFF|         41.0|      Normal|
|  TWR007|Aurangabad|            -93.0|         4G|         42.0|        76|               76|                 49|         OFF|         32.0|      Normal|
+--------+---------+-----------------+-----------+-------------+----------+-----------------+-------------------+------------+-------------+------------+
only showing top 20 rows
```

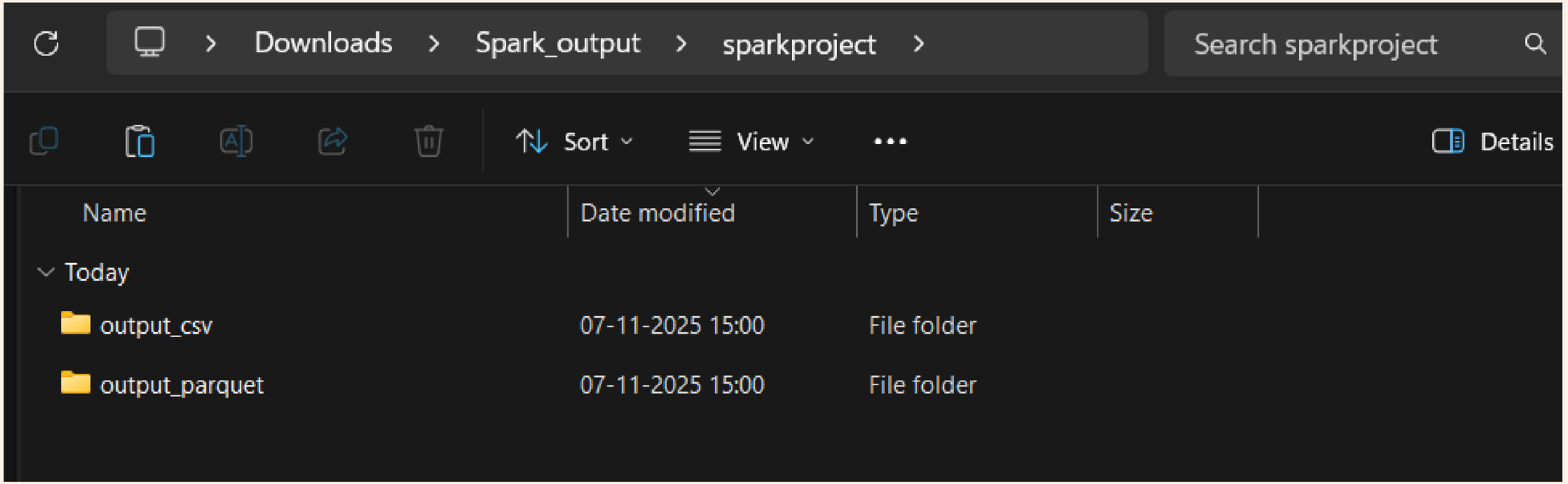
4.Data Cleaning

Removing Duplicate Values
Managing Null Values

```
df.createOrReplaceTempView("network_tower")
clean_df = spark.sql("SELECT DISTINCT * FROM network_tower")
clean_df.createOrReplaceTempView("clean_network_tower")
clean_df.show()
clean_df.printSchema()
cleaned_final = spark.sql("""SELECT Tower_ID,Location,COALESCE(Signal_Strength_dBm, (SELECT AVG(Signal_Strength_dBm) FROM clean_network_tower))
                          AS Signal_Strength_dBm,Network_Type,
                          COALESCE(Bandwidth_Mbps, (SELECT AVG(Bandwidth_Mbps) FROM clean_network_tower)) AS Bandwidth_Mbps,Latency_ms,
                          COALESCE(Uplink_Utilization, 0) AS Uplink_Utilization,
                          COALESCE(Downlink_Utilization, 0) AS Downlink_Utilization,
                          COALESCE(Power_Status, 'Unknown') AS Power_Status,
                          COALESCE(Temperature_C, (SELECT AVG(Temperature_C) FROM clean_network_tower)) AS Temperature_C,
                          Alarm_Status FROM clean_network_tower""")
cleaned_final.createOrReplaceTempView("cleaned_tower")
cleaned_final.show()
```

5.Transformation

```
# Save as Parquet
cleaned_final.write.mode("overwrite").parquet(r"C:\Users\ASUS\Downloads\Spark_output\sparkproject\output_parquet")
#Save as CSV (with header)
cleaned_final.write.mode("overwrite").option( key: "header",  value: True).csv(r"C:\Users\ASUS\Downloads\Spark_output\sparkproject\output_csv")
```



6.Aggregates Prepared

Loading Cleaned Data

```
from pyspark.sql import SparkSession
spark = SparkSession.builder.appName("df").getOrCreate()
df= spark.read.format("csv").option( key: "header", value: "true").option( key: "inferSchema", value: "true").load(r"C:\Users\ASUS\Downloads\Spark_output\sparkproject\output_csv"
df.show()
df.createOrReplaceTempView("aggregate")
```

```
+--------+----------+------------------+-----------+-------------+----------+-----------------+-------------------+------------+------------+------------+
|Tower_ID|  Location|Signal_Strength_dBm|Network_Type|Bandwidth_Mbps|Latency_ms|Uplink_Utilization|Downlink_Utilization|Power_Status|Temperature_C|Alarm_Status|
+--------+----------+------------------+-----------+-------------+----------+-----------------+-------------------+------------+------------+------------+
|  TWR002|    Nagpur|             -78.0|         5G|        160.6|       109|               43|                 49|     Battery|        42.0|      Normal|
|  TWR002|    Mumbai|             -69.0|         5G|        122.1|        34|               61|                 83|          ON|        40.0| Minor Alarm|
|  TWR010|Aurangabad|             -84.0|         3G|        153.5|        89|               65|                 97|         OFF|        46.0|      Normal|
|  TWR002|    Nashik|             -76.0|         3G|        174.6|        21|               80|                 89|         OFF|        45.0|      Normal|
|  TWR007|      Pune|             -84.0|         3G|          8.5|        86|               79|                 62|     Battery|        48.0|      Normal|
|  TWR018|Aurangabad|             -93.0|         4G|        244.6|        80|               70|                 90|         OFF|        33.0|      Normal|
|  TWR013|    Nagpur|             -93.0|         5G|        206.1|        46|               93|                 82|         OFF|        45.0|      Normal|
|  TWR013|Aurangabad|             -87.0|         5G|         29.2|        21|               90|                 46|          ON|        34.0|      Normal|
|  TWR008|Aurangabad|             -62.0|         3G|         85.7|        96|               51|                 65|     Battery|        30.0|      Normal|
|  TWR019|Aurangabad|             -70.0|         4G|         90.3|        93|               78|                 70|         OFF|        46.0|      Normal|
|  TWR018|    Nashik|             -74.0|         5G|        198.4|        48|               94|                 57|         OFF|        43.0|      Normal|
|  TWR006|Aurangabad|             -66.0|         5G|         97.4|        92|               51|                 89|     Battery|        33.0|      Normal|
|  TWR001|      Pune|             -59.0|         2G|         67.6|        34|               89|                 81|         OFF|        30.0|      Normal|
|  TWR005|    Nagpur|             -80.0|         3G|        135.3|        62|               75|                 73|          ON|        30.0| Minor Alarm|
|  TWR004|    Nashik|             -85.0|         4G|        102.5|        72|               85|                 94|         OFF|        33.0|      Normal|
|  TWR013|    Nashik|             -73.0|         3G|         55.2|        31|               57|                 62|         OFF|        34.0|      Normal|
|  TWR006|    Nagpur|             -67.0|         4G|        238.9|        42|               86|                 50|         OFF|        40.0|      Normal|
|  TWR002|Aurangabad|             -85.0|         3G|        196.8|        70|               72|                 52|          ON|        37.0|      Normal|
|  TWR020|Aurangabad|             -95.0|         2G|         64.9|        87|               64|                 64|         OFF|        41.0|      Normal|
|  TWR007|Aurangabad|             -93.0|         4G|         42.0|        76|               76|                 49|         OFF|        32.0|      Normal|
+--------+----------+------------------+-----------+-------------+----------+-----------------+-------------------+------------+------------+------------+
only showing top 20 rows
```

Max Function

```
df_max=spark.sql("select Location,max(Bandwidth_Mbps) from aggregate group by location")
df_max.show()
df_max.write.mode("overwrite").parquet(r"C:\Users\ASUS\Downloads\output_of_Parquet\df_max_output")
df_max.write.mode("overwrite").option( key: "header",  value: True).csv(r"C:\Users\ASUS\Downloads\output_of_csv/df_max.csv")
```

```
+---------+--------------------+
|  Location|max(Bandwidth_Mbps)|
+---------+--------------------+
|Aurangabad|               249.5|
|    Mumbai|               248.1|
|     Pune|               249.3|
|    Nagpur|               249.7|
|    Nashik|               247.8|
+---------+--------------------+
```

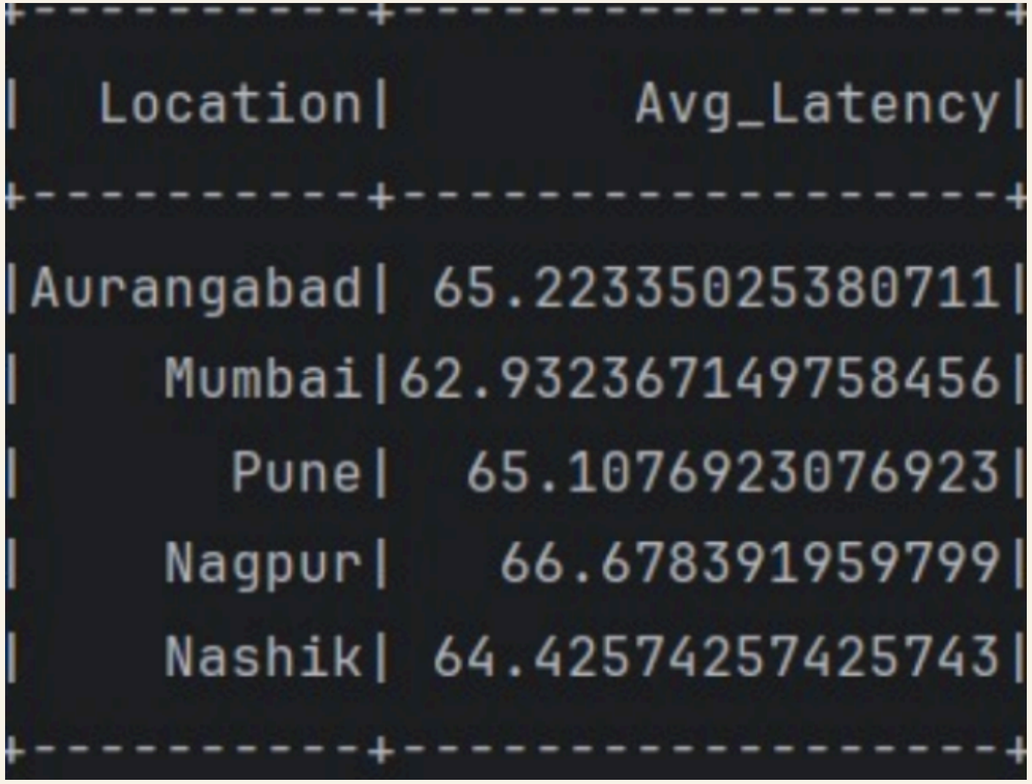
Min Function

```
df_min=spark.sql("select Location,min(Signal_Strength_dBm) from aggregate group by location")
df_min.show()
df_min.write.mode("overwrite").parquet(r"C:\Users\ASUS\Downloads\output_of_Parquet\df_min.parquet")
df_min.write.mode("overwrite").option( key: "header",  value: True).csv(r"C:\Users\ASUS\Downloads\output_of_csv\df_min.csv")
```

```
+----------+------------------------+
|  Location|min(Signal_Strength_dBm)|
+----------+------------------------+
|Aurangabad|                   -95.0|
|    Mumbai|                   -95.0|
|      Pune|                   -95.0|
|    Nagpur|                   -95.0|
|    Nashik|                   -95.0|
+----------+------------------------+
```

Avg Function

```
df_avg=spark.sql("select Location,avg(Latency_ms) from aggregate group by location")
df_avg.write.mode("overwrite").parquet(r"C:\Users\ASUS\Downloads\output_of_Parquet\df_avg.parquet")
df_avg.write.mode("overwrite").option( key: "header",  value: True).csv(r"C:\Users\ASUS\Downloads\output_of_csv\df_avg.csv")
```



Location	Avg_Latency
Aurangabad	65.22335025380711
Mumbai	62.932367149758456
Pune	65.1076923076923
Nagpur	66.678391959799
Nashik	64.42574257425743

Sum Function

```
df_sum=spark.sql("select Location,sum(Uplink_Utilization) from aggregate group by location")
df_sum.show()
df_sum.write.mode("overwrite").parquet(r"C:\Users\ASUS\Downloads\output_of_Parquet\df_sum.parquet")
df_sum.write.mode("overwrite").option( key: "header",  value: True).csv(r"C:\Users\ASUS\Downloads\output_of_csv\df_sum.csv")
```

```
+----------+-----------------------+
|  Location|sum(Uplink_Utilization)|
+----------+-----------------------+
|Aurangabad|                  13297|
|    Mumbai|                  14155|
|      Pune|                  13516|
|    Nagpur|                  13552|
|    Nashik|                  14024|
+----------+-----------------------+
```

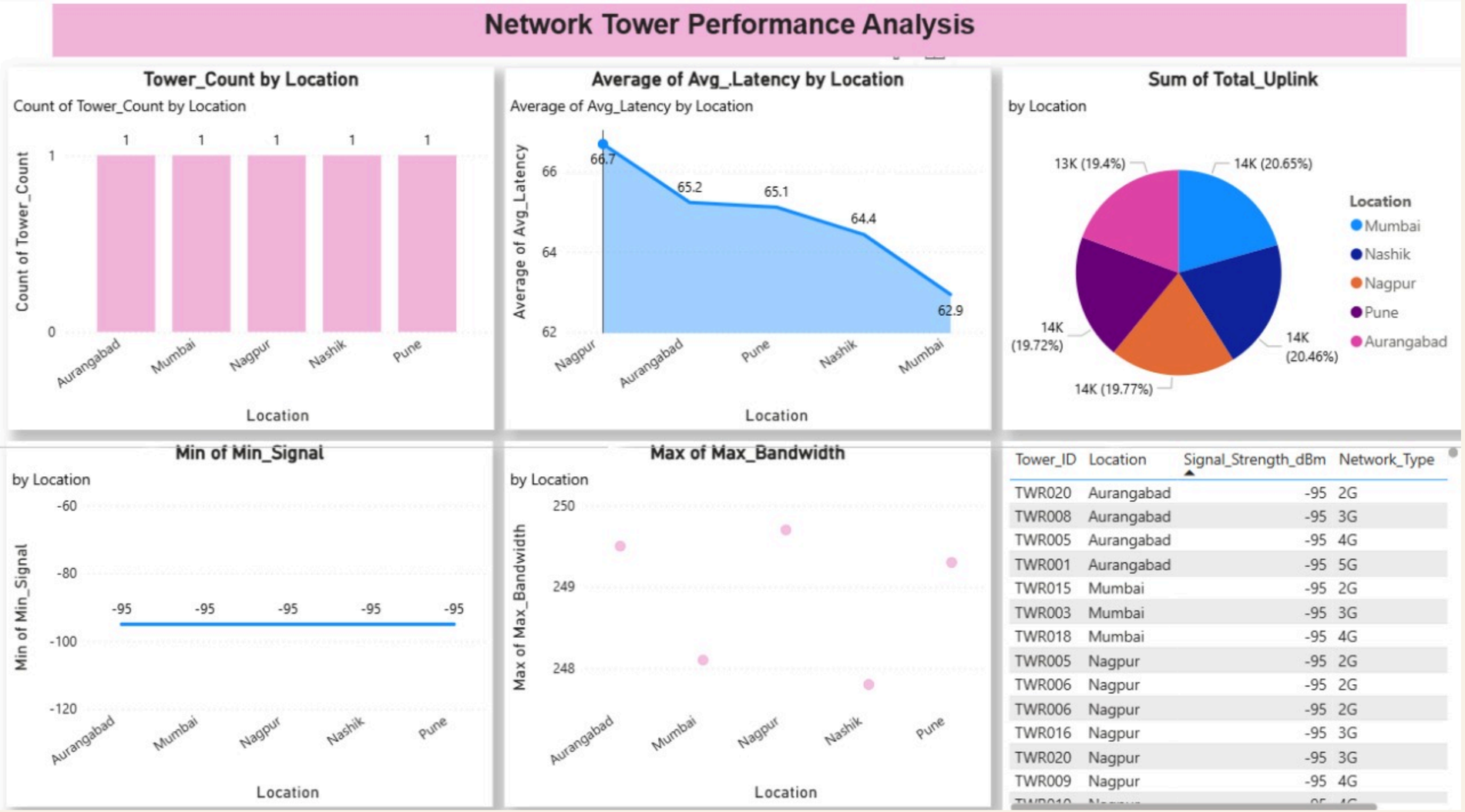
Count Function

```
df_count=spark.sql("select Location,count(Tower_ID) from aggregate group by location")
df_count.show()
df_count.write.mode("overwrite").parquet(r"C:\Users\ASUS\Downloads\output_of_Parquet\df_count.parquet")
df_count.write.mode("overwrite").option( key: "header",  value: True).csv(r"C:\Users\ASUS\Downloads\output_of_csv\df_count.csv")
```

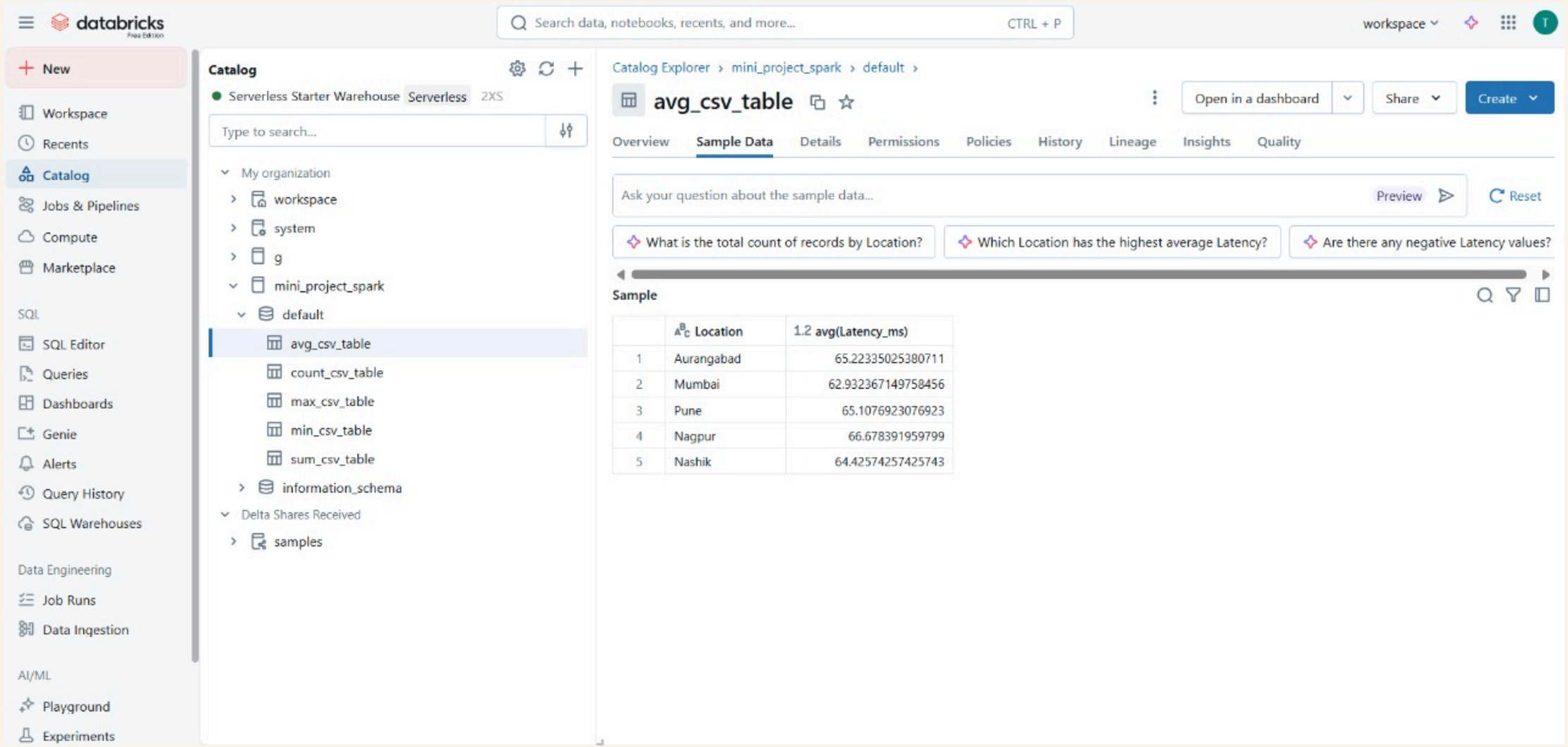
```
+----------+---------------+
|  Location|count(Tower_ID)|
+----------+---------------+
|Aurangabad|            197|
|    Mumbai|            207|
|      Pune|            195|
|    Nagpur|            199|
|    Nashik|            202|
+----------+---------------+
```

7.Data Visualization

PowerBI



Databricks



	Location	avg(Latency_ms)
1	Aurangabad	65.22335025380711
2	Mumbai	62.932367149758456
3	Pune	65.1076923076923
4	Nagpur	66.678391959799
5	Nashik	64.42574257425743

04.Conclusion

- The raw dataset was efficiently imported into PySpark using a Spark session.
- Schema detection and header options ensured accurate data loading.
- This step laid the foundation for data cleaning, transformation, and Power BI dashboard creation

Thank you