## **EMRDemo**

June 25, 2024

```
[18]: // MySQL database connection properties
      val jdbcUrl = "jdbc:mysql://34.100.169.199:3306/project2"
      val connectionProperties = new java.util.Properties()
      connectionProperties.put("user", "root")
      connectionProperties.put("password", "abhi@iit123")
      connectionProperties.put("driver", "com.mysql.cj.jdbc.Driver")
     VBox()
     FloatProgress(value=0.0, bar_style='info', description='Progress:',_
      →layout=Layout(height='25px', width='50%'),...
     jdbcUrl: String = jdbc:mysql://your-mysql-host:3306/your-database
     connectionProperties: java.util.Properties = {}
     res9: Object = null
     res10: Object = null
     res11: Object = null
 []: spark
     VBox()
     Starting Spark application
[29]: // S3 paths
      val inputS3Path = "s3://task-3-emr/air-quality-data/"
      val outputParquetS3Path = "s3://task-3-emr/air-quality-data-parquet/"
     VBox()
     FloatProgress(value=0.0, bar_style='info', description='Progress:',_
      →layout=Layout(height='25px', width='50%'),...
     inputS3Path: String = s3://task-3-emr/air-quality-data/
     outputParquetS3Path: String = s3://task-3-emr/air-quality-data-parquet/
[30]: val airQualityDF = spark.read.option("header", "true").option("inferSchema", ___
       VBox()
```

```
FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     →layout=Layout(height='25px', width='50%'),...
    airQualityDF: org.apache.spark.sql.DataFrame = [From Date: string, To Date:
    string ... 23 more fields]
[31]: airQualityDF.count()
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     →layout=Layout(height='25px', width='50%'),...
    res24: Long = 14296116
[32]: airQualityDF.write.format("parquet").mode("overwrite").save(outputParquetS3Path)
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     ⇒layout=Layout(height='25px', width='50%'),...
[33]: val parquetDF = spark.read.parquet(outputParquetS3Path)
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     parquetDF: org.apache.spark.sql.DataFrame = [From Date: string, To Date: string
    ... 23 more fields]
[36]: // Job 1: Filter by date range
    val filterDF = parquetDF.filter($"From Date" >= "2023-01-01" && $"To Date" <= __
     →"2023-12-31")
    filterDF.show()
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',_
     ⇔layout=Layout(height='25px', width='50%'),...
    filterDF: org.apache.spark.sql.Dataset[org.apache.spark.sql.Row] = [From Date:
    string, To Date: string ... 23 more fields]
    +-----
    ______
    _____
    ______
    ---+---+
             From Date
                               To Date | PM2.5 (ug/m3) | PM10 (ug/m3) | NO
    (ug/m3)|NO2 (ug/m3)|NOx (ppb)|NH3 (ug/m3)|SO2 (ug/m3)|CO (mg/m3)|Ozone
    (ug/m3)|Benzene (ug/m3)|Toluene (ug/m3)|Eth-Benzene (ug/m3)|MP-Xylene (ug/m3)|O
```

| (m/s)        | Xylene (u  | Temp (degree<br>g/m3) AT (de | gree C)   |                   |       |        |           |       |
|--------------|------------|------------------------------|-----------|-------------------|-------|--------|-----------|-------|
|              |            |                              |           |                   |       |        |           |       |
|              |            |                              |           |                   |       |        |           |       |
|              |            | +                            |           |                   |       |        |           |       |
| +            |            | +                            |           |                   |       |        |           |       |
|              |            | 00:00 2023-0                 |           |                   |       |        |           |       |
| 7.95         | 6.25       | 19.45                        | 14        | .55               | 0.3   | 61     | .85       | 0.1   |
| 0.2          |            | NULL                         |           | NULL              |       | NULL   |           | 56.0  |
| 1.85         | 239.5      | 219.0                        | NULL      | 25.65             | 0.0   | 1      | NULL      |       |
| NULL         |            |                              |           |                   |       |        |           |       |
|              |            | 00:00 2023-0                 |           |                   |       |        |           |       |
|              |            | 21.62                        |           |                   |       |        |           |       |
|              |            | NULL                         |           |                   |       |        |           |       |
| 2.12         | 241.0      | 236.5                        | NULL      | 26.18             | 0.0   | 1      | NULL      |       |
| NULL         |            |                              |           |                   |       |        |           |       |
| 2023-        | -02-10 11: | 00:00 2023-0                 | 2-10 12:0 | 00:00             | 13.2  | 5      | 96.5      | 1.78  |
|              |            | 23.6                         |           |                   |       |        |           |       |
|              |            | NULL                         |           |                   |       |        |           |       |
|              | 251.0      | 264.5                        | NULL      | 26.9              | 0.0   | 1      | NULL      |       |
| NULL         |            |                              |           |                   |       |        |           |       |
|              |            | 00:00 2023-0                 |           |                   |       |        |           |       |
|              |            | 24.45                        |           |                   |       |        |           |       |
|              |            | NULL                         |           |                   |       |        |           |       |
|              | 238.75     | 175.75                       | NULL      | 27.55             | 0.0   | l      | NULL      |       |
| NULL         |            |                              |           |                   |       |        | 1         |       |
|              |            | 00:00 2023-0                 |           |                   |       |        |           |       |
|              |            | 24.6                         |           |                   |       |        |           |       |
|              |            | NULL                         |           |                   |       |        |           |       |
|              | 248.01     | 266.25                       | NULLI     | 28.01             | 0.0   | ı      | NULLI     |       |
| NULL         | 00 40 44   | 00 0010000 0                 | 2 40 45   | 00 001            | 40    | 0.1    | 00.01     | 4 551 |
|              |            | 00:00 2023-0                 |           |                   |       |        |           |       |
|              |            | 25.93                        |           |                   |       |        |           |       |
|              |            | NULL <br>235.25              |           |                   |       |        |           |       |
|              | 231.15     | 235.25                       | NOLLI     | 20.45             | 0.0   | ı      | NOFF      |       |
| NULL         | -02-10 15. | 00:00 2023-0                 | 0_10_16.0 | 00.001            | 11 7  | E      | 94 AI     | 1 /5  |
|              |            | 27.02                        |           |                   |       |        |           |       |
|              |            | NULL                         |           |                   |       |        |           |       |
| 0.2 <br>1 73 | 2/1 5      | 185.5                        | мит т І   | 28 67 I           | 0 0   | INOFFI | мит Т     | 39.01 |
| NULL         | 241.51     | 100.01                       | MOLL      | 20.07             | 0.0   | ı      | MOLL      |       |
|              | -02-10 16: | 00:00 2023-0                 | 2-10 17:0 | 00.001            | 10.2  | ۶I     | 86 75 l   | 1 581 |
|              |            | 24.95                        |           |                   |       |        |           |       |
| 0.21         | 0.111      | NULL                         | ,         | · · ·<br>NTIT T I | 0.021 | NIII I | J J I     | 39 51 |
| 1.71         | 240 51     | 126.0                        | NULL.     | 28.671            | 0.01  | 140001 | NUTT.T. I | 55.51 |
| NULL         |            | 120.01                       | .,000     | 20.011            | 0.01  |        | 1400001   |       |
|              |            | 00:00 2023-0                 | 2-10 18:0 | 00:001            | 1.3   | 5 l    | 84.01     | 1.6   |
| , _ 020      |            |                              |           |                   | 10.   | - •    | 31.01     | 01    |

| 0.2                     |          | NULL         |         |                   |        | NULL    | 0.0 <br>42.75  |
|-------------------------|----------|--------------|---------|-------------------|--------|---------|----------------|
| 0.95  2<br>NULL         | 10.25    | 13.01        | NOL     | L  20.33          | 0.0    | , 1     | 10771          |
| 2023-02<br>11.43        | 7.3      | 21           | .72     | 11.38             | 0.4    | 67.52   | 75  1.48       |
| 0.0 <br>50.0  0<br>NULL |          | 0.2 <br>01.5 | 53.75   | 0.1 <br>NULL      | 27.53  | 0.1     | NULL  <br>NULL |
| 2023-02                 | -10 19:0 |              |         | 20:00:00 <br>7.67 |        |         | 2.0  1.3       |
| 0.031                   | 10.01    | 0.31         | . 101   | 0.031             | 0.111  | 0.11    | NIII.I.I       |
| 52 25 l                 | 0.381.2  | 00 751       | 53 01   | NIII.I.I          | 26 951 | 0.11    | NULL  <br>NULL |
| NULL                    |          | 001101       | 00.01   | 110221            | 20.001 | 0.01    | 110221         |
|                         |          | 0:001202     | 3-02-10 | 21:00:001         | 24.    | 51 136  | 3.0  2.15      |
|                         |          |              |         | 6.93              |        |         |                |
|                         |          |              |         |                   |        |         | 0.1            |
| 55.0  0                 | .351 2   | 16.0         | 53.0    | NULL              | 26.58  | 0.01    | NULL           |
| NULL                    | •        | ·            | ·       |                   | ·      | •       | ·              |
|                         | -10 21:0 | 0:00 202     | 3-02-10 | 22:00:00          | 41.7   | 5  226. | 25  1.42       |
| 22.15                   | 12.93    | 20           | .15     | 6.71              | 0.481  | 49.971  |                |
| 0.12                    |          | 1.82         |         | 1.05              |        | 1.05    | 0.3            |
| 54.75                   | 0.4      | 140.0        | 53.25   | NULL              | 26.4   | 0.01    | NULL           |
| NULL                    |          |              |         |                   |        |         |                |
| 2023-02                 | -10 22:0 | 0:00 202     | 3-02-10 | 23:00:00          | 23.7   | 5  95.  | 75  2.05       |
| 25.42                   | 15.2     | 18           | .77     | 5.7               | 0.51   | 37.43   |                |
| 0.0                     | 0        | .45          |         | 0.05              |        | 0.1     | NULL           |
| 63.5                    | 0.1  9   | 7.75         | 53.75   | NULL              | 25.53  | 0.0     | NULL           |
| NULL                    |          |              |         |                   |        |         |                |
| 2023-02                 | -10 23:0 | 0:00 202     | 3-02-11 | 00:00:00          | 19.2   | 94.     | 75  2.27       |
|                         |          |              |         | 4.75              |        |         |                |
|                         |          |              |         | 0.1               |        |         |                |
| 70.0  0                 | .15  13  | 0.25         | 54.0    | NULL              | 25.05  | 0.0     | NULL           |
| NULL                    |          |              |         |                   |        |         |                |
|                         |          |              |         |                   |        |         | 25  5.05       |
|                         |          |              |         | 3.52              |        |         |                |
| 0.12                    |          | 1.32         |         | 0.15              |        | 0.42    | 0.17           |
| 75.0                    | 0.1  9   | 6.75         | 54.0    | NULL              | 24.73  | 0.0     | NULL           |
| NULL                    |          |              |         |                   |        |         |                |
|                         |          |              |         |                   |        |         | 25  4.85       |
|                         |          |              |         | 3.1               |        |         |                |
|                         |          |              |         | 0.2               |        |         |                |
|                         |          | 104.5        | 54.0    | NULL              | 24.73  | 0.0     | NULL           |
| NULL                    |          |              |         |                   |        |         |                |
|                         |          |              |         |                   |        |         | 25  1.45       |
|                         |          |              |         | 2.92              |        |         |                |
|                         |          |              |         | 0.03              |        |         |                |
| 78.5                    | 0.1      | 76.01        | 53.5    | NULL              | 24.38  | 0.01    | NULL           |

```
|2023-02-11 03:00:00|2023-02-11 04:00:00|
                                            18.25|
                                                        69.0
                                                                4.67
    36.671
             23.31
                       21.81
                                 2.71
                                          0.381
                                                    11.58
    0.051
                 0.451
                                 0.03|
                                                0.121
                                                              NULLI
                 120.01
    82.25 | 0.15 |
                         53.01
                                  NULLI
                                          24.1
                                                   0.01
                                                               NULLI
    NULLI
    |2023-02-11 04:00:00|2023-02-11 05:00:00|
                                            24.25
                                                       90.75
                                                                7.571
    39.81
           27.321
                     23.121
                                2.221
                                         0.41
                                                    7.27
                                                                 0.051
    0.51
                    0.1
                                                             84.01
                                   0.21
                                                0.031
                                   24.051
                                             0.01
    0.15 | 111.25 |
                  53.25
                            NULLI
                                                        NULL
    NULL
    +----+
    ______
    ____+__
    ______
    ---+---+
    only showing top 20 rows
[41]: // Job 2: Aggregate by average PM10
    val avgPM10DF = parquetDF.groupBy("From Date", "To Date").agg(avg("PM10 (ug/
     →m3)").as("avg_pm10"))
    avgPM10DF.show()
    // writeToMySQL(avgPM10DF, "average_pm10")
    VBox()
    FloatProgress(value=0.0, bar style='info', description='Progress:', __
     →layout=Layout(height='25px', width='50%'),...
    avgPM10DF: org.apache.spark.sql.DataFrame = [From Date: string, To Date: string
    ... 1 more field]
    +----+
             From Datel
                               To Datel
                                              avg pm10|
    +----+
    |2023-02-12 00:00:00|2023-02-12 01:00:00|152.91847887323948|
    |2023-02-09 14:00:00|2023-02-09 15:00:00|114.16144092219021|
    |2023-01-07 07:00:00|2023-01-07 08:00:00|154.91086956521738|
    |2022-12-05 19:00:00|2022-12-05 20:00:00|223.41452887537994|
    |2022-12-23 20:00:00|2022-12-23 21:00:00| 245.6475076923077|
    |2022-12-25 02:00:00|2022-12-25 03:00:00|
    |2022-11-17 03:00:00|2022-11-17 04:00:00|155.64638095238095|
    |2022-08-07 10:00:00|2022-08-07 11:00:00| 44.20376383763837|
    |2010-10-18 16:00:00|2010-10-18 17:00:00|
                                                 1.86
    |2010-10-28 22:00:00|2010-10-28 23:00:00|
                                                 NULL
    |2010-12-11 20:00:00|2010-12-11 21:00:00|
                                               12.955l
    |2010-12-28 10:00:00|2010-12-28 11:00:00|
                                               59.165
    |2011-01-25 14:00:00|2011-01-25 15:00:00|
                                                 1.961
    |2011-02-08 15:00:00|2011-02-08 16:00:00|
                                                2.0851
```

NULLI

```
|2011-05-04 14:00:00|2011-05-04 15:00:00|
                                                        1.76
     |2011-05-21 14:00:00|2011-05-21 15:00:00|
                                                      35.2351
     |2011-05-22 23:00:00|2011-05-23 00:00:00|
                                                        NULL
     |2011-06-26 20:00:00|2011-06-26 21:00:00|
                                                        2.88|
     |2011-10-07 08:00:00|2011-10-07 09:00:00|
                                                      14.81
     |2011-12-06 22:00:00|2011-12-06 23:00:00|
                                                        2.36
     +------
    only showing top 20 rows
[43]: // Job 3: Count of records by date
     val countByDateDF = parquetDF.groupBy("From Date").agg(count("*").
      ⇔as("record_count"))
     countByDateDF.show()
     // writeToMySQL(countByDateDF, "count_by_date")
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',u
      countByDateDF: org.apache.spark.sql.DataFrame = [From Date: string,
    record_count: bigint]
     +----+
              From Date | record_count |
     +----+
     |2023-02-19 17:00:00|
                                426|
     |2022-12-18 00:00:00|
                                402|
     |2022-12-19 22:00:00|
                                403|
     12022-11-06 08:00:001
                                388 l
     |2022-08-09 19:00:00|
                                366
     12022-08-30 21:00:001
                                371 l
     |2022-09-10 17:00:00|
                                3721
     |2022-10-06 00:00:00|
                                377|
     |2010-10-29 15:00:00|
                                 26 l
     |2010-10-29 19:00:00|
                                 26|
     |2011-02-24 00:00:00|
                                 29|
     |2011-03-21 17:00:00|
                                 29|
     |2011-03-30 22:00:00|
                                 29|
     |2011-04-11 23:00:00|
                                 29|
     |2011-05-12 11:00:00|
                                 31 l
     |2011-06-18 21:00:00|
                                 321
     |2011-11-24 10:00:00|
                                 321
     |2012-01-01 02:00:00|
                                 32|
     12012-02-08 04:00:001
                                 32 l
     |2012-03-04 05:00:00|
                                 321
    only showing top 20 rows
```

```
[44]: // Job 4: Filter by high NO2 levels
    val highNO2DF = parquetDF.filter($"NO2 (ug/m3)" > 100)
    highNO2DF.show()
    // writeToMySQL(highNO2DF, "high_no2")
   VBox()
   FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     →layout=Layout(height='25px', width='50%'),...
   highNO2DF: org.apache.spark.sql.Dataset[org.apache.spark.sql.Row] = [From Date:
   string, To Date: string ... 23 more fields]
    +-----
    ______
    _____
    ______
    ---+---+
    From Date
                            To Date | PM2.5 (ug/m3) | PM10 (ug/m3) | NO
    (ug/m3)|NO2 (ug/m3)|NOx (ppb)|NH3 (ug/m3)|SO2 (ug/m3)|CO (mg/m3)|Ozone
    (ug/m3)|Benzene (ug/m3)|Toluene (ug/m3)|Eth-Benzene (ug/m3)|MP-Xylene (ug/m3)|O
   Xylene (ug/m3)|Temp (degree C)|RH (%)|WS (m/s)|WD (deg)|SR (W/mt2)|BP (mmHg)|VWS
    (m/s)|Xylene (ug/m3)|AT (degree C)|
    +-----
    ______
    ______
    ---+
    |2023-02-13 19:00:00|2023-02-13 20:00:00|
                                        60.5
                                                          7.95
                                                 262.0
   115.9
            68.1l
                    21.65
                            11.65l
                                     2.031
                                               17.57 l
   0.1
              1.75
                             0.45
                                          0.75
                                                       0.321
   31.0 | 0.12 | 114.25 |
                      9.01
                              NULLI
                                    24.35
                                             0.01
                                                        NULL
   NULL
    |2023-02-13 20:00:00|2023-02-13 21:00:00|
                                                         41.45|
                                       137.5L
                                                382.75
   129.02
           102.33|
                    27.681
                             10.12
                                      3.391
                                                8.53
   0.17|
                2.21
                               0.71
                                           1.12
                                                        0.5
   36.5 | 0.12
              79.75
                       9.01
                              NULL
                                    23.85
                                             0.01
                                                        NULL
   NULL
    |2023-02-13 21:00:00|2023-02-13 22:00:00|
                                       178.0l
                                                 474.51
                                                         89.721
   120.12
           136.88
                    32.12
                               8.01
                                       4.81
                                                6.671
   0.351
               2.921
                              0.931
                                            1.7|
                                                        0.751
   42.25 | 0.12 |
                90.0
                       9.0
                               NULL
                                     23.58
                                              0.0
                                                        NULL
   NULL
    |2023-02-13 22:00:00|2023-02-13 23:00:00|
                                       200.0
                                                543.25
                                                         102.8
   115.8
           145.2
                    32.12
                             7.821
                                     4.971
                                                6.471
   0.45|
                3.81
                               1.3
                                           2.47
                                                        1.15
   44.25 | 0.15 |
                36.01
                               NULLI
                                              0.01
                                                        NULLI
                       9.01
                                      23.3
   NULL
    |2023-02-13 23:00:00|2023-02-14 00:00:00|
                                       186.75
                                                 498.01
                                                         80.381
```

| 104.9  12  | 1.13       | 32.0       | 6.42           | 3.99    | 5.47          |          |
|------------|------------|------------|----------------|---------|---------------|----------|
| 0.53       | 4.35       |            | 1.58           |         | 3.05          | 1.4      |
| 45.0  0.2  | 81.5       | 9.0        | NULL           | 23.1    | 3.05 <br>0.0  | NULL     |
| NULL       |            |            |                |         |               |          |
| 2023-02-14 | 19:00:00 2 | 2023-02-14 | 20:00:00       | 116.0   | 433.75        | 85.25    |
|            |            |            |                |         | 10.1          |          |
|            |            |            |                |         |               |          |
| 33 5  0 15 | 1 120 51   | 7 51       | NIII.I.I       | 25 7I   | 0.97 <br>0.0  | NIII.I.I |
| NULL       |            | 1.01       | 11022          | 2011    | 0.01          | 110221   |
|            |            | 2023-02-14 | 21.00.001      | 275 79  | 634.0         | 98 851   |
|            |            |            |                |         |               |          |
| 0.281      | 2 55       | 42.001     | 14.701<br>0 01 | 0.001   | 7.03 <br>1.75 | 0 771    |
| 22 01 0 0  | J.551      | 9 AI       | 0.91<br>MIII I | 05 47 l | 0.0           | O. III   |
| NULL       | 1 52.01    | 0.01       | NOLLI          | 25.47   | 0.01          | NOLLI    |
|            | 00.00.001  | 0002-00-15 | 00.00.001      | 1/5 7   | 5  399.5      | 60 27 l  |
| 100 21 1   | 06.00.0012 | 46 071     | 10 051         | 140.73  | 12.02         | 00.37    |
| 100.3  1   | 06.71      | 40.27      | 10.95          | 2.50    | 12.02         | 0.051    |
|            |            |            |                |         | 1.98  0.0     |          |
|            |            | 99.751     | NOLL           | 24.95   | 0.01          | NOLLI    |
| NULL       |            | 2000 00 45 | 10 00 001      | 400.01  | -1            | 04 001   |
|            |            |            |                |         | 508.25        |          |
|            |            |            |                |         | 43.62         |          |
| 0.4        | 4.25       |            | 1.28           | 2       | 0.01          | 0.881    |
|            | 3  127.75  | 236.75     | NULLI          | 27.081  | 0.01          | NULLI    |
| NULL       |            |            |                |         |               |          |
|            |            |            |                |         | 255.25        |          |
|            |            |            | 51.1           | 1.1     | 63.0          |          |
|            | 3.37       |            | 0.97           |         | 1.58          | 0.73     |
|            | 166.0      | 297.5      | NULL           | 28.25   | 0.01          | NULL     |
| NULL       |            |            |                |         |               |          |
| 2023-02-16 | 10:00:00 2 | 2023-02-16 | 11:00:00       | 103.0   | 258.0         | 20.9     |
| 111.92     | 76.55      | 36.33      | 45.1           | 1.14    | 62.48         |          |
| 0.3        | 2.83       |            | 0.88           | -       | 1.62          | 0.75     |
| 27.75  0.  | 4  183.25  | 229.5      | NULL           | 27.55   | 0.0           | NULL     |
| NULL       |            |            |                |         |               |          |
| 2023-02-16 | 19:00:00 2 | 2023-02-16 | 20:00:00       | 201.25  | 750.0         | 105.95   |
| 108.4  1   | 43.8       | 30.17      | 11.92          | 4.02    | 7.05          |          |
| 0.1        | 2.78       |            | 0.55           |         | 1.2           | 0.57     |
| 39.5  0.12 | 73.5       | 7.25       | NULL           | 26.62   | 0.0           | NULL     |
| NULL       |            |            |                |         |               |          |
| 2023-02-16 | 20:00:00 2 | 2023-02-16 | 21:00:00       | 429.7   | 866.0         | 240.55   |
| 106.67  2  | 52.33      | 42.65      | 15.02          | 7.96    | 8.22          |          |
| 0.28       |            |            | 1.15           |         |               | 1.08     |
|            |            |            |                |         | 0.01          | NULL I   |
| NULL       |            | - ,        | •              | - •     | •             | •        |
|            | 10:00:0012 | 2023-02-17 | 11:00:00       | 77.2!   | 208.25        | 14.281   |
|            |            |            |                |         | 65.28         |          |
| 0.22       |            |            |                |         | 1.55          | 0.7      |
|            |            |            |                |         | 0.01          |          |
| 24.01 0.4  |            |            |                |         |               |          |

```
|2023-02-17 11:00:00|2023-02-17 12:00:00|
                                            89.0|
                                                      235.5|
                                                               16.18
    116.53
            75.13
                       33.91
                                46.331
                                          0.851
                                                     83.91
    0.21
                2.521
                                0.85|
                                               1.4
                                                             0.7|
          0.6 | 159.75 | 347.75
                                                  0.01
                                                             NULLI
    20.51
                                 NULLI
                                        29.65
    NULLI
    |2023-02-17 18:00:00|2023-02-17 19:00:00|
                                            55.01
                                                     287.75
                                                               43.05
    192.38
            137.35
                      26.651
                                15.17
                                          2.041
                                                     38.1
                3.02|
                                0.671
                                               1.27
                                                            0.721
    26.25 | 0.15 | 43.25 |
                                  NULLI
                                         28.671
                                                  0.0
                         NULL
                                                              NULL
    NULL
    |2023-02-17 19:00:00|2023-02-17 20:00:00|
                                           102.5
                                                               60.021
                                                      341.0
                       38.1
            137.57
                                 15.0
                                          4.34
                                                     7.47
                 3.27
                                 0.881
                                                1.6
                                                             188.0
    39.75 | 0.12
                 44.0
                         NULL
                                  NULL
                                         26.981
                                                  0.01
                                                              NULL
    NULL
    |2023-02-17 20:00:00|2023-02-17 21:00:00|
                                          203.25
                                                      592.5
                                                              139.53
                     43.75|
                                         7.21
           194.15
                                14.8
                                                    7.08
    0.31
                3.92
                                1.15
                                               2.35
                                                            1.15
    44.25 | 0.18 | 24.75 |
                         NULL
                                  NULLI
                                         26.451
                                                  0.01
                                                              NULLI
    NULLI
    |2023-02-17 21:00:00|2023-02-17 22:00:00|
                                           268.75
                                                     734.75
                                                              155.25
    120.77
            190.45
                       49.71
                                11.53
                                          7.471
                                                     6.851
                                               3.421
    0.531
                 4.921
                                  1.7
                                                             1.621
    46.75 | 0.12 |
                 183.01
                         NULLI
                                  NULL
                                         25.97
                                                  0.01
                                                              NULLI
    NULL
    |2023-02-17 22:00:00|2023-02-17 23:00:00|
                                          220.75
                                                     657.75
                                                              132.22
                      52.52
                                                     5.85
    107.68
            164.78
                                 9.47
                                          6.24
    0.751
                  5.71
                                 2.08
                                               4.15
                                                             2.081
    42.75 | 0.25 | 185.75 |
                         NULL
                                  NULL
                                         26.12
                                                   0.01
                                                              NULL
    NULL
    +-----
    ______
    _____
    ---+----
    only showing top 20 rows
[45]: // Job 5: Aggregate by sum of SO2
    val sumSO2DF = parquetDF.groupBy("From Date", "To Date").agg(sum("SO2 (ug/m3)").

→as("total_so2"))
    sumSO2DF.show()
    // writeToMySQL(sumSO2DF, "sum so2")
```

NULLI

VBox()

```
FloatProgress(value=0.0, bar_style='info', description='Progress:',u
      →layout=Layout(height='25px', width='50%'),...
    sumSO2DF: org.apache.spark.sql.DataFrame = [From Date: string, To Date: string
    ... 1 more field]
             From Date
                                 To Date
    +----+
     |2023-02-12 00:00:00|2023-02-12 01:00:00|
     |2023-02-09 14:00:00|2023-02-09 15:00:00| 5872.639999999999|
    |2023-01-07 07:00:00|2023-01-07 08:00:00| 4715.539999999999|
     |2022-12-05 19:00:00|2022-12-05 20:00:00|
    |2022-12-23 20:00:00|2022-12-23 21:00:00|
                                                   4735.4
    |2022-12-25 02:00:00|2022-12-25 03:00:00|
                                                   3968.581
    |2022-11-17 03:00:00|2022-11-17 04:00:00| 4462.87000000001|
    |2022-08-07 10:00:00|2022-08-07 11:00:00|
    |2010-10-18 16:00:00|2010-10-18 17:00:00| 81.7400000000001|
    |2010-10-28 22:00:00|2010-10-28 23:00:00|
    |2010-12-11 20:00:00|2010-12-11 21:00:00|117.32000000000002|
    |2010-12-28 10:00:00|2010-12-28 11:00:00|109.82999999999998|
    |2011-01-25 14:00:00|2011-01-25 15:00:00|203.2699999999999|
    |2011-02-08 15:00:00|2011-02-08 16:00:00|
    |2011-05-04 14:00:00|2011-05-04 15:00:00|190.0699999999994|
     |2011-05-21 14:00:00|2011-05-21 15:00:00|208.6400000000007|
     |2011-05-22 23:00:00|2011-05-23 00:00:00|
     |2011-06-26 20:00:00|2011-06-26 21:00:00| 55.22999999999999
    |2011-10-07 08:00:00|2011-10-07 09:00:00|47.169999999999999|
    |2011-12-06 22:00:00|2011-12-06 23:00:00|138.8799999999997|
    +----+
    only showing top 20 rows
[46]: // Job 6: Select specific columns
     val selectColumnsDF = parquetDF.select("From Date", "To Date", "PM10 (ug/m3)", 

¬"NO (ug/m3)")
     selectColumnsDF.show()
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     →layout=Layout(height='25px', width='50%'),...
    selectColumnsDF: org.apache.spark.sql.DataFrame = [From Date: string, To Date:
    string ... 2 more fields]
    +----+
             From Date
                                 To Date | PM10 (ug/m3) | NO (ug/m3) |
    +----+
     |2023-02-10 09:00:00|2023-02-10 10:00:00| 139.5|
                                                          2.45
    |2023-02-10 10:00:00|2023-02-10 11:00:00| 92.25| 1.95|
```

```
|2023-02-10 13:00:00|2023-02-10 14:00:00|
                                        93.5
                                                1.62
    |2023-02-10 14:00:00|2023-02-10 15:00:00|
                                        83.0
                                                1.55
    |2023-02-10 | 15:00:00 | 2023-02-10 | 16:00:00 |
                                        84.01
                                                1.45l
    |2023-02-10 16:00:00|2023-02-10 17:00:00|
                                       86.751
                                                1.581
    |2023-02-10 17:00:00|2023-02-10 18:00:00|
                                        84.0|
                                                 1.6
    |2023-02-10 18:00:00|2023-02-10 19:00:00|
                                       101.75
                                                1.481
    |2023-02-10 19:00:00|2023-02-10 20:00:00|
                                                 1.31
                                       132.0
    |2023-02-10 20:00:00|2023-02-10 21:00:00|
                                       136.01
                                                2.151
    |2023-02-10 21:00:00|2023-02-10 22:00:00|
                                                1.42|
                                       226.25
    |2023-02-10 22:00:00|2023-02-10 23:00:00|
                                                2.05
                                       95.75
                                                2.27
    |2023-02-10 23:00:00|2023-02-11 00:00:00|
                                       94.75
    |2023-02-11 00:00:00|2023-02-11 01:00:00|
                                       129.25
                                                5.05
    |2023-02-11 01:00:00|2023-02-11 02:00:00|
                                       150.25
                                                4.85
    |2023-02-11 02:00:00|2023-02-11 03:00:00|
                                       98.25
                                                1.45 l
    |2023-02-11 03:00:00|2023-02-11 04:00:00|
                                        69.01
                                                4.67
    |2023-02-11 04:00:00|2023-02-11 05:00:00|
                                       90.75
                                                7.571
    +-----
    only showing top 20 rows
[47]: // Job 7: Filter by CO2 range
    val filterCO2DF = parquetDF.filter(\mbox{"CO (mg/m3)"} >= 300 \&\& \mbox{"CO (mg/m3)"} <= 400)
    filterCO2DF.show()
    // writeToMySQL(filterCO2DF, "filtered_co2")
    VBox()
    FloatProgress(value=0.0, bar style='info', description='Progress:',
     →layout=Layout(height='25px', width='50%'),...
    filterCO2DF: org.apache.spark.sql.Dataset[org.apache.spark.sql.Row] = [From
    Date: string, To Date: string ... 23 more fields]
    +----+
    ____+___
    ______
                            To Date | PM2.5 (ug/m3) | PM10 (ug/m3) | NO
            From Date
    1
    (ug/m3)|NO2 (ug/m3)|NOx (ppb)|NH3 (ug/m3)|SO2 (ug/m3)|CO (mg/m3)|Ozone
    (ug/m3)|Benzene (ug/m3)|Toluene (ug/m3)|Eth-Benzene (ug/m3)|MP-Xylene (ug/m3)|O
    Xylene (ug/m3)|Temp (degree C)|RH (%)|WS (m/s)|WD (deg)|SR (W/mt2)|BP (mmHg)|VWS
    (m/s)|Xylene (ug/m3)|AT (degree C)|
    +-----
    ______
```

96.51

115.0

1.781

1.6

|2023-02-10 11:00:00|2023-02-10 12:00:00|

|2023-02-10 12:00:00|2023-02-10 13:00:00|

---+----+

| 44.6  8.15<br>58.0                   | 0.21<br>2.73    | 17.78 <br>174.7! | 336.0 <br>5  48 | 36.8 <br>NULL <br>34.25 | NULL <br>706.0 |
|--------------------------------------|-----------------|------------------|-----------------|-------------------------|----------------|
|                                      | 0.0             | NULL  NU         | LL  NULL        | NULL                    |                |
| NULL                                 |                 |                  | 0.0             |                         | 4 051          |
| 12020-08-23 02                       | 2:00:00 2020-08 | 3-23 03:00:00    | 2.0             | 1.88 <br>NULL           | 4.35           |
| 3.00  0.93<br>92.5                   | 0.241<br>2.071  | 10.01            | 349.31<br>Ni    | J UI<br>MOTT!           | 707 01         |
| 02.51                                | 2.07 J          | MIII I MIII      | JI NIIITI       | 2.0 <br>NULL            | 707.01         |
| NULL                                 | 00.01           | NOLL NOL         | ri Morri        | NOLL                    |                |
| 12020-08-25 02                       | 2:00:00 2020-08 | 8-25 03:00:001   | 1.5             | 2.83                    | 11.38          |
| 8.35  1.33                           | 0.16            | 11.65            | 338.1           | NULL                    | NULL           |
| 79.25                                | 2.0             | 226.2            | 25              | 2.0                     | 708.25         |
|                                      |                 |                  |                 | NULL                    |                |
| NULL                                 |                 |                  |                 |                         |                |
|                                      |                 |                  |                 | 1.05                    |                |
|                                      |                 |                  |                 | NULL                    |                |
|                                      |                 |                  |                 | 2.0                     |                |
|                                      | 273.42          | NULL  NU         | LL  NULL        | NULL                    |                |
| NULL                                 | , 00 0010040 05 |                  | NIII T          | 0.661                   | 00.051         |
|                                      |                 |                  |                 | 9.66 <br>NULL           |                |
| MIII I                               | л мити Г        | MIII I           | 313.211         | литі І                  | 30 831         |
| NULLI<br>NULLI   183 43              | 87 051 736      | 31 736 31        | 736 31          | NULL <br>736.3          | 736 31         |
| 736.3                                | 01.001 100.     | 700.01           | 700.01          | 100.01                  | 100.01         |
| 12018-05-06 08                       | 8:00:00 2018-05 | 5-06 09:00:00    | NULL            | 9.09                    | 21.65          |
| 16.49  NUL                           | .L  0.0         | NULL             | 311.65          | NULL                    |                |
| NULL                                 | NULL            | NULL             | 1               | NULL                    | 30.55          |
| NULL  20.05                          | 358.3  735.9    | 735.93           | 735.93          | 735.93                  | 735.93         |
| 735.93                               |                 |                  |                 |                         |                |
| 2013-02-28 03                        | 3:00:00 2013-02 | 2-28 04:00:00    | NULL            | 128.0                   | 128.0          |
| 128.0  128.                          |                 |                  |                 |                         |                |
|                                      |                 |                  |                 | 7.83                    |                |
|                                      | 0.13  0.        | OI NULLI         | NULLI           | NULL                    | NULLI          |
| NULL                                 | .00.001201E 06  | 2 00 15.00.001   | NIIIT T         | 27.97                   | 14 E21         |
|                                      |                 |                  |                 | NULL                    |                |
|                                      |                 |                  |                 | NOLL  <br>392.74        |                |
| -0.03   190.27                       | 'l NULL.        | NUT.T.I N        | UT.T.I NUT.T.   | NULL                    | .l             |
| NULL                                 | ,               |                  |                 |                         |                |
| 12020-12-25 18                       | 8:00:00 2020-12 | 2-25 19:00:00    | 255.25          | 87.83                   | 136.55         |
| 144.02  20.                          | 87  4.11        | 65.37            | 315.13          | 7.3                     |                |
| 144.02  20.<br>NULL <br>750.5  -0.11 | 94.0            | 0.3              | 14              | 11.5                    | 7.0            |
| 750.5  -0.11                         | 18.05  18.      | 27  NULL         | NULL            | NULL                    | NULL           |
| NULL                                 |                 |                  |                 |                         |                |
| 2018-11-22 20                        | 0:00:00 2018-11 | -22 21:00:00     | 63.33           | 175.4                   | NULL           |
|                                      |                 |                  |                 | 40.49                   |                |
| NULL                                 | NULL            | NULI             | Ll              | NULL                    | NULL           |

|                                                                                                                                                                                                                  | NULL                                                                               | 65.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 42.2                                                                                                | 21  1.2                                                                                                                           | NUL                                                                                                      | L  NULL                                                                                                            |                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| 2018-                                                                                                                                                                                                            | 11-22 23:                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | 19  145.55                                                                                                         |                                                                                                               |
| NUI.I.I                                                                                                                                                                                                          | NOLL                                                                               | NUT.T. I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 00.001                                                                                              | NUI.I.                                                                                                                            | 017.02                                                                                                   | 21.8 <br>NULL                                                                                                      | NULL.                                                                                                         |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | NULL                                                                                                               |                                                                                                               |
| NULL                                                                                                                                                                                                             |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ·                                                                                                   | ·                                                                                                                                 | ·                                                                                                        | ·                                                                                                                  | ·                                                                                                             |
| 2018-                                                                                                                                                                                                            | 11-27 07:                                                                          | 00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 18-11-27                                                                                            | 08:00:00                                                                                                                          | 66                                                                                                       | .3  144.08                                                                                                         | NULL                                                                                                          |
| 11.87                                                                                                                                                                                                            | NULL                                                                               | .  2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 20.98                                                                                               | 10.32                                                                                                                             | 311.88                                                                                                   | 25.67                                                                                                              |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | NULL                                                                                                               |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    | NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 110.0                                                                                               | 24.25                                                                                                                             | 1.45                                                                                                     | NULL                                                                                                               | NULL                                                                                                          |
| NULL                                                                                                                                                                                                             |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          |                                                                                                                    |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | 52  136.66                                                                                                         |                                                                                                               |
| 11.19                                                                                                                                                                                                            | NULL                                                                               | .  3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 31.83                                                                                               | 16.15                                                                                                                             | 305.54                                                                                                   | 12.51                                                                                                              |                                                                                                               |
| NULL                                                                                                                                                                                                             |                                                                                    | NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 445.01                                                                                              | NULL                                                                                                                              | 4 001                                                                                                    | NULL <br>NULL                                                                                                      | NULL                                                                                                          |
|                                                                                                                                                                                                                  |                                                                                    | NULLI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 145.0                                                                                               | 40.831                                                                                                                            | 1.38                                                                                                     | NULL                                                                                                               | NULLI                                                                                                         |
|                                                                                                                                                                                                                  | 10 02 00.                                                                          | 00.00100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 10 10 00                                                                                            | 01.00.001                                                                                                                         | 40                                                                                                       | 43  137.88                                                                                                         | NITT T I                                                                                                      |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | 14.78                                                                                                              |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | NULL                                                                                                               |                                                                                                               |
| MIIII                                                                                                                                                                                                            | MIII I I                                                                           | NOT<br>NIII I I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 30 1<br>احت                                                                                         | NOLL<br>141 5.0                                                                                                                   | i<br>Mili                                                                                                | L   NULL                                                                                                           | NOLLI                                                                                                         |
| NULL                                                                                                                                                                                                             |                                                                                    | NOLL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 00.1                                                                                                | 0.0                                                                                                                               | NOL                                                                                                      |                                                                                                                    |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    | 00:00120                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | )18-12-23                                                                                           | 02:00:001                                                                                                                         | 47.3                                                                                                     | 34  127.87                                                                                                         | NULLI                                                                                                         |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | 10.11                                                                                                              |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | NULL                                                                                                               |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     | 11000                                                                                                                             |                                                                                                          | 110111                                                                                                             |                                                                                                               |
|                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                     |                                                                                                                                   |                                                                                                          | NULL                                                                                                               |                                                                                                               |
| NULL <br>NULL                                                                                                                                                                                                    | NULL                                                                               | NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | NULL                                                                                                | 36.46                                                                                                                             | 5.2                                                                                                      | NULL                                                                                                               | NULL                                                                                                          |
| NULL <br>NULL                                                                                                                                                                                                    | NULL                                                                               | NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | NULL                                                                                                | 36.46                                                                                                                             | 5.2                                                                                                      |                                                                                                                    | NULL                                                                                                          |
| NULL <br>NULL <br> 2018-<br>51.08                                                                                                                                                                                | NULL <br>12-23 04:<br>NULL                                                         | NULL <br>00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | NULL  018-12-23 07.45                                                                               | 36.46 <br>05:00:00 <br>11.15                                                                                                      | 5.2 <br>48.4<br>327.01                                                                                   | NULL  48  82.24  7.04                                                                                              | NULL                                                                                                          |
| NULL <br>NULL <br> 2018-<br>51.08 <br>NULL                                                                                                                                                                       | NULL <br>12-23 04:<br>NULL                                                         | NULL  00:00 20 .  E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | NULL <br>018-12-23<br>57.45                                                                         | 36.46 <br>05:00:00 <br>11.15 <br>NULL                                                                                             | 5.2 <br>48.4<br>327.01                                                                                   | NULL  48  82.24  7.04  NULL                                                                                        | NULL   NULL                                                                                                   |
| NULL  NULL   2018- 51.08  NULL  NULL                                                                                                                                                                             | NULL  12-23 04: NULL NULL                                                          | NULL  00:00 20 .  E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | NULL <br>018-12-23<br>57.45                                                                         | 36.46 <br>05:00:00 <br>11.15 <br>NULL                                                                                             | 5.2 <br>48.4<br>327.01                                                                                   | NULL  48  82.24  7.04                                                                                              | NULL   NULL                                                                                                   |
| NULL  NULL   2018- 51.08  NULL  NULL  NULL                                                                                                                                                                       | NULL  12-23 04: NULL NULL                                                          | NULL <br>00:00 20<br>.  5<br>NULL <br>NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | NULL <br>018-12-23<br>57.45 <br>NULL                                                                | 36.46 <br>05:00:00 <br>11.15 <br>NULL <br>31.29                                                                                   | 5.2 <br>48.4<br>327.01 <br>2.36                                                                          | NULL  48  82.24  7.04  NULL  NULL                                                                                  | NULL    NULL    NULL                                                                                          |
| NULL  NULL   2018- 51.08  NULL  NULL  NULL   2018-                                                                                                                                                               | NULL  12-23 04: NULL  NULL  12-23 21:                                              | NULL   00:00 20 .  E NULL   NULL   00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | NULL   018-12-23 57.45   NULL   018-12-23                                                           | 36.46 <br>05:00:00 <br>11.15 <br>NULL <br>31.29 <br>22:00:00                                                                      | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0                                                                 | NULL  48  82.24  7.04  NULL  NULL  65  155.48                                                                      | NULL    NULL    NULL                                                                                          |
| NULL  NULL   2018- 51.08  NULL  NULL  NULL   2018- 24.46                                                                                                                                                         | NULL  12-23 04: NULL  NULL  12-23 21: NULL                                         | NULL   00:00   20   1   1   1   1   1   1   1   1   1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | NULL   018-12-23 07.45   NULL   018-12-23 04.75                                                     | 36.46  05:00:00  11.15  NULL  31.29  22:00:00  16.14                                                                              | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01                                                       | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22                                                                | NULL    NULL    NULL    NULL                                                                                  |
| NULL  NULL   2018- 51.08  NULL  NULL  NULL   2018- 24.46  NULL                                                                                                                                                   | NULL  12-23 04: NULL  NULL  12-23 21: NULL                                         | NULL   00:00   20 .   E NULL   NULL   00:00   20 .   E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | NULL   018-12-23 57.45   NULL   018-12-23 54.75                                                     | 36.46  05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL                                                                       | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01                                                       | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL                                                          | NULL    NULL    NULL    NULL    NULL                                                                          |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  2018- 24.46  NULL  NULL                                                                                                                                              | NULL  12-23 04: NULL  NULL  12-23 21: NULL                                         | NULL   00:00   20 .   E NULL   NULL   00:00   20 .   E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | NULL   018-12-23 57.45   NULL   018-12-23 54.75                                                     | 36.46  05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL                                                                       | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01                                                       | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22                                                                | NULL    NULL    NULL    NULL    NULL                                                                          |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  12018- 24.46  NULL  NULL  NULL  NULL                                                                                                                                 | NULL  12-23 04: NULL  NULL  12-23 21: NULL                                         | NULL   00:00 20 .  5 NULL   NULL   00:00 20 .  5 NULL   NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | NULL  018-12-23 07.45  NULL  018-12-23 04.75  NULL                                                  | 36.46  05:00:00  11.15  NULL  31.29  22:00:00  16.14  NULL  44.64                                                                 | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7                                               | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL                                                    | NULL    NULL    NULL    NULL    NULL    NULL                                                                  |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  12018- 24.46  NULL  NULL  NULL  NULL  NULL  NULL                                                                                                                     | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  12-23 22:                        | NULL   00:00 20   E NULL   NULL   00:00 20   E NULL   NULL   NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | NULL  018-12-23 07.45  NULL  018-12-23 04.75  NULL  018-12-23                                       | 36.46  05:00:00  11.15  NULL  31.29  22:00:00  16.14  NULL  44.64  23:00:00                                                       | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.4<br>327.01 <br>1.7 <br>52.8                                      | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL                                              | NULL    NULL    NULL    NULL    NULL    NULL                                                                  |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  24.46  NULL  NULL  NULL  NULL  NULL  48.95                                                                                                                           | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  12-23 22: NULL                   | NULL   00:00 20 .  E NULL   00:00 20 .  E NULL   NULL   00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | NULL   018-12-23 57.45   NULL   018-12-23 54.75   NULL   018-12-23 55.77                            | 36.46  05:00:00  11.15  NULL  31.29  22:00:00  16.14  NULL  44.64  23:00:00  16.47                                                | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.8<br>392.2                             | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  157.54  10.16                               | NULL    NULL    NULL    NULL    NULL    NULL    NULL                                                          |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  12018- 24.46  NULL  NULL  NULL  12018- 48.95  NULL                                                                                                                   | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  12-23 22: NULL                   | NULL   00:00 20 .  5 NULL   00:00 20 .  5 NULL   NULL   00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | NULL   018-12-23 57.45   NULL   018-12-23 54.75   NULL   018-12-23 55.77                            | 36.46   05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL  44.64   23:00:00  16.47  NULL                                       | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.8<br>392.2                             | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  157.54  10.16  NULL                         | NULL    NULL    NULL    NULL    NULL    NULL    NULL    NULL                                                  |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  12018- 24.46  NULL                                                         | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  12-23 22: NULL                   | NULL   00:00 20 .  5 NULL   00:00 20 .  5 NULL   NULL   00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | NULL   018-12-23 57.45   NULL   018-12-23 54.75   NULL   018-12-23 55.77                            | 36.46   05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL  44.64   23:00:00  16.47  NULL                                       | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.8<br>392.2                             | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  157.54  10.16                               | NULL    NULL    NULL    NULL    NULL    NULL    NULL    NULL                                                  |
| NULL  NULL  12018- 51.08  NULL                                                                 | NULL   12-23 04:                                                                   | NULL   00:00 20 .  E NULL   00:00 20 .  E NULL   NULL   00:00 20 .  E NULL   NULL   NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | NULL   018-12-23 57.45   NULL   018-12-23 54.75   NULL   018-12-23 55.77   NULL                     | 36.46  05:00:00  11.15  NULL  31.29  22:00:00  16.14  NULL  44.64  23:00:00  16.47  NULL  44.99                                   | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.8<br>392.2 <br>4.62                    | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  157.54  10.16  NULL                         | NULL    NULL    NULL    NULL    NULL    NULL    NULL    NULL    NULL                                          |
| NULL  NULL  12018- 51.08  NULL                                                                 | NULL   12-23 04:                                                                   | NULL   00:00 20 .  E NULL   00:00 20 .  E NULL   00:00 20 .  E NULL   00:00 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | NULL   018-12-23 67.45   NULL   018-12-23 64.75   NULL   018-12-23 65.77   NULL   018-12-24         | 36.46   05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL  44.64   23:00:00  16.47  NULL  44.99   00:00:00                     | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.3<br>392.2 <br>4.62 <br>58.3           | NULL  48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  10.16  NULL  NULL  NULL                     | NULL                             |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  12018- 24.46  NULL  NULL  NULL  NULL  12018- 48.95  NULL                                           | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  NULL  NULL  12-23 22: NULL       | NULL    00:00 20 .  E  NULL    00:00 20 .  E  NULL    NULL    NULL    00:00 20 .  E  NULL    NULL | NULL  018-12-23 07.45  NULL  018-12-23 04.75  NULL  018-12-23 05.77  NULL  018-12-24 065  LL        | 36.46   05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL  44.64   23:00:00  16.47  NULL  44.99   00:00:00  17.66  NULL        | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.8<br>392.2 <br>4.62 <br>58.3<br>372.22 | NULL   48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  NULL  32  138.62  22.12  NULL              | NULL        |
| NULL  NULL  12018- 51.08  NULL  NULL  NULL  12018- 24.46  NULL  NULL  NULL  NULL  12018- 48.95  NULL                                           | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  NULL  NULL  12-23 22: NULL       | NULL    00:00 20 .  E  NULL    00:00 20 .  E  NULL    NULL    NULL    00:00 20 .  E  NULL    NULL | NULL  018-12-23 07.45  NULL  018-12-23 04.75  NULL  018-12-23 05.77  NULL  018-12-24 065  LL        | 36.46   05:00:00  11.15  NULL  31.29   22:00:00  16.14  NULL  44.64   23:00:00  16.47  NULL  44.99   00:00:00  17.66  NULL        | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.0<br>327.01 <br>1.7 <br>52.8<br>392.2 <br>4.62 <br>58.3<br>372.22 | NULL   48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  NULL  10.16  NULL  NULL  32  138.62  22.12 | NULL        |
| NULL  NULL | NULL  12-23 04: NULL  NULL  12-23 21: NULL  NULL  12-23 22: NULL  NULL  NULL  NULL | NULL    00:00 20  NULL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | NULL  018-12-23 07.45  NULL  018-12-23 04.75  NULL  018-12-23 05.77  NULL  018-12-24 055  LL  037.0 | 36.46  05:00:00  11.15  NULL  31.29  22:00:00  16.14  NULL  44.64   23:00:00  16.47  NULL  44.99   00:00:00  17.66  NULL  01  2.0 | 5.2 <br>48.4<br>327.01 <br>2.36 <br>37.4<br>327.01 <br>1.7 <br>52.8<br>392.2 <br>4.62 <br>58.3<br>372.22 | NULL   48  82.24  7.04  NULL  NULL  65  155.48  8.22  NULL  NULL  NULL  NULL  32  138.62  22.12  NULL              | NULL   NULL |

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       ______
    only showing top 20 rows
[50]: // Job 8: Aggregate by max NO
     val maxNODF = parquetDF.groupBy("From Date", "To Date").agg(max("NO (ug/m3)").
      →as("max no"))
     maxNODF.show()
    VBox()
    FloatProgress(value=0.0, bar_style='info', description='Progress:',u
     ⇒layout=Layout(height='25px', width='50%'),...
    maxNODF: org.apache.spark.sql.DataFrame = [From Date: string, To Date: string
    ... 1 more field]
             From Date
                                To Date | max_no |
    +----+
    |2010-01-01 12:00:00|2010-01-01 13:00:00|
    |2010-01-01 14:00:00|2010-01-01 15:00:00| 6.83|
    |2010-01-05 06:00:00|2010-01-05 07:00:00| 53.31|
    |2010-01-05 17:00:00|2010-01-05 18:00:00|
    |2010-01-07 20:00:00|2010-01-07 21:00:00|
                                        7.31
    |2010-01-08 03:00:00|2010-01-08 04:00:00|
    |2010-01-10 08:00:00|2010-01-10 09:00:00|
                                        8.941
    |2010-01-10 19:00:00|2010-01-10 20:00:00|
                                       7.981
    |2010-01-10 22:00:00|2010-01-10 23:00:00| 82.13|
    |2010-01-11 06:00:00|2010-01-11 07:00:00|
                                        9.64
    |2010-01-11 14:00:00|2010-01-11 15:00:00|
                                        7.46
    |2010-01-11 16:00:00|2010-01-11 17:00:00|
                                        9.371
    |2010-01-19 19:00:00|2010-01-19 20:00:00|
    |2010-01-23 02:00:00|2010-01-23 03:00:00|
                                        88.21
    |2010-01-23 16:00:00|2010-01-23 17:00:00|
                                         9.51
    |2010-01-24 02:00:00|2010-01-24 03:00:00| 87.68|
    |2010-01-24 22:00:00|2010-01-24 23:00:00| 74.25|
    |2010-01-25 01:00:00|2010-01-25 02:00:00|
    |2010-01-25 02:00:00|2010-01-25 03:00:00| 58.25|
    |2010-01-28 14:00:00|2010-01-28 15:00:00| 7.83|
    +----+
    only showing top 20 rows
```

```
[52]: // Job 9: Aggregate by min PM10
     val minPM10DF = parquetDF.groupBy("From Date", "To Date").agg(min("PM10 (ug/
      →m3)").as("min_pm10"))
     minPM10DF.show()
     VBox()
     FloatProgress(value=0.0, bar style='info', description='Progress:',u
      →layout=Layout(height='25px', width='50%'),...
     minPM10DF: org.apache.spark.sql.DataFrame = [From Date: string, To Date: string
     ... 1 more field]
     +----+
               From Date
                                   To Date|min pm10|
     +----+
     |2010-01-01 12:00:00|2010-01-01 13:00:00|
                                               NULLI
     |2010-01-01 14:00:00|2010-01-01 15:00:00|
                                               NULL
     |2010-01-05 06:00:00|2010-01-05 07:00:00|
                                               NULL
     |2010-01-05 17:00:00|2010-01-05 18:00:00|
                                               NULL
     |2010-01-07 20:00:00|2010-01-07 21:00:00|
                                               NULL
     |2010-01-08 03:00:00|2010-01-08 04:00:00|
                                               NULL|
     |2010-01-10 08:00:00|2010-01-10 09:00:00|
                                               NULL
     |2010-01-10 19:00:00|2010-01-10 20:00:00|
                                               NULL
     |2010-01-10 22:00:00|2010-01-10 23:00:00|
                                               NULL
     |2010-01-11 06:00:00|2010-01-11 07:00:00|
                                               NULL
     |2010-01-11 14:00:00|2010-01-11 15:00:00|
                                               NULL
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                                               NULL
     |2010-01-19 19:00:00|2010-01-19 20:00:00|
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     |2010-01-23 02:00:00|2010-01-23 03:00:00|
                                               NULL
     |2010-01-23 16:00:00|2010-01-23 17:00:00|
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     |2010-01-24 02:00:00|2010-01-24 03:00:00|
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     |2010-01-24 22:00:00|2010-01-24 23:00:00|
                                               NULL
     |2010-01-25 01:00:00|2010-01-25 02:00:00|
                                               NULL
     |2010-01-25 02:00:00|2010-01-25 03:00:00|
                                               NULL
     |2010-01-28 14:00:00|2010-01-28 15:00:00|
                                               NULL
     +----+
     only showing top 20 rows
[53]: // Job 10: Filter by low SO2 levels
     val lowSO2DF = parquetDF.filter($"SO2 (ug/m3)" < 50)</pre>
     lowSO2DF.show()
     //
     // writeToMySQL(lowSO2DF, "low_so2")
```

VBox()

→layout=Layout(height='25px', width='50%'),... lowSO2DF: org.apache.spark.sql.Dataset[org.apache.spark.sql.Row] = [From Date: string, To Date: string ... 23 more fields] +------\_\_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_\_ ---+----+ To Date | PM2.5 (ug/m3) | PM10 (ug/m3) | NO ı From Date (ug/m3)|NO2 (ug/m3)|NOx (ppb)|NH3 (ug/m3)|SO2 (ug/m3)|CO (mg/m3)|Ozone (ug/m3)|Benzene (ug/m3)|Toluene (ug/m3)|Eth-Benzene (ug/m3)|MP-Xylene (ug/m3)|O Xylene (ug/m3)|Temp (degree C)|RH (%)|WS (m/s)|WD (deg)|SR (W/mt2)|BP (mmHg)|VWS (m/s)|Xylene (ug/m3)|AT (degree C)| +-----\_\_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_\_ |2023-02-10 09:00:00|2023-02-10 10:00:00| 40.0 139.5 2.45 7.95 6.25 14.55 0.31 61.85 0.1 19.45 0.2 NULL NULL NULL 1.85 239.51 219.0 NULL 25.65 0.01 NULL | NULL |2023-02-10 10:00:00|2023-02-10 11:00:00| 18.75 92.25 1.95 5.881 4.67 21.62 15.1 0.29 64.92 0.01 0.2 NULL NULL NULL 56.25 2.12 241.0 236.51 NULL 26.18 0.01 NULL NULL |2023-02-10 11:00:00|2023-02-10 12:00:00| 13.25 96.51 1.78 4.281 23.61 14.18 0.271 5.35l 66.17 l 0.01 0.21 NULLI NULL NULL 53.251 1.95 251.0 264.5 NULL 26.91 0.01 NULL NULLI |2023-02-10 12:00:00|2023-02-10 13:00:00| 15.25 115.0 1.6 5.0 3.97 24.45 13.05 0.261 70.331 0.01 0.21 NULL NULL NULL 48.5 1.75 | 238.75 | 175.75 | NULL 27.55 0.0 NULL | NULL |2023-02-10 13:00:00|2023-02-10 14:00:00| 18.5 93.5 1.62 5.4214.231 24.61 11.62 0.27 71.47 0.01 0.21 NULL NULL NULL 45.0| 1.95 248.0| 266.25| 0.01 NULL NULL 28.0 NULL |2023-02-10 14:00:00|2023-02-10 15:00:00| 12.01 83.01 1.55 4.47 3.621 25.931 8.721 0.271 73.61 0.01 0.2 NULL NULL NULL 40.75

FloatProgress(value=0.0, bar\_style='info', description='Progress:',u

|                                                                                                                          |                                                                                                          | 235.25                                                                                                                       | l NUI                                                                                                               | LL  28.45                                                                                                | 0.0                                                              | NULL                                                                                                                                               | I                                                        |
|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
|                                                                                                                          | -02-10 15                                                                                                | .00.0012                                                                                                                     | 002_00_10                                                                                                           | 16.00.001                                                                                                | 11 7                                                             | 5  84.0                                                                                                                                            | 1 /5                                                     |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 76.92                                                                                                                                              |                                                          |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | NULL                                                                                                                                               |                                                          |
| 0.21<br>1 73 l                                                                                                           | 241 51                                                                                                   | 185.5                                                                                                                        | LI MITT                                                                                                             | .tl                                                                                                      | 1 00                                                             | NULL                                                                                                                                               | 39.01<br>I                                               |
| NULL                                                                                                                     |                                                                                                          | 100.0                                                                                                                        | 1 1101                                                                                                              | 20.07                                                                                                    | 0.0                                                              | I NOLL                                                                                                                                             | 1                                                        |
|                                                                                                                          |                                                                                                          | .00.0012                                                                                                                     | 023-02-10                                                                                                           | 17.00.001                                                                                                | 10.2                                                             | 5  86.75                                                                                                                                           | 1 581                                                    |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 79.83                                                                                                                                              |                                                          |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | NULL                                                                                                                                               |                                                          |
| 1 71                                                                                                                     | 240 51                                                                                                   | 126 01                                                                                                                       | □I<br>MIII I                                                                                                        | 1 28 671                                                                                                 | 0.01                                                             | NULL                                                                                                                                               | 00.01                                                    |
| NULL                                                                                                                     |                                                                                                          | 120.01                                                                                                                       | NOLI                                                                                                                | 20.071                                                                                                   | 0.01                                                             | MOLLI                                                                                                                                              |                                                          |
|                                                                                                                          |                                                                                                          | .00.0012                                                                                                                     | 023-02-10                                                                                                           | 18.00.001                                                                                                | 13                                                               | 5  84.0                                                                                                                                            | 1.61                                                     |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 80.42                                                                                                                                              |                                                          |
| 0.701                                                                                                                    | 4.00                                                                                                     | NIII                                                                                                                         | σ.10 <br>Γ                                                                                                          | 0 031                                                                                                    | 0.551                                                            | MIII I                                                                                                                                             | 42 75 l                                                  |
| 0.21                                                                                                                     | 210 251                                                                                                  | 73 0                                                                                                                         | LI MITT                                                                                                             | 75 25 33 33 33 33 33 33 33 33 33 33 33 33 33                                                             | 1 00                                                             | NULL   NULL                                                                                                                                        | 42.70)<br>                                               |
| 0.901<br>MIII I                                                                                                          | 210.201                                                                                                  | 75.0                                                                                                                         | 1 1101                                                                                                              | LL  20.00                                                                                                | 0.0                                                              | I NOTE                                                                                                                                             | 1                                                        |
|                                                                                                                          |                                                                                                          | .00.0012                                                                                                                     | 023-02-10                                                                                                           | 19.00.001                                                                                                | 20                                                               | 0  101.75                                                                                                                                          | 1 481                                                    |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 67.52                                                                                                                                              |                                                          |
| 0 01                                                                                                                     | 1.                                                                                                       | 01<br>0 21                                                                                                                   | 21.12                                                                                                               | 0.11                                                                                                     | 0.41                                                             | 0.1                                                                                                                                                | NIII I I                                                 |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 0.0                                                                                                                                                |                                                          |
| NULL                                                                                                                     |                                                                                                          | 201.01                                                                                                                       | 00.701                                                                                                              | NOLL                                                                                                     | 27.001                                                           | 0.01                                                                                                                                               | NOLLI                                                    |
|                                                                                                                          |                                                                                                          | .00.0012                                                                                                                     | 023-02-10                                                                                                           | 20.00.001                                                                                                | 22                                                               | 0  132.0                                                                                                                                           | 1 31                                                     |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 53.25                                                                                                                                              |                                                          |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  | 0.1                                                                                                                                                |                                                          |
|                                                                                                                          |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  |                                                                                                                                                    |                                                          |
| 02.201                                                                                                                   | () 381                                                                                                   | 200 751                                                                                                                      | 53 01                                                                                                               | MIII I I                                                                                                 | 26 951                                                           | 0 01                                                                                                                                               | MIII I                                                   |
|                                                                                                                          |                                                                                                          | 200.75                                                                                                                       | 53.01                                                                                                               | NULL                                                                                                     | 26.95                                                            | 0.0                                                                                                                                                | NULL                                                     |
| NULL                                                                                                                     |                                                                                                          |                                                                                                                              |                                                                                                                     |                                                                                                          |                                                                  |                                                                                                                                                    |                                                          |
| NULL <br> 2023-                                                                                                          | -02-10 20                                                                                                | :00:00 2                                                                                                                     | 023-02-10                                                                                                           | 21:00:00                                                                                                 | 24.                                                              | 5  136.0                                                                                                                                           | 2.15                                                     |
| NULL <br> 2023-<br>49.15                                                                                                 | -02-10 20<br>27.8                                                                                        | :00:00 2                                                                                                                     | 023-02-10<br>20.4                                                                                                   | 21:00:00                                                                                                 | 24.<br>0.83                                                      | 5  136.0 <br>21.0                                                                                                                                  | 2.15                                                     |
| NULL <br> 2023-<br>49.15 <br>0.12                                                                                        | -02-10 20<br>27.8                                                                                        | :00:00 2<br>8 <br>0.75                                                                                                       | 023-02-10<br>20.4                                                                                                   | 21:00:00 <br>6.93 <br>0.38                                                                               | 24.<br>0.83                                                      | 5  136.0 <br>21.0 <br>0.45                                                                                                                         | 2.15 <br>0.1                                             |
| NULL <br> 2023-<br>49.15 <br>0.12 <br>55.0                                                                               | -02-10 20<br>27.8<br>0.35                                                                                | :00:00 2<br>8 <br>0.75                                                                                                       | 023-02-10<br>20.4                                                                                                   | 21:00:00 <br>6.93 <br>0.38                                                                               | 24.<br>0.83                                                      | 5  136.0 <br>21.0                                                                                                                                  | 2.15 <br>0.1                                             |
| NULL   2023- 49.15  0.12  55.0  NULL                                                                                     | -02-10 20<br>27.8<br>0.35                                                                                | :00:00 2<br>8 <br>0.75 <br>216.0                                                                                             | 023-02-10<br>20.4 <br>53.0                                                                                          | 21:00:00 <br>6.93 <br>0.38 <br>NULL                                                                      | 24.<br>0.83 <br>26.58                                            | 5  136.0 <br>21.0 <br>0.45 <br>0.0                                                                                                                 | 2.15 <br>0.1 <br>NULL                                    |
| NULL <br> 2023-<br>49.15 <br>0.12 <br>55.0 <br>NULL <br> 2023-<br>22.15                                                  | -02-10 20<br>27.8<br>0.35 <br>-02-10 21                                                                  | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2                                                                                | 023-02-10<br>20.4 <br>53.0 <br>023-02-10                                                                            | 21:00:00 <br>6.93 <br>0.38 <br>NULL <br>22:00:00                                                         | 24.<br>0.83 <br>26.58 <br>41.7                                   | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25                                                                                                   | 2.15 <br>0.1 <br>NULL <br>1.42                           |
| NULL <br> 2023-<br>49.15 <br>0.12 <br>55.0 <br>NULL <br> 2023-<br>22.15                                                  | -02-10 20<br>27.8<br>0.35 <br>-02-10 21                                                                  | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2                                                                                | 023-02-10<br>20.4 <br>53.0 <br>023-02-10                                                                            | 21:00:00 <br>6.93 <br>0.38 <br>NULL <br>22:00:00                                                         | 24.<br>0.83 <br>26.58 <br>41.7                                   | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25                                                                                                   | 2.15 <br>0.1 <br>NULL <br>1.42                           |
| NULL <br> 2023-<br>49.15 <br>0.12 <br>55.0 <br>NULL <br> 2023-<br>22.15 <br>0.12                                         | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9                                                          | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82                                                                  | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15                                                                   | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05                                                         | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48                           | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05                                                                                | 2.15 <br>0.1 <br>NULL <br>1.42 <br>0.3                   |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75                                                          | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4                                                   | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82                                                                  | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15                                                                   | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05                                                         | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48                           | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25                                                                                                   | 2.15 <br>0.1 <br>NULL <br>1.42 <br>0.3                   |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL                                                    | 0.35<br>0.35<br>0.27.8<br>0.35<br>0.2-10 21<br>12.9                                                      | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0                                                        | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25                                                         | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL                                                   | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48 <br>26.4                  | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0                                                                        | 2.15 <br>0.1 <br>NULL <br>1.42 <br>0.3 <br>NULL          |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023-                                            | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4                                                   | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2                                           | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10                                           | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00                                        | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48 <br>26.4 <br>23.7         | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75                                                           | 2.15 <br>0.1 <br>NULL <br>1.42 <br>0.3 <br>NULL          |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42                                      | 0.35   0.35   0.35   0.4   0.4   0.2 - 10 22 15.                                                         | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2                                           | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77                                  | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7                                   | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48 <br>26.4 <br>23.7<br>0.51 | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43                                                 | 2.15 <br>0.1 <br>NULL <br>1.42 <br>0.3 <br>NULL <br>2.05 |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0                                 | 0.35 <br>0.35 <br>0.2-10 21<br>12.9<br>0.4 <br>-02-10 22<br>15.                                          | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45                             | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77                                  | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05                             | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48 <br>26.4 <br>23.7<br>0.51 | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43 <br>0.1                                         | 2.15  0.1  NULL  1.42  0.3  NULL  2.05                   |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0                                 | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4 <br>-02-10 22<br>15.                              | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45                             | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77                                  | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05                             | 24.<br>0.83 <br>26.58 <br>41.7<br>0.48 <br>26.4 <br>23.7<br>0.51 | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43                                                 | 2.15  0.1  NULL  1.42  0.3  NULL  2.05                   |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0  63.5  NULL                     | 0.2-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4 <br>-02-10 22<br>15.                              | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45 <br>97.75                   | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77 <br>53.75                        | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05  NULL                       | 24. 0.83  26.58  41.7 0.48  26.4  23.7 0.51  25.53               | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43 <br>0.1 <br>0.0                                 | 2.15  0.1  NULL  1.42  0.3  NULL  2.05  NULL  NULL       |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0  63.5  NULL   2023-             | 0.35 <br>0.35 <br>0.35 <br>0.2-10 21<br>12.9<br>0.4 <br>0.2-10 22<br>15.<br>0.1                          | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45 <br>97.75 <br>:00:00 2      | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77 <br>53.75 <br>023-02-11          | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05  NULL   00:00:00            | 24. 0.83  26.58  41.7 0.48  26.4  23.7 0.51  25.53  19.2         | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43 <br>0.1                                         | 2.15  0.1  NULL  1.42  0.3  NULL  2.05  NULL  NULL       |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0  63.5  NULL   2023- 40.77  0.08 | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4 <br>-02-10 22<br>15.<br>0.1 <br>-02-10 23<br>23.5 | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45 <br>97.75 <br>:00:00 2<br>5 | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77 <br>53.75 <br>023-02-11<br>18.17 | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05  NULL   00:00:00  4.75  0.1 | 24. 0.83  26.58  41.7 0.48  26.4  23.7 0.51  25.53  19.2 0.64    | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43 <br>0.1 <br>0.0 <br>5  94.75 <br>15.22 <br>0.12 | 2.15  0.1  NULL  1.42  0.3  NULL  2.05  NULL  NULL  0.03 |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0  63.5  NULL   2023- 40.77  0.08 | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4 <br>-02-10 22<br>15.<br>0.1 <br>-02-10 23<br>23.5 | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45 <br>97.75 <br>:00:00 2<br>5 | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77 <br>53.75 <br>023-02-11<br>18.17 | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05  NULL   00:00:00  4.75  0.1 | 24. 0.83  26.58  41.7 0.48  26.4  23.7 0.51  25.53  19.2 0.64    | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43 <br>0.1 <br>0.0 <br>5  94.75 <br>15.22 <br>0.12 | 2.15  0.1  NULL  1.42  0.3  NULL  2.05  NULL  NULL  0.03 |
| NULL   2023- 49.15  0.12  55.0  NULL   2023- 22.15  0.12  54.75  NULL   2023- 25.42  0.0  63.5  NULL   2023- 40.77  0.08 | -02-10 20<br>27.8<br>0.35 <br>-02-10 21<br>12.9<br>0.4 <br>-02-10 22<br>15.<br>0.1 <br>-02-10 23<br>23.5 | :00:00 2<br>8 <br>0.75 <br>216.0 <br>:00:00 2<br>3 <br>1.82 <br>140.0 <br>:00:00 2<br>2 <br>0.45 <br>97.75 <br>:00:00 2<br>5 | 023-02-10<br>20.4 <br>53.0 <br>023-02-10<br>20.15 <br>53.25 <br>023-02-10<br>18.77 <br>53.75 <br>023-02-11<br>18.17 | 21:00:00  6.93  0.38  NULL   22:00:00  6.7  1.05  NULL   23:00:00  5.7  0.05  NULL   00:00:00  4.75  0.1 | 24. 0.83  26.58  41.7 0.48  26.4  23.7 0.51  25.53  19.2 0.64    | 5  136.0 <br>21.0 <br>0.45 <br>0.0 <br>5  226.25 <br>49.97 <br>1.05 <br>0.0 <br>5  95.75 <br>37.43 <br>0.1 <br>0.0 <br>5  94.75 <br>15.22          | 2.15  0.1  NULL  1.42  0.3  NULL  2.05  NULL  NULL  0.03 |

| 49.65   | 30.53     | 1        | 9.32     | 3.52      | 0.86  | 5.   | 83    |      |
|---------|-----------|----------|----------|-----------|-------|------|-------|------|
| 0.12    |           | 1.32     |          | 0.15      |       | 0.42 |       | 0.17 |
| 75.0    | 0.1       | 96.75    | 54.0     | NULL      | 24.73 | 0.0  |       | NULL |
| NULL    |           |          |          |           |       |      |       |      |
| 2023-0  | )2-11 01: | 00:00 20 | 23-02-11 | 02:00:00  | 44.   | 0  1 | 50.25 | 4.85 |
| 39.47   | 24.92     | 1        | 20.1     | 3.1       | 0.58  | 19.  | 35    |      |
|         |           |          |          | 0.2       |       |      |       |      |
| 74.75   | 0.27      | 104.5    | 54.0     | NULL      | 24.73 | 0.01 |       | NULL |
| NULL    |           |          |          |           |       |      |       |      |
| 2023-0  | 2-11 02:  | 00:00 20 | 23-02-11 | 03:00:00  | 27.2  | :5   | 98.25 | 1.45 |
| 15.78   | 9.57      | 1 2      | 20.43    | 2.92      | 0.33  | 32.  | 75    |      |
| 0.03    |           | 0.38     |          | 0.03      |       | 0.15 |       | 0.03 |
| 78.5    | 0.1       | 76.0     | 53.5     | NULL      | 24.38 | 0.0  |       | NULL |
| NULL    |           |          |          |           |       |      |       |      |
| 2023-0  | 2-11 03:  | 00:00 20 | 23-02-11 | 04:00:00  | 18.2  | :5   | 69.0  | 4.67 |
|         |           |          |          | 2.7       |       |      |       |      |
|         |           |          |          | 0.03      |       |      |       |      |
| 82.25   | 0.15      | 120.0    | 53.0     | NULL      | 24.1  | 0.0  |       | NULL |
| NULL    |           |          |          |           |       |      |       |      |
|         |           |          |          | 05:00:00  |       |      |       |      |
|         |           |          |          | 2.22      |       |      |       |      |
|         |           |          |          | 0.2       |       |      |       |      |
| 0.15    | 111.25    | 53.25    | NU!      | LL  24.05 | 0.0   | 1    | NULL  |      |
| NULL    |           |          |          |           |       |      |       |      |
|         |           |          |          |           |       |      |       |      |
|         |           |          |          | -+        |       |      |       |      |
|         |           |          |          | +         |       |      |       |      |
|         |           |          | +        |           | +     | +    | +-    |      |
| ·       |           | •        |          |           |       |      |       |      |
| only sh | nowing to | p 20 row | is       |           |       |      |       |      |

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