Imports

import os,time from pyspark import SparkContext from pyspark.sql.functions import col, count, max as spark_max from pyspark.sql.types import * from pyspark.sql.functions import * from pyspark.sql.functions import col, sum, max as spark_max import pyspark.sql.functions as F import pyspark.sql.functions as f from pyspark.sql.window import Window from pyspark.sql.functions import row_number from pyspark.sql import SparkSession from pyspark.ml.feature import StringIndexer, OneHotEncoder, VectorAssembler,MinMaxScaler from pyspark.ml import Pipeline from pyspark.ml.linalg import Vectors, SparseVector from pyspark.ml.clustering import KMeans from pyspark.ml.evaluation import ClusteringEvaluator from pyspark.ml.linalg import DenseVector, SparseVector, VectorUDT from pyspark.ml.linalg import Vectors from pyspark.ml.feature import PCA from pyspark.mllib.linalg import Vectors as OldVectors from pyspark.mllib.linalg.distributed import RowMatrix import matplotlib.pyplot as plt import seaborn as sns import matplotlib.pyplot as plt import pandas as pd

Spark Load

In [0]:
```
spark = SparkSession.builder.appName("my_project_2").getOrCreate()
spark.conf.set("spark.sql.execution.arrow.pyspark.enabled", "true")
sc = spark.sparkContext
```

Read Sub Demographic data

In [0]:
```
demographic_df = spark.read.parquet("/dbfs/mnt/coursedata2024/fwm-stb-data/Project2_demographic.parquet")
demographic_df.printSchema()
display(demographic_df.limit(10))
```

```
root
 |-- household_id: string (nullable = true)
 |-- household_size: integer (nullable = true)
 |-- num_adults: integer (nullable = true)
 |-- num_generations: integer (nullable = true)
 |-- marital_status: string (nullable = true)
 |-- race_code: string (nullable = true)
 |-- dwelling_type: string (nullable = true)
 |-- home_owner_status: string (nullable = true)
 |-- length_residence: integer (nullable = true)
 |-- home_market_value: integer (nullable = true)
 |-- net_worth: integer (nullable = true)
 |-- education_highest: integer (nullable = true)
 |-- gender_individual: string (nullable = true)
```

household_id	household_size	num_adults	num_generations	marital_status	race_code	dwelling_type	home_owner_status	length_residence
00000015	2	2	1	S	B	S	O	5
00000028	3	2	2	S	W	S	O	3
00000056	2	2	1	S	W	S	O	4
00000061	2	2	2	M	W	S	O	15
00000098	3	2	2	M	W	S	O	4
00000111	2	2	1	S	W	S	O	15
00000122	3	2	2	M	W	S	O	8
00000130	2	2	2	S	W	S	O	8
00000145	1	1	1	B	W	S	O	3
00000160	2	2	1	A	W	S	O	15

Read Static Viewing Data

In [0]:
```
static_viewing_df = spark.read.parquet("/dbfs/mnt/coursedata2024/fwm-stb-data/Project2_static_viewing_data.parquet")
static_viewing_df.printSchema()
display(static_viewing_df.limit(10))
```

```
root
 |-- device_id: string (nullable = true)
 |-- event_date: integer (nullable = true)
 |-- event_time: integer (nullable = true)
 |-- station_num: string (nullable = true)
 |-- prog_code: string (nullable = true)
 |-- household_id: long (nullable = true)
```

device_id	event_date	event_time	station_num	prog_code	household_id
000000d8b042	20151101	500	31709	EP015686040014	1463331
000000fb0fe7	20151101	230000	11006	EP001151270249	1447701
0000010e4717	20151101	13000	49788	EP003267331348	1447541
0000015ce10e	20151101	153432	50001	EP013605340004	2880783
000004351a40	20151101	65207	59636	SP003189620000	2882159
000004d26feb	20151101	210550	14988	MV002161540000	405836
000005ac0b7c	20151101	194211	63322	EP015662900055	397950
000013fb3e40	20151101	123000	16374	SH006818540000	399721
00001602e18b	20151101	64445	18090	SP003189620000	400046
000002c427cf	20151101	52403	59337	MV002415180000	1300668

Static Data Analysis

Feature Extraction

In [0]:
```
df=demographic_df.dropna().dropDuplicates()
numerical_columns = [col for col, dtype in df.dtypes \
                     if dtype in ['int', 'double'] and col != "household_id"]
categorical_columns = [col for col, dtype in df.dtypes \
                       if dtype == 'string' and col != "household_id"]

# Normalize numerical columns and assemble and scale the numerical columns
numerical_assemblers = [VectorAssembler(inputCols=[col],\
                        outputCol=f"{col}_vec") for col in numerical_columns]
numerical_scalers = [MinMaxScaler(inputCol=f"{col}_vec",\
                      outputCol=f"{col}_scaled") for col in numerical_columns]

# Combine numerical stages into a pipeline
numerical_pipeline = Pipeline(stages=numerical_assemblers + numerical_scalers)
                                                    it(df).transform(df)
```

```
# One-Hot Encode categorical columns index and encode the categorical columns
categorical_indexers = [StringIndexer(inputCol=col, outputCol=f"{col}_index") \
                        for col in categorical_columns]
categorical_encoders = [OneHotEncoder(inputCol=f"{col}_index", \
                    outputCol=f"{col}_encoded") for col in categorical_columns]

# Combine categorical stages into a pipeline
categorical_pipeline = \
                    Pipeline(stages=categorical_indexers + categorical_encoders)
df_categorical = categorical_pipeline.fit(df).transform(df)

assembler_inputs = [f"{col}_scaled" for col in numerical_columns] \
                        + [f"{col}_encoded" for col in categorical_columns]
assembler = VectorAssembler(inputCols=assembler_inputs, outputCol="features")

# applying the assembler to combine all features into a single vector
df_combined = assembler\
                  .transform(df_numerical.join(df_categorical, "household_id"))

df_combined.select("features").limit(10).display()
```

features
Map(vectorType -> dense, length -> 16, values -> List(0.375, 0.4, 0.5, 1.0, 0.7222222222222222, 0.75, 0.3333333333333333, 1.0, 0.0, 0.0, 1.0, 0.0, 0.0, 1.0, 1.0, 1.0))
Map(vectorType -> dense, length -> 16, values -> List(0.5, 0.8, 0.5, 0.4666666666666667, 0.5555555555555556, 0.875, 0.0, 0.0, 0.0, 1.0, 1.0, 0.0, 0.0, 1.0, 1.0, 0.0))
Map(vectorType -> dense, length -> 16, values -> List(0.25, 0.4, 0.0, 0.6666666666666666, 0.5, 0.75, 0.6666666666666666, 1.0, 0.0, 0.0, 1.0, 0.0, 0.0, 1.0, 1.0, 1.0))
Map(vectorType -> dense, length -> 16, values -> List(0.125, 0.2, 0.0, 0.3333333333333333, 0.2222222222222222, 0.625, 0.0, 1.0, 0.0, 0.0, 1.0, 0.0, 0.0, 1.0, 1.0, 1.0))
Map(vectorType -> dense, length -> 16, values -> List(0.375, 0.6000000000000001, 0.5, 1.0, 0.6666666666666666, 0.75, 0.0, 1.0, 0.0, 0.0, 1.0, 0.0, 0.0, 1.0, 1.0, 1.0))
Map(vectorType -> dense, length -> 16, values -> List(0.125, 0.2, 0.5, 0.6666666666666666, 0.3333333333333333, 0.875, 0.3333333333333333, 1.0, 0.0, 0.0, 0.0, 1.0, 0.0, 1.0, 1.0, 1.0))
Map(vectorType -> dense, length -> 16, values -> List(0.125, 0.2, 0.0, 1.0, 0.6666666666666666, 1.0, 0.6666666666666666, 0.0, 1.0, 0.0, 0.0, 0.0, 1.0, 1.0,

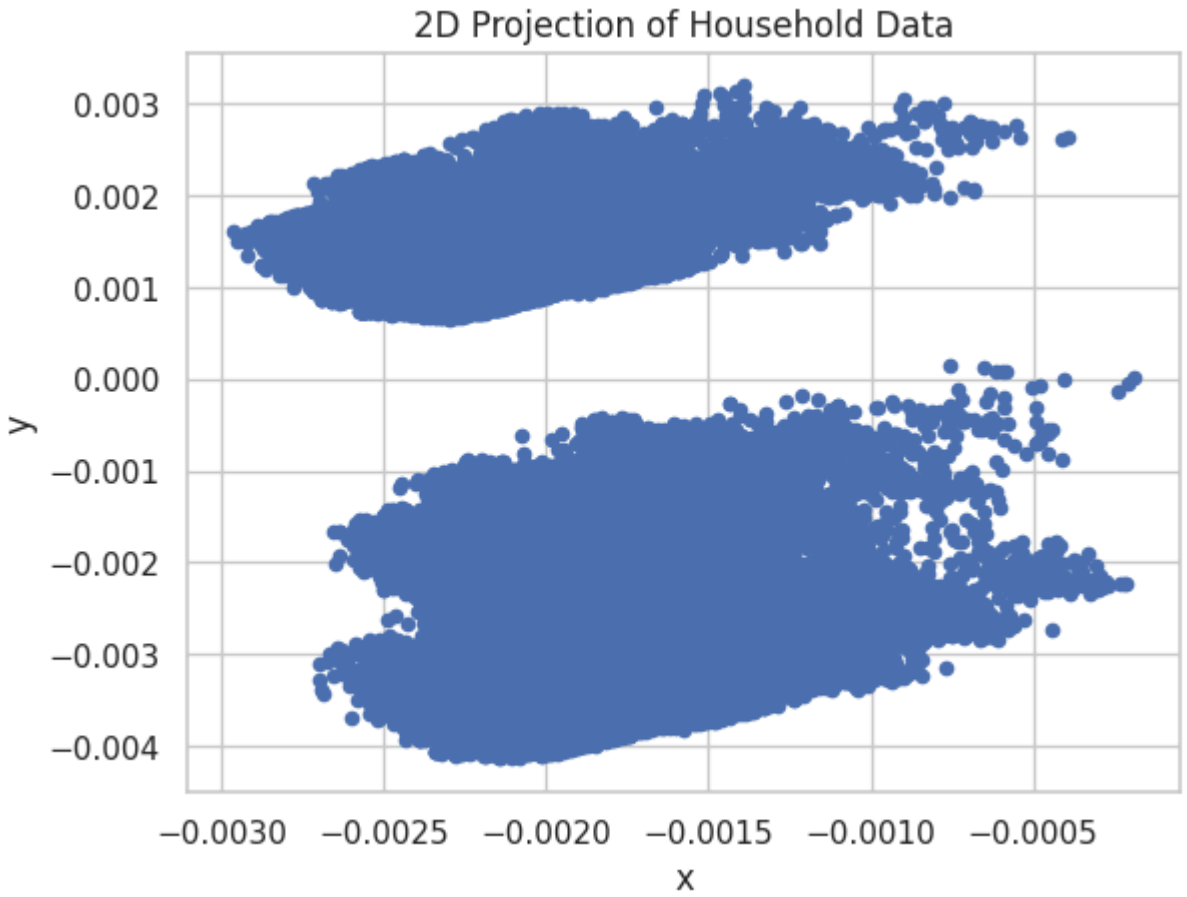
Visual Analysis

In [0]:
```
dense_rdd = df_combined.select("features")\
                .rdd.map(lambda row: OldVectors.fromML(row["features"]))

mat = RowMatrix(dense_rdd)
svd_rows_2d = mat.computeSVD(k=2, computeU=True).U\
          .rows.map(lambda row: (float(row[0]), float(row[1]))).toDF(["x", "y"])

svd_rows_2d.show(10, truncate=False)
df_pandas = svd_rows_2d.toPandas()\
            .plot.scatter(x="x", y="y", title='2D Projection of Household Data')
```

```
+----------------------+----------------------+
|x                     |y                     |
+----------------------+----------------------+
|-0.002588668168017163 |0.0011345726798525318 |
|-0.0020339425335158968|-0.0013994324906703795|
|-0.0023753887130978 5 |9.55507905940435E-4   |
|-0.0020917172580856404|9.453044736316297E-4  |
|-0.002578873291683497 |0.001271089802926344  |
|-0.002037846910098868 |0.0014518876076378986 |
|-0.001963404447922104 |-0.0034439630750510214|
|-0.0022835453042494274|9.550634227776585E-4  |
|-0.0023586534671342094|8.260237497763863E-4  |
|-0.0019441033320626653|-0.00389996150489472  |
+----------------------+----------------------+
only showing top 10 rows
```



Clustering

In [0]:
```
df_demo_kmeans = df_combined.select("household_id", "features")
kmeans = KMeans(k=8, seed=7, featuresCol='features', predictionCol='cluster')
model = kmeans.fit(df_demo_kmeans)
df_clustered = kmeans.fit(df_demo_kmeans).transform(df_demo_kmeans)
centroids = model.clusterCenters()
```

In [0]:
```
centroids_data = [Row(int(i), DenseVector(centroid)) \
                  for i, centroid in enumerate(centroids)]
                                                    e(\
                                  [Row(int(i), DenseVector(centroid)) \
```

```
                                    for i, centroid in enumerate(centroids)],\
                                                ["centroid", "cluster_v"])

df_with_centroids = df_clustered.\
    join(centroids_df, df_clustered.cluster == centroids_df.centroid, "left")
```

In [0]:
```
@udf(DoubleType())
def euclidean_distance(vector1, vector2):
    # Ensure both vectors are DenseVector
    v1 = vector1.toArray() if isinstance(vector1, SparseVector) else vector1
    v2 = vector2.toArray() if isinstance(vector2, SparseVector) else vector2

    # Convert to arrays for efficient computation
    v1_array = v1.toArray() if isinstance(v1, DenseVector) else v1
    v2_array = v2.toArray() if isinstance(v2, DenseVector) else v2
    diff = v1_array - v2_array
    return float((diff @ diff) ** 0.5)

result_df = df_with_centroids.withColumn(
    "dist",
    euclidean_distance(df_with_centroids["features"], \
            df_with_centroids["centroid"])
).select("household_id", "features", "centroid", "dist")
```

In [0]:
```
result_df.limit(10).display()
```

household_id	features	centroid	dist
00011019	Map(vectorType -> dense, length -> 16, values -> List(0.125, 0.2, 0.0, 1.0, 0.6666666666666666, 1.0, 0.6666666666666666, 0.0, 1.0, 0.0, 0.0, 0.0, 1.0, 1.0, 1.0, 1.0))	0	2.8186014065292895
00015902	Map(vectorType -> sparse, length -> 16, indices -> List(3, 4, 5, 8, 12, 13, 14), values -> List(1.0, 0.2777777777777778, 0.75, 1.0, 1.0, 1.0, 1.0))	0	2.3747969373879445
00006192	Map(vectorType -> sparse, length -> 16, indices -> List(3, 4, 5, 6, 8, 12, 13, 14, 15), values -> List(0.7333333333333333, 0.2222222222222222, 0.75, 0.3333333333333333, 1.0, 1.0, 1.0, 1.0, 1.0))	0	2.502153393566884
00004689	Map(vectorType -> dense, length -> 16, values -> List(0.25, 0.2, 0.5, 0.7333333333333333, 0.2777777777777778, 0.75, 0.0, 0.0, 1.0, 0.0, 0.0, 1.0, 0.0, 1.0, 1.0, 0.0))	0	2.3515820784325046
00014172	Map(vectorType -> dense, length -> 16, values -> List(0.125, 0.0, 0.5, 0.6666666666666666, 0.05555555555555555, 0.75, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 1.0, 1.0, 1.0, 1.0))	0	2.5051259178327805
00005059	Map(vectorType -> sparse, length -> 16, indices -> List(3, 4, 5, 6, 8, 11, 13, 14), values -> List(0.5333333333333333, 0.16666666666666666, 0.75, 0.3333333333333333, 1.0, 1.0, 1.0, 1.0))	0	2.2328979675151603
[illegible]	Map(vectorType -> dense, length -> 16, values -> List(0.75, 1.0, 1.0, 0.8666666666666667,	0	[illegible]

Visual Clustering

In [0]:
```
pca = PCA(k=2, inputCol="features", outputCol="pca_features")

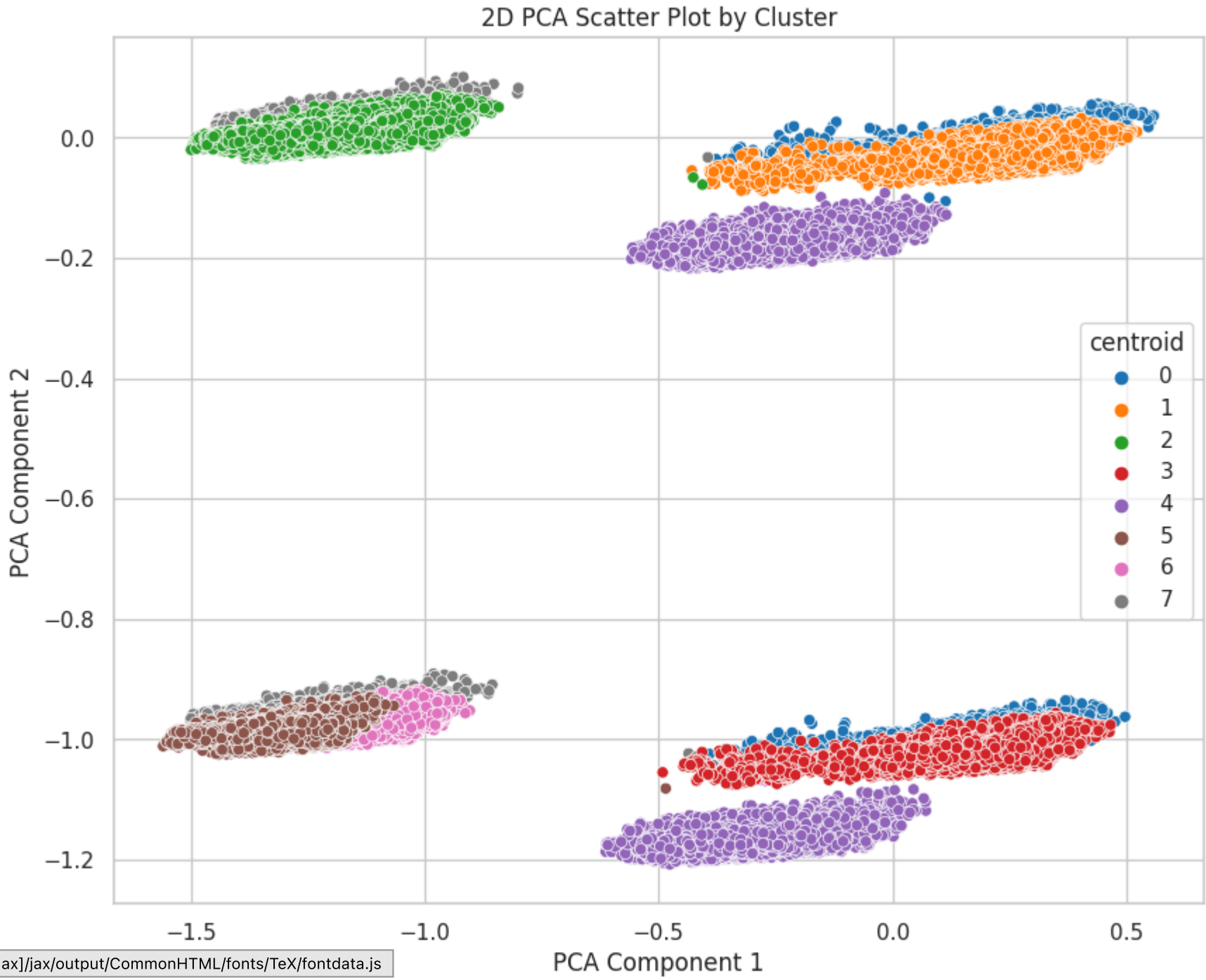
final_df_pca = pca.fit(result_df).transform(result_df)\
                    .select("household_id", "centroid", "dist", "pca_features")

final_df_pca.display()
```

household_id	centroid	dist	pca_features
00011019	0	2.8186014065292895	Map(vectorType -> dense, length -> 2, values -> List(0.1828211427950973, -0.9953950996664802))
00068002	0	2.240377227936579	Map(vectorType -> dense, length -> 2, values -> List(-0.254539840272358, -0.017146090141217606))
00400109	0	2.368573175751361	Map(vectorType -> dense, length -> 2, values -> List(0.2817123126223771, -0.011150868877038849))
01267872	0	2.0381564685086024	Map(vectorType -> dense, length -> 2, values -> List(0.31231993060290314, 0.0014785180136785668))
01979014	0	2.1882754357521015	Map(vectorType -> dense, length -> 2, values -> List(0.3478423756274747, -0.9689666854025228))
02081161	0	2.542515037526697	Map(vectorType -> dense, length -> 2, values -> List(0.12607784157841484, -0.9890033827349533))
02088191	0	2.4372700904551308	Map(vectorType -> dense, length -> 2, values -> List(0.1310370844099728, -0.007095365390023185))
02140001	0	2.6722857465306946	Map(vectorType -> dense, length -> 2, values -> List(0.0024294751082073462, -1.009139797982013))
02218088	0	2.2091036392367127	Map(vectorType -> dense, length -> 2, values -> List(0.2895289622721339,

In [0]:
```
final_df_pca_pd = final_df_pca\
                .select("household_id", "centroid", "pca_features").toPandas()
final_df_pca_pd[['pca_x', 'pca_y']] = \
                    pd.DataFrame(final_df_pca_pd['pca_features'].tolist(),\
                        index=final_df_pca_pd.index)

sns.set(style="whitegrid")
plt.figure(figsize=(10, 8))
scatter_plot = sns.scatterplot(
    x="pca_x",
    y="pca_y",
    hue="centroid",  # Different colors for each cluster
    palette="tab10",  # More distinct colors
    data=final_df_pca_pd,
    legend="full"
)
scatter_plot.set_title("2D PCA Scatter Plot by Cluster")
scatter_plot.set_xlabel("PCA Component 1")
scatter_plot.set_ylabel("PCA Component 2")
plt.show()
```



Dividing households into subsets

In [0]:
```
window_spec = Window.partitionBy("centroid").orderBy("dist")

# creating subsets for different groups by centroids
result_df_with_row_num = result_df\
                         .withColumn("row_num", row_number().over(window_spec))

sevenths_subset = result_df_with_row_num\
                .filter(result_df_with_row_num["row_num"] % 7 == 0)\
                         .select("household_id", "features", "centroid", "dist")

eleventhss_subset = result_df_with_row_num\
                .filter(result_df_with_row_num["row_num"] % 11 == 0)\
                         .select("household_id", "features", "centroid", "dist")

total_data_clustered = result_df_with_row_num\
                                .drop(result_df_with_row_num["row_num"])
```

Cluster's Viewing Analysis

In [0]:
```
def process_subset_data(subset_df: DataFrame, station_view_counts:\
                                        DataFrame, window_spec) -> DataFrame:
    # Join subset data with station view counts based on household_id
    subset_pop = subset_df.join(station_view_counts, "household_id", "inner")

    # Aggregate by station_num and centroid to get the total view count per station
    subset_pop = subset_pop.groupBy("station_num", "centroid")\
        .agg(F.count("*").alias("view_count_rows"))

    # Calculate the sum of view counts across all stations within each cluster
    subset_pop = subset_pop.withColumn(
        "total_view_count",
        F.sum("view_count_rows").over(window_spec)
    )

    # Calculate the view percentage for each station within each cluster
    subset_pop = subset_pop.withColumn(
```

```
        (F.col("view_count_rows") / F.col("total_view_count")) * 100
    ).select(
        F.col("station_num"),
        F.col("view_count_rows").alias("view_count"),
        F.col("centroid"),
        F.col("view_percentage")
    )

    return subset_pop
```

In [0]:
```
station_view_counts = static_viewing_df

# Calculate the percentage of views for each station for their subset

window_spec = Window.partitionBy("centroid")

sevenths_subset_pop = process_subset_data(sevenths_subset, \
                                          station_view_counts, window_spec)

eleventhss_subset_pop = process_subset_data(eleventhss_subset,\
                                           station_view_counts, window_spec)

clustered_data_views_pop = process_subset_data(total_data_clustered, \
                                          station_view_counts, window_spec)
```

In [0]:
```
demo_count_views = total_data_clustered\
                        .join(station_view_counts, "household_id", "inner")

demo_count_views = demo_count_views.groupBy("station_num")\
        .agg(F.count("*").alias("view_count_rows"))

# Calculate the sum view count using a windows
# Define a window with no partitioning and unbounded frame
window_spec = Window.orderBy(F.lit(1))\
    .rowsBetween(Window.unboundedPreceding, Window.unboundedFollowing)


# Calculate the sum view count across all rows using the window function
demo_count_views = demo_count_views.withColumn(
        "total_view_count",
        F.lit(sum("view_count_rows").over(window_spec))
```

```
demo_count_views = demo_count_views.withColumn(
        "general_view_percentage",
        (F.col("view_count_rows") / F.col("total_view_count")) * 100
    ) \
    .select(
        F.col("station_num"),
        F.col("view_count_rows").alias("view_count"),
        F.col("general_view_percentage")
    )
# Extract general popularity
general_popularity = demo_count_views\
    .select("general_view_percentage", "station_num")
```

In [0]:
```
clustered_data_views_popularity = clustered_data_views_pop\
            .join(general_popularity, \
                on=["station_num"], how="inner")\
                    .withColumn("rank_diff", col("view_percentage") - col("general_view_percentage"))

sevenths_subset_popularity = sevenths_subset_pop.join(general_popularity, \
                on=["station_num"], how="inner")\
                .withColumn("rank_diff", col("view_percentage") - col("general_view_percentage"))

elevenths_subset_popularity = elevenths_subset_pop.join(general_popularity, \
                on=["station_num"], how="inner")\
                .withColumn("rank_diff", col("view_percentage") - col("general_view_percentage"))
```

In [0]:
```
"""
For each subset calculate the top-10 highest 'diff rank' stations. Overall you need to return 24 groups of top ranked
"""
x = 8
data_popularity_dict, seven_pop_dict, eleven_pop_dict = {},{},{}
for i in range(x):
    data_popularity_dict[i] = \
        clustered_data_views_popularity.filter(col("centroid") == i)\
                                .orderBy(col("rank_diff").desc()).limit(10)
    seven_pop_dict[i] = sevenths_subset_popularity.filter(col("centroid") == i)\
                                    .orderBy(col("rank_diff").desc()).limit(10)
    eleven_pop_dict[i] = elevenths_subset_popularity\
                                .filter(col("centroid") == i)\
                                    .orderBy(col("rank_diff").desc()).limit(10)
```



```
    displayHTML(f"<h2>Cluster #{i} - Popularity on Full Data Set</h2>")
```

```
    display(data_popularity_dict[i])

    displayHTML(f"<h2>Cluster #{i} - Popularity on Data (Filtered by Every 7th Row) Set</h2>")
    display(seven_pop_dict[i])

    displayHTML(f"<h2>Cluster #{i} - Popularity on Data (Filtered by Every 11th Row) Set</h2>")
    display(eleven_pop_dict[i])
```

Cluster #0 - Popularity on Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
10171	3192	0	1.6749047634039604	0.9217651588543606	0.7531396045495998
12131	2943	0	1.544249598589554	0.8552705119606528	0.6889790866289011
99993	16389	0	8.599628498567515	8.000394341356783	0.5992341572107325
35513	1007	0	0.5283925741691067	0.15692922969918274	0.3714633444699239
70387	1428	0	0.7492994994175612	0.3853677621283255	0.3639317372892357
11118	806	0	0.4229239471502482	0.06581153588195843	0.3571124112682898
16615	1767	0	0.9271794225986211	0.6113067292644757	0.31587269333414536
47540	1210	0	0.6349106402627795	0.34304592990039	0.29186471036238953
21883	977	0	0.5126509880468889	0.2305344412151924	0.2821165468316965
10918	1510	0	0.7923265014849563	0.5148793998559257	0.27744710162903063

Cluster #0 - Popularity on Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	2400	0	8.866558297620806	8.000394341356783	0.8661639562640229
12131	394	0	1.4555933205260825	0.8552705119606528	0.6003228085654296
10171	402	0	1.4851485148514851	0.9217651588543606	0.5633833559971245
11118	148	0	0.5467710950199498	0.06581153588195843	0.4809595591379914
16615	291	0	1.0750701935865228	0.6113067292644757	0.46376346432204707
11561	153	0	0.5652430914733265	0.17360334848597758	0.39163974298734894
35513	148	0	0.5467710950199498	0.15692922969918274	0.38984186532076703
70387	202	0	0.7462686567164178	0.3853677621283255	0.3609008945880923
60048	188	0	0.6945470666469632	0.38983903420523136	0.30470803244173184
47540	171	0	0.6317422787054825	0.34304592990039	0.2886963488050925

Cluster #0 - Popularity on Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
12131	281	0	1.6838446788111219	0.8552705119606528	0.828574166850469
10171	291	0	1.7437679769894534	0.9217651588543606	0.8220028181350928
21883	158	0	0.9467881112176415	0.2305344412151924	0.7162536700024491
11118	84	0	0.5033557046979865	0.06581153588195843	0.4375441688160281
59684	138	0	0.826941514860978	0.4359956032491244	0.3909459116118536
18279	105	0	0.6291946308724832	0.23957013687060635	0.3896244940018768
47540	116	0	0.6951102588686481	0.34304592990039	0.35206432896825807
12729	80	0	0.4793863854266539	0.16413294582308666	0.3152534396035672
18480	115	0	0.6891179290508149	0.3867650346523586	0.3023528943984563
11809	66	0	0.39549376797698943	0.09818168268872493	0.29731208528826447

Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
11221	7373	1	1.122846025569761	0.8102317609359863	0.31261426463377473
16615	5382	1	0.8196334340996139	0.6113067292644757	0.20832670483513815
12131	6915	1	1.0530964691190692	0.8552705119606528	0.19782595715841633
11207	6555	1	0.9982714902495298	0.810604366942395	0.18766712330713475
11069	4251	1	0.6473916254844777	0.4700114265841966	0.17738019890028112
11158	5063	1	0.7710524111568832	0.6004856298283529	0.17056678132853031
12574	5194	1	0.7910026118010767	0.6219570509476613	0.16904556085341538
10171	7122	1	1.0846208319690542	0.9217651588543606	0.16285567311469362
74796	4031	1	0.6138874717308703	0.4582898626325856	0.15559760909828474
10918	4377	1	0.6665803680888165	0.5148793998559257	0.1517009682328908

Cluster #1 - Popularity on Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
11221	1051	1	1.1291119657936013	0.8102317609359863	0.31888020485761503
16615	818	1	0.8787950409316517	0.6113067292644757	0.267488311667176
74796	646	1	0.6940117315915	0.4582898626325856	0.2357218689589144
14902	1072	1	1.1516727186781548	0.9497261345852894	0.20194658409286537
11207	924	1	0.9926731269203497	0.810604366942395	0.1820687599779547
61522	580	1	0.6231065082400464	0.45273182303698734	0.1703746852030591
11344	453	1	0.4866676693667949	0.3322248304642671	0.1544428389025278
10145	664	1	0.71334951977826	0.5651967359713839	0.14815278380687613
10918	608	1	0.6531875120861177	0.5148793998559257	0.13830811223019202
11164	711	1	0.7638426333770224	0.6261022927689595	0.13774034060806295

Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
12131	727	1	1.2312434373200556	0.8552705119606528	0.37597292535940274
74796	465	1	0.7875215933340108	0.4582898626325856	0.32923173070142525
11221	661	1	1.1194661789113574	0.8102317609359863	0.3092344179753711
11069	425	1	0.719777800359042	0.4700114265841966	0.24976637377484545
12574	501	1	0.8484910070114825	0.6219570509476613	0.2265339560638212
16615	492	1	0.8332486535921146	0.6113067292644757	0.22194192432763893
11158	480	1	0.8129255156996241	0.6004856298283529	0.21243988587127127
10145	457	1	0.773972834739017	0.5651967359713839	0.20877609876763314
11713	301	1	0.5097720421366392	0.3344138907519189	0.17535815138472027
11187	619	1	1.0483351962876402	0.8912425168293712	0.157092679458269

Cluster #2 - Popularity on Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	28640	2	1.6415796535831317	1.477662269915791	0.16391738366734065
60179	29377	2	1.6838228171547367	1.5491249968949499	0.13469782025978683
14902	18114	2	1.038253276711063	0.9497261345852894	0.08852714212577362
99993	140970	2	8.080079740419485	8.000394341356783	0.07968539906270244
11221	15292	2	0.8765026558168033	0.8102317609359863	0.06627089488081706
61522	8970	2	0.5141399962514208	0.45273182303698734	0.06140817321443348
11069	9230	2	0.5290426048384185	0.4700114265841966	0.05903117825422188
49788	16841	2	0.965287812360109	0.9067832923466727	0.05850452001343631
11344	6737	2	0.3861495155792444	0.3322248304642671	0.05392468511497728
31709	4392	2	0.25173944966959194	0.20452964701790996	0.04720980265168198

Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	21162	2	8.311861743912019	8.000394341356783	0.31146740255523575
16374	4221	2	1.6578947368421053	1.477662269915791	0.18023246692631423
49788	2567	2	1.0082482325216024	0.9067832923466727	0.1014649401749298
60179	4200	2	1.6496465043205029	1.5491249968949499	0.10052150742555299
66268	1218	2	0.4783974862529458	0.39635963931738577	0.08203784693556004
11344	1042	2	0.40926944226237233	0.3322248304642671	0.07704461179810523
11221	2246	2	0.8821681068342498	0.8102317609359863	0.07193634589826359
31709	698	2	0.2741555380989788	0.20452964701790996	0.06962589108106884
14902	2572	2	1.0102120974076982	0.9497261345852894	0.06048596282240881
61522	1299	2	0.5102120974076984	0.45273182303698734	0.057480274370711015

Cluster #2 - Popularity on Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2730	2	1.755028832616536	1.5491249968949499	0.2059038357215861
99993	12693	2	8.159919770110509	8.000394341356783	0.15952542875372622
11344	674	2	0.43329283266796526	0.3322248304642671	0.10106800220369816
16374	2452	2	1.5763116108336066	1.477662269915791	0.09864934091781552
66268	758	2	0.48729371982539715	0.39635963931738577	0.09093408050801138
11765	480	2	0.30857649804246784	0.22539558337680404	0.0831809146656638
99995	1740	2	1.1185898054039 46	1.0362328290732046	0.08235697633074146
12852	960	2	0.6171529960849357	0.5486778696872594	0.06847512639767628
14902	1582	2	1.0170167081316337	0.9497261345852894	0.06729057354634427
11069	834	2	0.5361516653487879	0.4700114265841966	0.0661402387645913

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Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	9659	3	1.5480928118423731	1.3472346424224357	0.2008581694199374
58515	5445	3	0.8726954509247046	0.6785621134212684	0.1941333375034362
60048	3151	3	0.5050254115452238	0.38983903420523136	0.11518637733999249
74796	3534	3	0.566410601206227	0.4582898626325856	0.1081207385736414
11867	5335	3	0.8550652397949126	0.7518412946816703	0.10322394511324229
58574	2860	3	0.4583854893745923	0.3554506048637504	0.10293488451084187
14771	6103	3	0.9781561684101877	0.8762606503216832	0.1018955180885045
56905	3773	3	0.604716241751866	0.5062939364582557	0.09842230529361029
12131	5874	3	0.9414532743308935	0.8552705119606528	0.0861827623702407
64241	2656	3	0.4256894614611598	0.34231624313783937	0.08337321832332045

Cluster #3 - Popularity on Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
58515	824	3	0.9333831741824401	0.6785621134212684	0.2548210607611717
11867	804	3	0.9107282427702449	0.7518412946816703	0.15888694808857462
74796	528	3	0.5980901892819519	0.4582898626325856	0.1398003266493663
32645	1306	3	1.4793670212163432	1.3472346424224357	0.1321323787939075
11713	408	3	0.462160600808781	0.3344138907519189	0.1277467100568621
31046	341	3	0.3862665805779273	0.27263891993938943	0.11362766063853785
14771	871	3	0.9866222630010987	0.8762606503216832	0.11036161267941547
18284	323	3	0.3658771423069517	0.2635721737834414	0.10230496852351029
59684	471	3	0.5335236347571958	0.4359956032491244	0.09752803150807138
12852	569	3	0.644532798676952	0.5486778696872594	0.09585492898969261

Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
58515	564	3	1.0126036841538295	0.6785621134212684	0.33404157073256113
32645	933	3	1.6751050307012818	1.3472346424224357	0.32787038827884607
10179	627	3	1.1257136701497361	0.8952790818988002	0.23043458825093588
58574	284	3	0.5098926352831341	0.3554506048637504	0.1544420304193837
18151	143	3	0.2567417142446766	0.11021375164567654	0.14652796259900008
56905	361	3	0.6481381737225753	0.5062939364582557	0.1418442372643196
31046	229	3	0.41114582211210454	0.27263891993938943	0.1385069021727151
51529	269	3	0.48296168623648966	0.3586022306679584	0.12435945556853129
75003	87	3	0.15619950447053754	0.03882865091785279	0.11737085355268476
45507	338	3	0.6068440518510538	0.4895732419206597	0.11727080993039413

Cluster #4 - Popularity on Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99995	11012	4	1.194371745494262	1.0362328290732046	0.15813891642105737
59684	5447	4	0.5907866779610648	0.4359956032491244	0.15479107471194037
10171	9924	4	1.0763662552020574	0.9217651588543606	0.1546010963476968
32645	13575	4	1.4723571054381224	1.3472346424224357	0.12512246301568664
12131	8905	4	0.9658445689816929	0.8552705119606528	0.11057405702104006
60179	15193	4	1.6478468878763457	1.5491249968949499	0.09872189098139583
11713	3881	4	0.4209368638088658	0.3344138907519189	0.0865229730569469
74796	4976	4	0.5397015806011122	0.4582898626325856	0.08141171796852659
18001	2278	4	0.24707399529930335	0.19287018406736717	0.05420381123193618
18279	2708	4	0.29371219458758274	0.23957013687060635	0.05414205771697639

Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2375	4	1.8070318265858132	1.5491249968949499	0.2579068296908633
99995	1617	4	1.2303033530902145	1.0362328290732046	0.19407052401700997
16374	2124	4	1.616057094597165	1.477662269915791	0.13839482468137398
12131	1276	4	0.9708516255677884	0.8552705119606528	0.11558111360713552
45507	755	4	0.5744459069778058	0.4895732419206597	0.08487266505714613
32645	1872	4	1.4243215071025863	1.3472346424224357	0.07708686468015058
59684	666	4	0.5067297669499585	0.4359956032491244	0.07073416370083413
19628	266	4	0.20238756457761106	0.13198015252005862	0.07040741205755244
49788	1283	4	0.9761776141093045	0.9067832923466727	0.06939432176263183
11317	227	4	0.1727141998463072	0.11398638746056586	0.058727812385741346

Cluster #4 - Popularity on Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	1362	4	1.627084627514694	1.3472346424224357	0.2798499850922582
59684	516	4	0.6164285372963157	0.4359956032491244	0.18043293404719135
12131	846	4	1.010656090218378	0.8552705119606528	0.15538557825772525
74796	508	4	0.6068715057103263	0.4582898626325856	0.14858164307774074
99995	990	4	1.1826826587661872	1.0362328290732046	0.1464498296929826
45507	524	4	0.6259855688823052	0.4895732419206597	0.13641232696164546
10171	868	4	1.0369379270798489	0.9217651588543606	0.11517276822548828
34742	167	4	0.19950303435752856	0.0935862086096828	0.10591682574784576
15433	269	4	0.3213551870788933	0.21694984723153737	0.10440533984735595
58812	332	4	0.39661681081855976	0.29626835084581565	0.10034845997274411

Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	16391	5	1.5724516373508828	1.3472346424224357	0.22521699492844705
99993	85241	5	8.177496798207956	8.000394341356783	0.17710245685117343
60179	17573	5	1.6858454409838974	1.5491249968949499	0.13672044408894757
31709	3127	5	0.2999851302541767	0.20452964701790996	0.09545548323626676
30754	2819	5	0.2704375062956585	0.17632026728270858	0.09411723901294991
57708	4713	5	0.4521362068717412	0.3595647961845145	0.09257141068722674
49788	10386	5	0.996368904003799	0.9067832923466727	0.08958561165712631
45507	6008	5	0.5763705348791474	0.4895732419206597	0.08679729295848765
58515	7925	5	0.7602757138677169	0.6785621134212684	0.08171360044644849
56905	6121	5	0.5872110592535388	0.5062939364582557	0.08091712279528307

Cluster #5 - Popularity on Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	12310	5	8.35726457429547	8.000394341356783	0.3568702329386877
60179	2509	5	1.7033612361419446	1.5491249968949499	0.1542362392469947
32645	2207	5	1.4983332993883107	1.3472346424224357	0.151098656965875
56905	909	5	0.6171205116193812	0.5062939364582557	0.11082657516112548
14771	1429	5	0.9701487470892143	0.8762606503216832	0.09388809676753107
49788	1463	5	0.9932313624853188	0.9067832923466727	0.0864480701386462
31046	526	5	0.3571016381867927	0.27263891993938943	0.08446271824740326
45507	843	5	0.5723130817328256	0.4895732419206597	0.08273983981216587
65732	539	5	0.3659273440735385	0.2925888665325285	0.07333847754100997
57708	635	5	0.4311017875448923	0.3595647961845145	0.07153699136037783

Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	1540	5	1.6252268985605132	1.3472346424224357	0.27799225613807743
60179	1627	5	1.7170416649077629	1.5491249968949499	0.16791666801281302
45507	602	5	0.6353159694372915	0.4895732419206597	0.1457427275166318
57708	469	5	0.4949554645616108	0.3595647961845145	0.13539066837709635
11713	430	5	0.45379712102663683	0.3344138907519189	0.11938323027471792
31709	304	5	0.320824011144413	0.20452964701790996	0.11629436412650304
49788	963	5	1.016294482671282	0.9067832923466727	0.10951119032460943
34540	281	5	0.29655114188019754	0.19066559852944828	0.10588554335074926
61854	342	5	0.3609270125374646	0.26604068857589985	0.09488632396156477
59337	461	5	0.48651272742623153	0.3975861340884815	0.08892659333775005

Cluster #6 - Popularity on Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	17124	6	1.992390659359838	1.5491249968949499	0.4432656624648881
16374	15144	6	1.76201612621732	1.477662269915791	0.2843538563015289
11187	8409	6	0.9783936612098153	0.8912425168293712	0.08715114438044413
61854	2947	6	0.34288573190454585	0.26604068857589985	0.076845043328646
14765	4703	6	0.5471976916006376	0.47915579899147975	0.06804189260915783
19630	1949	6	0.2267676591387716	0.16206808753757113	0.06469957160120046
12852	5222	6	0.6075837434698128	0.5486778696872594	0.05890587378255341
11066	5559	6	0.6467939544137666	0.5880809548649923	0.05871299954877429
64241	3434	6	0.3995485589956601	0.34231624313783937	0.05723231585782074
58646	5750	6	0.6690169523078177	0.6139770723104057	0.055039879997412

Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2490	6	2.0653616456536166	1.5491249968949499	0.5162366487586667
16374	2320	6	1.9243530192435303	1.477662269915791	0.4466907493277392
61854	470	6	0.38984737889847376	0.26604068857589985	0.12380669032257391
99995	1381	6	1.145487723954877	1.0362328290732046	0.1092548948816725
58646	855	6	0.7091904445919044	0.6139770723104057	0.09521337228149873
64241	520	6	0.43132050431320507	0.34231624313783937	0.0890042611753657
32645	1716	6	1.4233576642335766	1.3472346424224357	0.07612302181114083
10335	298	6	0.24717982747179826	0.1749229947586755	0.07225683271312275
11187	1159	6	0.9613470471134705	0.8912425168293712	0.07010453028409935
32797	169	6	0.14017916390179164	0.07101249472141491	0.06916666918037673

Cluster #6 - Popularity on Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	1479	6	1.8796705810584107	1.5491249968949499	0.3305455841634608
16374	1324	6	1.682680087438361	1.477662269915791	0.20501781752256987
19630	243	6	0.30883025773982004	0.16206808753757113	0.1467621702022489
10335	227	6	0.2884957551725891	0.1749229947586755	0.11357276041391356
64241	354	6	0.44990086929998474	0.34231624313783937	0.10758462616214537
32645	1139	6	1.4475624015047532	1.3472346424224357	0.1003277590823175
15433	248	6	0.3151847897920797	0.21694984723153737	0.09823494256054233
10142	757	6	0.9620761527121142	0.8874388305139478	0.07463732219816643
29931	79	6	0.1004016064257028	0.027417591971582583	0.07298401445412021
11713	318	6	0.4041482385237151	0.3344138907519189	0.06973434777179621

Full Data Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	36356	7	9.055697671811911	8.000394341356783	1.0553033304551285
10171	4873	7	1.2137863008785192	0.9217651588543606	0.29202114202415863
12131	4599	7	1.145537286628424	0.8552705119606528	0.29026677466777107
11118	1388	7	0.34572858313551913	0.06581153588195843	0.2799170472535607
70387	2611	7	0.650358307324813	0.3853677621283255	0.2649905451964875
10642	1729	7	0.430666224957718	0.18490573068037855	0.24576049427733945
11809	1258	7	0.3133476639657659	0.09818168268872493	0.21516598127704098
10222	1013	7	0.2523220855304617	0.046063417542290784	0.2062586679881709
14909	2674	7	0.6660505989224627	0.4622332762004124	0.20381732272205028
35513	1437	7	0.35793369882257997	0.15692922969918274	0.20100446912339723

Cluster #7 - Popularity on Data (Filtered by Every 7th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	5191	7	8.901044256588762	8.000394341356783	0.9006499152319787
11118	201	7	0.3446561155026664	0.06581153588195843	0.27884457962070797
12131	660	7	1.131706647919203	0.8552705119606528	0.2764361359585502
10642	258	7	0.4423944169138703	0.18490573068037855	0.25748868623349175
14765	420	7	0.7201769577667655	0.47915579899147975	0.24102115877528574
14767	295	7	0.5058385774790377	0.26521785031174705	0.24062072716729066
70387	353	7	0.6052915859325434	0.3853677621283255	0.21992382380421788
11809	176	7	0.3017884394451208	0.09818168268872493	0.20360675675639586
14909	384	7	0.6584475042439	0.4622332762004124	0.1962142280434876
10222	141	7	0.241773692964557	0.046063417542290784	0.1957102754222662

Data (Filtered by Every 11th Row) Set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	3264	7	8.989259157256955	8.000394341356783	0.9888648159001718
10171	510	7	1.404571743321399	0.9217651588543606	0.4828065844670383
12131	480	7	1.321949876067199	0.8552705119606528	0.4666793641065462
11561	215	7	0.592123381988433	0.17360334848597758	0.41852003350245537
14909	297	7	0.8179564858165794	0.4622332762004124	0.35572320961616705
11367	155	7	0.42687964748003304	0.11876816454281243	0.3081114829372206
11118	132	7	0.3635362159184798	0.06581153588195843	0.29772468003652136
35070	167	7	0.459928394381713	0.1666790868668803	0.2932493075148327
70387	231	7	0.6361883778573395	0.3853677621283255	0.250820615729014
14767	184	7	0.5067474524924264	0.26521785031174705	0.24152960218067931

Start - **Calculating Statistics in order to compare results of subsets/clusters**

In [0]:
```
from pyspark.sql.functions import avg, stddev, expr

# Function to calculate summary statistics for a given DataFrame
def calculate_stats_by_cluster(df, subset_name):
    return df.groupBy("centroid").agg(
        avg("view_percentage").alias(f"{subset_name}_avg_view_percentage"),
        avg("general_view_percentage").alias(f"{subset_name}_avg_general_view_percentage"),
        avg("rank_diff").alias(f"{subset_name}_avg_rank_diff"),
        stddev("view_percentage").alias(f"{subset_name}_stddev_view_percentage"),
        stddev("general_view_percentage").alias(f"{subset_name}_stddev_general_view_percentage"),
        stddev("rank_diff").alias(f"{subset_name}_stddev_rank_diff")
    )

# Calculate stats for each subset
sevenths_cluster_stats = calculate_stats_by_cluster(sevenths_subset_popularity, "sevenths")
eleventhss_cluster_stats = calculate_stats_by_cluster(eleventhss_subset_popularity, "eleventhss")
full_cluster_stats = calculate_stats_by_cluster(clustered_data_views_popularity, "full")

# Display the statistics for each subset
sevenths_cluster_stats.display()
```

```
elevenths_cluster_stats.display()
full_cluster_stats.display()
```

centroid	sevenths_avg_view_percentage	sevenths_avg_general_view_percentage	sevenths_avg_rank_diff	sevenths_stddev_view_percentage	s
0	0.0744601638123603	0.0711049757356638	0.0033551880766965773	0.28320430035320027	
7	0.05998800239952009	0.059002479629269765	9.85522770250332E-4	0.2549193680901976	
6	0.049900199600798424	0.04967220153924208	2.279980615562975E-4	0.21460703237080267	
5	0.04970178926441351	0.0494755002538116	2.2628901060191308E-4	0.21974709999925604	
1	0.052002080083203304	0.05171420496683744	2.8787511636590833E-4	0.20610673018256642	
3	0.05299417064122947	0.05264659262173761	3.4757801949185553E-4	0.21135690591399897	
2	0.04470272686633883	0.04461331613804641	8.941072829244711E-5	0.20706949861221646	
4	0.04812319538017324	0.04797350148491323	1.4969389526000952E-4	0.21104555843135434	

centroid	elevenths_avg_view_percentage	elevenths_avg_general_view_percentage	elevenths_avg_rank_diff	elevenths_stddev_view_percentage
0	0.08561643835616432	0.07983984896185838	0.005776589394305964	0.2801364283263304
7	0.06591957811470009	0.06419444341693283	0.0017251346977672402	0.26851298141121355
6	0.05321979776476852	0.05286274179614708	3.570559686214053E-4	0.20987868194206816
5	0.05257623554153524	0.052224093153643424	3.5214238789176055E-4	0.2199234816961371
1	0.059031877213695384	0.05833678774734198	6.950894663534146E-4	0.218335713099126
3	0.0582750582750583	0.057576503439179506	6.985548358787793E-4	0.220522793010641
2	0.04743833017077796	0.047299626642182624	1.3870352859537795E-4	0.2126852666653432
4	0.0531914893617021	0.0528421960050294	3.492933566727393E-4	0.2210154216590307

centroid	full_avg_view_percentage	full_avg_general_view_percentage	full_avg_rank_diff	full_stddev_view_percentage	full_stddev_general
0	0.04800768122899665	0.047715436839668564	2.922443893280913E-4	0.2236639645428829	0.20
7	0.04264392324093818	0.042570626846180654	7.329639475750012E-5	0.21637328196644937	0.19
6	0.039215686274509824	0.03920326607429617	1.24202002136277 15E-5	0.18963518982835248	0.1
5	0.0390777647518562	0.039065721914114865	1.2042837741329807E-5	0.19376780441628427	0.18
1	0.04001600640256103	0.03999849312504889	1.7513277512113187E-5	0.18402017707170695	0.19
3	0.040485829959514164	0.040464239176248064	2.1590783266098782E-5	0.18556232585519605	0.19
2	0.03762227238525208	0.0376179968084291	4.27557682297573E-6	0.18810631395302896	0.186
4	0.03901677721420213	0.03900681270515439	9.964509047706387E-	0.1891109117041676	0.18

In [0]:
```
# Function to calculate ranks for each column
def calculate_ranks(df, column_name):
    window_asc = Window.orderBy(F.asc(column_name))
    window_desc = Window.orderBy(F.desc(column_name))

    df = df.withColumn(f"{column_name}_rank_asc", F.row_number().over(window_asc))
    df = df.withColumn(f"{column_name}_rank_desc", F.row_number().over(window_desc))

    return df

# Function to get extreme clusters based on ranking
def get_extreme_clusters(df, column_name):
    # Highest value
    highest_cluster = df.filter(F.col(f"{column_name}_rank_desc") == 1).select("centroid", column_name)\
                                                                       .collect()
    # Lowest value
    lowest_cluster = df.filter(F.col(f"{column_name}_rank_asc") == 1).select("centroid", column_name).collect()

    # Middle value (approximate median)
    median_rank = (df.count() // 2) + 1
    middle_cluster = df.filter(F.col(f"{column_name}_rank_asc") == median_rank)\
                .select("centroid", column_name).collect()
                cluster, lowest_cluster
```

```
# Function to process and print results
def process_and_print(df, name):
    print(f"Checking table {name} results:")

    # List of columns to evaluate
    columns_to_check = [
        f"{name}_avg_view_percentage",
        f"{name}_avg_rank_diff",
        f"{name}_stddev_view_percentage"
    ]

    for col_name in columns_to_check:
        df_ranked = calculate_ranks(df, col_name)

        highest_cluster, middle_cluster, lowest_cluster = get_extreme_clusters(df_ranked, col_name)

        print(f"\nFor {col_name}:")
        print(f"  Highest: Cluster {highest_cluster[0]['centroid']} with value {highest_cluster[0][col_name]}")
        print(f"  Middle: Cluster {middle_cluster[0]['centroid']} with value {middle_cluster[0][col_name]}")
        print(f"  Lowest: Cluster {lowest_cluster[0]['centroid']} with value {lowest_cluster[0][col_name]}")

# Process each DataFrame
for df, name in [(sevenths_cluster_stats, "sevenths"), (elevenths_cluster_stats, "elevenths"), (full_cluster_stats, "f
    process_and_print(df, name)
```

```
Checking table sevenths results:

For sevenths_avg_view_percentage:
  Highest: Cluster 0 with value 0.07457121551081283
  Middle: Cluster 3 with value 0.05219206680584552
  Lowest: Cluster 2 with value 0.04474272930648769

For sevenths_avg_rank_diff:
  Highest: Cluster 0 with value 0.003730304883270004
  Middle: Cluster 1 with value 0.00032378425847299613
  Lowest: Cluster 2 with value 8.022534457184039e-05

For sevenths_stddev_view_percentage:
  Highest: Cluster 0 with value 0.2790316701994497
  Middle: Cluster 4 with value 0.21148151216782468
  Lowest: Cluster 2 with value 0.20662652581793584
Checking table elevenths results:

For elevenths_avg_view_percentage:
  Highest: Cluster 0 with value 0.08718395815170005
  Middle: Cluster 3 with value 0.05803830528148577
  Lowest: Cluster 2 with value 0.047687172150691466

For elevenths_avg_rank_diff:
  Highest: Cluster 0 with value 0.005805506731320231
  Middle: Cluster 3 with value 0.0005921444137890031
  Lowest: Cluster 2 with value 0.00016773857665559476

For elevenths_stddev_view_percentage:
  Highest: Cluster 0 with value 0.2846552020454802
  Middle: Cluster 4 with value 0.22173434329984332
  Lowest: Cluster 3 with value 0.21397350755876457
Checking table full results:

For full_avg_view_percentage:
  Highest: Cluster 0 with value 0.04800768122899664
  Middle: Cluster 1 with value 0.04001600640256105
  Lowest: Cluster 2 with value 0.03762227238525205

For full_avg_rank_diff:
  Highest: Cluster 0 with value 0.0002922443893280914
  Middle: Cluster 1 with value 1.751327751211325e-05
  Lowest: Cluster 2 with value 5.576822975792e-06
```

```
For full_stddev_view_percentage:
  Highest: Cluster 0 with value 0.2236639645428829
  Middle: Cluster 6 with value 0.1896351898283524
  Lowest: Cluster 1 with value 0.184020177071707
```

In [0]:

```
from pyspark.sql import functions as F
from pyspark.sql.window import Window

# Ensure that 'rank_diff' is calculated in each DataFrame
clustered_data_views_popularity_check = clustered_data_views_pop\
    .withColumnRenamed("centroid", "clustered_centroid")\
    .join(general_popularity, on=["station_num"], how="inner")\
    .withColumn("rank_diff", F.col("view_percentage") - F.col("general_view_percentage"))\
    .withColumn("subset_type", F.lit("full"))\
    .select(F.col("clustered_centroid").alias("centroid"), "subset_type", "rank_diff")

sevenths_subset_popularity_check = sevenths_subset_pop\
    .withColumnRenamed("centroid", "sevenths_centroid")\
    .join(general_popularity, on=["station_num"], how="inner")\
    .withColumn("rank_diff", F.col("view_percentage") - F.col("general_view_percentage"))\
    .withColumn("subset_type", F.lit("sevenths"))\
    .select(F.col("sevenths_centroid").alias("centroid"), "subset_type", "rank_diff")

elevenths_subset_popularity_check = elevenths_subset_pop\
    .withColumnRenamed("centroid", "elevenths_centroid")\
    .join(general_popularity, on=["station_num"], how="inner")\
    .withColumn("rank_diff", F.col("view_percentage") - F.col("general_view_percentage"))\
    .withColumn("subset_type", F.lit("elevenths"))\
    .select(F.col("elevenths_centroid").alias("centroid"), "subset_type", "rank_diff")

# Union all DataFrames
combined_df = clustered_data_views_popularity_check\
    .union(sevenths_subset_popularity_check)\
    .union(elevenths_subset_popularity_check)

# Define the column to check
metric_column = "rank_diff"

# Function to calculate summary statistics and rank
def summarize_metrics(df, metric):
    # Group by centroid and subset_type and calculate average and standard deviation
    summary_df = df.groupBy("centroid", "subset_type").agg(
        F.avg(metric).alias(f"avg_{metric}"),
        F.stddev(metric).alias(f"stddev_{metric}")
```

```
    )

    # Rank metrics within each centroid
    window = Window.partitionBy("centroid").orderBy(F.desc(f"avg_{metric}"))
    ranked_df = summary_df.withColumn(f"{metric}_rank", F.row_number().over(window))

    return summary_df, ranked_df

# Compute summary statistics
summary_df, ranked_df = summarize_metrics(combined_df, metric_column)

# Get highest, middle, and lowest clusters for each metric within each centroid
def get_extreme_clusters(df, metric):
    count = df.count()

    if count == 0:
        return [], [], []  # Handle case when DataFrame is empty

    highest = df.filter(F.col(f"{metric}_rank") == 1).select("centroid", "subset_type", f"avg_{metric}").collect()
    lowest = df.filter(F.col(f"{metric}_rank") == count).select("centroid", "subset_type", f"avg_{metric}").collect()
    median_rank = (count // 2) + 1
    middle = df.filter(F.col(f"{metric}_rank") == median_rank).select("centroid", "subset_type", f"avg_{metric}").coll

    return highest, middle, lowest

# Print results for each cluster
for centroid in ranked_df.select("centroid").distinct().collect():
    centroid_value = centroid["centroid"]
    centroid_df = ranked_df.filter(F.col("centroid") == centroid_value)

    highest, middle, lowest = get_extreme_clusters(centroid_df, metric_column)

    if highest and middle and lowest:  # Ensure there are results to print
        print(f"\nFor Cluster {centroid_value}:")
        print(f"  Highest: Subset {highest[0]['subset_type']} with value {highest[0][f'avg_{metric_column}']}")
        print(f"  Middle: Subset {middle[0]['subset_type']} with value {middle[0][f'avg_{metric_column}']}")
        print(f"  Lowest: Subset {lowest[0]['subset_type']} with value {lowest[0][f'avg_{metric_column}']}")
```

```
For Cluster 0:
  Highest: Subset elevenths with value 0.006116228711717073
  Middle: Subset sevenths with value 0.00335894301450459
  Lowest: Subset full with value 0.0002922443893280915

For Cluster 7:
  Highest: Subset elevenths with value 0.0018159906871739926
  Middle: Subset sevenths with value 0.000963656988696112
  Lowest: Subset full with value 7.329639475749983e-05

For Cluster 6:
  Highest: Subset elevenths with value 0.0003444971322411404
  Middle: Subset sevenths with value 0.00021769167750667316
  Lowest: Subset full with value 1.2420200213627749e-05

For Cluster 5:
  Highest: Subset elevenths with value 0.000293305463378187
  Middle: Subset sevenths with value 0.00020256245249885313
  Lowest: Subset full with value 1.2042837741329807e-05

For Cluster 1:
  Highest: Subset elevenths with value 0.0006195528319193443
  Middle: Subset sevenths with value 0.00036779899041705313
  Lowest: Subset full with value 1.7513277512113305e-05

For Cluster 3:
  Highest: Subset elevenths with value 0.0007396059289912993
  Middle: Subset sevenths with value 0.00033831289031265277
  Lowest: Subset full with value 2.1590783266098677e-05

For Cluster 2:
  Highest: Subset elevenths with value 0.00017490784361082502
  Middle: Subset sevenths with value 8.61818327995327e-05
  Lowest: Subset full with value 4.2755768229758135e-06

For Cluster 4:
  Highest: Subset elevenths with value 0.0003452610530881975 5
  Middle: Subset sevenths with value 0.00016328565491403147
  Lowest: Subset full with value 9.964509047706438e-06
```

Finish - **Calculating statistics for comparing results**

Dynamic Data Analysis - Streaming

In [0]:
```
SCHEMA = "device_id STRING, event_date INT, event_time INT, station_num STRING, prog_code STRING, household_id STRING"
kafka_server = "kafka.eastus.cloudapp.azure.com:29092"
topic = "view_data"
OFFSETS_PER_TRIGGER = 50000

streaming_df = spark.readStream\
                  .format("kafka")\
                  .option("kafka.bootstrap.servers", kafka_server)\
                  .option("subscribe", topic)\
                  .option("startingOffsets", "earliest")\
                  .option("failOnDataLoss",False)\
                  .option("maxOffsetsPerTrigger", OFFSETS_PER_TRIGGER)\
                  .load()\
                  .select(f.from_csv(f.decode("value", "US-ASCII"), schema=SCHEMA).alias("value")).select("value.*")

viewing_counts = streaming_df.groupBy("event_date").count()
count_viewing_query =viewing_counts.writeStream\
.queryName('num_viewing')\
.format("memory")\
.outputMode("complete")\
.start()

time.sleep(10)

for i in range(10):
    print("Batch number: "+str(i))
    print(count_viewing_query.status)
    spark.sql('SELECT * FROM num_viewing').show()
    time.sleep(5)

count_viewing_query.stop()
```

```
Batch number: 0
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+-----+
|event_date|count|
+----------+-----+
+----------+-----+

Batch number: 1
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+-----+
|event_date|count|
+----------+-----+
|  20150913|12582|
|  20151004|18896|
|  20151018|18522|
+----------+-----+

Batch number: 2
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+-----+
|event_date|count|
+----------+-----+
|  20150913|30085|
|  20151004|35537|
|  20151018|34378|
+----------+-----+

Batch number: 3
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+-----+
|event_date|count|
+----------+-----+
|  20150913|64487|
|  20151004|70127|
|  20151018|65386|
+----------+-----+

Batch number: 4
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+-----+
|event_date|count|
+----------+-----+
```



```
|  20151004|87203|
```

```
|  20151018|81067|
+----------+-----+

Batch number: 5
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+------+
|event_date| count|
+----------+------+
|  20150913| 98115|
|  20151004|104351|
|  20151018| 97534|
+----------+------+

Batch number: 6
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+------+
|event_date| count|
+----------+------+
|  20150913|133167|
|  20151004|138044|
|  20151018|128789|
+----------+------+

Batch number: 7
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+------+
|event_date| count|
+----------+------+
|  20150913|167737|
|  20151004|172268|
|  20151018|159995|
+----------+------+

Batch number: 8
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+------+
|event_date| count|
+----------+------+
|  20150913|184615|
|  20151004|189606|
|  20151018|175779|
+----------+------+
```



```
Batch number: 9
```

```
{'message': 'Processing new data', 'isDataAvailable': True, 'isTriggerActive': True}
+----------+------+
|event_date| count|
+----------+------+
|  20150913|217367|
|  20151004|226205|
|  20151018|206428|
+----------+------+
```

In [0]:

```
from pyspark.sql.functions import col, count, max as spark_max
window_spec = Window.partitionBy("centroid").orderBy("dist")

result_df_with_row_num = result_df\
                        .withColumn("row_num", row_number().over(window_spec))

sevenths_subset = result_df_with_row_num\
                .filter(result_df_with_row_num["row_num"] % 7 == 0)\
                        .select("household_id", "features", "centroid", "dist")\
                            .withColumn(\
                                "household_id",  F.regexp_replace(F.col("household_id"), "^0+", ""))

# Path to external storage
external_storage_path = \
    "/Workspace/Users/gil.caplan@campus.technion.ac.il/storage"
schema = StructType([
            StructField("household_id", StringType(), True),
            StructField("station_num", StringType(), True),
            StructField("view_count_rows", LongType(), True)
        ])
def read_batches_from_file():
    if os.path.exists(external_storage_path):
        return spark.read.format("parquet").load(external_storage_path)
    return spark.createDataFrame([], schema)

def write_batches_to_file(df):
    df.write.mode("overwrite").parquet(external_storage_path)

write_batches_to_file(station_view_counts)
def process_batch(batch_df, batch_id):
    displayHTML(f"<h1>Processing batch {batch_id}:</h1>")
    batch_df = batch_df.withColumn(\
                                "household_id",  F.regexp_replace(F.col("household_id"), "^0+", ""))
    station_views = batch_df\
```

```
                            .groupby("household_id", "station_num") \
                                .agg(count("*").alias("view_count_rows"))
batches = read_batches_from_file()

# Aggregate counts from previous and current batch
aggregated_batches = batches.union(station_views)\
    .groupBy("household_id", "station_num")\
    .agg(count("*").alias("view_count_rows"))

write_batches_to_file(batches.union(station_views))
if aggregated_batches.count() > 0:
    station_view_counts = aggregated_batches
else:
    station_view_counts = station_views

# Update the external storage with aggregated batches

window_spec = Window.partitionBy("centroid")
sevenths_batch = process_subset_data(sevenths_subset, station_view_counts, window_spec)
clustered_data_views_pop = process_subset_data(total_data_clustered, station_view_counts, window_spec)

# views over all the data
demo_count_views = total_data_clustered.join(station_view_counts, "household_id", "inner")

# Calculate the maximum view count within the DataFrame using a window function
window_spec = Window.orderBy(F.lit(1))\
    .rowsBetween(Window.unboundedPreceding, Window.unboundedFollowing)

demo_count_views = demo_count_views.groupBy("station_num")\
        .agg(F.count("*").alias("view_count_rows"))
demo_count_views = demo_count_views.withColumn(
    "total_view_count",
    F.lit(sum("view_count_rows").over(window_spec))
)
# Calculate the percentage of views for each station
demo_count_views = demo_count_views\
    .withColumn(
        "general_view_percentage",
        (F.col("view_count_rows") / F.col("total_view_count")) * 100
    ) \
    .select(
        F.col("station_num"),
        ).alias("view_count"),
        F.col("general_view_percentage")
```

```
        )


    # Extract general popularity
    general_popularity = demo_count_views.select("general_view_percentage", "station_num")

    sevenths_batch_pop = sevenths_batch.join(general_popularity, \
                on=["station_num"], how="inner")\
                .withColumn("rank_diff", col("view_percentage") - col("general_view_percentage"))
    seven_pop_dict = {i  : sevenths_subset_popularity.filter(col("centroid") == i)\
        .orderBy(col("rank_diff").desc()).limit(10) for i in range(10)}

    displayHTML(f"<h1>Results for batch {batch_id}:</h1>")
    for i in range(x):
        displayHTML(f"<h2>Cluster #{i} - Populatriy on data (filtered by every 7th row) set</h2>")
        seven_pop_dict[i].display()


# Set up a streaming query to process each trigger
query = streaming_df.writeStream \
    .foreachBatch(process_batch) \
    .outputMode("append") \
    .start()

# Allow the streaming query to run for sufficient time to process multiple batches
time.sleep(720)
query.stop()
```

Processing batch 0:

Results for batch 0:

Cluster #0 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	2348	0	8.794666267136115	8.000394341356783	0.7942719257793325
10171	447	0	1.6742827178065771	0.9217651588543606	0.7525175589522165
12131	414	0	1.5506779534047495	0.8552705119606528	0.6954074414440966
16615	296	0	1.1086972806951831	0.6113067292644757	0.49739055143070743
11118	143	0	0.535620645741254	0.06581153588195843	0.4698091098592956
35513	145	0	0.5431118435837891	0.15692922969918274	0.3861826138846063
70387	203	0	0.7603565810173046	0.3853677621283255	0.3749888188889791
47540	187	0	0.7004269982770245	0.34304592990039	0.35738106837663447
59684	207	0	0.7753389767023747	0.4359956032491244	0.33934337345325033
11561	119	0	0.4457262716308337	0.17360334848597758	0.27212292314485614

Cluster #1 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
11221	1046	1	1.1057666895713305	0.8102317609359863	0.29553492863534425
14902	1091	1	1.1533379142660818	0.9497261345852894	0.20361177968079236
15433	386	1	0.4080553940483112	0.21694984723153737	0.19110554681677383
11713	495	1	0.5232834716422644	0.3344138907519189	0.1888695808903455
74796	608	1	0.6427401025424176	0.4582898626325856	0.18445023990983206
11207	941	1	0.9947671652835773	0.810604366942395	0.18416279834118232
16615	748	1	0.7907394682594218	0.6113067292644757	0.17943273899494605
12574	749	1	0.7917966065859717	0.6219570509476613	0.16983955563831044
11164	749	1	0.7917966065859717	0.6261022927689595	0.16569431381701227
11066	679	1	0.7177969237274697	0.5880809548649923	0.12971596886247738

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	4255	2	1.686865443243222	1.477662269915791	0.20920317332743088
99993	20588	2	8.161970798000342	8.000394341356783	0.16157645664355869
11221	2335	2	0.9256946674436951	0.8102317609359863	0.11546290650770885
12852	1641	2	0.650563147441158	0.5486778696872594	0.10188527775389855
11066	1731	2	0.6862430275567607	0.5880809548649923	0.09816207269176835
11069	1421	2	0.5633456627141289	0.4700114265841966	0.0933342361299323
61522	1370	2	0.5431270639819539	0.45273182303698734	0.09039524094496654
66268	1218	2	0.48286771089782476	0.39635963931738577	0.086508071580439
14902	2597	2	1.0295627628913389	0.9497261345852894	0.07983662830604943
49788	2468	2	0.9784216013923082	0.9067832923466727	0.0716383090456355

Cluster #3 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
58515	802	3	0.9080821576575556	0.6785621134212684	0.22952004423628725
32645	1382	3	1.5647999275345907	1.3472346424224357	0.217565285112155
74796	529	3	0.5989718970085373	0.4582898626325856	0.14068203437595167
14771	892	3	1.009986639190199	0.8762606503216832	0.13372598886851583
18284	333	3	0.3770465816707806	0.2635721737834414	0.1134744078873392
11867	762	3	0.8627912769763808	0.7518412946816703	0.11094998229471054
56905	543	3	0.6148237052469485	0.5062939364582557	0.1085297687886928
11713	383	3	0.4336601825222492	0.3344138907519189	0.09924629177033029
60048	431	3	0.48800923933965895	0.38983903420523136	0.09817020513442759
58574	397	3	0.44951199076066034	0.3554506048637504	0.09406138589690993

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2339	4	1.772627717864965	1.5491249968949499	0.2235027209700151
99995	1608	4	1.2186341899644566	1.0362328290732046	0.18240136089125203
10171	1456	4	1.1034399133011497	0.9217651588543606	0.18167475444678904
12131	1340	4	1.015528491637047	0.8552705119606528	0.1602579796763942
45507	769	4	0.5827920970663352	0.4895732419206597	0.09321885514567546
32645	1896	4	1.4368970299580905	1.3472346424224357	0.08966238753565481
59684	687	4	0.5206478162348144	0.4359956032491244	0.08465221298568998
18284	443	4	0.33573068790687455	0.2635721737834414	0.07215851412343316
11713	532	4	0.40317996832157393	0.3344138907519189	0.06876607756965503
70225	310	4	0.23493569582648102	0.167005117122488	0.06793057870399302

Cluster #5 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	12588	5	8.422320353271779	8.000394341356783	0.4219260119149961
32645	2219	5	1.4846781747624782	1.3472346424224357	0.13744353234004247
56905	958	5	0.6409741736919577	0.5062939364582557	0.13468023723370204
14776	527	5	0.35260270306436503	0.2582780634423827	0.09432463962198234
11150	1139	5	0.762076809848789	0.6869302233151998	0.07514658653358919
45507	839	5	0.5613542084838753	0.4895732419206597	0.07178096656321559
14765	813	5	0.543958249698916	0.47915579899147975	0.06480245070743629
57708	634	5	0.42419376421785093	0.3595647961845145	0.06462896803333645
15952	410	5	0.2743208885320487	0.21024293911617856	0.06407794941587017
14771	1398	5	0.9353673223604978	0.8762606503216832	0.05910667203881459

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	2378	6	1.9316215711280247	1.477662269915791	0.4539593012122336
60179	2333	6	1.8950685977467123	1.5491249968949499	0.34594360085176246
11187	1256	6	1.0202341014873	0.8912425168293712	0.12899158465792882
19630	329	6	0.2672428498322625	0.16206808753757113	0.10517476229469136
32797	203	6	0.16489452436458746	0.07101249472141491	0.09388202964317255
64241	532	6	0.43213737419684994	0.34231624313783937	0.08982113105901057
20290	261	6	0.21200724561161247	0.1245435576421492	0.08746368796946327
10142	1197	6	0.9723090919429124	0.8874388305139478	0.08487026142896459
99995	1368	6	1.1112103907918998	1.0362328290732046	0.07497756171869518
32645	1749	6	1.4206922320870123	1.3472346424224357	0.0734575896645766

Cluster #7 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	5236	7	8.893569317525563	8.000394341356783	0.8931749761687797
10642	291	7	0.494275911268132	0.18490573068037855	0.30937018058775345
14909	448	7	0.7609471073818663	0.4622332762004124	0.29871383118145395
11118	200	7	0.33970853008119034	0.06581153588195843	0.2738969941992319
12131	658	7	1.1176410639671164	0.8552705119606528	0.26237055200646353
70387	365	7	0.6199680673981723	0.3853677621283255	0.23460030526984682
10222	160	7	0.2717668240649523	0.046063417542290784	0.2257034065226615
10918	421	7	0.7150864558209057	0.5148793998559257	0.20020705596498
10171	660	7	1.1210381492679282	0.9217651588543606	0.1992729904135676
14767	273	7	0.4637021435608248	0.26521785031174705	0.19848429324907774

Processing batch 1:

Results for batch 1:

Cluster #0 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
12131	396	0	1.4759597465523668	0.8552705119606528	0.620689234591714
10171	409	0	1.5244129705553484	0.9217651588543606	0.6026478117009878
99993	2290	0	8.53522176667909	8.000394341356783	0.5348274253223071
11118	147	0	0.5478941483414088	0.06581153588195843	0.4820826124594504
16615	280	0	1.0436079016026836	0.6113067292644757	0.43230117233820786
70387	206	0	0.7677972418934029	0.3853677621283255	0.3824294797650774
11561	146	0	0.5441669772642564	0.17360334848597758	0.37056362877827886
35513	141	0	0.5255311218784942	0.15692922969918274	0.3686018921793114
59684	210	0	0.7827059262020127	0.4359956032491244	0.34671032295288834
10559	145	0	0.540439806187104	0.2125717266562337	0.32786807953087027

Cluster #1 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16615	823	1	0.872284048754637	0.6113067292644757	0.26097731949016134
14902	1115	1	1.1817700052994171	0.9497261345852894	0.2320438707141277
11221	973	1	1.0312665606783253	0.8102317609359863	0.22103479974233908
74796	640	1	0.6783253842077371	0.4582898626325856	0.22003552157515155
10145	715	1	0.7578166401695814	0.5651967359713839	0.19261990419819752
12574	749	1	0.7938526762056175	0.6219570509476613	0.1718956252579562
15433	363	1	0.3847376788553259	0.21694984723153737	0.16778783162378852
11207	907	1	0.9613142554319024	0.810604366942395	0.1507098884895074
11713	454	1	0.48118706942236356	0.3344138907519189	0.14677317867044465
61623	216	1	0.2289348171701113	0.08399160394465559	0.14494321322545572

Cluster #2 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	4151	2	1.6586020753503203	1.477662269915791	0.18093980543452926
11221	2343	2	0.9361851752700073	0.8102317609359863	0.12595341433402107
14902	2653	2	1.060050904819176	0.9497261345852894	0.11032477023388654
12852	1597	2	0.6381082906129755	0.5486778696872594	0.08943042092571607
11069	1397	2	0.558194916710286	0.4700114265841966	0.08818349012608939
31709	727	2	0.29048511413627626	0.20452964701790996	0.0859554671183663
61522	1347	2	0.5382165732346136	0.45273182303698734	0.08548475019762625
11344	1045	2	0.41754737864155256	0.3322248304642671	0.08532254817728546
60179	4077	2	1.6290341270063253	1.5491249968949499	0.07990913011137546
11066	1663	2	0.6644797040008631	0.5880809548649923	0.07639874913587075

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
11867	832	3	0.9262661011099608	0.7518412946816703	0.1744248064282905
14771	943	3	1.0498424679647753	0.8762606503216832	0.1735818176430921
74796	545	3	0.6067488282511161	0.4582898626325856	0.1484589656185305
11207	853	3	0.9496454137581689	0.810604366942395	0.1390410468157739
31046	367	3	0.4085813210424947	0.27263891993938943	0.1359424011031053
10179	914	3	1.017556750498202	0.8952790818988002	0.1222776685994017
58515	719	3	0.8004631330505549	0.6785621134212684	0.12190101962928657
11150	720	3	0.8015764336528506	0.6869302233151998	0.11464621033765077
32645	1298	3	1.4450641817797225	1.3472346424224357	0.09782953935728678
65732	347	3	0.3863153089965822	0.2925888665325285	0.09372644246405365

Cluster #4 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2334	4	1.7717252687192566	1.5491249968949499	0.22260027182430675
99995	1572	4	1.1932956822736382	1.0362328290732046	0.15706285320043367
32645	1970	4	1.495415072569381	1.3472346424224357	0.14818043014694537
10171	1356	4	1.029331390052833	0.9217651588543606	0.1075662311984723
12131	1260	4	0.9564583712880307	0.8552705119606528	0.10118785932737784
45507	752	4	0.5708386469909515	0.4895732419206597	0.08126540507029184
59684	673	4	0.510870225299083	0.4359956032491244	0.0748746220499586
19628	261	4	0.19812351976680634	0.13198015252005862	0.06614336724674771
59615	467	4	0.35449687253294465	0.2909587152544899	0.06353815727845474
49788	1278	4	0.970122062306431	0.9067832923466727	0.0633387699597584

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	2296	5	1.5648748304605338	1.3472346424224357	0.21764018803809804
49788	1509	5	1.0284826302983214	0.9067832923466727	0.12169933795164878
60179	2451	5	1.6705175128304741	1.5491249968949499	0.12139251593552425
45507	896	5	0.6106828606675254	0.4895732419206597	0.12110961874686571
56905	895	5	0.6100012949748161	0.5062939364582557	0.10370735851656043
99993	11867	5	8.088140075381165	8.000394341356783	0.08774573402438257
31709	426	5	0.2903469850941583	0.20452964701790996	0.08581733807624833
57708	629	5	0.42870482071414456	0.3595647961845145	0.06914002452963008
24959	438	5	0.2985257734066698	0.2305344412151924	0.0679913321914774
42952	274	5	0.18674899980234594	0.11898551804655091	0.06776348175579502

Cluster #6 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	2262	6	1.8549498130289312	1.477662269915791	0.37728754311314017
60179	2286	6	1.8746309781539068	1.5491249968949499	0.3255059812589569
11187	1219	6	0.9996391786393755	0.8912425168293712	0.10839666181000429
58646	879	6	0.720822672702224	0.6139770723104057	0.10684560039181834
11066	845	6	0.6929410221085088	0.5880809548649923	0.10486006724351649
61854	430	6	0.3526208751558092	0.26604068857589985	0.08658018657990935
19630	296	6	0.2427343698746966	0.16206808753757113	0.08066628233712547
99995	1361	6	1.1160860722954797	1.0362328290732046	0.07985324322227516
10626	246	6	0.20173194253099783	0.12319286086891722	0.07853908166208061
64241	497	6	0.4075641277963655	0.34231624313783937	0.06524788465852616

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	5190	7	8.916146987579241	8.000394341356783	0.9157526462224581
14765	445	7	0.7644865914205706	0.47915579899147975	0.2853307924290909
11809	218	7	0.3745125324262571	0.09818168268872493	0.2763308497375322
14909	429	7	0.7369994330773592	0.4622332762004124	0.2747661568769468
12131	645	7	1.108076070710715	0.8552705119606528	0.25280555875006205
11118	171	7	0.2937690047930733	0.06581153588195843	0.22795746891111485
14767	284	7	0.48789706059200466	0.26521785031174705	0.2226792102802576
10171	664	7	1.1407170712432786	0.9217651588543606	0.21895191238891798
10179	647	7	1.1115119655036163	0.8952790818988002	0.21623288360481607
70387	342	7	0.5875380095861465	0.3853677621283255	0.20217024745782103

Processing batch 2:

Results for batch 2:

Cluster #0 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
10171	415	0	1.5536670285650107	0.9217651588543606	0.6319018697106501
12131	388	0	1.452585077308974	0.8552705119606528	0.5973145653483211
99993	2293	0	8.584478304818239	8.000394341356783	0.5840839634614561
11118	156	0	0.5840290517015462	0.06581153588195843	0.5182175158195877
16615	284	0	1.0632323761746099	0.6113067292644757	0.45192564691013415
35513	137	0	0.5128973082250758	0.15692922969918274	0.3559680785258931
70387	197	0	0.7375238665718243	0.3853677621283255	0.3521561044434988
47540	185	0	0.6925985549024747	0.34304592990039	0.34955262500208467
10559	141	0	0.527872412114859	0.2125717266562337	0.31530068545862533
11561	130	0	0.48669087641795516	0.17360334848597758	0.3130875279319776

Cluster #1 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
11221	1032	1	1.0781333249757106	0.8102317609359863	0.2679015640397243
74796	682	1	0.7124873329781344	0.4582898626325856	0.2541974703455488
15433	422	1	0.4408645960656491	0.21694984723153737	0.22391474883411172
14902	1113	1	1.1627542545522926	0.9497261345852894	0.21302811996700322
11069	634	1	0.6623415969327525	0.4700114265841966	0.19233017034855593
12574	779	1	0.8138235079031769	0.6219570509476613	0.19186645695551563
11207	951	1	0.9935123953991287	0.810604366942395	0.1829080284567337
11164	774	1	0.8085999937317829	0.6261022927689595	0.18249770096282347
11713	492	1	0.5139937944651644	0.3344138907519189	0.17957990371324545
16615	757	1	0.7908400455490436	0.6113067292644757	0.17953331628456792

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	21475	2	8.355836050520221	8.000394341356783	0.3554417091634381
41537	1035	2	0.4027143335175054	0.07371388826787888	0.3290004452496265
16374	4421	2	1.7201933028800884	1.477662269915791	0.24253103296429734
11344	1113	2	0.43306381952172324	0.3322248304642671	0.10083898905745614
14902	2672	2	1.0396644436316662	0.9497261345852894	0.08993830904637679
49788	2539	2	0.9879146790347306	0.9067832923466727	0.08113138668805797
61522	1353	2	0.526446853380855	0.45273182303698734	0.07371503034386762
11765	747	2	0.2906546928865474	0.22539558337680404	0.06525910950974334
30754	608	2	0.23657035244313362	0.17632026728270858	0.06025008516042504
36069	626	2	0.2435740799825685	0.18465732667610602	0.05891675330646248

Cluster #3 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
58515	794	3	0.9010235809445994	0.6785621134212684	0.22246146752333107
14771	960	3	1.0893987880438483	0.8762606503216832	0.21313813772216506
32645	1316	3	1.493384171943442	1.3472346424224357	0.14614952952100624
10179	912	3	1.034928848641656	0.8952790818988002	0.13964976674285567
11207	831	3	0.9430108259004563	0.810604366942395	0.13240645895806125
11150	712	3	0.8079707677991874	0.6869302233151998	0.1210405444839876
11867	766	3	0.8692494496266541	0.7518412946816703	0.1174081549449838
11713	395	3	0.44824220966387507	0.3344138907519189	0.11382831891195616
11187	882	3	1.0008851365152858	0.8912425168293712	0.1096426196859146
16616	282	3	0.3200108939878804	0.2149160394465559	0.1050948545413245

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2359	4	1.7983198402171097	1.5491249968949499	0.2491948433221598
99995	1686	4	1.2852764945341444	1.0362328290732046	0.2490436654609398
12131	1353	4	1.0314229520193934	0.8552705119606528	0.17615244005874053
10171	1373	4	1.0466694110292885	0.9217651588543606	0.12490425217492784
32645	1882	4	1.434691792831115	1.3472346424224357	0.08745715040867919
14902	1360	4	1.0367592126728566	0.9497261345852894	0.08703307808756722
45507	753	4	0.5740291817225449	0.4895732419206597	0.0844559398018852
59684	681	4	0.5191419292869232	0.4359956032491244	0.08314632603779876
11713	519	4	0.395645611306774	0.3344138907519189	0.061231720554855096
19628	251	4	0.19134306057418166	0.13198015252005862	0.05936290805412303

Cluster #5 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	2384	5	1.6101254195849064	1.3472346424224357	0.26289077716247067
60179	2632	5	1.7776216880652156	1.5491249968949499	0.22849669117026572
99993	12103	5	8.174223134746695	8.000394341356783	0.1738287933899123
45507	913	5	0.6166294077521055	0.4895732419206597	0.1270561658314458
56905	886	5	0.5983939269094912	0.5062939364582557	0.09209999045123551
31046	534	5	0.36065728777614936	0.27263891993938943	0.08801836783675993
48639	487	5	0.32891404334641333	0.24202312641279777	0.08689091693361556
31709	431	5	0.2910923053024726	0.20452964701790996	0.08656265828456264
82547	559	5	0.3775419922600515	0.29817795662866087	0.0793640356313906
30754	373	5	0.25191979089981964	0.17632026728270858	0.07559952361711106

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2563	6	2.0800194773575718	1.5491249968949499	0.5308944804626219
16374	2243	6	1.8203213763999349	1.477662269915791	0.34265910648414377
99993	10112	6	8.20645999026132	8.000394341356783	0.20606564890453782
61854	470	6	0.38143158578152897	0.26604068857589985	0.11539089720562912
58646	898	6	0.7287777958123681	0.6139770723104057	0.11480072350196247
10139	551	6	0.4471676675864308	0.3483710907419828	0.09879657684444798
14765	699	6	0.5672780392793377	0.47915579899147975	0.08812224028785798
64241	522	6	0.423632527187145	0.34231624313783937	0.08131628404930563
11066	820	6	0.6654763837039441	0.5880809548649923	0.07739542883895179
18284	412	6	0.33436130498295735	0.2635721737834414	0.07078913119951596

Cluster #7 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	5160	7	8.842429954588296	8.000394341356783	0.8420356132315128
12131	700	7	1.1995544512038385	0.8552705119606528	0.3442839392431857
11118	214	7	0.3667209322251735	0.06581153588195843	0.30090939634321506
10171	702	7	1.2029817496358497	0.9217651588543606	0.2812165907814891
10642	256	7	0.43869419929740383	0.18490573068037855	0.2537884686170253
10222	168	7	0.28789306828892125	0.046063417542290784	0.24182965074663046
14767	294	7	0.5038128695056122	0.26521785031174705	0.23859501919386517
14765	409	7	0.7008825293462428	0.47915579899147975	0.2217267303547631
70387	350	7	0.5997772256019193	0.3853677621283255	0.21440946347359374
11809	181	7	0.31017050809699254	0.09818168268872493	0.2119888254082676

Processing batch 3:

Results for batch 3:

Cluster #0 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	2343	0	8.847853177750086	8.000394341356783	0.8474588363933027
10171	428	0	1.6162531626449155	0.9217651588543606	0.6944880037905549
11118	162	0	0.6117593746459726	0.06581153588195843	0.5459478387640142
12131	370	0	1.3972282013519128	0.8552705119606528	0.54195768939126
16615	298	0	1.1253351459537027	0.6113067292644757	0.5140284166892269
35513	143	0	0.5400098183603338	0.15692922969918274	0.383080588661151
70387	200	0	0.7552584872172501	0.3853677621283255	0.36989072508892457
11561	141	0	0.5324572334881613	0.17360334848597758	0.35885388500218374
74796	202	0	0.7628110720894226	0.4582898626325856	0.30452120945683697
47540	165	0	0.6230882519542313	0.34304592990039	0.28004232205384133

Cluster #1 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
74796	730	1	0.7731494720342305	0.4582898626325856	0.31485960940164487
11221	1035	1	1.0961776761033266	0.8102317609359863	0.28594591516734036
11713	520	1	0.550736610216164	0.3344138907519189	0.21632271946424514
10145	736	1	0.7795041252290323	0.5651967359713839	0.21430738925764847
16615	776	1	0.8218684798610449	0.6113067292644757	0.21056175059656923
11069	642	1	0.6799478918438027	0.4700114265841966	0.20993646525960608
12131	989	1	1.0474586682765121	0.8552705119606528	0.19218815631585928
10171	1035	1	1.0961776761033266	0.9217651588543606	0.174412517248966
11207	903	1	0.956375305817685	0.810604366942395	0.14577093887529002
14902	1027	1	1.0877048051769242	0.9497261345852894	0.13797867059163482

Cluster #2 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	4169	2	1.6781927526547569	1.477662269915791	0.2005304827389658
60179	4222	2	1.6995274170564605	1.5491249968949499	0.15040242016151062
99993	20200	2	8.13132492291343	8.000394341356783	0.1309305815566475
11344	1116	2	0.4492355749490786	0.3322248304642671	0.11701074448481152
11221	2288	2	0.9210134368131647	0.8102317609359863	0.11078167587717846
49788	2517	2	1.0131952886620348	0.9067832923466727	0.10641199631536213
14902	2618	2	1.0538519132766018	0.9497261345852894	0.10412577869131234
11069	1419	2	0.57120544879278	0.4700114265841966	0.10119402220858342
61522	1343	2	0.5406123451224126	0.45273182303698734	0.0878805220854253
31709	692	2	0.2785582597354502	0.20452964701790996	0.07402861271754022

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
14771	933	3	1.0481261795632246	0.8762606503216832	0.17186552924154141
58515	748	3	0.8402983733261437	0.6785621134212684	0.16173625990487528
32645	1342	3	1.5075941403792577	1.3472346424224357	0.16035949795682192
10179	920	3	1.0335220634492677	0.8952790818988002	0.13824298155046744
74796	525	3	0.5897816122944189	0.4582898626325856	0.13149174966183336
11207	838	3	0.9414037925766154	0.810604366942395	0.13079942563422042
18284	346	3	0.38869416734070283	0.2635721737834414	0.12512199355726145
11867	774	3	0.8695066055540577	0.7518412946816703	0.11766531087238741
60048	445	3	0.4999101285162218	0.38983903420523136	0.11007109431099044
31046	338	3	0.3797070189628831	0.27263891993938943	0.10706809902349368

Cluster #4 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2369	4	1.802658712343152	1.5491249968949499	0.253533715448202
99995	1638	4	1.246414086457612	1.0362328290732046	0.21018125738440752
12131	1366	4	1.0394393419420622	0.8552705119606528	0.18416882998140938
10171	1404	4	1.0683549312493819	0.9217651588543606	0.14658977239502125
45507	785	4	0.5973352001643623	0.4895732419206597	0.10776195824370255
59684	710	4	0.5402649581104423	0.4359956032491244	0.10426935486131789
32645	1893	4	1.44045290944094	1.3472346424224357	0.09321826701850422
33585	217	4	0.16512323367600842	0.08557517947189308	0.07954805420411534
11713	541	4	0.4116666793489427	0.3344138907519189	0.07725278859702378
18284	446	4	0.3393777060806441	0.2635721737834414	0.07580553229720272

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2556	5	1.7457346975016048	1.5491249968949499	0.19660970060665495
32645	2257	5	1.5415192536232873	1.3472346424224357	0.1942846112008516
58515	1154	5	0.788175994098925	0.6785621134212684	0.10961388067765665
14776	531	5	0.3626702364527982	0.2582780634423827	0.10439217301041553
11150	1155	5	0.7888589888945046	0.6869302233151998	0.10192876557930475
42952	305	5	0.20831341265179557	0.11898551804655091	0.08932789460524465
49788	1448	5	0.9889764639993442	0.9067832923466727	0.08219317165267159
14771	1395	5	0.9527777398336225	0.8762606503216832	0.07651708951193925
11867	1210	5	0.8264237026513858	0.7518412946816703	0.07458240796971549
10149	285	5	0.19465351674020245	0.12157823484114565	0.07307528189905681

Cluster #6 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	2451	6	2.0135716867667837	1.477662269915791	0.5359094168509926
60179	2514	6	2.0653281193519764	1.5491249968949499	0.5162031224570265
58646	880	6	0.7229469948407874	0.6139770723104057	0.10896992253038174
14765	715	6	0.5873944333081398	0.47915579899147975	0.10823863431666003
61854	439	6	0.3606519667444382	0.26604068857589985	0.09461127816853837
12852	781	6	0.6416154579211988	0.5486778696872594	0.09293758823393938
99995	1370	6	1.125497026058953	1.0362328290732046	0.08926419698574839
64241	513	6	0.4214452367651408	0.34231624313783937	0.07912899362730141
29952	164	6	0.1347310308566922	0.05896490051419628	0.07576613034249591
20375	138	6	0.11337123328185074	0.03917020642372755	0.07420102685812319

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	5125	7	8.655486311665062	8.000394341356783	0.6550919703082787
12131	676	7	1.1416797554508453	0.8552705119606528	0.2864092434901925
11118	186	7	0.31413082028677103	0.06581153588195843	0.2483192844048126
14765	422	7	0.7127054094678353	0.47915579899147975	0.23354961047635558
10642	247	7	0.41715221833780886	0.18490573068037855	0.2322464876574303
14909	407	7	0.6873722787995474	0.4622332762004124	0.22513900259913505
11809	191	7	0.32257519717620037	0.09818168268872493	0.22439351448747544
70387	352	7	0.5944841330158247	0.3853677621283255	0.20911637088749918
10559	248	7	0.4188410937156948	0.2125717266562337	0.20626936705946108
10222	145	7	0.24488692979345053	0.046063417542290784	0.19882351225115974

Processing batch 4:

Results for batch 4:

Cluster #0 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
10171	449	0	1.6966444981862152	0.9217651588543606	0.7748793393318546
12131	406	0	1.5341596130592503	0.8552705119606528	0.6788891010985975
99993	2289	0	8.649486094316808	8.000394341356783	0.6490917529600253
11118	150	0	0.566807738814994	0.06581153588195843	0.5009962029330356
16615	285	0	1.0769347037484884	0.6113067292644757	0.4656279744840127
70387	202	0	0.7633010882708585	0.3853677621283255	0.377933326142533
35513	134	0	0.5063482466747279	0.15692922969918274	0.3494190169755451
11561	129	0	0.4874546553808948	0.17360334848597758	0.3138513068949172
47540	165	0	0.6234885126964933	0.34304592990039	0.2804425827961033
60048	177	0	0.6688331318016928	0.38983903420523136	0.27899409759646143

Cluster #1 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16615	844	1	0.8984649449636996	0.6113067292644757	0.28715821569922384
74796	670	1	0.7132363899593349	0.4582898626325856	0.25494652732674933
11207	958	1	1.0198215844493177	0.810604366942395	0.20921721750692268
11221	953	1	1.0144989248227554	0.8102317609359863	0.20426716388676913
11713	491	1	0.5226851753284081	0.3344138907519189	0.18827128457648917
11069	604	1	0.6429772828887138	0.4700114265841966	0.17296585630451722
10145	678	1	0.7217526453618345	0.5651967359713839	0.1565559093904506
14902	1037	1	1.1039196065490002	0.9497261345852894	0.1541934719637108
11066	680	1	0.7238817092124592	0.5880809548649923	0.13580075434746686
10171	993	1	1.057080201835253	0.9217651588543606	0.13531504298089236

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	21027	2	8.262634439235626	8.000394341356783	0.26224009787884306
16374	4269	2	1.6775187340608213	1.477662269915791	0.19985646414503022
60179	4269	2	1.6775187340608213	1.5491249968949499	0.12839373716587144
61522	1382	2	0.5430618155240232	0.45273182303698734	0.09032999248703588
10145	1654	2	0.6499451829788238	0.5651967359713839	0.08474844700743989
12852	1595	2	0.6267609231264957	0.5486778696872594	0.07808305343923627
14902	2589	2	1.0173567586047005	0.9497261345852894	0.06763062401941111
11344	1012	2	0.397668999500949	0.3322248304642671	0.06544416903668193
66268	1175	2	0.4617204292624654	0.39635963931738577	0.06536078994507966
11066	1656	2	0.6507310900924619	0.5880809548649923	0.06265013522746954

Cluster #3 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
58515	755	3	0.843377531528915	0.6785621134212684	0.16481541810764666
14771	924	3	1.0321600518314138	0.8762606503216832	0.15589940150973058
11713	433	3	0.4836853922543314	0.3344138907519189	0.14927150150241247
11207	859	3	0.9595513901766066	0.810604366942395	0.1489470232342116
11867	803	3	0.8969962355201573	0.7518412946816703	0.145154940838487
10179	916	3	1.0232236011662068	0.8952790818988002	0.12794451926740658
31046	355	3	0.3965549982685627	0.27263891993938943	0.12391607832917328
14321	545	3	0.60879570156723	0.5038875226668654	0.10490817890036452
74796	503	3	0.5618793355748931	0.4582898626325856	0.10358947294230753
10138	176	3	0.196601914634555	0.10159723774747248	0.09500467688708253

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2361	4	1.8438398100712232	1.5491249968949499	0.29471481317627335
99995	1634	4	1.2760839685118082	1.0362328290732046	0.2398511394386036
12131	1333	4	1.0410158690491067	0.8552705119606528	0.18574535708845386
32645	1894	4	1.4791328251905536	1.3472346424224357	0.13189818276811782
45507	776	4	0.606022741471948	0.4895732419206597	0.1164494995512883
10171	1327	4	1.036330126202674	0.9217651588543606	0.11456496734831345
59684	691	4	0.5396413844808197	0.4359956032491244	0.10364578123169527
49788	1292	4	1.0089966262651506	0.9067832923466727	0.10221333391847798
59615	458	4	0.35767837061102087	0.2909587152544899	0.06671965535653096
11443	215	4	0.16790578533050107	0.10735710559654221	0.06054867973395886

Cluster #5 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	12383	5	8.286989633734198	8.000394341356783	0.2865952923774149
60179	2610	5	1.7466722881406975	1.5491249968949499	0.19754729124574766
49788	1526	5	1.0212344489282392	0.9067832923466727	0.11445115658156657
31709	472	5	0.31587330268291536	0.20452964701790996	0.1113436556650054
32645	2173	5	1.4542217939194388	1.3472346424224357	0.10698715149700311
56905	892	5	0.5969470042227978	0.5062939364582557	0.09065306776454207
11867	1256	5	0.8405442122240292	0.7518412946816703	0.08870291754235893
45980	200	5	0.13384461978089635	0.060998708299177785	0.07284591148171857
43017	159	5	0.1064064727258126	0.036732742131803164	0.06967373059400944
30754	361	5	0.24158953870451794	0.17632026728270858	0.06526927142180936

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2551	6	2.045119291944587	1.5491249968949499	0.495994295049637
16374	2298	6	1.8422909184197023	1.477662269915791	0.3646286485039112
58646	926	6	0.7423678809645973	0.6139770723104057	0.1283908086541916
11066	890	6	0.7135069266290406	0.5880809548649923	0.12542597176404824
12852	827	6	0.6630002565418163	0.5486778696872594	0.11432238685455687
11187	1241	6	0.9949012314007183	0.8912425168293712	0.10365871457134712
14899	319	6	0.25574012314007183	0.15593561368209255	0.09980450945797928
14765	719	6	0.5764173935351462	0.47915579899147975	0.09726159454366645
20451	204	6	0.16354540790148794	0.0916455523263035	0.07189985557518444
58812	454	6	0.3639687018984094	0.29626835084581565	0.06770035105259375

Cluster #7 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
99993	5059	7	8.807757930290052	8.000394341356783	0.8073635889332689
14765	457	7	0.795640516731084	0.47915579899147975	0.3164847177396043
12131	663	7	1.1542881019534106	0.8552705119606528	0.29901758999275774
11118	202	7	0.35168355444131066	0.06581153588195843	0.28587201855935224
11809	197	7	0.3429785159650406	0.09818168268872493	0.24479683327631566
10222	144	7	0.25070510811657787	0.046063417542290784	0.20464169057428708
14909	381	7	0.663323931891779	0.4622332762004124	0.20109065569136658
10642	220	7	0.3830216929558829	0.18490573068037855	0.19811596227550435
10171	643	7	1.1194679480483303	0.9217651588543606	0.19770278919396966
70387	327	7	0.5693095163480623	0.3853677621283255	0.18394175421973674

Processing batch 5:

Results for batch 5:

Cluster #0 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
10171	417	0	1.603846153846154	0.9217651588543606	0.6820809949917933
12131	371	0	1.4269230769230767	0.8552705119606528	0.5716525649624239
16615	290	0	1.1153846153846154	0.6113067292644757	0.5040778861201397
11118	145	0	0.5576923076923077	0.06581153588195843	0.4918807718103493
99993	2186	0	8.407692307692308	8.000394341356783	0.4072979663355252
35513	142	0	0.5461538461538461	0.15692922969918274	0.38922461645466333
70387	188	0	0.7230769230769231	0.3853677621283255	0.33770916094859754
21883	143	0	0.5499999999999999	0.2305344412151924	0.31946555878480754
10559	137	0	0.5269230769230769	0.2125717266562337	0.31435135026684324
47540	162	0	0.6230769230769231	0.34304592990039	0.28003099317653307

Cluster #1 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16615	859	1	0.9236857102917299	0.6113067292644757	0.31237898102725414
11221	1011	1	1.0871318429626762	0.8102317609359863	0.2769000820266899
74796	658	1	0.7075497059044916	0.4582898626325856	0.24925984327190603
12131	983	1	1.057023344839081	0.8552705119606528	0.20175283287842805
10145	706	1	0.7591642741163693	0.5651967359713839	0.19396753814498546
14902	1036	1	1.1140144305730293	0.9497261345852894	0.16428829598773986
11713	463	1	0.497865522543738	0.3344138907519189	0.1634516317918191
11765	361	1	0.38818456509349764	0.22539558337680404	0.1627889817166936
15433	338	1	0.3634525844919729	0.21694984723153737	0.1465027372604355
10171	985	1	1.059173951847909	0.9217651588543606	0.13740879299354847

Cluster #2 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	4118	2	1.6543534242062679	1.477662269915791	0.17669115429047677
61522	1411	2	0.5668510640007391	0.45273182303698734	0.11411924096375181
14909	1406	2	0.5648423784443936	0.4622332762004124	0.10260910224398118
49788	2460	2	0.9882732937220542	0.9067832923466727	0.08149000137538154
11221	2208	2	0.8870355416822341	0.8102317609359863	0.07680378074624783
14902	2555	2	1.0264383192926214	0.9497261345852894	0.07671218470733199
11344	1017	2	0.4085666421607029	0.3322248304642671	0.07634181169643578
31709	678	2	0.27237776144046855	0.20452964701790996	0.06784811442255859
60179	4023	2	1.6161883986357009	1.5491249968949499	0.06706340174075098
12852	1524	2	0.6122473575741506	0.5486778696872594	0.06356948788689121

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
58515	794	3	0.8905039085719413	0.6785621134212684	0.2119417951506729
11867	819	3	0.9185424447360452	0.7518412946816703	0.1667011500543749
11207	827	3	0.9275147763085585	0.810604366942395	0.11691040936616348
32645	1303	3	1.4613685048730976	1.3472346424224357	0.11413386245066182
14771	883	3	0.9903210973161514	0.8762606503216832	0.11406044699446816
74796	505	3	0.5663784305148997	0.4582898626325856	0.10808856788231408
11713	390	3	0.43740116416002156	0.3344138907519189	0.10298727340810265
65732	337	3	0.37795946749212117	0.2925888665325285	0.08537060095959265
10179	874	3	0.980227224297074	0.8952790818988002	0.08494814239827375
24959	280	3	0.3140316050379642	0.2305344412151924	0.08349716382277178

Cluster #4 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
60179	2424	4	1.8293649296252972	1.5491249968949499	0.2802399327303473
99995	1639	4	1.2369344553035735	1.0362328290732046	0.2007016262303689
59684	761	4	0.5743179502660277	0.4359956032491244	0.13832234701690332
10171	1385	4	1.045243575714124	0.9217651588543606	0.12347841685976346
32645	1945	4	1.4678691370136976	1.3472346424224357	0.12063449459126185
12131	1255	4	0.9471340704124374	0.8552705119606528	0.09186355845178451
11713	545	4	0.41130523376476363	0.3344138907519189	0.07689134301284473
45507	746	4	0.5629976227312177	0.4895732419206597	0.07342438081055797
16374	2054	4	1.5501301837666503	1.477662269915791	0.07246791385085927
70225	308	4	0.23244405871476548	0.167005117122488	0.06543894159227748

data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
32645	2285	5	1.5389070729111947	1.3472346424224357	0.19167243048875893
11150	1217	5	0.8196279683732708	0.6869302233151998	0.13269774505807097
49788	1531	5	1.0311014129658813	0.9067832923466727	0.12431812061920866
60179	2477	5	1.6682156759741922	1.5491249968949499	0.11909067907924231
99993	12047	5	8.113441359895475	8.000394341356783	0.11304701853869226
25544	359	5	0.2417801484355006	0.13786422237126464	0.10391592606423597
10335	412	5	0.2774747107393489	0.1749229947586755	0.10255171598067336
57708	679	5	0.4572944868738298	0.3595647961845145	0.09772969068931531
14771	1428	5	0.9617327352810443	0.8762606503216832	0.0854720849593611
31046	524	5	0.3529047291927641	0.27263891993938943	0.08026580925337468

Cluster #6 - Populatriy on data (filtered by every 7th row) set

station_num	view_count	centroid	view_percentage	general_view_percentage	rank_diff
16374	2310	6	1.8626628822087474	1.477662269915791	0.38500061229295635
60179	2393	6	1.9295897303573732	1.5491249968949499	0.3804647334624234
99995	1420	6	1.1450135466391433	1.0362328290732046	0.10878071756593877
58646	889	6	0.7168429880015482	0.6139770723104057	0.10286591569114256
64241	534	6	0.4305896013417624	0.34231624313783937	0.08827335820392301
14899	300	6	0.24190427041672044	0.15593561368209255	0.08596865673462789
12852	784	6	0.632176493355696	0.5486778696872594	0.08349862366843663
10139	526	6	0.4241388207973165	0.3483710907419828	0.07576773005533372
61854	418	6	0.3370532834472971	0.26604068857589985	0.07101259487139727
11069	663	6	0.5346084376209521	0.4700114265841966	0.06459701103675553

data (filtered by every 7th row) set

```
ERROR:py4j.clientserver:There was an exception while executing the Python Proxy on the Python Side.
Traceback (most recent call last):
  File "/databricks/spark/python/lib/py4j-0.10.9.7-src.zip/py4j/clientserver.py", line 642, in _call_proxy
    return_value = getattr(self.pool[obj_id], method)(*params)
  File "/databricks/spark/python/pyspark/sql/utils.py", line 122, in call
    raise e
  File "/databricks/spark/python/pyspark/sql/utils.py", line 119, in call
    self.func(DataFrame(jdf, wrapped_session_jdf), batch_id)
  File "/root/.ipykernel/1217/command-504777624709021-2807044692", line 94, in process_batch
    seven_pop_dict[i].display()
  File "/databricks/python_shell/dbruntime/monkey_patches.py", line 46, in df_display
    display(df, *args, **kwargs)
  File "/databricks/python_shell/dbruntime/display.py", line 202, in display
    self.add_custom_display_data("table", input._jdf)
  File "/databricks/python_shell/dbruntime/display.py", line 48, in add_custom_display_data
    return_code = self.entry_point.addCustomDisplayData(custom_display_key, data_type, data)
  File "/databricks/spark/python/lib/py4j-0.10.9.7-src.zip/py4j/java_gateway.py", line 1355, in __call__
    return_value = get_return_value(
  File "/databricks/spark/python/pyspark/errors/exceptions/captured.py", line 224, in deco
    return f(*a, **kw)
  File "/databricks/spark/python/lib/py4j-0.10.9.7-src.zip/py4j/protocol.py", line 326, in get_return_value
    raise Py4JJavaError(
py4j.protocol.Py4JJavaError: An error occurred while calling t.addCustomDisplayData.
: java.lang.InterruptedException
        at java.util.concurrent.locks.AbstractQueuedSynchronizer.doAcquireSharedInterruptibly(AbstractQueuedSynchroni
zer.java:1000)
        at java.util.concurrent.locks.AbstractQueuedSynchronizer.acquireSharedInterruptibly(AbstractQueuedSynchronize
r.java:1308)
        at scala.concurrent.impl.Promise$DefaultPromise.tryAwait(Promise.scala:242)
        at scala.concurrent.impl.Promise$DefaultPromise.ready(Promise.scala:258)
        at scala.concurrent.impl.Promise$DefaultPromise.ready(Promise.scala:187)
        at org.apache.spark.util.ThreadUtils$.awaitReady(ThreadUtils.scala:498)
        at org.apache.spark.scheduler.DAGScheduler.$anonfun$runJob$1(DAGScheduler.scala:1348)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at com.databricks.spark.util.FrameProfiler$.record(FrameProfiler.scala:94)
        at org.apache.spark.scheduler.DAGScheduler.runJob(DAGScheduler.scala:1345)
        at org.apache.spark.SparkContext.runJobInternal(SparkContext.scala:3011)
        at org.apache.spark.SparkContext.runJob(SparkContext.scala:2994)
        at org.apache.spark.SparkContext.runJob(SparkContext.scala:3106)
        at org.apache.spark.rdd.RDD.$anonfun$reduce$1(RDD.scala:1193)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:165)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:125)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:112)
```

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        at org.apache.spark.rdd.RDD.withScope(RDD.scala:450)
        at org.apache.spark.rdd.RDD.reduce(RDD.scala:1175)
        at org.apache.spark.rdd.RDD.$anonfun$takeOrdered$1(RDD.scala:1623)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:165)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:125)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:112)
        at org.apache.spark.rdd.RDD.withScope(RDD.scala:450)
        at org.apache.spark.rdd.RDD.takeOrdered(RDD.scala:1610)
        at org.apache.spark.sql.execution.TakeOrderedAndProjectExec.$anonfun$executeCollect$1(limit.scala:294)
        at org.apache.spark.sql.execution.SparkPlan$.org$apache$spark$sql$execution$SparkPlan$$withExecuteQueryLoggin
g(SparkPlan.scala:130)
        at org.apache.spark.sql.execution.SparkPlan.$anonfun$executeQuery$1(SparkPlan.scala:385)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:165)
        at org.apache.spark.sql.execution.SparkPlan.executeQuery(SparkPlan.scala:381)
        at org.apache.spark.sql.execution.TakeOrderedAndProjectExec.executeCollect(limit.scala:288)
        at org.apache.spark.sql.execution.collect.Collector$.collect(Collector.scala:102)
        at org.apache.spark.sql.execution.collect.Collector$.collect(Collector.scala:131)
        at org.apache.spark.sql.execution.qrc.InternalRowFormat$.collect(cachedSparkResults.scala:94)
        at org.apache.spark.sql.execution.qrc.InternalRowFormat$.collect(cachedSparkResults.scala:90)
        at org.apache.spark.sql.execution.qrc.InternalRowFormat$.collect(cachedSparkResults.scala:78)
        at org.apache.spark.sql.execution.qrc.ResultCacheManager.$anonfun$computeResult$1(ResultCacheManager.scala:54
9)
        at com.databricks.spark.util.FrameProfiler$.record(FrameProfiler.scala:94)
        at org.apache.spark.sql.execution.qrc.ResultCacheManager.collectResult$1(ResultCacheManager.scala:540)
        at org.apache.spark.sql.execution.qrc.ResultCacheManager.computeResult(ResultCacheManager.scala:557)
        at org.apache.spark.sql.execution.qrc.ResultCacheManager.$anonfun$getOrComputeResultInternal$1(ResultCacheMan
ager.scala:400)
        at scala.Option.getOrElse(Option.scala:189)
        at org.apache.spark.sql.execution.qrc.ResultCacheManager.getOrComputeResultInternal(ResultCacheManager.scala:
400)
        at org.apache.spark.sql.execution.qrc.ResultCacheManager.getOrComputeResult(ResultCacheManager.scala:318)
        at org.apache.spark.sql.execution.SparkPlan.$anonfun$executeCollectResult$1(SparkPlan.scala:558)
        at com.databricks.spark.util.FrameProfiler$.record(FrameProfiler.scala:94)
        at org.apache.spark.sql.execution.SparkPlan.executeCollectResult(SparkPlan.scala:555)
        at org.apache.spark.sql.Dataset.collectResult(Dataset.scala:3780)
        at org.apache.spark.sql.Dataset.$anonfun$collectResult$1(Dataset.scala:3771)
        at org.apache.spark.sql.Dataset.$anonfun$withAction$3(Dataset.scala:4727)
        at org.apache.spark.sql.execution.QueryExecution$.withInternalError(QueryExecution.scala:1103)
        at org.apache.spark.sql.Dataset.$anonfun$withAction$2(Dataset.scala:4725)
        at org.apache.spark.sql.execution.SQLExecution$.$anonfun$withNewExecutionId0$9(SQLExecution.scala:392)
        at org.apache.spark.sql.execution.SQLExecution$.withSQLConfPropagated(SQLExecution.scala:700)
        at org.apache.spark.sql.execution.SQLExecution$.$anonfun$withNewExecutionId0$1(SQLExecution.scala:277)
        at org.apache.spark.sql.SparkSession.withActive(SparkSession.scala:1175)
        at org.apache.spark.sql.execution.SQLExecution$.withNewExecutionId0(SQLExecution.scala:164)
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	at org.apache.spark.sql.execution.SQLExecution$.withNewExecutionId(SQLExecution.scala:637)
	at org.apache.spark.sql.Dataset.withAction(Dataset.scala:4725)
	at org.apache.spark.sql.Dataset.collectResult(Dataset.scala:3770)
	at com.databricks.backend.daemon.driver.OutputAggregator$.withOutputAggregation0(OutputAggregator.scala:323)
	at com.databricks.backend.daemon.driver.OutputAggregator$.withOutputAggregation(OutputAggregator.scala:101)
	at com.databricks.backend.daemon.driver.PythonDriverLocalBase.generateTableResult(PythonDriverLocalBase.scal
a:852)
	at com.databricks.backend.daemon.driver.JupyterDriverLocal.computeListResultsItem(JupyterDriverLocal.scala:14
91)
	at com.databricks.backend.daemon.driver.JupyterDriverLocal$JupyterEntryPoint.addCustomDisplayData(JupyterDriv
erLocal.scala:286)
	at sun.reflect.GeneratedMethodAccessor786.invoke(Unknown Source)
	at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
	at java.lang.reflect.Method.invoke(Method.java:498)
	at py4j.reflection.MethodInvoker.invoke(MethodInvoker.java:244)
	at py4j.reflection.ReflectionEngine.invoke(ReflectionEngine.java:397)
	at py4j.Gateway.invoke(Gateway.java:306)
	at py4j.commands.AbstractCommand.invokeMethod(AbstractCommand.java:132)
	at py4j.commands.CallCommand.execute(CallCommand.java:79)
	at py4j.ClientServerConnection.sendCommand(ClientServerConnection.java:261)
	at py4j.CallbackClient.sendCommand(CallbackClient.java:384)
	at py4j.CallbackClient.sendCommand(CallbackClient.java:356)
	at py4j.reflection.PythonProxyHandler.invoke(PythonProxyHandler.java:106)
	at com.sun.proxy.$Proxy162.call(Unknown Source)
	at org.apache.spark.sql.execution.streaming.sources.PythonForeachBatchHelper$.$anonfun$callForeachBatch$1(For
eachBatchSink.scala:400)
	at org.apache.spark.sql.execution.streaming.sources.PythonForeachBatchHelper$.$anonfun$callForeachBatch$1$ada
pted(ForeachBatchSink.scala:400)
	at org.apache.spark.sql.execution.streaming.sources.ForeachBatchSink.callBatchWriter(ForeachBatchSink.scala:1
57)
	at org.apache.spark.sql.execution.streaming.sources.ForeachBatchSink.$anonfun$addBatchLegacy$1(ForeachBatchSi
nk.scala:138)
	at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
	at org.apache.spark.sql.execution.streaming.sources.ForeachBatchSink.runWithAQE(ForeachBatchSink.scala:180)
	at org.apache.spark.sql.execution.streaming.sources.ForeachBatchSink.addBatchLegacy(ForeachBatchSink.scala:13
8)
	at org.apache.spark.sql.execution.streaming.sources.ForeachBatchSink.$anonfun$addBatch$2(ForeachBatchSink.sca
la:100)
	at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
	at org.apache.spark.util.Utils$.timeTakenMs(Utils.scala:531)
	at org.apache.spark.sql.execution.streaming.sources.ForeachBatchSink.addBatch(ForeachBatchSink.scala:90)
	at org.apache.spark.sql.execution.streaming.MicroBatchExecution.addBatch(MicroBatchExecution.scala:1217)
	at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runBatch$18(MicroBatchExecution.scal
a:1433)
```

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        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at org.apache.spark.sql.execution.streaming.ProgressContext.reportTimeTaken(ProgressReporter.scala:321)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.markAndTimeCollectBatch(MicroBatchExecution.s
cala:1225)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runBatch$17(MicroBatchExecution.scal
a:1433)
        at org.apache.spark.sql.execution.SQLExecution$.$anonfun$withNewExecutionId0$9(SQLExecution.scala:392)
        at org.apache.spark.sql.execution.SQLExecution$.withSQLConfPropagated(SQLExecution.scala:700)
        at org.apache.spark.sql.execution.SQLExecution$.$anonfun$withNewExecutionId0$1(SQLExecution.scala:277)
        at org.apache.spark.sql.SparkSession.withActive(SparkSession.scala:1175)
        at org.apache.spark.sql.execution.SQLExecution$.withNewExecutionId0(SQLExecution.scala:164)
        at org.apache.spark.sql.execution.SQLExecution$.withNewExecutionId(SQLExecution.scala:637)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runBatch$16(MicroBatchExecution.scal
a:1426)
        at org.apache.spark.sql.execution.streaming.ProgressContext.reportTimeTaken(ProgressReporter.scala:321)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.runBatch(MicroBatchExecution.scala:1426)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$executeOneBatch$6(MicroBatchExecutio
n.scala:740)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.handleDataSourceException(MicroBatchExecutio
n.scala:1807)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$executeOneBatch$5(MicroBatchExecutio
n.scala:740)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.withSchemaEvolution(MicroBatchExecution.scal
a:1775)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$executeOneBatch$4(MicroBatchExecutio
n.scala:736)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at org.apache.spark.sql.execution.streaming.ProgressContext.reportTimeTaken(ProgressReporter.scala:321)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$executeOneBatch$3(MicroBatchExecutio
n.scala:696)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at com.databricks.logging.UsageLogging.$anonfun$withAttributionContext$1(UsageLogging.scala:426)
        at scala.util.DynamicVariable.withValue(DynamicVariable.scala:62)
        at com.databricks.logging.AttributionContext$.withValue(AttributionContext.scala:216)
        at com.databricks.logging.UsageLogging.withAttributionContext(UsageLogging.scala:424)
        at com.databricks.logging.UsageLogging.withAttributionContext$(UsageLogging.scala:418)
        at com.databricks.spark.util.PublicDBLogging.withAttributionContext(DatabricksSparkUsageLogger.scala:27)
        at com.databricks.logging.UsageLogging.withAttributionTags(UsageLogging.scala:472)
        at com.databricks.logging.UsageLogging.withAttributionTags$(UsageLogging.scala:455)
        at com.databricks.spark.util.PublicDBLogging.withAttributionTags(DatabricksSparkUsageLogger.scala:27)
        at com.databricks.spark.util.PublicDBLogging.withAttributionTags0(DatabricksSparkUsageLogger.scala:72)
        at com.databricks.spark.util.DatabricksSparkUsageLogger.withAttributionTags(DatabricksSparkUsageLogger.scala:
```



```
        at com.databricks.spark.util.UsageLogging.$anonfun$withAttributionTags$1(UsageLogger.scala:491)
```

```
        at com.databricks.spark.util.UsageLogging$.withAttributionTags(UsageLogger.scala:603)
        at com.databricks.spark.util.UsageLogging$.withAttributionTags(UsageLogger.scala:612)
        at com.databricks.spark.util.UsageLogging.withAttributionTags(UsageLogger.scala:491)
        at com.databricks.spark.util.UsageLogging.withAttributionTags$(UsageLogger.scala:489)
        at org.apache.spark.sql.execution.streaming.StreamExecution.withAttributionTags(StreamExecution.scala:84)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.executeOneBatch(MicroBatchExecution.scala:69
0)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runActivatedStreamWithListener$1(Mic
roBatchExecution.scala:649)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.$anonfun$runActivatedStreamWithListener$1$ada
pted(MicroBatchExecution.scala:649)
        at org.apache.spark.sql.execution.streaming.TriggerExecutor.runOneBatch(TriggerExecutor.scala:83)
        at org.apache.spark.sql.execution.streaming.TriggerExecutor.runOneBatch$(TriggerExecutor.scala:71)
        at org.apache.spark.sql.execution.streaming.ProcessingTimeExecutor.runOneBatch(TriggerExecutor.scala:128)
        at org.apache.spark.sql.execution.streaming.ProcessingTimeExecutor.execute(TriggerExecutor.scala:141)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.runActivatedStreamWithListener(MicroBatchExec
ution.scala:649)
        at org.apache.spark.sql.execution.streaming.MicroBatchExecution.runActivatedStream(MicroBatchExecution.scala:
433)
        at org.apache.spark.sql.execution.streaming.StreamExecution.$anonfun$runStream$2(StreamExecution.scala:450)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at org.apache.spark.sql.SparkSession.withActive(SparkSession.scala:1175)
        at org.apache.spark.sql.execution.streaming.StreamExecution.$anonfun$runStream$1(StreamExecution.scala:398)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at com.databricks.logging.UsageLogging.$anonfun$withAttributionContext$1(UsageLogging.scala:426)
        at scala.util.DynamicVariable.withValue(DynamicVariable.scala:62)
        at com.databricks.logging.AttributionContext$.withValue(AttributionContext.scala:216)
        at com.databricks.logging.UsageLogging.withAttributionContext(UsageLogging.scala:424)
        at com.databricks.logging.UsageLogging.withAttributionContext$(UsageLogging.scala:418)
        at com.databricks.spark.util.PublicDBLogging.withAttributionContext(DatabricksSparkUsageLogger.scala:27)
        at com.databricks.logging.UsageLogging.withAttributionTags(UsageLogging.scala:472)
        at com.databricks.logging.UsageLogging.withAttributionTags$(UsageLogging.scala:455)
        at com.databricks.spark.util.PublicDBLogging.withAttributionTags(DatabricksSparkUsageLogger.scala:27)
        at com.databricks.spark.util.PublicDBLogging.withAttributionTags0(DatabricksSparkUsageLogger.scala:72)
        at com.databricks.spark.util.DatabricksSparkUsageLogger.withAttributionTags(DatabricksSparkUsageLogger.scala:
172)
        at com.databricks.spark.util.UsageLogging.$anonfun$withAttributionTags$1(UsageLogger.scala:491)
        at com.databricks.spark.util.UsageLogging$.withAttributionTags(UsageLogger.scala:603)
        at com.databricks.spark.util.UsageLogging$.withAttributionTags(UsageLogger.scala:612)
        at com.databricks.spark.util.UsageLogging.withAttributionTags(UsageLogger.scala:491)
        at com.databricks.spark.util.UsageLogging.withAttributionTags$(UsageLogger.scala:489)
        at org.apache.spark.sql.execution.streaming.StreamExecution.withAttributionTags(StreamExecution.scala:84)
        at org.apache.spark.sql.execution.streaming.StreamExecution.org$apache$spark$sql$execution$streaming$StreamEx
ecution$$runStream(StreamExecution.scala:378)
```

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        at org.apache.spark.sql.execution.streaming.StreamExecution$$anon$1.$anonfun$run$3(StreamExecution.scala:282)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at org.apache.spark.JobArtifactSet$.withActiveJobArtifactState(JobArtifactSet.scala:97)
        at org.apache.spark.sql.execution.streaming.StreamExecution$$anon$1.$anonfun$run$2(StreamExecution.scala:282)
        at scala.runtime.java8.JFunction0$mcV$sp.apply(JFunction0$mcV$sp.java:23)
        at com.databricks.unity.EmptyHandle$.runWithAndClose(UCSHandle.scala:129)
        at org.apache.spark.sql.execution.streaming.StreamExecution$$anon$1.run(StreamExecution.scala:281)
```

In [0]: