KMeans Clustering using Spark

Step 1 : Import libraries and Load the Iris dataset

In [2]:
```
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#Reference : https://www.data4v.com/tutorial-k-means-clustering-on-spark/

##########################################################################################

import findspark
import pandas as pd
from sklearn.datasets import load_iris
from pyspark.sql import SparkSession
from pyspark.ml.feature import VectorAssembler
from pyspark.ml.clustering import KMeans
from pyspark.ml.evaluation import ClusteringEvaluator
import matplotlib.pyplot as plt
from pyspark import SparkContext
from pyspark.sql import SQLContext
from pyspark import SparkConf

#Initialize spark location
findspark.init('/home/ubuntu/hadoop/spark-3.3.0')

#Create spark context
# conf = SparkConf().setAppName("IrisExample").setMaster("local")
# sc = SparkContext.getOrCreate(conf)
# spark = SQLContext(sc)
conf = SparkConf().setAppName("IrisKmeans").setMaster("local")
sc = SparkContext.getOrCreate(conf)
spark = SQLContext(sc)

#Load iris dataset
df_iris = load_iris(as_frame=True)
pd_df_iris = pd.DataFrame(df_iris.data, columns = df_iris.feature_names)
pd_df_iris['target'] = pd.Series(df_iris.target)

spark_df_iris = spark.createDataFrame(pd_df_iris)
spark_df_iris = spark_df_iris.drop("target")

print(f'Size of Iris dataset : {pd_df_iris.size}')
pd_df_iris.head()
```

```
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/home/ubuntu/hadoop/spark-3.3.0/jars/log4j-slf4j-im
pl-2.17.2.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/home/ubuntu/hadoop/hadoop-3.3.2/share/hadoop/commo
n/lib/slf4j-log4j12-1.7.30.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.apache.logging.slf4j.Log4jLoggerFactory]
```

```
22/09/09 15:54:33 WARN Utils: Your hostname, MSI resolves to a loopback address: 127.
0.1.1; using 172.28.105.141 instead (on interface eth0)
22/09/09 15:54:33 WARN Utils: Set SPARK_LOCAL_IP if you need to bind to another addre
ss
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(new
Level).
22/09/09 15:54:35 WARN NativeCodeLoader: Unable to load native-hadoop library for you
r platform... using builtin-java classes where applicable
/home/ubuntu/.local/lib/python3.8/site-packages/pyspark/sql/context.py:112: FutureWar
ning: Deprecated in 3.0.0. Use SparkSession.builder.getOrCreate() instead.
  warnings.warn(
Size of Iris dataset : 750
```

Out[2]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target
0	5.1	3.5	1.4	0.2	0
1	4.9	3.0	1.4	0.2	0
2	4.7	3.2	1.3	0.2	0
3	4.6	3.1	1.5	0.2	0
4	5.0	3.6	1.4	0.2	0

Transform features into a single feature set

In [3]:

```
assemble=VectorAssembler(inputCols=[
'sepal length (cm)',
'sepal width (cm)',
'petal length (cm)',
'petal width (cm)'],outputCol = 'iris_features')

assembled_data=assemble.transform(spark_df_iris)
```

Find optimal number of clusters using the silhouette method

In [4]:

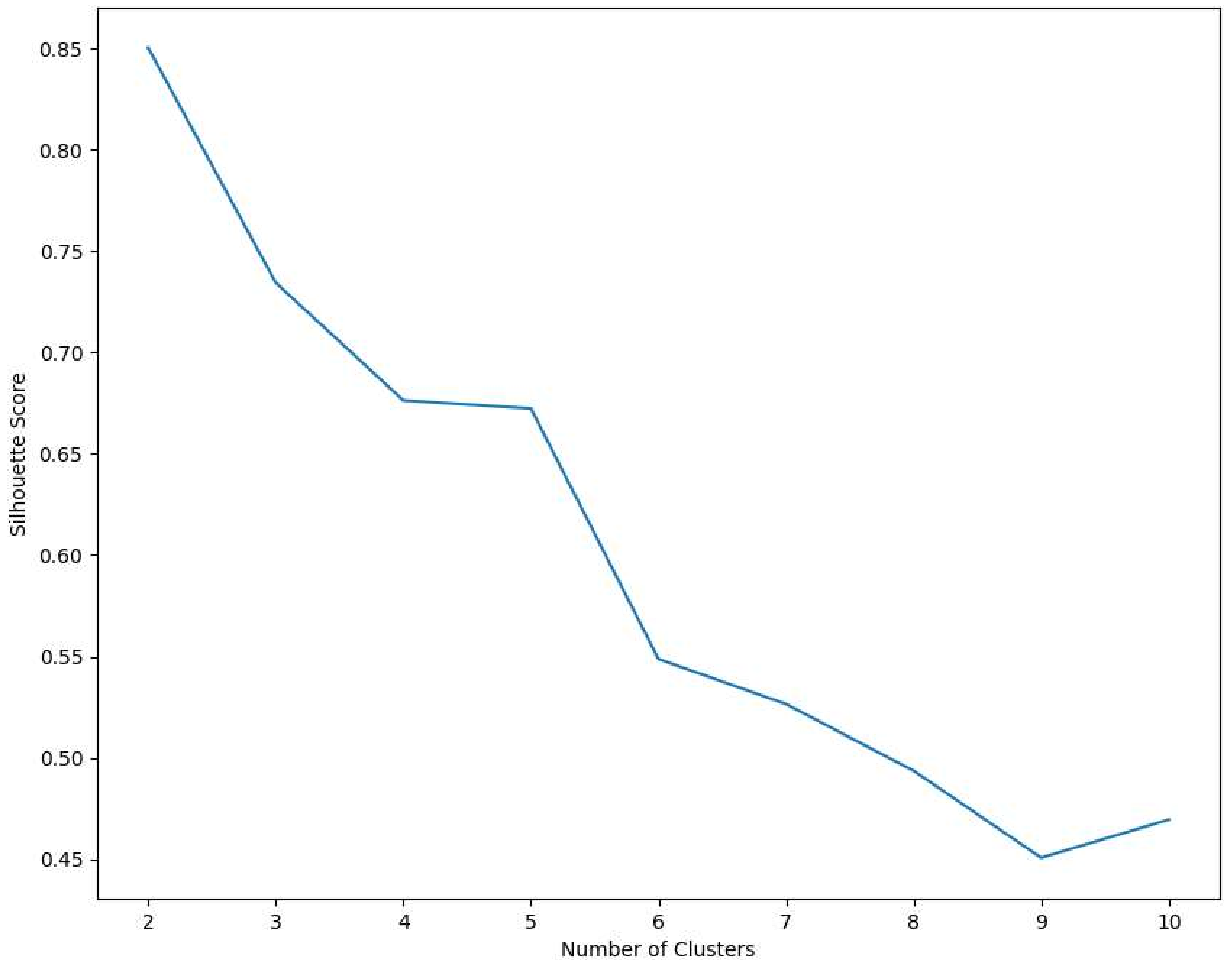
```
# Array to hold silhouette scored for all values of K
silhouette_scores=[]

evaluator = ClusteringEvaluator(featuresCol='iris_features', \
metricName='silhouette', distanceMeasure='squaredEuclidean')

for K in range(2,11):

    KMeans_=KMeans(featuresCol='iris_features', k=K)

    # Fit the Iris dataset onto KMeans model
    KMeans_fit=KMeans_.fit(assembled_data)

    KMeans_transform=KMeans_fit.transform(assembled_data)
```

```
    evaluation_score=evaluator.evaluate(KMeans_transform)

    silhouette_scores.append(evaluation_score)
```

Plot the silouette score vs number of clusters (Elbow Method)

In [5]:
```
fig, ax = plt.subplots(1,1, figsize =(10,8))
ax.plot(range(2,11),silhouette_scores)
ax.set_xlabel('Number of Clusters')
ax.set_ylabel('Silhouette Score')
```

Out[5]: Text(0, 0.5, 'Silhouette Score')



Using elbow method, we can see that the first elbow occurs at K = 3, showing that 3 clusters is the optimal value.

Create K Means model with optimal K = 3 clusters

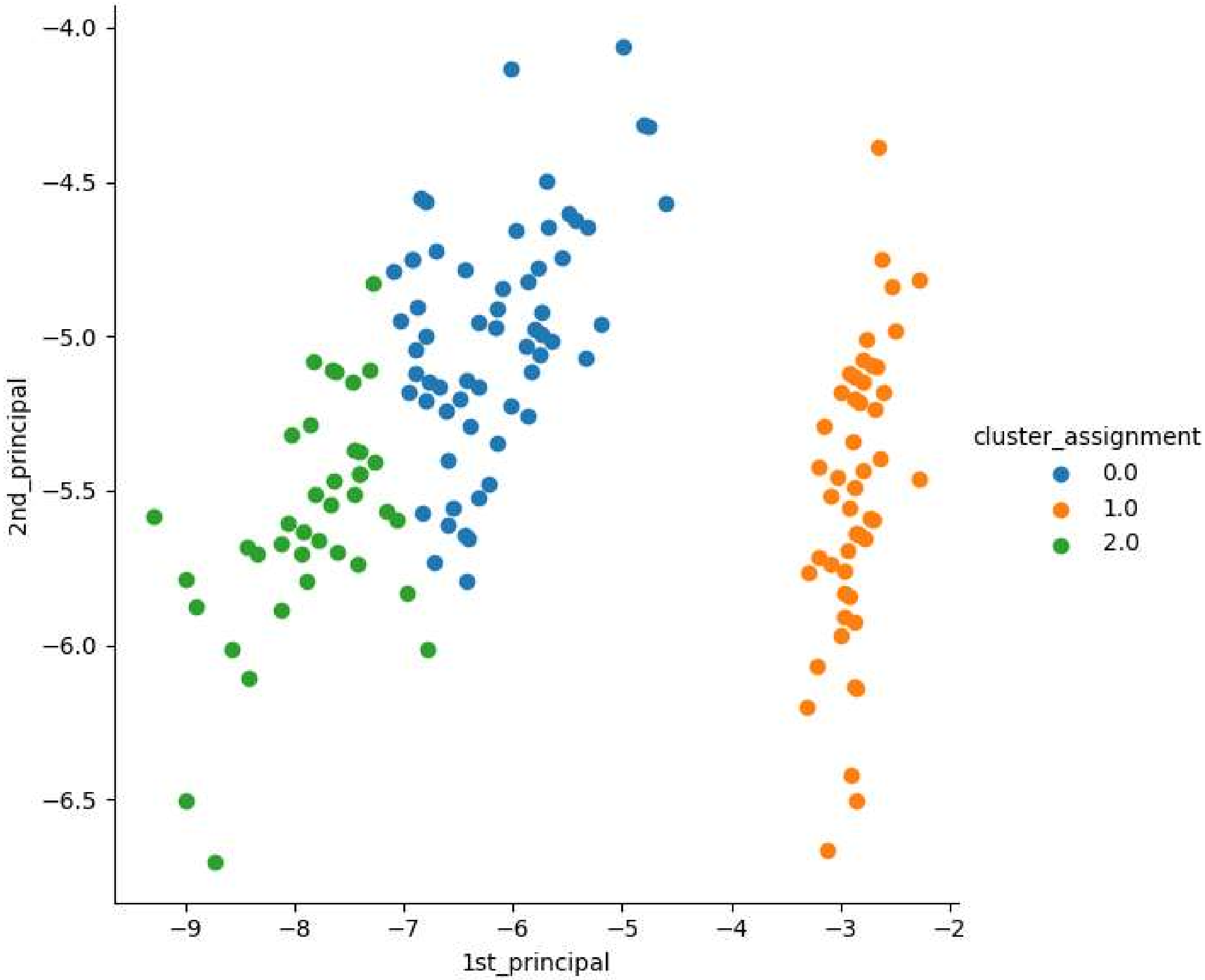
In [6]:
```
KMeans_=KMeans(featuresCol='iris_features', k=3)
KMeans_Model=KMeans_.fit(assembled_data)
KMeans_Assignments=KMeans_Model.transform(assembled_data)
```

Use PCA for dimensionality reduction to visualize in 2D

In [7]:
```
from pyspark.ml.feature import PCA as PCAml

pca = PCAml(k=2, inputCol="iris_features", outputCol="pca")
pca_model = pca.fit(assembled_data)
pca_transformed = pca_model.transform(assembled_data)
```

```
22/09/09 15:58:50 WARN InstanceBuilder$NativeBLAS: Failed to load implementation fro
m:dev.ludovic.netlib.blas.JNIBLAS
22/09/09 15:58:50 WARN InstanceBuilder$NativeBLAS: Failed to load implementation fro
m:dev.ludovic.netlib.blas.ForeignLinkerBLAS
22/09/09 15:58:50 WARN LAPACK: Failed to load implementation from: com.github.fommil.
netlib.NativeSystemLAPACK
22/09/09 15:58:50 WARN LAPACK: Failed to load implementation from: com.github.fommil.
netlib.NativeRefLAPACK
```

In [8]:
```
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

x_pca = np.array(pca_transformed.rdd.map(lambda row: row.pca).collect())

# Cluster assignment to plot
cluster_assignment = np.array(KMeans_Assignments.rdd.map(lambda row: row.prediction).c

# Plotting data points
pca_data = np.hstack((x_pca,cluster_assignment))

# Create pca data frame
pca_df = pd.DataFrame(data=pca_data, columns=("1st_principal", "2nd_principal","cluste
sns.FacetGrid(pca_df,hue="cluster_assignment", height=6).map(plt.scatter, '1st_princip

plt.show()
```


2nd_principal
1st_principal
cluster_assignment
0.0
1.0
2.0
−4.0
−4.5
−5.0
−5.5
−6.0
−6.5
−9
−8
−7
−6
−5
−4
−3
−2