Vivek_Narasimhamurthy_pyspark

```
from pyspark.sql import SparkSession
import pandas as pd
from pyspark.ml.feature import OneHotEncoderEstimator, StringIndexer,
VectorAssembler
from pyspark.ml import Pipeline
```

```
df= spark.read.csv("/FileStore/tables/bank.csv", header=True, inferSchema=True)
df.printSchema()
```

```
root
 |-- age: integer (nullable = true)
 |-- job: string (nullable = true)
 |-- marital: string (nullable = true)
 |-- education: string (nullable = true)
 |-- default: string (nullable = true)
 |-- balance: integer (nullable = true)
 |-- housing: string (nullable = true)
 |-- loan: string (nullable = true)
 |-- contact: string (nullable = true)
 |-- day: integer (nullable = true)
 |-- month: string (nullable = true)
 |-- duration: integer (nullable = true)
 |-- campaign: integer (nullable = true)
 |-- pdays: integer (nullable = true)
 |-- previous: integer (nullable = true)
 |-- poutcome: string (nullable = true)
 |-- deposit: string (nullable = true)
```

```
df.head(5)
df.select('age','balance','deposit').show(5)
df.groupBy("age").count().sort("count",ascending=True).show()
df.describe().show()
df.describe('balance').show()
df.filter(df.age > 40).count()
df.groupby('marital').agg({'balance':'mean'}).show()
```

```
+---+-------+-------+
|age|balance|deposit|
+---+-------+-------+
| 59|   2343|    yes|
| 56|     45|    yes|
| 41|   1270|    yes|
| 55|   2476|    yes|
| 54|    184|    yes|
+---+-------+-------+
only showing top 5 rows

+---+-----+
|age|count|
+---+-----+
| 95|    1|
| 89|    1|
| 88|    2|
| 92|    2|
| 93|    2|
| 90|    2|
```

```
pd.DataFrame(df.take(5), columns=df.columns).transpose()
```

```
Out[6]:
```

	0	1	2	3	4
age	59	56	41	55	54
job	admin.	admin.	technician	services	admin.
marital	married	married	married	married	married
education	secondary	secondary	secondary	secondary	tertiary
default	no	no	no	no	no
balance	2343	45	1270	2476	184
housing	yes	no	yes	yes	no
loan	no	no	no	no	no
contact	unknown	unknown	unknown	unknown	unknown
day	5	5	5	5	5
month	may	may	may	may	may
duration	1042	1467	1389	579	673
campaign	1	1	1	1	2
pdays	-1	-1	-1	-1	-1
previous	0	0	0	0	0
poutcome	unknown	unknown	unknown	unknown	unknown
deposit	yes	yes	yes	yes	yes

```
numeric_features = [t[0] for t in df.dtypes if t[1] == 'int']
df.select(numeric_features).describe().toPandas().transpose()
```

Out[7]:

	0	1	2	3	4
summary	count	mean	stddev	min	max
age	11162	41.231947679627304	11.913369192215518	18	95
balance	11162	1528.5385235620856	3225.413325946149	-6847	81204
day	11162	15.658036194230425	8.420739541006462	1	31
duration	11162	371.99381831213043	347.12838571630687	2	3881
campaign	11162	2.508421429851281	2.7220771816614824	1	63
pdays	11162	51.33040673714388	108.75828197197717	-1	854
previous	11162	0.8325568894463358	2.292007218670508	0	58

```
categoricalColumns =
['job','marital','education','default','housing','loan','contact','poutcome']
stages = []
for categoricalCol in categoricalColumns:
  stringIndexer = StringIndexer(inputCol=
categoricalCol,outputCol=categoricalCol + 'Index')
  encoder = OneHotEncoderEstimator(inputCols=
[stringIndexer.getOutputCol()],outputCols=[categoricalCol + "classVec"])
  stages += [stringIndexer, encoder]
label_stringIdx = StringIndexer (inputCol='deposit',outputCol = 'label')
stages += [label_stringIdx]
numericCols = ['age','balance','duration','campaign','pdays','previous']
assemblerInputs = [c + "classVec" for c in categoricalColumns] + numericCols
assembler = VectorAssembler(inputCols=assemblerInputs, outputCol = "features")
stages += [assembler]
```

```
pipeline = Pipeline(stages = stages)
pipelineModel = pipeline.fit(df)
df = pipelineModel.transform(df)
df.printSchema()
```

```
root
 |-- age: integer (nullable = true)
 |-- job: string (nullable = true)
 |-- marital: string (nullable = true)
 |-- education: string (nullable = true)
 |-- default: string (nullable = true)
 |-- balance: integer (nullable = true)
 |-- housing: string (nullable = true)
 |-- loan: string (nullable = true)
 |-- contact: string (nullable = true)
 |-- day: integer (nullable = true)
 |-- month: string (nullable = true)
 |-- duration: integer (nullable = true)
 |-- campaign: integer (nullable = true)
 |-- pdays: integer (nullable = true)
 |-- previous: integer (nullable = true)
 |-- poutcome: string (nullable = true)
 |-- deposit: string (nullable = true)
 |-- jobIndex: double (nullable = false)
 |-- jobclassVec: vector (nullable = true)
 |-- maritalIndex: double (nullable = false)
```

```
pd.DataFrame(df.take(5), columns=df.columns).transpose()
```

```
Out[10]:
```

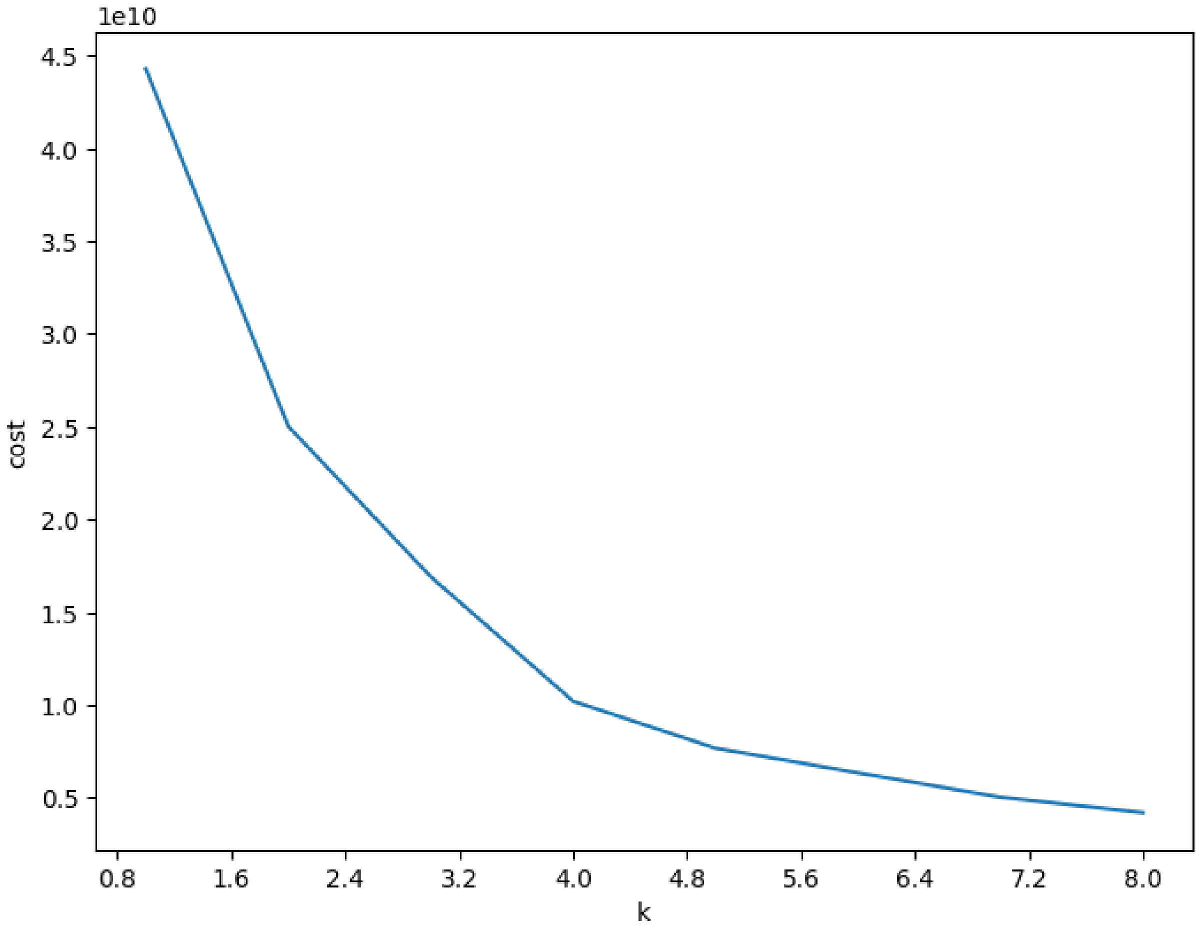
	0	1	2	3	4
age	59	56	41	55	54
job	admin.	admin.	technician	services	admin.
marital	married	married	married	married	married
education	secondary	secondary	secondary	secondary	tertiary
default	no	no	no	no	no
balance	2343	45	1270	2476	184
housing	yes	no	yes	yes	no
loan	no	no	no	no	no
contact	unknown	unknown	unknown	unknown	unknown
day	5	5	5	5	5
month	may	may	may	may	may
duration	1042	1467	1389	579	673
campaign	1	1	1	1	2
pdays	-1	-1	-1	-1	-1
previous	0	0	0	0	0
poutcome	unknown	unknown	unknown	unknown	unknown
deposit	yes	yes	yes	yes	yes
jobIndex	3	3	2	4	3
	(0.0, 0.0, 0.0,	(0.0, 0.0, 0.0,	(0.0, 0.0, 1.0,	(0.0, 0.0, 0.0,	(0.0, 0.0, 0.0,

jobclassVec	1.0, 0.0, 0.0, 0.0, 0.0, 0.0, ...	1.0, 0.0, 0.0, 0.0, 0.0, 0.0, ...	0.0, 0.0, 0.0, 0.0, 0.0, 0.0, ...	0.0, 1.0, 0.0, 0.0, 0.0, 0.0, ...	1.0, 0.0, 0.0, 0.0, 0.0, 0.0, ...
maritalIndex	0	0	0	0	0
maritalclassVec	(1.0, 0.0)	(1.0, 0.0)	(1.0, 0.0)	(1.0, 0.0)	(1.0, 0.0)
educationIndex	0	0	0	0	1
educationclassVec	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(0.0, 1.0, 0.0)
defaultIndex	0	0	0	0	0
defaultclassVec	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
housingIndex	1	0	1	1	0
housingclassVec	(0.0)	(1.0)	(0.0)	(0.0)	(1.0)
loanIndex	0	0	0	0	0
loanclassVec	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
contactIndex	1	1	1	1	1
contactclassVec	(0.0, 1.0)	(0.0, 1.0)	(0.0, 1.0)	(0.0, 1.0)	(0.0, 1.0)
poutcomeIndex	0	0	0	0	0
poutcomeclassVec	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)
label	1	1	1	1	1
features	(0.0, 0.0, 0.0, 1.0, 0.0, 0.0,	(0.0, 0.0, 0.0, 1.0, 0.0, 0.0,	(0.0, 0.0, 1.0, 0.0, 0.0, 0.0,	(0.0, 0.0, 0.0, 0.0, 1.0, 0.0,	(0.0, 0.0, 0.0, 1.0, 0.0, 0.0,

```
train, test = df.randomSplit([0.8,0.2],seed = 99999)
from pyspark.ml.clustering import KMeans
import numpy as np
cost = np.zeros(10)
for k in range(2,10):
  kmeans = KMeans().setK(k).setSeed(1)
  model = kmeans.fit(train)
  cost[k] = model.computeCost(train)
```

```
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt
import seaborn as sbs
from matplotlib.ticker import MaxNLocator

fig, ax = plt.subplots(1,1, figsize = (8,6))
ax.plot(range(1,9),cost[2:10])
ax.set_xlabel('k')
ax.set_ylabel('cost')
ax.xaxis.set_major_locator(MaxNLocator(interger=True))
display(fig)
```



```
from pyspark.ml.clustering import KMeans
from pyspark.ml.evaluation import ClusteringEvaluator
kmeans = KMeans().setK(8).setSeed(999)
model = kmeans.fit(train)


evaluator = ClusteringEvaluator()
predictions = model.transform(train)
silhouette = evaluator.evaluate(predictions)
print("Training Dataset Performance = " + str(silhouette))
```

```
Training Dataset Performance = 0.7363543157476975
```

```
centers = model.clusterCenters()
print("Cluster Centers : ")
for center in centers:
  print(center)
```

```
Cluster Centers :
[2.08811932e-01 1.89610835e-01 1.63723641e-01 1.31836105e-01
 8.96622664e-02 5.55460312e-02 3.48019887e-02 3.25732899e-02
 3.24018515e-02 2.98302760e-02 2.50300017e-02 5.46374079e-01
 3.28990228e-01 5.17229556e-01 3.03960226e-01 1.34579119e-01
 9.77884451e-01 4.94771130e-01 8.41248071e-01 7.18155323e-01
 2.25441454e-01 7.67529573e-01 1.06806103e-01 8.31476084e-02
 4.01242928e+01 2.86513972e+02 3.65381279e+02 2.56197497e+00
 4.94575690e+01 7.32041831e-01]
[3.18681319e-01 9.89010989e-02 2.30769231e-01 7.69230769e-02
 2.19780220e-02 9.89010989e-02 5.49450549e-02 1.09890110e-02
 2.19780220e-02 3.29670330e-02 1.09890110e-02 5.05494505e-01
 4.06593407e-01 3.73626374e-01 5.38461538e-01 5.49450549e-02
 1.00000000e+00 5.93406593e-01 9.78021978e-01 8.02197802e-01
 9.89010989e-02 7.14285714e-01 8.79120879e-02 1.31868132e-01
 4.10879121e+01 1.48263516e+04 4.36164835e+02 2.42857143e+00
 5.56813187e+01 9.01098901e-01]
[3.01694915e-01 9.15254237e-02 1.96610169e-01 9.15254237e-02
 5.42372881e-02 9.15254237e-02 4.06779661e-02 3.38983051e-02
 4.06779661e-02 2.03389831e-02 2.71186441e-02 6.03389831e-01
 3.01694915e-01 3.45762712e-01 4.50847458e-01 1.55932203e-01
```

```
kmeans = KMeans().setK(8).setSeed(999)
model = kmeans.fit(test)



evaluator = ClusteringEvaluator()
predictions = model.transform(test)
silhouette = evaluator.evaluate(predictions)
print("Testing Dataset Performance= "+ str(silhouette))
```

```
Testing Dataset Performance= 0.744601569802811
```

```
#Training Dataset
cluster=[3,4,5,8]
train_performance=[]
for i in cluster:
  kmeans = KMeans().setK(i).setSeed(999)
  model = kmeans.fit(train)
  evaluator = ClusteringEvaluator()
  predictions = model.transform(train)
  silhouette = evaluator.evaluate(predictions)
  train_performance.append(silhouette)
  print("Training Dataset Performance for K-mean with "+str(i)+"Cluster = " +
str(silhouette))
```

```
Training Dataset Performance for K-mean with 3Cluster = 0.879399553497968
Training Dataset Performance for K-mean with 4Cluster = 0.8651895328329998
Training Dataset Performance for K-mean with 5Cluster = 0.8208494545136753
Training Dataset Performance for K-mean with 8Cluster = 0.7363543157476975

Training Dataset Performance for K-mean with 3Cluster = 0.8816599450996049
Training Dataset Performance for K-mean with 4Cluster = 0.8690850392233181
Training Dataset Performance for K-mean with 5Cluster = 0.8328806996735177
Training Dataset Performance for K-mean with 8Cluster = 0.7446001569802811
```