Spark MLlib (MultiLayer perceptron classifier)
Exercise 4

Today you'll learn about Spark MLlib
How to perform operations and train learners using Spark MLlib
(Sources: https://spark.apache.org/;
https://spark.apache.org/docs/latest/ml-classification-regression.html
https://github.com/Apress/learn-pyspark)
NB. Text and images are directly copied from these sources.

In this exercise, we will cover a basic overview of Spark's multi-layer perceptron classifier. The algorithm is based on a feedforward artificial neural network. More details are mentioned in the following URL:

https://spark.apache.org/docs/latest/ml-classification-regression.html#multilayer-perceptron-classifier

Let's proceed to a practical example.

1) Reading the data
We will use sample data provided by Apache Spark, which can be downloaded/copied from the following github repository:
https://github.com/Apress/learn-pyspark/blob/master/chap_8/dl_data.csv

```
import os
import numpy as np
import pandas as pd
from pyspark.sql.types import *
from pyspark.ml import Pipeline
from pyspark.sql import functions as f
from pyspark.sql.functions import udf, StringType
from pyspark.sql import SparkSession, functions as F
from pyspark.ml.evaluation import MulticlassClassificationEvaluator
from pyspark.ml.classification import MultilayerPerceptronClassifier
from pyspark.ml.feature import OneHotEncoder, VectorAssembler,
StringIndexer

#Building session now

spark =
SparkSession.builder.appName('deep_learning_with_spark').getOrCreate(
)

#Finding out the directory to read the file
```

```
pwd
```

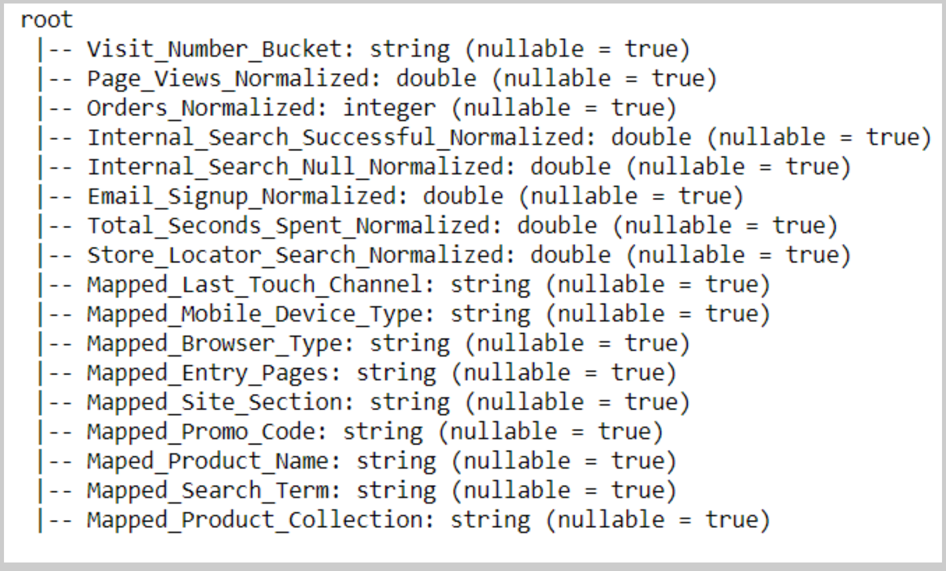
```
#Reading the file now
```

```
data = spark.read.csv('/home/jovyan/work/dl_data.csv', header=True,
inferSchema=True)
```

2) Exploring schema

Now, we will check the data types of parameters present in the read file. Also, if there is categorical data, how should we proceed with it?

```
data.dtypes
```



```
root
 |-- Visit_Number_Bucket: string (nullable = true)
 |-- Page_Views_Normalized: double (nullable = true)
 |-- Orders_Normalized: integer (nullable = true)
 |-- Internal_Search_Successful_Normalized: double (nullable = true)
 |-- Internal_Search_Null_Normalized: double (nullable = true)
 |-- Email_Signup_Normalized: double (nullable = true)
 |-- Total_Seconds_Spent_Normalized: double (nullable = true)
 |-- Store_Locator_Search_Normalized: double (nullable = true)
 |-- Mapped_Last_Touch_Channel: string (nullable = true)
 |-- Mapped_Mobile_Device_Type: string (nullable = true)
 |-- Mapped_Browser_Type: string (nullable = true)
 |-- Mapped_Entry_Pages: string (nullable = true)
 |-- Mapped_Site_Section: string (nullable = true)
 |-- Mapped_Promo_Code: string (nullable = true)
 |-- Maped_Product_Name: string (nullable = true)
 |-- Mapped_Search_Term: string (nullable = true)
 |-- Mapped_Product_Collection: string (nullable = true)
```

As we can see, we need to do a bit of preprocessing to rename the column of our target variable “Orders_normalized as label” (**Do yourself**)

Let's explore the schema once again to check out the changes.

data.printSchema()

3) Applying MPC

```
train, validation, test  = data.randomSplit([0.7, 0.2, 0.1], 1234)
```

4) Building the pipeline

```
categorical_columns = [item[0] for item in data.dtypes if item[1].startswith('string')]
```

```
numeric_columns = [item[0] for item in data.dtypes if item[1].startswith('double')]
indexers = [StringIndexer(inputCol=column, outputCol='{0}_index'.format(
   column)) for column in categorical_columns]


#Now we will building string indexer to further create the feature set from our data

featuresCreator = VectorAssembler(inputCols=[indexer.getOutputCol() for indexer in indexers] +
numeric_columns, outputCol="features")

#Configure the classifier

layers = [len(featuresCreator.getInputCols()), 4, 2, 2]

classifier = MultilayerPerceptronClassifier(labelCol='label', featuresCol='features', maxIter=100,
layers=layers, blockSize=128, seed=1234)

#Now are pipeline is configured so we can further move to fitting and prediction
```

5) Fit and get output from pipeline

```
pipeline = Pipeline(stages=indexers + [featuresCreator, classifier])
model = pipeline.fit(train)

# let's checkout the results

train_output_df = model.transform(train)
validation_output_df = model.transform(validation)
test_output_df = model.transform(test)
```

6) Evaluate using different metrics

```
train_predictionAndLabels = train_output_df.select("prediction", "label")
validation_predictionAndLabels = validation_output_df.select("prediction",
"label")
test_predictionAndLabels = test_output_df.select("prediction", "label")

metrics = ['weightedPrecision', 'weightedRecall', 'accuracy']

for metric in metrics:
    evaluator = MulticlassClassificationEvaluator(metricName=metric)
    print('Train ' + metric + ' = ' +
str(evaluator.evaluate(train_predictionAndLabels)))
    print('Validation ' + metric + ' = ' +
str(evaluator.evaluate(validation_predictionAndLabels)))
```

```
    print('Test ' + metric + ' = ' +
str(evaluator.evaluate(test_predictionAndLabels)))
```

7) Plots and visualizations

```
import matplotlib.pyplot as plt
import numpy as np
import itertools

def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):
    """
    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    print(cm)

    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    fmt = '.2f' if normalize else 'd'
    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], fmt),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

```
#Get Class labels

class_temp = test_predictionAndLabels.select("label").groupBy("label").count().sort('count',
ascending=False).toPandas()["label"].tolist()

#Calculate confusion matrix

from sklearn.metrics import confusion_matrix
y_true = test_predictionAndLabels.select("label")
y_true = y_true.toPandas()

y_pred = test_predictionAndLabels.select("prediction")
y_pred = y_pred.toPandas()

cnf_matrix = confusion_matrix(y_true, y_pred,labels=class_temp)
cnf_matrix


#Plotting Results

plt.figure()
plot_confusion_matrix(cnf_matrix, classes=class_temp,
                      title='Confusion matrix, without normalization')
plt.show()
```

Questions for the Exercise 4 report:

Please answer the following questions. Compile your answers into a 1 page report, put there your student ID number and your name.

1. What have you learned today?
2. Put results of steps 6 and 7. Explain what you have got there.