databricksClassification - Prediction and Probability

```
import org.apache.spark
from pyspark.sql import SparkSession
import pandas as pd
import numpy as np
from collections import defaultdict
from pyspark.ml import Pipeline
from pyspark.ml.feature import OneHotEncoder, StringIndexer, Imputer,
VectorAssembler, StandardScaler
from pyspark.ml.classification import LogisticRegression, NaiveBayes,
DecisionTreeClassifier, RandomForestClassifier
from pyspark.ml.evaluation import BinaryClassificationEvaluator
import seaborn as sns
from sklearn.metrics import confusion_matrix, classification_report
```

```
order_sparkDF = spark.read.csv("/FileStore/tables/orders.csv", header="true",
inferSchema="true")
orders_df = order_sparkDF.toPandas()
orders_df
```

	order_id	user_id	eval_set	order_number	order_dow	order_hour_of_day	days_since_pı
0	2539329	1	prior	1	2	8	
1	2398795	1	prior	2	3	7	
2	473747	1	prior	3	3	12	
3	2254736	1	prior	4	4	7	
4	431534	1	prior	5	4	15	
...	...	...	...	...	...	...	
3421078	2266710	206209	prior	10	5	18	
3421079	1854736	206209	prior	11	4	10	
3421080	626363	206209	prior	12	1	12	
3421081	2977660	206209	prior	13	1	12	
3421082	272231	206209	train	14	6	14	

3421083 rows × 7 columns

```
order_products_prior_sparkDF =
spark.read.csv("/FileStore/tables/order_products__prior.csv", header="true",
inferSchema="true")
order_products_prior_df = order_products_prior_sparkDF.toPandas()
order_products_prior_df
```

	order_id	product_id	add_to_cart_order	reordered
0	2	33120	1	1
1	2	28985	2	1
2	2	9327	3	0
3	2	45918	4	1
4	2	30035	5	0
...	...	...	...	...
32434484	3421083	39678	6	1
32434485	3421083	11352	7	0
32434486	3421083	4600	8	0
32434487	3421083	24852	9	1
32434488	3421083	5020	10	1

32434489 rows × 4 columns

```
urlA = 'https://drive.google.com/file/d/1W8bNivEj7H0WXqZx1X83fQEYz4A3XadY/view?
usp=sharing'
urlA2 = 'https://drive.google.com/uc?id=' + urlA.split('/')[-2]
aisles_df = pd.read_csv(urlA2)
aisles_df
```

	aisle_id	aisle
0	1	prepared soups salads
1	2	specialty cheeses
2	3	energy granola bars
3	4	instant foods
4	5	marinades meat preparation
...	...	...
129	130	hot cereal pancake mixes
130	131	dry pasta
131	132	beauty
132	133	muscles joints pain relief
133	134	specialty wines champagnes

134 rows × 2 columns

```
urlD = 'https://drive.google.com/file/d/1unatDL4jGx5CCHYN2Q9YnDjnq43AgtJp/view?
usp=sharing'
urlD2 = 'https://drive.google.com/uc?id=' + urlD.split('/')[-2]
departments_df = pd.read_csv(urlD2)
departments_df
```

	department_id	department
0	1	frozen
1	2	other
2	3	bakery
3	4	produce
4	5	alcohol
5	6	international
6	7	beverages
7	8	pets
8	9	dry goods pasta
9	10	bulk
10	11	personal care
11	12	meat seafood
12	13	pantry
13	14	breakfast
14	15	canned goods
15	16	dairy eggs
16	17	household
17	18	babies
18	19	snacks
19	20	deli
20	21	missing

```
urlOPT =
'https://drive.google.com/file/d/1IyZbHlrD8zXB8zhgx2XKxt812THThGRu/view?
usp=sharing'
urlOPT2 = 'https://drive.google.com/uc?id=' + urlOPT.split('/')[-2]
order_products_train = pd.read_csv(urlOPT2)
order_products_train
```

	order_id	product_id	add_to_cart_order	reordered
0	1	49302	1	1
1	1	11109	2	1
2	1	10246	3	0
3	1	49683	4	0
4	1	43633	5	1
...	...	...	...	...
1384612	3421063	14233	3	1
1384613	3421063	35548	4	1
1384614	3421070	35951	1	1
1384615	3421070	16953	2	1
1384616	3421070	4724	3	1

1384617 rows × 4 columns

```
urlP = 'https://drive.google.com/file/d/1Gkwkg56XgLzX_hyZDjEyHyRbcSjuWKp3/view?
usp=sharing'
urlP2 = 'https://drive.google.com/uc?id=' + urlP.split('/')[-2]
products = pd.read_csv(urlP2)
products
```

	product_id	product_name	aisle_id	department_id
0	1	Chocolate Sandwich Cookies	61	19
1	2	All-Seasons Salt	104	13
2	3	Robust Golden Unsweetened Oolong Tea	94	7
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38	1
4	5	Green Chile Anytime Sauce	5	13
...	...	...	...	...
49683	49684	Vodka, Triple Distilled, Twist of Vanilla	124	5
49684	49685	En Croute Roast Hazelnut Cranberry	42	1
49685	49686	Artisan Baguette	112	3
49686	49687	Smartblend Healthy Metabolism Dry Cat Food	41	8
49687	49688	Fresh Foaming Cleanser	73	11

49688 rows × 4 columns

```
#merging the data together
temp = pd.merge(order_products_prior_df, products, on=["product_id"])
temp = pd.merge(temp, orders_df, on=["order_id"])
temp = pd.merge(temp, aisles_df, on=["aisle_id"])
data = pd.merge(temp, departments_df, on=["department_id"])
del temp
data
```

	order_id	product_id	add_to_cart_order	reordered	product_name	aisle_id	department
0	2	33120	1	1	Organic Egg Whites	86	
1	26	33120	5	0	Organic Egg Whites	86	
2	120	33120	13	0	Organic Egg Whites	86	
3	327	33120	5	1	Organic Egg Whites	86	
4	390	33120	28	1	Organic Egg Whites	86	
...	...	...	...	...	...	...	
32434484	3243156	20731	1	0	Straight Sherry	134	
32434485	860862	30582	1	0	Natural Champagne	134	
32434486	1333472	27906	1	0	Imperial Champagne	134	

```
# data1 = data.sample(frac =.01)
```

```
#converting to spark dataframe
sparkDF = spark.createDataFrame(data)
```

```
# from pyspark.sql.functions import col, explode, array, lit
# major_df = sparkDF.filter(col("reordered") == 1)
# minor_df = sparkDF.filter(col("reordered") == 0)
# ratio = int(major_df.count()/minor_df.count())
# print("ratio: {}".format(ratio))
```

```
# sampled_majority_df = major_df.sample(False, 1/ratio)
# sparkDF = sampled_majority_df.unionAll(minor_df)
# sparkDF.show()


# a = range(ratio)
# # duplicate the minority rows
# oversampled_df = minor_df.withColumn("dummy", explode(array([lit(x) for x in
a]))).drop('dummy')
# # combine both oversampled minority rows and previous majority rows
# sparkDF = major_df.unionAll(oversampled_df)
# sparkDF.show()


data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 32434489 entries, 0 to 32434488
Data columns (total 15 columns):
 #   Column                  Dtype
---  ------                  -----
 0   order_id                int32
 1   product_id              int32
 2   add_to_cart_order       int32
 3   reordered               int32
 4   product_name            object
 5   aisle_id                int64
 6   department_id           int64
 7   user_id                 int32
 8   eval_set                object
 9   order_number            int32
 10  order_dow               int32
 11  order_hour_of_day       int32
 12  days_since_prior_order  float64
 13  aisle                   object
 14  department              object
dtypes: float64(1), int32(8), int64(2), object(4)
```

```
data_types = defaultdict(list)
for entry in sparkDF.schema.fields:
   data_types[str(entry.dataType)].append(entry.name)
```

```
#filling missing values
strings_used = [var for var in data_types["StringType"]]

missing_data_fill = {}
for var in strings_used:
   missing_data_fill[var] = "missing"

sparkDF = sparkDF.fillna(missing_data_fill)


sparkDF.drop('eval_set')
```

```
Out[17]: DataFrame[order_id: int, product_id: int, add_to_cart_order: int, reor
dered: int, product_name: string, aisle_id: bigint, department_id: bigint, user
_id: int, order_number: int, order_dow: int, order_hour_of_day: int, days_since
_prior_order: double, aisle: string, department: string]
```

```
sparkDF.drop('eval_set_string_encoded')
```

```
Out[18]: DataFrame[order_id: int, product_id: int, add_to_cart_order: int, reor
dered: int, product_name: string, aisle_id: bigint, department_id: bigint, user
_id: int, eval_set: string, order_number: int, order_dow: int, order_hour_of_da
y: int, days_since_prior_order: double, aisle: string, department: string]
```

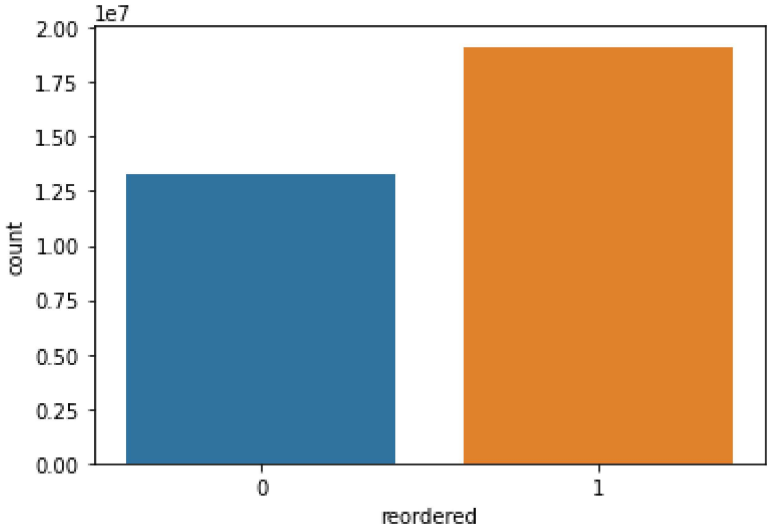
```
strings_used.remove('eval_set')


#encoding and indexing dataset
stage_string = [StringIndexer(inputCol= c, outputCol= c+"_string_encoded") for
c in strings_used]
stage_one_hot = [OneHotEncoder(inputCol= c+"_string_encoded", outputCol= c+
"_one_hot") for c in strings_used]

ppl = Pipeline(stages= stage_string + stage_one_hot)
sparkDF = ppl.fit(sparkDF).transform(sparkDF)


sparkDF.show()
```

```
+--------+----------+----------------+---------+--------------------+--------
+-------------+-------+--------+-----------+---------+-----------------+-----
-----------------+-----+----------+---------------------------+---------------
-----+-------------------------+--------------------+---------------+--------
----------+
|order_id|product_id|add_to_cart_order|reordered|        product_name|aisle_id
|department_id|user_id|eval_set|order_number|order_dow|order_hour_of_day|days_
```

```
since_prior_order|aisle|department|product_name_string_encoded|aisle_string_en
coded|department_string_encoded|product_name_one_hot|   aisle_one_hot|departme
nt_one_hot|
+--------+---------+----------------+---------+--------------------+--------
+-------------+-------+--------+-----------+---------+-----------------+-----
-----------------+-----+----------+---------------------------+---------------
-----+--------------------------+--------------------+---------------+--------
----------+
|       2|     33120|                1|        1|  Organic Egg Whites|      86
|           16| 202279|   prior|           3|        5|                9|
8.0| eggs|dairy eggs|                       199.0|               15.0|
1.0| (49676,[199],[1.0])|(133,[15],[1.0])|    (20,[1],[1.0])|
|      26|     33120|                5|        0|  Organic Egg Whites|      86
```

```
for c in data_types["LongType"]:
  sparkDF = sparkDF.withColumn(c+ "_cast_to_double", sparkDF[c].cast("double"))

cast_vars = [var for var in  sparkDF.columns if
var.endswith("_cast_to_double")]
cast_vars_imputed  = [var+ "imputed" for var in cast_vars]

imputer_for_cast_vars = Imputer(inputCols = cast_vars, outputCols =
cast_vars_imputed)
sparkDF = imputer_for_cast_vars.fit(sparkDF).transform(sparkDF)


features = cast_vars_imputed + [var + "_one_hot" for var in strings_used]

vector_assembler = VectorAssembler(inputCols = features, outputCol= "features")
data_training_and_test = vector_assembler.transform(sparkDF)


#scaling dataset
scale = StandardScaler(inputCol='features', outputCol='standardized')
data_scale=scale.fit(data_training_and_test)
data_training_and_test =data_scale.transform(data_training_and_test)


# from pyspark.ml.feature import PCA
# pca_model = PCA(k = 6, inputCol = "features", outputCol = "pca_features")


# model = pca_model.fit(data_training_and_test)
# data_training_and_test = model.transform(data_training_and_test)


sns.countplot(x=data['reordered'])
```

```
Out[27]: <AxesSubplot:xlabel='reordered', ylabel='count'>
```




```
#splitting data into training and testing
(training_data, test_data) = data_training_and_test.randomSplit([0.7, 0.3])


#training logistic regression model
lr = LogisticRegression(labelCol="reordered", featuresCol = 'features',
maxIter=10)
lrModel = lr.fit(training_data)


#getting predictions
lrpredictions = lrModel.transform(test_data)


#gettin accuracy
evaluator= BinaryClassificationEvaluator(labelCol = "reordered",
rawPredictionCol="probability", metricName= "areaUnderROC")
accuracy = evaluator.evaluate(lrpredictions)


print("Accuracy of logistic regression model is: ", accuracy)

Accuracy of logistic regression model is:  0.6692412226857567


print('Below table shows the prediction and probability whether the order will
be reordered.')
lrpredictions.select('order_id', 'reordered', 'prediction', 'rawPrediction',
'probability').limit(10).toPandas()
```

```
Below table shows the prediction and probability whether the order will be reor
dered.
/databricks/spark/python/pyspark/sql/pandas/conversion.py:92: UserWarning: toPa
ndas attempted Arrow optimization because 'spark.sql.execution.arrow.pyspark.en
abled' is set to true; however, failed by the reason below:
  Unable to convert the field rawPrediction. If this column is not necessary, y
ou may consider dropping it or converting to primitive type before the conversi
on.
Direct cause: Unsupported type in conversion to Arrow: VectorUDT
Attempting non-optimization as 'spark.sql.execution.arrow.pyspark.fallback.enab
led' is set to true.
  warnings.warn(msg)
```

	order_id	reordered	prediction	rawPrediction	probability
0	2	1	1.0	[-0.8901820229062557, 0.8901820229062557]	[0.2910722657241014, 0.7089277342758986]
1	3	1	1.0	[-0.27357181653923024, 0.27357181653923024]	[0.4320304303005824, 0.5679695696994176]
2	5	1	1.0	[-0.2649134537820823, 0.2649134537820823]	[0.4341562583254993, 0.5658437416745007]
3	13	0	0.0	[0.40902708407822586, -0.40902708407822586]	[0.6008545689338733, 0.39914543106612665]
4	22	1	1.0	[-0.4383667819939765, 0.4383667819939765]	[0.39213020114479435, 0.6078697988552056]
5	25	1	1.0	[-0.6466470222771324, 0.6466470222771324]	[0.34374552047451357, 0.6562544795254864]
6	26	0	1.0	[-1.1485165123721166, 1.1485165123721166]	[0.24076015243157403, 0.7592398475684261]

```
#training the naive bayes model
nb = NaiveBayes(labelCol="reordered", featuresCol = 'features')
nbModel = nb.fit(training_data)
```

```
  The spark driver has stopped unexpectedly and is restarting. Your notebook wi
  ll be automatically reattached.
```

```
#getting predictions
nbpredictions = nbModel.transform(test_data)
```

```
  Cancelled
```

```
#getting accuracy
evaluator= BinaryClassificationEvaluator(labelCol = "reordered",
rawPredictionCol="probability", metricName= "areaUnderROC")
accuracy = evaluator.evaluate(nbpredictions)
```

```
  Cancelled
```

```
print("Accuracy of naive bayes model is: ", accuracy)
```

```
  Cancelled
```

```
print('Below table shows the prediction and probability whether the order will
be reordered.')
nbpredictions.select('order_id', 'reordered', 'prediction', 'rawPrediction',
'probability').limit(10).toPandas()
```

```
  Cancelled
```

```
# #training decision tree classifier
# dt = DecisionTreeClassifier(labelCol="reordered", featuresCol = 'features')
# dtModel = dt.fit(training_data)
```

```
  Cancelled
```

```
# #getting predictions
# dtpredictions = dtModel.transform(test_data)
```

```
  Cancelled
```

```
# #getting accuracy
# evaluator= BinaryClassificationEvaluator(labelCol = "reordered",
rawPredictionCol="probability", metricName= "areaUnderROC")
# accuracy = evaluator.evaluate(dtpredictions)
```

```
  Cancelled
```

```
# print("Accuracy of decision tree classifier is: ", accuracy)
```

```
  Cancelled
```

```
# print('Below table shows the prediction and probability whether the order
will be reordered.')
# dtpredictions.select('order_id', 'reordered', 'prediction', 'rawPrediction',
'probability').limit(10).toPandas()
```

```
  Cancelled
```

```
# #training random forest classifier
# rf = RandomForestClassifier(labelCol="reordered", featuresCol = 'features')
# rfModel = rf.fit(training_data)
```

```
  Cancelled
```

```
# #getting predictions
# rfpredictions = rfModel.transform(test_data)
```

Cancelled

```
# #getting accuracy
# evaluator= BinaryClassificationEvaluator(labelCol = "reordered",
rawPredictionCol="probability", metricName= "areaUnderROC")
# accuracy = evaluator.evaluate(rfpredictions)
```

Cancelled

```
# print("Accuracy of random forest classifier is: ", accuracy)
```

Cancelled

Cancelled