ML-Classification-Categorical-Snow

November 30, 2017

```
In [1]: from pyspark.sql.types import StructType, StructField, FloatType, LongType, StringType
        from pyspark.shell import spark

        feats = []
        f = open('features.txt')
        for line_num, line in enumerate(f):
            if line_num == 0:
                # Timestamp
                feats.append(StructField(line.strip(), LongType(), True))
            elif line_num == 1:
                # Geohash
                feats.append(StructField(line.strip(), StringType(), True))
            else:
                # Other features
                feats.append(StructField(line.strip(), FloatType(), True))

        schema = StructType(feats)
```

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 2.2.0
      /_/

Using Python version 3.6.3 (default, Oct  6 2017 12:04:38)
SparkSession available as 'spark'.
```

```
In [2]: df = spark.read.format('csv').option('sep', '\t').schema(schema).load('inputs/mini-samp
```

```
In [5]: col_names = []
        for i in range(2,len(df.columns)):
            col_names.append(df.columns[i])
```

```
In [39]: from pyspark.ml.stat import Correlation
         from pyspark.ml.feature import VectorAssembler
         vectorAssembler = VectorAssembler(inputCols=col_names,
                                           outputCol="features")
         trans_features = vectorAssembler.transform(df)
         coeff = Correlation.corr(trans_features,'features',method='pearson').collect()[0][0]
```

```
In [43]: mtrx = coeff.toArray()
```

```
In [44]: list_corr_pairs_coeffs = []
         feature_pairs = []

         for i in range(0,56):
             for j in range(0,56):

                 if (i != j) and not(((col_names[i]+"_"+col_names[j]) in feature_pairs) or
                                     ((col_names[j]+"_"+col_names[i]) in feature_pairs)):
                     feature_pairs.append(col_names[i] +"_"+col_names[j])
                     corr_pair_coeff = []
                     corr_pair_coeff.append(col_names[i]+" , "+col_names[j])
                     corr_pair_coeff.append(col_names[i])
                     corr_pair_coeff.append(col_names[j])
                     corr_pair_coeff.append(float(mtrx[i][j]))
                     list_corr_pairs_coeffs.append(tuple(corr_pair_coeff))
```

```
In [45]: df_corr_coeff_col_names = []
         df_corr_coeff_col_names.append(StructField("Feature_Pair", StringType(), True))
         df_corr_coeff_col_names.append(StructField("Feature1", StringType(), True))
         df_corr_coeff_col_names.append(StructField("Feature2", StringType(), True))
         df_corr_coeff_col_names.append(StructField("Pearson_Coeff", FloatType(), True))
         df_corr_coeff = spark.createDataFrame(list_corr_pairs_coeffs,StructType(df_corr_coeff_
```

```
In [46]: df_corr_coeff.where((df_corr_coeff.Feature1 == 'temperature_surface') |
                             (df_corr_coeff.Feature2 == 'temperature_surface')).sort(df_corr_co
```

```
+--------------------+--------------------+--------------------+-------------+
|        Feature_Pair|            Feature1|            Feature2|Pearson_Coeff|
+--------------------+--------------------+--------------------+-------------+
|upward_long_wave_...|upward_long_wave_...| temperature_surface|    0.9507364|
|geopotential_heig...|geopotential_heig...| temperature_surface|   0.88414276|
|downward_long_wav...|downward_long_wav...| temperature_surface|   0.83087575|
|geopotential_heig...|geopotential_heig...| temperature_surface|    0.8231031|
|temperature_surfa...| temperature_surface|precipitable_wate...|     0.708688|
|temperature_surfa...| temperature_surface|convective_availa...|    0.4671096|
|temperature_surfa...| temperature_surface|geopotential_heig...|   0.37617406|
|temperature_surfa...| temperature_surface|downward_short_wa...|   0.34058186|
|visibility_surfac...|  visibility_surface| temperature_surface|   0.28188124|
|pressure_surface ...|    pressure_surface| temperature_surface|   0.20792589|
|geopotential_heig...|geopotential_heig...| temperature_surface|  0.117955595|
|lightning_surface...|   lightning_surface| temperature_surface|   0.11171691|
|vegetation_surfac...|  vegetation_surface| temperature_surface|   0.09736003|
|temperature_surfa...| temperature_surface|v-component_of_wi...|   0.08873683|
|upward_short_wave...|upward_short_wave...| temperature_surface|   0.08651417|
|v-component_of_wi...|v-component_of_wi...| temperature_surface|   0.07520971|
|categorical_rain_...|categorical_rain_...| temperature_surface|   0.05293761|
|temperature_surfa...| temperature_surface|latent_heat_net_f...|  0.012255301|
|sensible_heat_net...|sensible_heat_net...| temperature_surface|  0.011762388|
|drag_coefficient_...|drag_coefficient_...| temperature_surface|   0.00251122|
+--------------------+--------------------+--------------------+-------------+
only showing top 20 rows
```

```
In [47]: #categorical_snow_yes1_no0_surface
         df_corr_coeff.where((df_corr_coeff.Feature1 == 'categorical_snow_yes1_no0_surface') |
                             (df_corr_coeff.Feature2 == 'categorical_snow_yes1_no0_surface')
                            ).sort(df_corr_coeff.Pearson_Coeff.desc()).show()
```

```
+--------------------+--------------------+--------------------+-------------+
|        Feature_Pair|            Feature1|            Feature2|Pearson_Coeff|
+--------------------+--------------------+--------------------+-------------+
|categorical_snow_...|categorical_snow_...|  snow_cover_surface|   0.30012408|
|categorical_snow_...|categorical_snow_...|maximumcomposite_...|    0.2645679|
|categorical_snow_...|categorical_snow_...|  snow_depth_surface|    0.2408605|
|categorical_snow_...|categorical_snow_...|      albedo_surface|    0.2254173|
|water_equiv_of_ac...|water_equiv_of_ac...|categorical_snow_...|    0.2251549|
|categorical_snow_...|categorical_snow_...| pressure_tropopause|    0.2167491|
|relative_humidity...|relative_humidity...|categorical_snow_...|   0.18254393|
|categorical_snow_...|categorical_snow_...|friction_velocity...|   0.17027378|
|categorical_snow_...|categorical_snow_...|temperature_tropo...|   0.16374761|
|categorical_snow_...|categorical_snow_...|plant_canopy_surf...|  0.124861635|
|number_of_soil_la...|number_of_soil_la...|categorical_snow_...|   0.11009545|
|categorical_snow_...|categorical_snow_...|land_cover_land1_...|  0.103146575|
|categorical_snow_...|categorical_snow_...|soil_porosity_sur...|  0.103146575|
|categorical_snow_...|categorical_snow_...|surface_wind_gust...|  0.098745205|
|categorical_snow_...|categorical_snow_...|transpiration_str...|   0.09675234|
|categorical_snow_...|categorical_snow_...|geopotential_heig...|  0.094172865|
|categorical_snow_...|categorical_snow_...|surface_roughness...|   0.08816603|
|categorical_snow_...|categorical_snow_...|geopotential_heig...|   0.07994601|
|categorical_snow_...|categorical_snow_...|v-component_of_wi...|   0.07057235|
|categorical_snow_...|categorical_snow_...|soil_type_as_in_z...|   0.06916345|
+--------------------+--------------------+--------------------+-------------+
only showing top 20 rows
```

```
In [48]: df_corr_coeff.where((df_corr_coeff.Feature1 == 'categorical_snow_yes1_no0_surface') |
                             (df_corr_coeff.Feature2 == 'categorical_snow_yes1_no0_surface')
                            ).sort(df_corr_coeff.Pearson_Coeff.asc()).show()
```

```
+--------------------+--------------------+--------------------+-------------+
|        Feature_Pair|            Feature1|            Feature2|Pearson_Coeff|
+--------------------+--------------------+--------------------+-------------+
|visibility_surfac...|  visibility_surface|categorical_snow_...|  -0.45647138|
|categorical_snow_...|categorical_snow_...|geopotential_heig...|  -0.26098943|
|categorical_snow_...|categorical_snow_...| temperature_surface|  -0.21268843|
|categorical_snow_...|categorical_snow_...|upward_long_wave_...|   -0.2037285|
|geopotential_heig...|geopotential_heig...|categorical_snow_...|  -0.19996537|
|categorical_snow_...|categorical_snow_...|precipitable_wate...|  -0.15940763|
|pressure_reduced_...|pressure_reduced_...|categorical_snow_...|  -0.13463028|
|categorical_snow_...|categorical_snow_...|mean_sea_level_pr...| -0.122622825|
|categorical_snow_...|categorical_snow_...|downward_long_wav...|  -0.11768969|
|categorical_snow_...|categorical_snow_...|    pressure_surface|  -0.10548218|
|categorical_snow_...|categorical_snow_...|convective_availa...|  -0.07774716|
|categorical_snow_...|categorical_snow_...|downward_short_wa...|  -0.07093287|
|categorical_snow_...|categorical_snow_...|  vegetation_surface|  -0.05607693|
|categorical_snow_...|categorical_snow_...|categorical_rain_...| -0.052368812|
|categorical_snow_...|categorical_snow_...|v-component_of_wi...| -0.019803138|
|categorical_snow_...|categorical_snow_...|geopotential_heig...| -0.011431282|
|categorical_snow_...|categorical_snow_...|latent_heat_net_f...|  -0.00841602|
|sensible_heat_net...|sensible_heat_net...|categorical_snow_...| -0.008250166|
|categorical_freez...|categorical_freez...|categorical_snow_...| -0.004402432|
|upward_short_wave...|upward_short_wave...|categorical_snow_...| -0.003501976|
+--------------------+--------------------+--------------------+-------------+
only showing top 20 rows
```

```
In [49]: #snow_cover_surface
         #snow_depth_surface
         #visibility_surface

         df_corr_coeff.where(((df_corr_coeff.Feature1 == 'categorical_snow_yes1_no0_surface') &
                               (df_corr_coeff.Feature2 == 'temperature_surface')) |
                               ((df_corr_coeff.Feature2 == 'categorical_snow_yes1_no0_surface') &
                               (df_corr_coeff.Feature1 == 'temperature_surface'))
                              ).sort(df_corr_coeff.Pearson_Coeff.asc()).show()
         #temperature_surface
```

```
+--------------------+--------------------+-------------------+-------------+
|        Feature_Pair|            Feature1|           Feature2|Pearson_Coeff|
+--------------------+--------------------+-------------------+-------------+
|categorical_snow_...|categorical_snow_...|temperature_surface|  -0.21268843|
+--------------------+--------------------+-------------------+-------------+
```

```
In [50]: df_corr_coeff.where(((df_corr_coeff.Feature1 == 'categorical_snow_yes1_no0_surface') &
                               (df_corr_coeff.Feature2 == 'precipitable_water_entire_atmosphere')
                               ((df_corr_coeff.Feature2 == 'categorical_snow_yes1_no0_surface') &
                             (df_corr_coeff.Feature1 == 'precipitable_water_entire_atmosphere'
                            ).sort(df_corr_coeff.Pearson_Coeff.asc()).show()
         #precipitable_water_entire_atmosphere
```

```
+--------------------+--------------------+--------------------+-------------+
|        Feature_Pair|            Feature1|            Feature2|Pearson_Coeff|
+--------------------+--------------------+--------------------+-------------+
|categorical_snow_...|categorical_snow_...|precipitable_wate...|  -0.15940763|
+--------------------+--------------------+--------------------+-------------+
```

```
In [51]: #snow_cover_surface
         #snow_depth_surface
         #visibility_surface
         #temperature_surface
         #precipitable_water_entire_atmosphere
```

```
In [61]: def prepare_data(dframe, predictors, target):
             assembler = VectorAssembler(inputCols=predictors, outputCol="features")
             output = assembler.transform(dframe)
             return output.select("features", target).withColumnRenamed(target, "label")


         prepped = prepare_data(df,
             ["snow_cover_surface",
                  "snow_depth_surface",
                  "visibility_surface",
                  "temperature_surface",
                  "precipitable_water_entire_atmosphere"],
             "categorical_snow_yes1_no0_surface")

         prepped.show()
         (trainingData, testData) = prepped.randomSplit([0.9, 0.1])
```

```
+--------------------+-----+
|            features|label|
+--------------------+-----+
|[0.0,0.0,24221.20...|  0.0|
|[100.0,0.01775999...|  0.0|
|[100.0,0.05375999...|  0.0|
|[0.0,0.0,22024.20...|  0.0|
|[0.0,0.0,24222.64...|  0.0|
|[100.0,0.90279996...|  0.0|
|[0.0,0.0,24225.47...|  0.0|
|[0.0,0.0,24225.27...|  0.0|
|[0.0,0.0,24224.25...|  0.0|
|[0.0,0.0,24225.79...|  0.0|
|[0.0,0.0,21825.27...|  0.0|
|[0.0,0.0,24222.57...|  0.0|
|[100.0,0.00944000...|  0.0|
|[0.0,0.0,24225.83...|  0.0|
|[100.0,0.02439999...|  0.0|
|[0.0,0.0,24224.25...|  0.0|
|[0.0,0.0,24222.07...|  0.0|
|[0.0,0.0,24224.07...|  0.0|
|[0.0,0.0,24222.07...|  0.0|
|[0.0,0.0,24223.87...|  0.0|
+--------------------+-----+
only showing top 20 rows
```

```
In [67]: from pyspark.ml.classification import RandomForestClassifier
         from pyspark.ml.evaluation import BinaryClassificationEvaluator

         rf = RandomForestClassifier(numTrees=3, maxDepth=2, labelCol="label", seed=42)
         model = rf.fit(prepped)
```

```
In [68]: model.featureImportances
```

```
Out[68]: SparseVector(5, {0: 0.075, 1: 0.0754, 2: 0.7194, 3: 0.1303})
```

```
In [72]: predictions = model.transform(testData)
         predictions.select(predictions.probability).show(n=5)
```

```
+--------------------+
|         probability|
+--------------------+
|[0.95664279808010...|
|[0.75998844918654...|
|[0.95664279808010...|
|[0.95664279808010...|
|[0.95664279808010...|
+--------------------+
only showing top 5 rows
```

```
In [74]: predictions.select(*predictions.columns).show(n=5)
```

```
+--------------------+-----+--------------------+--------------------+----------+
|            features|label|       rawPrediction|         probability|prediction|
+--------------------+-----+--------------------+--------------------+----------+
|[0.0,0.0,17.33257...|  0.0|[2.86992839424032...|[0.95664279808010...|       0.0|
|[0.0,0.0,17.51190...|  0.0|[2.27996534755964...|[0.75998844918654...|       0.0|
|[0.0,0.0,17.51190...|  0.0|[2.86992839424032...|[0.95664279808010...|       0.0|
|[0.0,0.0,18.01349...|  0.0|[2.86992839424032...|[0.95664279808010...|       0.0|
|[0.0,0.0,18.04895...|  0.0|[2.86992839424032...|[0.95664279808010...|       0.0|
+--------------------+-----+--------------------+--------------------+----------+
only showing top 5 rows
```

```
In [84]: evaluator = BinaryClassificationEvaluator()
         evaluator.evaluate(predictions)#by default considers area under roc to evaluate
```

```
Out[84]: 0.965504638264051
```

```
In [87]: samp_predns = predictions.sample(False, .1)
         samp_predns
```

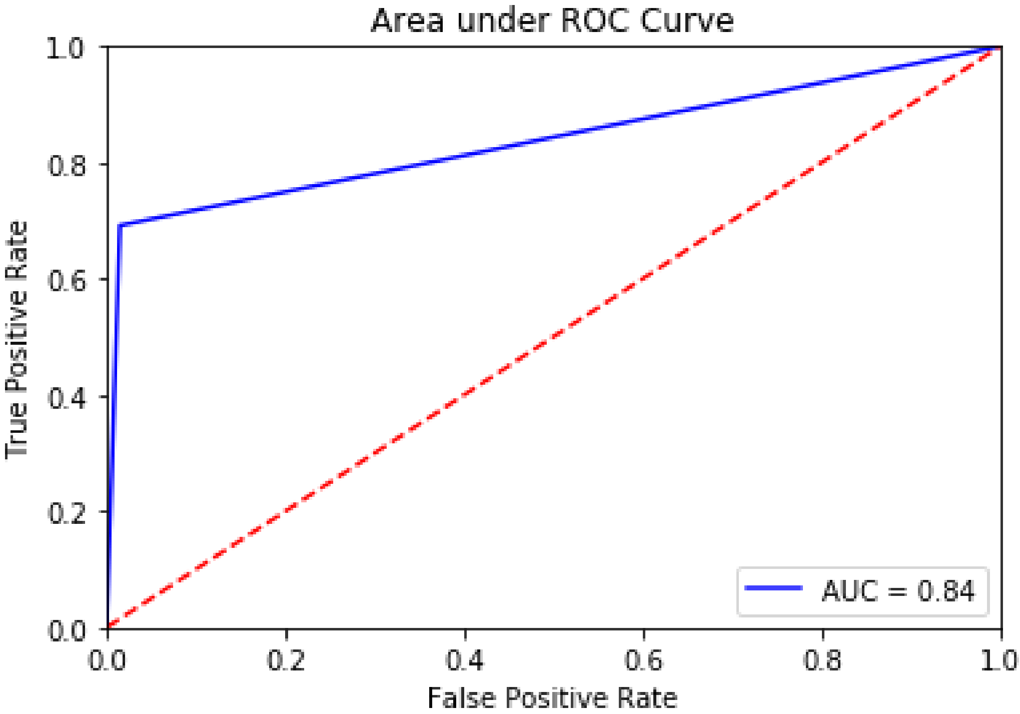
```
Out[87]: DataFrame[features: vector, label: float, rawPrediction: vector, probability: vector,
```

```
In [97]: import numpy as np
         from sklearn import metrics
         predns = np.array(samp_predns.select(samp_predns.prediction).collect())
```

```
In [98]: labels = np.array(samp_predns.select(samp_predns.label).collect())
```

```
In [99]: fpr, tpr, thresholds = metrics.roc_curve(labels, predns)
         roc_auc = metrics.auc(fpr, tpr)
```

```
In [100]: import matplotlib.pyplot as plt
          plt.title('Area under ROC Curve')
          plt.plot(fpr, tpr, 'b', label = 'AUC = %0.2f' % roc_auc)
          plt.legend(loc = 'lower right')
          plt.plot([0, 1], [0, 1],'r--')
          plt.xlim([0, 1])
          plt.ylim([0, 1])
          plt.ylabel('True Positive Rate')
          plt.xlabel('False Positive Rate')
          plt.show()
```


Area under ROC Curve
1.0
0.8
0.6
0.4
0.2
0.0
True Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
False Positive Rate
AUC = 0.84