S5 - HOPE SVM-V2

December 15, 2020

1 Import data from DB.

[1]:
```
import pandas as pd
import numpy as np
```

[2]:
```
dfOrg = pd.read_csv('hope_dataset_cleaned.csv')

print(dfOrg.shape[0])
```

```
1243
```

[3]:
```
dfOrg.head(10)
```

[3]:
```
   pedido.data.attributes.age pedido.data.attributes.diagnostic_main  \
0                        75.0                     FISTULA PERITONEAL
1                        75.0                     FISTULA PERITONEAL
2                        75.0                     FISTULA PERITONEAL
3                        75.0                     FISTULA PERITONEAL
4                        75.0                     FISTULA PERITONEAL
5                        75.0                     FISTULA PERITONEAL
6                        75.0                     FISTULA PERITONEAL
7                        75.0                     FISTULA PERITONEAL
8                        75.0                     FISTULA PERITONEAL
9                        75.0                     FISTULA PERITONEAL

  pedido.data.attributes.gender  articulo  respuesta.articlesRevisedYear  \
0                          male  27395425                           2018
1                          male  28560554                           2018
2                          male  28641726                           2017
3                          male  26245344                           2016
4                          male  28942543                           2018
5                          male  24782153                           2014
6                          male  28002229                           2018
7                          male  27505109                           2017
8                          male  24850546                           2015
9                          male  29371050                           2019
```

```
   respuesta.articlesRevisedMonth  \
0                               1
1                               4
2                              12
3                              12
4                               6
5                               6
6                               9
7                               4
8                               1
9                               4

                                respuesta.pubmed_keys  utilidad
0  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       1.0
1  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
2  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
3  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
4  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
5  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
6  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
7  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
8  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
9  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
```

Expand pubmed_keys attribute

[4]:
```
dfOrg['respuesta.pubmed_keys'] = dfOrg['respuesta.pubmed_keys'].apply(lambda x :
 ↪ str(x).split(','))

dfOrg = dfOrg.explode('respuesta.pubmed_keys').reset_index(drop=True)

dfOrg.head(10)
```

[4]:
```
   pedido.data.attributes.age pedido.data.attributes.diagnostic_main  \
0                        75.0                      FISTULA PERITONEAL
1                        75.0                      FISTULA PERITONEAL
2                        75.0                      FISTULA PERITONEAL
3                        75.0                      FISTULA PERITONEAL
4                        75.0                      FISTULA PERITONEAL
5                        75.0                      FISTULA PERITONEAL
6                        75.0                      FISTULA PERITONEAL
7                        75.0                      FISTULA PERITONEAL
8                        75.0                      FISTULA PERITONEAL
9                        75.0                      FISTULA PERITONEAL

  pedido.data.attributes.gender  articulo  respuesta.articlesRevisedYear  \
0                          male  27395425                           2018
```

```
1                           male  27395425                           2018
2                           male  27395425                           2018
3                           male  27395425                           2018
4                           male  27395425                           2018
5                           male  27395425                           2018
6                           male  27395425                           2018
7                           male  27395425                           2018
8                           male  27395425                           2018
9                           male  27395425                           2018

   respuesta.articlesRevisedMonth respuesta.pubmed_keys  utilidad
0                               1               Abdomen       1.0
1                               1        Adenocarcinoma       1.0
2                               1           Antiemetics       1.0
3                               1         Blood Culture       1.0
4                               1             Catharsis       1.0
5                               1              Diuresis       1.0
6                               1               Fistula       1.0
7                               1           Gastrectomy       1.0
8                               1      Incisional Hernia      1.0
9                               1            Intestines       1.0
```

2 Transform (factorice) from Categories to continuous atributes

Transform 'pedido.data.attributes.diagnostic_main' atribute

[5]:
```
dataDiagnosticMain, categoriesDiagnosticMain = pd.factorize(dfOrg['pedido.data.
 ↪attributes.diagnostic_main'])

dfOrg['pedido.data.attributes.diagnostic_main'] = dataDiagnosticMain
```

Transform 'gender' atribute

[6]:
```
dataGender, categoriesGender = pd.factorize(dfOrg['pedido.data.attributes.
 ↪gender'])

dfOrg['pedido.data.attributes.gender'] = dataGender
```

Transform 'respuesta.pubmed_keys' atribute

[7]:
```
categoriesORGPubMedKeys = dfOrg['respuesta.pubmed_keys'].value_counts()

print("total: " + str(categoriesORGPubMedKeys.size))
```

```
total: 353
```

[8]:
```
dataPubMedKeys, categoriesPubMedKeys = pd.factorize(dfOrg['respuesta.
 ↪pubmed_keys'])

dfOrg['respuesta.pubmed_keys'] = dataPubMedKeys
```

[9]:
```
dfOrg.head(10)
```

[9]:
```
   pedido.data.attributes.age  pedido.data.attributes.diagnostic_main  \
0                        75.0                                       0
1                        75.0                                       0
2                        75.0                                       0
3                        75.0                                       0
4                        75.0                                       0
5                        75.0                                       0
6                        75.0                                       0
7                        75.0                                       0
8                        75.0                                       0
9                        75.0                                       0

   pedido.data.attributes.gender  articulo  respuesta.articlesRevisedYear  \
0                              0  27395425                           2018
1                              0  27395425                           2018
2                              0  27395425                           2018
3                              0  27395425                           2018
4                              0  27395425                           2018
5                              0  27395425                           2018
6                              0  27395425                           2018
7                              0  27395425                           2018
8                              0  27395425                           2018
9                              0  27395425                           2018

   respuesta.articlesRevisedMonth  respuesta.pubmed_keys  utilidad
0                               1                      0       1.0
1                               1                      1       1.0
2                               1                      2       1.0
3                               1                      3       1.0
4                               1                      4       1.0
5                               1                      5       1.0
6                               1                      6       1.0
7                               1                      7       1.0
8                               1                      8       1.0
9                               1                      9       1.0
```

[10]:
```
print("age NaN => " + str(dfOrg[pd.isnull(dfOrg['pedido.data.attributes.age'])].
 ↪shape[0]))
print("diagnostic_main NaN => " + str(dfOrg[pd.isnull(dfOrg['pedido.data.
 ↪attributes.diagnostic_main'])].shape[0]))
```

```
print("gender NaN => " + str(dfOrg[pd.isnull(dfOrg['pedido.data.attributes.
↪gender'])].shape[0]))
print("articulo NaN => " + str(dfOrg[pd.isnull(dfOrg['articulo'])].shape[0]))
print("articlesRevisedYear NaN => " + str(dfOrg[pd.isnull(dfOrg['respuesta.
↪articlesRevisedYear'])].shape[0]))
print("articlesRevisedMonth NaN => " + str(dfOrg[pd.isnull(dfOrg['respuesta.
↪articlesRevisedMonth'])].shape[0]))
print("pubmed_keys NaN => " + str(dfOrg[pd.isnull(dfOrg['respuesta.
↪pubmed_keys'])].shape[0]))
print("utilidad NaN => " + str(dfOrg[pd.isnull(dfOrg['utilidad'])].shape[0]))
```

```
age NaN => 10
diagnostic_main NaN => 0
gender NaN => 0
articulo NaN => 0
articlesRevisedYear NaN => 0
articlesRevisedMonth NaN => 0
pubmed_keys NaN => 0
utilidad NaN => 14758
```

Remove row with age eq NaN

[11]:
```
dfOrg = dfOrg[pd.notnull(dfOrg['pedido.data.attributes.age'])]
```

3 Standardize the Data

Choosed “age”, “diagnostic_main”, “month” and “pubmed_keys” attributes (based on PCA_V3 study)

[12]:
```
from sklearn.preprocessing import StandardScaler

features = ["pedido.data.attributes.age",
    "pedido.data.attributes.diagnostic_main",
    "respuesta.articlesRevisedMonth",
    "respuesta.pubmed_keys",
    "utilidad"
]

# Separating out the features
x = dfOrg.loc[:, features].values

featuresTransformed = StandardScaler().fit_transform(x)

dfStandarized = pd.DataFrame(featuresTransformed, index=dfOrg.index,␣
↪columns=features)
dfStandarized['utilidad'] = dfOrg['utilidad']
```

```
dfStandarized
```

[12]:

```
       pedido.data.attributes.age  pedido.data.attributes.diagnostic_main  \
0                        1.285887                                -1.503163
1                        1.285887                                -1.503163
2                        1.285887                                -1.503163
3                        1.285887                                -1.503163
4                        1.285887                                -1.503163
…                             …                                      …
15583                   -0.607930                                -0.586347
15584                   -0.607930                                -0.586347
15585                   -0.607930                                -0.586347
15586                   -0.607930                                -0.586347
15587                   -0.607930                                -0.586347

       respuesta.articlesRevisedMonth  respuesta.pubmed_keys  utilidad
0                           -1.463658              -1.089722       1.0
1                           -1.463658              -1.080463       1.0
2                           -1.463658              -1.071203       1.0
3                           -1.463658              -1.061944       1.0
4                           -1.463658              -1.052684       1.0
…                                 …                      …       …
15583                       -1.178433              -0.330441       NaN
15584                       -1.178433              -0.978608       NaN
15585                       -1.178433               0.891817       NaN
15586                       -1.178433              -0.876753       NaN
15587                       -1.178433               0.901077       NaN

[15578 rows x 5 columns]
```

4 Separe data by utilidad is defined

[13]:

```
dfDataSetComplete = dfStandarized[pd.notnull(dfStandarized['utilidad'])]

print(dfDataSetComplete.shape[0])

dfDataSetToPredict = dfStandarized[pd.isnull(dfStandarized['utilidad'])]

print(dfDataSetToPredict.shape[0])
```

```
830
14748
```

5 SVM

We check the number of results

[14]:
```python
dfDataSetComplete.groupby('utilidad').size()
```

[14]:
```
utilidad
0.0    346
1.0    484
dtype: int64
```

Separe “utilidad” atribute from data to train

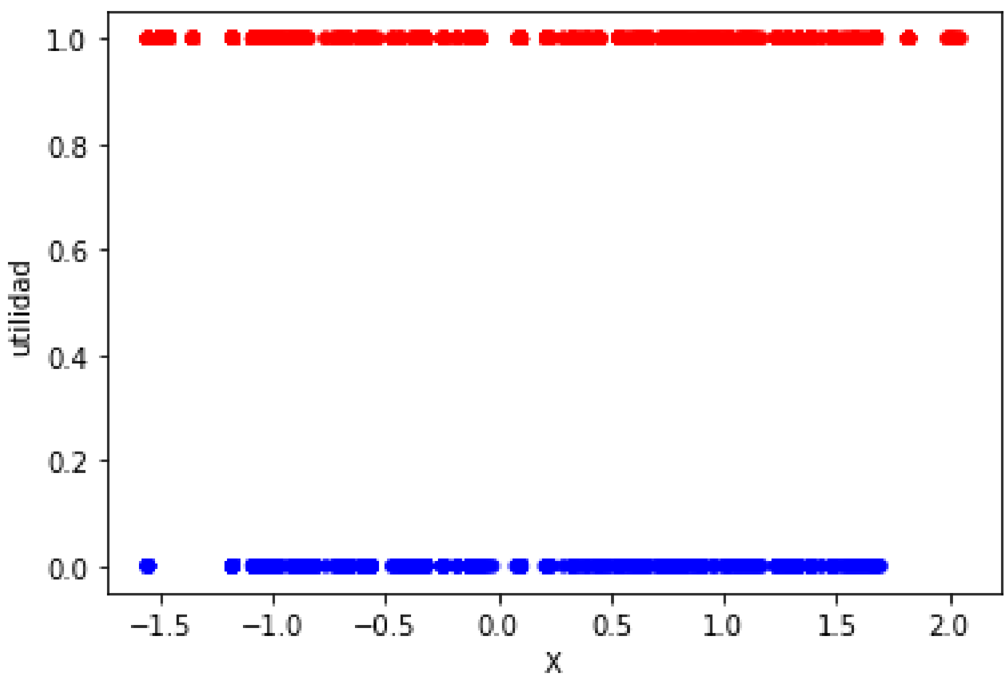
[15]:
```python
X = np.array(dfDataSetComplete.drop(['utilidad'],1))
y = np.array(dfDataSetComplete['utilidad'])
X.shape
```

[15]:
```
(830, 4)
```

[16]:
```python
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=0)
```

[17]:
```python
ax = dfDataSetComplete.plot.scatter(x="pedido.data.attributes.age",␣
↪y="utilidad", c=dfDataSetComplete.utilidad.map({0:'b', 1:'r'}))
dfDataSetComplete.plot.scatter(x="pedido.data.attributes.diagnostic_main",␣
↪y="utilidad", c=dfDataSetComplete.utilidad.map({0:'b', 1:'r'}), ax=ax)
dfDataSetComplete.plot.scatter(x="respuesta.articlesRevisedMonth",␣
↪y="utilidad", c=dfDataSetComplete.utilidad.map({0:'b', 1:'r'}), ax=ax)
dfDataSetComplete.plot.scatter(x="respuesta.pubmed_keys", y="utilidad",␣
↪c=dfDataSetComplete.utilidad.map({0:'b', 1:'r'}), ax=ax)
ax.set_xlabel('X')
```

[17]:
```
Text(0.5, 0, 'X')
```



A simple vista no podemos crear un hiperplano lineal (división de valores) que nos ayude a poder clasificar los valores del campo utilidad en base los atributos del data set, ya que los resultados del campo "utilidad" están distribuidos sobre todo el plano de X. Exploraremos con los kernel methods, que método nos ayuda a poder crear el hiperplano más optimo para la clasificación.

6 Exploring Hiper Parameters

· C: El valor de penalización de los errores en la clasificación. Indica el compromiso entre obtener el hiperplano con el margen más grande posible y clasificar el máximo número de ejemplos correctamente. Probaremos valores aleatorios distribuidos uniformemente entre 1 y 500.

https://scikit-learn.org/stable/modules/generated/sklearn.svm.SVC.html

https://scikit-learn.org/stable/auto_examples/svm/plot_rbf_parameters.html

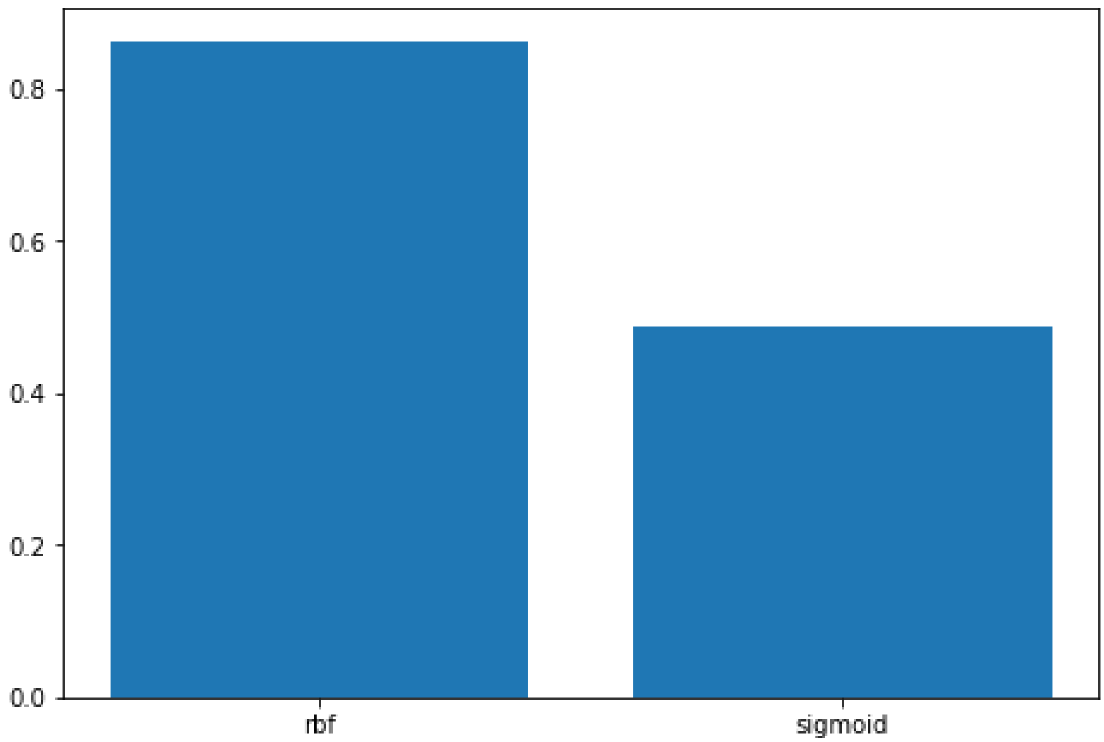
[18]:
```
from sklearn.model_selection import RandomizedSearchCV
from sklearn import svm
from scipy.stats import uniform as sp_rand
from time import time

clf = svm.SVC()

kernels = ['rbf', 'sigmoid']

param_dist = {
    "C":     sp_rand(loc=1, scale=500),
```

```python
    "gamma": sp_rand(loc=1e-3, scale=1e3)
}

best_score = []

for k in kernels:
    param_dist['kernel'] = [k]
    n_iter_search = 10
    random_search = RandomizedSearchCV(clf, param_distributions=param_dist,␣
 ↪n_iter=n_iter_search, cv=4)

    start = time()
    random_search.fit(X_train, y_train)
    end = time()
    print("El entrenamiento a durado {} segundos".format(end - start))

    means = random_search.cv_results_["mean_test_score"]
    stds = random_search.cv_results_["std_test_score"]
    params = random_search.cv_results_['params']
    ranks = random_search.cv_results_['rank_test_score']
    best_score.append({'kernel':k,'score':random_search.best_score_, 'params':␣
 ↪random_search.best_params_})

    for rank, mean, std, pms in zip(ranks, means, stds, params):
        print("{}) Precisión media: {:.2f} +/- {:.2f} con parámetros {}".
 ↪format(rank, mean*100, std*100, pms))
```

```
El entrenamiento a durado 0.6093668937683105 segundos
10) Precisión media: 76.21 +/- 3.94 con parámetros {'C': 360.85775701024386,
'gamma': 907.3825530117131, 'kernel': 'rbf'}
2) Precisión media: 82.15 +/- 3.10 con parámetros {'C': 317.80497788196783,
'gamma': 119.40946797705895, 'kernel': 'rbf'}
6) Precisión media: 76.69 +/- 4.23 con parámetros {'C': 87.01059367021347,
'gamma': 806.2789163354661, 'kernel': 'rbf'}
5) Precisión media: 77.98 +/- 3.45 con parámetros {'C': 149.54484171124932,
'gamma': 564.5199301320216, 'kernel': 'rbf'}
6) Precisión media: 76.69 +/- 4.23 con parámetros {'C': 118.97768424072203,
'gamma': 793.486590684318, 'kernel': 'rbf'}
6) Precisión media: 76.69 +/- 4.23 con parámetros {'C': 150.02147952417772,
'gamma': 737.8299797134209, 'kernel': 'rbf'}
6) Precisión media: 76.69 +/- 4.23 con parámetros {'C': 363.8370243112447,
'gamma': 848.9827977113308, 'kernel': 'rbf'}
3) Precisión media: 79.74 +/- 2.79 con parámetros {'C': 423.45666708016336,
'gamma': 277.59190556966644, 'kernel': 'rbf'}
1) Precisión media: 86.33 +/- 1.48 con parámetros {'C': 169.2424566596866,
'gamma': 21.685491125386175, 'kernel': 'rbf'}
```

```
4) Precisión media: 78.62 +/- 3.45 con parámetros {'C': 56.26738061340281,
'gamma': 313.7065587800348, 'kernel': 'rbf'}
El entrenamiento a durado 0.2546238899230957 segundos
7) Precisión media: 48.38 +/- 4.50 con parámetros {'C': 391.1677890243306,
'gamma': 497.20459077927774, 'kernel': 'sigmoid'}
7) Precisión media: 48.38 +/- 4.50 con parámetros {'C': 492.9377695700987,
'gamma': 453.0399489373676, 'kernel': 'sigmoid'}
4) Precisión media: 48.54 +/- 4.64 con parámetros {'C': 330.13037526527904,
'gamma': 724.4299745866858, 'kernel': 'sigmoid'}
1) Precisión media: 48.86 +/- 4.52 con parámetros {'C': 141.66423772199033,
'gamma': 964.081623637728, 'kernel': 'sigmoid'}
7) Precisión media: 48.38 +/- 4.50 con parámetros {'C': 277.89947393631587,
'gamma': 499.06800915767286, 'kernel': 'sigmoid'}
4) Precisión media: 48.54 +/- 4.64 con parámetros {'C': 339.4193364446046,
'gamma': 849.8383579899024, 'kernel': 'sigmoid'}
1) Precisión media: 48.86 +/- 4.52 con parámetros {'C': 8.782687504322816,
'gamma': 965.8092683063094, 'kernel': 'sigmoid'}
4) Precisión media: 48.54 +/- 4.64 con parámetros {'C': 232.84344873561824,
'gamma': 200.82390241386747, 'kernel': 'sigmoid'}
7) Precisión media: 48.38 +/- 4.50 con parámetros {'C': 340.8373827954047,
'gamma': 346.17465054874623, 'kernel': 'sigmoid'}
1) Precisión media: 48.86 +/- 4.52 con parámetros {'C': 491.55519979656776,
'gamma': 857.6069742445022, 'kernel': 'sigmoid'}
```

[19]:
```
import matplotlib.pyplot as plt

fig = plt.figure()
ax = fig.add_axes([0,0,1,1])
ax.bar([dic['kernel'] for dic in best_score],[dic['score'] for dic in␣
↪best_score])
plt.show()
```



[20]:
```
pd.DataFrame(best_score)
```

[20]:

	kernel	score	params
0	rbf	0.863327	{'C': 169.2424566596866, 'gamma': 21.685491125…
1	sigmoid	0.488617	{'C': 141.66423772199033, 'gamma': 964.0816236…

Vemos que el kernel que mejor se ajusta al modelo es el radial (rbf). Utilizaremos este kernel con sus correspondientes parámetros para entrenar el modelo predictivo.

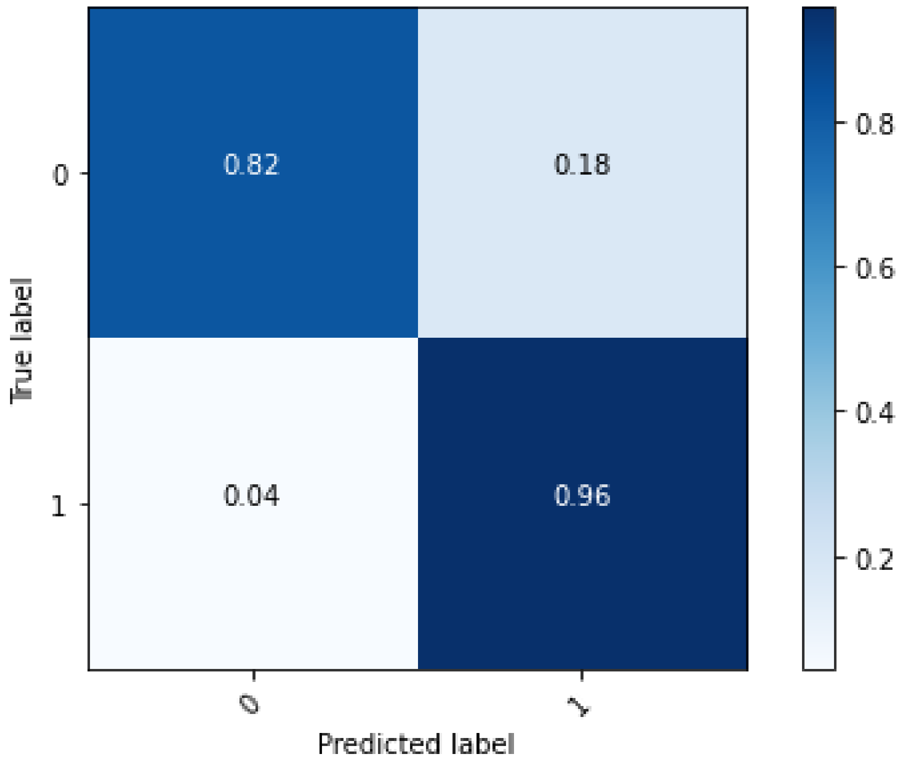
6.1 Evaluating the Algorithm

[21]:
```
from sklearn.metrics import accuracy_score

print("Valor óptimo para C: {}".format(best_score[0]['params']['C']))
print("Valor óptimo para gamma: {}".format(best_score[0]['params']["gamma"]))

modelSVM = svm.SVC(kernel=best_score[0]['kernel'],␣
 ↪gamma=best_score[0]['params']["gamma"], C=best_score[0]['params']['C']).
 ↪fit(X_train, y_train)
predict = modelSVM.predict(X_test)

accuracy = np.true_divide(np.sum(predict == y_test), predict.shape[0])*100
print("Precisión en el conjunto de test: {:.2f}%".format(accuracy))
```

```
Valor óptimo para C: 169.2424566596866
Valor óptimo para gamma: 21.685491125386175
Precisión en el conjunto de test: 89.42%
```

[22]:

```python
from sklearn.metrics import confusion_matrix
import itertools


cnf_matrix = confusion_matrix(y_test, predict)

def plot_confusion_matrix(cm, classes):
    cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]

    cmap=plt.cm.Blues

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

    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], ".2f"),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

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

n_classes=["0","1"]
plot_confusion_matrix(cnf_matrix, classes=n_classes)
```



7 Run Prediction

[23]:
```
result = modelSVM.predict(dfDataSetToPredict[["pedido.data.attributes.age",
    "pedido.data.attributes.diagnostic_main",
    "respuesta.articlesRevisedMonth",
    "respuesta.pubmed_keys"
]])

result
```

[23]:
```
array([1., 1., 1., …, 1., 1., 1.])
```

[ ]:
```

```