#3 - Trabajo CIMAT Gto - CNN basic and LSTM

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1 Clasificador CNN básico

```
In [1]: import numpy as np
        import pandas as pd
        import re # lidia con expresiones regulares
        import nltk
        import matplotlib.pyplot as plt
        from nltk.corpus import stopwords
        from sklearn.feature_extraction.text import CountVectorizer
        from nltk import word_tokenize # sentencia en palabras
        from nltk.stem import SnowballStemmer # idioma steam
        from nltk.stem.porter import PorterStemmer
        from nltk.stem import WordNetLemmatizer
        from sklearn.ensemble import RandomForestClassifier
        from sklearn.feature_extraction.text import TfidfVectorizer
        from sklearn import feature_extraction, model_selection, naive_bayes, metrics, svm



        from sklearn.model_selection import train_test_split
        from sklearn.feature_extraction.text import TfidfVectorizer
        # Any results you write to the current directory are saved as output.
        from sklearn.naive_bayes import GaussianNB
        from sklearn.metrics import accuracy_score
```

```
In [2]: import numpy as np
        import pylab as pl
        from IPython.display import SVG
        from os.path import join, exists, split
        import os

        from gensim.models import word2vec, KeyedVectors
        from keras.models import Sequential, Model
        from keras.layers import Dense, Dropout, Flatten, Input, MaxPooling1D, Convolution1D,
        from keras.layers.merge import Concatenate
        from keras.datasets import imdb
        from keras.preprocessing import sequence
        from keras.utils.vis_utils import model_to_dot

        %matplotlib inline
```

```
Using TensorFlow backend.
```

```
In [3]: import os
        import time
        import numpy as np # linear algebra
        import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

        import math

        from sklearn.metrics import roc_curve, auc,  f1_score
        from sklearn.model_selection import train_test_split

        import matplotlib.pyplot as plt
        import keras
        from sklearn import metrics
        from keras.layers import Input, Embedding, Dense, Conv2D, MaxPool2D, Reshape, Flatten,
        from keras.preprocessing.text import Tokenizer
        from keras.preprocessing.sequence import pad_sequences
        from keras.layers import Bidirectional, GlobalMaxPool1D, TimeDistributed
        from keras.models import Model
        from keras import initializers, regularizers, constraints, optimizers, layers
```

```
In [4]: # con stemming
        def review_to_words( raw_review ):
            # 1. Remover todo menos letras y comas
            letters_only = re.sub('[^\w]\d*',  " ", raw_review)
            # 2. convertir a mínusculas
            words = letters_only.lower().split()
            # 3. remover stopwords
            stops = set(stopwords.words("spanish"))
            # 3.1 retirando stopwords
            meaningful_words = [w for w in words if not w in stops]
            # 4 stemming en español
            stemmer = SnowballStemmer('spanish')
            stemmed_text = [stemmer.stem(i) for i in meaningful_words]
            # 5. uniendo documeto
            return( " ".join( stemmed_text ))
        # sin stemming
        def review_to_words2( raw_review ):
            # 1. Remover todo menos letras y comas
            letters_only = re.sub('[^\w]\d*',  " ", raw_review)
            # 2. convertir a mínusculas
            words = letters_only.lower().split()
            # 3. remover stopwords
            stops = set(stopwords.words("spanish"))
            # 3.1 retirando stopwords
            meaningful_words = [w for w in words if not w in stops]
            return( " ".join( meaningful_words ))
```

```
In [5]: import gensim
        from gensim.models import word2vec, KeyedVectors


        from keras.models import Sequential, Model
        from keras.layers import Dense, Dropout, Flatten, Input, MaxPooling1D, Convolution1D,
        from keras.layers.merge import Concatenate
        from keras.datasets import imdb
        from keras.preprocessing import sequence
        from keras.utils.vis_utils import model_to_dot

        %matplotlib inline
```

```
In [6]: # Load Google's pre-trained Word2Vec model.
        os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Datos
        modelo_google = gensim.models.KeyedVectors.load_word2vec_format('GoogleNews-vectors-ne
```

```
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\smart_open\smart_open_lib.py:398
  'See the migration notes for details: %s' % _MIGRATION_NOTES_URL
```

1.1 México

```
In [6]: # Importando los textos
        import os
        # introducit path datos de entrenamiento
        os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Datos
        train = pd.read_csv('irosva.mx.training.csv');
        # introducit path datos de prueba
        os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Datos
        test_nolabel = pd.read_csv('irosva.mx - irosva.mx.test.csv');
        # introducit path etiquetas verdaderas de prueba
        os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Datos
        test_label = pd.read_csv('irosva.mx.test.truth.csv');

        test = pd.merge(test_nolabel, test_label, on='ID')
        entrenamiento = train["TOPIC"].astype(str).str.cat(train["MESSAGE"].astype(str), sep='
        prueba = test["TOPIC_y"].astype(str).str.cat(test["MESSAGE"].astype(str), sep=' ')

        x_train = train["MESSAGE"]
        x_test = test["MESSAGE"]
        y_train = train['IS_IRONIC']
        y_test = test['IS_IRONIC_y']

        #Limpiando datos de entrenamiento
        num = x_train.size
        # Lista para guardar twits limpios
        clean_train = []
        for i in range( 0, num):
            clean_train.append(review_to_words2(x_train.values[i]))
        x_train_mx = clean_train

        num= x_test.size
        clean_test_train = []
        for i in range( 0, num):
            clean_test_train.append( review_to_words2(x_test.values[i] ) )
        x_test_mx = clean_test_train

        x_train_mx = train["TOPIC"].astype(str).str.cat(x_train_mx, sep=' ')
        x_test_mx = test["TOPIC_y"].astype(str).str.cat(x_test_mx, sep=' ')

        x_test_mx# Datos de entrenamient y de prueba ya pre-procesados

        x_train_mx = pd.Series(x_train_mx)
        y_train = pd.Series(y_train)
        x_test_mx = pd.Series(x_test_mx)
        y_test = pd.Series(y_test)

        print(x_train_mx.shape)
        print(y_train.shape)
        print(x_test_mx.shape)
        print(y_test.shape)
```

```
(2400,)
(2400,)
(600,)
(600,)
```

```
In [7]: from pickle import load
        from numpy import array
        from keras.preprocessing.text import Tokenizer
        from keras.preprocessing.sequence import pad_sequences
        from keras.utils.vis_utils import plot_model
        from keras.models import Model
        from keras.layers import Input
        from keras.layers import Dense
        from keras.layers import Flatten
        from keras.layers import Dropout
        from keras.layers import Embedding
        from keras.layers.convolutional import Conv1D
        from keras.layers.convolutional import MaxPooling1D
        from keras.layers.merge import concatenate


        # fit a tokenizer
        def create_tokenizer(lines):
                tokenizer = Tokenizer()
                tokenizer.fit_on_texts(lines)
                return tokenizer

        # calculate the maximum document length
        def max_length(lines):
                return max([len(s.split()) for s in lines])

        # encode a list of lines
        def encode_text(tokenizer, lines, length):
                # integer encode
                encoded = tokenizer.texts_to_sequences(lines)
                # pad encoded sequences
                padded = pad_sequences(encoded, maxlen=length, padding='post')
                return padded
```

```
In [8]: # create tokenizer
        tokenizer_mx = create_tokenizer(x_train_mx)
        # calculate max document length
        length_mx = max_length(x_train_mx)
        # calculate vocabulary size
        vocab_size_mx = len(tokenizer_mx.word_index) + 1
        print('Max document length México: %d' % length_mx)
        print('Vocabulary size México: %d' % vocab_size_mx)

        # encode data
        trainX_mx = encode_text(tokenizer_mx, x_train_mx, length_mx)
        print(trainX_mx.shape)


        testX_mx = encode_text(tokenizer_mx, x_test_mx, length_mx)
        print(testX_mx.shape)
```

```
Max document length México: 36
Vocabulary size México: 8281
```

```
(2400, 36)
(600, 36)
```

```
In [9]: tokenizer_mx.word_index
        vocabulary_inv_mx = dict((v, k) for k, v in tokenizer_mx.word_index.items())
        vocabulary_inv_mx[0] = "<PAD/>"
```

```
In [11]: # pesos
         embedding_weights_mx = {key: modelo_google[word] if word in modelo_google else
                                   np.random.uniform(-0.25, 0.25, modelo_google.vector_size)
                              for key, word in vocabulary_inv_mx.items()}

         weights_mx = np.array([embedding_weights_mx[i] for i in range(len(embedding_weights_m
```

1.2 España

```
In [11]: # Importando los textos
         import os
         # introducit path datos de entrenamiento
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dato
         train_es = pd.read_csv('irosva.es.training.csv');
         # introducit path datos de prueba
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dato
         test_nolabel_es = pd.read_csv('irosva.es - irosva.es.test.csv');
         # introducit path etiquetas verdaderas de prueba
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dato
         test_label_es = pd.read_csv('irosva.es.test.truth.csv');

         test_es = pd.merge(test_nolabel_es, test_label_es, on='ID')

         x_train_es = train_es["MESSAGE"]
         x_test_es = test_es["MESSAGE"]
         y_train_es = train_es['IS_IRONIC']
         y_test_es = test_es['IS_IRONIC_y']

         #Limpiando datos de entrenamiento
         num = x_train_es.size
         # Lista para guardar twits limpios
         clean_train = []
         for i in range( 0, num):
             clean_train.append(review_to_words(x_train_es.values[i]))
         x_train_es = clean_train

         num= x_test_es.size
         clean_test_train = []
         for i in range( 0, num):
             clean_test_train.append( review_to_words(x_test_es.values[i] ) )
         x_test_es= clean_test_train

         x_train_es = train_es["TOPIC"].astype(str).str.cat(x_train_es, sep=' ')
         x_test_es = test_es["TOPIC_y"].astype(str).str.cat(x_test_es, sep=' ')

         x_test_mx# Datos de entrenamient y de prueba ya pre-procesados

         x_train_es= pd.Series(x_train_es)
         y_train_es = pd.Series(y_train_es)
         x_test_es = pd.Series(x_test_es)
         y_test_es = pd.Series(y_test_es)

         print(x_train_es.shape)
         print(y_train_es.shape)
         print(x_test_es.shape)
         print(y_test_es.shape)
```

```
(2400,)
(2400,)
(600,)
(600,)
```

```
In [12]: # create tokenizer
         tokenizer_es = create_tokenizer(x_train_es)
         # calculate max document length
         length_es = max_length(x_train_es)
         # calculate vocabulary size
         vocab_size_es = len(tokenizer_es.word_index) + 1
         print('Max document length España: %d' % length_es)
         print('Vocabulary size España: %d' % vocab_size_es)

         # encode data
         trainX_es = encode_text(tokenizer_es, x_train_es, length_es)
         print(trainX_es.shape)


         testX_es = encode_text(tokenizer_es, x_test_es, length_es)
         print(testX_es.shape)

         tokenizer_es.word_index
         vocabulary_inv_es = dict((v, k) for k, v in tokenizer_es.word_index.items())
         vocabulary_inv_es[0] = "<PAD/>"
```

```
Max document length España: 38
Vocabulary size España: 6995
(2400, 38)
(600, 38)
```

```
In [ ]: # pesos
        embedding_weights_es = {key: modelo_google[word] if word in modelo_google else
                                     np.random.uniform(-0.25, 0.25, modelo_google.vector_size)
                                for key, word in vocabulary_inv_es.items()}

        weights_es = np.array([embedding_weights_es[i] for i in range(len(embedding_weights_es
```

1.3 Cuba

```
In [13]: # Importando los textos
         import os
         # introducit path datos de entrenamiento
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dato
         train_cu = pd.read_csv('irosva.cu.training.csv');
         # introducit path datos de prueba
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dato
         test_nolabel_cu = pd.read_csv('irosva.cu - irosva.cu.test.csv');
         # introducit path etiquetas verdaderas de prueba
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dato
         test_label_cu = pd.read_csv('irosva.cu.test.truth.csv');

         test_cu = pd.merge(test_nolabel_cu, test_label_cu, on='ID')

         x_train_cu = train_cu["MESSAGE"]
         x_test_cu = test_cu["MESSAGE"]
         y_train_cu = train_cu['IS_IRONIC']
         y_test_cu = test_cu['IS_IRONIC_y']

         #Limpiando datos de entrenamiento
         num = x_train_cu.size
         # Lista para guardar twits limpios
         clean_train = []
         for i in range( 0, num):
             clean_train.append(review_to_words2(x_train_cu.values[i]))
         x_train_cu = clean_train

         num= x_test_cu.size
         clean_test_train = []
         for i in range( 0, num):
             clean_test_train.append( review_to_words2(x_test_cu.values[i] ) )
         x_test_cu= clean_test_train

         x_train_cu = train_cu["TOPIC"].astype(str).str.cat(x_train_cu, sep=' ')
         x_test_cu = test_cu["TOPIC_y"].astype(str).str.cat(x_test_cu, sep=' ')

         x_test_mx# Datos de entrenamient y de prueba ya pre-procesados

         x_train_cu= pd.Series(x_train_cu)
         y_train_cu = pd.Series(y_train_cu)
         x_test_cu = pd.Series(x_test_cu)
         y_test_cu = pd.Series(y_test_cu)

         print(x_train_cu.shape)
         print(y_train_cu.shape)
         print(x_test_cu.shape)
         print(y_test_cu.shape)
```

```
(2400,)
(2400,)
(600,)
(600,)
```

```
In [14]: # create tokenizer
         tokenizer_cu = create_tokenizer(x_train_cu)
         # calculate max document length
         length_cu = max_length(x_train_cu)
         # calculate vocabulary size
         vocab_size_cu = len(tokenizer_cu.word_index) + 1
         print('Max document length Cuba: %d' % length_cu)
         print('Vocabulary size Cuba: %d' % vocab_size_cu)

         # encode data
         trainX_cu = encode_text(tokenizer_cu, x_train_cu, length_cu)
         print(trainX_cu.shape)


         testX_cu = encode_text(tokenizer_cu, x_test_cu, length_cu)
         print(testX_cu.shape)

         tokenizer_cu.word_index
         vocabulary_inv_cu = dict((v, k) for k, v in tokenizer_cu.word_index.items())
         vocabulary_inv_cu[0] = "<PAD/>"
```

```
Max document length Cuba: 41
Vocabulary size Cuba: 9304
(2400, 41)
(600, 41)
```

```
In [ ]: # pesos
        embedding_weights_cu = {key: modelo_google[word] if word in modelo_google else
                                     np.random.uniform(-0.25, 0.25, modelo_google.vector_size)
                                for key, word in vocabulary_inv_cu.items()}

        weights_cu = np.array([embedding_weights_cu[i] for i in range(len(embedding_weights_cu
```

```
In [16]: del modelo_google
```

1.3.1 Clasificador CNN México

```
In [10]: # one hot representación targets
         from keras.utils import to_categorical
         y_train_label_mx = to_categorical(y_train)
         y_test_label_mx  = to_categorical(y_test)
```

```
In [16]: # define the model
         def define_model_mx1(length, vocab_size, n ):



                 # channel 1
                 np.random.seed(n)
                 inputs1 = Input(shape=(length,))
                 embedding1 = Embedding(vocab_size, 300)(inputs1)
                 conv1 = Conv1D(filters=100, kernel_size=4, activation='relu')(embedding1)
                 pool1 = GlobalMaxPooling1D()(conv1)
                 drop1 = Dropout(0.5)(pool1)
                 # interpretation
                 dense1 = Dense(10, activation='relu')(drop1)
                 outputs = Dense(2, activation='softmax')(dense1)
                 model = Model(inputs1, outputs=outputs)
                 # compile
                 model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
                 # summarize
                 print(model.summary())

                 return model
```

```
In [17]: from sklearn.utils import class_weight
         class_weights_mx = class_weight.compute_class_weight('balanced',
                                                          np.unique(array(y_train_label_mx)),
                                                          y_train)
```

```
In [38]: del model_mx, hist_mx
```

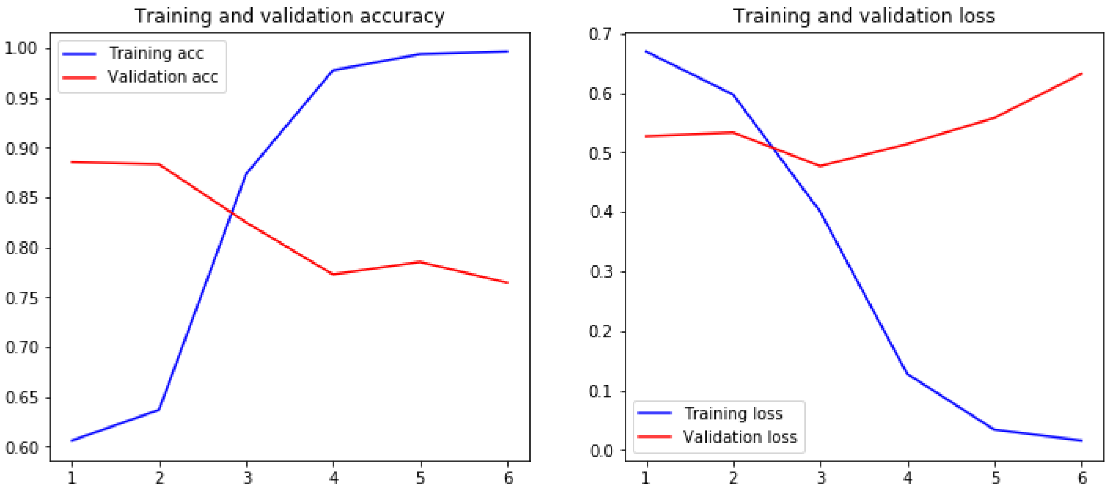
```
In [18]: model_mx = define_model_mx1(length_mx, vocab_size_mx, 16) #16
         # fit model


         hist_mx = model_mx.fit(trainX_mx,  array(y_train_label_mx), epochs=6, batch_size=50, v
```

```
WARNING: Logging before flag parsing goes to stderr.
W0710 11:55:10.738850  7060 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:55:10.750820  7060 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:55:10.752815  7060 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens
```

```
W0710 11:55:10.780740  7060 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:55:10.785759  7060 deprecation.py:506] From C:\Users\h_air\Anaconda3\envs\tensorflow-g
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
W0710 11:55:10.817643  7060 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:55:10.834602  7060 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:55:10.841581  7060 deprecation.py:323] From C:\Users\h_air\Anaconda3\envs\tensorflow-g
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where


_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         (None, 36)                0
_________________________________________________________________
embedding_1 (Embedding)      (None, 36, 300)           2484300
_________________________________________________________________
conv1d_1 (Conv1D)            (None, 33, 100)           120100
_________________________________________________________________
global_max_pooling1d_1 (Glob (None, 100)               0
_________________________________________________________________
dropout_1 (Dropout)          (None, 100)               0
_________________________________________________________________
dense_1 (Dense)              (None, 10)                1010
_________________________________________________________________
dense_2 (Dense)              (None, 2)                 22
=================================================================
Total params: 2,605,432
Trainable params: 2,605,432
Non-trainable params: 0
_________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/6
1920/1920 [==============================] - 7s 4ms/step - loss: 0.6696 - acc: 0.6063 - val_los
Epoch 2/6
1920/1920 [==============================] - 0s 194us/step - loss: 0.5974 - acc: 0.6370 - val_l
Epoch 3/6
1920/1920 [==============================] - 0s 193us/step - loss: 0.4005 - acc: 0.8734 - val_l
Epoch 4/6
1920/1920 [==============================] - 0s 194us/step - loss: 0.1278 - acc: 0.9776 - val_l
Epoch 5/6
1920/1920 [==============================] - 0s 193us/step - loss: 0.0341 - acc: 0.9938 - val_l
```

```
Epoch 6/6
1920/1920 [==============================] - 0s 203us/step - loss: 0.0157 - acc: 0.9964 - val_
```

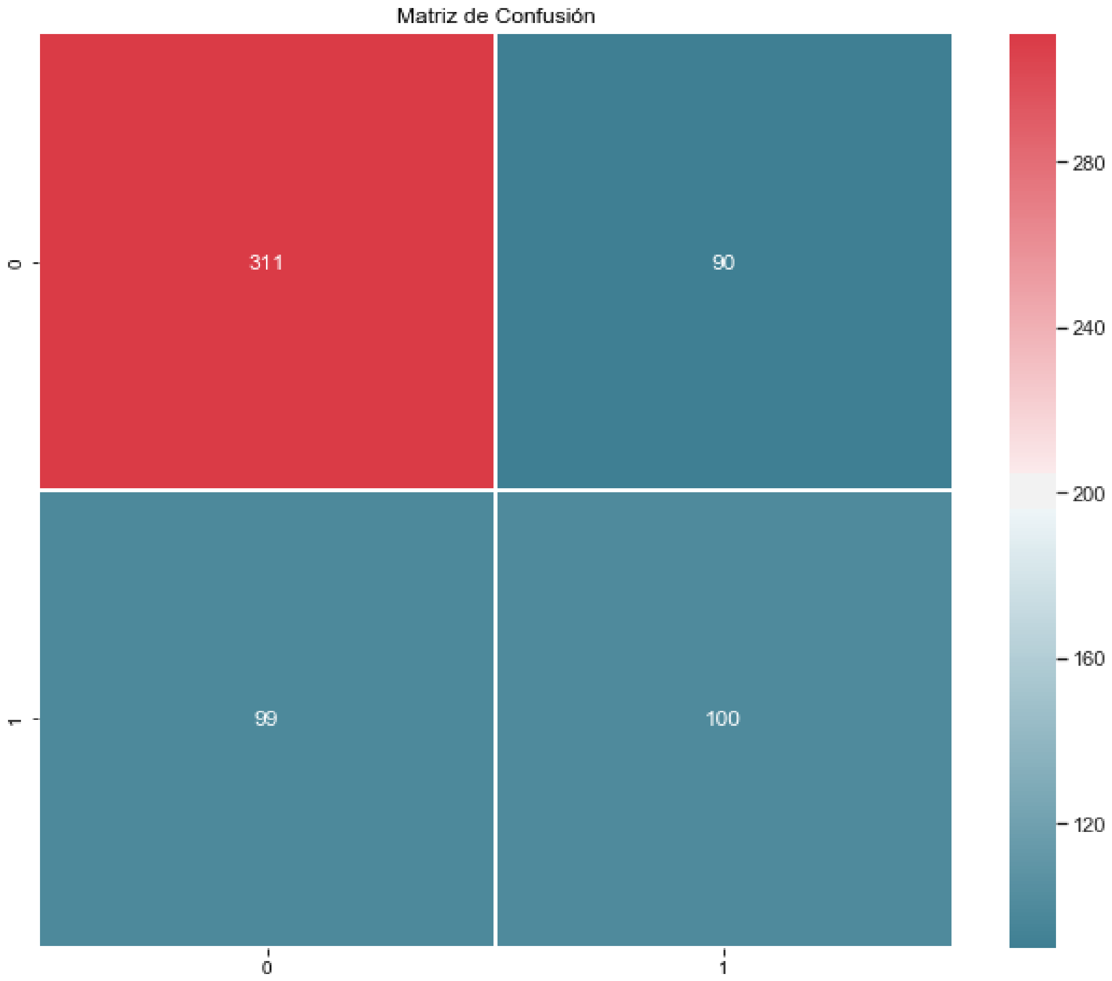
```
In [19]: def plot_history(history):
                acc = history.history["acc"]
                val_acc = history.history["val_acc"]
                loss = history.history["loss"]
                val_loss = history.history["val_loss"]
                x = range(1, len(acc) + 1)

                plt.figure(figsize=(12, 5))
                plt.subplot(1, 2, 1)
                plt.plot(x, acc, "b", label="Training acc")
                plt.plot(x, val_acc, "r", label="Validation acc")
                plt.title("Training and validation accuracy")
                plt.legend()
                plt.subplot(1, 2, 2)
                plt.plot(x, loss, "b", label="Training loss")
                plt.plot(x, val_loss, "r", label="Validation loss")
                plt.title("Training and validation loss")
                plt.legend()

         plot_history(history=hist_mx)
```



```
In [12]: #########################
         # Tabla de confusión
         #########################
         from sklearn.metrics import confusion_matrix, precision_score, recall_score
         from sklearn.metrics import f1_score, cohen_kappa_score
```

```
import seaborn as sns

y_predict_mx = model_mx.predict(testX_mx)

test_true_labels_mx      = np.argmax(y_test_label_mx, axis=1)
test_predicted_labels_mx = np.argmax(y_predict_mx,axis=1)


%matplotlib inline
C = confusion_matrix(test_true_labels_mx, test_predicted_labels_mx)
print(C)

##########################
# F1
##########################
print('F1 test:', f1_score(test_true_labels_mx, test_predicted_labels_mx,  average='ma


f, ax = plt.subplots(figsize=(11, 9))
sns.set()
cmap = sns.diverging_palette(220, 10, as_cmap=True)
ax = sns.heatmap(C, cmap=cmap, square=True,
                 annot=True, fmt='d', linewidths=.5)
ax.set_title('Matriz de Confusión')
plt.show()


#F1 test:  0.6405465973963402 16semillas,6 epocas
```

```
[[311  90]
 [ 99 100]]
F1 test: 0.6405465973963402
```



```
In [11]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         #model_mx.save(DATA_PATH+'Cnn_mx_basico.h5')

         model_mx = load_model(DATA_PATH+'Cnn_mx_basico.h5') # Cargar
```

```
WARNING: Logging before flag parsing goes to stderr.
W0711 12:14:43.745559 16644 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0711 12:14:43.991924 16644 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0711 12:14:44.194498 16644 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0711 12:14:44.194498 16644 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0711 12:14:44.202478 16644 deprecation.py:506] From C:\Users\h_air\Anaconda3\envs\tensorflow-g
Instructions for updating:
```

```
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
W0711 12:14:44.393966 16644 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0711 12:15:00.984575 16644 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0711 12:15:00.990558 16644 deprecation.py:323] From C:\Users\h_air\Anaconda3\envs\tensorflow-g
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
```

1.3.2 CNN-SVM

En proceso…

```
In [50]: model_feat = Model(inputs=model_mx.input,outputs=model_mx.get_layer('global_max_poolin

         feat_train = model_feat.predict(trainX_mx)
         print(feat_train.shape)

         feat_test = model_feat.predict(testX_mx)
         print(feat_test.shape)
```

```
(2400, 10)
(600, 10)
```

```
In [51]: del svm_mx
```

```
In [52]: from sklearn.pipeline import Pipeline
         from sklearn.svm import LinearSVC
         from sklearn.model_selection import GridSearchCV
         from sklearn.preprocessing import StandardScaler
         import time
         tic=time.time()

         SVCpipe = Pipeline([('SVC',LinearSVC(class_weight="balanced", random_state=1,verbose=(

         # Gridsearch to determine the value of C
         param_grid = {'SVC__C':np.arange(1,15,1)}
         linearSVC = GridSearchCV(SVCpipe,param_grid,cv=5,return_train_score=True, verbose=0)
         linearSVC.fit(feat_train, np.argmax(y_train_label_mx, axis=1))
         print(linearSVC.best_params_)
         #linearSVC.coef_
         #linearSVC.intercept_

         svm_mx = linearSVC.best_estimator_
         svm_mx.fit(feat_train, np.argmax(y_train_label_mx, axis=1))


         print('Tiempo de procesamiento (secs): ', time.time()-tic)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
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  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
```

```
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
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C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
```

```
{'SVC__C': 8}
Tiempo de procesamiento (secs):  8.855379819869995
```

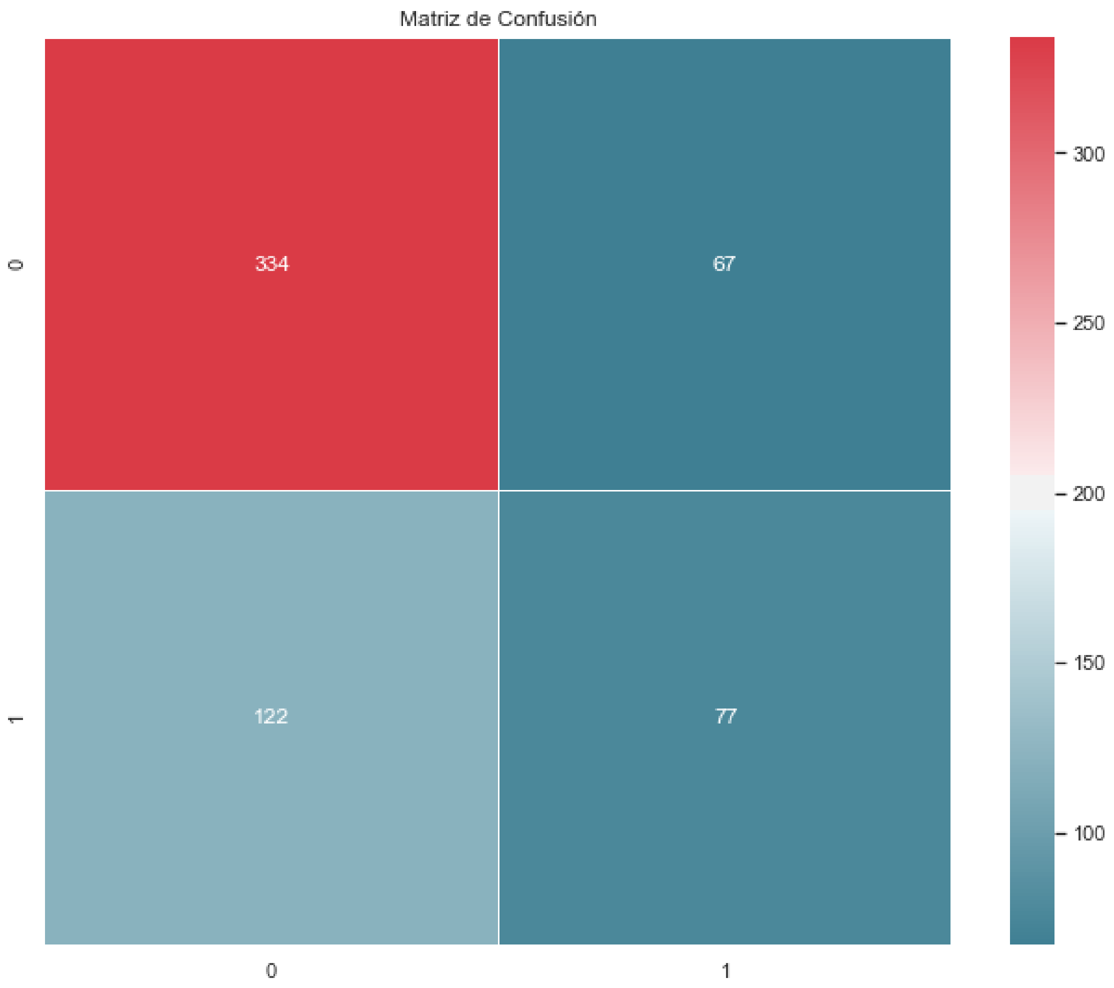
```
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
C:\Users\h_air\Anaconda3\envs\tensorflow-gpu\lib\site-packages\sklearn\svm\base.py:931: Converg
  "the number of iterations.", ConvergenceWarning)
```

```
In [39]:
```

```
In [54]: ##########################
         # Tabla de confusión
```

```
##########################
from sklearn.metrics import confusion_matrix, precision_score, recall_score
from sklearn.metrics import f1_score, cohen_kappa_score
import seaborn as sns

y_predict_mx = svm_mx.predict(feat_test)

test_true_labels_mx      = np.argmax(y_test_label_mx, axis=1)
test_predicted_labels_mx = y_predict_mx


%matplotlib inline
C = confusion_matrix(test_true_labels_mx, test_predicted_labels_mx)
print(C)

##########################
# F1
##########################
print('F1 test:', f1_score(test_true_labels_mx, test_predicted_labels_mx,  average='ma


f, ax = plt.subplots(figsize=(11, 9))
sns.set()
cmap = sns.diverging_palette(220, 10, as_cmap=True)
ax = sns.heatmap(C, cmap=cmap, square=True,
                 annot=True, fmt='d', linewidths=.5)
ax.set_title('Matriz de Confusión')
plt.show()


#F1 test:  0.6405465973963402 16semillas,6 epocas
```

```
[[334  67]
 [122  77]]
F1 test: 0.6142214178553569
```



```
In [22]: from keras.utils.vis_utils import plot_model
         plot_model(model_mx, show_shapes=True, to_file=DATA_PATH+'Cnn_mx_basico.png')
```

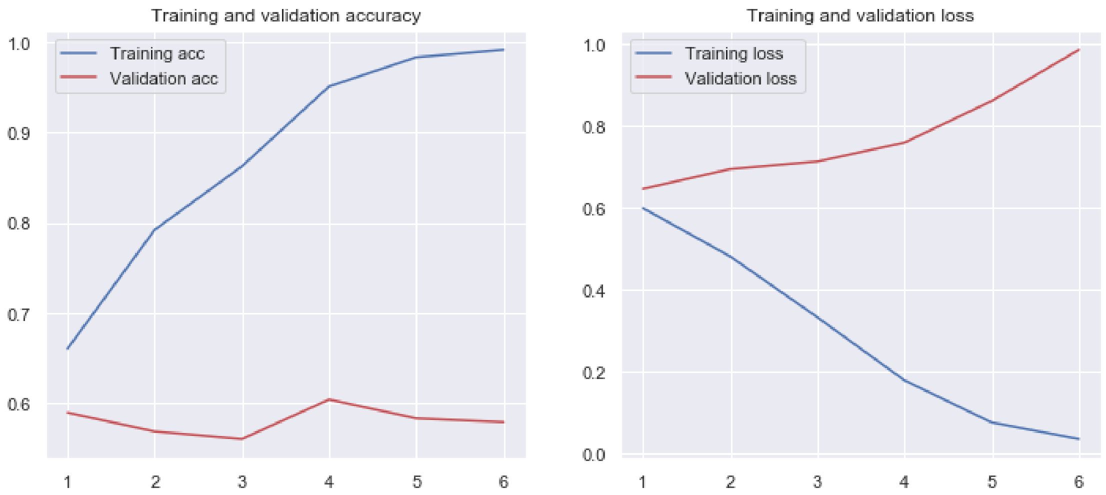
1.3.3 Clasificador España

```
In [23]: # one hot representación targets
         from keras.utils import to_categorical
         y_train_label_es = to_categorical(y_train_es)
         y_test_label_es  = to_categorical(y_test_es)
```

```
In [24]: # define the model
         def define_model_es1(length, vocab_size, n ):
                 # channel 1
                 np.random.seed(n)
                 inputs1 = Input(shape=(length,))
                 embedding1 = Embedding(vocab_size, 300)(inputs1)
                 conv1 = Conv1D(filters=100, kernel_size=4, activation='relu')(embedding1)
                 pool1 = GlobalMaxPooling1D()(conv1)
                 drop1 = Dropout(0.5)(pool1)
                 # interpretation
                 dense1 = Dense(10, activation='relu')(drop1)
                 outputs = Dense(2, activation='softmax')(dense1)
                 model = Model(inputs1, outputs=outputs)
                 # compile
                 model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accurac
                 # summarize
                 print(model.summary())

                 return model

In [25]: from sklearn.utils import class_weight
         class_weights_es = class_weight.compute_class_weight('balanced',
                                                         np.unique(array(y_train_label_es)),
                                                          y_train_es)

In [77]: del model_es, hist_es

In [26]: model_es = define_model_es1(length_es, vocab_size_es, 17)
         # fit model


         hist_es = model_es.fit(trainX_es, array(y_train_label_es), epochs = 6, batch_size=50,

         def plot_history(history):
                 acc = history.history["acc"]
                 val_acc = history.history["val_acc"]
                 loss = history.history["loss"]
                 val_loss = history.history["val_loss"]
                 x = range(1, len(acc) + 1)

                 plt.figure(figsize=(12, 5))
                 plt.subplot(1, 2, 1)
                 plt.plot(x, acc, "b", label="Training acc")
                 plt.plot(x, val_acc, "r", label="Validation acc")
                 plt.title("Training and validation accuracy")
                 plt.legend()
                 plt.subplot(1, 2, 2)
                 plt.plot(x, loss, "b", label="Training loss")
                 plt.plot(x, val_loss, "r", label="Validation loss")
                 plt.title("Training and validation loss")
                 plt.legend()

         plot_history(history=hist_es)
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
```

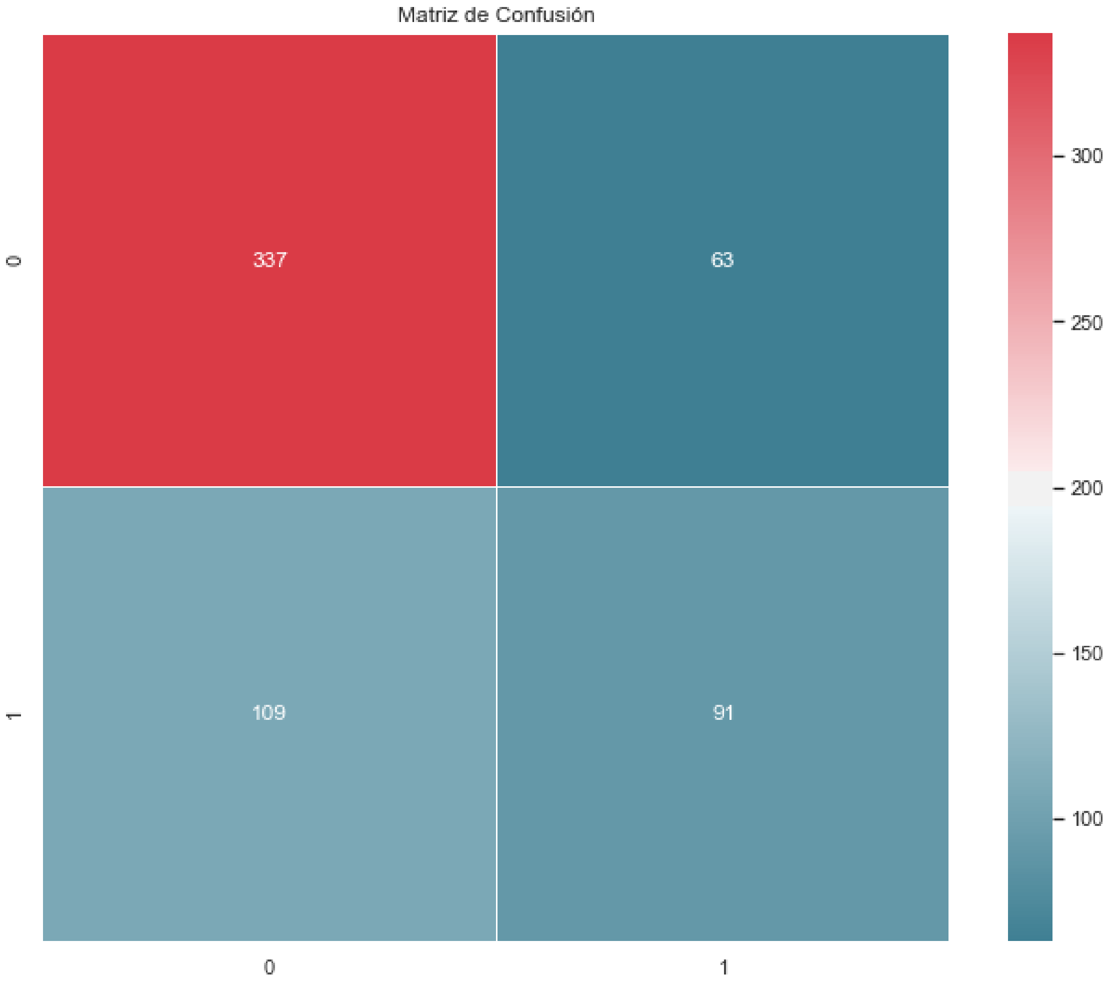
```
=================================================================
input_2 (InputLayer)         (None, 38)                0
_________________________________________________________________
embedding_2 (Embedding)      (None, 38, 300)           2098500
_________________________________________________________________
conv1d_2 (Conv1D)            (None, 35, 100)           120100
_________________________________________________________________
global_max_pooling1d_2 (Glob (None, 100)               0
_________________________________________________________________
dropout_2 (Dropout)          (None, 100)               0
_________________________________________________________________
dense_3 (Dense)              (None, 10)                1010
_________________________________________________________________
dense_4 (Dense)              (None, 2)                 22
=================================================================
Total params: 2,219,632
Trainable params: 2,219,632
Non-trainable params: 0
_________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/6
1920/1920 [==============================] - 1s 575us/step - loss: 0.5986 - acc: 0.6604 - val_
Epoch 2/6
1920/1920 [==============================] - 0s 184us/step - loss: 0.4807 - acc: 0.7922 - val_
Epoch 3/6
1920/1920 [==============================] - 0s 179us/step - loss: 0.3320 - acc: 0.8625 - val_
Epoch 4/6
1920/1920 [==============================] - 0s 201us/step - loss: 0.1778 - acc: 0.9510 - val_
Epoch 5/6
1920/1920 [==============================] - 0s 183us/step - loss: 0.0750 - acc: 0.9833 - val_
Epoch 6/6
1920/1920 [==============================] - 0s 193us/step - loss: 0.0347 - acc: 0.9917 - val_
```



```
In [27]: ##########################
         # Tabla de confusión
         ##########################
         from sklearn.metrics import confusion_matrix, precision_score, recall_score
         from sklearn.metrics import f1_score, cohen_kappa_score
         import seaborn as sns

         y_predict_es = model_es.predict(testX_es)

         test_true_labels_es      = np.argmax(y_test_label_es, axis=1)
         test_predicted_labels_es = np.argmax(y_predict_es,axis=1)


         %matplotlib inline
         C = confusion_matrix(test_true_labels_es, test_predicted_labels_es)
         print(C)

         ##########################
         # F1
         ##########################
         print('F1 test:', f1_score(test_true_labels_es, test_predicted_labels_es,  average='ma


         f, ax = plt.subplots(figsize=(11, 9))
         sns.set()
         cmap = sns.diverging_palette(220, 10, as_cmap=True)
         ax = sns.heatmap(C, cmap=cmap, square=True,
                          annot=True, fmt='d', linewidths=.5)
         ax.set_title('Matriz de Confusión')
         plt.show()
```

```
        # F1 test:0.6554073005569581 seed 17 epoca 6
```

```
[[337  63]
 [109  91]]
F1 test: 0.6554073005569581
```



```
In [28]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         model_es.save(DATA_PATH+'Cnn_es_basico.h5')

         #model_es = load_model(DATA_PATH+'Cnn_es_basico.h5') # Cargar
```

```
In [29]: from keras.utils.vis_utils import plot_model
         plot_model(model_es, show_shapes=True, to_file=DATA_PATH+'Cnn_es_basico.png')
```

1.3.4 Clasificación Cuba

```
In [30]: # one hot representación targets
         from keras.utils import to_categorical
         y_train_label_cu = to_categorical(y_train_cu)
         y_test_label_cu  = to_categorical(y_test_cu)
```

```
In [31]: # define the model
         def define_model_cu1(length, vocab_size, n ):
                 # channel 1
                 np.random.seed(n)
                 inputs1 = Input(shape=(length,))
                 embedding1 = Embedding(vocab_size, 300)(inputs1)
                 conv1 = Conv1D(filters=100, kernel_size=4, activation='relu')(embedding1)
                 pool1 = GlobalMaxPooling1D()(conv1)
                 drop1 = Dropout(0.5)(pool1)
                 # interpretation
                 dense1 = Dense(10, activation='relu')(drop1)
                 outputs = Dense(2, activation='sigmoid')(dense1)
                 model = Model(inputs1, outputs=outputs)
                 # compile
                 model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accurac
                 # summarize
                 print(model.summary())


                 return model
```

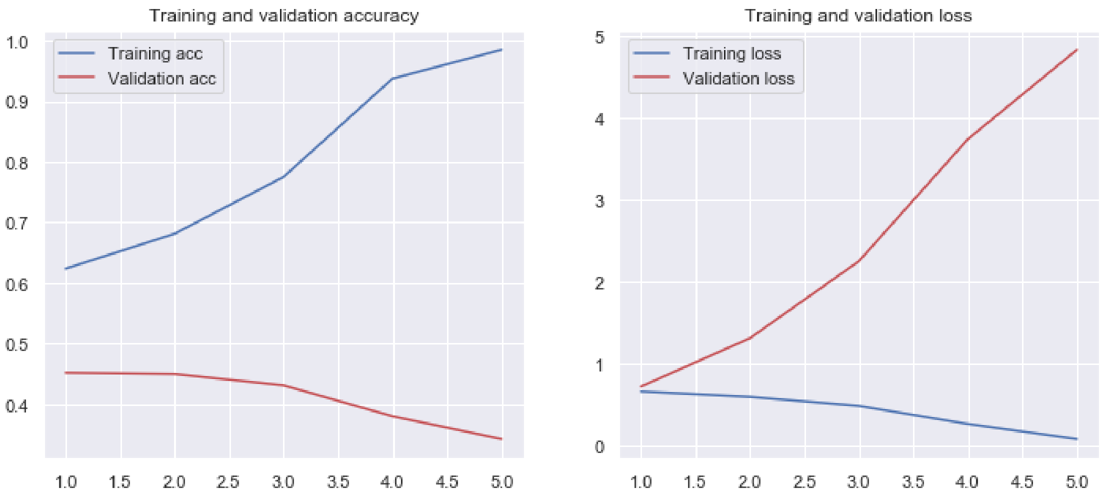
```
In [32]: from sklearn.utils import class_weight
         class_weights_cu = class_weight.compute_class_weight('balanced',
                                                              np.unique(array(y_train_label_cu)),
                                                               y_train_cu)
```

```
In [32]: del model_cu, hist_cu
```

```
In [33]: model_cu = define_model_cu1(length_cu, vocab_size_cu, 17)
         # fit model


         hist_cu = model_cu.fit(trainX_cu, array(y_train_label_cu), epochs=5, batch_size=50, va

         def plot_history(history):
                 acc = history.history["acc"]
                 val_acc = history.history["val_acc"]
                 loss = history.history["loss"]
                 val_loss = history.history["val_loss"]
                 x = range(1, len(acc) + 1)

                 plt.figure(figsize=(12, 5))
```

```
        plt.subplot(1, 2, 1)
        plt.plot(x, acc, "b", label="Training acc")
        plt.plot(x, val_acc, "r", label="Validation acc")
        plt.title("Training and validation accuracy")
        plt.legend()
        plt.subplot(1, 2, 2)
        plt.plot(x, loss, "b", label="Training loss")
        plt.plot(x, val_loss, "r", label="Validation loss")
        plt.title("Training and validation loss")
        plt.legend()

plot_history(history=hist_cu)
```

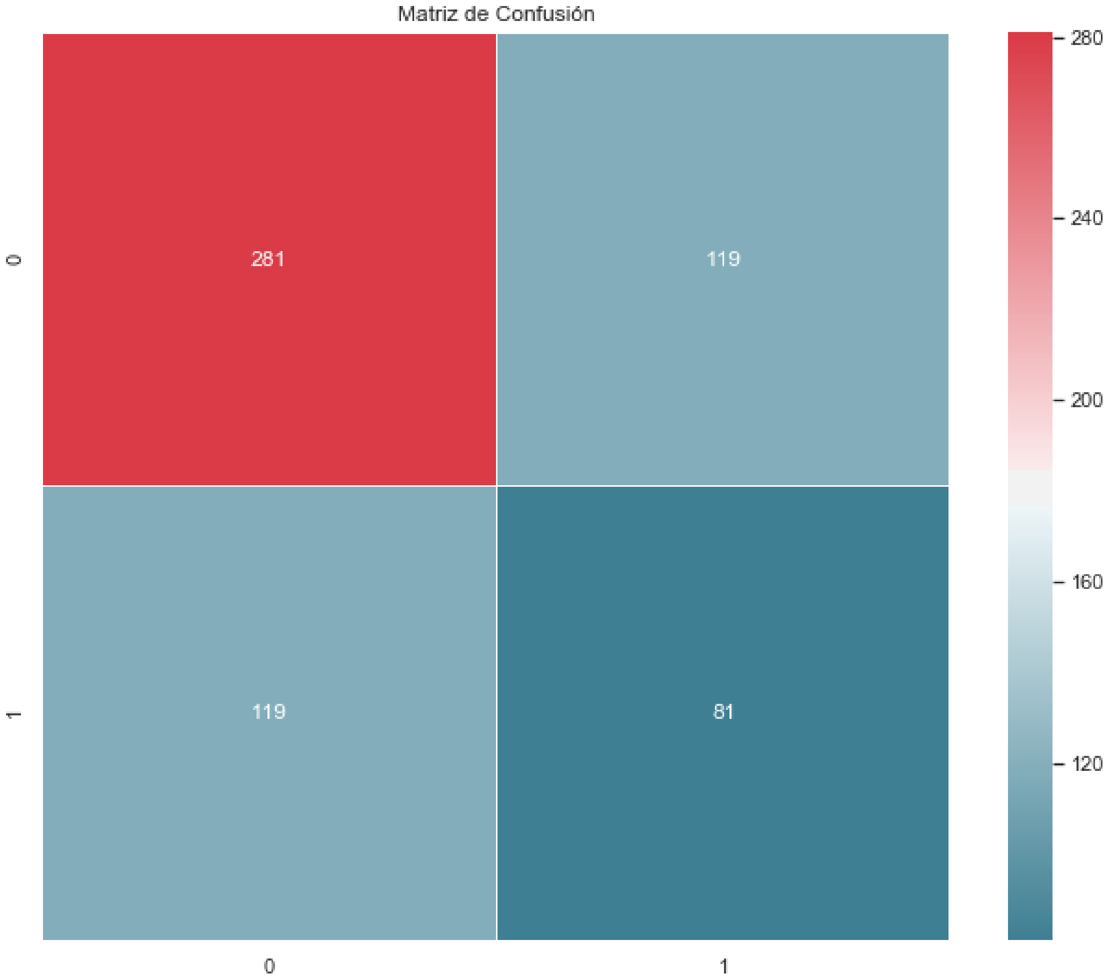
```
-----------------------------------------------------------------
Layer (type)                 Output Shape              Param #
=================================================================
input_3 (InputLayer)         (None, 41)                0
-----------------------------------------------------------------
embedding_3 (Embedding)      (None, 41, 300)           2791200
-----------------------------------------------------------------
conv1d_3 (Conv1D)            (None, 38, 100)           120100
-----------------------------------------------------------------
global_max_pooling1d_3 (Glob (None, 100)               0
-----------------------------------------------------------------
dropout_3 (Dropout)          (None, 100)               0
-----------------------------------------------------------------
dense_5 (Dense)              (None, 10)                1010
-----------------------------------------------------------------
dense_6 (Dense)              (None, 2)                 22
=================================================================
Total params: 2,912,332
Trainable params: 2,912,332
Non-trainable params: 0
-----------------------------------------------------------------
None
Train on 1920 samples, validate on 480 samples
Epoch 1/5
1920/1920 [==============================] - 1s 650us/step - loss: 0.6586 - acc: 0.6237 - val_
Epoch 2/5
1920/1920 [==============================] - 0s 224us/step - loss: 0.5943 - acc: 0.6813 - val_
Epoch 3/5
1920/1920 [==============================] - 0s 221us/step - loss: 0.4837 - acc: 0.7750 - val_
Epoch 4/5
1920/1920 [==============================] - 0s 207us/step - loss: 0.2625 - acc: 0.9372 - val_
Epoch 5/5
1920/1920 [==============================] - 0s 215us/step - loss: 0.0796 - acc: 0.9849 - val_
```



```
In [34]: ##########################
         # Tabla de confusión
         ##########################
         from sklearn.metrics import confusion_matrix, precision_score, recall_score
         from sklearn.metrics import f1_score, cohen_kappa_score
         import seaborn as sns

         y_predict_cu = model_cu.predict(testX_cu)

         test_true_labels_cu      = np.argmax(y_test_label_cu, axis=1)
         test_predicted_labels_cu = np.argmax(y_predict_cu,axis=1)


         %matplotlib inline
         C = confusion_matrix(test_true_labels_cu, test_predicted_labels_cu)
         print(C)

         ##########################
         # F1
         ##########################
         print('F1 test:', f1_score(test_true_labels_cu, test_predicted_labels_cu,  average='ma


         f, ax = plt.subplots(figsize=(11, 9))
         sns.set()
         cmap = sns.diverging_palette(220, 10, as_cmap=True)
         ax = sns.heatmap(C, cmap=cmap, square=True,
                          annot=True, fmt='d', linewidths=.5)
         ax.set_title('Matriz de Confusión')
```

```
        plt.show()

        # F1 test 0.55375 seed 17 epoca 5
```

```
[[281 119]
 [119  81]]
F1 test: 0.55375
```



```
In [35]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         model_cu.save(DATA_PATH+'Cnn_cu_basico.h5')

         #model_cu = load_model(DATA_PATH+'Cnn_cu_basico.h5') # Cargar

In [36]: from keras.utils.vis_utils import plot_model
         plot_model(model_cu, show_shapes=True, to_file=DATA_PATH+'Cnn_cu_basico.png')
```

2 Clasificador LSTM

### México

```
In [40]: np.random.seed(50)
         inputs = Input(name='inputs',shape=[length_mx])
         np.random.seed(50)
         layer = Embedding(vocab_size_mx,300, input_length=length_mx)(inputs)
         layer = LSTM(64,  return_sequences=False)(layer)
         layer = Dense(256, activation= 'relu')(layer)
         layer = Dropout(0.5)(layer)
         layer = Dense(2, activation= 'softmax')(layer)
         model_lstm_mx = Model(inputs=inputs,outputs=layer)
             model_lstm_mx.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accu
         print(model_lstm_mx.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
inputs (InputLayer)          (None, 36)                0
_________________________________________________________________
embedding_6 (Embedding)      (None, 36, 300)           2484300
_________________________________________________________________
lstm_6 (LSTM)                (None, 64)                93440
_________________________________________________________________
dense_11 (Dense)             (None, 256)               16640
_________________________________________________________________
dropout_6 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_12 (Dense)             (None, 2)                 514
=================================================================
Total params: 2,594,894
Trainable params: 2,594,894
Non-trainable params: 0
_________________________________________________________________
None
```

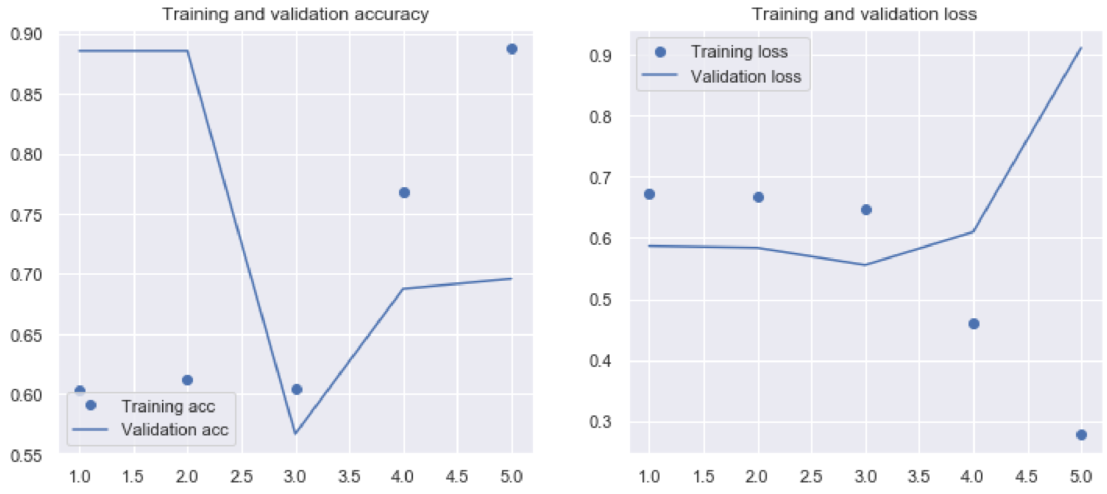
```
In [39]: del model_lstm_mx, history_lstm_mx
```

```
In [41]: from sklearn.utils import class_weight
         class_weights_mx = class_weight.compute_class_weight('balanced',
                                                         np.unique(array(y_train_label_mx)),
                                                          y_train)


         history_lstm_mx = model_lstm_mx.fit(trainX_mx, y_train_label_mx,batch_size=50,epochs=
```

```
Train on 1920 samples, validate on 480 samples
Epoch 1/5
```

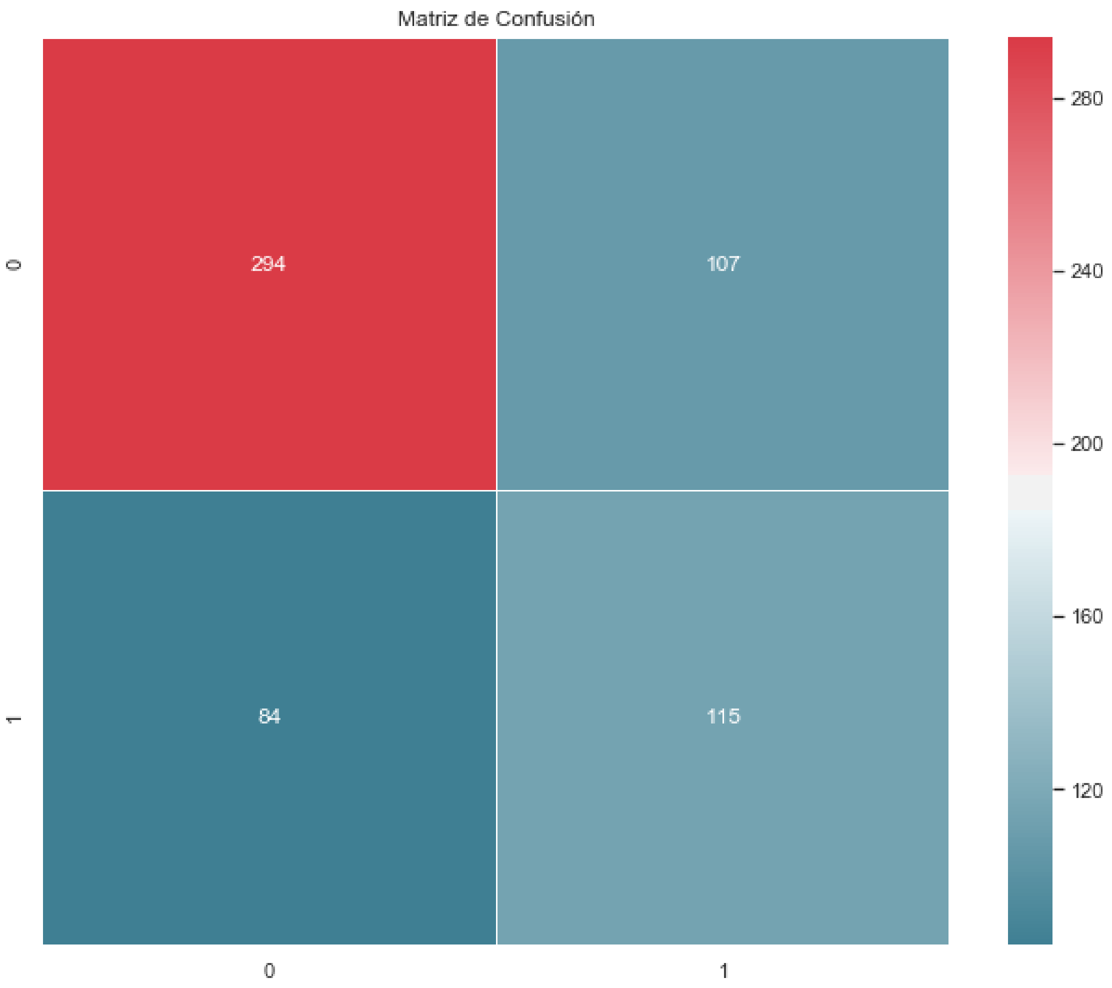
```
1920/1920 [==============================] - 6s 3ms/step - loss: 0.6733 - acc: 0.6031 - val_los
Epoch 2/5
1920/1920 [==============================] - 4s 2ms/step - loss: 0.6669 - acc: 0.6120 - val_los
Epoch 3/5
1920/1920 [==============================] - 4s 2ms/step - loss: 0.6472 - acc: 0.6047 - val_los
Epoch 4/5
1920/1920 [==============================] - 4s 2ms/step - loss: 0.4611 - acc: 0.7677 - val_los
Epoch 5/5
1920/1920 [==============================] - 4s 2ms/step - loss: 0.2790 - acc: 0.8880 - val_los
```

```
In [47]: def plot_history(history):
                 acc = history.history["acc"]
                 val_acc = history.history["val_acc"]
                 loss = history.history["loss"]
                 val_loss = history.history["val_loss"]
                 x = range(1, len(acc) + 1)

                 plt.figure(figsize=(12, 5))
                 plt.subplot(1, 2, 1)
                 plt.plot(x, acc, "bo", label="Training acc")
                 plt.plot(x, val_acc, "b", label="Validation acc")
                 plt.title("Training and validation accuracy")
                 plt.legend()
                 plt.subplot(1, 2, 2)
                 plt.plot(x, loss, "bo", label="Training loss")
                 plt.plot(x, val_loss, "b", label="Validation loss")
                 plt.title("Training and validation loss")
                 plt.legend()

         plot_history(history=history_lstm_mx)
```



```
In [38]: ##########################
         # Tabla de confusión
         ##########################
         from sklearn.metrics import confusion_matrix, precision_score, recall_score
         from sklearn.metrics import f1_score, cohen_kappa_score
         import seaborn as sns

         y_predict_mx = model_lstm_mx.predict(testX_mx)

         test_true_labels_mx_lstm      = np.argmax(y_test_label_mx, axis=1)
         test_predicted_labels_mx_lstm = np.argmax(y_predict_mx,axis=1)


         %matplotlib inline
         C = confusion_matrix(test_true_labels_mx_lstm, test_predicted_labels_mx_lstm)
         print(C)

         ##########################
         # F1
         ##########################
         print('F1 test:', f1_score(test_true_labels_mx_lstm, test_predicted_labels_mx_lstm,  a


         f, ax = plt.subplots(figsize=(11, 9))
         sns.set()
         cmap = sns.diverging_palette(220, 10, as_cmap=True)
         ax = sns.heatmap(C, cmap=cmap, square=True,
                          annot=True, fmt='d', linewidths=.5)
         ax.set_title('Matriz de Confusión')
         plt.show()

         #   0.6505660768571682
```

```
[[294 107]
 [ 84 115]]
F1 test: 0.6505660768571682
```



```
In [37]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         #model_lstm_mx.save(DATA_PATH+'LSTM_mx.h5')

         model_lstm_mx = load_model(DATA_PATH+'LSTM_mx.h5') # Cargar
```

```
In [44]: print("Número de epocas", len(history_lstm_mx.epoch))
```

```
Número de epocas 5
```

```
In [45]: from keras.utils.vis_utils import plot_model
         plot_model(model_lstm_mx, show_shapes=True, to_file=DATA_PATH+'LSTM_mx.png')
```

2.0.1 España

```
In [86]: np.random.seed(50)
         inputs = Input(name='inputs',shape=[length_es])
```

```
np.random.seed(50)
layer = Embedding(vocab_size_es,300, input_length=length_es)(inputs)
layer = LSTM(64,  return_sequences=False)(layer)
layer = Dense(256, activation= 'relu')(layer)
layer = Dropout(0.5)(layer)
layer = Dense(2, activation= 'softmax')(layer)
model_lstm_es = Model(inputs=inputs,outputs=layer)
model_lstm_es.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accurac
print(model_lstm_es.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
inputs (InputLayer)          (None, 38)                0
_________________________________________________________________
embedding_14 (Embedding)     (None, 38, 300)           2098500
_________________________________________________________________
lstm_14 (LSTM)               (None, 64)                93440
_________________________________________________________________
dense_27 (Dense)             (None, 256)               16640
_________________________________________________________________
dropout_14 (Dropout)         (None, 256)               0
_________________________________________________________________
dense_28 (Dense)             (None, 2)                 514
=================================================================
Total params: 2,209,094
Trainable params: 2,209,094
Non-trainable params: 0
_________________________________________________________________
None
```

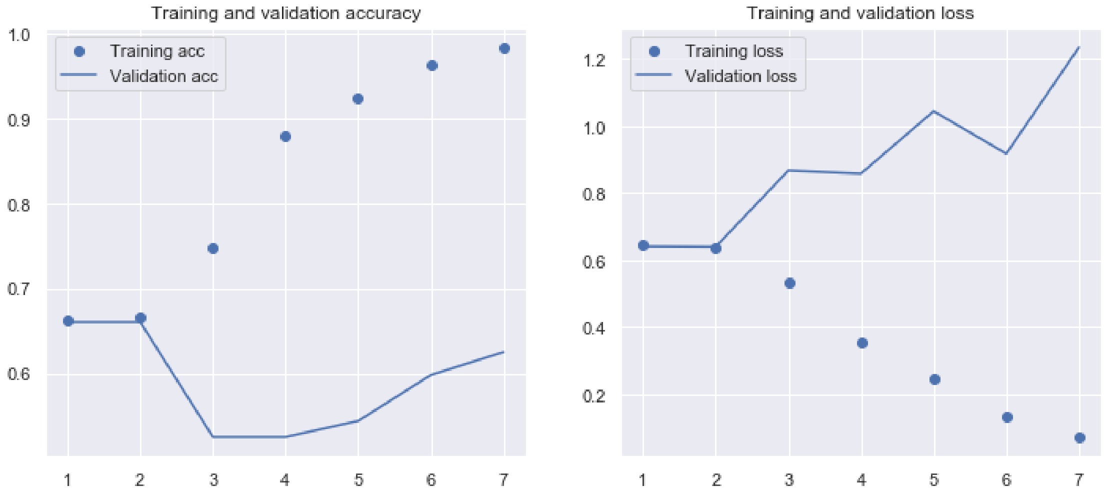
```
In [85]: del model_lstm_es, history_lstm_es
```

```
In [87]: from sklearn.utils import class_weight
         class_weights_es = class_weight.compute_class_weight('balanced',
                                                              np.unique(array(y_train_label_es)),
                                                               y_train_es)


         history_lstm_es = model_lstm_es.fit(trainX_es, y_train_label_es,batch_size=50,epochs=
                                             class_weight = class_weights_es)
```

```
Train on 1920 samples, validate on 480 samples
Epoch 1/7
1920/1920 [==============================] - 8s 4ms/step - loss: 0.6444 - acc: 0.6615 - val_los
Epoch 2/7
1920/1920 [==============================] - 4s 2ms/step - loss: 0.6366 - acc: 0.6667 - val_los
Epoch 3/7
```

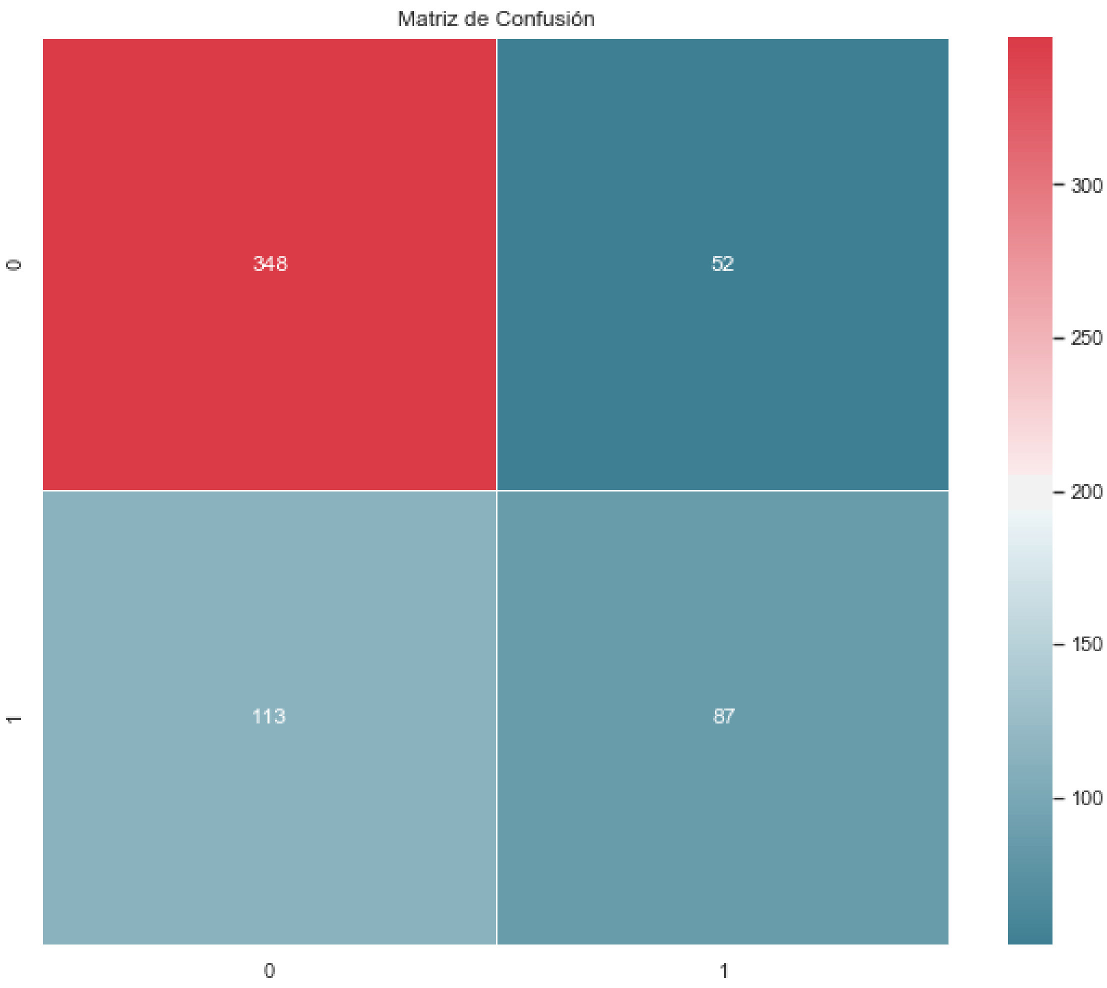
```
1920/1920 [==============================] - 4s 2ms/step - loss: 0.5328 - acc: 0.7484 - val_lo
Epoch 4/7
1920/1920 [==============================] - 4s 2ms/step - loss: 0.3551 - acc: 0.8797 - val_lo
Epoch 5/7
1920/1920 [==============================] - 4s 2ms/step - loss: 0.2459 - acc: 0.9234 - val_lo
Epoch 6/7
1920/1920 [==============================] - 4s 2ms/step - loss: 0.1315 - acc: 0.9630 - val_lo
Epoch 7/7
1920/1920 [==============================] - 4s 2ms/step - loss: 0.0728 - acc: 0.9839 - val_lo
```

```
In [88]: def plot_history(history):
             acc = history.history["acc"]
             val_acc = history.history["val_acc"]
             loss = history.history["loss"]
             val_loss = history.history["val_loss"]
             x = range(1, len(acc) + 1)

             plt.figure(figsize=(12, 5))
             plt.subplot(1, 2, 1)
             plt.plot(x, acc, "bo", label="Training acc")
             plt.plot(x, val_acc, "b", label="Validation acc")
             plt.title("Training and validation accuracy")
             plt.legend()
             plt.subplot(1, 2, 2)
             plt.plot(x, loss, "bo", label="Training loss")
             plt.plot(x, val_loss, "b", label="Validation loss")
             plt.title("Training and validation loss")
             plt.legend()

         plot_history(history=history_lstm_es)
```



```
In [40]: ##########################
         # Tabla de confusión
         ##########################
         from sklearn.metrics import confusion_matrix, precision_score, recall_score
         from sklearn.metrics import f1_score, cohen_kappa_score
         import seaborn as sns

         y_predict_es = model_lstm_es.predict(testX_es)

         test_true_labels_es_lstm      = np.argmax(y_test_label_es, axis=1)
         test_predicted_labels_es_lstm = np.argmax(y_predict_es,axis=1)


         %matplotlib inline
         C = confusion_matrix(test_true_labels_es_lstm, test_predicted_labels_es_lstm)
         print(C)

         ##########################
         # F1
         ##########################
         print('F1 test:', f1_score(test_true_labels_es_lstm, test_predicted_labels_es_lstm,  a


         f, ax = plt.subplots(figsize=(11, 9))
         sns.set()
         cmap = sns.diverging_palette(220, 10, as_cmap=True)
         ax = sns.heatmap(C, cmap=cmap, square=True,
                          annot=True, fmt='d', linewidths=.5)
         ax.set_title('Matriz de Confusión')
         plt.show()

         # 0.6608183528105824 # 7 epocas
```

```
[[348  52]
 [113  87]]
F1 test: 0.6608183528105824
```



```
In [39]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         #model_lstm_es.save(DATA_PATH+'LSTM_es.h5')

         model_lstm_es = load_model(DATA_PATH+'LSTM_es.h5') # Cargar

In [91]: print("Número de epocas", len(history_lstm_es.epoch))

Número de epocas 7


In [92]: from keras.utils.vis_utils import plot_model
         plot_model(model_lstm_es, show_shapes=True, to_file=DATA_PATH+'LSTM_es.png')
```

2.0.2 Cuba

```
In [123]: np.random.seed(50)
          inputs = Input(name='inputs',shape=[length_cu])
```

```
np.random.seed(50)
layer = Embedding(vocab_size_cu,300, input_length=length_cu)(inputs)
layer = LSTM(64,  return_sequences=False)(layer)
layer = Dense(256, activation= 'relu')(layer)
layer = Dropout(0.5)(layer)
layer = Dense(2, activation= 'softmax')(layer)
model_lstm_cu = Model(inputs=inputs,outputs=layer)
model_lstm_cu.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accura
print(model_lstm_cu.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
inputs (InputLayer)          (None, 41)                0
_________________________________________________________________
embedding_20 (Embedding)     (None, 41, 300)           2791200
_________________________________________________________________
lstm_20 (LSTM)               (None, 64)                93440
_________________________________________________________________
dense_39 (Dense)             (None, 256)               16640
_________________________________________________________________
dropout_20 (Dropout)         (None, 256)               0
_________________________________________________________________
dense_40 (Dense)             (None, 2)                 514
=================================================================
Total params: 2,901,794
Trainable params: 2,901,794
Non-trainable params: 0
_________________________________________________________________
None
```

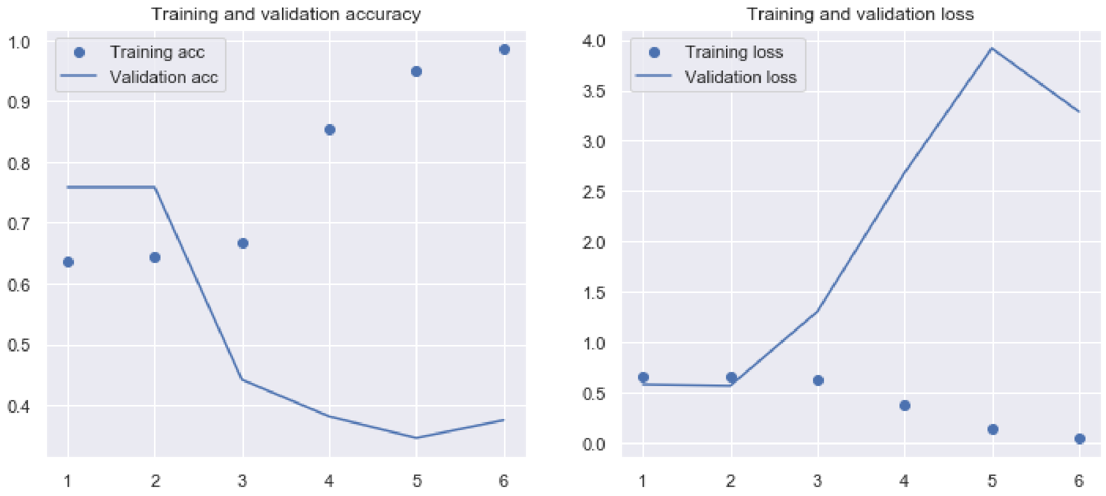
```
In [122]: del model_lstm_cu, history_lstm_cu
```

```
In [124]: from sklearn.utils import class_weight
          class_weights_cu = class_weight.compute_class_weight('balanced',
                                                          np.unique(array(y_train_label_cu)),
                                                           y_train_cu)


          history_lstm_cu = model_lstm_cu.fit(trainX_cu, y_train_label_cu,batch_size=50,epochs
                                              class_weight = class_weights_cu)
```

```
Train on 1920 samples, validate on 480 samples
Epoch 1/6
1920/1920 [==============================] - 6s 3ms/step - loss: 0.6603 - acc: 0.6354 - val_los
Epoch 2/6
1920/1920 [==============================] - 3s 1ms/step - loss: 0.6531 - acc: 0.6438 - val_los
Epoch 3/6
```

```
1920/1920 [==============================] - 3s 1ms/step - loss: 0.6277 - acc: 0.6677 - val_los
Epoch 4/6
1920/1920 [==============================] - 3s 1ms/step - loss: 0.3724 - acc: 0.8531 - val_los
Epoch 5/6
1920/1920 [==============================] - 3s 1ms/step - loss: 0.1422 - acc: 0.9516 - val_los
Epoch 6/6
1920/1920 [==============================] - 3s 1ms/step - loss: 0.0491 - acc: 0.9870 - val_los
```

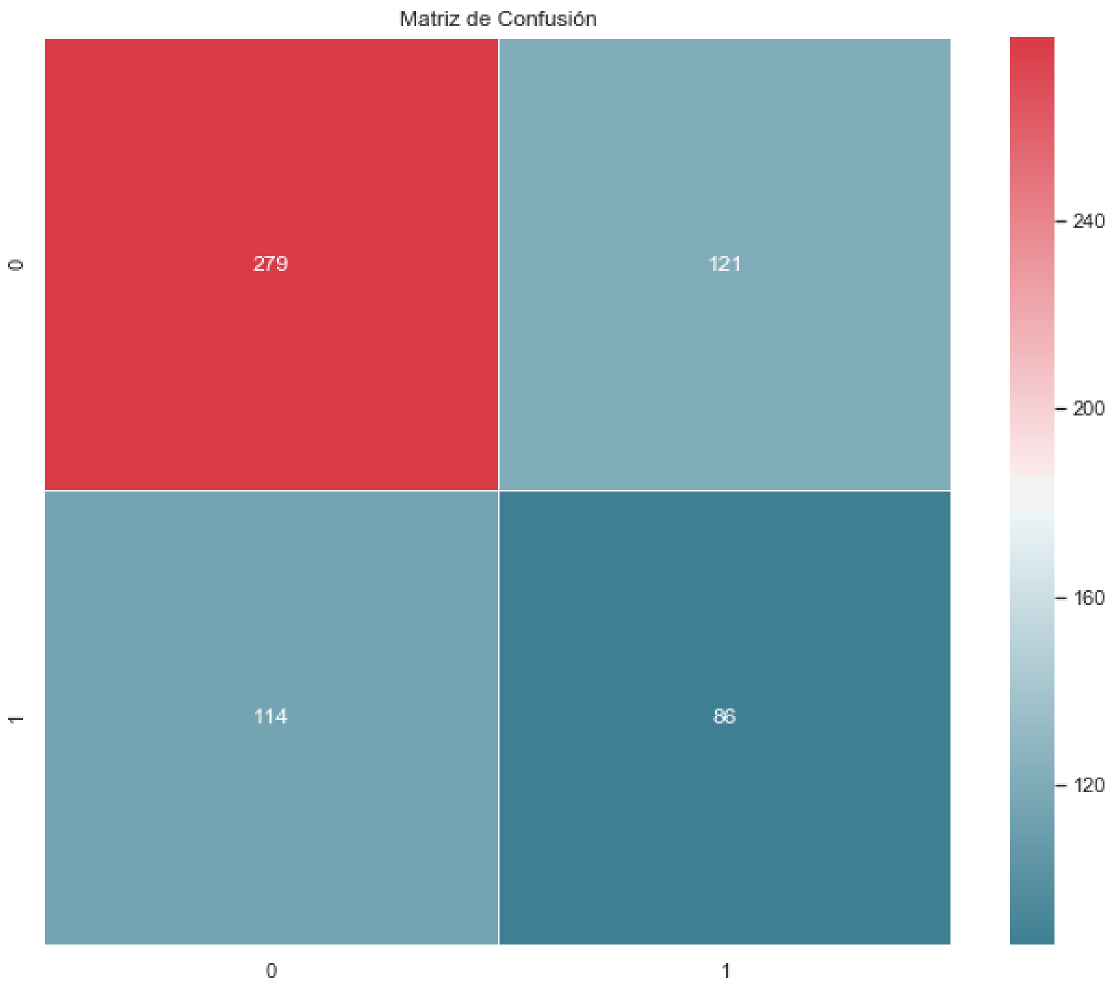
```
In [125]: def plot_history(history):
                  acc = history.history["acc"]
                  val_acc = history.history["val_acc"]
                  loss = history.history["loss"]
                  val_loss = history.history["val_loss"]
                  x = range(1, len(acc) + 1)

                  plt.figure(figsize=(12, 5))
                  plt.subplot(1, 2, 1)
                  plt.plot(x, acc, "bo", label="Training acc")
                  plt.plot(x, val_acc, "b", label="Validation acc")
                  plt.title("Training and validation accuracy")
                  plt.legend()
                  plt.subplot(1, 2, 2)
                  plt.plot(x, loss, "bo", label="Training loss")
                  plt.plot(x, val_loss, "b", label="Validation loss")
                  plt.title("Training and validation loss")
                  plt.legend()

          plot_history(history=history_lstm_cu)
```



```
In [42]: ##########################
         # Tabla de confusión
```

```
##########################
from sklearn.metrics import confusion_matrix, precision_score, recall_score
from sklearn.metrics import f1_score, cohen_kappa_score
import seaborn as sns

y_predict_cu = model_lstm_cu.predict(testX_cu)

test_true_labels_cu_lstm      = np.argmax(y_test_label_cu, axis=1)
test_predicted_labels_cu_lstm = np.argmax(y_predict_cu,axis=1)


%matplotlib inline
C = confusion_matrix(test_true_labels_cu_lstm, test_predicted_labels_cu_lstm)
print(C)

##########################
# F1
##########################
print('F1 test:', f1_score(test_true_labels_cu_lstm, test_predicted_labels_cu_lstm,  a


f, ax = plt.subplots(figsize=(11, 9))
sns.set()
cmap = sns.diverging_palette(220, 10, as_cmap=True)
ax = sns.heatmap(C, cmap=cmap, square=True,
                 annot=True, fmt='d', linewidths=.5)
ax.set_title('Matriz de Confusión')
plt.show()

#  0.5631307106716943  6 epocas
```

```
[[279 121]
 [114  86]]
F1 test: 0.5631307106716943
```



```
In [41]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         #model_lstm_cu.save(DATA_PATH+'LSTM_cu.h5')

         model_lstm_cu = load_model(DATA_PATH+'LSTM_cu.h5') # Cargar

In [128]: print("Número de epocas", len(history_lstm_cu.epoch))

Número de epocas 6


In [129]: from keras.utils.vis_utils import plot_model
          plot_model(model_lstm_cu, show_shapes=True, to_file=DATA_PATH+'LSTM_cu.png')

In [ ]:
```

3 Resultados

```
In [43]: Tabla= {'País':['México', 'España', 'Cuba'],
                'CNN_chanel1':[f1_score(test_true_labels_mx, test_predicted_labels_mx,  averag
                            f1_score(test_true_labels_es, test_predicted_labels_es,  average=
                              f1_score(test_true_labels_cu, test_predicted_labels_cu,  average
                'LSTM':[f1_score(test_true_labels_mx_lstm, test_predicted_labels_mx_lstm,  ave
                            f1_score(test_true_labels_es_lstm, test_predicted_labels_es_lstm,
                              f1_score(test_true_labels_cu_lstm, test_predicted_labels_cu_lstm

         # Create DataFrame
         Tabla = pd.DataFrame(Tabla)
         Tabla
```

```
Out[43]:      País  CNN_chanel1      LSTM
         0  México     0.640547  0.650566
         1  España     0.655407  0.660818
         2    Cuba     0.553750  0.563131
```

https://www.kaggle.com/kredy10/simple-lstm-for-text-classification