#2 - Trabajo CIMAT Gto - CNN multichanel

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Estancia de Investigación Dr. Pastor CIMAT Guanajuato Junio 2019
Hairo Ulises Miranda Belmonte Cimat Monterrey
hairo.miranda@cimat.mx
Cimat Gto.

1 CNN NLP

- Librerias

```
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
```

- Funciones pre-procesamiento

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 ))
```

- Función W2Vec average

1.0.1 Word2Vec Google

```
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-neg
```

```
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
```

2 México

```
In [7]: # 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,)
```

- Pesos Word2vec Google, introducir a embedding de CNN

In [8]:
```
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 [9]:
```
# 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 [10]: 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()}

In [12]: weights_mx = np.array([embedding_weights_mx[i] for i in range(len(embedding_weights_mx
```

3 España

```
In [13]: # Importando los textos
         import os
         # introducit path datos de entrenamiento
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Datos
         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\\Datos
         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\\Datos
         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 [14]: # 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/>"

        # 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
```

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

4 Cuba

```
In [15]: # Importando los textos
         import os
         # introducit path datos de entrenamiento
         os.chdir('C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Datos
         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\\Datos
         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\\Datos
         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 [16]:
```
# 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/>"
```

```
        # 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
```

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

4.0.1 Clasificación CNN México

```
In [17]: # 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)
```

- Arquitectura CNN

```
In [18]: # 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)
             # channel 2
             np.random.seed(n)
             inputs2 = Input(shape=(length,))
             embedding2 = Embedding(vocab_size, 300)(inputs2)
             conv2 = Conv1D(filters=100, kernel_size=6, activation='relu')(embedding2)
             pool2 = GlobalMaxPooling1D()(conv2)
             drop2 = Dropout(0.5)(pool2)
             # channel 3
             np.random.seed(n)
             inputs3 = Input(shape=(length,))
             embedding3 = Embedding(vocab_size, 300)(inputs3)
             conv3 = Conv1D(filters=100, kernel_size=8, activation='relu')(embedding3)
             pool3 = GlobalMaxPooling1D()(conv3)
             drop3 = Dropout(0.5)(pool3)
```

```
        # merge
        merged = concatenate([pool1, pool2, pool3])
        # interpretation
        dense1 = Dense(10, activation='relu')(merged)
        outputs = Dense(2, activation='softmax')(dense1)
        model = Model(inputs=[inputs1, inputs2, inputs3], outputs=outputs)
        # compile
        model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
        # summarize
        print(model.summary())

        return model
```

```
In [58]: del model_mx, hist_mx
```

```
In [60]: from sklearn.utils import class_weight
         class_weights = class_weight.compute_class_weight('balanced',
                                                           np.unique(array(y_train_label_mx)),
                                                           y_train)
```

```
In [61]: model_mx = define_model_mx1(length_mx, vocab_size_mx, 17)
         # fit model


         hist_mx = model_mx.fit([trainX_mx,trainX_mx,trainX_mx], array(y_train_label_mx), epoch

         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)
```

```
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
```

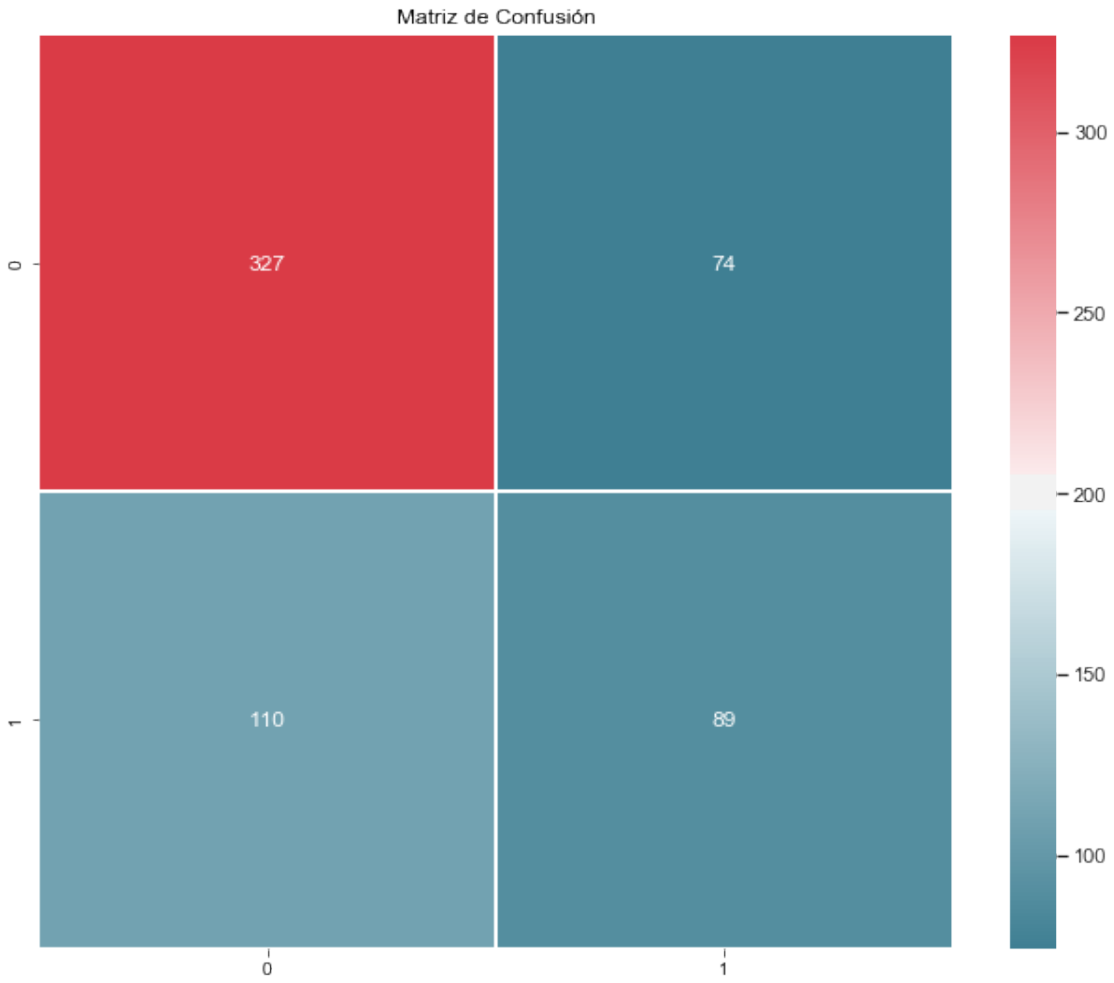
```
==========================================================================================
input_28 (InputLayer)           (None, 36)           0
------------------------------------------------------------------------------------------
input_29 (InputLayer)           (None, 36)           0
------------------------------------------------------------------------------------------
input_30 (InputLayer)           (None, 36)           0
------------------------------------------------------------------------------------------
embedding_28 (Embedding)        (None, 36, 300)      2484300     input_28[0][0]
------------------------------------------------------------------------------------------
embedding_29 (Embedding)        (None, 36, 300)      2484300     input_29[0][0]
------------------------------------------------------------------------------------------
embedding_30 (Embedding)        (None, 36, 300)      2484300     input_30[0][0]
------------------------------------------------------------------------------------------
conv1d_28 (Conv1D)              (None, 33, 100)      120100      embedding_28[0][0]
------------------------------------------------------------------------------------------
conv1d_29 (Conv1D)              (None, 31, 100)      180100      embedding_29[0][0]
------------------------------------------------------------------------------------------
conv1d_30 (Conv1D)              (None, 29, 100)      240100      embedding_30[0][0]
------------------------------------------------------------------------------------------
global_max_pooling1d_28 (Global (None, 100)          0           conv1d_28[0][0]
------------------------------------------------------------------------------------------
global_max_pooling1d_29 (Global (None, 100)          0           conv1d_29[0][0]
------------------------------------------------------------------------------------------
global_max_pooling1d_30 (Global (None, 100)          0           conv1d_30[0][0]
------------------------------------------------------------------------------------------
concatenate_10 (Concatenate)    (None, 300)          0           global_max_pooling1d_28[0][0]
                                                                 global_max_pooling1d_29[0][0]
                                                                 global_max_pooling1d_30[0][0]
------------------------------------------------------------------------------------------
dense_19 (Dense)                (None, 10)           3010        concatenate_10[0][0]
------------------------------------------------------------------------------------------
dense_20 (Dense)                (None, 2)            22          dense_19[0][0]
==========================================================================================
Total params: 7,996,232
Trainable params: 7,996,232
Non-trainable params: 0
------------------------------------------------------------------------------------------
None
Train on 1920 samples, validate on 480 samples
Epoch 1/25
1920/1920 [==============================] - 3s 1ms/step - loss: 0.6547 - acc: 0.6161 - val_los
Epoch 2/25
1920/1920 [==============================] - 1s 495us/step - loss: 0.3410 - acc: 0.9245 - val_l
Epoch 3/25
1920/1920 [==============================] - 1s 495us/step - loss: 0.0613 - acc: 0.9885 - val_l
Epoch 4/25
1920/1920 [==============================] - 1s 561us/step - loss: 0.0103 - acc: 0.9984 - val_l
Epoch 5/25
```

```
1920/1920 [==============================] - 1s 517us/step - loss: 0.0047 - acc: 0.9990 - val_l
Epoch 6/25
1920/1920 [==============================] - 1s 497us/step - loss: 0.0018 - acc: 1.0000 - val_l
Epoch 7/25
1920/1920 [==============================] - 1s 489us/step - loss: 0.0010 - acc: 1.0000 - val_l
Epoch 8/25
1920/1920 [==============================] - 1s 522us/step - loss: 7.0745e-04 - acc: 1.0000 - v
Epoch 9/25
1920/1920 [==============================] - 1s 496us/step - loss: 5.1231e-04 - acc: 1.0000 - v
Epoch 10/25
1920/1920 [==============================] - 1s 497us/step - loss: 4.0542e-04 - acc: 1.0000 - v
Epoch 11/25
1920/1920 [==============================] - 1s 487us/step - loss: 3.3110e-04 - acc: 1.0000 - v
Epoch 12/25
1920/1920 [==============================] - 1s 499us/step - loss: 2.7447e-04 - acc: 1.0000 - v
Epoch 13/25
1920/1920 [==============================] - 1s 499us/step - loss: 2.3374e-04 - acc: 1.0000 - v
Epoch 14/25
1920/1920 [==============================] - 1s 506us/step - loss: 2.0001e-04 - acc: 1.0000 - v
Epoch 15/25
1920/1920 [==============================] - 1s 500us/step - loss: 1.7307e-04 - acc: 1.0000 - v
Epoch 16/25
1920/1920 [==============================] - 1s 499us/step - loss: 1.5310e-04 - acc: 1.0000 - v
Epoch 17/25
1920/1920 [==============================] - 1s 499us/step - loss: 1.3322e-04 - acc: 1.0000 - v
Epoch 18/25
1920/1920 [==============================] - 1s 501us/step - loss: 1.1817e-04 - acc: 1.0000 - v
Epoch 19/25
1920/1920 [==============================] - 1s 497us/step - loss: 1.0606e-04 - acc: 1.0000 - v
Epoch 20/25
1920/1920 [==============================] - 1s 496us/step - loss: 9.5787e-05 - acc: 1.0000 - v
Epoch 21/25
1920/1920 [==============================] - 1s 502us/step - loss: 8.6800e-05 - acc: 1.0000 - v
Epoch 22/25
1920/1920 [==============================] - 1s 492us/step - loss: 7.9081e-05 - acc: 1.0000 - v
Epoch 23/25
1920/1920 [==============================] - 1s 496us/step - loss: 7.1904e-05 - acc: 1.0000 - v
Epoch 24/25
1920/1920 [==============================] - 1s 493us/step - loss: 6.6109e-05 - acc: 1.0000 - v
Epoch 25/25
1920/1920 [==============================] - 1s 494us/step - loss: 6.1180e-05 - acc: 1.0000 - v
```


```
In [62]: model_mx.evaluate([testX_mx,testX_mx,testX_mx],y_test_label_mx)

600/600 [==============================] - 0s 108us/step


Out[62]: [1.3451624313990276, 0.6933333333333334]

In [19]: ############################
         # 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,testX_mx,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()

        # con 25 epocas y seed 17

        #[[327  74]
        # [110  89]]
        #F1 test:0.6360711507271983
```

```
[[327  74]
 [110  89]]
F1 test: 0.6360711507271983
```



```
In [18]: 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.h5')

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

```
WARNING: Logging before flag parsing goes to stderr.
W0710 10:59:44.147166  8800 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 10:59:45.088257  8800 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 10:59:45.938836  8800 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 10:59:45.939798  8800 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 10:59:45.939798  8800 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:00:38.074687  8800 deprecation_wrapper.py:119] From C:\Users\h_air\Anaconda3\envs\tens

W0710 11:00:38.084628  8800 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
```

```
In [70]: from keras.utils.vis_utils import plot_model
         plot_model(model_mx, show_shapes=True, to_file=DATA_PATH+'Cnn_mx.png')
```

4.0.2 Clasificación CNN España

```
In [20]: # 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)
```

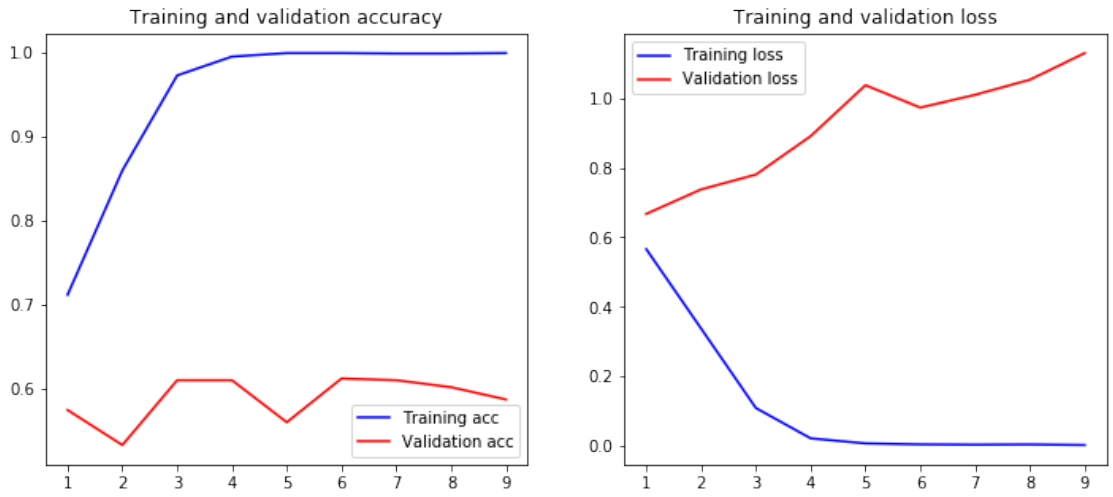
```
In [21]: # define the model
         def define_model_es1(length, vocab_size, n ):



                 # 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)
                 # channel 2
                 np.random.seed(n)
                 inputs2 = Input(shape=(length,))
```

```
        embedding2 = Embedding(vocab_size, 300)(inputs2)
        conv2 = Conv1D(filters=100, kernel_size=6, activation='relu')(embedding2)
        pool2 = GlobalMaxPooling1D()(conv2)
        drop2 = Dropout(0.5)(pool2)
        # channel 3
        np.random.seed(n)
        inputs3 = Input(shape=(length,))
        embedding3 = Embedding(vocab_size, 300)(inputs3)
        conv3 = Conv1D(filters=100, kernel_size=8, activation='relu')(embedding3)
        pool3 = GlobalMaxPooling1D()(conv3)
        drop3 = Dropout(0.5)(pool3)
        # merge
        merged = concatenate([pool1, pool2, pool3])
        # interpretation
        dense1 = Dense(10, activation='relu')(merged)
        outputs = Dense(2, activation='softmax')(dense1)
        model = Model(inputs=[inputs1, inputs2, inputs3], outputs=outputs)
        # compile
        model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
        # summarize
        print(model.summary())

        return model

In [24]: 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 [112]: del model_es, hist_es

In [26]: model_es = define_model_es1(length_es, vocab_size_es, 16) #16
         # fit model


         hist_es = model_es.fit([trainX_es,trainX_es,trainX_es], array(y_train_label_es), epoch
                                class_weight = class_weights_es)

         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 #     Connected to
==================================================================================================
input_7 (InputLayer)            (None, 38)           0
__________________________________________________________________________________________________
input_8 (InputLayer)            (None, 38)           0
__________________________________________________________________________________________________
input_9 (InputLayer)            (None, 38)           0
__________________________________________________________________________________________________
embedding_7 (Embedding)         (None, 38, 300)      2098500     input_7[0][0]
__________________________________________________________________________________________________
embedding_8 (Embedding)         (None, 38, 300)      2098500     input_8[0][0]
__________________________________________________________________________________________________
embedding_9 (Embedding)         (None, 38, 300)      2098500     input_9[0][0]
__________________________________________________________________________________________________
conv1d_7 (Conv1D)               (None, 35, 100)      120100      embedding_7[0][0]
__________________________________________________________________________________________________
conv1d_8 (Conv1D)               (None, 33, 100)      180100      embedding_8[0][0]
__________________________________________________________________________________________________
conv1d_9 (Conv1D)               (None, 31, 100)      240100      embedding_9[0][0]
__________________________________________________________________________________________________
global_max_pooling1d_7 (GlobalM (None, 100)          0           conv1d_7[0][0]
__________________________________________________________________________________________________
global_max_pooling1d_8 (GlobalM (None, 100)          0           conv1d_8[0][0]
__________________________________________________________________________________________________
global_max_pooling1d_9 (GlobalM (None, 100)          0           conv1d_9[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 300)          0           global_max_pooling1d_7[0][0]
                                                                 global_max_pooling1d_8[0][0]
                                                                 global_max_pooling1d_9[0][0]
__________________________________________________________________________________________________
dense_5 (Dense)                 (None, 10)           3010        concatenate_3[0][0]
__________________________________________________________________________________________________
dense_6 (Dense)                 (None, 2)            22          dense_5[0][0]
==================================================================================================
Total params: 6,838,832
Trainable params: 6,838,832
```

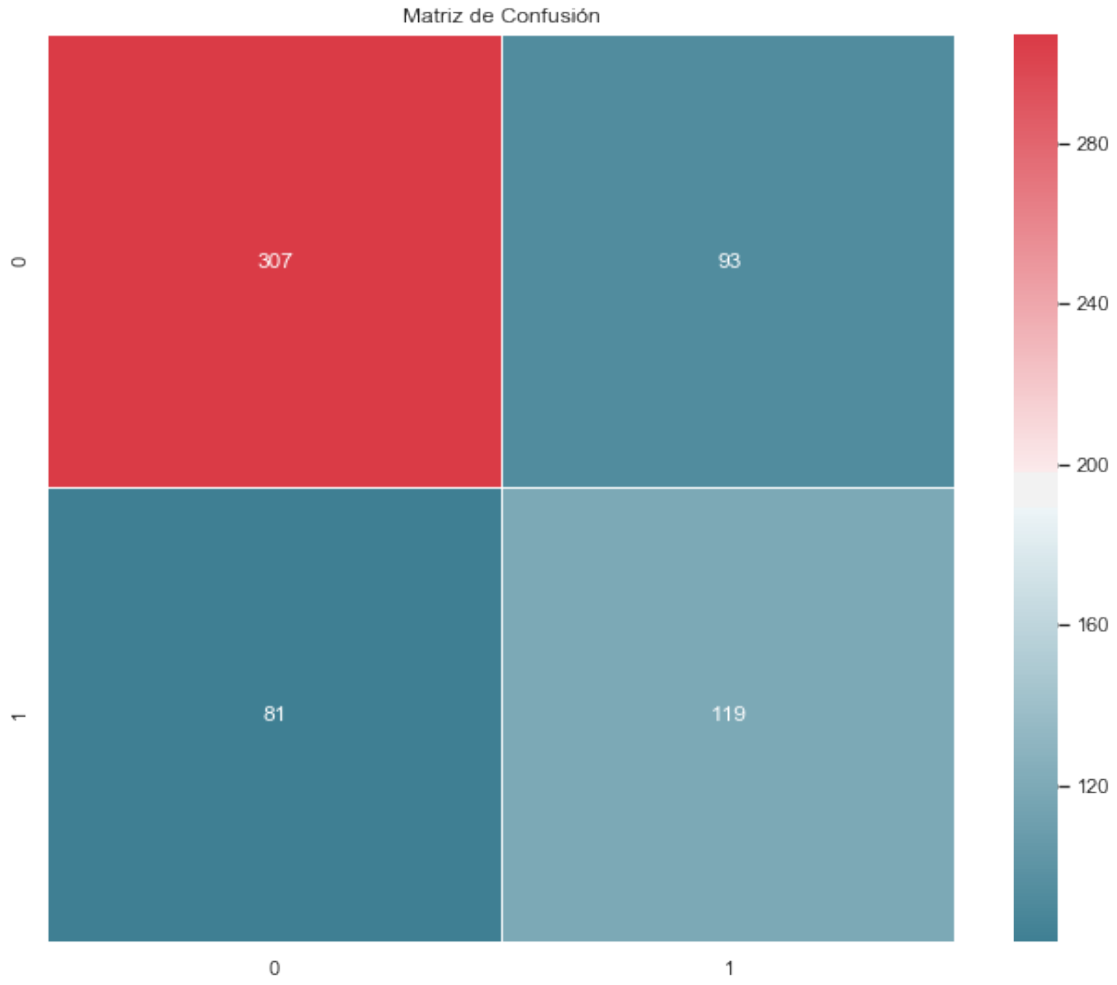
```
Non-trainable params: 0
_________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/9
1920/1920 [==============================] - 12s 6ms/step - loss: 0.5657 - acc: 0.7120 - val_lo
Epoch 2/9
1920/1920 [==============================] - 1s 469us/step - loss: 0.3377 - acc: 0.8599 - val_l
Epoch 3/9
1920/1920 [==============================] - 1s 458us/step - loss: 0.1093 - acc: 0.9729 - val_l
Epoch 4/9
1920/1920 [==============================] - 1s 455us/step - loss: 0.0221 - acc: 0.9953 - val_l
Epoch 5/9
1920/1920 [==============================] - 1s 452us/step - loss: 0.0076 - acc: 0.9995 - val_l
Epoch 6/9
1920/1920 [==============================] - 1s 447us/step - loss: 0.0047 - acc: 0.9995 - val_l
Epoch 7/9
1920/1920 [==============================] - 1s 449us/step - loss: 0.0039 - acc: 0.9990 - val_l
Epoch 8/9
1920/1920 [==============================] - 1s 449us/step - loss: 0.0045 - acc: 0.9990 - val_l
Epoch 9/9
1920/1920 [==============================] - 1s 454us/step - loss: 0.0029 - acc: 0.9995 - val_l
```




```
In [22]: ############################
         # 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,testX_es,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()


#  0.6784288600857523 semilla 9 epocas
```

```
[[307  93]
 [ 81 119]]
F1 test: 0.6784288600857523
```




```
In [21]: 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.h5')

         model_es = load_model(DATA_PATH+'Cnn_es.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.png')
```

4.0.3 Clasificación CNN Cuba

```
In [23]: # 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)
```

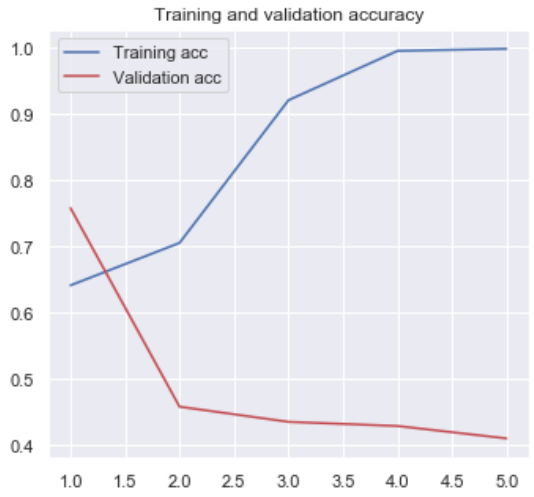
```
In [24]: from keras import backend as K
         # define the model
```

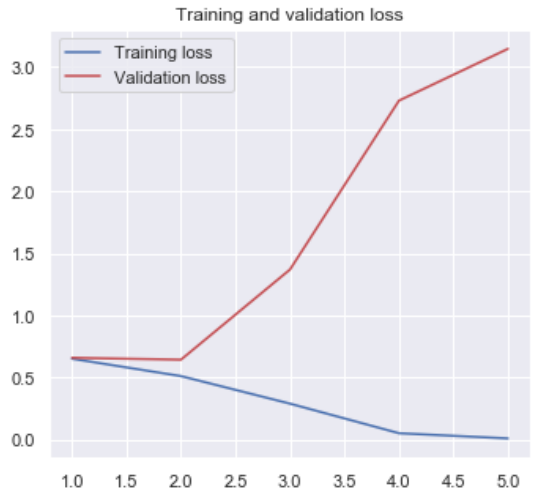
```
        def recall_m(y_true, y_pred):
                true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
                possible_positives = K.sum(K.round(K.clip(y_true, 0, 1)))
                recall = true_positives / (possible_positives + K.epsilon())
                return recall

        def precision_m(y_true, y_pred):
                true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
                predicted_positives = K.sum(K.round(K.clip(y_pred, 0, 1)))
                precision = true_positives / (predicted_positives + K.epsilon())
                return precision

        def f1_m(y_true, y_pred):
            precision = precision_m(y_true, y_pred)
            recall = recall_m(y_true, y_pred)
            return 2*((precision*recall)/(precision+recall+K.epsilon()))
```

In [33]:
```
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)
        # channel 2
        np.random.seed(n)
        inputs2 = Input(shape=(length,))
        embedding2 = Embedding(vocab_size, 300)(inputs2)
        conv2 = Conv1D(filters=100, kernel_size=6, activation='relu')(embedding2)
        pool2 = GlobalMaxPooling1D()(conv2)
        drop2 = Dropout(0.5)(pool2)
        # channel 3
        np.random.seed(n)
        inputs3 = Input(shape=(length,))
        embedding3 = Embedding(vocab_size, 300)(inputs3)
        conv3 = Conv1D(filters=100, kernel_size=8, activation='relu')(embedding3)
        pool3 = GlobalMaxPooling1D()(conv3)
        drop3 = Dropout(0.5)(pool3)
        # merge
        merged = concatenate([pool1, pool2, pool3])
        # interpretation
        dense1 = Dense(10, activation='relu')(merged)
        outputs = Dense(2, activation='softmax')(dense1)
        model = Model(inputs=[inputs1, inputs2, inputs3], outputs=outputs)
        # compile
```

```
                model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
                # summarize
                print(model.summary())
                return model

In [34]: 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 [35]: del model_cu, hist_cu

In [36]: model_cu = define_model_cu1(length_cu, vocab_size_cu, 17)
         # fit model


         hist_cu = model_cu.fit([trainX_cu,trainX_cu,trainX_cu], array(y_train_label_cu), epoch
                                class_weight = class_weights_cu)

         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 #     Connected to
==================================================================================================
input_4 (InputLayer)            (None, 41)           0
__________________________________________________________________________________________________
input_5 (InputLayer)            (None, 41)           0
__________________________________________________________________________________________________
input_6 (InputLayer)            (None, 41)           0
__________________________________________________________________________________________________
```

```
embedding_4 (Embedding)         (None, 41, 300)      2791200     input_4[0][0]
__________________________________________________________________________________________
embedding_5 (Embedding)         (None, 41, 300)      2791200     input_5[0][0]
__________________________________________________________________________________________
embedding_6 (Embedding)         (None, 41, 300)      2791200     input_6[0][0]
__________________________________________________________________________________________
conv1d_4 (Conv1D)               (None, 38, 100)      120100      embedding_4[0][0]
__________________________________________________________________________________________
conv1d_5 (Conv1D)               (None, 36, 100)      180100      embedding_5[0][0]
__________________________________________________________________________________________
conv1d_6 (Conv1D)               (None, 34, 100)      240100      embedding_6[0][0]
__________________________________________________________________________________________
global_max_pooling1d_4 (GlobalM (None, 100)          0           conv1d_4[0][0]
__________________________________________________________________________________________
global_max_pooling1d_5 (GlobalM (None, 100)          0           conv1d_5[0][0]
__________________________________________________________________________________________
global_max_pooling1d_6 (GlobalM (None, 100)          0           conv1d_6[0][0]
__________________________________________________________________________________________
concatenate_2 (Concatenate)     (None, 300)          0           global_max_pooling1d_4[0][0]
                                                                 global_max_pooling1d_5[0][0]
                                                                 global_max_pooling1d_6[0][0]
__________________________________________________________________________________________
dense_3 (Dense)                 (None, 10)           3010        concatenate_2[0][0]
__________________________________________________________________________________________
dense_4 (Dense)                 (None, 2)            22          dense_3[0][0]
==========================================================================================
Total params: 8,916,932
Trainable params: 8,916,932
Non-trainable params: 0
__________________________________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/5
1920/1920 [==============================] - 2s 1ms/step - loss: 0.6500 - acc: 0.6417 - val_los
Epoch 2/5
1920/1920 [==============================] - 1s 542us/step - loss: 0.5099 - acc: 0.7057 - val_l
Epoch 3/5
1920/1920 [==============================] - 1s 539us/step - loss: 0.2879 - acc: 0.9214 - val_l
Epoch 4/5
1920/1920 [==============================] - 1s 538us/step - loss: 0.0496 - acc: 0.9958 - val_l
Epoch 5/5
1920/1920 [==============================] - 1s 540us/step - loss: 0.0077 - acc: 0.9990 - val_l
```

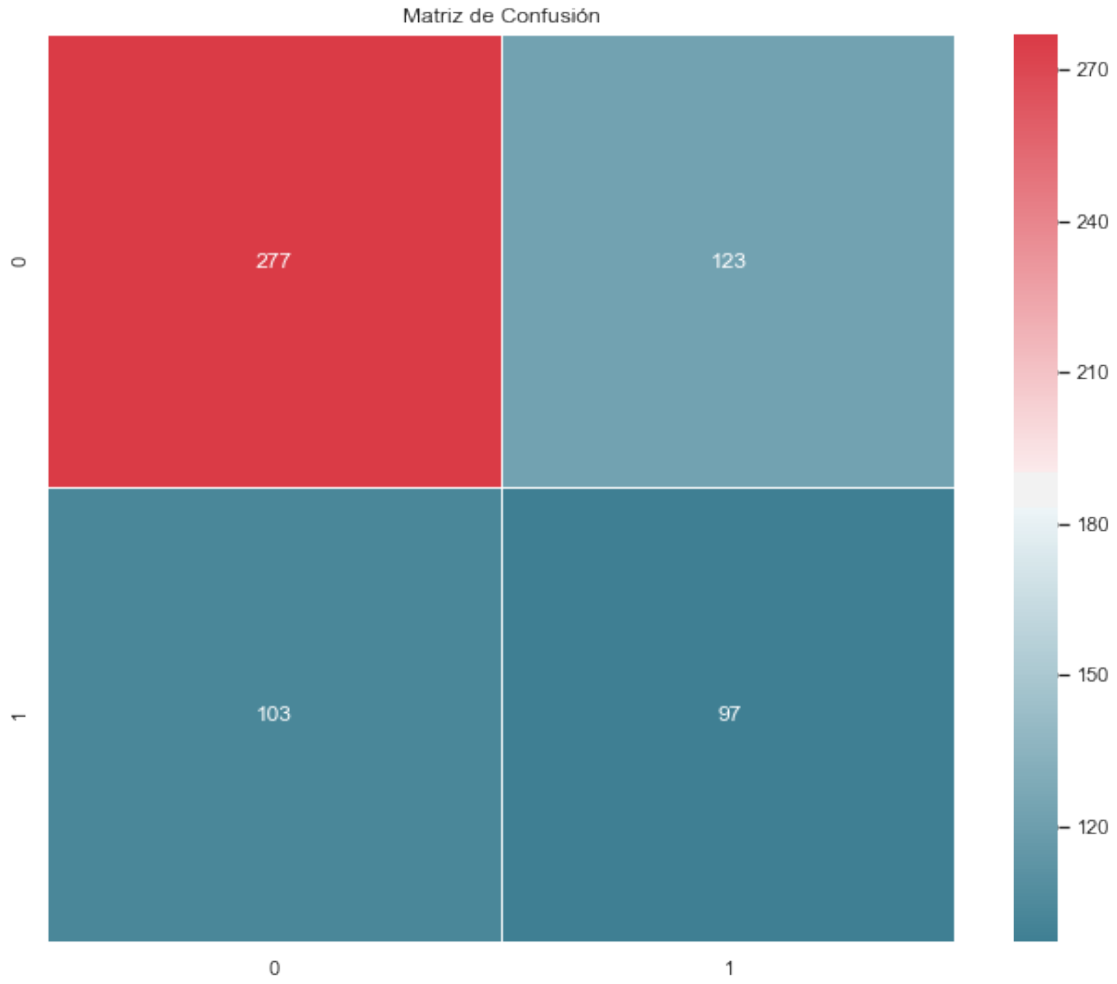




In [25]:
```
############################
# Tabla de confusión
############################
from sklearn.metrics import confusion_matrix, precision_score, recall_score
from sklearn.metrics import f1_score, cohen_kappa_score
import seaborn as sns

y_predict_cu = model_cu.predict([testX_cu,testX_cu,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 0.5860805860805861 seed 17 epoca 5
```

```
[[277 123]
 [103  97]]
F1 test: 0.5860805860805861
```



In [24]:
```
from keras.models import load_model
#DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Da
#model_cu.save(DATA_PATH+'Cnn_cu.h5')

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

#from keras.utils.vis_utils import plot_model
#plot_model(model_cu, show_shapes=True, to_file=DATA_PATH+'Cnn_cu.png')
```

In [26]:
```
del modelo_google
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

5 Word2Vec Pesos (entrenables)

5.1 México

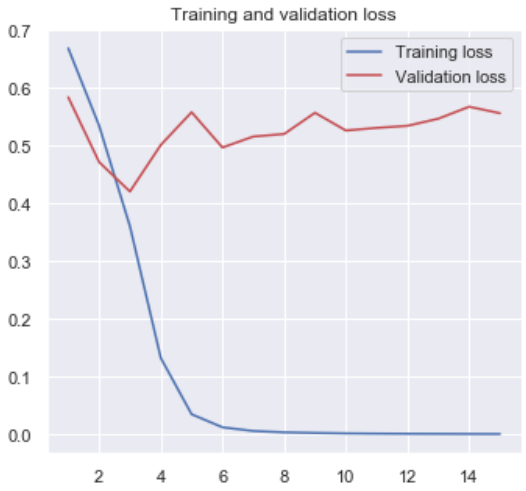
In [27]:
```
# define the model
def define_model_mx1_w2v(length, vocab_size, n , weights):
        # channel 1
        np.random.seed(n)
        inputs1 = Input(shape=(length,))
        embedding1 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(inp
        conv1 = Conv1D(filters=100, kernel_size=4, activation='relu')(embedding1)
        pool1 = GlobalMaxPooling1D()(conv1)
        drop1 = Dropout(0.5)(pool1)
        # channel 2
        np.random.seed(n)
        inputs2 = Input(shape=(length,))
        embedding2 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(inp
        conv2 = Conv1D(filters=100, kernel_size=6, activation='relu')(embedding2)
        pool2 = GlobalMaxPooling1D()(conv2)
        drop2 = Dropout(0.5)(pool2)
        # channel 3
        np.random.seed(n)
        inputs3 = Input(shape=(length,))
        embedding3 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(inp
        conv3 = Conv1D(filters=100, kernel_size=8, activation='relu')(embedding3)
        pool3 = GlobalMaxPooling1D()(conv3)
        drop3 = Dropout(0.5)(pool3)
        # merge
        merged = concatenate([pool1, pool2, pool3])
        # interpretation
        dense1 = Dense(10, activation='relu')(merged)
        outputs = Dense(2, activation='softmax')(dense1)
        model = Model(inputs=[inputs1, inputs2, inputs3], outputs=outputs)
        # compile
        model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
        # summarize
        print(model.summary())

        return model
```

```
In [28]: del model_mx_w2v, hist_mx_w2v

In [44]: 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 [45]: model_mx_w2v = define_model_mx1_w2v(length_mx, vocab_size_mx, 17, weights_mx) #16
         # fit model


         hist_mx_w2v = model_mx_w2v.fit([trainX_mx,trainX_mx,trainX_mx], array(y_train_label_mx
                                        validation_split=.2, class_weight=class_weights_mx)

         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_w2v)
```

```
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_7 (InputLayer)            (None, 36)           0
__________________________________________________________________________________________________
input_8 (InputLayer)            (None, 36)           0
__________________________________________________________________________________________________
input_9 (InputLayer)            (None, 36)           0
__________________________________________________________________________________________________
embedding_7 (Embedding)         (None, 36, 300)      2484300     input_7[0][0]
__________________________________________________________________________________________________
embedding_8 (Embedding)         (None, 36, 300)      2484300     input_8[0][0]
__________________________________________________________________________________________________
```

```
embedding_9 (Embedding)         (None, 36, 300)      2484300     input_9[0][0]
__________________________________________________________________________________________
conv1d_7 (Conv1D)               (None, 33, 100)      120100      embedding_7[0][0]
__________________________________________________________________________________________
conv1d_8 (Conv1D)               (None, 31, 100)      180100      embedding_8[0][0]
__________________________________________________________________________________________
conv1d_9 (Conv1D)               (None, 29, 100)      240100      embedding_9[0][0]
__________________________________________________________________________________________
global_max_pooling1d_7 (GlobalM (None, 100)          0           conv1d_7[0][0]
__________________________________________________________________________________________
global_max_pooling1d_8 (GlobalM (None, 100)          0           conv1d_8[0][0]
__________________________________________________________________________________________
global_max_pooling1d_9 (GlobalM (None, 100)          0           conv1d_9[0][0]
__________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 300)          0           global_max_pooling1d_7[0][0]
                                                                 global_max_pooling1d_8[0][0]
                                                                 global_max_pooling1d_9[0][0]
__________________________________________________________________________________________
dense_5 (Dense)                 (None, 10)           3010        concatenate_3[0][0]
__________________________________________________________________________________________
dense_6 (Dense)                 (None, 2)            22          dense_5[0][0]
==========================================================================================
Total params: 7,996,232
Trainable params: 7,996,232
Non-trainable params: 0
__________________________________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/15
1920/1920 [==============================] - 3s 2ms/step - loss: 0.6678 - acc: 0.6083 - val_los
Epoch 2/15
1920/1920 [==============================] - 1s 494us/step - loss: 0.5340 - acc: 0.6542 - val_l
Epoch 3/15
1920/1920 [==============================] - 1s 502us/step - loss: 0.3601 - acc: 0.8547 - val_l
Epoch 4/15
1920/1920 [==============================] - 1s 499us/step - loss: 0.1322 - acc: 0.9677 - val_l
Epoch 5/15
1920/1920 [==============================] - 1s 498us/step - loss: 0.0348 - acc: 0.9958 - val_l
Epoch 6/15
1920/1920 [==============================] - 1s 499us/step - loss: 0.0123 - acc: 0.9995 - val_l
Epoch 7/15
1920/1920 [==============================] - 1s 498us/step - loss: 0.0059 - acc: 1.0000 - val_l
Epoch 8/15
1920/1920 [==============================] - 1s 503us/step - loss: 0.0036 - acc: 1.0000 - val_l
Epoch 9/15
1920/1920 [==============================] - 1s 501us/step - loss: 0.0026 - acc: 1.0000 - val_l
Epoch 10/15
1920/1920 [==============================] - 1s 499us/step - loss: 0.0018 - acc: 1.0000 - val_l
```

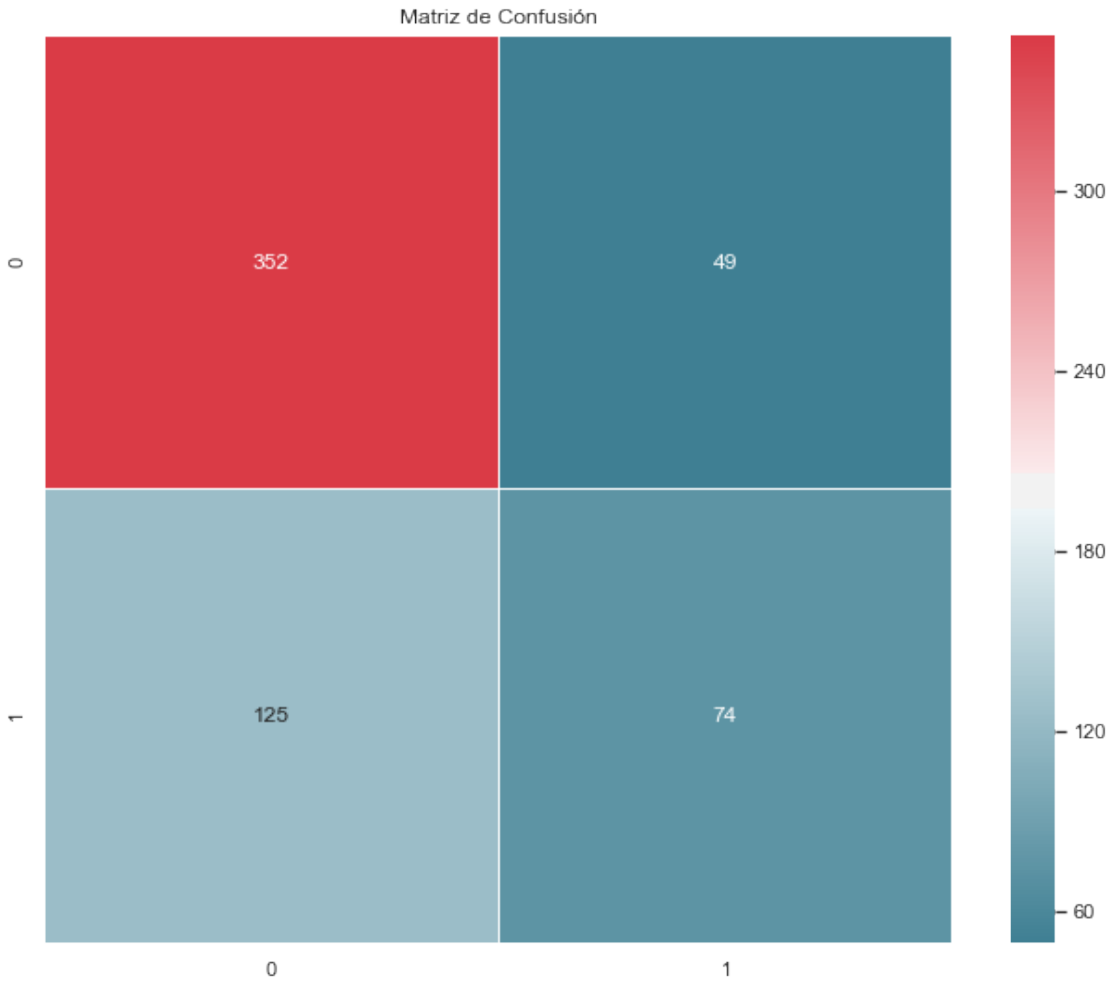
```
Epoch 11/15
1920/1920 [==============================] - 1s 496us/step - loss: 0.0013 - acc: 1.0000 - val_l
Epoch 12/15
1920/1920 [==============================] - 1s 500us/step - loss: 0.0011 - acc: 1.0000 - val_l
Epoch 13/15
1920/1920 [==============================] - 1s 498us/step - loss: 8.9558e-04 - acc: 1.0000 - v
Epoch 14/15
1920/1920 [==============================] - 1s 498us/step - loss: 7.4098e-04 - acc: 1.0000 - v
Epoch 15/15
1920/1920 [==============================] - 1s 499us/step - loss: 6.3452e-04 - acc: 1.0000 - v
```



In [30]:
```
############################
# 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_w2v = model_mx_w2v.predict([testX_mx,testX_mx,testX_mx])

test_true_labels_mx_w2v      = np.argmax(y_test_label_mx, axis=1)
test_predicted_labels_mx_w2v = np.argmax(y_predict_mx_w2v,axis=1)


%matplotlib inline
C = confusion_matrix(test_true_labels_mx_w2v, test_predicted_labels_mx_w2v)
print(C)

############################
# F1
```

```
##########################
print('F1 test:', f1_score(test_true_labels_mx_w2v, test_predicted_labels_mx_w2v,  ave

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()

#0.6307248263274806  con 15 epocas y 17 semillas
```

```
[[352  49]
 [125  74]]
F1 test: 0.6307248263274806
```



```
In [29]: from keras.models import load_model
         DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
         #model_mx_w2v.save(DATA_PATH+'Cnn_mx_w2v.h5')

         model_mx_w2v = load_model(DATA_PATH+'Cnn_mx_w2v.h5') # Cargar

         #from keras.utils.vis_utils import plot_model
         #plot_model(model_mx_w2v, show_shapes=True, to_file=DATA_PATH+'Cnn_mx_w2v.png')
```

5.2 España

```
In [79]: # define the model
         def define_model_es1_w2v(length, vocab_size, n , weights):

                 # channel 1
                 np.random.seed(n)
                 inputs1 = Input(shape=(length,))
                 embedding1 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(inp
                 conv1 = Conv1D(filters=100, kernel_size=4, activation='relu')(embedding1)
                 pool1 = GlobalMaxPooling1D()(conv1)
                 drop1 = Dropout(0.5)(pool1)
                 # channel 2
                 np.random.seed(n)
                 inputs2 = Input(shape=(length,))
                 embedding2 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(inp
                 conv2 = Conv1D(filters=100, kernel_size=6, activation='relu')(embedding2)
                 pool2 = GlobalMaxPooling1D()(conv2)
                 drop2 = Dropout(0.5)(pool2)
                 # channel 3
                 np.random.seed(n)
                 inputs3 = Input(shape=(length,))
                 embedding3 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(inp
                 conv3 = Conv1D(filters=100, kernel_size=8, activation='relu')(embedding3)
                 pool3 = GlobalMaxPooling1D()(conv3)
                 drop3 = Dropout(0.5)(pool3)
                 # merge
                 merged = concatenate([pool1, pool2, pool3])
                 # interpretation
                 dense1 = Dense(10, activation='relu')(merged)
                 outputs = Dense(2, activation='softmax')(dense1)
                 model = Model(inputs=[inputs1, inputs2, inputs3], outputs=outputs)
                 # compile
                 model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy
                 # summarize
                 print(model.summary())
```

```
                return model

In [69]: 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 [98]: del model_es_w2v, hist_es_w2v

In [102]: model_es_w2v = define_model_es1_w2v(length_es, vocab_size_es, 16, weights_es)
          # fit model


          hist_es_w2v = model_es_w2v.fit([trainX_es,trainX_es,trainX_es], array(y_train_label_e
                                         validation_split=.2, class_weight = class_weights_es)

          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_w2v)
```

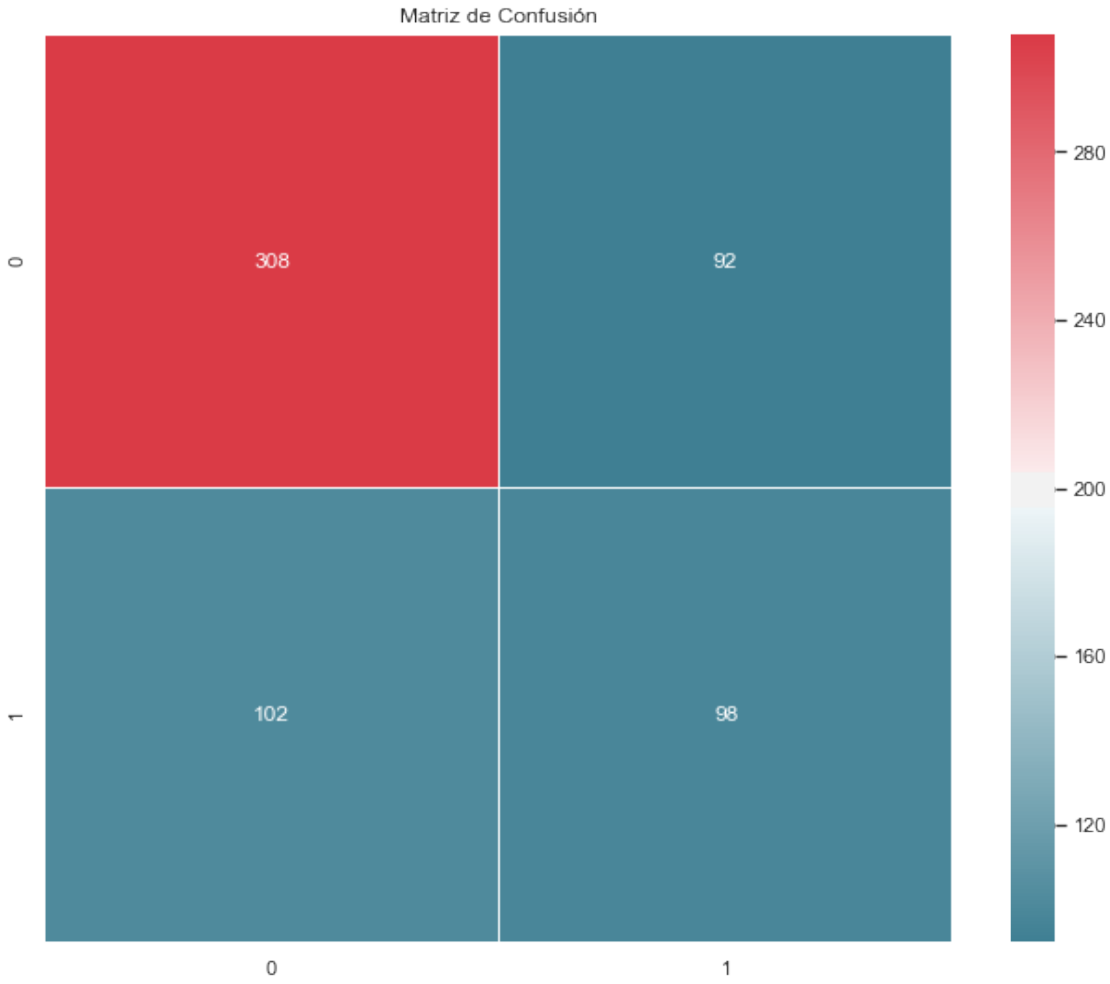
```
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_43 (InputLayer)           (None, 38)           0
__________________________________________________________________________________________________
input_44 (InputLayer)           (None, 38)           0
__________________________________________________________________________________________________
input_45 (InputLayer)           (None, 38)           0
__________________________________________________________________________________________________
embedding_43 (Embedding)        (None, 38, 300)      2098500     input_43[0][0]
__________________________________________________________________________________________________
```

```
embedding_44 (Embedding)        (None, 38, 300)      2098500     input_44[0][0]
__________________________________________________________________________________________
embedding_45 (Embedding)        (None, 38, 300)      2098500     input_45[0][0]
__________________________________________________________________________________________
conv1d_43 (Conv1D)              (None, 35, 100)      120100      embedding_43[0][0]
__________________________________________________________________________________________
conv1d_44 (Conv1D)              (None, 33, 100)      180100      embedding_44[0][0]
__________________________________________________________________________________________
conv1d_45 (Conv1D)              (None, 31, 100)      240100      embedding_45[0][0]
__________________________________________________________________________________________
global_max_pooling1d_43 (Global (None, 100)          0           conv1d_43[0][0]
__________________________________________________________________________________________
global_max_pooling1d_44 (Global (None, 100)          0           conv1d_44[0][0]
__________________________________________________________________________________________
global_max_pooling1d_45 (Global (None, 100)          0           conv1d_45[0][0]
__________________________________________________________________________________________
concatenate_15 (Concatenate)    (None, 300)          0           global_max_pooling1d_43[0][0]
                                                                 global_max_pooling1d_44[0][0]
                                                                 global_max_pooling1d_45[0][0]
__________________________________________________________________________________________
dense_29 (Dense)                (None, 10)           3010        concatenate_15[0][0]
__________________________________________________________________________________________
dense_30 (Dense)                (None, 2)            22          dense_29[0][0]
==========================================================================================
Total params: 6,838,832
Trainable params: 6,838,832
Non-trainable params: 0
__________________________________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/5
1920/1920 [==============================] - 3s 2ms/step - loss: 0.5391 - acc: 0.7198 - val_los
Epoch 2/5
1920/1920 [==============================] - 1s 478us/step - loss: 0.2998 - acc: 0.8875 - val_l
Epoch 3/5
1920/1920 [==============================] - 1s 497us/step - loss: 0.1192 - acc: 0.9755 - val_l
Epoch 4/5
1920/1920 [==============================] - 1s 492us/step - loss: 0.0357 - acc: 0.9958 - val_l
Epoch 5/5
1920/1920 [==============================] - 1s 494us/step - loss: 0.0212 - acc: 0.9969 - val_l
```

In [32]:
```
############################
# 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_w2v = model_es_w2v.predict([testX_es,testX_es,testX_es])

test_true_labels_es_w2v      = np.argmax(y_test_label_es, axis=1)
test_predicted_labels_es_w2v = np.argmax(y_predict_es_w2v,axis=1)


%matplotlib inline
C = confusion_matrix(test_true_labels_es_w2v, test_predicted_labels_es_w2v)
print(C)

############################
# F1
############################
print('F1 test:', f1_score(test_true_labels_es_w2v, test_predicted_labels_es_w2v,  ave


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()
```

```
        #  0.6315289648622984 semilla 16 epoca 5
```

```
[[308  92]
 [102  98]]
F1 test: 0.6315289648622984
```



In [31]:
```
from keras.models import load_model
DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
#model_es_w2v.save(DATA_PATH+'Cnn_es_w2v.h5')

model_es_w2v = load_model(DATA_PATH+'Cnn_es_w2v.h5') # Cargar

#from keras.utils.vis_utils import plot_model
#plot_model(model_es_w2v, show_shapes=True, to_file=DATA_PATH+'Cnn_es_w2v.png')
```

6 Cuba

In [106]:
```
# define the model
def define_model_cu1_w2v(length, vocab_size, n , weights):



    # channel 1
    np.random.seed(n)
    inputs1 = Input(shape=(length,))
    embedding1 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(in
    conv1 = Conv1D(filters=100, kernel_size=4, activation='relu')(embedding1)
    pool1 = GlobalMaxPooling1D()(conv1)
    drop1 = Dropout(0.5)(pool1)
    # channel 2
    np.random.seed(n)
    inputs2 = Input(shape=(length,))
    embedding2 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(in
    conv2 = Conv1D(filters=100, kernel_size=6, activation='relu')(embedding2)
    pool2 = GlobalMaxPooling1D()(conv2)
    drop2 = Dropout(0.5)(pool2)
    # channel 3
    np.random.seed(n)
    inputs3 = Input(shape=(length,))
    embedding3 = Embedding(vocab_size, 300, weights=[weights], trainable=True)(in
    conv3 = Conv1D(filters=100, kernel_size=8, activation='relu')(embedding3)
    pool3 = GlobalMaxPooling1D()(conv3)
    drop3 = Dropout(0.5)(pool3)
    # merge
    merged = concatenate([pool1, pool2, pool3])
    # interpretation
    dense1 = Dense(10, activation='relu')(merged)
    outputs = Dense(2, activation='softmax')(dense1)
    model = Model(inputs=[inputs1, inputs2, inputs3], outputs=outputs)
    # compile
    model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accurac
    # summarize
    print(model.summary())


    return model
```

In [107]:
```
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)
```

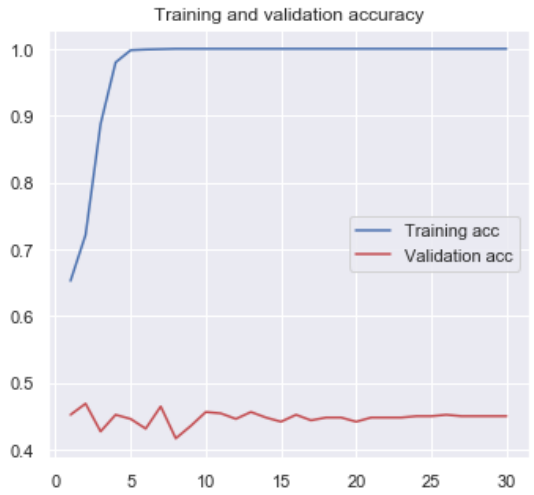
In [127]:
```
del model_cu_w2v, hist_cu_w2v
```

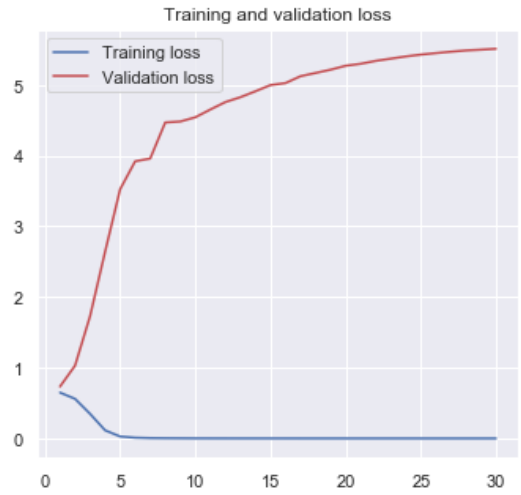
```
In [128]: model_cu_w2v = define_model_cu1_w2v(length_cu, vocab_size_cu, 16, weights_cu)
          # fit model


          hist_cu_w2v = model_cu_w2v.fit([trainX_cu,trainX_cu,trainX_cu], array(y_train_label_
                                         validation_split=.2, class_weight = class_weights_cu )

          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_w2v)
```

```
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_64 (InputLayer)           (None, 41)           0
__________________________________________________________________________________________________
input_65 (InputLayer)           (None, 41)           0
__________________________________________________________________________________________________
input_66 (InputLayer)           (None, 41)           0
__________________________________________________________________________________________________
embedding_64 (Embedding)        (None, 41, 300)      2791200     input_64[0][0]
__________________________________________________________________________________________________
embedding_65 (Embedding)        (None, 41, 300)      2791200     input_65[0][0]
__________________________________________________________________________________________________
embedding_66 (Embedding)        (None, 41, 300)      2791200     input_66[0][0]
__________________________________________________________________________________________________
conv1d_64 (Conv1D)              (None, 38, 100)      120100      embedding_64[0][0]
__________________________________________________________________________________________________
conv1d_65 (Conv1D)              (None, 36, 100)      180100      embedding_65[0][0]
__________________________________________________________________________________________________
conv1d_66 (Conv1D)              (None, 34, 100)      240100      embedding_66[0][0]
```

```
____________________________________________________________________________________________________
global_max_pooling1d_64 (Global (None, 100)          0           conv1d_64[0][0]
____________________________________________________________________________________________________
global_max_pooling1d_65 (Global (None, 100)          0           conv1d_65[0][0]
____________________________________________________________________________________________________
global_max_pooling1d_66 (Global (None, 100)          0           conv1d_66[0][0]
____________________________________________________________________________________________________
concatenate_22 (Concatenate)    (None, 300)          0           global_max_pooling1d_64[0][0]
                                                                 global_max_pooling1d_65[0][0]
                                                                 global_max_pooling1d_66[0][0]
____________________________________________________________________________________________________
dense_43 (Dense)                (None, 10)           3010        concatenate_22[0][0]
____________________________________________________________________________________________________
dense_44 (Dense)                (None, 2)            22          dense_43[0][0]
====================================================================================================
Total params: 8,916,932
Trainable params: 8,916,932
Non-trainable params: 0
____________________________________________________________________________________________________
None
Train on 1920 samples, validate on 480 samples
Epoch 1/30
1920/1920 [==============================] - 4s 2ms/step - loss: 0.6488 - acc: 0.6526 - val_los
Epoch 2/30
1920/1920 [==============================] - 1s 558us/step - loss: 0.5604 - acc: 0.7214 - val_l
Epoch 3/30
1920/1920 [==============================] - 1s 559us/step - loss: 0.3479 - acc: 0.8875 - val_l
Epoch 4/30
1920/1920 [==============================] - 1s 558us/step - loss: 0.1145 - acc: 0.9797 - val_l
Epoch 5/30
1920/1920 [==============================] - 1s 567us/step - loss: 0.0273 - acc: 0.9979 - val_l
Epoch 6/30
1920/1920 [==============================] - 1s 561us/step - loss: 0.0102 - acc: 0.9990 - val_l
Epoch 7/30
1920/1920 [==============================] - 1s 562us/step - loss: 0.0045 - acc: 0.9995 - val_l
Epoch 8/30
1920/1920 [==============================] - 1s 565us/step - loss: 0.0028 - acc: 1.0000 - val_l
Epoch 9/30
1920/1920 [==============================] - 1s 566us/step - loss: 0.0020 - acc: 1.0000 - val_l
Epoch 10/30
1920/1920 [==============================] - 1s 579us/step - loss: 0.0011 - acc: 1.0000 - val_l
Epoch 11/30
1920/1920 [==============================] - 1s 575us/step - loss: 8.3525e-04 - acc: 1.0000 - v
Epoch 12/30
1920/1920 [==============================] - 1s 576us/step - loss: 6.7843e-04 - acc: 1.0000 - v
Epoch 13/30
1920/1920 [==============================] - 1s 564us/step - loss: 5.6113e-04 - acc: 1.0000 - v
Epoch 14/30
```

```
1920/1920 [==============================] - 1s 572us/step - loss: 4.7398e-04 - acc: 1.0000 - v
Epoch 15/30
1920/1920 [==============================] - 1s 566us/step - loss: 4.0606e-04 - acc: 1.0000 - v
Epoch 16/30
1920/1920 [==============================] - 1s 562us/step - loss: 3.5140e-04 - acc: 1.0000 - v
Epoch 17/30
1920/1920 [==============================] - 1s 579us/step - loss: 3.0855e-04 - acc: 1.0000 - v
Epoch 18/30
1920/1920 [==============================] - 1s 580us/step - loss: 2.7479e-04 - acc: 1.0000 - v
Epoch 19/30
1920/1920 [==============================] - 1s 565us/step - loss: 2.4213e-04 - acc: 1.0000 - v
Epoch 20/30
1920/1920 [==============================] - 1s 568us/step - loss: 2.1765e-04 - acc: 1.0000 - v
Epoch 21/30
1920/1920 [==============================] - 1s 585us/step - loss: 1.9524e-04 - acc: 1.0000 - v
Epoch 22/30
1920/1920 [==============================] - 1s 563us/step - loss: 1.7679e-04 - acc: 1.0000 - v
Epoch 23/30
1920/1920 [==============================] - 1s 565us/step - loss: 1.6068e-04 - acc: 1.0000 - v
Epoch 24/30
1920/1920 [==============================] - 1s 565us/step - loss: 1.4633e-04 - acc: 1.0000 - v
Epoch 25/30
1920/1920 [==============================] - 1s 563us/step - loss: 1.3423e-04 - acc: 1.0000 - v
Epoch 26/30
1920/1920 [==============================] - 1s 569us/step - loss: 1.2341e-04 - acc: 1.0000 - v
Epoch 27/30
1920/1920 [==============================] - 1s 568us/step - loss: 1.1370e-04 - acc: 1.0000 - v
Epoch 28/30
1920/1920 [==============================] - 1s 564us/step - loss: 1.0489e-04 - acc: 1.0000 - v
Epoch 29/30
1920/1920 [==============================] - 1s 560us/step - loss: 9.7238e-05 - acc: 1.0000 - v
Epoch 30/30
1920/1920 [==============================] - 1s 562us/step - loss: 8.9995e-05 - acc: 1.0000 - v
```

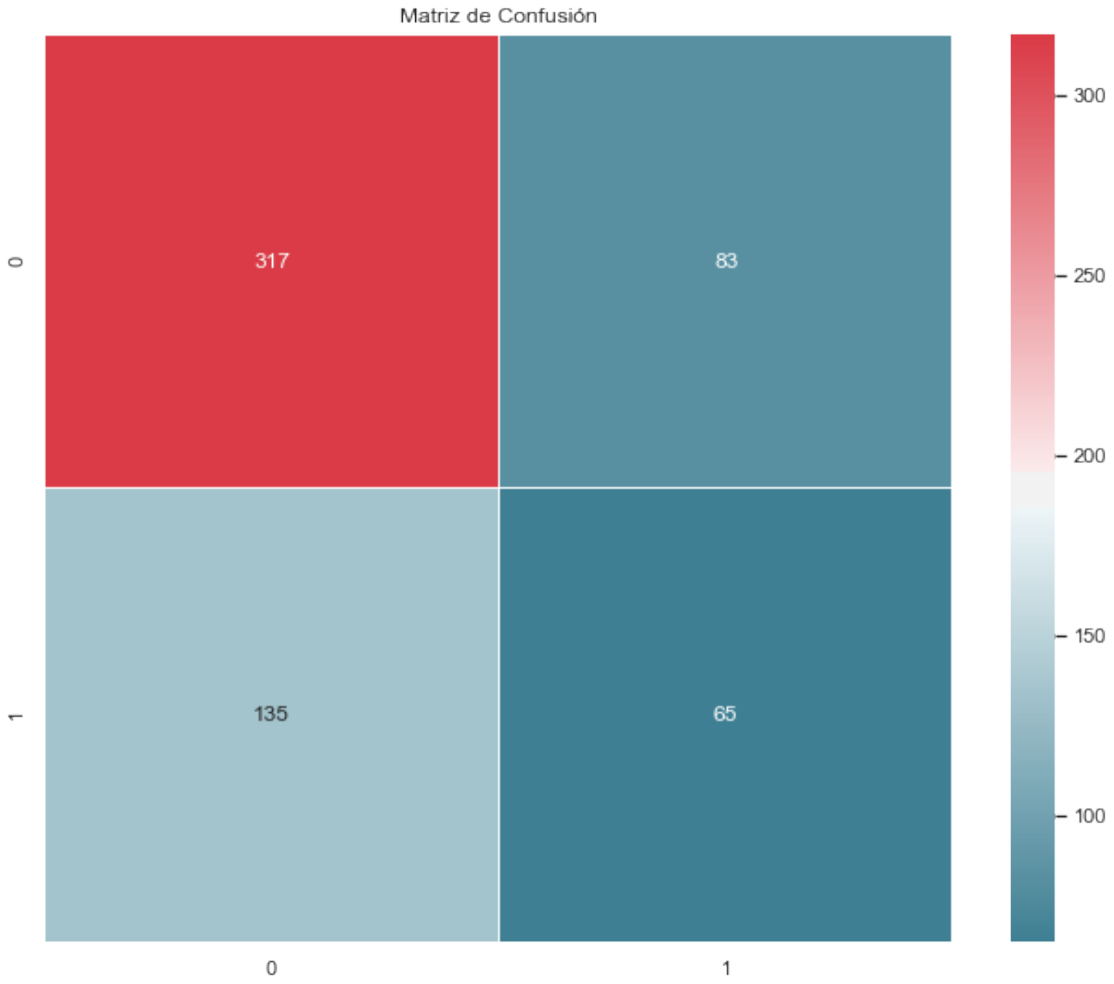




In [37]:
```
############################
# Tabla de confusión
############################
from sklearn.metrics import confusion_matrix, precision_score, recall_score
from sklearn.metrics import f1_score, cohen_kappa_score
import seaborn as sns

y_predict_cu_w2v = model_cu_w2v.predict([testX_cu,testX_cu,testX_cu])

test_true_labels_cu_w2v      = np.argmax(y_test_label_cu, axis=1)
test_predicted_labels_cu_w2v = np.argmax(y_predict_cu_w2v,axis=1)


%matplotlib inline
C = confusion_matrix(test_true_labels_cu_w2v, test_predicted_labels_cu_w2v)
print(C)

############################
# F1
############################
print('F1 test:', f1_score(test_true_labels_cu_w2v, test_predicted_labels_cu_w2v,  ave


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()
```

```
        #   0.5588473368949328 con 30 epocas semilla 17
```

```
[[317  83]
 [135  65]]
F1 test: 0.5588473368949328
```



In [36]:
```
from keras.models import load_model
DATA_PATH='C:\\Users\\h_air\\Documents\\Diplomado Deep Learning\\Estancia\\Datos\\Dat
#model_cu_w2v.save(DATA_PATH+'Cnn_cu_w2v.h5')

model_cu_w2v = load_model(DATA_PATH+'Cnn_cu_w2v.h5') # Cargar

#from keras.utils.vis_utils import plot_model
#plot_model(model_cu_w2v, show_shapes=True, to_file=DATA_PATH+'Cnn_cu_w2v.png')
```

In [ ]:

7 Resultados

```
In [40]: Tabla= {'País':['México', 'España', 'Cuba'],
                 'CNN_chanels3':[f1_score(test_true_labels_mx, test_predicted_labels_mx,  avera
                                 f1_score(test_true_labels_es, test_predicted_labels_es,  average=
                                  f1_score(test_true_labels_cu, test_predicted_labels_cu,  averag
                 'CNN_chanels3-W2VGoogle':[f1_score(test_true_labels_mx_w2v, test_predicted_lab
                                  f1_score(test_true_labels_es_w2v, test_predicted_labels_es_w2v,
                                  f1_score(test_true_labels_cu_w2v, test_predicted_labels_cu_w2v,

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

```
Out[40]:      País  CNN_chanels3  CNN_chanels3-W2VGoogle
         0  México      0.636071                0.630725
         1  España      0.678429                0.631529
         2    Cuba      0.586081                0.558847
```