Model

February 29, 2024

0.1 Model for Football Prediction

Took a promising database from internet and decided to perform an approach with **Machine Learning** to see if I could get a good estimator.

[1]:
```
import numpy as np
import pandas as pd
import requests
import xlsxwriter
import math
import tensorflow as tf
```

```
WARNING:tensorflow:From C:\Users\marti\AppData\Local\Packages\PythonSoftwareFoun
dation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
packages\keras\src\losses.py:2976: The name
tf.losses.sparse_softmax_cross_entropy is deprecated. Please use
tf.compat.v1.losses.sparse_softmax_cross_entropy instead.
```

[2]:
```
df = pd.read_csv('C:\\Users\\marti\\Downloads\\archive\\full_data.csv')
```

[3]:
```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 96337 entries, 0 to 96336
Data columns (total 56 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   League               96337 non-null  object
 1   Home                 96337 non-null  object
 2   Away                 96337 non-null  object
 3   INC                  96305 non-null  object
 4   Round                96337 non-null  object
 5   Date                 96337 non-null  object
 6   Time                 96337 non-null  object
 7   H_Score              96305 non-null  float64
 8   A_Score              96305 non-null  float64
 9   HT_H_Score           96305 non-null  float64
 10  HT_A_Score           96305 non-null  float64
 11  WIN                  96305 non-null  object
```

```
 12  H_BET                95181 non-null  float64
 13  X_BET                95181 non-null  float64
 14  A_BET                95181 non-null  float64
 15  WIN_BET              95181 non-null  float64
 16  OVER_2.5             96305 non-null  object
 17  OVER_3.5             96305 non-null  object
 18  H_15                 96337 non-null  bool
 19  A_15                 96337 non-null  bool
 20  H_45_50              96337 non-null  bool
 21  A_45_50              96337 non-null  bool
 22  H_90                 96337 non-null  bool
 23  A_90                 96337 non-null  bool
 24  H_Missing_Players    50213 non-null  float64
 25  A_Missing_Players    50213 non-null  float64
 26  Missing_Players      50213 non-null  float64
 27  H_Ball_Possession    51887 non-null  object
 28  A_Ball_Possession    51887 non-null  object
 29  H_Goal_Attempts      52800 non-null  float64
 30  A_Goal_Attempts      52800 non-null  float64
 31  H_Shots_on_Goal      52797 non-null  float64
 32  A_Shots_on_Goal      52797 non-null  float64
 33  H_Attacks            30673 non-null  float64
 34  A_Attacks            30673 non-null  float64
 35  H_Dangerous_Attacks  30679 non-null  float64
 36  A_Dangerous_Attacks  30679 non-null  float64
 37  H_Shots_off_Goal     52338 non-null  float64
 38  A_Shots_off_Goal     52338 non-null  float64
 39  H_Blocked_Shots      35190 non-null  float64
 40  A_Blocked_Shots      35190 non-null  float64
 41  H_Free_Kicks         36390 non-null  float64
 42  A_Free_Kicks         36390 non-null  float64
 43  H_Corner_Kicks       52611 non-null  float64
 44  A_Corner_Kicks       52611 non-null  float64
 45  H_Offsides           47294 non-null  float64
 46  A_Offsides           47294 non-null  float64
 47  H_Throw_in           21683 non-null  float64
 48  A_Throw_in           21683 non-null  float64
 49  H_Goalkeeper_Saves   52799 non-null  float64
 50  A_Goalkeeper_Saves   52799 non-null  float64
 51  H_Fouls              46301 non-null  float64
 52  A_Fouls              46301 non-null  float64
 53  H_Yellow_Cards       52716 non-null  float64
 54  A_Yellow_Cards       52716 non-null  float64
 55  Game Link            96337 non-null  object
dtypes: bool(6), float64(37), object(13)
memory usage: 37.3+ MB
None
```

The dataset at hand is extensive, yet we will be streamlining it by removing columns pertaining to betting and sparse data, and standardizing all data types for uniformity.

[4]:
```
print(df.columns)
```

```
Index(['League', 'Home', 'Away', 'INC', 'Round', 'Date', 'Time', 'H_Score',
       'A_Score', 'HT_H_Score', 'HT_A_Score', 'WIN', 'H_BET', 'X_BET', 'A_BET',
       'WIN_BET', 'OVER_2.5', 'OVER_3.5', 'H_15', 'A_15', 'H_45_50', 'A_45_50',
       'H_90', 'A_90', 'H_Missing_Players', 'A_Missing_Players',
       'Missing_Players', 'H_Ball_Possession', 'A_Ball_Possession',
       'H_Goal_Attempts', 'A_Goal_Attempts', 'H_Shots_on_Goal',
       'A_Shots_on_Goal', 'H_Attacks', 'A_Attacks', 'H_Dangerous_Attacks',
       'A_Dangerous_Attacks', 'H_Shots_off_Goal', 'A_Shots_off_Goal',
       'H_Blocked_Shots', 'A_Blocked_Shots', 'H_Free_Kicks', 'A_Free_Kicks',
       'H_Corner_Kicks', 'A_Corner_Kicks', 'H_Offsides', 'A_Offsides',
       'H_Throw_in', 'A_Throw_in', 'H_Goalkeeper_Saves', 'A_Goalkeeper_Saves',
       'H_Fouls', 'A_Fouls', 'H_Yellow_Cards', 'A_Yellow_Cards', 'Game Link'],
      dtype='object')
```

[5]:
```
columns_to_drop = [
    'H_Score', 'A_Score', 'HT_H_Score', 'HT_A_Score',
    'H_BET', 'X_BET', 'A_BET', 'WIN_BET',
    'OVER_2.5', 'OVER_3.5',
    'H_15', 'A_15', 'H_45_50', 'A_45_50', 'H_90', 'A_90',
    'Game Link', 'INC', 'Round', 'Home', 'Away', 'H_Throw_in', 'A_Throw_in',␣
 ↪'A_Dangerous_Attacks', 'H_Dangerous_Attacks', 'H_Missing_Players',␣
 ↪'A_Missing_Players',
    'Missing_Players'
]

df['Date'] = pd.to_datetime(df['Date'])
df['Year'] = df['Date'].dt.year
df['Month'] = df['Date'].dt.month
df['Day'] = df['Date'].dt.day
df.drop(['Date', 'Time'], axis=1, inplace=True)

df['H_Attacks'].fillna(0, inplace=True)
df['A_Attacks'].fillna(0, inplace=True)

df.drop(columns_to_drop, axis=1, inplace=True)
```

```
C:\Users\marti\AppData\Local\Temp\ipykernel_10404\4203122447.py:10: UserWarning:
Parsing dates in %d.%m.%Y format when dayfirst=False (the default) was
specified. Pass `dayfirst=True` or specify a format to silence this warning.
  df['Date'] = pd.to_datetime(df['Date'])
C:\Users\marti\AppData\Local\Temp\ipykernel_10404\4203122447.py:16:
FutureWarning: A value is trying to be set on a copy of a DataFrame or Series
through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
```

```
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.


  df['H_Attacks'].fillna(0, inplace=True)
C:\Users\marti\AppData\Local\Temp\ipykernel_10404\4203122447.py:17:
FutureWarning: A value is trying to be set on a copy of a DataFrame or Series
through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.


  df['A_Attacks'].fillna(0, inplace=True)
```

[6]:
```
print(df.columns)
```

```
Index(['League', 'WIN', 'H_Ball_Possession', 'A_Ball_Possession',
       'H_Goal_Attempts', 'A_Goal_Attempts', 'H_Shots_on_Goal',
       'A_Shots_on_Goal', 'H_Attacks', 'A_Attacks', 'H_Shots_off_Goal',
       'A_Shots_off_Goal', 'H_Blocked_Shots', 'A_Blocked_Shots',
       'H_Free_Kicks', 'A_Free_Kicks', 'H_Corner_Kicks', 'A_Corner_Kicks',
       'H_Offsides', 'A_Offsides', 'H_Goalkeeper_Saves', 'A_Goalkeeper_Saves',
       'H_Fouls', 'A_Fouls', 'H_Yellow_Cards', 'A_Yellow_Cards', 'Year',
       'Month', 'Day'],
      dtype='object')
```

[7]:
```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 96337 entries, 0 to 96336
Data columns (total 29 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   League              96337 non-null  object
 1   WIN                 96305 non-null  object
 2   H_Ball_Possession   51887 non-null  object
 3   A_Ball_Possession   51887 non-null  object
 4   H_Goal_Attempts     52800 non-null  float64
 5   A_Goal_Attempts     52800 non-null  float64
 6   H_Shots_on_Goal     52797 non-null  float64
```

```
 7   A_Shots_on_Goal     52797 non-null  float64
 8   H_Attacks           96337 non-null  float64
 9   A_Attacks           96337 non-null  float64
 10  H_Shots_off_Goal    52338 non-null  float64
 11  A_Shots_off_Goal    52338 non-null  float64
 12  H_Blocked_Shots     35190 non-null  float64
 13  A_Blocked_Shots     35190 non-null  float64
 14  H_Free_Kicks        36390 non-null  float64
 15  A_Free_Kicks        36390 non-null  float64
 16  H_Corner_Kicks      52611 non-null  float64
 17  A_Corner_Kicks      52611 non-null  float64
 18  H_Offsides          47294 non-null  float64
 19  A_Offsides          47294 non-null  float64
 20  H_Goalkeeper_Saves  52799 non-null  float64
 21  A_Goalkeeper_Saves  52799 non-null  float64
 22  H_Fouls             46301 non-null  float64
 23  A_Fouls             46301 non-null  float64
 24  H_Yellow_Cards      52716 non-null  float64
 25  A_Yellow_Cards      52716 non-null  float64
 26  Year                96337 non-null  int32
 27  Month               96337 non-null  int32
 28  Day                 96337 non-null  int32
dtypes: float64(22), int32(3), object(4)
memory usage: 20.2+ MB
None
```

[8]:
```
df['WIN'] = df['WIN'].map({'Home': 1, 'Draw': 0, 'Away': 2})
big_leagues = ['championship', 'premier-league', 'bundesliga', 'laliga',␣
 ↪'serie-a']
df_filtered = df[df['League'].isin(big_leagues)]
df = df_filtered
```

[9]:
```
df['H_Ball_Possession'] = df['H_Ball_Possession'].str.rstrip('%').astype(float)␣
 ↪/ 100.0
df['A_Ball_Possession'] = df['A_Ball_Possession'].str.rstrip('%').astype(float)␣
 ↪/ 100.0
```

[10]:
```
print(df.columns)
```

```
Index(['League', 'WIN', 'H_Ball_Possession', 'A_Ball_Possession',
       'H_Goal_Attempts', 'A_Goal_Attempts', 'H_Shots_on_Goal',
       'A_Shots_on_Goal', 'H_Attacks', 'A_Attacks', 'H_Shots_off_Goal',
       'A_Shots_off_Goal', 'H_Blocked_Shots', 'A_Blocked_Shots',
       'H_Free_Kicks', 'A_Free_Kicks', 'H_Corner_Kicks', 'A_Corner_Kicks',
       'H_Offsides', 'A_Offsides', 'H_Goalkeeper_Saves', 'A_Goalkeeper_Saves',
       'H_Fouls', 'A_Fouls', 'H_Yellow_Cards', 'A_Yellow_Cards', 'Year',
       'Month', 'Day'],
      dtype='object')
```

[11]:
```
df = pd.get_dummies(df, columns=['League'])
df = df.dropna()
```

[12]:
```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 13142 entries, 1671 to 41248
Data columns (total 33 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   WIN                     13142 non-null  float64
 1   H_Ball_Possession       13142 non-null  float64
 2   A_Ball_Possession       13142 non-null  float64
 3   H_Goal_Attempts         13142 non-null  float64
 4   A_Goal_Attempts         13142 non-null  float64
 5   H_Shots_on_Goal         13142 non-null  float64
 6   A_Shots_on_Goal         13142 non-null  float64
 7   H_Attacks               13142 non-null  float64
 8   A_Attacks               13142 non-null  float64
 9   H_Shots_off_Goal        13142 non-null  float64
 10  A_Shots_off_Goal        13142 non-null  float64
 11  H_Blocked_Shots         13142 non-null  float64
 12  A_Blocked_Shots         13142 non-null  float64
 13  H_Free_Kicks            13142 non-null  float64
 14  A_Free_Kicks            13142 non-null  float64
 15  H_Corner_Kicks          13142 non-null  float64
 16  A_Corner_Kicks          13142 non-null  float64
 17  H_Offsides              13142 non-null  float64
 18  A_Offsides              13142 non-null  float64
 19  H_Goalkeeper_Saves      13142 non-null  float64
 20  A_Goalkeeper_Saves      13142 non-null  float64
 21  H_Fouls                 13142 non-null  float64
 22  A_Fouls                 13142 non-null  float64
 23  H_Yellow_Cards          13142 non-null  float64
 24  A_Yellow_Cards          13142 non-null  float64
 25  Year                    13142 non-null  int32
 26  Month                   13142 non-null  int32
 27  Day                     13142 non-null  int32
 28  League_bundesliga       13142 non-null  bool
 29  League_championship     13142 non-null  bool
 30  League_laliga           13142 non-null  bool
 31  League_premier-league   13142 non-null  bool
 32  League_serie-a          13142 non-null  bool
dtypes: bool(5), float64(25), int32(3)
memory usage: 2.8 MB
None
```

Our final data has information of 13.142 matches, which should be more than enough. Now we

check if everything is numerical and change types to float32, to avoid problems.

[13]:
```
df[['League_bundesliga', 'League_championship', 'League_laliga',␣
 ↪'League_premier-league', 'League_serie-a']] = df[['League_bundesliga',␣
 ↪'League_championship', 'League_laliga', 'League_premier-league',␣
 ↪'League_serie-a']].astype(int)

numeric_columns = df.select_dtypes(include=['number']).columns

if len(numeric_columns) == len(df.columns):
    print("Todas las columnas son numéricas.")
else:
    print("No todas las columnas son numéricas.")
    print("Columnas no numéricas:", df.columns.difference(numeric_columns))
```

```
Todas las columnas son numéricas.
```

[14]:
```
df = df.astype(np.float32)
print(df.dtypes)
```

```
WIN                     float32
H_Ball_Possession       float32
A_Ball_Possession       float32
H_Goal_Attempts         float32
A_Goal_Attempts         float32
H_Shots_on_Goal         float32
A_Shots_on_Goal         float32
H_Attacks               float32
A_Attacks               float32
H_Shots_off_Goal        float32
A_Shots_off_Goal        float32
H_Blocked_Shots         float32
A_Blocked_Shots         float32
H_Free_Kicks            float32
A_Free_Kicks            float32
H_Corner_Kicks          float32
A_Corner_Kicks          float32
H_Offsides              float32
A_Offsides              float32
H_Goalkeeper_Saves      float32
A_Goalkeeper_Saves      float32
H_Fouls                 float32
A_Fouls                 float32
H_Yellow_Cards          float32
A_Yellow_Cards          float32
Year                    float32
Month                   float32
Day                     float32
League_bundesliga       float32
```

```
League_championship      float32
League_laliga            float32
League_premier-league    float32
League_serie-a           float32
dtype: object
```

[15]:
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler

X = df.drop('WIN', axis=1)
Y = df['WIN']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

x_train, x_test, y_train, y_test = train_test_split(X_scaled, Y, test_size=0.2,␣
↪random_state=42)
```

[16]:
```
from tensorflow.keras.utils import to_categorical

Y_one_hot = to_categorical(Y)
Y_one_hot
```

[16]:
```
array([[0., 0., 1.],
       [0., 1., 0.],
       [0., 1., 0.],
       …,
       [0., 0., 1.],
       [0., 1., 0.],
       [0., 0., 1.]], dtype=float32)
```

[17]:
```
from keras.models import Sequential
from keras.layers import Dense

model = Sequential([
    Dense(32, input_shape=(32,), activation='relu'),
    Dense(20, activation='relu'),
    Dense(3, activation='softmax')
])
```

```
WARNING:tensorflow:From C:\Users\marti\AppData\Local\Packages\PythonSoftwareFoun
dation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
packages\keras\src\backend.py:873: The name tf.get_default_graph is deprecated.
Please use tf.compat.v1.get_default_graph instead.
```

[18]:
```
from keras.optimizers import Adam
```

```
model.compile(optimizer=Adam(),
              loss='categorical_crossentropy',
              metrics=['accuracy'])
```

[19]:
```
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(X_scaled, Y_one_hot,␣
 ↪test_size=0.2, random_state=42)

history = model.fit(
    x=x_train,
    y=y_train,
    validation_split=0.8,
    batch_size=10,
    epochs=10,
    callbacks=[tf.keras.callbacks.ReduceLROnPlateau()],
    shuffle=True,
    verbose=2
)
```

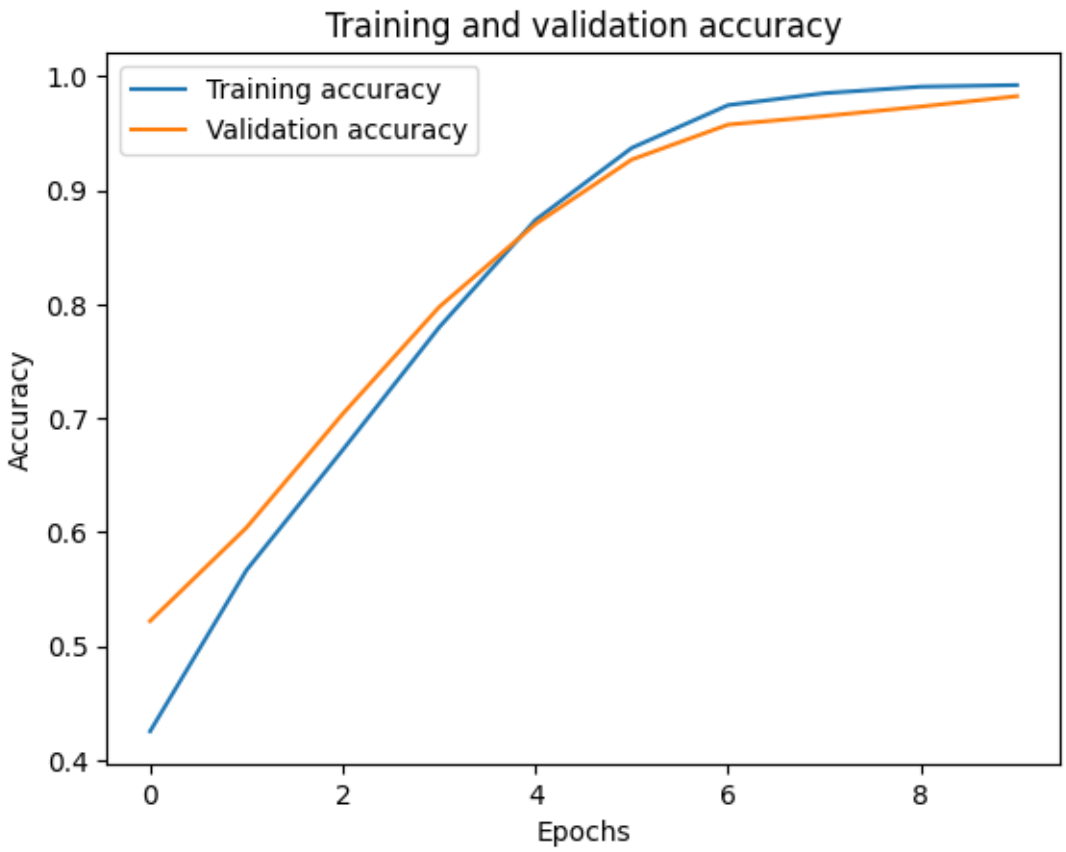
```
Epoch 1/10
WARNING:tensorflow:From C:\Users\marti\AppData\Local\Packages\PythonSoftwareFoun
dation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue
is deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.

WARNING:tensorflow:From C:\Users\marti\AppData\Local\Packages\PythonSoftwareFoun
dation.Python.3.10_qbz5n2kfra8p0\LocalCache\local-packages\Python310\site-
packages\keras\src\engine\base_layer_utils.py:384: The name
tf.executing_eagerly_outside_functions is deprecated. Please use
tf.compat.v1.executing_eagerly_outside_functions instead.

211/211 - 2s - loss: 1.0708 - accuracy: 0.4253 - val_loss: 0.9875 -
val_accuracy: 0.5221 - lr: 0.0010 - 2s/epoch - 8ms/step
Epoch 2/10
211/211 - 1s - loss: 0.9060 - accuracy: 0.5666 - val_loss: 0.8512 -
val_accuracy: 0.6040 - lr: 0.0010 - 796ms/epoch - 4ms/step
Epoch 3/10
211/211 - 1s - loss: 0.7351 - accuracy: 0.6722 - val_loss: 0.6678 -
val_accuracy: 0.7038 - lr: 0.0010 - 826ms/epoch - 4ms/step
Epoch 4/10
211/211 - 1s - loss: 0.5451 - accuracy: 0.7797 - val_loss: 0.4900 -
val_accuracy: 0.7975 - lr: 0.0010 - 811ms/epoch - 4ms/step
Epoch 5/10
211/211 - 1s - loss: 0.3851 - accuracy: 0.8739 - val_loss: 0.3645 -
val_accuracy: 0.8704 - lr: 0.0010 - 886ms/epoch - 4ms/step
Epoch 6/10
211/211 - 1s - loss: 0.2708 - accuracy: 0.9372 - val_loss: 0.2635 -
```

```
val_accuracy: 0.9270 - lr: 0.0010 - 869ms/epoch - 4ms/step
Epoch 7/10
211/211 - 1s - loss: 0.1884 - accuracy: 0.9748 - val_loss: 0.1961 -
val_accuracy: 0.9577 - lr: 0.0010 - 798ms/epoch - 4ms/step
Epoch 8/10
211/211 - 1s - loss: 0.1326 - accuracy: 0.9853 - val_loss: 0.1569 -
val_accuracy: 0.9652 - lr: 0.0010 - 783ms/epoch - 4ms/step
Epoch 9/10
211/211 - 1s - loss: 0.0942 - accuracy: 0.9910 - val_loss: 0.1276 -
val_accuracy: 0.9735 - lr: 0.0010 - 792ms/epoch - 4ms/step
Epoch 10/10
211/211 - 1s - loss: 0.0754 - accuracy: 0.9924 - val_loss: 0.1017 -
val_accuracy: 0.9826 - lr: 0.0010 - 832ms/epoch - 4ms/step
```

[20]:
```
y_pred = model.evaluate(x_test, y_test, batch_size=10)
```

```
263/263 [==============================] - 0s 810us/step - loss: 0.1040 -
accuracy: 0.9821
```

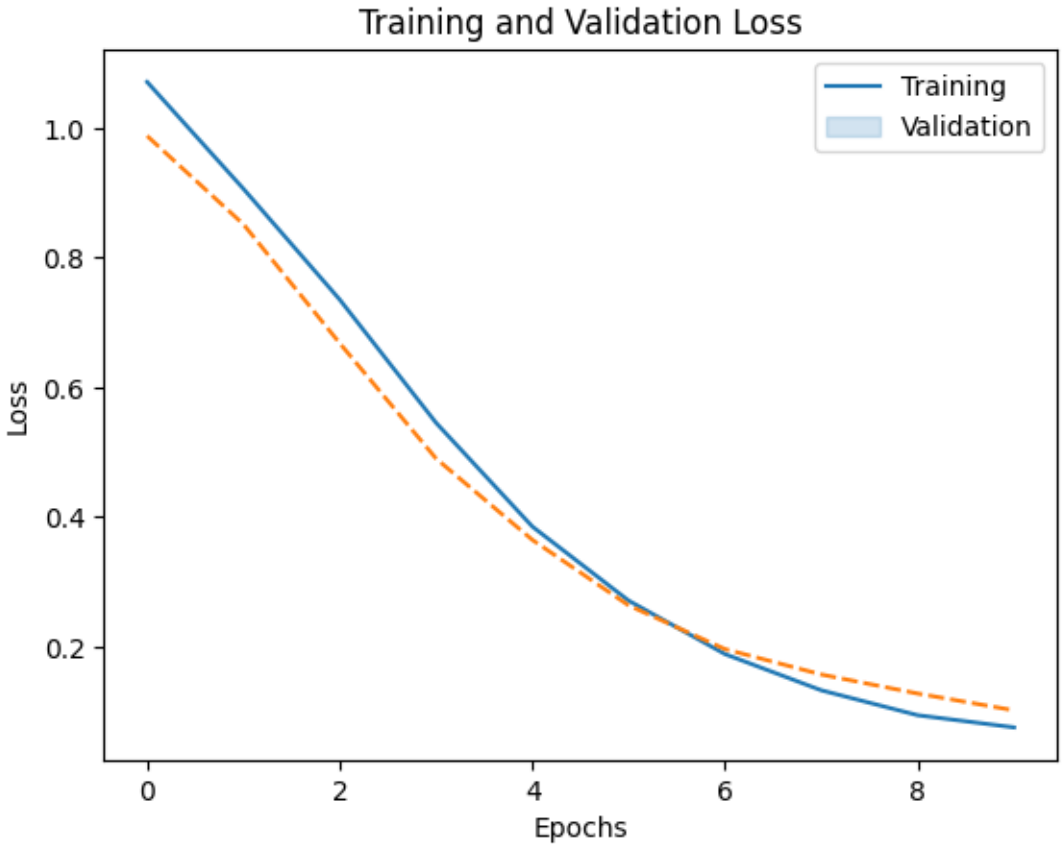
[21]:
```
import matplotlib.pyplot as plt

plt.plot(history.history['accuracy'], label="Training accuracy")
plt.plot(history.history['val_accuracy'], label="Validation accuracy")
plt.title('Training and validation accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```



[22]:
```
import seaborn as sns

df_history = pd.DataFrame(history.history)
print(df_history)

my_plot = sns.lineplot(data=df_history[["loss","val_loss"]])
my_plot.set_xlabel('Epochs')
my_plot.set_ylabel('Loss')
plt.legend(labels=["Training", "Validation"])
plt.title('Training and Validation Loss')
plt.show()
```

```
       loss  accuracy  val_loss  val_accuracy     lr
0  1.070768  0.425309  0.987519      0.522054  0.001
1  0.906004  0.566603  0.851231      0.603971  0.001
2  0.735107  0.672217  0.667760      0.703840  0.001
3  0.545077  0.779734  0.489970      0.797527  0.001
4  0.385065  0.873930  0.364530      0.870408  0.001
5  0.270785  0.937203  0.263471      0.927000  0.001
6  0.188398  0.974786  0.196050      0.957675  0.001
```

```
7  0.132558  0.985252  0.156920       0.965165  0.001
8  0.094152  0.990961  0.127557       0.973487  0.001
9  0.075382  0.992388  0.101677       0.982642  0.001
```



[23]:
```
y_test_class = np.argmax(y_test, axis=1)
predictions = np.argmax(model.predict(x_test),axis=1)
predictions.size
```

```
83/83 [==============================] - 0s 799us/step
```

[23]:
```
2629
```

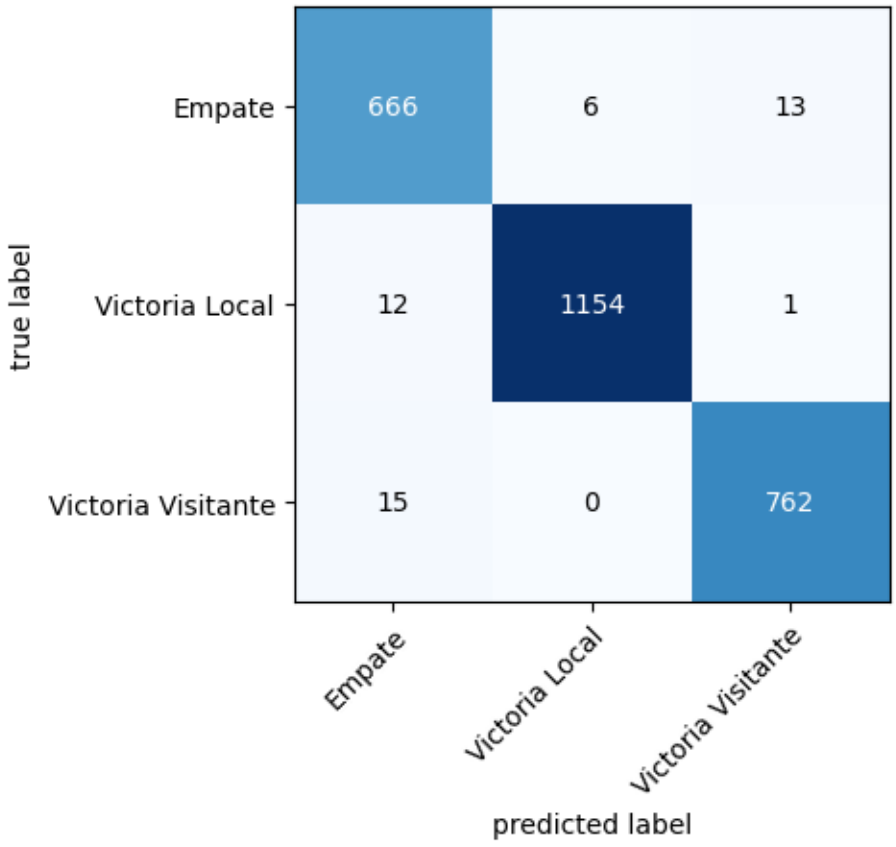
[24]:
```
from sklearn.metrics import accuracy_score

accuracy_score(y_test_class, predictions)
```

[24]:
```
0.9821224800304298
```

[25]:
```
from mlxtend.plotting import plot_confusion_matrix
from sklearn.metrics import confusion_matrix
mat = confusion_matrix(y_test_class, predictions)
```

```
plot_confusion_matrix(conf_mat=mat, figsize=(4, 5), class_names=['Empate',␣
 ↪'Victoria Local', 'Victoria Visitante'])
```

[25]:
```
(<Figure size 400x500 with 1 Axes>,
 <Axes: xlabel='predicted label', ylabel='true label'>)
```

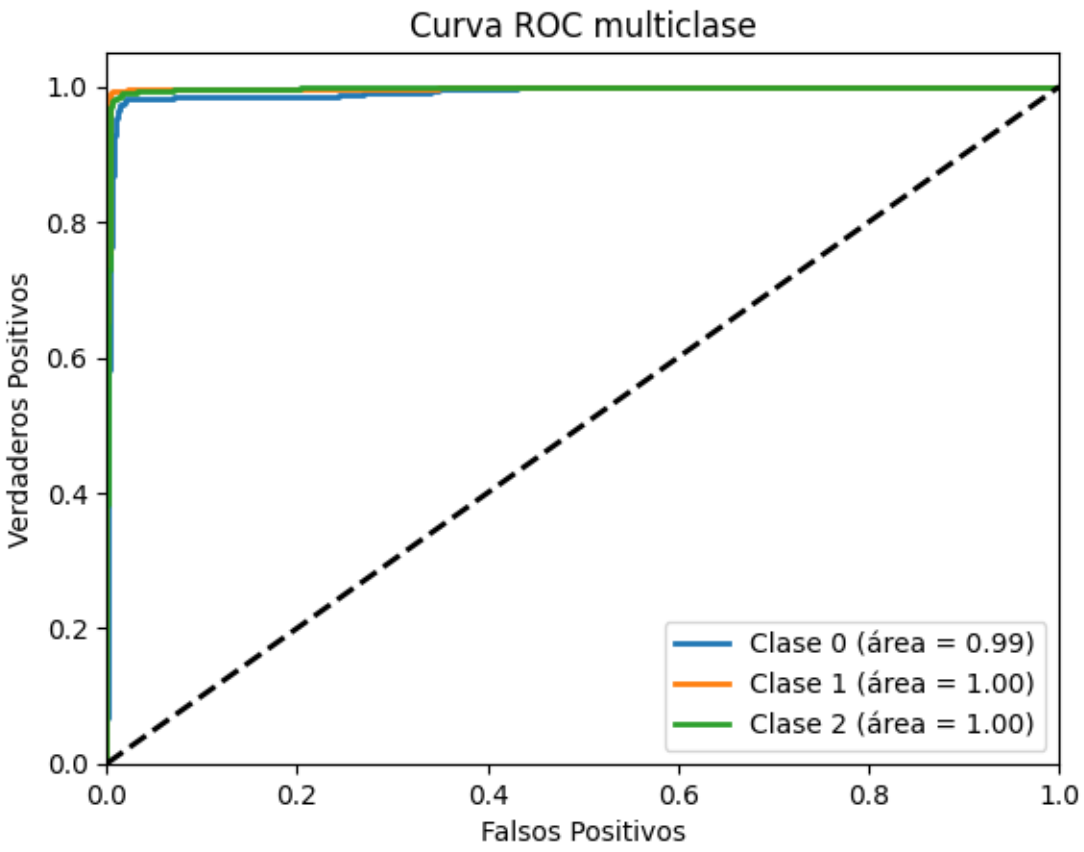


[26]:
```
from sklearn.metrics import classification_report
print(classification_report(y_test_class, predictions, target_names=['Empate',␣
 ↪'Victoria Local', 'Victoria Visitante']))
```

```
                   precision    recall  f1-score   support

           Empate       0.96      0.97      0.97       685
    Victoria Local       0.99      0.99      0.99      1167
Victoria Visitante       0.98      0.98      0.98       777

         accuracy                           0.98      2629
        macro avg       0.98      0.98      0.98      2629
     weighted avg       0.98      0.98      0.98      2629
```

[27]:
```
from sklearn.metrics import roc_curve, auc
from sklearn.preprocessing import label_binarize
import matplotlib.pyplot as plt

y_test_binarized = label_binarize(y_test_class, classes=[0, 1, 2])
n_classes = y_test_binarized.shape[1]

y_pred = model.predict(x_test)

for i in range(n_classes):
    fpr, tpr, thresholds = roc_curve(y_test_binarized[:, i], y_pred[:, i])
    roc_auc = auc(fpr, tpr)
    plt.plot(fpr, tpr, lw=2, label='Clase {0} (área = {1:0.2f})'.format(i,␣
 ↪roc_auc))

plt.plot([0, 1], [0, 1], 'k--', lw=2)
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('Falsos Positivos')
plt.ylabel('Verdaderos Positivos')
plt.title('Curva ROC multiclase')
plt.legend(loc="lower right")
plt.show()
```

```
83/83 [==============================] - 0s 859us/step
```



The model's exceptional performance raises concerns about the integrity of the data, warranting a thorough validation to ensure its reliability.

[ ]: