Model-2

Use the same model as above but for 'input_seq_total_text_data' give only some words in the sentance not all the words. Filter the words as below.

```
1. Fit TF-IDF vectorizer on the Train data

2. Get the idf value for each word we have in the train data. Please go through this


3. Do some analysis on the Idf values and based on those values choose the low and high
threshold value. Because very
frequent words and very very rare words don't give much information.
Hint - A preferable IDF range is 2-11 for model 2.

4.Remove the low idf value and high idf value words from the train and test data. You can go
through each of the
sentence of train and test data and include only those features(words) which are present in
the defined IDF range.
5. Perform tokenization on the modified text data same as you have done for previous model.
6. Create embedding matrix for model 2 and then use the rest of the features similar to
previous model.
7. Define the model, compile and fit the model.
```

In [ ]:

In [1]:

```
import tensorflow
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input
from tensorflow.keras.layers import LSTM
from tensorflow.keras.layers import Embedding
from tensorflow.keras import regularizers
from tensorflow.keras.regularizers import l2
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Dense, Input , Dropout
from tensorflow.keras.layers import concatenate
from tensorflow.keras.layers import BatchNormalization
from tensorflow.keras.callbacks import TensorBoard
import tensorflow as tf
from sklearn.metrics import roc_auc_score
from tensorflow.keras.metrics import AUC

from sklearn import preprocessing
import numpy as np
from sklearn.preprocessing import OrdinalEncoder
import numpy as np
from scipy.sparse import coo_matrix, hstack
from scipy.sparse import csr_matrix
from numpy import asarray
from numpy import zeros


from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Flatten
from keras.layers import Embedding
from tqdm import tqdm
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from sklearn.model_selection import train_test_split
from keras.utils import np_utils
import matplotlib.pyplot as plt
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
import seaborn as sns
import pandas as pd
import warnings
warnings.filterwarnings("ignore")
tf.keras.backend.clear_session()
```

In [2]:

```
#read the csv file

p1 = '/content/drive/MyDrive/AAIC/Assignments/LSTM on Donors Choose/preprocessed_data_final.csv'
p2 = "C:/Users/darsh/Downloads/Srujan/Donars Choose Assignment/preprocessed_data_final.csv"
df_2 = pd.read_csv(p2)
```

In [3]:

```
text_input = ['essay','project_title','project_resource_summary',]
```

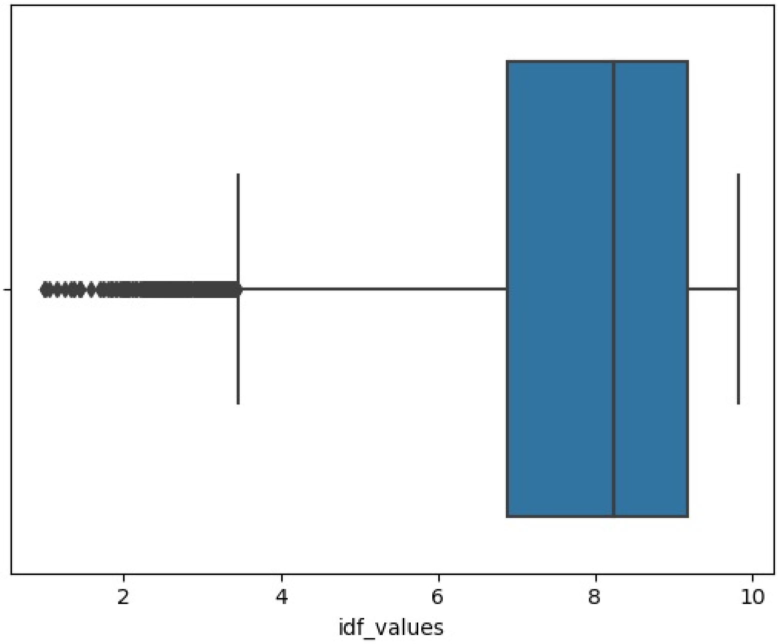
In [3]:
```
text_input = ['essay','project_title','project_resource_summary',]
df_2['total_text_input'] = df_2['essay'] + ' ' + df_2['project_title'] + ' ' + df_2['project_resource_summary']
```

In [4]:
```
corpus = df_2['total_text_input']
vectorizer = TfidfVectorizer(min_df=15)
X = vectorizer.fit_transform(corpus)
idf = vectorizer.idf_
idf_values = (dict(zip(vectorizer.get_feature_names_out(), idf)))
```

In [5]:
```
word_features = pd.DataFrame(idf_values.items(),columns=['word_features','idf_values']).sort_values(['idf_value
```

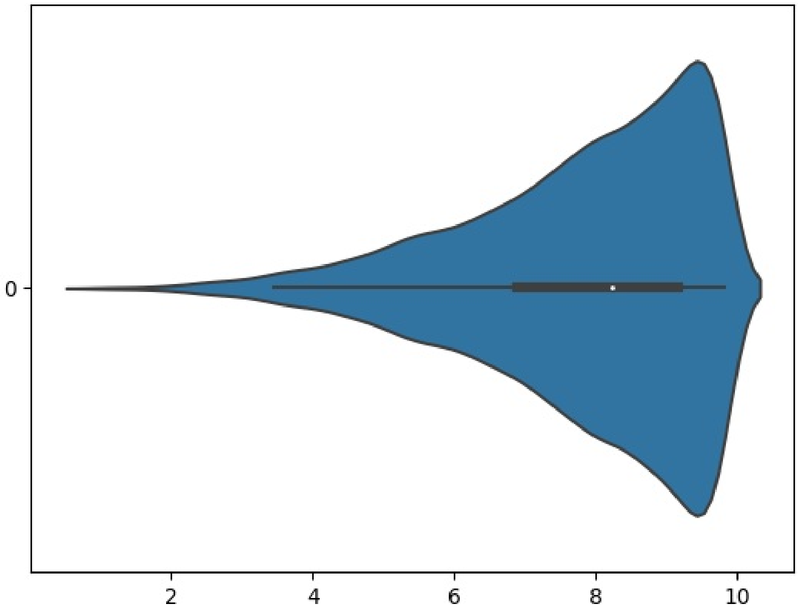
In [6]:
```
sns.boxplot(x=word_features['idf_values'],)
```

Out[6]:
```
<AxesSubplot: xlabel='idf_values'>
```



In [7]:
```
sns.violinplot(word_features['idf_values'],orient='h')
```

Out[7]:
```
<AxesSubplot: >
```



In [8]:
```
percentiles = np.percentile(word_features['idf_values'],np.arange(0,100))[[0,25,75,90]]
percentiles
```

Out[8]:
```
array([1.        , 6.88025485, 9.16739776, 9.60565269])
```

In [9]:
```
word_features = word_features[(word_features.idf_values >= percentiles[1]) & (word_features.idf_values <= percen
```

In [10]:
```
feats = list(word_features['word_features'].values)
```

In [11]:
```
dummy_words = set(vectorizer.get_feature_names()).difference(set(feats))
```

In [12]:
```
final_text = dict()
```

```
df_2['text_data_for_model_2'] = ""
for indx in tqdm(df_2['total_text_input'].index):
    temp_list = list()
    for j in df_2['total_text_input'][indx].split():
        if j not in dummy_words:
            temp_list.append(j)
    final_text[indx] = " ".join(temp_list)
    df_2['text_data_for_model_2'].loc[indx] = " ".join(temp_list)
```

```
100%|█████████████████████████████████████████████████████████████████████████████████████████████████████████
██| 109248/109248 [00:22<00:00, 4912.87it/s]
```

In [13]:

```
df_2[pd.isnull(df_2).any(axis=1)]
```

Out[13]:

teacher_number_of_previously_posted_projects	resource_summary_contains_numerical_digits	price	quantity	school_state	project_grade_cat

In [ ]:

In [14]:

```
y = df_2['project_is_approved'].values
df_2.drop(['project_is_approved'],axis=1,inplace=True)
X_train, X_test, y_train, y_test = train_test_split(df_2, y,
                                                    stratify=y,
                                                    test_size=0.10,
                                                   )
```

In [ ]:

In [ ]:

In [15]:

```
num_words = 1000
oov_token = '<UNK>'
pad_type = 'post'
trunc_type = 'post'

# Tokenize our training data
tokenizer = Tokenizer(num_words=num_words, oov_token=oov_token)
tokenizer.fit_on_texts(X_train['text_data_for_model_2'])

# Get our training data word index
word_index = tokenizer.word_index

# Encode training data sentences into sequences
train_sequences = tokenizer.texts_to_sequences(X_train['text_data_for_model_2'])
test_sequences = tokenizer.texts_to_sequences(X_test['text_data_for_model_2'])

# Get max training sequence length
maxlen = max([len(x) for x in train_sequences])

# Pad the training sequences
train_padded = pad_sequences(train_sequences, padding=pad_type, truncating=trunc_type, maxlen=maxlen)
test_padded = pad_sequences(test_sequences, padding=pad_type, truncating=trunc_type, maxlen=maxlen)
```

In [16]:

```
maxlen
```

Out[16]:

```
122
```

In [17]:

```
# Output the results of our work
#print("Word index:\n", word_index)
#print("\nTraining sequences:\n", train_sequences)
#print("\nPadded training sequences:\n", train_padded)
print("\nPadded training shape, Test Shape:", train_padded.shape,test_padded.shape)
print("Training sequences data type:", type(train_sequences),type(test_sequences))
print("Padded Training sequences data type:", type(train_padded),type(test_padded))
```

```
Padded training shape, Test Shape: (98323, 122) (10925, 122)
Training sequences data type: <class 'list'> <class 'list'>
Padded Training sequences data type: <class 'numpy.ndarray'> <class 'numpy.ndarray'>
```

In [18]:

```
from tqdm import tqdm

# load the whole embedding into memory
embeddings_index = dict()
p1 = '/content/drive/MyDrive/AAIC/Assignments/LSTM on Donors Choose/glove.6B.300d.txt'
p2 = "C:/Users/darsh/Downloads/Srujan/Donars Choose Assignment/glove.6B.300d.txt"
f = open(p2,encoding="utf8")
for line in tqdm(f):
    values = line.split()
    word = values[0]
    coefs = asarray(values[1:], dtype='float32')
    embeddings_index[word] = coefs
f.close()
```

```
print('\nLoaded %s word vectors.' % len(embeddings_index))
```

```
400000it [00:21, 18381.50it/s]
Loaded 400000 word vectors.
```

In [19]:

```
vocab_size = len(tokenizer.word_index) + 1
```

In [20]:

```
# create a weight matrix for words in training docs
embedding_matrix = zeros((vocab_size, 300))
for word, i in tokenizer.word_index.items():
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

Categorical feature Vectorization

In [21]:

```
enc = OrdinalEncoder(handle_unknown='use_encoded_value',unknown_value=np.nan)
```

In [22]:

```
school_state_enc = (enc.fit_transform(np.array(X_train['school_state']).reshape(-1,1)))
teacher_prefix_enc = (enc.fit_transform(np.array(X_train['teacher_prefix']).reshape(-1,1)))
project_grade_category_enc = (enc.fit_transform(np.array(X_train['project_grade_category']).reshape(-1,1)))
clean_categories_enc = (enc.fit_transform(np.array(X_train['clean_categories']).reshape(-1,1)))
clean_subcategories_enc = (enc.fit_transform(np.array(X_train['clean_subcategories']).reshape(-1,1)))
```

In [23]:

```
school_state_enc_test = (enc.transform(np.array(X_test['school_state']).reshape(-1,1)))
teacher_prefix_enc_test = (enc.transform(np.array(X_test['teacher_prefix']).reshape(-1,1)))
project_grade_category_enc_test = (enc.transform(np.array(X_test['project_grade_category']).reshape(-1,1)))
clean_categories_enc_test = (enc.transform(np.array(X_test['clean_categories']).reshape(-1,1)))
clean_subcategories_enc_test = (enc.transform(np.array(X_test['clean_subcategories']).reshape(-1,1)))
```

In [ ]:

Numerical Feature Vectorization

In [24]:

```
numerical_input = ['teacher_number_of_previously_posted_projects',
                   'resource_summary_contains_numerical_digits',
                   'price','quantity'
                  ]

scaler  = preprocessing.StandardScaler().fit(X_train[numerical_input])
std_data_train = np.array(pd.DataFrame(scaler.transform(X_train[numerical_input]),columns=numerical_input))
std_data_test = np.array(pd.DataFrame(scaler.transform(X_test[numerical_input]),columns=numerical_input))
```

In [ ]:

defining the model

In [25]:

```
elements_in_school_state = (len(set(pd.DataFrame(school_state_enc)[0])))
elements_in_teacher_prefix = (len(set(pd.DataFrame(teacher_prefix_enc)[0])))
elements_in_project_grade_category = (len(set(pd.DataFrame(project_grade_category_enc)[0])))
elements_in_clean_categories = (len(set(pd.DataFrame(clean_categories_enc)[0])))
elements_in_clean_subcategories = (len(set(pd.DataFrame(clean_subcategories_enc)[0])))
```

In [ ]:

In [26]:

```
input_seq_total_text_data = Input(shape=(maxlen,),name='input_seq_total_text_data_')
emb_text_data = Embedding(input_dim=vocab_size,output_dim=300,
                          weights=[embedding_matrix], input_length=maxlen,trainable=False,
                          name='emb_text_data')(input_seq_total_text_data)
lstm = LSTM(units=25,activation='tanh',return_sequences=True)(emb_text_data)
flatten_text = Flatten()(lstm)

input_school_state = Input(shape=1,name='input_school_state')
input_school_state_emb = Embedding(input_dim=elements_in_school_state,
                                   output_dim=int(min(elements_in_school_state / 2, 50)),
                                   input_length=1,
                                  name='input_school_state_emb')(input_school_state)
flatten_school_state = Flatten()(input_school_state_emb)


input_grade_category = Input(shape=1,name='input_grade_category')
input_grade_category_emb = Embedding(input_dim=elements_in_project_grade_category,
                                   output_dim=int(min(elements_in_project_grade_category / 2, 50)),
                                   input_length=1,
                                  name='input_grade_category_emb')(input_grade_category)
flatten_grade_category = Flatten()(input_grade_category_emb)


input_clean_categories = Input(shape=1,name='input_clean_categories')
input_clean_categories_emb = Embedding(input_dim=elements_in_clean_categories,
                                      output_dim=int(min(elements_in_clean_categories / 2, 50)),
                                      input_length=1,
                                      name='input_clean_categories_emb')(input_clean_categories)
flatten_clean_categories = Flatten()(input_clean_categories_emb)



input_clean_sub_categories = Input(shape=1,name='input_clean_sub_categories')
input_clean_sub_categories_emb = Embedding(input_dim=elements_in_clean_subcategories,
                                      output_dim=int(min(elements_in_clean_subcategories / 2, 50)),
                                      input_length=1,
                                      name='input_clean_sub_categories_emb')(input_clean_sub_categories)
flatten_clean_sub_categories = Flatten()(input_clean_sub_categories_emb)


input_teacher_prefix = Input(shape=1,name='input_teacher_prefix')
input_teacher_prefix_emb = Embedding(input_dim=elements_in_teacher_prefix,
                                      output_dim=int(min(elements_in_teacher_prefix / 2, 50)),
                                      input_length=1,
                                      name='input_teacher_prefix_emb')(input_teacher_prefix)
flatten_teacher_prefix = Flatten()(input_teacher_prefix_emb)



input_remaining = Input(shape=4,name='input_remaining')
input_remaining_dense = Dense(units=128,activation='relu',
                               kernel_initializer='he_normal',kernel_regularizer=l2(0.00001),
                              name='input_remaining_dense')(input_remaining)
flatten_remaining = Flatten()(input_remaining_dense)

concat_layer = concatenate([flatten_text,flatten_school_state,flatten_grade_category,
                            flatten_clean_categories,flatten_clean_sub_categories,
                            flatten_teacher_prefix,flatten_remaining],)

dense_layer1_after_concat = Dense(units=128,activation='relu',
                                  kernel_initializer='he_normal',kernel_regularizer=l2(0.00001),
                                  name='dense_layer1_after_concat')(concat_layer)
drop1 = Dropout(0.5)(dense_layer1_after_concat)

dense_layer2_after_concat = Dense(units=128,activation='relu',
                                  kernel_initializer='he_normal',kernel_regularizer=l2(0.00001),
                                  name='dense_layer2_after_concat')(drop1)
drop2 = Dropout(0.5)(dense_layer2_after_concat)

bn1 = BatchNormalization()(drop2)

dense_layer3_after_concat = Dense(units=128,activation='relu',
                                  kernel_initializer='he_normal',kernel_regularizer=l2(0.00001),
                                  name='dense_layer3_after_concat')(bn1)
drop3 = Dropout(0.5)(dense_layer3_after_concat)

dense_layer4_after_concat = Dense(units=128,activation='relu',
                                  kernel_initializer='he_normal',kernel_regularizer=l2(0.00001),
                                  name='dense_layer4_after_concat')(drop3)
drop4 = Dropout(0.5)(dense_layer4_after_concat)

output = Dense(units=2,activation='softmax')(drop4)
```

In [27]:

```
m2 = Model(inputs=[input_seq_total_text_data,
                   input_school_state,
                   input_grade_category,
                   input_clean_categories,
                   input_clean_sub_categories,
                   input_teacher_prefix,
                   input_remaining],
           outputs=[output])
```

In [28]:

```
m2.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_seq_total_text_data_ (Inp [(None, 122)]        0
__________________________________________________________________________________________________
emb_text_data (Embedding)       (None, 122, 300)     17916300    input_seq_total_text_data_[0][0]
__________________________________________________________________________________________________
input_school_state (InputLayer) [(None, 1)]          0
__________________________________________________________________________________________________
input_grade_category (InputLaye [(None, 1)]          0
__________________________________________________________________________________________________
input_clean_categories (InputLa [(None, 1)]          0
__________________________________________________________________________________________________
input_clean_sub_categories (Inp [(None, 1)]          0
__________________________________________________________________________________________________
input_teacher_prefix (InputLaye [(None, 1)]          0
__________________________________________________________________________________________________
input_remaining (InputLayer)    [(None, 4)]          0
__________________________________________________________________________________________________
lstm (LSTM)                     (None, 122, 25)      32600       emb_text_data[0][0]
__________________________________________________________________________________________________
input_school_state_emb (Embeddi (None, 1, 25)        1275        input_school_state[0][0]
__________________________________________________________________________________________________
input_grade_category_emb (Embed (None, 1, 2)         8           input_grade_category[0][0]
__________________________________________________________________________________________________
input_clean_categories_emb (Emb (None, 1, 25)        1275        input_clean_categories[0][0]
__________________________________________________________________________________________________
input_clean_sub_categories_emb  (None, 1, 50)        20000       input_clean_sub_categories[0][0]
__________________________________________________________________________________________________
input_teacher_prefix_emb (Embed (None, 1, 2)         10          input_teacher_prefix[0][0]
__________________________________________________________________________________________________
input_remaining_dense (Dense)   (None, 128)          640         input_remaining[0][0]
__________________________________________________________________________________________________
flatten (Flatten)               (None, 3050)         0           lstm[0][0]
__________________________________________________________________________________________________
flatten_1 (Flatten)             (None, 25)           0           input_school_state_emb[0][0]
__________________________________________________________________________________________________
flatten_2 (Flatten)             (None, 2)            0           input_grade_category_emb[0][0]
__________________________________________________________________________________________________
flatten_3 (Flatten)             (None, 25)           0           input_clean_categories_emb[0][0]
__________________________________________________________________________________________________
flatten_4 (Flatten)             (None, 50)           0           input_clean_sub_categories_emb[0]
__________________________________________________________________________________________________
flatten_5 (Flatten)             (None, 2)            0           input_teacher_prefix_emb[0][0]
__________________________________________________________________________________________________
flatten_6 (Flatten)             (None, 128)          0           input_remaining_dense[0][0]
__________________________________________________________________________________________________
concatenate (Concatenate)       (None, 3282)         0           flatten[0][0]
                                                                 flatten_1[0][0]
                                                                 flatten_2[0][0]
                                                                 flatten_3[0][0]
                                                                 flatten_4[0][0]
                                                                 flatten_5[0][0]
                                                                 flatten_6[0][0]
__________________________________________________________________________________________________
dense_layer1_after_concat (Dens (None, 128)          420224      concatenate[0][0]
__________________________________________________________________________________________________
dropout (Dropout)               (None, 128)          0           dense_layer1_after_concat[0][0]
__________________________________________________________________________________________________
dense_layer2_after_concat (Dens (None, 128)          16512       dropout[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)             (None, 128)          0           dense_layer2_after_concat[0][0]
__________________________________________________________________________________________________
batch_normalization (BatchNorma (None, 128)          512         dropout_1[0][0]
__________________________________________________________________________________________________
dense_layer3_after_concat (Dens (None, 128)          16512       batch_normalization[0][0]
__________________________________________________________________________________________________
dropout_2 (Dropout)             (None, 128)          0           dense_layer3_after_concat[0][0]
__________________________________________________________________________________________________
dense_layer4_after_concat (Dens (None, 128)          16512       dropout_2[0][0]
__________________________________________________________________________________________________
dropout_3 (Dropout)             (None, 128)          0           dense_layer4_after_concat[0][0]
__________________________________________________________________________________________________
dense (Dense)                   (None, 2)            258         dropout_3[0][0]
==================================================================================================
Total params: 18,442,638
Trainable params: 526,082
Non-trainable params: 17,916,556
__________________________________________________________________________________________________
```

In [ ]:

In [29]:

```
test_data = [test_padded,school_state_enc_test,project_grade_category_enc_test,
```

In [29]:
```
test_data = [test_padded,school_state_enc_test,project_grade_category_enc_test,
            clean_categories_enc_test,clean_subcategories_enc_test,teacher_prefix_enc_test,(std_data_test)]

train_data = [train_padded,school_state_enc,project_grade_category_enc,
              clean_categories_enc,clean_subcategories_enc,teacher_prefix_enc,(std_data_train)]

y_train_enc =  tensorflow.keras.utils.to_categorical(y_train, 2)
y_test_enc =  tensorflow.keras.utils.to_categorical(y_test, 2)
```

In [30]:
```
def auc1(y_true, y_pred):
    if len(np.unique(y_true[:,1])) == 1:
        return 0.5
    else:
        return roc_auc_score( y_true, y_pred, average='macro', sample_weight=None).astype('double')

def auroc(y_true, y_pred):
    return tensorflow.numpy_function(auc1, (y_true, y_pred), tensorflow.double)

callbacks = [
    tf.keras.callbacks.ModelCheckpoint('./LSTM_Model_2.h5', save_weights_only=False,save_best_only=True, \
                                       mode='max', monitor='val_auroc',verbose=1),
    tf.keras.callbacks.ReduceLROnPlateau(monitor='val_auroc', patience=2,mode='max',verbose=1,min_lr=0.00001),
]
```

In [31]:
```
m2.compile(optimizer='adam', loss='categorical_crossentropy', metrics=[auroc])
```

In [32]:
```
m2.fit(train_data,y_train_enc,
       validation_data=(test_data,y_test_enc),
       batch_size=128,
       epochs=50,
       callbacks=callbacks,
       verbose=1)
```

```
Epoch 1/50
769/769 [==============================] - 22s 20ms/step - loss: 0.4851 - auroc: 0.5610 - val_loss: 0.4843 - va
l_auroc: 0.6053

Epoch 00001: val_auroc improved from -inf to 0.60534, saving model to .\LSTM_Model_2.h5
Epoch 2/50
769/769 [==============================] - 14s 18ms/step - loss: 0.4279 - auroc: 0.6325 - val_loss: 0.4552 - va
l_auroc: 0.6596

Epoch 00002: val_auroc improved from 0.60534 to 0.65958, saving model to .\LSTM_Model_2.h5
Epoch 3/50
769/769 [==============================] - 14s 18ms/step - loss: 0.4187 - auroc: 0.6636 - val_loss: 0.4376 - va
l_auroc: 0.6794

Epoch 00003: val_auroc improved from 0.65958 to 0.67940, saving model to .\LSTM_Model_2.h5
Epoch 4/50
769/769 [==============================] - 14s 18ms/step - loss: 0.4131 - auroc: 0.6794 - val_loss: 0.4381 - va
l_auroc: 0.6842

Epoch 00004: val_auroc improved from 0.67940 to 0.68418, saving model to .\LSTM_Model_2.h5
Epoch 5/50
769/769 [==============================] - 14s 18ms/step - loss: 0.4088 - auroc: 0.6905 - val_loss: 0.4281 - va
l_auroc: 0.6836

Epoch 00005: val_auroc did not improve from 0.68418
Epoch 6/50
769/769 [==============================] - 14s 18ms/step - loss: 0.4061 - auroc: 0.6964 - val_loss: 0.4190 - va
l_auroc: 0.6911

Epoch 00006: val_auroc improved from 0.68418 to 0.69108, saving model to .\LSTM_Model_2.h5
Epoch 7/50
769/769 [==============================] - 14s 18ms/step - loss: 0.4019 - auroc: 0.7081 - val_loss: 0.4163 - va
l_auroc: 0.6939

Epoch 00007: val_auroc improved from 0.69108 to 0.69386, saving model to .\LSTM_Model_2.h5
Epoch 8/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3997 - auroc: 0.7129 - val_loss: 0.4149 - va
l_auroc: 0.6935

Epoch 00008: val_auroc did not improve from 0.69386
Epoch 9/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3967 - auroc: 0.7223 - val_loss: 0.4196 - va
l_auroc: 0.6903

Epoch 00009: val_auroc did not improve from 0.69386

Epoch 00009: ReduceLROnPlateau reducing learning rate to 0.00010000000474974513.
Epoch 10/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3882 - auroc: 0.7403 - val_loss: 0.4130 - va
l_auroc: 0.6881
```

```
Epoch 00010: val_auroc did not improve from 0.69386
Epoch 11/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3846 - auroc: 0.7481 - val_loss: 0.4135 - va
l_auroc: 0.6854

Epoch 00011: val_auroc did not improve from 0.69386

Epoch 00011: ReduceLROnPlateau reducing learning rate to 1.0000000474974514e-05.
Epoch 12/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3822 - auroc: 0.7530 - val_loss: 0.4131 - va
l_auroc: 0.6850

Epoch 00012: val_auroc did not improve from 0.69386
Epoch 13/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3824 - auroc: 0.7516 - val_loss: 0.4129 - va
l_auroc: 0.6847

Epoch 00013: val_auroc did not improve from 0.69386

Epoch 00013: ReduceLROnPlateau reducing learning rate to 1e-05.
Epoch 14/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3821 - auroc: 0.7536 - val_loss: 0.4129 - va
l_auroc: 0.6843

Epoch 00014: val_auroc did not improve from 0.69386
Epoch 15/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3809 - auroc: 0.7557 - val_loss: 0.4127 - va
l_auroc: 0.6840

Epoch 00015: val_auroc did not improve from 0.69386
Epoch 16/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3811 - auroc: 0.7562 - val_loss: 0.4127 - va
l_auroc: 0.6839

Epoch 00016: val_auroc did not improve from 0.69386
Epoch 17/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3815 - auroc: 0.7546 - val_loss: 0.4126 - va
l_auroc: 0.6834

Epoch 00017: val_auroc did not improve from 0.69386
Epoch 18/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3806 - auroc: 0.7571 - val_loss: 0.4126 - va
l_auroc: 0.6834

Epoch 00018: val_auroc did not improve from 0.69386
Epoch 19/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3800 - auroc: 0.7575 - val_loss: 0.4126 - va
l_auroc: 0.6832

Epoch 00019: val_auroc did not improve from 0.69386
Epoch 20/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3805 - auroc: 0.7569 - val_loss: 0.4128 - va
l_auroc: 0.6828

Epoch 00020: val_auroc did not improve from 0.69386
Epoch 21/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3793 - auroc: 0.7584 - val_loss: 0.4127 - va
l_auroc: 0.6832

Epoch 00021: val_auroc did not improve from 0.69386
Epoch 22/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3791 - auroc: 0.7592 - val_loss: 0.4129 - va
l_auroc: 0.6828

Epoch 00022: val_auroc did not improve from 0.69386
Epoch 23/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3800 - auroc: 0.7578 - val_loss: 0.4128 - va
l_auroc: 0.6827

Epoch 00023: val_auroc did not improve from 0.69386
Epoch 24/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3792 - auroc: 0.7588 - val_loss: 0.4126 - va
l_auroc: 0.6826

Epoch 00024: val_auroc did not improve from 0.69386
Epoch 25/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3789 - auroc: 0.7589 - val_loss: 0.4125 - va
l_auroc: 0.6823

Epoch 00025: val_auroc did not improve from 0.69386
Epoch 26/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3782 - auroc: 0.7594 - val_loss: 0.4124 - va
l_auroc: 0.6825
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Epoch 00026: val_auroc did not improve from 0.69386
Epoch 27/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3794 - auroc: 0.7582 - val_loss: 0.4127 - va
l_auroc: 0.6819

Epoch 00027: val_auroc did not improve from 0.69386
Epoch 28/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3785 - auroc: 0.7599 - val_loss: 0.4126 - va
l_auroc: 0.6820

Epoch 00028: val_auroc did not improve from 0.69386
Epoch 29/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3782 - auroc: 0.7606 - val_loss: 0.4125 - va
l_auroc: 0.6820

Epoch 00029: val_auroc did not improve from 0.69386
Epoch 30/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3772 - auroc: 0.7635 - val_loss: 0.4123 - va
l_auroc: 0.6820

Epoch 00030: val_auroc did not improve from 0.69386
Epoch 31/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3782 - auroc: 0.7597 - val_loss: 0.4120 - va
l_auroc: 0.6816

Epoch 00031: val_auroc did not improve from 0.69386
Epoch 32/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3787 - auroc: 0.7591 - val_loss: 0.4127 - va
l_auroc: 0.6813

Epoch 00032: val_auroc did not improve from 0.69386
Epoch 33/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3776 - auroc: 0.7613 - val_loss: 0.4124 - va
l_auroc: 0.6812

Epoch 00033: val_auroc did not improve from 0.69386
Epoch 34/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3786 - auroc: 0.7592 - val_loss: 0.4125 - va
l_auroc: 0.6813

Epoch 00034: val_auroc did not improve from 0.69386
Epoch 35/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3777 - auroc: 0.7611 - val_loss: 0.4123 - va
l_auroc: 0.6812

Epoch 00035: val_auroc did not improve from 0.69386
Epoch 36/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3759 - auroc: 0.7639 - val_loss: 0.4125 - va
l_auroc: 0.6808

Epoch 00036: val_auroc did not improve from 0.69386
Epoch 37/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3758 - auroc: 0.7645 - val_loss: 0.4125 - va
l_auroc: 0.6806

Epoch 00037: val_auroc did not improve from 0.69386
Epoch 38/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3767 - auroc: 0.7630 - val_loss: 0.4123 - va
l_auroc: 0.6807

Epoch 00038: val_auroc did not improve from 0.69386
Epoch 39/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3766 - auroc: 0.7618 - val_loss: 0.4124 - va
l_auroc: 0.6804

Epoch 00039: val_auroc did not improve from 0.69386
Epoch 40/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3762 - auroc: 0.7640 - val_loss: 0.4125 - va
l_auroc: 0.6805

Epoch 00040: val_auroc did not improve from 0.69386
Epoch 41/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3760 - auroc: 0.7649 - val_loss: 0.4122 - va
l_auroc: 0.6800

Epoch 00041: val_auroc did not improve from 0.69386
Epoch 42/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3760 - auroc: 0.7656 - val_loss: 0.4123 - va
l_auroc: 0.6800

Epoch 00042: val_auroc did not improve from 0.69386
Epoch 43/50
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769/769 [==============================] - 14s 18ms/step - loss: 0.3757 - auroc: 0.7649 - val_loss: 0.4121 - va
l_auroc: 0.6800

Epoch 00043: val_auroc did not improve from 0.69386
Epoch 44/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3756 - auroc: 0.7652 - val_loss: 0.4123 - va
l_auroc: 0.6797

Epoch 00044: val_auroc did not improve from 0.69386
Epoch 45/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3749 - auroc: 0.7668 - val_loss: 0.4121 - va
l_auroc: 0.6796

Epoch 00045: val_auroc did not improve from 0.69386
Epoch 46/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3753 - auroc: 0.7661 - val_loss: 0.4121 - va
l_auroc: 0.6794

Epoch 00046: val_auroc did not improve from 0.69386
Epoch 47/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3751 - auroc: 0.7663 - val_loss: 0.4122 - va
l_auroc: 0.6794

Epoch 00047: val_auroc did not improve from 0.69386
Epoch 48/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3753 - auroc: 0.7653 - val_loss: 0.4122 - va
l_auroc: 0.6795

Epoch 00048: val_auroc did not improve from 0.69386
Epoch 49/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3748 - auroc: 0.7664 - val_loss: 0.4125 - va
l_auroc: 0.6795

Epoch 00049: val_auroc did not improve from 0.69386
Epoch 50/50
769/769 [==============================] - 14s 18ms/step - loss: 0.3752 - auroc: 0.7647 - val_loss: 0.4124 - va
l_auroc: 0.6793

Epoch 00050: val_auroc did not improve from 0.69386
```

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Out[32]: <keras.callbacks.History at 0x24fb3dd5ca0>
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