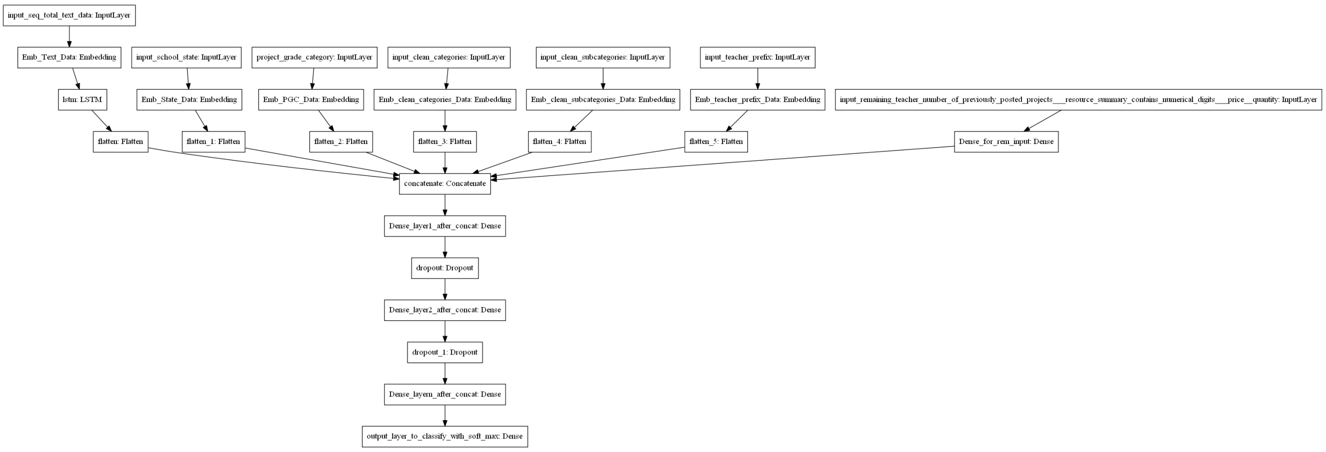

input_seq_total_text_data: InputLayer
Emb_Text_Data: Embedding
input_school_state: InputLayer
project_grade_category: InputLayer
input_clean_categories: InputLayer
input_clean_subcategories: InputLayer
input_teacher_prefix: InputLayer
lstm: LSTM
Emb_State_Data: Embedding
Emb_PGC_Data: Embedding
Emb_clean_categories_Data: Embedding
Emb_clean_subcategories_Data: Embedding
Emb_teacher_prefix_Data: Embedding
input_remaining_teacher_number_of_previously_posted_projects___resource_summary_contains_numerical_digits___price__quantity: InputLayer
flatten: Flatten
flatten_1: Flatten
flatten_2: Flatten
flatten_3: Flatten
flatten_4: Flatten
flatten_5: Flatten
Dense_for_rem_input: Dense
concatenate: Concatenate
Dense_layer1_after_concat: Dense
dropout: Dropout
Dense_layer2_after_concat: Dense
dropout_1: Dropout
Dense_layern_after_concat: Dense
output_layer_to_classify_with_soft_max: Dense

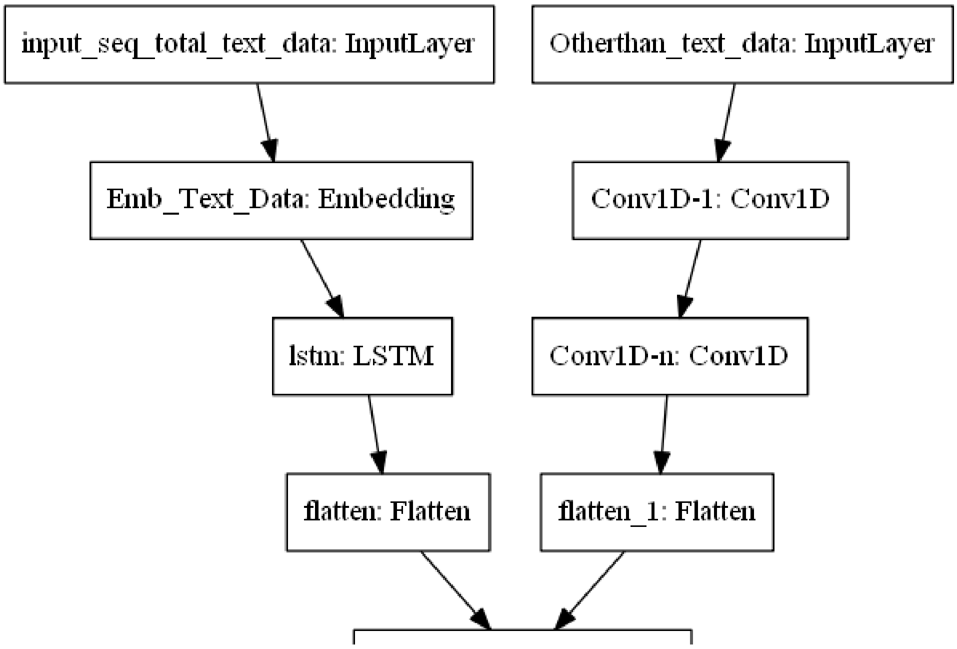
ref: https://i.imgur.com/w395Yk9.png

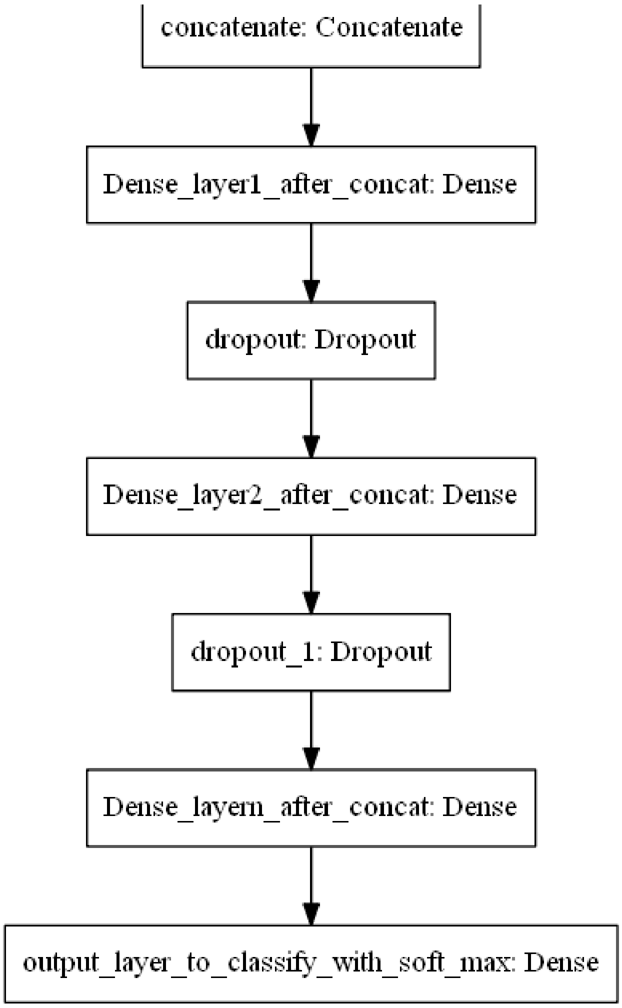
- **Input_seq_total_text_data** --- You have to give Total text data columns. After this use the Embedding layer to get word vectors. Use given predefined glove word vectors, don't train any word vectors. After this use LSTM and get the LSTM output and Flatten that output.
- **Input_school_state** --- Give 'school_state' column as input to embedding layer and Train the Keras Embedding layer.
- **Project_grade_category** --- Give 'project_grade_category' column as input to embedding layer and Train the Keras Embedding layer.
- **Input_clean_categories** --- Give 'input_clean_categories' column as input to embedding layer and Train the Keras Embedding layer.
- **Input_clean_subcategories** --- Give 'input_clean_subcategories' column as input to embedding layer and Train the Keras Embedding layer.
- **Input_clean_subcategories** --- Give 'input_teacher_prefix' column as input to embedding layer and Train the Keras Embedding layer.
- **Input_remaining_teacher_number_of_previously_posted_projects._resource_summary_contains_numerical_digits._price** ---concatenate remaining columns and add a Dense layer after that.

Model-2

```
1.LSTM after removing the Low and High idf value words. (In model-1 Trained on total data b
ut in Model-2 trained on data after removing some words based on IDF values)
```

Model-3




concatenate: Concatenate
Dense_layer1_after_concat: Dense
dropout: Dropout
Dense_layer2_after_concat: Dense
dropout_1: Dropout
Dense_layern_after_concat: Dense
output_layer_to_classify_with_soft_max: Dense

In [1]:

```
##importing all required modules
import numpy as np
import pandas as pd
import sklearn
import seaborn as sns
import matplotlib.pyplot as plt
from time import time
import tensorflow as tf
from tensorflow.keras.layers import Dense,Conv1D,
MaxPooling1D,concatenate,BatchNormalization,Activation,Dropout,Input,Flatten,Embedding,LSTM
from tensorflow.keras.models import Model
from tensorflow.keras.callbacks import TensorBoard
from tensorflow.keras.preprocessing.text import one_hot
from tensorflow.keras.preprocessing.sequence import pad_sequences
```

In [2]:

```
final = pd.read_csv("lstm_preprocessed_data.csv")
final.shape
```

Out[2]:

```
(109248, 9)
```

In [3]:

```
"""final_neg = final[final["project_is_approved"] == 0]
final_pos = final[final["project_is_approved"] == 1]

lst_ran = []
for i in range(10000):
    lst_ran.append(final_neg.iloc[i])
    lst_ran.append(final_pos.iloc[-i])
```

```
project_data = pd.DataFrame(lst_ran)
project_data.shape"""
project_data = final
```

In [4]:

```
project_data.head(2)
```

Out[4]:

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previously_posted_projects	project_is_approved	clean_cate
0	ca	mrs	grades_prek_2	53	1	math_s
1	ut	ms	grades_3_5	4	1	special

In [5]:

```
from sklearn.model_selection import train_test_split

project_data_train, project_data_test, y_train, y_test = train_test_split(project_data, project_dat
a["project_is_approved"], test_size=0.2, stratify=project_data["project_is_approved"],
random_state = 0)

print("Number of data points in train data", project_data_train.shape)
print('-'*50)
print("Number of data points in test data", project_data_test.shape)
print('-'*50)
```

```
Number of data points in train data (87398, 9)
--------------------------------------------------
Number of data points in test data (21850, 9)
--------------------------------------------------
```

One Hot Encoding

Categorical Features

In [6]:

```
val = dict(project_data_train["clean_categories"].value_counts())
val_d = dict(enumerate(val.keys()))
category_val = {v: k for k, v in val_d.items()}

cate_train = project_data_train["clean_categories"].values
category_train = []
for i in  cate_train:
    category_train.append(category_val[i])

cate_test = project_data_test["clean_categories"].values
category_test = []
for i in  cate_test:
    if i in category_val:
        category_test.append(category_val[i])
    else:
        category_test.append(len(val_d.keys()))

category_train = np.array(category_train)
category_test = np.array(category_test)
```

In [7]:

```
val = dict(project_data_train["clean_subcategories"].value_counts())
val_d = dict(enumerate(val.keys()))
subcategory_val = {v: k for k, v in val_d.items()}

subcate_train = project_data_train["clean_subcategories"].values
subcategory_train = []
for i in  subcate_train:
    subcategory_train.append(subcategory_val[i])

subcate_test = project_data_test["clean_subcategories"].values
subcategory_test = []
for i in  subcate_test:
    if i in subcategory_val:
        subcategory_test.append(subcategory_val[i])
    else:
        subcategory_test.append(len(val_d.keys()))

subcategory_train = np.array(subcategory_train)
subcategory_test = np.array(subcategory_test)
```

In [8]:

```
val = dict(project_data_train["school_state"].value_counts())
val_d = dict(enumerate(val.keys()))
state_val = {v: k for k, v in val_d.items()}

state_tr = project_data_train["school_state"].values
state_enc_train = []
for i in  state_tr:
    state_enc_train.append(state_val[i])

state_te = project_data_test["school_state"].values
state_enc_test = []
for i in  state_te:
    if i in state_val:
        state_enc_test.append(state_val[i])
    else:
        state_enc_test.append(len(val_d.keys()))

state_enc_train = np.array(state_enc_train)
state_enc_test = np.array(state_enc_test)
```

In [9]:

```
val = dict(project_data_train["project_grade_category"].value_counts())
val_d = dict(enumerate(val.keys()))
grade_val = {v: k for k, v in val_d.items()}

grade_train = project_data_train["project_grade_category"].values
grade_enc_train = []
for i in  grade_train:
    grade_enc_train.append(grade_val[i])

grade_test = project_data_test["project_grade_category"].values
grade_enc_test = []
for i in  grade_test:
    if i in grade_val:
        grade_enc_test.append(grade_val[i])
    else:
        grade_enc_test.append(len(val_d.keys()))

grade_enc_train = np.array(grade_enc_train)
grade_enc_test = np.array(grade_enc_test)
```

In [10]:

```
val = dict(project_data_train["teacher_prefix"].value_counts())
val_d = dict(enumerate(val.keys()))
prefix_val = {v: k for k, v in val_d.items()}

prefix_train = project_data_train["teacher_prefix"].values
prefix_enc_train = []
for i in  prefix_train:
```

```
for i in  prefix_train:
    prefix_enc_train.append(prefix_val[i])

prefix_test = project_data_test["teacher_prefix"].values
prefix_enc_test = []
for i in  prefix_test:
    if i in prefix_val:
        prefix_enc_test.append(prefix_val[i])
    else:
        prefix_enc_test.append(len(val_d.keys()))

prefix_enc_train = np.array(prefix_enc_train)
prefix_enc_test = np.array(prefix_enc_test)
```

Text Data

In [11]:

```
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

essay_train = project_data_train["essay"].values
essay_test = project_data_test["essay"].values

t = Tokenizer()
t.fit_on_texts(essay_train)
vocab_size = len(t.word_index) + 1
```

In [12]:

```
# integer encode the documents
#Train
enc_docs_train = t.texts_to_sequences(essay_train)
print(enc_docs_train[1])
```

```
[175, 20, 23, 2131, 53, 80, 14, 491, 312, 10, 1600, 457, 3729, 116, 10, 25, 1510, 292, 1, 816, 3,
30, 182, 840, 344, 4, 1, 6163, 1263, 547, 142, 1897, 4, 1, 1853, 1176, 880, 10, 14, 2480, 391,
160, 284, 4, 1, 40, 67, 26, 6, 1480, 1603, 463, 1824, 78, 6, 1441, 14, 1441, 44, 88, 102, 9, 3465,
14, 46, 32, 8818, 346, 8986, 38, 32, 101, 46, 827, 32, 6, 167, 98, 33016, 54, 2, 34, 153, 2720, 32
54, 3692, 231, 487, 376, 32, 2, 34, 1, 407, 538, 5053, 2705, 57, 118, 14, 15, 2852, 33, 1519, 14,
115, 5, 33, 2852, 193, 4, 1, 28, 15, 2346, 2519, 664, 1894, 3649, 530, 142, 13]
```

In [13]:

```
#Test
enc_docs_test = t.texts_to_sequences(essay_test)
print(enc_docs_test[1])
```

```
[14, 492, 20, 70, 26, 120, 864, 146, 4, 1, 19, 6164, 968, 624, 65, 1052, 118, 4578, 6, 7897, 2433,
161, 194, 20, 14, 19, 792, 73, 854, 109, 686, 14, 19, 17, 337, 23, 767, 1236, 74, 102, 241, 32, 69
, 4, 23, 26, 373, 6, 4280, 14, 347, 50, 132, 138, 1, 169, 67, 273, 414, 680, 206, 3, 115, 216, 352
, 623, 39, 1, 295, 48, 429, 6173, 110, 65, 41, 26, 638, 1047, 944, 1, 67, 134, 1526, 422, 125, 26,
38, 118, 791, 101, 160, 4318, 68, 309, 242, 207, 472, 1519, 4467, 4368, 1212, 3172, 19404, 50,
330, 32, 1941, 288, 1, 25, 23, 46, 32, 131, 2491, 303, 1941, 288, 68, 309, 203, 255, 1222, 1184, 3
2, 28, 49, 1313, 186, 2254, 3771, 202, 2712, 45, 15, 186, 2375, 159, 27, 100, 15, 10, 17, 102, 2,
89, 40, 3618, 1950, 23, 46, 32, 131, 13]
```

In [14]:

```
# truncate and/or pad input sequences
max_review_length = 400
pad_docs_train = pad_sequences(enc_docs_train, maxlen=max_review_length)
pad_docs_test = pad_sequences(enc_docs_test, maxlen=max_review_length)

print(pad_docs_train.shape)
print(pad_docs_train[10])
```

```
(87398, 400)
[    0     0     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0     0     0
```

```
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    2   49 1520 1637  380 1153   22    3   20 1009   89  160    6
  229   14  133  157  719  208   25   23 1231 3501   14 3475   10  491
   19 2227  817  208    4    3  113  184  335  617  867    1  134   64
   81  221    1  686  161  525    8    2  137  433  659   33   44   37
   62  137   53   10  225  197   84    4  142  719   22    6  208   89
   10  198  317  519  158  320  143 1779  174  666  417   44   35  280
  714   16  307    1  666  417  754  739    1  697   21  174   52  112
  786  420 1607 1679 1056 1008  725  249  112  163  217 1493   11   12
   62 2833  248 1257  123  587 4419  409    2   94 1740   49  261  157
   76 1892  249  112    6  525 3264  319   90  801   39  503  249  112
  282   11    1   40  249  112  282   13]
```

In [15]:

```
"""# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039
def loadGloveModel(gloveFile):
    print ("Loading Glove Model")
    f = open(gloveFile,'r', encoding="utf8")
    model = {}
    for line in f:
        splitLine = line.split()
        word = splitLine[0]
        embedding = np.array([float(val) for val in splitLine[1:]])
        model[word] = embedding
    print ("Done.",len(model)," words loaded!")
    return model
glovemodel = loadGloveModel('glove.42B.300d.txt')"""
```

```
Loading Glove Model
Done. 1917495  words loaded!
```

In [16]:

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

Numerical Features

In [17]:

```
from sklearn.preprocessing import StandardScaler


price_scalar = StandardScaler()
price_scalar.fit(project_data_train['price'].values.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
price_standardized = price_scalar.transform(project_data_train['price'].values.reshape(-1, 1))
```

```
Mean : 298.3417191468912, Standard deviation : 365.8936474660223
```

In [18]:

```
from sklearn.preprocessing import StandardScaler


price_scalar = StandardScaler()
price_scalar.fit(project_data_train['price'].values.reshape(-1,1)) # finding the mean and standard
deviation of this data
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
price_standardized_test = price_scalar.transform(project_data_test['price'].values.reshape(-1, 1))
```

```
Mean : 298.3417191468912, Standard deviation : 365.8936474660223
```

In [19]:

```
from sklearn.preprocessing import StandardScaler
import warnings
previouspro_scalar = StandardScaler()
previouspro_scalar.fit(project_data_train['teacher_number_of_previously_posted_projects'].values.r
eshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {previouspro_scalar.mean_[0]}, Standard deviation :
{np.sqrt(previouspro_scalar.var_[0])}")


previouspro_standardized_train =
previouspro_scalar.transform(project_data_train['teacher_number_of_previously_posted_projects'].va
lues.reshape(-1, 1))
warnings.filterwarnings("ignore")
```

```
Mean : 11.131524748850088, Standard deviation : 27.733763561081116
```

In [20]:

```
from sklearn.preprocessing import StandardScaler

previouspro_scalar = StandardScaler()
previouspro_scalar.fit(project_data_train['teacher_number_of_previously_posted_projects'].values.r
eshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {previouspro_scalar.mean_[0]}, Standard deviation :
{np.sqrt(previouspro_scalar.var_[0])}")


previouspro_standardized_test =
previouspro_scalar.transform(project_data_test['teacher_number_of_previously_posted_projects'].val
ues.reshape(-1, 1))
warnings.filterwarnings("ignore")
```

```
Mean : 11.131524748850088, Standard deviation : 27.733763561081116
```

In [21]:

```
remain_train = np.stack((price_standardized, previouspro_standardized_train), axis=-1)
remain_train = remain_train.reshape(remain_train.shape[0],
remain_train.shape[1]*remain_train.shape[2])
remain_test = np.stack((price_standardized_test, previouspro_standardized_test), axis=-1)
remain_test = remain_test.reshape(remain_test.shape[0], remain_test.shape[1]*remain_test.shape[2])
```

Model 1

In [27]:

```
tf.keras.backend.clear_session()

Input_model_1 = Input(shape=(max_review_length,) ,name="Text_data")
```

```
layer11 = Embedding(vocab_size, 300 ,weights=[embedding_matrix],trainable=False ,name="layer11")
(Input_model_1)
layer21 = LSTM(units = 100,activation='relu',kernel_initializer='he_normal',return_sequences = Fals
e,name="layer21")(layer11)
layer31 = Flatten()(layer21)

Input_model_2 = Input(shape=(1,),name="School_state")
layer12 = Embedding(len(state_val) + 1, 32 ,name="layer12")(Input_model_2)
layer22 = Flatten()(layer12)

Input_model_3 = Input(shape=(1,),name="Grade")
layer13 = Embedding(len(grade_val) + 1, 32 ,name="layer13")(Input_model_3)
layer23 = Flatten()(layer13)

Input_model_4 = Input(shape=(1,),name="Categories")
layer14 = Embedding(len(category_val) + 1, 32 ,name="layer14")(Input_model_4)
layer24 = Flatten()(layer14)

Input_model_5 = Input(shape=(1,),name="sub_Category")
layer15 = Embedding(len(subcategory_val) + 1, 32 ,name="layer15")(Input_model_5)
layer25 = Flatten()(layer15)

Input_model_6 = Input(shape=(1,),name="Prefix")
layer16 = Embedding(len(prefix_val) + 1, 32 ,name="layer16")(Input_model_6)
layer26 = Flatten()(layer16)

Input_model_7 = Input(shape=(2,),name="Remaining_features")
layer27 = Dense(units=8,activation='relu',kernel_initializer="he_normal",name="layer27")(Input_mode
l_7)

concat_layer = concatenate(inputs=[layer31,layer22,layer23,layer24,layer25,layer26,layer27],name="
concat")

layer2 = Dense(units=512,activation='relu',kernel_initializer='he_normal',name="layer2")(concat_lay
er)
norm_1 = BatchNormalization()(layer2)
layer3 = Dropout(0.25)(norm_1)
layer4 = Dense(units=256,activation='relu',kernel_initializer='he_normal',name="layer4")(layer3)
norm_2 = BatchNormalization()(layer4)
layer5 = Dense(units=128,activation='relu',kernel_initializer='he_normal',name="layer5")(norm_2)
norm_3 = BatchNormalization()(layer5)
layer6 = Dense(units=64,activation='relu',kernel_initializer='he_normal',name="layer6")(norm_3)

output = Dense(units=1,activation='sigmoid',kernel_initializer="glorot_uniform",name="output")(laye
r6)

model = Model(inputs=[Input_model_1,Input_model_2,Input_model_3,Input_model_4,Input_model_5,Input_m
odel_6,Input_model_7],outputs=output)
```

In [28]:

```
model.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to                     
==================================================================================================
Text_data (InputLayer)          [(None, 400)]        0                                            
__________________________________________________________________________________________________
layer11 (Embedding)             (None, 400, 300)     15540900    Text_data[0][0]                  
__________________________________________________________________________________________________
School_state (InputLayer)       [(None, 1)]          0                                            
__________________________________________________________________________________________________
Grade (InputLayer)              [(None, 1)]          0                                            
__________________________________________________________________________________________________
Categories (InputLayer)         [(None, 1)]          0                                            
__________________________________________________________________________________________________
sub_Category (InputLayer)       [(None, 1)]          0                                            
__________________________________________________________________________________________________
Prefix (InputLayer)             [(None, 1)]          0                                            
__________________________________________________________________________________________________
layer21 (LSTM)                  (None, 100)          160400      layer11[0][0]                    
__________________________________________________________________________________________________
layer12 (Embedding)             (None, 1, 32)        1664        School_state[0][0]               
__________________________________________________________________________________________________
layer13 (Embedding)             (None, 1, 32)        160         Grade[0][0]
```

```
layer13 (Embedding)             (None, 1, 32)        160         Grade[0][0]                      
__________________________________________________________________________________________________
layer14 (Embedding)             (None, 1, 32)        1664        Categories[0][0]                 
__________________________________________________________________________________________________
layer15 (Embedding)             (None, 1, 32)        12608       sub_Category[0][0]               
__________________________________________________________________________________________________
layer16 (Embedding)             (None, 1, 32)        192         Prefix[0][0]                     
__________________________________________________________________________________________________
Remaining_features (InputLayer) [(None, 2)]          0                                            
__________________________________________________________________________________________________
flatten (Flatten)               (None, 100)          0           layer21[0][0]                    
__________________________________________________________________________________________________
flatten_1 (Flatten)             (None, 32)           0           layer12[0][0]                    
__________________________________________________________________________________________________
flatten_2 (Flatten)             (None, 32)           0           layer13[0][0]                    
__________________________________________________________________________________________________
flatten_3 (Flatten)             (None, 32)           0           layer14[0][0]                    
__________________________________________________________________________________________________
flatten_4 (Flatten)             (None, 32)           0           layer15[0][0]                    
__________________________________________________________________________________________________
flatten_5 (Flatten)             (None, 32)           0           layer16[0][0]                    
__________________________________________________________________________________________________
layer27 (Dense)                 (None, 8)            24          Remaining_features[0][0]         
__________________________________________________________________________________________________
concat (Concatenate)            (None, 268)          0           flatten[0][0]                    
                                                                 flatten_1[0][0]                  
                                                                 flatten_2[0][0]                  
                                                                 flatten_3[0][0]                  
                                                                 flatten_4[0][0]                  
                                                                 flatten_5[0][0]                  
                                                                 layer27[0][0]                    
__________________________________________________________________________________________________
layer2 (Dense)                  (None, 512)          137728      concat[0][0]                     
__________________________________________________________________________________________________
batch_normalization (BatchNorma (None, 512)          2048        layer2[0][0]                     
__________________________________________________________________________________________________
dropout (Dropout)               (None, 512)          0           batch_normalization[0][0]        
__________________________________________________________________________________________________
layer4 (Dense)                  (None, 256)          131328      dropout[0][0]                    
__________________________________________________________________________________________________
batch_normalization_1 (BatchNor (None, 256)          1024        layer4[0][0]                     
__________________________________________________________________________________________________
layer5 (Dense)                  (None, 128)          32896       batch_normalization_1[0][0]      
__________________________________________________________________________________________________
batch_normalization_2 (BatchNor (None, 128)          512         layer5[0][0]                     
__________________________________________________________________________________________________
layer6 (Dense)                  (None, 64)           8256        batch_normalization_2[0][0]      
__________________________________________________________________________________________________
output (Dense)                  (None, 1)            65          layer6[0][0]                     
==================================================================================================
Total params: 16,031,469
Trainable params: 488,777
Non-trainable params: 15,542,692
__________________________________________________________________________________________________
```

In [29]:

```
from sklearn.metrics import roc_auc_score
def auc(y_true, y_pred):
    return tf.py_func(roc_auc_score, (y_true, y_pred), tf.double)
```

In [30]:

```
#compile
model.compile(optimizer='adam',loss='binary_crossentropy',metrics = ["accuracy", auc])
```

In [31]:

```
"""class_weights = {0 : 1,
                 1 :0.2}"""
```

Out[31]:

```
'class_weights = {0 : 1,\n                 1 :0.2}'
```

In [32]:

```
from time import time
logs = r"C:\Users\Dewang\Desktop\AAIC notes\0.0 Assignments\AAIC classroom Assignments\logs\ex1"
tensorboard = TensorBoard(log_dir = logs )
```

In [34]:

```
#train
model.fit([pad_docs_train,state_enc_train,grade_enc_train,category_train,subcategory_train,prefix_e
nc_train,remain_train],y_train,
          batch_size=256,epochs=10,
          validation_data= ([pad_docs_test,state_enc_test,grade_enc_test,category_test,subcategory
_test,prefix_enc_test,remain_test],y_test),
         callbacks = [tensorboard])
```

```
Train on 87398 samples, validate on 21850 samples
Epoch 1/10
87398/87398 [==============================] - 577s 7ms/sample - loss: 0.4248 - acc: 0.8480 - auc:
0.5906 - val_loss: 0.4334 - val_acc: 0.8486 - val_auc: 0.4089
Epoch 2/10
87398/87398 [==============================] - 504s 6ms/sample - loss: 0.4169 - acc: 0.8485 - auc:
0.6133 - val_loss: 0.4318 - val_acc: 0.8486 - val_auc: 0.4115
Epoch 3/10
87398/87398 [==============================] - 504s 6ms/sample - loss: 0.4134 - acc: 0.8486 - auc:
0.6260 - val_loss: 0.4389 - val_acc: 0.8486 - val_auc: 0.4212
Epoch 4/10
87398/87398 [==============================] - 504s 6ms/sample - loss: 0.4115 - acc: 0.8485 - auc:
0.6354 - val_loss: 0.4345 - val_acc: 0.8486 - val_auc: 0.4400
Epoch 5/10
87398/87398 [==============================] - 504s 6ms/sample - loss: 0.4094 - acc: 0.8486 - auc:
0.6408 - val_loss: 0.4292 - val_acc: 0.8486 - val_auc: 0.5081
Epoch 6/10
87398/87398 [==============================] - 503s 6ms/sample - loss: 0.4076 - acc: 0.8488 - auc:
0.6480 - val_loss: 0.4304 - val_acc: 0.8486 - val_auc: 0.5037
Epoch 7/10
87398/87398 [==============================] - 504s 6ms/sample - loss: 0.4058 - acc: 0.8488 - auc:
0.6546 - val_loss: 0.4263 - val_acc: 0.8486 - val_auc: 0.5504
Epoch 8/10
87398/87398 [==============================] - 504s 6ms/sample - loss: 0.4035 - acc: 0.8493 - auc:
0.6623 - val_loss: 0.4239 - val_acc: 0.8486 - val_auc: 0.5406
Epoch 9/10
87398/87398 [==============================] - 506s 6ms/sample - loss: 0.4010 - acc: 0.8496 - auc:
0.6694 - val_loss: 0.4246 - val_acc: 0.8486 - val_auc: 0.5396
Epoch 10/10
87398/87398 [==============================] - 506s 6ms/sample - loss: 0.3980 - acc: 0.8501 - auc:
0.6783 - val_loss: 0.4350 - val_acc: 0.8486 - val_auc: 0.4985
```

Out[34]:

```
<tensorflow.python.keras.callbacks.History at 0x1c0cf7d4ef0>
```

In [57]:

```
model_json = model.to_json()
with open("model1.json", "w") as json_file:
    json_file.write(model_json)

model.save_weights("model1.h5")
print("Saved model to disk")
```

```
Saved model to disk
```

In [58]:

```
from tensorflow.keras.models import model_from_json
json_file = open('model1.json', 'r')
loaded_model_json = json_file.read()
json_file.close()

loaded_model = model_from_json(loaded_model_json)
loaded_model = model_from_json(loaded_model_json)
# load weights into new model
loaded_model.load_weights("model1.h5")
print("Loaded model from disk")
```

```
W1011 12:07:16.377816  8056 deprecation.py:506] From C:\Users\Dewang\Anaconda3\lib\site-
packages\tensorflow\python\ops\init_ops.py:97: calling Orthogonal.__init__ (from
tensorflow.python.ops.init_ops) with dtype is deprecated and will be removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the constructor
W1011 12:07:16.409270  8056 deprecation.py:506] From C:\Users\Dewang\Anaconda3\lib\site-
packages\tensorflow\python\ops\init_ops.py:97: calling Zeros.__init__ (from
tensorflow.python.ops.init_ops) with dtype is deprecated and will be removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the constructor
W1011 12:07:16.429961  8056 deprecation.py:506] From C:\Users\Dewang\Anaconda3\lib\site-
packages\tensorflow\python\ops\init_ops.py:97: calling Ones.__init__ (from
tensorflow.python.ops.init_ops) with dtype is deprecated and will be removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the constructor
W1011 12:07:16.437951  8056 deprecation.py:506] From C:\Users\Dewang\Anaconda3\lib\site-
packages\tensorflow\python\ops\init_ops.py:97: calling GlorotUniform.__init__ (from
tensorflow.python.ops.init_ops) with dtype is deprecated and will be removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the constructor
```

```
Loaded model from disk
```

In [59]:

```
#compile
loaded_model.compile(optimizer='adam',loss='binary_crossentropy',metrics = ["accuracy", auc])
```

In [63]:

```
score = 
loaded_model.evaluate([pad_docs_test,state_enc_test,grade_enc_test,category_test,subcategory_test,
prefix_enc_test,remain_test],y_test,batch_size = 64, verbose=1)
print('Test score:', score[0])
print('Test accuracy:', score[1])
```

```
21850/21850 [==============================] - 177s 8ms/sample - loss: 0.5534 - acc: 0.7437 - auc:
0.7261
Test score: 0.5534265434059998
Test accuracy: 0.7437071
```

In [ ]:

```
%load_ext tensorboard
%tensorboard --logdir {logs_base_dir}
```

In [66]:

```
%tensorboard --logdir=logs --host localhost --port 810
```

```
Reusing TensorBoard on port 810 (pid 10556), started 0:00:45 ago. (Use '!kill 10556' to kill it.)
```

Model 2

In [24]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
essay_train = project_data_train["essay"]
vectorizer = TfidfVectorizer()
X = vectorizer.fit_transform(essay_train)
idf = vectorizer.idf_
idf_dict = dict(zip(vectorizer.get_feature_names(), idf))
idf_dict["i"] = 1
```

In [25]:

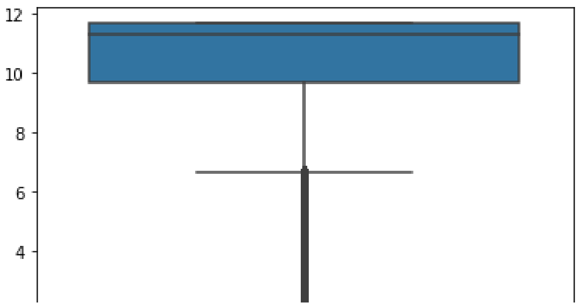
```
sorted_idf_dict = dict(sorted(idf_dict.items(), key=lambda kv: kv[1]))
sorted_idf = list(sorted_idf_dict.values())
```

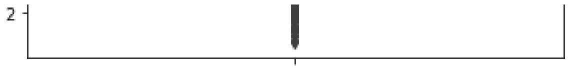
In [26]:

```
sns.boxplot(y = sorted_idf)
```

Out[26]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x20a69ed67b8>
```





In [27]:

```
"""Removing Values below 6 and above 10"""
remove_words = {}
for i,j in idf_dict.items():
    if(int(j)<6 or int(j) >10):
        remove_words[i] = idf_dict[i]
```

In [29]:

```
"""Removing Words from Data
from tqdm import tqdm

essay_train = project_data_train["essay"]
essay_test = project_data_test["essay"]

stopwords = list(remove_words.keys())

idf_essay_train = []

for query in tqdm(essay_train):

    querywords = query.split()
    resultwords  = [word for word in querywords if word.lower() not in stopwords]
    result = ' '.join(resultwords)
    idf_essay_train.append(result)


"""
```

Out[29]:

```
'Removing Words from Data\nfrom tqdm import tqdm\n\nessay_train =
project_data_train["essay"]\nessay_test = project_data_test["essay"]\n\nstopwords =
list(remove_words.keys())\n\nidf_essay_train = []\n\nfor query in tqdm(essay_train):\n    \n    que
rywords = query.split()\n    resultwords  = [word for word in querywords if word.lower() not in
stopwords]\n    result = \' \'.join(resultwords)\n    idf_essay_train.append(result)\n    \n    \n'
```

In [ ]:

```
"""idf_essay_test = []

for query in tqdm(essay_test):

    querywords = query.split()
    resultwords  = [word for word in querywords if word.lower() not in stopwords]
    result = ' '.join(resultwords)
    idf_essay_test.append(result)"""
```

In [106]:

```
"""df2_train = pd.DataFrame(idf_essay_train,columns = ["train_essay"])
df2_test = pd.DataFrame(idf_essay_test,columns = ["test_essay"])
df2_train.to_csv(r'lstm_model2_train.csv')
df2_test.to_csv(r"lstm_model2_test.csv")"""

df2_train = pd.read_csv("lstm_model2_train.csv")
df2_test = pd.read_csv("lstm_model2_test.csv")

idf_essay_train= df2_train["train_essay"].astype(str)
idf_essay_test= df2_test["test_essay"].astype(str)
```

In [107]:

```
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

t = Tokenizer()
```

```
t.fit_on_texts(idf_essay_train)
vocab_size_idf = len(t.word_index) + 1
```

In [108]:

```
# integer encode the documents
#Train
idf_docs_train = t.texts_to_sequences(idf_essay_train)
print(idf_docs_train[1])
```

```
[2360, 3424, 3381, 4526, 244]
```

In [109]:

```
#Test
idf_docs_test = t.texts_to_sequences(idf_essay_test)
print(idf_docs_test[1])
```

```
[370, 9405, 613, 613, 613, 370, 2857, 15363, 731, 987, 12924, 370, 836, 2937, 21536, 2453, 1561, 3
99, 278, 1773, 2163, 1147, 4067, 1346, 1147, 2761, 21536, 15181, 170]
```

In [110]:

```
# truncate and/or pad input sequences
max_review_length = 200
pad_idf_train = pad_sequences(idf_docs_train, maxlen=max_review_length)
pad_idf_test = pad_sequences(idf_docs_test, maxlen=max_review_length)

print(pad_idf_train.shape)
print(pad_idf_train[10])
```

```
(87398, 200)
[   0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0  414  784  920
 1525  542    1    3]
```

In [111]:

```
# create a weight matrix for words in training docs
embedding_matrix_idf = np.zeros((vocab_size_idf, 300))
for word, i in t.word_index.items():
    embedding_vector = glovemodel.get(word)
    if embedding_vector is not None:
        embedding_matrix_idf[i] = embedding_vector
```

In [204]:

```
tf.keras.backend.clear_session()

Input_model_1 = Input(shape=(max_review_length,) ,name="Text_data")
layer11 = Embedding(vocab_size_idf, 300 ,weights=[embedding_matrix_idf],trainable=False
,name="layer11")(Input_model_1)
layer21 = LSTM(units = 100,activation='relu',kernel_initializer='he_normal',return_sequences = Fals
e,name="layer21")(layer11)
layer31 = Flatten()(layer21)

Input_model_2 = Input(shape=(1,),name="School_state")
layer12 = Embedding(state_size + 1, 2 ,name="layer12")(Input_model_2)
```

```
layer22 = Flatten()(layer12)

Input_model_3 = Input(shape=(3,),name="Grade")
layer13 = Embedding(grade_size + 1, 2 ,name="layer13")(Input_model_3)
layer23 = Flatten()(layer13)

Input_model_4 = Input(shape=(max_category_length,),name="Categories")
layer14 = Embedding(cate_size + 1, 4 ,name="layer14")(Input_model_4)
layer24 = Flatten()(layer14)

Input_model_5 = Input(shape=(max_subcategory_length,),name="sub_Category")
layer15 = Embedding(subcate_size + 1, 4 ,name="layer15")(Input_model_5)
layer25 = Flatten()(layer15)

Input_model_6 = Input(shape=(1,),name="Prefix")
layer16 = Embedding(prefix_size + 1, 2 ,name="layer16")(Input_model_6)
layer26 = Flatten()(layer16)

Input_model_7 = Input(shape=(2,),name="Remaining_features")
layer27 = Dense(units=8,activation='relu',kernel_initializer="he_normal",name="layer27")(Input_mode
l_7)

concat_layer = concatenate(inputs=[layer31,layer22,layer23,layer24,layer25,layer26,layer27],name="
concat")

layer2 = Dense(units=512,activation='relu',kernel_initializer='he_normal',name="layer2")(concat_lay
er)
norm_1 = BatchNormalization()(layer2)
layer3 = Dropout(0.25)(norm_1)
layer4 = Dense(units=256,activation='relu',kernel_initializer='he_normal',name="layer4")(layer3)
norm_2 = BatchNormalization()(layer4)
layer5 = Dense(units=128,activation='relu',kernel_initializer='he_normal',name="layer5")(norm_2)
norm_3 = BatchNormalization()(layer5)
layer6 = Dense(units=64,activation='relu',kernel_initializer='he_normal',name="layer6")(norm_3)

output = Dense(units=1,activation='sigmoid',kernel_initializer="glorot_uniform",name="output")(laye
r6)

model = Model(inputs=[Input_model_1,Input_model_2,Input_model_3,Input_model_4,Input_model_5,Input_m
odel_6,Input_model_7],outputs=output)
model.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to                     
==================================================================================================
Text_data (InputLayer)          [(None, 400)]        0                                            
__________________________________________________________________________________________________
layer11 (Embedding)             (None, 400, 300)     7017000     Text_data[0][0]                  
__________________________________________________________________________________________________
School_state (InputLayer)       [(None, 1)]          0                                            
__________________________________________________________________________________________________
Grade (InputLayer)              [(None, 3)]          0                                            
__________________________________________________________________________________________________
Categories (InputLayer)         [(None, 5)]          0                                            
__________________________________________________________________________________________________
sub_Category (InputLayer)       [(None, 6)]          0                                            
__________________________________________________________________________________________________
Prefix (InputLayer)             [(None, 1)]          0                                            
__________________________________________________________________________________________________
layer21 (LSTM)                  (None, 100)          160400      layer11[0][0]                    
__________________________________________________________________________________________________
layer12 (Embedding)             (None, 1, 2)         104         School_state[0][0]               
__________________________________________________________________________________________________
layer13 (Embedding)             (None, 3, 2)         10          Grade[0][0]                      
__________________________________________________________________________________________________
layer14 (Embedding)             (None, 5, 4)         40          Categories[0][0]                 
__________________________________________________________________________________________________
layer15 (Embedding)             (None, 6, 4)         124         sub_Category[0][0]               
__________________________________________________________________________________________________
layer16 (Embedding)             (None, 1, 2)         12          Prefix[0][0]                     
__________________________________________________________________________________________________
Remaining_features (InputLayer) [(None, 2)]          0                                            
__________________________________________________________________________________________________
flatten (Flatten)               (None, 100)          0           layer21[0][0]                    
__________________________________________________________________________________________________
flatten_1 (Flatten)             (None, 2)            0           layer12[0][0]                    
```

```
flatten_1 (Flatten)             (None, 2)            0           layer12[0][0]
__________________________________________________________________________________________________
flatten_2 (Flatten)             (None, 6)            0           layer13[0][0]
__________________________________________________________________________________________________
flatten_3 (Flatten)             (None, 20)           0           layer14[0][0]
__________________________________________________________________________________________________
flatten_4 (Flatten)             (None, 24)           0           layer15[0][0]
__________________________________________________________________________________________________
flatten_5 (Flatten)             (None, 2)            0           layer16[0][0]
__________________________________________________________________________________________________
layer27 (Dense)                 (None, 8)            24          Remaining_features[0][0]
__________________________________________________________________________________________________
concat (Concatenate)            (None, 162)          0           flatten[0][0]
                                                                 flatten_1[0][0]
                                                                 flatten_2[0][0]
                                                                 flatten_3[0][0]
                                                                 flatten_4[0][0]
                                                                 flatten_5[0][0]
                                                                 layer27[0][0]
__________________________________________________________________________________________________
layer2 (Dense)                  (None, 512)          83456       concat[0][0]
__________________________________________________________________________________________________
batch_normalization (BatchNorma (None, 512)          2048        layer2[0][0]
__________________________________________________________________________________________________
dropout (Dropout)               (None, 512)          0           batch_normalization[0][0]
__________________________________________________________________________________________________
layer4 (Dense)                  (None, 256)          131328      dropout[0][0]
__________________________________________________________________________________________________
batch_normalization_1 (BatchNor (None, 256)          1024        layer4[0][0]
__________________________________________________________________________________________________
layer5 (Dense)                  (None, 128)          32896       batch_normalization_1[0][0]
__________________________________________________________________________________________________
batch_normalization_2 (BatchNor (None, 128)          512         layer5[0][0]
__________________________________________________________________________________________________
layer6 (Dense)                  (None, 64)           8256        batch_normalization_2[0][0]
__________________________________________________________________________________________________
output (Dense)                  (None, 1)            65          layer6[0][0]
==================================================================================================
Total params: 7,437,299
Trainable params: 418,507
Non-trainable params: 7,018,792
__________________________________________________________________________________________________
```

In [146]:

```
from sklearn.metrics import roc_auc_score
def auc(y_true, y_pred):
    return tf.py_func(roc_auc_score, (y_true, y_pred), tf.double)
```

In [147]:

```
#compile
model.compile(optimizer='adam',loss='binary_crossentropy',metrics = ["accuracy", auc])
```

In [148]:

```
from time import time
logs1 = r"C:\Users\Dewang\Desktop\AAIC notes\0.0 Assignments\AAIC classroom Assignments\logs\ex2"
tensorboard = TensorBoard(log_dir = logs1 )
```

In [149]:

```
class_weights = {0: 1,
                1: 0.2}
```

In [150]:

```
#train
model.fit([pad_idf_train,state_enc_train,grade_enc_train,category_train,subcategory_train,prefix_en
c_train,remain_train],y_train,
           batch_size=256,epochs=10,
           validation_data= ([pad_idf_test,state_enc_test,grade_enc_test,category_test,subcategory_
test,prefix_enc_test,remain_test],y_test),
test,prefix_enc_test,remain_test],y_test),
           class_weight=class_weights,callbacks = [tensorboard])
```

```
Train on 87398 samples, validate on 21850 samples
Epoch 1/10
87398/87398 [==============================] - 273s 3ms/sample - loss: 0.2299 - acc: 0.6048 - auc:
0.5190 - val_loss: 0.6576 - val_acc: 0.8486 - val_auc: 0.5000
Epoch 2/10
87398/87398 [==============================] - 271s 3ms/sample - loss: 0.2246 - acc: 0.6398 - auc:
0.5180 - val_loss: 0.6976 - val_acc: 0.1514 - val_auc: 0.5002
Epoch 3/10
87398/87398 [==============================] - 271s 3ms/sample - loss: 0.2232 - acc: 0.6618 - auc:
0.5192 - val_loss: 0.6093 - val_acc: 0.8486 - val_auc: 0.4998
Epoch 4/10
87398/87398 [==============================] - 271s 3ms/sample - loss: 0.2219 - acc: 0.6815 - auc:
0.5323 - val_loss: 0.6406 - val_acc: 0.8486 - val_auc: 0.5000
Epoch 5/10
87398/87398 [==============================] - 270s 3ms/sample - loss: 0.2210 - acc: 0.6997 - auc:
0.5450 - val_loss: 0.6357 - val_acc: 0.8486 - val_auc: 0.5000
Epoch 6/10
87398/87398 [==============================] - 273s 3ms/sample - loss: 0.2204 - acc: 0.6919 - auc:
0.5499 - val_loss: 0.6409 - val_acc: 0.8486 - val_auc: 0.5000
Epoch 7/10
87398/87398 [==============================] - 308s 4ms/sample - loss: 0.2204 - acc: 0.7116 - auc:
0.5489 - val_loss: 0.7018 - val_acc: 0.1514 - val_auc: 0.5000
Epoch 8/10
87398/87398 [==============================] - 301s 3ms/sample - loss: 0.2201 - acc: 0.7057 - auc:
0.5512 - val_loss: 0.6591 - val_acc: 0.8486 - val_auc: 0.5003
Epoch 9/10
87398/87398 [==============================] - 261s 3ms/sample - loss: 0.2198 - acc: 0.7297 - auc:
0.5562 - val_loss: 0.6475 - val_acc: 0.8486 - val_auc: 0.5000
Epoch 10/10
87398/87398 [==============================] - 260s 3ms/sample - loss: 0.2195 - acc: 0.7385 - auc:
0.5590 - val_loss: 0.6431 - val_acc: 0.8486 - val_auc: 0.5000
```

Out[150]:

```
<tensorflow.python.keras.callbacks.History at 0x2434efff898>
```

In [56]:

```
model_json = model.to_json()
with open("model2.json", "w") as json_file:
    json_file.write(model_json)

model.save_weights("model2.h5")
print("Saved model to disk")
```

```
Saved model to disk
```

In [57]:

```
from tensorflow.keras.models import model_from_json
json_file = open('model2.json', 'r')
loaded_model_json = json_file.read()
json_file.close()

loaded_model = model_from_json(loaded_model_json)
# load weights into new model
loaded_model.load_weights("model2.h5")
print("Loaded model from disk")
```

```
Loaded model from disk
```

In [58]:

```
#compile
loaded_model.compile(optimizer='adam',loss='binary_crossentropy',metrics = ["accuracy", auc])
```

In [59]:

```
score =
loaded_model.evaluate([pad_idf_test,state_enc_test,grade_enc_test,category_test,subcategory_test,p
refix_enc_test,remain_test],y_test,
           callbacks = [tensorboard])
print('Test score:', score[0])
print('Test accuracy:', score[1])
```

```
9600/9600 [==============================] - 73s 8ms/sample - loss: 0.6638 - acc: 0.6085 - auc: 0.
6357
Test score: 0.6637970036268235
Test accuracy: 0.60854167
```

In [77]:

```
%tensorboard --logdir=logs1 --host localhost --port 8089
```

```
'kill' is not recognized as an internal or external command,
operable program or batch file.
```

```
Reusing TensorBoard on port 8089 (pid 11512), started 0:01:58 ago. (Use '!kill 11512' to kill it.)
```

Model 3

Categorica Features

In [206]:

```
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer()
categories_one_hot = vectorizer.fit_transform(project_data_train['clean_categories'].values)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",categories_one_hot.shape)
```

```
['appliedlearning', 'care_hunger', 'health_sports', 'history_civics', 'literacy_language',
'math_science', 'music_arts', 'specialneeds', 'warmth']
Shape of matrix after one hot encodig  (87398, 9)
```

In [207]:

```
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer()
vectorizer.fit(project_data_train['clean_categories'].values)
categories_one_hot_test = vectorizer.transform(project_data_test['clean_categories'].values)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",categories_one_hot_test.shape)
```

```
['appliedlearning', 'care_hunger', 'health_sports', 'history_civics', 'literacy_language',
'math_science', 'music_arts', 'specialneeds', 'warmth']
Shape of matrix after one hot encodig  (21850, 9)
```

In [208]:

```
# we use count vectorizer to convert the values into one
vectorizer = CountVectorizer()
sub_categories_one_hot = vectorizer.fit_transform(project_data_train['clean_subcategories'].values
)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",sub_categories_one_hot.shape)
```

```
['appliedsciences', 'care_hunger', 'charactereducation', 'civics_government',
'college_careerprep', 'communityservice', 'earlydevelopment', 'economics', 'environmentalscience',
'esl', 'extracurricular', 'financialliteracy', 'foreignlanguages', 'gym_fitness',
'health_lifescience', 'health_wellness', 'history_geography', 'literacy', 'literature_writing', 'm
athematics', 'music', 'nutritioneducation', 'other', 'parentinvolvement', 'performingarts', 'socia
lsciences', 'specialneeds', 'teamsports', 'visualarts', 'warmth']
Shape of matrix after one hot encodig  (87398, 30)
```

In [209]:

```
# we use count vectorizer to convert the values into one
vectorizer = CountVectorizer()
vectorizer.fit(project_data_train['clean_subcategories'].values)
sub_categories_one_hot_test = vectorizer.transform(project_data_test['clean_subcategories'].values
)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",sub_categories_one_hot_test.shape)
```

```
['appliedsciences', 'care_hunger', 'charactereducation', 'civics_government',
'college_careerprep', 'communityservice', 'earlydevelopment', 'economics', 'environmentalscience',
'esl', 'extracurricular', 'financialliteracy', 'foreignlanguages', 'gym_fitness',
'health_lifescience', 'health_wellness', 'history_geography', 'literacy', 'literature_writing', 'm
athematics', 'music', 'nutritioneducation', 'other', 'parentinvolvement', 'performingarts', 'socia
lsciences', 'specialneeds', 'teamsports', 'visualarts', 'warmth']
Shape of matrix after one hot encodig  (21850, 30)
```

In [210]:

```
vectorizer = CountVectorizer()
school_state_one_hot = vectorizer.fit_transform(project_data_train['school_state'].values)
```

```
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",school_state_one_hot.shape)
```

```
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi', 'ia', 'id', 'il', 'in', 'k
s', 'ky', 'la', 'ma', 'md', 'me', 'mi', 'mn', 'mo', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm',
'nv', 'ny', 'oh', 'ok', 'or', 'pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va', 'vt', 'wa', 'wi', 'wv
', 'wy']
Shape of matrix after one hot encodig  (87398, 51)
```

In [211]:

```
vectorizer = CountVectorizer()
vectorizer.fit(project_data_train['school_state'].values)
print(vectorizer.get_feature_names())
school_state_one_hot_test = vectorizer.transform(project_data_test['school_state'].values)
print("Shape of matrix after one hot encodig ",school_state_one_hot_test.shape)
```

```
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi', 'ia', 'id', 'il', 'in', 'k
s', 'ky', 'la', 'ma', 'md', 'me', 'mi', 'mn', 'mo', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm',
'nv', 'ny', 'oh', 'ok', 'or', 'pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va', 'vt', 'wa', 'wi', 'wv
', 'wy']
Shape of matrix after one hot encodig  (21850, 51)
```

In [212]:

```
vectorizer = CountVectorizer()
gra_cat_one_hot = vectorizer.fit_transform(project_data_train['project_grade_category'].values)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",gra_cat_one_hot.shape)
```

```
['grades_3_5', 'grades_6_8', 'grades_9_12', 'grades_prek_2']
Shape of matrix after one hot encodig  (87398, 4)
```

In [213]:

```
vectorizer = CountVectorizer()
vectorizer.fit(project_data_train['project_grade_category'].values)
print(vectorizer.get_feature_names())
gra_cat_one_hot_test = vectorizer.transform(project_data_test['project_grade_category'].values)
print("Shape of matrix after one hot encodig ",gra_cat_one_hot_test.shape)
```

```
['grades_3_5', 'grades_6_8', 'grades_9_12', 'grades_prek_2']
Shape of matrix after one hot encodig  (21850, 4)
```

In [214]:

```
vectorizer = CountVectorizer()
tea_pre_one_hot = vectorizer.fit_transform(project_data_train['teacher_prefix'].values.astype('str'
))
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",tea_pre_one_hot.shape)
```

```
['dr', 'mr', 'mrs', 'ms', 'teacher']
Shape of matrix after one hot encodig  (87398, 5)
```

In [215]:

```
vectorizer = CountVectorizer()
vectorizer.fit(project_data_train['teacher_prefix'].values.astype('str'))
tea_pre_one_hot_test =
vectorizer.transform(project_data_test['teacher_prefix'].values.astype('str'))
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",tea_pre_one_hot_test.shape)
```

```
['dr', 'mr', 'mrs', 'ms', 'teacher']
Shape of matrix after one hot encodig  (21850, 5)
```

Concating Numerical and Categorical Features

In [216]:

```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(school_state_one_hot.shape)
print(gra_cat_one_hot.shape)
print(tea_pre_one_hot.shape)
print(remain_train.shape)
```

```
(87398, 9)
(87398, 30)
(87398, 51)
(87398, 4)
(87398, 5)
(87398, 2)
```

In [217]:

```
from scipy.sparse import hstack
concat_train =
hstack((categories_one_hot,sub_categories_one_hot,school_state_one_hot,gra_cat_one_hot,tea_pre_one_
hot, remain_train))
concat_train.shape
```

Out[217]:

```
(87398, 101)
```

In [218]:

```
from scipy.sparse import hstack
concat_test =
hstack((categories_one_hot_test,sub_categories_one_hot_test,school_state_one_hot_test,gra_cat_one_h
ot_test,tea_pre_one_hot_test, remain_test))
concat_test.shape
```

Out[218]:

```
(21850, 101)
```

In [219]:

```
concat_array_train = concat_train.toarray()
concat_array_test = concat_test.toarray()
nrows, ncols = concat_array_train.shape
```

In [240]:

```
tf.keras.backend.clear_session()

Input_model_1 = Input(shape=(max_review_length,) ,name="Text_data")
layer11 = Embedding(vocab_size, 300 ,weights=[embedding_matrix],trainable=False ,name="layer11")
(Input_model_1)
layer21 = LSTM(units = 100,activation='relu',kernel_initializer='he_normal',return_sequences = Fals
e,name="layer21")(layer11)
layer41 = Flatten()(layer21)

Input_model_2 = Input(shape=(ncols,),name="Concat_input")
layer12 = Embedding(ncols + 1, 16 ,name="layer12")(Input_model_2)
layer22 = Conv1D(64, kernel_size = 10, activation='relu' ,name="layer22")(layer12)
pool_1 =  MaxPooling1D(pool_size=2)(layer22)
layer32 = Conv1D(32, kernel_size = 10, activation='relu' ,name="layer32")(pool_1)
layer42 = Flatten()(layer32)

concat_layer = concatenate(inputs=[layer41,layer42],name="concat")

layer2 = Dense(units=512,activation='relu',kernel_initializer='he_normal',name="layer2")(concat_lay
er)
norm_1 = BatchNormalization()(layer2)
```

```
layer3 = Dropout(0.25)(norm_1)
layer4 = Dense(units=256,activation='relu',kernel_initializer='he_normal',name="layer4")(layer3)
norm_2 = BatchNormalization()(layer4)
layer5 = Dense(units=128,activation='relu',kernel_initializer='he_normal',name="layer5")(norm_2)
norm_3 = BatchNormalization()(layer5)
layer6 = Dense(units=64,activation='relu',kernel_initializer='he_normal',name="layer6")(norm_3)

output = Dense(units=1,activation='sigmoid',kernel_initializer="glorot_uniform",name="output")(laye
r6)

model = Model(inputs=[Input_model_1,Input_model_2],outputs=output)
model.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
Concat_input (InputLayer)       [(None, 101)]        0
__________________________________________________________________________________________________
layer12 (Embedding)             (None, 101, 16)      1632        Concat_input[0][0]
__________________________________________________________________________________________________
Text_data (InputLayer)          [(None, 400)]        0
__________________________________________________________________________________________________
layer22 (Conv1D)                (None, 92, 64)       10304       layer12[0][0]
__________________________________________________________________________________________________
layer11 (Embedding)             (None, 400, 300)     15497100    Text_data[0][0]
__________________________________________________________________________________________________
max_pooling1d (MaxPooling1D)    (None, 46, 64)       0           layer22[0][0]
__________________________________________________________________________________________________
layer21 (LSTM)                  (None, 100)          160400      layer11[0][0]
__________________________________________________________________________________________________
layer32 (Conv1D)                (None, 37, 32)       20512       max_pooling1d[0][0]
__________________________________________________________________________________________________
flatten (Flatten)               (None, 100)          0           layer21[0][0]
__________________________________________________________________________________________________
flatten_1 (Flatten)             (None, 1184)         0           layer32[0][0]
__________________________________________________________________________________________________
concat (Concatenate)            (None, 1284)         0           flatten[0][0]
                                                                 flatten_1[0][0]
__________________________________________________________________________________________________
layer2 (Dense)                  (None, 512)          657920      concat[0][0]
__________________________________________________________________________________________________
batch_normalization (BatchNorma (None, 512)          2048        layer2[0][0]
__________________________________________________________________________________________________
dropout (Dropout)               (None, 512)          0           batch_normalization[0][0]
__________________________________________________________________________________________________
layer4 (Dense)                  (None, 256)          131328      dropout[0][0]
__________________________________________________________________________________________________
batch_normalization_1 (BatchNor (None, 256)          1024        layer4[0][0]
__________________________________________________________________________________________________
layer5 (Dense)                  (None, 128)          32896       batch_normalization_1[0][0]
__________________________________________________________________________________________________
batch_normalization_2 (BatchNor (None, 128)          512         layer5[0][0]
__________________________________________________________________________________________________
layer6 (Dense)                  (None, 64)           8256        batch_normalization_2[0][0]
__________________________________________________________________________________________________
output (Dense)                  (None, 1)            65          layer6[0][0]
==================================================================================================
Total params: 16,523,997
Trainable params: 1,025,105
Non-trainable params: 15,498,892
__________________________________________________________________________________________________
```

In [241]:

```
from sklearn.metrics import roc_auc_score
def auc(y_true, y_pred):
    return tf.py_func(roc_auc_score, (y_true, y_pred), tf.double)
```

In [242]:

```
#compile
model.compile(optimizer='adam',loss='binary_crossentropy',metrics = ["accuracy", auc])
```

In [243]:

```
from time import time
logs2 = r"C:\Users\Dewang\Desktop\AAIC notes\0.0 Assignments\AAIC classroom Assignments\logs\ex3"
tensorboard = TensorBoard(log_dir = logs2 )
```

In [244]:

```
class_weights = {0: 1,
                1: 0.2}
```

In [245]:

```
#train
model.fit([pad_docs_train, concat_array_train],y_train,
           batch_size=256,epochs=10,
           validation_data= ([pad_docs_test,concat_array_test],y_test),class_weight = class_weights
         ,callbacks = [tensorboard])
```

```
Train on 87398 samples, validate on 21850 samples
Epoch 1/10
87398/87398 [==============================] - 546s 6ms/sample - loss: 0.2305 - acc: 0.5756 - auc:
0.5344 - val_loss: 0.6402 - val_acc: 0.8486 - val_auc: 0.5170
Epoch 2/10
87398/87398 [==============================] - 546s 6ms/sample - loss: 0.2204 - acc: 0.6201 - auc:
0.5768 - val_loss: 0.6936 - val_acc: 0.5209 - val_auc: 0.5219
Epoch 3/10
87398/87398 [==============================] - 558s 6ms/sample - loss: 0.2169 - acc: 0.6335 - auc:
0.6068 - val_loss: 0.6650 - val_acc: 0.8414 - val_auc: 0.5246
Epoch 4/10
87398/87398 [==============================] - 527s 6ms/sample - loss: 0.2147 - acc: 0.6387 - auc:
0.6239 - val_loss: 0.6180 - val_acc: 0.8486 - val_auc: 0.5431
Epoch 5/10
87398/87398 [==============================] - 528s 6ms/sample - loss: 0.2129 - acc: 0.6458 - auc:
0.6352 - val_loss: 0.6631 - val_acc: 0.8078 - val_auc: 0.5630
Epoch 6/10
87398/87398 [==============================] - 526s 6ms/sample - loss: 0.2112 - acc: 0.6497 - auc:
0.6471 - val_loss: 0.6115 - val_acc: 0.8484 - val_auc: 0.5450
Epoch 7/10
87398/87398 [==============================] - 525s 6ms/sample - loss: 0.2094 - acc: 0.6563 - auc:
0.6580 - val_loss: 0.5731 - val_acc: 0.8486 - val_auc: 0.5539
Epoch 8/10
87398/87398 [==============================] - 533s 6ms/sample - loss: 0.2080 - acc: 0.6567 - auc:
0.6660 - val_loss: 0.6101 - val_acc: 0.8333 - val_auc: 0.5605
Epoch 9/10
87398/87398 [==============================] - 534s 6ms/sample - loss: 0.2068 - acc: 0.6606 - auc:
0.6739 - val_loss: 0.5590 - val_acc: 0.8290 - val_auc: 0.5790
Epoch 10/10
87398/87398 [==============================] - 546s 6ms/sample - loss: 0.2047 - acc: 0.6665 - auc:
0.6846 - val_loss: 0.5887 - val_acc: 0.8335 - val_auc: 0.5519
```

Out[245]:

```
<tensorflow.python.keras.callbacks.History at 0x2438487e080>
```

In [246]:

```
model_json = model.to_json()
with open("model3.json", "w") as json_file:
    json_file.write(model_json)

model.save_weights("model3.h5")
print("Saved model to disk")
```

```
Saved model to disk
```

In [247]:

```
from tensorflow.keras.models import model_from_json
json_file = open('model3.json', 'r')
loaded_model_json = json_file.read()
loaded_model_json = json_file.read()
json_file.close()

loaded_model = model_from_json(loaded_model_json)
# load weights into new model
loaded_model.load_weights("model3.h5")
print("Loaded model from disk")
```

```
Loaded model from disk
```

In [ ]:

```
#compile
loaded_model.compile(optimizer='adam',loss='binary_crossentropy',metrics = ["accuracy", auc])
```

In [ ]:

```
score =
loaded_model.evaluate([pad_idf_test,state_enc_test,grade_enc_test,category_test,subcategory_test,p
refix_enc_test,remain_test],y_test,
           callbacks = [tensorboard])
print('Test score:', score[0])
print('Test accuracy:', score[1])
```