Assignment : 14

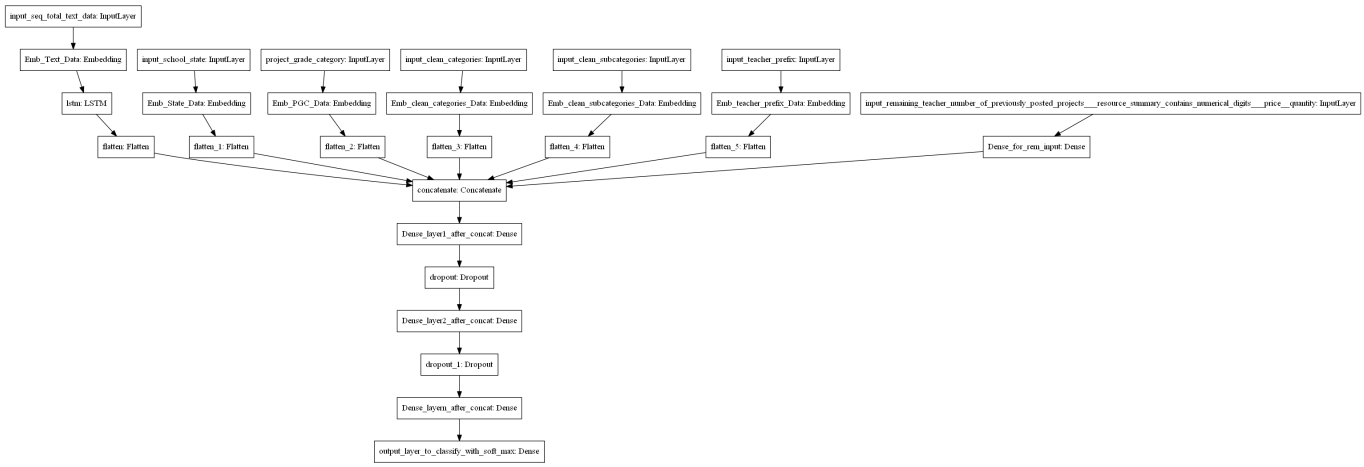
1. You can work with preprocessed_data.csv for the assignment. You can get the data fro
2. Load the data in your notebook.
3. After step 2 you have to train 3 types of models as discussed below.
4. For all the model use 'auc' as a metric. check this and this for using auc as a metr
5. You are free to choose any number of layers/hiddden units but you have to use same t
6. You can use any one of the optimizers and choice of Learning rate and momentum.
7. For all the model's use TensorBoard and plot the Metric value and Loss with epoch. W
8. Make sure that you are using GPU to train the given models.

```
#you can use gdown modules to import dataset for the assignment
#for importing any file from drive to Colab you can write the syntax as !gdown --id file_i
#you can run the below cell to import the required preprocessed data.csv file and glove ve


!gdown --id 1GpATd_pM4mcnWWIs28-s1lgqdAg2Wdv-
!gdown --id 1pGd5tLwA30M7wkbJKdXHaae9tYVDICJ_
```

```
Downloading...
From: https://drive.google.com/uc?id=1GpATd_pM4mcnWWIs28-s1lgqdAg2Wdv-
To: /content/preprocessed_data.csv
100% 124M/124M [00:04<00:00, 30.0MB/s]
Downloading...
From: https://drive.google.com/uc?id=1pGd5tLwA30M7wkbJKdXHaae9tYVDICJ_
To: /content/glove_vectors
100% 128M/128M [00:05<00:00, 25.0MB/s]
```

Model-1

Build and Train deep neural network as shown below



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._quantity** ---concatenate remaining columns and add a Dense layer after that.

Below is an example of embedding layer for a categorical columns. In below code all are dummy values, we gave only for referance.

```
# https://stats.stackexchange.com/questions/270546/how-does-keras-embedding-layer-work
input_layer = Input(shape=(n,))
embedding = Embedding(no_1, no_2, input_length=n)(input_layer)
flatten = Flatten()(embedding)
```

1. Go through this blog, if you have any doubt on using predefined Embedding values in Embedding layer - https://machinelearningmastery.com/use-word-embedding-layers-deep-learning-keras/

2. Please go through this link https://keras.io/getting-started/functional-api-guide/ and check the 'Multi-input and multi-output models' then you will get to know how to give multiple inputs.

Model-1

```
# import all the libraries
```

```
#make sure that you import your libraries from tf.keras and not just keras
import tensorflow
from tensorflow.keras.layers import Input,Dense,LSTM
```

```
#read the csv file
import pandas as pd
df = pd.read_csv('preprocessed_data.csv',nrows=100000)
```

```
df.head()
```

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previous
0	ca	mrs	grades_prek_2	
1	ut	ms	grades_3_5	
2	ca	mrs	grades_prek_2	
3	ga	mrs	grades_prek_2	
4	wa	mrs	grades_3_5	

```
df.columns
```

```
Index(['school_state', 'teacher_prefix', 'project_grade_category',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
```

```
       'clean_categories', 'clean_subcategories', 'essay', 'price'],
      dtype='object')
```

```
X = df.drop(['project_is_approved'],axis=1)
Y = df['project_is_approved']
X.head(3)
```

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previous
0	ca	mrs	grades_prek_2	
1	ut	ms	grades_3_5	
2	ca	mrs	grades_prek_2	

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.20, stratify =Y)
#X_train, X_cv , y_train, y_cv  = train_test_split(X_train,y_train, test_size =0.25, strat
```

```
from numpy import zeros
import os
import sys
import numpy as np
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.layers import Dense, Input, Flatten, LSTM, GlobalMaxPool1D
from tensorflow.keras.layers import Conv1D, MaxPooling1D, Embedding
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.initializers import Constant
import pickle
from tqdm import tqdm
import tensorflow as tf
from tensorflow.keras import layers
```

1.1 Text Vectorization

```
from google.colab import files
files=files.upload()
```

Choose Files glove_vectors

- **glove_vectors**(n/a) - 127506004 bytes, last modified: 5/29/2019 - 100% done

```
Saving glove_vectors to glove_vectors (1)
```

```
#since the data is already preprocessed, we can directly move to vectorization part
#first we will vectorize the text data
#for vectorization of text data in deep learning we use tokenizer, you can go through belo
# https://www.kdnuggets.com/2020/03/tensorflow-keras-tokenization-text-data-prep.html
#https://stackoverflow.com/questions/51956000/what-does-keras-tokenizer-method-exactly-do
# after text vectorization you should get train_padded_docs and test_padded_docs

# Using tokenizer:
t = Tokenizer()
t.fit_on_texts(X_train['essay'].values)
vocab_size = len(t.word_index) + 1

print(vocab_size)

X_train_essay_pre_seq = t.texts_to_sequences(X_train['essay'].values)
X_test_essay_pre_seq = t.texts_to_sequences(X_test['essay'].values)


# padd sequence
max_length = 600
X_train_essay_pad_seq = pad_sequences(X_train_essay_pre_seq,maxlen=max_length)
X_test_essay_pad_seq = pad_sequences(X_test_essay_pre_seq,maxlen=max_length)

embeddings_index = dict()

f = open("glove_vectors", "rb")
text = f.read().decode(errors='replace')

for line in f:
    values = line.split()
    word = values[0]
    coefs = np.asarray(values[1:], dtype='float32')
    embeddings_index[word] = coefs
f.close()


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

```
        embedding_matrix[i] = embedding_vector

# define feature
essay_input = Input(shape=(600,), name="essay")
essay_feature = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=4, tra
#essay_feature = Embedding(input_dim=vocab_size + 1, output_dim= 300, weights=[embedding_m
essay_feature = LSTM(100)(essay_feature)
essay_feature = Flatten()(essay_feature)
```

```
49952
```

```
embedding_matrix
```

```
array([[0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 0.],
       ...,
       [0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 0.]])
```

```
#after getting the padded_docs you have to use predefined glove vectors to get 300 dim rep
# we will be storing this data in form of an embedding matrix and will use it while defini
# Please go through following blog's 'Example of Using Pre-Trained GloVe Embedding' sectio
# https://machinelearningmastery.com/use-word-embedding-layers-deep-learning-keras/
```

1.2 Categorical feature Vectorization

```
# for model 1 and model 2, we have to assign a unique number to each feature in a particul
# you can either use tokenizer,label encoder or ordinal encoder to perform the task
# label encoder gives an error for 'unseen values' (values present in test but not in trai
# handle unseen values with label encoder - https://stackoverflow.com/a/56876351
# ordinal encoder also gives error with unseen values but you can use modify handle_unknow
# documentation of ordianl encoder https://scikit-learn.org/stable/modules/generated/sklea
# after categorical feature vectorization you will have column_train_data and column_test_
```

```
# Apply tokenizer: [Input_school_state]
t2 = Tokenizer()
t2.fit_on_texts(X_train['school_state'].values)
vocab_size = len(t2.word_index) + 1

X_train_school_state_pre_seq = t2.texts_to_sequences(X_train['school_state'])
X_test_school_state_pre_seq = t2.texts_to_sequences(X_test['school_state'])

max_length = 1
```

```
X_train_school_state_pad_seq = pad_sequences(X_train_school_state_pre_seq,maxlen=max_lengt
X_test_school_state_pad_seq = pad_sequences(X_test_school_state_pre_seq,maxlen=max_length)

print(vocab_size)

embedding_size = min(vocab_size ,50)
school_state_input = Input(shape=(1,), name="school_state")
school_state_feature = Embedding(input_dim=vocab_size +1,output_dim=embedding_size)(school
#school_state_feature = Embedding(input_dim = vocab_size+1, output_dim = 2, input_length =
school_state_feature = Flatten()(school_state_feature)
```

```
52
```

```
X_train_school_state_pad_seq.shape
```

```
(80000, 1)
```

```
#[Project Grade Category]:
# Apply tokenizer

t3 = Tokenizer()
t3.fit_on_texts(X_train['project_grade_category'].values)
vocab_size = len(t3.word_index) + 1

print(vocab_size)

X_train_project_grade_category_pre_seq = t3.texts_to_sequences(X_train['project_grade_cate
X_test_project_grade_category_pre_seq = t3.texts_to_sequences(X_test['project_grade_catego

max_length = 5
X_train_project_grade_category_pad_seq = pad_sequences(X_train_project_grade_category_pre_
X_test_project_grade_category_pad_seq = pad_sequences(X_test_project_grade_category_pre_se

embedding_size = min(vocab_size ,50)

project_grade_category_input = Input(shape=(5,), name="project_grade_category")
project_grade_category_feature = Embedding(input_dim=vocab_size +1,output_dim=embedding_si
project_grade_category_feature = Flatten()(project_grade_category_feature)
```

```
10
```

```
X_train_project_grade_category_pad_seq
```

```
array([[0, 0, 1, 4, 5],
       [0, 0, 1, 6, 7],
       [0, 0, 1, 4, 5],
       ...,
       [0, 0, 1, 4, 5],
       [0, 0, 1, 4, 5],
       [0, 0, 1, 2, 3]], dtype=int32)
```

```
#[project_subject_categories]
# Apply tokenizer
```

```
t4 = Tokenizer()
t4.fit_on_texts(X_train['clean_categories'].values)
vocab_size = len(t4.word_index) + 1

print(vocab_size)

X_train_clean_categories_pre_seq = t4.texts_to_sequences(X_train['clean_categories'])
X_test_clean_categories_pre_seq = t4.texts_to_sequences(X_test['clean_categories'])

max_length = 5
X_train_clean_categories_pad_seq = pad_sequences(X_train_clean_categories_pre_seq,maxlen=m
X_test_clean_categories_pad_seq = pad_sequences(X_test_clean_categories_pre_seq,maxlen=max

embedding_size = min(vocab_size ,50)

project_subject_categories_input = Input(shape=(5,), name="clean_categories")
project_subject_categories_feature = Embedding(input_dim=vocab_size +1,output_dim=embeddir
project_subject_categories_feature = Flatten()(project_subject_categories_feature)
```

```
16
```

```
X_train_clean_categories_pad_seq[9]
```

```
array([0, 0, 8, 1, 2], dtype=int32)
```

```
#project_subject_subcategories
# Apply tokenizer

t5 = Tokenizer()
t5.fit_on_texts(X_train['clean_subcategories'].values)
vocab_size = len(t5.word_index) + 1

print(vocab_size)

X_train_clean_subcategories_pre_seq = t5.texts_to_sequences(X_train['clean_subcategories']
X_test_clean_subcategories_pre_seq = t5.texts_to_sequences(X_test['clean_subcategories'])

max_length = 5
X_train_clean_subcategories_pad_seq = pad_sequences(X_train_clean_subcategories_pre_seq,ma
X_test_clean_subcategories_pad_seq = pad_sequences(X_test_clean_subcategories_pre_seq,maxl

embedding_size = min(vocab_size ,50)

project_subject_subcategories_input = Input(shape=(5,), name="clean_subcategories")
project_subject_subcategories_feature = Embedding(input_dim=vocab_size +1,output_dim=embed
project_subject_subcategories_feature = Flatten()(project_subject_subcategories_feature)
```

```
38
```

```
X_train_clean_subcategories_pad_seq
```

```
array([[ 0,  0,  0,  1, 24],
```

```
       [ 0,  0,  0, 18, 25],
       [ 0,  0,  0,  0,  1],
       ...,
       [ 0,  0,  3,  4,  2],
       [ 0,  0,  0,  5,  7],
       [ 0,  0,  0,  0,  1]], dtype=int32)
```

```
#[teacher_prefix]
# prepare tokenizer
t6 = Tokenizer()
t6.fit_on_texts(X_train['teacher_prefix'].values)
#t6.fit_on_texts(np.array_str(X_train['teacher_prefix'].values))
vocab_size = len(t6.word_index) + 1

print(vocab_size)

X_train_teacher_prefix_pre_seq = t6.texts_to_sequences(X_train['teacher_prefix'])
X_test_teacher_prefix_pre_seq = t6.texts_to_sequences(X_test['teacher_prefix'])

max_length = 1
X_train_teacher_prefix_pad_seq = pad_sequences(X_train_teacher_prefix_pre_seq,maxlen=max_l
X_test_teacher_prefix_pad_seq = pad_sequences(X_test_teacher_prefix_pre_seq,maxlen=max_ler

embedding_size = min(vocab_size ,50)

teacher_prefix_input = Input(shape=(1,), name="teacher_prefix")
teacher_prefix_feature = Embedding(input_dim=vocab_size +1,output_dim=embedding_size)(teac
teacher_prefix_feature = Flatten()(teacher_prefix_feature)
```

```
6
```

```
X_train_teacher_prefix_pad_seq.shape
```

```
(80000, 1)
```

1.3 Numerical feature Vectorization

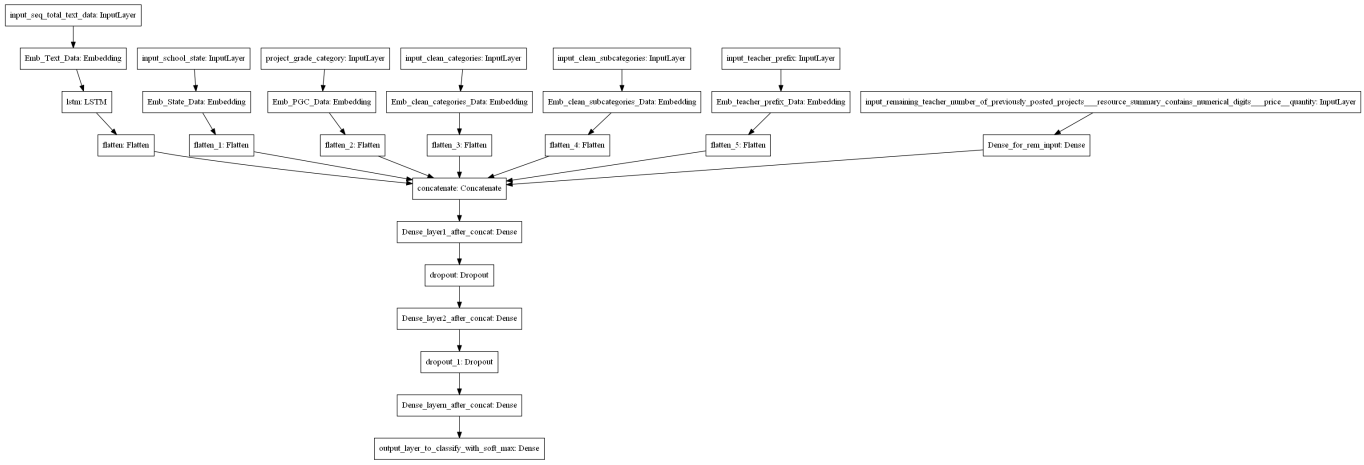
```
# you have to standardise the numerical columns
# stack both the numerical features
#after numerical feature vectorization you will have numerical_data_train and numerical_da


#[teacher_number_of_previously_posted_projects]
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import Normalizer

normalizer = Normalizer()
scaler = StandardScaler()

normalizer.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1
X_train_teacher_number_of_previously_posted_project = normalizer.transform(X_train['teache
X_test_teacher_number_of_previously_posted_project = normalizer.transform(X_test['teacher_
```

```
normalizer.fit(X_train['price'].values.reshape(1,-1))
X_train_price_norm = scaler.fit_transform(X_train['price'].values.reshape(1,-1))
X_test_price_norm = scaler.fit_transform(X_test['price'].values.reshape(1,-1))

# to cancatenate numeric feature reshaping array
X_train_price_norm = X_train_price_norm.reshape(-1,1)
X_test_price_norm = X_test_price_norm.reshape(-1,1)

X_train_num_teacher_number_of_previously_posted_projects_and_price = np.hstack((X_train_te
X_test_num_teacher_number_of_previously_posted_projects_and_price = np.hstack((X_test_teac

numerical_input = Input(shape=(2,))
numeric_dense = Dense(10)(numerical_input )



#Merge all layers:

from keras.layers.merge import concatenate
from keras.layers import Dropout

# concat all embeddings
merge = concatenate([essay_feature,school_state_feature,project_grade_category_feature,pro
                     teacher_prefix_feature,numeric_dense])
dense1 = Dense(100, activation='relu', kernel_initializer='he_normal')(merge)
drop_out_layer1 = Dropout(0.6)(dense1)
dense2 = Dense(100, activation='relu', kernel_initializer='he_normal')(drop_out_layer1)
drop_out_layer2 = Dropout(0.6)(dense2)
dense3 = Dense(50, activation='relu', kernel_initializer='he_normal')(drop_out_layer2)


output =Dense(2, activation='softmax')(dense3)
model = Model(inputs=[essay_input,school_state_input,project_grade_category_input,project_
                      project_subject_subcategories_input,teacher_prefix_input,numerical_i
model.compile(optimizer=tf.keras.optimizers.Adam(lr=0.0001), loss='categorical_crossentrop
model.summary()
```

```
      teacher_prefix (InputLayer)    [(None, 1)]          0           []

      lstm (LSTM)                    (None, 100)          160400      ['embedding[0][0]

      embedding_1 (Embedding)        (None, 1, 50)        2650        ['school_state[0]

      embedding_2 (Embedding)        (None, 5, 10)        110         ['project_grade_c

      embedding_3 (Embedding)        (None, 5, 16)        272         ['clean_categorie

      embedding_4 (Embedding)        (None, 5, 38)        1482        ['clean_subcatego

      embedding_5 (Embedding)        (None, 1, 6)         42          ['teacher_prefix[

      input_2 (InputLayer)           [(None, 2)]          0           []

      flatten (Flatten)              (None, 100)          0           ['lstm[0][0]']

      flatten_1 (Flatten)            (None, 50)           0           ['embedding_1[0][
```

```
flatten_2 (Flatten)            (None, 50)           0           ['embedding_2[0][

flatten_3 (Flatten)            (None, 80)           0           ['embedding_3[0][

flatten_4 (Flatten)            (None, 190)          0           ['embedding_4[0][

flatten_5 (Flatten)            (None, 6)            0           ['embedding_5[0][

dense (Dense)                  (None, 10)           30          ['input_2[0][0]']

concatenate (Concatenate)      (None, 486)          0           ['flatten[0][0]',
                                                                 'flatten_1[0][0]
                                                                 'flatten_2[0][0]
                                                                 'flatten_3[0][0]
                                                                 'flatten_4[0][0]
                                                                 'flatten_5[0][0]
                                                                 'dense[0][0]']

dense_1 (Dense)                (None, 100)          48700       ['concatenate[0][

dropout (Dropout)              (None, 100)          0           ['dense_1[0][0]']

dense_2 (Dense)                (None, 100)          10100       ['dropout[0][0]']

dropout_1 (Dropout)            (None, 100)          0           ['dense_2[0][0]']

dense_3 (Dense)                (None, 50)           5050        ['dropout_1[0][0]

dense_4 (Dense)                (None, 2)            102         ['dense_3[0][0]']

==================================================================================================
Total params: 15,214,538
Trainable params: 228,938
Non-trainable params: 14,985,600
__________________________________________________________________________________________________
/usr/local/lib/python3.7/dist-packages/keras/optimizer_v2/adam.py:105: UserWarning
  super(Adam, self).__init__(name, **kwargs)
```

1.4 Defining the model



```
# as of now we have vectorized all our features now we will define our model.
# as it is clear from above image that the given model has multiple input layers and hence
# Please go through - https://keras.io/guides/functional_api/
# it is a good programming practise to define your complete model i.e all inputs , interme
# while defining your model make sure that you use variable names while defining any lengt
#for ex.- you should write the code as 'input_text = Input(shape=(pad_length,))' and not a
# the embedding layer for text data should be non trainable
# the embedding layer for categorical data should be trainable
# https://stats.stackexchange.com/questions/270546/how-does-keras-embedding-layer-work
# https://towardsdatascience.com/deep-embeddings-for-categorical-variables-cat2vec-b05c8ab
#print model.summary() after you have defined the model
#plot the model using utils.plot_model module and make sure that it is similar to the abov


%load_ext tensorboard

# Clear any logs from previous runs
!rm -rf ./logs/

import tensorflow as tf
import datetime

log_dir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1, wr
```

```
WARNING:tensorflow:`write_grads` will be ignored in TensorFlow 2.0 for the `TensorBo
```

```
y_tr_ohe =pd.get_dummies(y_train)
y_test_ohe = pd.get_dummies(y_test)


import keras
import numpy as np
import sklearn.metrics as sklm


class Metrics(keras.callbacks.Callback):

    def __init__(self,training_data,validation_data):
        self.x = training_data[0]
        self.y = training_data[1]
        self.x_val = validation_data[0]
        self.y_val = validation_data[1]

    def on_train_begin(self, logs={}):
        self.auc_tr = []
        self.auc_te = []

    def on_epoch_end(self, epoch, logs={}):
        score_train = np.asarray(self.model.predict(self.x))
        score_test = np.asarray(self.model.predict(self.x_val))
        #predict = np.round(np.asarray(self.model.predict(self.validation_data[0])))
        #targ_train = validation_data[1]
```

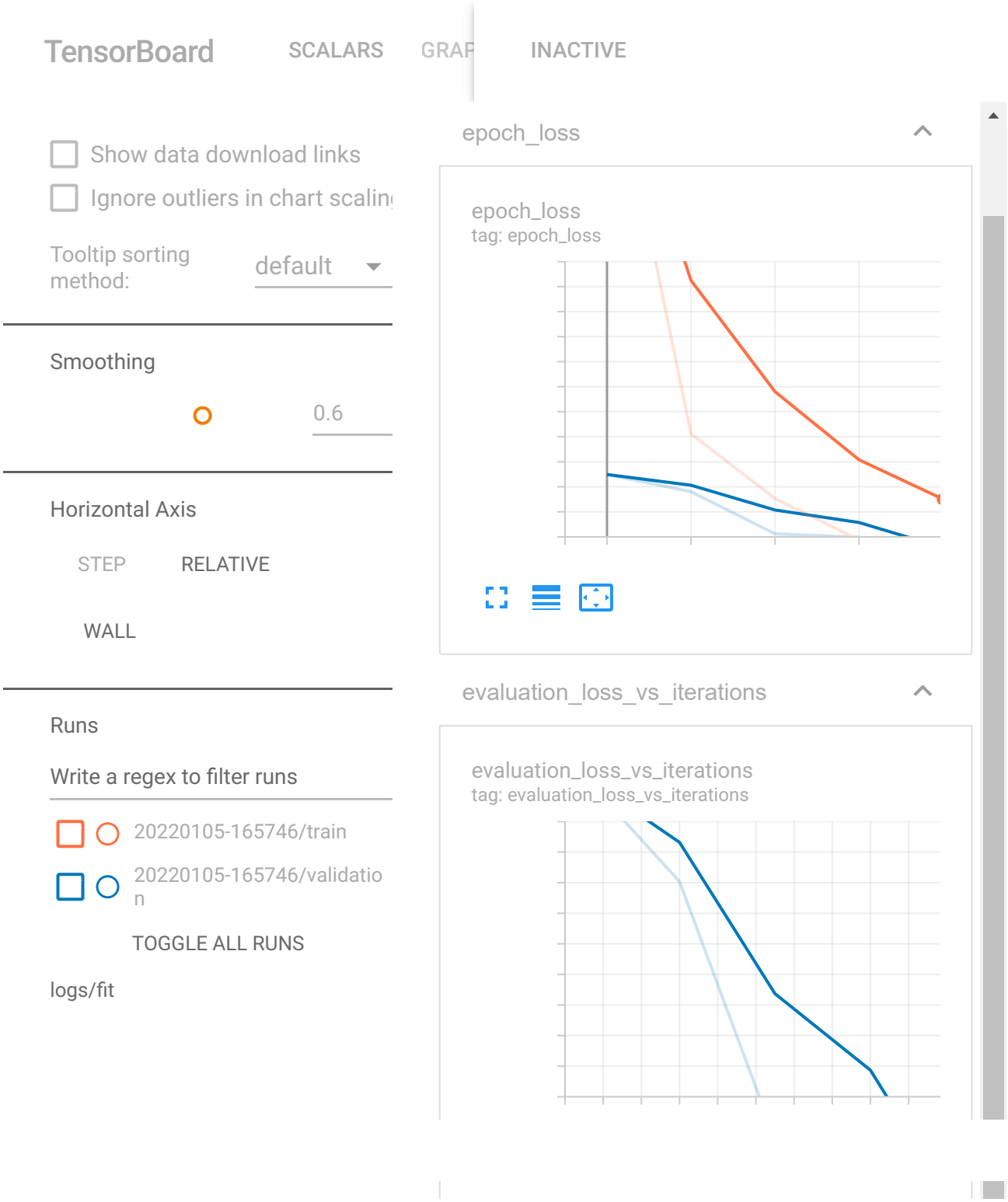
```
        auc_train =sklm.roc_auc_score(self.y, score_train)
        auc_test =sklm.roc_auc_score(self.y_val, score_test)
        self.auc_tr.append(auc_train)
        self.auc_te.append(auc_test)
        #print("  auc: "+"{:.4f}".format(auc));
        print(' roc-auc_train: %s - roc-auc_test: %s' % (str(round(auc_train,4)),str(round
        return

validation_data=([X_test_essay_pad_seq,X_test_school_state_pad_seq,X_test_project_grade_ca
                          X_test_clean_subcategories_pad_seq,X_test_teacher_prefix_pad_s
training_data =([X_train_essay_pad_seq,X_train_school_state_pad_seq,X_train_project_grade_
          X_train_teacher_prefix_pad_seq,X_train_num_teacher_number_of_previously_posted_

metrics = Metrics(training_data,validation_data)
```

1.5 Compiling and fititng your model

```
#define custom auc as metric , do not use tf.keras.metrics
# https://stackoverflow.com/a/46844409 - custom AUC reference 1
# https://www.kaggle.com/c/santander-customer-transaction-prediction/discussion/80807  - c
# compile and fit your model

model.fit([X_train_essay_pad_seq,X_train_school_state_pad_seq,X_train_project_grade_catego
          X_train_teacher_prefix_pad_seq,X_train_num_teacher_number_of_previously_posted_
          validation_data=([X_test_essay_pad_seq,X_test_school_state_pad_seq,X_test_projec
                          X_test_clean_subcategories_pad_seq,X_test_teacher_prefix_pad_s
          callbacks=[tensorboard_callback, metrics])
```

```
Epoch 1/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4445 roc-auc_train: 0
2500/2500 [==============================] - 2689s 1s/step - loss: 0.4445 - val_loss
Epoch 2/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4281 roc-auc_train: 0
2500/2500 [==============================] - 2675s 1s/step - loss: 0.4281 - val_loss
Epoch 3/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4255 roc-auc_train: 0
2500/2500 [==============================] - 2673s 1s/step - loss: 0.4255 - val_loss
Epoch 4/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4239 roc-auc_train: 0
2500/2500 [==============================] - 2607s 1s/step - loss: 0.4239 - val_loss
Epoch 5/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4235 roc-auc_train: 0
2500/2500 [==============================] - 2655s 1s/step - loss: 0.4235 - val_loss
<keras.callbacks.History at 0x7fe76a5b1f10>
```

```
tensorboard --logdir logs/fit
```



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 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 ca sentence of train and test data and include only those features(words) which are present
5. Perform tokenization on the modified text data same as you have done for previous mod
6. Create embedding matrix for model 2 and then use the rest of the features similar to
7. Define the model, compile and fit the model.

```
from sklearn.feature_extraction.text import TfidfVectorizer
import matplotlib.pyplot as plt

vectorizer = TfidfVectorizer()

# encoding eassay
train_tf=vectorizer.fit(X_train['essay'].values) # fit has to happen only on train data
idf_scores = train_tf.idf_

# generate boxplot on idf_ values

#plt.boxplot([vectorizer.idf_])

#q75, q25 = np.percentile(idf_scores, [75 ,25])
#print(q75, q25)

#listofNum = list(filter(lambda x : x >= q25 and x <= q75, vectorizer.idf_))

filtered_indices = np.argwhere(((idf_scores> 2) & (idf_scores < 11) ))
filtered_indices = [idx[0] for idx in filtered_indices]

vocabulary = train_tf.get_feature_names()

#preparing a set with filtered vocabulary
filtered_voc = {vocabulary[i] for i in filtered_indices}
#removing the words (which are not in filtered voc) from essays

filtered_text_list = []
for text in X_train['essay'].values:
  text_word_list = [word for word in text.split() if word in filtered_voc]
  filtered_text_list.append(' '.join(text_word_list))
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarnin
  warnings.warn(msg, category=FutureWarning)
```

```
# prepare tokenizer
t_1 = Tokenizer()
```

```
t_1.fit_on_texts(filtered_text_list)
vocab_size = len(t_1.word_index) + 1

print(vocab_size)

X_train_essay_pre_seq2 = t_1.texts_to_sequences(X_train['essay'].values)
X_test_essay_pre_seq2 = t_1.texts_to_sequences(X_test['essay'].values)

# padd sequence

max_length = 600
X_train_essay_pad_seq2 = pad_sequences(X_train_essay_pre_seq2,maxlen=max_length)
X_test_essay_pad_seq2 = pad_sequences(X_test_essay_pre_seq2,maxlen=max_length)

embeddings_index = dict()

f = open("glove_vectors", "rb")
text = f.read().decode(errors='replace')

for line in f:
  values = line.split()
  word = values[0]
  coefs = np.asarray(values[1:], dtype='float32')
  embeddings_index[word] = coefs
f.close()

# create a weight matrix for words in training docs
embedding_matrix = zeros((vocab_size, 300))
for word, i in t_1.word_index.items():
  embedding_vector = embeddings_index.get(word)
  if embedding_vector is not None:
    embedding_matrix[i] = embedding_vector

# define feature

essay_input = Input(shape=(600,), name="essay")
essay_feature = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=4, tra
#essay_feature = Embedding(input_dim=vocab_size + 1, output_dim= 300, weights=[embedding_m
essay_feature = LSTM(100)(essay_feature)
essay_feature = Flatten()(essay_feature)
```

```
24730
```

```
y_tr_ohe =pd.get_dummies(y_train)
y_test_ohe = pd.get_dummies(y_test)


validation_data=([X_test_essay_pad_seq2,X_test_school_state_pad_seq,X_test_project_grade_c
                            X_test_clean_subcategories_pad_seq,X_test_teacher_prefix_pad_s


training_data =([X_train_essay_pad_seq2,X_train_school_state_pad_seq,X_train_project_grade
           X_train_teacher_prefix_pad_seq,X_train_num_teacher_number_of_previously_posted_
```

```
from keras.layers.merge import concatenate
from keras.layers import Dropout

# concat all embeddings
merge = concatenate([essay_feature,school_state_feature,project_grade_category_feature,pro
                     teacher_prefix_feature,numeric_dense])
dense1 = Dense(100, activation='relu', kernel_initializer='he_normal')(merge)
drop_out_layer1 = Dropout(0.5)(dense1)
dense2 = Dense(100, activation='relu', kernel_initializer='he_normal')(drop_out_layer1)
drop_out_layer2 = Dropout(0.5)(dense2)
dense3 = Dense(50, activation='relu', kernel_initializer='he_normal')(drop_out_layer2)

output =Dense(2, activation='softmax')(dense3)
model = Model(inputs=[essay_input,school_state_input,project_grade_category_input,project_
                      project_subject_subcategories_input,teacher_prefix_input,numerical_i
model.compile(optimizer=tf.keras.optimizers.Adam(lr=0.0001), loss='categorical_crossentrop
model.summary()
```

```
teacher_prefix (InputLayer)    [(None, 1)]          0           []

lstm_1 (LSTM)                  (None, 100)          160400      ['embedding_6[0][

embedding_1 (Embedding)        (None, 1, 50)        2650        ['school_state[0]

embedding_2 (Embedding)        (None, 5, 10)        110         ['project_grade_c

embedding_3 (Embedding)        (None, 5, 16)        272         ['clean_categorie

embedding_4 (Embedding)        (None, 5, 38)        1482        ['clean_subcatego

embedding_5 (Embedding)        (None, 1, 6)         42          ['teacher_prefix[

input_2 (InputLayer)           [(None, 2)]          0           []

flatten_6 (Flatten)            (None, 100)          0           ['lstm_1[0][0]']

flatten_1 (Flatten)            (None, 50)           0           ['embedding_1[0][

flatten_2 (Flatten)            (None, 50)           0           ['embedding_2[0][

flatten_3 (Flatten)            (None, 80)           0           ['embedding_3[0][

flatten_4 (Flatten)            (None, 190)          0           ['embedding_4[0][

flatten_5 (Flatten)            (None, 6)            0           ['embedding_5[0][

dense (Dense)                  (None, 10)           30          ['input_2[0][0]']

concatenate_1 (Concatenate)    (None, 486)          0           ['flatten_6[0][0]
                                                                 'flatten_1[0][0]
                                                                 'flatten_2[0][0]
                                                                 'flatten_3[0][0]
                                                                 'flatten_4[0][0]
                                                                 'flatten_5[0][0]
                                                                 'dense[0][0]']

dense_5 (Dense)                (None, 100)          48700       ['concatenate_1[0
```

```
 dense_5 (Dense)                (None, 100)          48700       [ concatenate_1[0

 dropout_2 (Dropout)            (None, 100)          0           ['dense_5[0][0]']

 dense_6 (Dense)                (None, 100)          10100       ['dropout_2[0][0]

 dropout_3 (Dropout)            (None, 100)          0           ['dense_6[0][0]']

 dense_7 (Dense)                (None, 50)           5050        ['dropout_3[0][0]

 dense_8 (Dense)                (None, 2)            102         ['dense_7[0][0]']

==================================================================================
Total params: 7,647,938
Trainable params: 228,938
Non-trainable params: 7,419,000
__________________________________________________________________________________
/usr/local/lib/python3.7/dist-packages/keras/optimizer_v2/adam.py:105: UserWarning
  super(Adam, self).__init__(name, **kwargs)
```

```
%load_ext tensorboard

# Clear any logs from previous runs
!rm -rf ./logs/

import tensorflow as tf
import datetime

log_dir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1, wr
```

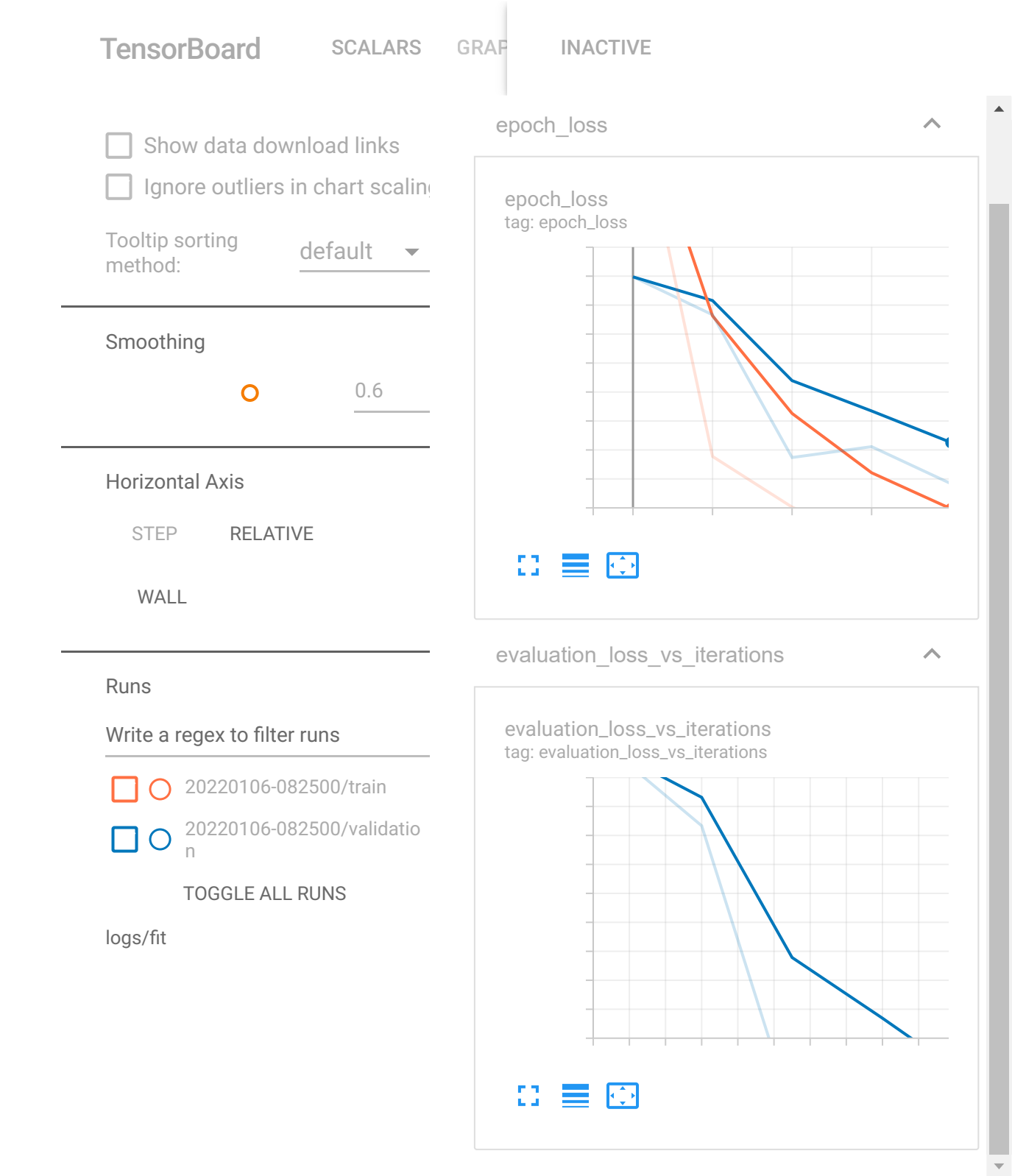
```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
WARNING:tensorflow:`write_grads` will be ignored in TensorFlow 2.0 for the `TensorBo
```

```
model.fit([X_train_essay_pad_seq2,X_train_school_state_pad_seq,X_train_project_grade_categ
           X_train_teacher_prefix_pad_seq,X_train_num_teacher_number_of_previously_posted_
          validation_data=([X_test_essay_pad_seq2,X_test_school_state_pad_seq,X_test_proje
                            X_test_clean_subcategories_pad_seq,X_test_teacher_prefix_pad_s
          callbacks=[tensorboard_callback, metrics])
```

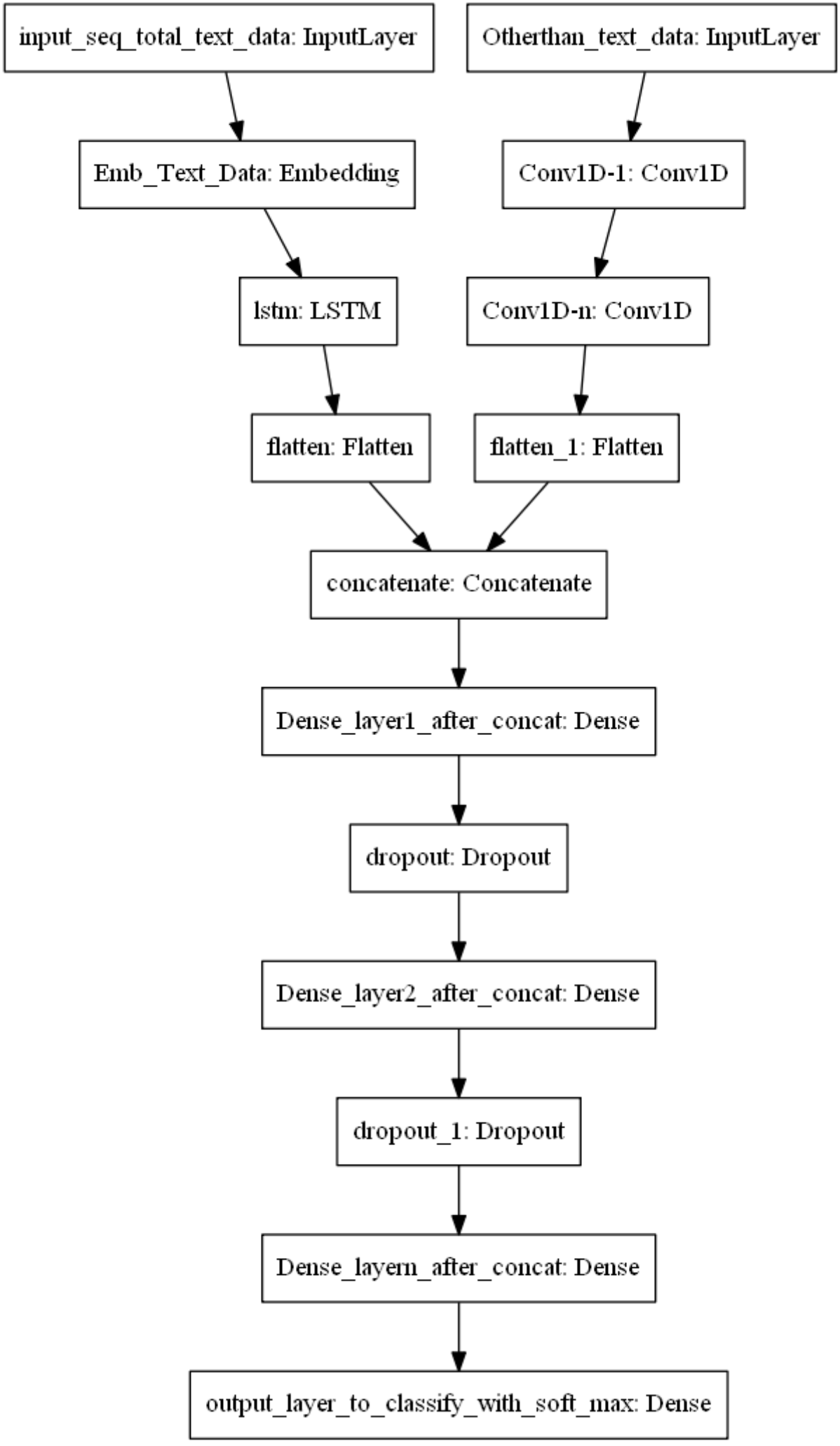
```
Epoch 1/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4397 roc-auc_train: 0
2500/2500 [==============================] - 2675s 1s/step - loss: 0.4397 - val_loss
Epoch 2/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4268 roc-auc_train: 0
2500/2500 [==============================] - 2737s 1s/step - loss: 0.4268 - val_loss
Epoch 3/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4250 roc-auc_train: 0
2500/2500 [==============================] - 2705s 1s/step - loss: 0.4250 - val_loss
Epoch 4/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4238 roc-auc_train: 0
2500/2500 [==============================] - 2754s 1s/step - loss: 0.4238 - val_loss
Epoch 5/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4233 roc-auc_train: 0
```

```
2500/2500 [==============================] - 2722s 1s/step - loss: 0.4233 - val_loss
<keras.callbacks.History at 0x7f33185fc4d0>
```

```
tensorboard --logdir logs/fit
```



Model-3


input_seq_total_text_data: InputLayer
Otherthan_text_data: InputLayer
Emb_Text_Data: Embedding
Conv1D-1: Conv1D
lstm: LSTM
Conv1D-n: Conv1D
flatten: Flatten
flatten_1: Flatten
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/fkQ8nGo.png

```
#in this model you can use the text vectorized data from model1
#for other than text data consider the following steps
# you have to perform one hot encoding of categorical features. You can use onehotencoder(
# Stack up standardised numerical features and all the one hot encoded categorical feature
#the input to conv1d layer is 3d, you can convert your 2d data to 3d using np.newaxis
# Note - deep learning models won't work with sparse features, you have to convert them to
```

School state

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer

vectorizer = CountVectorizer()
vectorizer.fit(X_train['school_state'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_state_ohe = vectorizer.transform(X_train['school_state'].values)
X_test_state_ohe = vectorizer.transform(X_test['school_state'].values)

print("After vectorizations")
print(X_train_state_ohe.shape, y_train.shape)
print(X_test_state_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(80000, 51) (80000,)
(20000, 51) (20000,)
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi', 'ia', 'id',
====================================================================================
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarnin
  warnings.warn(msg, category=FutureWarning)
```

encoding categorical features: project_grade_category

```
vectorizer = CountVectorizer()
vectorizer.fit(X_train['project_grade_category'].values) # fit has to happen only on trair

# we use the fitted CountVectorizer to convert the text to vector
X_train_grade_ohe = vectorizer.transform(X_train['project_grade_category'].values)
X_test_grade_ohe = vectorizer.transform(X_test['project_grade_category'].values)
```

```
print("After vectorizations")
print(X_train_grade_ohe.shape, y_train.shape)
print(X_test_grade_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(80000, 4) (80000,)
(20000, 4) (20000,)
['grades_3_5', 'grades_6_8', 'grades_9_12', 'grades_prek_2']
====================================================================================================
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarnin
  warnings.warn(msg, category=FutureWarning)
```

encoding categorical features: clean_categories

```
vectorizer = CountVectorizer()
vectorizer.fit(X_train['clean_categories'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_clean_categories_ohe = vectorizer.transform(X_train['clean_categories'].values)
X_test_clean_categories_ohe = vectorizer.transform(X_test['clean_categories'].values)

print("After vectorizations")
print(X_train_clean_categories_ohe.shape, y_train.shape)
print(X_test_clean_categories_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(80000, 9) (80000,)
(20000, 9) (20000,)
['appliedlearning', 'care_hunger', 'health_sports', 'history_civics', 'literacy_lang
====================================================================================================
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarnin
  warnings.warn(msg, category=FutureWarning)
```

encoding categorical features: clean_subcategories

```
vectorizer = CountVectorizer()
vectorizer.fit(X_train['clean_subcategories'].values) # fit has to happen only on train da

# we use the fitted CountVectorizer to convert the text to vector
X_train_clean_subcategories_ohe = vectorizer.transform(X_train['clean_subcategories'].valu
X_test_clean_subcategories_ohe = vectorizer.transform(X_test['clean_subcategories'].values

print("After vectorizations")
print(X_train_clean_subcategories_ohe.shape, y_train.shape)
print(X_test_clean_subcategories_ohe.shape, y_test.shape)
```

```
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(80000, 30) (80000,)
(20000, 30) (20000,)
['appliedsciences', 'care_hunger', 'charactereducation', 'civics_government', 'colle
====================================================================================
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarnin
  warnings.warn(msg, category=FutureWarning)
```

encoding categorical features: teacher_prefix

```
vectorizer = CountVectorizer()
vectorizer.fit(X_train['teacher_prefix'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_teacher_ohe = vectorizer.transform(X_train['teacher_prefix'].values)
X_test_teacher_ohe = vectorizer.transform(X_test['teacher_prefix'].values)

print("After vectorizations")
print(X_train_teacher_ohe.shape, y_train.shape)
print(X_test_teacher_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(80000, 5) (80000,)
(20000, 5) (20000,)
['dr', 'mr', 'mrs', 'ms', 'teacher']
====================================================================================
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarnin
  warnings.warn(msg, category=FutureWarning)
```

Numerical features - price & teacher_number_of_previously_posted_projects

```
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import Normalizer
normalizer = Normalizer()
scaler = StandardScaler()

normalizer.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1
X_train_teacher_number_of_previously_posted_project = normalizer.transform(X_train['teache
X_test_teacher_number_of_previously_posted_project = normalizer.transform(X_test['teacher_


normalizer.fit(X_train['price'].values.reshape(1,-1))
```

```
X_train_price_norm = scaler.fit_transform(X_train['price'].values.reshape(1,-1))
X_test_price_norm = scaler.fit_transform(X_test['price'].values.reshape(1,-1))

# to cancatenate numeric feature reshaping array
X_train_price_norm =X_train_price_norm.reshape(-1,1)
X_test_price_norm =X_test_price_norm.reshape(-1,1)
```

Concatenate all except essay feature

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
X_tr = hstack((X_train_state_ohe, X_train_teacher_ohe, X_train_grade_ohe,X_train_clean_cat
X_te = hstack((X_test_state_ohe, X_test_teacher_ohe, X_test_grade_ohe,X_test_clean_categor

print("Final Data matrix")
print(X_tr.shape, y_train.shape)
print(X_te.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(80000, 101) (80000,)
(20000, 101) (20000,)
====================================================================================================
```

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers

input_cat_data = keras.Input(shape=(101,1))

cov1 = layers.Conv1D(64,3,activation='relu')(input_cat_data)
cov2 = layers.Conv1D(64,3,activation='relu')(cov1)
flatten2 = Flatten()(cov2)


from keras.layers.merge import concatenate
from keras.layers import Dropout

# concat all embeddings
merge = concatenate([essay_feature,flatten2])
dense1 = Dense(100, activation='relu', kernel_initializer='he_normal')(merge)
drop_out_layer1 = Dropout(0.6)(dense1)
dense2 = Dense(100, activation='relu', kernel_initializer='he_normal')(drop_out_layer1)
drop_out_layer2 = Dropout(0.6)(dense2)
dense3 = Dense(50, activation='relu', kernel_initializer='he_normal')(drop_out_layer2)

output =Dense(2, activation='softmax')(dense3)
model = Model(inputs=[essay_input,input_cat_data], outputs=output)
model.compile(optimizer=tf.keras.optimizers.Adam(lr=0.0001), loss='categorical_crossentrop
model.summary()
```

```
Model: "model_2"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 essay (InputLayer)             [(None, 600)]        0           []

 input_7 (InputLayer)           [(None, 101, 1)]     0           []

 embedding_6 (Embedding)        (None, 600, 300)     7419000     ['essay[0][0]']

 conv1d_5 (Conv1D)              (None, 99, 64)       256         ['input_7[0][0]']

 lstm_1 (LSTM)                  (None, 100)          160400      ['embedding_6[0][0]

 conv1d_6 (Conv1D)              (None, 97, 64)       12352       ['conv1d_5[0][0]']

 flatten_6 (Flatten)            (None, 100)          0           ['lstm_1[0][0]']

 flatten_7 (Flatten)            (None, 6208)         0           ['conv1d_6[0][0]']

 concatenate_2 (Concatenate)    (None, 6308)         0           ['flatten_6[0][0]',
                                                                  'flatten_7[0][0]']

 dense_9 (Dense)                (None, 100)          630900      ['concatenate_2[0][

 dropout_4 (Dropout)            (None, 100)          0           ['dense_9[0][0]']

 dense_10 (Dense)               (None, 100)          10100       ['dropout_4[0][0]']

 dropout_5 (Dropout)            (None, 100)          0           ['dense_10[0][0]']

 dense_11 (Dense)               (None, 50)           5050        ['dropout_5[0][0]']

 dense_12 (Dense)               (None, 2)            102         ['dense_11[0][0]']

==================================================================================================
Total params: 8,238,160
Trainable params: 819,160
Non-trainable params: 7,419,000
__________________________________________________________________________________________________
/usr/local/lib/python3.7/dist-packages/keras/optimizer_v2/adam.py:105: UserWarning:
  super(Adam, self).__init__(name, **kwargs)
```

```
y_tr_ohe =pd.get_dummies(y_train)
y_test_ohe = pd.get_dummies(y_test)


import sklearn.metrics as metrics

#validation_data=([X_test_essay_pad_seq,X_te],y_test_ohe)
#training_data =([X_train_essay_pad_seq,X_tr],y_tr_ohe)

#metrics = Metrics(training_data,validation_data)


validation_data=([X_test_essay_pad_seq2,X_test_school_state_pad_seq,X_test_project_grade_c
                              X_test_clean_subcategories_pad_seq,X_test_teacher_prefix_pad_s
```

```
training_data =([X_train_essay_pad_seq2,X_train_school_state_pad_seq,X_train_project_grade
           X_train_teacher_prefix_pad_seq,X_train_num_teacher_number_of_previously_posted_

metrics = Metrics(training_data,validation_data)


from keras.layers.merge import concatenate
from keras.layers import Dropout

# concat all embeddings
merge = concatenate([essay_feature,school_state_feature,project_grade_category_feature,pro
                     teacher_prefix_feature,numeric_dense])
dense1 = Dense(100, activation='relu', kernel_initializer='he_normal')(merge)
drop_out_layer1 = Dropout(0.5)(dense1)
dense2 = Dense(100, activation='relu', kernel_initializer='he_normal')(drop_out_layer1)
drop_out_layer2 = Dropout(0.5)(dense2)
dense3 = Dense(50, activation='relu', kernel_initializer='he_normal')(drop_out_layer2)

output =Dense(2, activation='softmax')(dense3)
model = Model(inputs=[essay_input,school_state_input,project_grade_category_input,project_
                      project_subject_subcategories_input,teacher_prefix_input,numerical_i
model.compile(optimizer=tf.keras.optimizers.Adam(lr=0.0001), loss='categorical_crossentrop
model.summary()
```

```
teacher_prefix (InputLayer)    [(None, 1)]          0           []

lstm_1 (LSTM)                  (None, 100)          160400      ['embedding_6[0][

embedding_1 (Embedding)        (None, 1, 50)        2650        ['school_state[0]

embedding_2 (Embedding)        (None, 5, 10)        110         ['project_grade_c

embedding_3 (Embedding)        (None, 5, 16)        272         ['clean_categorie

embedding_4 (Embedding)        (None, 5, 38)        1482        ['clean_subcatego

embedding_5 (Embedding)        (None, 1, 6)         42          ['teacher_prefix[

input_2 (InputLayer)           [(None, 2)]          0           []

flatten_6 (Flatten)            (None, 100)          0           ['lstm_1[0][0]']

flatten_1 (Flatten)            (None, 50)           0           ['embedding_1[0][

flatten_2 (Flatten)            (None, 50)           0           ['embedding_2[0][

flatten_3 (Flatten)            (None, 80)           0           ['embedding_3[0][

flatten_4 (Flatten)            (None, 190)          0           ['embedding_4[0][

flatten_5 (Flatten)            (None, 6)            0           ['embedding_5[0][

dense (Dense)                  (None, 10)           30          ['input_2[0][0]']

concatenate_3 (Concatenate)    (None, 486)          0           ['flatten_6[0][0]
                                                                 'flatten_1[0][0]
                                                                 'flatten_2[0][0]
```

```
                                                                 'flatten_2[0][0]',
                                                                 'flatten_3[0][0]',
                                                                 'flatten_4[0][0]',
                                                                 'flatten_5[0][0]',
                                                                 'dense[0][0]']

 dense_13 (Dense)               (None, 100)          48700       ['concatenate_3[0

 dropout_6 (Dropout)            (None, 100)          0           ['dense_13[0][0]'

 dense_14 (Dense)               (None, 100)          10100       ['dropout_6[0][0]

 dropout_7 (Dropout)            (None, 100)          0           ['dense_14[0][0]'

 dense_15 (Dense)               (None, 50)           5050        ['dropout_7[0][0]

 dense_16 (Dense)               (None, 2)            102         ['dense_15[0][0]'

==================================================================================
Total params: 7,647,938
Trainable params: 228,938
Non-trainable params: 7,419,000
__________________________________________________________________________________
/usr/local/lib/python3.7/dist-packages/keras/optimizer_v2/adam.py:105: UserWarning
  super(Adam, self).__init__(name, **kwargs)
```

```
%load_ext tensorboard

# Clear any logs from previous runs
!rm -rf ./logs/

import tensorflow as tf
import datetime

log_dir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1, wr
```

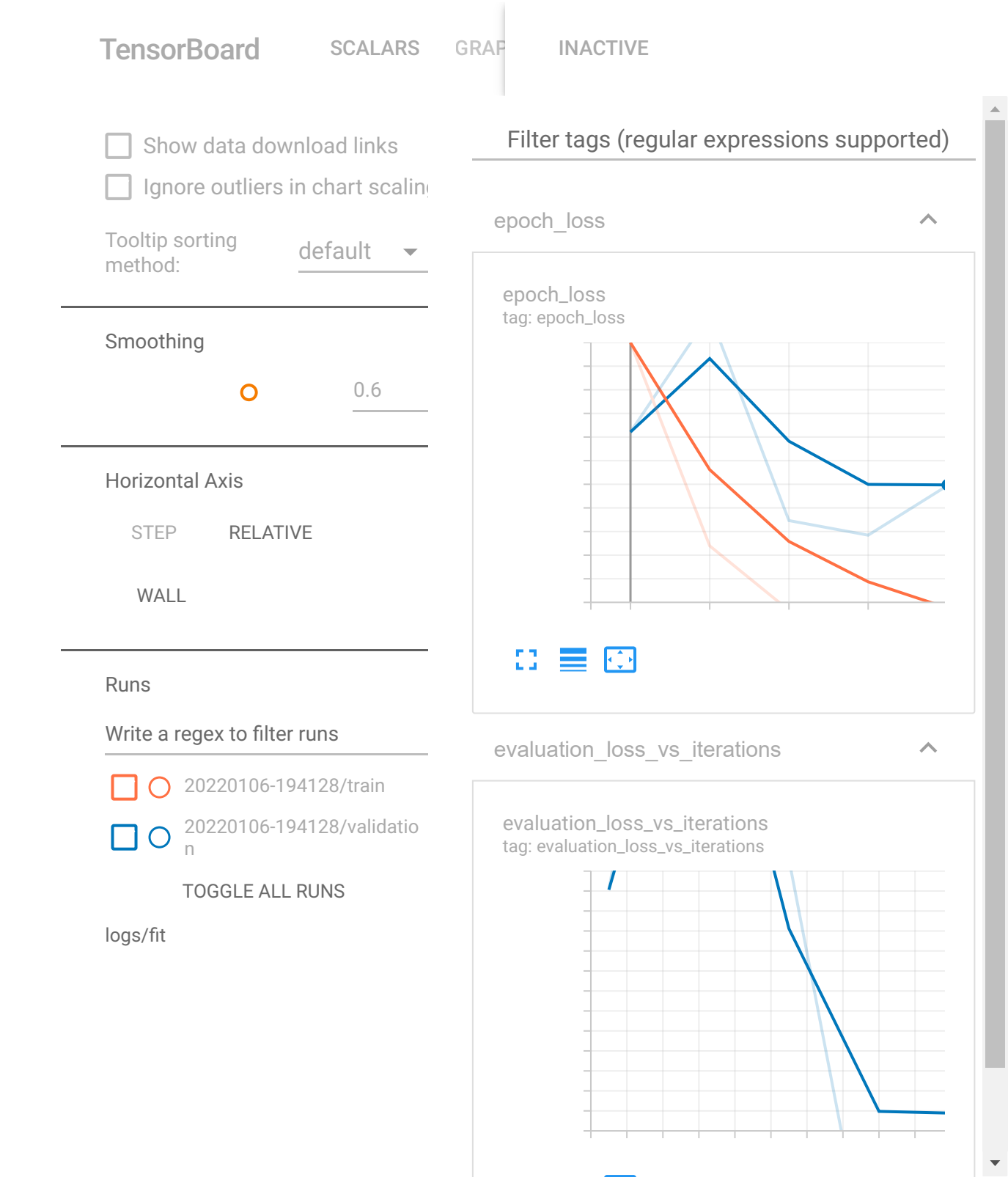
```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
WARNING:tensorflow:`write_grads` will be ignored in TensorFlow 2.0 for the `TensorBo
```

```
model.fit([X_train_essay_pad_seq,X_tr],y_tr_ohe,epochs=5,
          validation_data=([X_test_essay_pad_seq,X_te],y_test_ohe),
          callbacks=[tensorboard_callback, metrics])
```

```
Epoch 1/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4360 roc-auc_train: 0
2500/2500 [==============================] - 2383s 952ms/step - loss: 0.4360 - val_l
Epoch 2/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4274 roc-auc_train: 0
2500/2500 [==============================] - 2425s 970ms/step - loss: 0.4274 - val_l
Epoch 3/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4247 roc-auc_train: 0
2500/2500 [==============================] - 2430s 972ms/step - loss: 0.4247 - val_l
Epoch 4/5
```

```
2500/2500 [==============================] - ETA: 0s - loss: 0.4239 roc-auc_train: 0
2500/2500 [==============================] - 2444s 978ms/step - loss: 0.4239 - val_l
Epoch 5/5
2500/2500 [==============================] - ETA: 0s - loss: 0.4233 roc-auc_train: 0
2500/2500 [==============================] - 2438s 975ms/step - loss: 0.4233 - val_l
<keras.callbacks.History at 0x7fdbff5d3bd0>
```

```
tensorboard --logdir logs/fit
```



✓ 5s completed at 4:33 AM